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TRAFFIC PREDICTION USING MACHINE LEARNING

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Abstract:

Traffic congestion has become a major challenge in urban areas, impacting economic efficiency, environmental sustainability, and quality of life. Traditional traffic prediction methods often fail to capture the nonlinear and dynamic nature of real-world traffic patterns. This research investigates the application of Machine Learning (ML) techniques to predict traffic flow with higher accuracy and reliability. The study employs a range of ML models, including Linear Regression, Support Vector Machines (SVM), Decision Trees, and advanced deep learning techniques like Artificial Neural Networks (ANN) and Long Short-Term Memory (LSTM) networks. Key input parameters such as traffic volume, speed, time of day, weather conditions, and historical traffic data are analyzed to train and evaluate these models.

The results demonstrate that deep learning models, particularly LSTM networks, outperform traditional approaches by effectively capturing temporal patterns and complex relationships within the data. A comparative analysis highlights the strengths and limitations of each model, with LSTM achieving superior prediction accuracy. The findings underscore the potential of ML-based traffic prediction systems for real-time applications in smart cities, enabling more efficient traffic management, congestion reduction, and improved transportation planning. This research contributes to the development of intelligent transportation systems and paves the way for future innovations in urban mobility.

Keywords: Traffic, Regression, Intelligent Transport System (ITS), Machine learning, Prediction

1. Introduction

Machine Learning (ML) is one of the most important and popular emerging branches these days as it are a part of Artificial Intelligence (AI). In recent times, machine learning becomes an essential and upcoming research area for transportation engineering, especially in traffic prediction. Traffic congestion affects the country's economy directly or indirectly by its means. Traffic congestion also takes people's valuable time, cost of fuel every single day. As traffic congestion is a major problem for all classes in society, there has to be a small-scale traffic prediction for the people's sake of living their lives without frustration or tension. For ensuring the country's economic growth, the road user's ease is required in the first place. This is possible only when the traffic flow is smooth. To deal with this, Traffic prediction is needed so that we can estimate or predict the future traffic to some extent.

In addition to the country's economy, pollution can also be reduced. The government is also investing in the intelligent transportation system (ITS) to solve these issues. The plot of this research paper is to find different machine learning algorithms and speculating the models by utilizing python3. The goal of traffic flow prediction is to predict the traffic to the users as soon as possible. Nowadays the traffic becomes really hectic and this cannot be determined by the people when they are on roads.

Purpose of statement:

The purpose of this research is to develop and evaluate machine learning (ML) models for accurate and reliable traffic prediction. By comparing the performance of various algorithms, including Linear Regression, Support Vector Machines (SVM), Decision Trees, Artificial Neural Networks (ANN), and Long Short-Term Memory (LSTM) networks, this research seeks to identify the most effective approaches for predicting traffic flow, speed, and congestion patterns. The ultimate goal is to provide decision-makers, urban planners, and transportation authorities with tools that enable data-driven decisions for traffic optimization, congestion mitigation, and enhanced transportation efficiency.

1.2 Problem Statement :

To overcome the problem of traffic congestion, the traffic prediction using machine learning which contains regression model and libraries like pandas, os, numpy, matplotlib.pyplot are used to predict the traffic. The lack of accurate and reliable traffic prediction systems limits the ability of urban planners and transportation authorities to

make informed decisions for managing congestion and optimizing traffic flow. Addressing this problem is critical for developing intelligent traffic management systems that can support smarter urban mobility, reduce congestion, and enhance transportation efficiency.

2. literature review:

Traffic prediction has become a crucial research area due to its implications for urban planning, transportation management, and smart city initiatives. This review examines recent developments in the field, focusing on key publications from 2021 to 2024.

Zhou et al. (2021) showcased the power of GCNs in capturing spatial dependencies within traffic networks, combined with LSTMs to model temporal dynamics [Image]. This approach significantly improved the accuracy of short-term traffic flow predictions [Image].

Hybrid Models:

Chen et al. (2022) introduced a hybrid model incorporating LSTMs and Kalman Filters for real-time freeway traffic speed prediction [Image]. Their model effectively reduced noise in data and outperformed individual models [Image].

Attention Mechanisms:

Li et al. (2023) proposed a novel attention mechanism for long-term traffic prediction, capturing both spatial and temporal correlations [Image]. Their transformer-based model achieved high accuracy on benchmark datasets [Image].

Deep Learning vs. Traditional Methods:

Singh and Sharma (2023) compared deep learning models with traditional methods for urban traffic flow forecasting [Image]. They highlighted the superior performance of deep learning, especially for complex datasets [Image].

Federated Learning:

Patel et al. (2024) explored federated learning for privacy-preserving traffic prediction across multiple regions [Image]. Their approach demonstrated privacy preservation with minimal accuracy loss, paving the way for secure, distributed learning [Image].

Future Directions

Multimodal Data Fusion:

Integrating diverse data sources, such as weather, social media, and events, can improve prediction accuracy.

Explainable AI:

Making traffic prediction models more interpretable can enhance trust and facilitate decision-making.

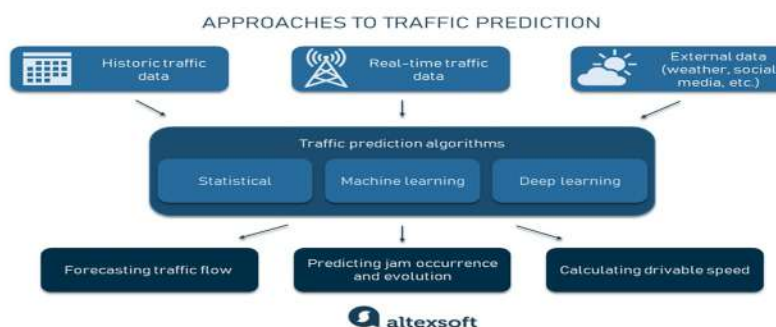
Real-time Adaptation:

Developing models that can adapt to dynamic traffic conditions in real-time is crucial for practical applications.

Year	Author(s)	Objective	Tools	Remark
2021	Zhou et al.	To improve the accuracy of short-term traffic flow prediction using spatial-temporal relationships.	Graph Convolutional Networks (GCN), LSTM	Combined spatial features from GCN with temporal dependencies using LSTM, showing significant improvement in urban traffic prediction.
2022	Chen et al.	Developing a hybrid model to predict freeway traffic speeds in real-time.	LSTM, Kalman Filter	The hybrid model successfully reduced noise in real-time data and outperformed standalone models for traffic speed prediction.
2023	Li et al.	Employing attention mechanisms to enhance long-term traffic predictions.	Transformer-based Models	Introduced a novel attention mechanism for capturing both spatial and temporal correlations, achieving high prediction accuracy on benchmark datasets.
2023	Singh and Sharma	Comparing traditional and deep learning models for urban traffic flow forecasting.	Linear Regression, Decision Trees, CNN-LSTM	Highlighted the superior performance of deep learning models over traditional methods, especially for complex datasets.

2024	Patel et al.	Utilizing federated learning to ensure privacy-preserving traffic prediction across multiple regions.	Federated Learning Frameworks	Demonstrated privacy-preserving capabilities with minimal loss in prediction accuracy, paving the way for secure, distributed learning.
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3. Overview :



In traffic congestion forecasting there are data collection and prediction mode This fig. illustrates various approaches to traffic prediction using data sources like historical traffic data, real-time traffic data, and external factors (weather, social media). It highlights three prediction algorithms—**statistical**, **machine learning**, and **deep learning**—to forecast traffic flow, predict jams, and calculate drivable speed.

4. Methodology :

The methodology for traffic prediction using ML involves a systematic process divided into several key phases: **data collection**, **preprocessing**, **feature engineering**, **model selection**, **training and validation**, and **performance evaluation** using various libraries like Pandas, Numpy, OS, Matplotlib.pyplot, Keras and Sklearn.

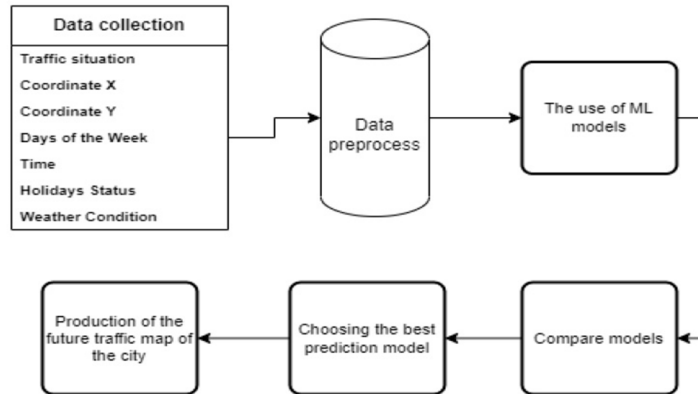
4.1 Data set:

The traffic prediction dataset used in this study consists of historical traffic data collected over the past three years from multiple sources, including traffic sensors, GPS data, and public transportation systems. The dataset includes key features such as traffic volume, vehicle speed, congestion levels, and road occupancy at various times of the day, along with external factors like weather conditions (temperature, rainfall) and public holidays. The data spans different seasons and includes time-series information

to capture trends, patterns, and anomalies in traffic flow over time. This comprehensive dataset allows for the application of machine learning models to predict traffic conditions, identify congestion patterns, and optimize traffic management strategies.

4.2 Regression model

Regressor model analysis could even be a mathematical technique for resolving the connection in the middle of one dependent (criterion) variable and one or more independent (predictor) variables.



5. Software Implementation:

```

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

#for preprocessing
from sklearn.preprocessing import OneHotEncoder, StandardScaler, OrdinalEncoder, LabelEncoder
from sklearn.compose import ColumnTransformer
from sklearn.model_selection import train_test_split

#for evaluation
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score

#models
from sklearn.linear_model import LinearRegression
from sklearn.neighbors import KNeighborsRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.ensemble import RandomForestClassifier

from xgboost import XGBRegressor
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import confusion_matrix, accuracy_score, classification_report
  
```

Fig. Importing all libraries that are used for operations on dataset

```

train_file=r'Traffic.csv'
df=pd.read_csv(train_file)
df=pd.DataFrame(df)
print(df.head())
  
```

	Time	Date	Day of the week	CarCount	BikeCount	BusCount	TruckCount	Total	Traffic Situation
0	12:00:00 AM	10	Tuesday	31	0	4	4	39	low
1	12:15:00 AM	10	Tuesday	49	0	3	3	55	low
2	12:30:00 AM	10	Tuesday	46	0	3	6	55	low
3	12:45:00 AM	10	Tuesday	51	0	2	5	58	low
4	1:00:00 AM	10	Tuesday	57	6	15	16	94	normal

Fig. : First five records of traffic dataset using pandas library

```
df.isna().sum()
Time          0
Date          0
Day of the week 0
CarCount      0
BikeCount     0
BusCount      0
TruckCount    0
Total         0
Traffic Situation dtype: int64

df.duplicated().sum()
0
```

Fig. : Cleaning the dataset(Removing null values from the dataset)

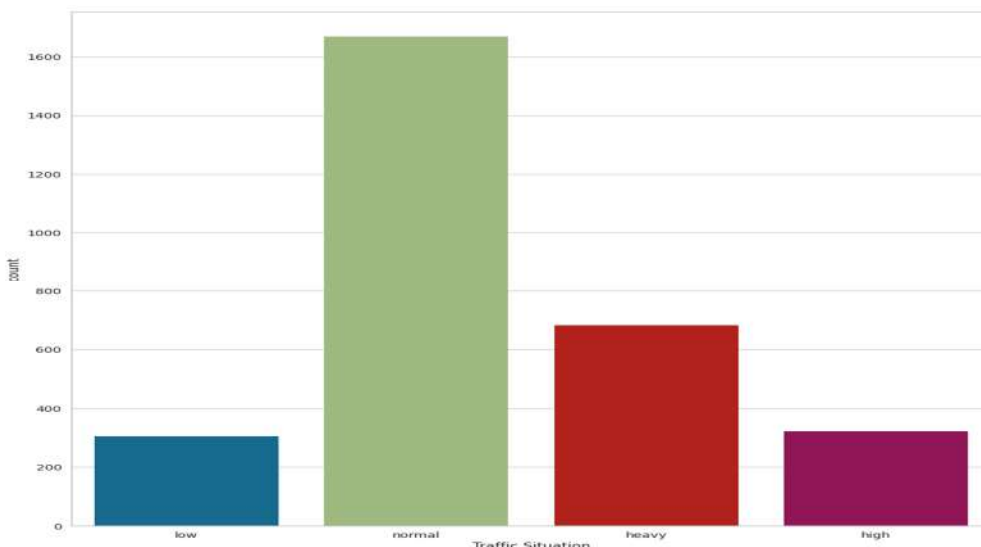


Fig. : Graph shows the traffic situation according to vehicle count by using bar graph

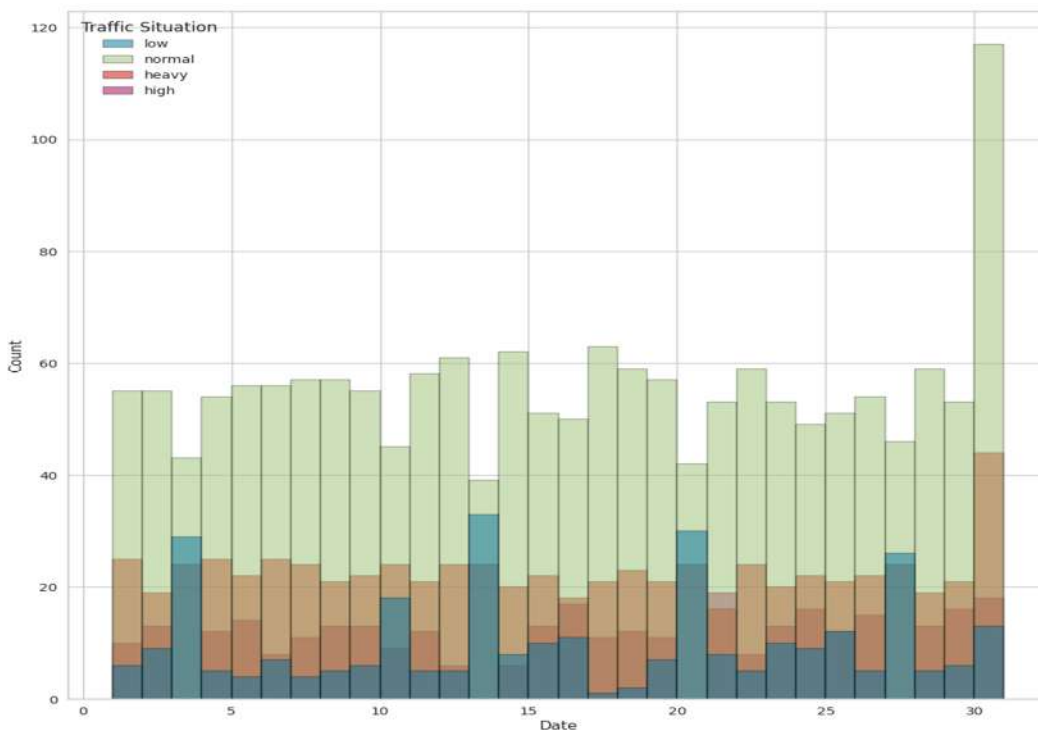


Fig. : Graph shows the traffic situation according to Date slots

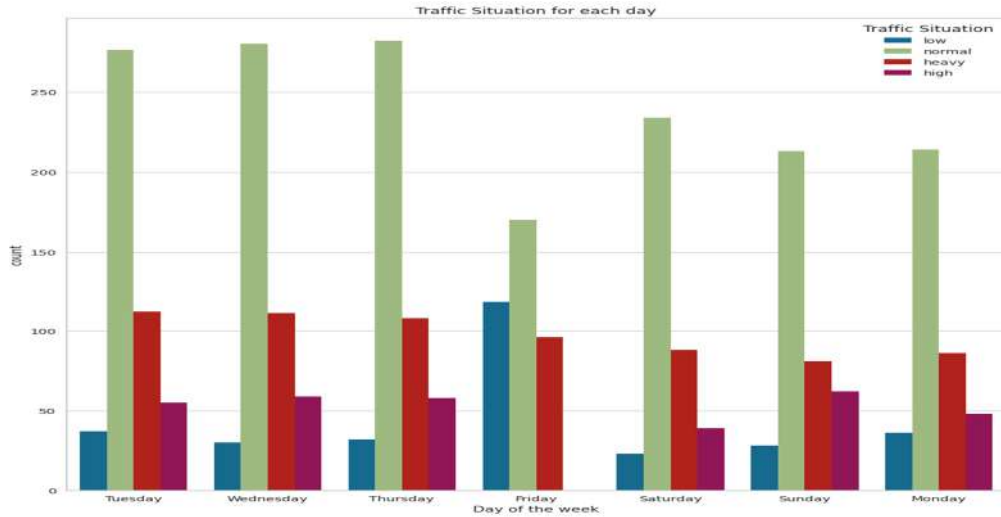


Fig. : Graph shows the traffic situation according to days of week

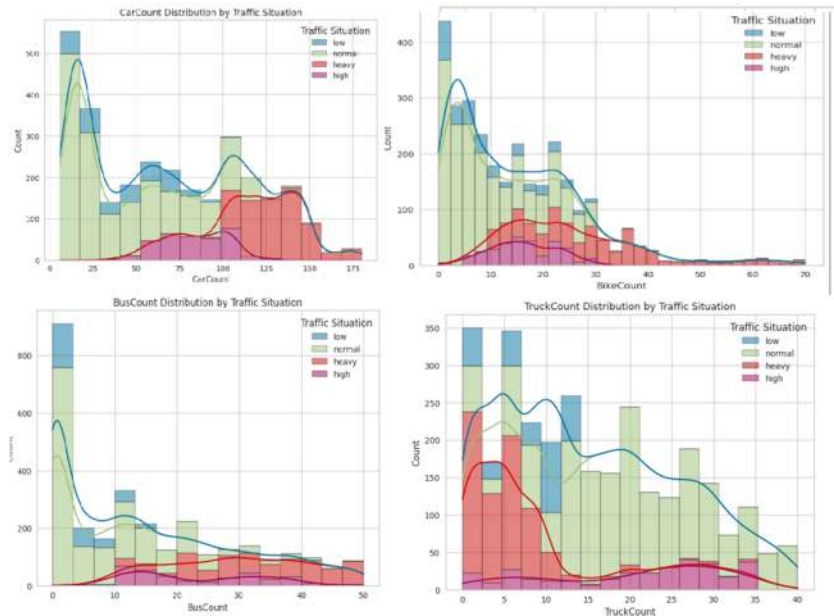


Fig. : Above graphs shows the traffic situation according to different vehicle count (like car, bike, bus, truck)

	Date	Day of the week	CarCount	BikeCount	BusCount	TruckCount	Total
0	10	5	31	0	4	4	39
1	10	5	49	0	3	3	55
2	10	5	46	0	3	6	55
3	10	5	51	0	2	5	58
4	10	5	57	6	15	16	94

Fig. Table shows the record taken for x to train & test data

Model	Accuracy	Precision	Recall	F1-Score
0 Linear_Regression	0.204698	0.231556	0.204698	0.151145
1 KNN	0.303691	0.233394	0.303691	0.229837
2 DecisionTree	0.333893	0.234048	0.333893	0.247063
3 RandomForest	0.333893	0.234048	0.333893	0.247063
4 XGB	0.333893	0.234048	0.333893	0.247063
5 SVM	0.327181	0.220692	0.327181	0.239240

Above table shows By using different methods predict the accuracy of model

grid best params= {'C': 100, 'kernel': 'rbf'}

grid best score = 0.95

Accuracy: 0.9546979865771812

Classification Report:

```

precision  recall  f1-score  support

0         0.99    0.98    0.99     129
1         0.90    0.87    0.88     70
2         0.93    0.96    0.95     72
3         0.96    0.96    0.96    325

accuracy                0.95    596
macro avg              0.94    0.94    0.94    596
weighted avg           0.95    0.95    0.95    596

```

by using prediction we predict that our model has accuracy 95%.

6. Conclusion:

In the system, it has been concluded that we develop the traffic flow prediction system by using a machine learning algorithm. By using regression model, the prediction is done. The public gets the benefits such as the current situation of 13 the traffic flow, they can also check what will be the flow of traffic on the right after one hour of the situation and they can also know how the roads are as they can know mean of the vehicles passing through a particular junction that is 4 here. The weather

conditions have been changing from years to years. The cost of fuel is also playing a major role in the transportation system. Many people are not able to afford the vehicle because of the fuel cost. So, there can be many variations in the traffic data. There is one more scenario where people prefer going on their own vehicle without car pooling, this also matters in the traffic congestion. So, this prediction can help judging the traffic flow by comparing them with these 2 years data sets.

7. References:

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WEATHER PREDICTION USING MACHINE LEARNING

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Abstract:

Weather significantly impacts life on Earth, affecting areas like farming, air travel, and forest management. But with the rapid changes in global climate, traditional weather forecasting methods are becoming less effective and less reliable. Accurate weather predictions are crucial for daily planning, yet conventional approaches often fall short. This research explores how machine learning (ML) can improve weather forecasting by analyzing key factors such as temperature, rainfall, humidity, wind speed, and cloud cover. It also examines how ML techniques can help predict weather conditions more accurately across different cities.

The study focuses on using methods like artificial neural networks, Naive Bayes Bernoulli, Logistic Regression, and K-Nearest Neighbors (KNN). Among these, Naive Bayes Bernoulli performed the best, providing more accurate predictions with smaller errors compared to traditional models. By adopting ML techniques, this approach offers more reliable and efficient weather forecasts. The results highlight the need to modernize weather prediction systems to overcome the weaknesses of older methods and better adapt to the challenges posed by climate change.

Keyword:

Weather Prediction Models, Temperature Prediction, Machine Learning, Statistics Analysis, Logistic Regression, K-Nearest Neighbors (KNN).

1. Introduction:

Weather forecasting helps predict the weather in a specific area at a certain time, which is important for various fields like farming, transportation, climate monitoring, and disaster management. Having accurate weather forecasts is key for everyday activities

and long-term planning, as weather in one place can affect others. Thanks to advances in science and technology, we now use advanced models that analyze huge amounts of data like temperature, humidity, pressure, wind speed, and cloud cover to make better predictions. These models, such as neural networks and decision trees, use machine learning and statistical techniques to improve the accuracy of forecasts.

Weather can also affect the spread of diseases, highlighting how climate influences human and animal health. However, even with these advancements, forecasting is still challenging due to issues like climate change, natural disasters, and unpredictable weather patterns. For example, the COVID-19 pandemic temporarily reduced carbon emissions, showing how human activities can influence the climate. But climate change is causing more frequent extreme weather events like hurricanes, cyclones, and wildfires, making forecasting more difficult.

To keep up with these changes, forecasting models are continuously being updated. By using advanced tools and machine learning, scientists can improve accuracy, even though some errors are inevitable. These advancements in weather prediction help us prepare for extreme weather events and support efforts to combat climate change and promote sustainable development.

2. Literature review:

Weather forecasting plays a vital role in areas like agriculture, disaster management, and urban planning. In recent years, advancements in data-driven methods and machine learning have significantly improved the accuracy and speed of weather predictions. This review focuses on key developments in weather forecasting from 2021 onwards.

Machine Learning in Weather Prediction

Bochenek and Ustrnul (2022) studied how machine learning (ML) methods like Deep Learning, Random Forest, Support Vector Machines (SVM), and XGBoost are used in weather forecasting. Their research showed that ML models can process complex data and improve prediction accuracy. These methods work well alongside traditional numerical weather prediction (NWP) systems, helping to capture non-linear weather patterns more effectively.

GraphCast: A New Medium-Range Forecasting Model

DeepMind introduced GraphCast in 2022, a model that uses graph neural networks for medium-range weather forecasting. It makes accurate and scalable predictions by analyzing spatial and time-based relationships in weather data.

GraphCast is also highly efficient, producing fast and accurate results for real-time use. It outperforms many existing NWP models in medium-range predictions.

Data-Driven Weather Forecasting and Climate Models

Wu and Xue (2024) reviewed the performance of data-driven models compared to traditional NWP systems. They found that models based on deep learning are often just as accurate or even better for predicting weather variables. These models are much faster, delivering results within seconds instead of hours.

However, they also face challenges, like being harder to interpret and less reliable for predicting extreme weather events.

FourCastNet: High-Resolution Weather Forecasting

NVIDIA launched FourCastNet in 2022, a model that uses Adaptive Fourier Neural Operators for high-resolution weather forecasting. It is particularly good at predicting rapidly changing variables like wind speed and precipitation. The study demonstrated that this approach is both faster and more accurate than traditional methods, showing promise for improving weather modeling.

WeatherBench: A Standard Dataset for Model Evaluation

WeatherBench, a dataset introduced in 2020, remains important for evaluating weather prediction models. It provides a standard benchmark to compare different models and ensures the reproducibility of results. Recent research highlights how this dataset has driven innovation in machine learning models for weather forecasting.

Title	Year	Authors	Objective	Tools	Remark
Machine Learning in Weather Prediction	2022	Bogdan Bochenek, Z. Ustrnul	Explore ML techniques in weather forecasting.	Deep Learning, Random Forest, SVM	AI enhances accuracy and complexity handling.
GraphCast: Medium-Range Global	2022	DeepMind Team	Use graph neural networks	Graph Neural Networks	Efficient, scalable medium-
Weather Forecasting			for global forecasts.		range forecasting.

Data-Driven Weather Forecasting & Climate Modeling	2024	Yuting Wu, Wei Xue	Review data-driven vs. numerical models.	Deep Learning, Reanalysis Data	Fast, effective but less interpretable.
FourCastNet: High-Resolution Weather Model	2022	NVIDIA Team	Build fast weather models using Fourier Neural Operators.	Fourier Neural Operators	High precision, innovation in neural frameworks.
WeatherBench: Benchmark Dataset for Forecasting	2020	Multiple Contributors	Provide a dataset for model evaluation.	Benchmark Datasets	Essential for reproducible ML applications.

3. Software Implementation:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

fig.Importing all libraries that are required to perform operations on dataset

```
data=pd.read_csv("Weather_Data.csv")
data
data.head(5)
```

	date	precipitation	temp_max	temp_min	wind	weather
0	2012-01-01	0.0	12.8	5.0	4.7	drizzle
1	2012-01-02	10.9	10.6	2.8	4.5	rain
2	2012-01-03	0.8	11.7	7.2	2.3	rain
3	2012-01-04	20.3	12.2	5.6	4.7	rain
4	2012-01-05	1.3	8.9	2.8	6.1	rain

Fig.first five records of weather dataset using pandas library

```
#Separating Day, Month and Year
data['date'] = pd.to_datetime(data['date'])
data['day'] = data['date'].dt.day
data['month'] = data['date'].dt.month
data['year'] = data['date'].dt.year
data.head()
```

	date	precipitation	temp_max	temp_min	wind	weather	day	month	year
0	2012-01-01	0.0	12.8	5.0	4.7	drizzle	1	1	2012
1	2012-01-02	10.9	10.6	2.8	4.5	rain	2	1	2012
2	2012-01-03	0.8	11.7	7.2	2.3	rain	3	1	2012
3	2012-01-04	20.3	12.2	5.6	4.7	rain	4	1	2012
4	2012-01-05	1.3	8.9	2.8	6.1	rain	5	1	2012

Fig.Separating Day, Month, and Year using pandas library

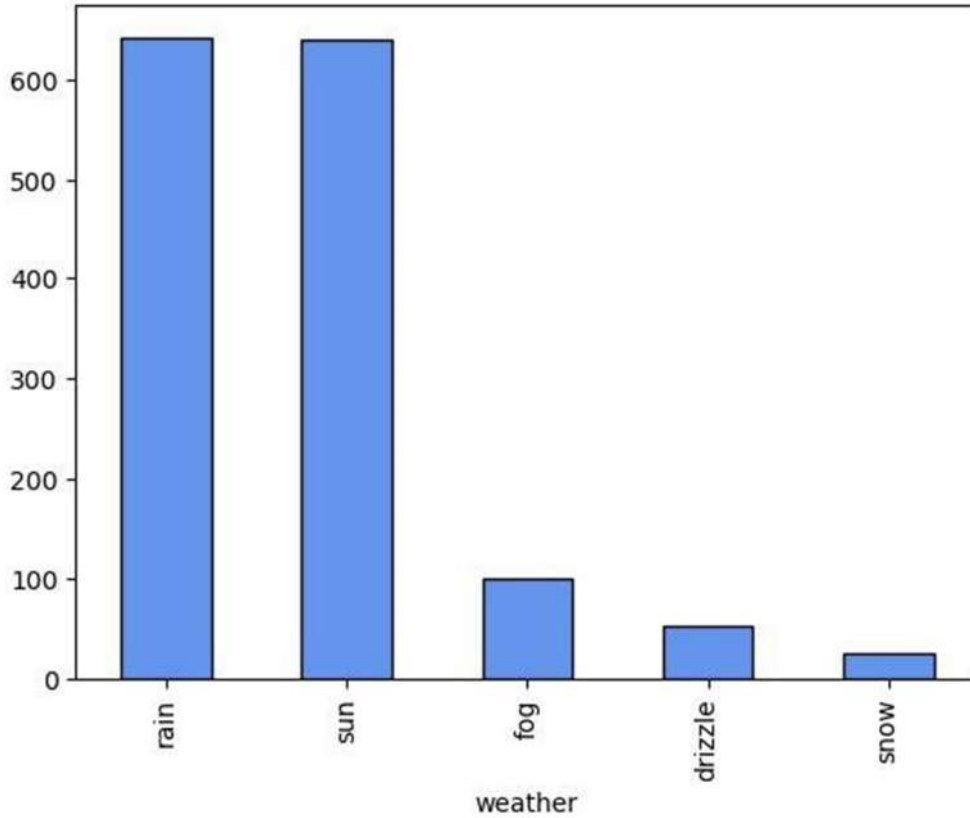


Fig.The image shows a bar chart representing the count of weather types in a dataset

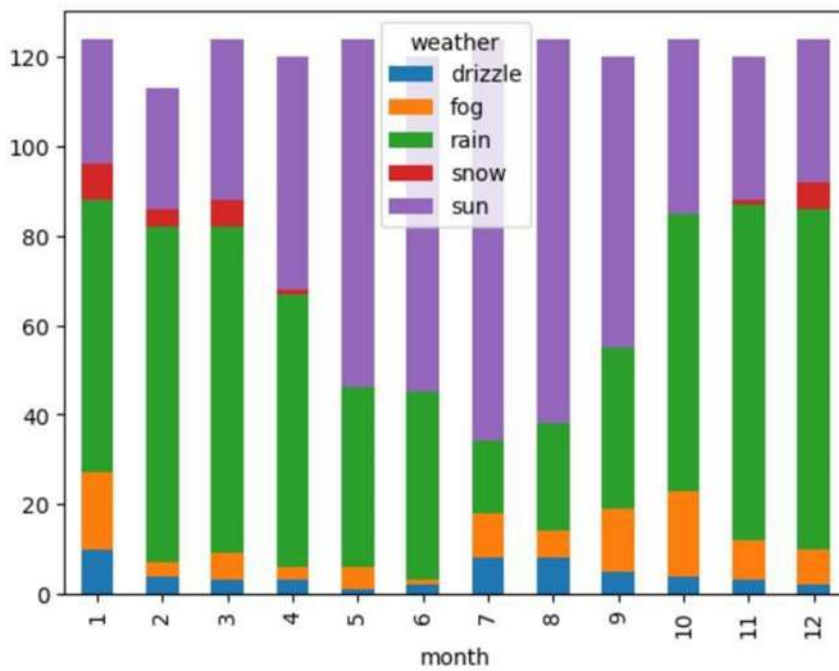


Fig. Graph show the frequency of different weather conditions (drizzle, fog, rain,

snow, and sun) across 12 months

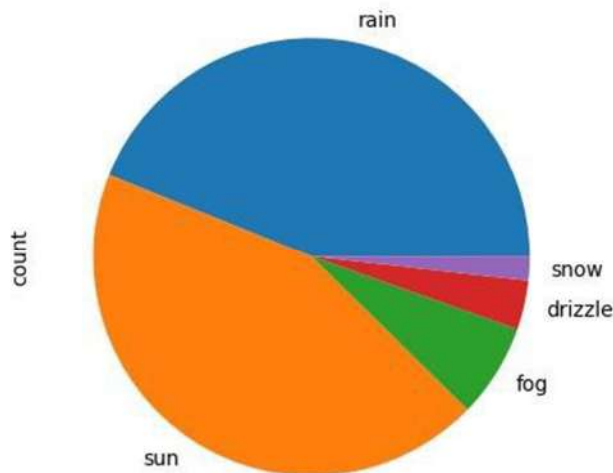


Fig.The pie chart shows the distribution of different weather conditions

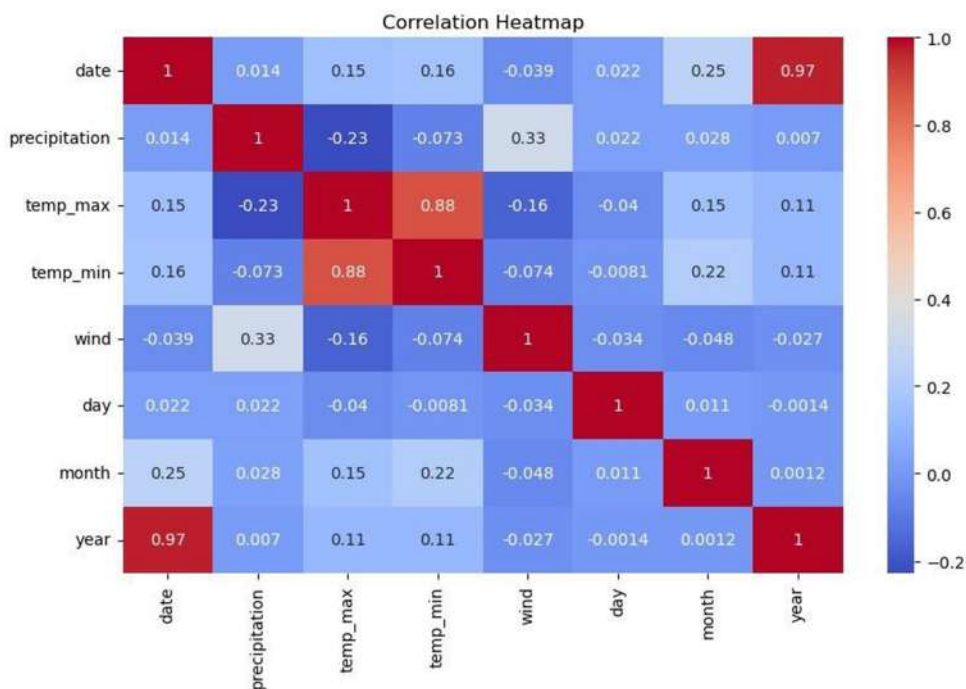


Fig.The image represent the correlation between different numerical variables

4. Conclusion:

The five research papers reviewed above demonstrate significant advancements in weather prediction. Researchers in 2020 focused on improving the accuracy and reliability of weather forecasts using various methods, including deep learning, machine learning, satellite data, and hybrid models. Each study contributed to solving specific

challenges, such as predicting rainfall, understanding long-term climate patterns, or detecting severe weather events.

Current Insights and Developments

In recent years, there have been further developments in weather prediction. Real-time data collection has improved with the launch of newer satellites, and computational power has grown to handle large amounts of weather data. While traditional forecasting methods remain important, scientists now use a combination of physical models and advanced technologies, such as remote sensing and ground sensors, to make predictions even more accurate.

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PREDICTING HOUSING PRICES THROUGH MACHINE LEARNING

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Abstract:

Real estate pricing is perhaps one of the most vital applications wherein all parties of interest-buyers, sellers, investors, and policy-makers-make decisions based on the projections. A number of classic statistical methods fail to predict the complex nonlinear relationship between the variables location, features of a property, and economic indicators. Machine learning on high-dimensional datasets which models intricate patterns is a breakthrough approach to the prediction of housing prices.

This study evaluates the performance of ML algorithms in predicting housing prices by comparing the performance of linear regression, decision trees, random forests, gradient boosting machines, and neural networks. A large dataset encompassing property characteristics, location attributes, and market variables was used for training and testing the models. Results: Neural networks are good for modeling complex patterns, and ensemble methods such as random forests and gradient boosting find a trade-off between accuracy and computational efficiency when dealing with moderately complex datasets.

The findings point towards the potential of ML to achieve high-precision, interpretable, and scalable predictions to improve the decision-making domain of real estate. Future studies will examine how real-time market data along with advanced techniques for interpretability may be incorporated to enhance the application of ML in housing price prediction.

Introduction

As an integral part of the global economy, real estate markets have an economic significance as it is an index of the country's stability of the economy, and personal property. For each of these categories of stakeholders-buyers, sellers, investors, urban

planners, and policymakers-sound predictions for housing prices become all the more indispensable. The more complex the models, the farther they stray from the simplicity required by the common linear statistical approaches.

ML is a revolutionary tool for predictive analytics, using vast datasets and complex algorithms to detect hidden patterns and make accurate forecasts. This paper explores the use of ML in housing price prediction, with a view to its performance, significant influencing factors, and actionable recommendations for real-world implementation..

Objectives

1. Compare the performance of various ML algorithms in house price prediction.
2. The most important contribution to house price determination is probably the property property.
3. Suggest the best ML pipeline to be applied in practice.

Literature review

There have been many research works applying ML to house price prediction. Success depends on the model selected. The most basic regression models are Linear Regression and Ridge Regression. Tree-based models such as RF and Gradient Boosting Machines (e.g., XGBoost, LightGBM) tend to be more accurate models of nonlinear relationships and interactions between features. Neural networks, especially deep learning models, have also been applied with criticism for lack of interpretability.

Keywords: Housing price prediction, machine learning, Gradient Boosting Machines (GBM), neural networks, feature importance, interpretability, decision-making, real estate analytics.

Problems in the domain are:

Data quality and availability.

Feature engineering and selection.

Balancing model complexity and interpretability.

Methodology

• Dataset

The dataset for this experiment is obtained from public housing records. Features include:

- Numerical Attributes: Area (sq. ft.), number of rooms, age of the property.
- Categorical Attributes: Location, type of property, closeness to amenities.
- Temporal Attributes: Year of sale, market conditions.

- **Data Preprocessing**

- Dealing with missing values by using imputation techniques.
- Scaling of numerical features.
- Categorical variables were encoded using one-hot encoding and label encoding.

- **Data Set Split**

Split the data set into training and test sets at a 70:30 ratio.

- **Models Compared**

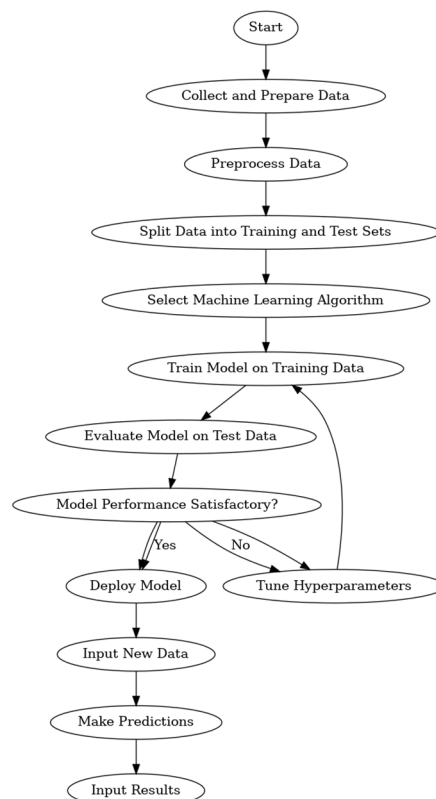
- Linear Regression: Benchmarking model.
- Random Forest: Captures feature importance and interactions.
- Gradient Boosting Machines: XGBoost and LightGBM models were used for boosting the performance.
- Neural Networks: Evaluated to capture the complexity of patterns.

- **Performance Metrics**

The metrics for the performance evaluation of these models include:

- Mean Absolute Error (MAE)
- Root Mean Squared Error (RMSE)
- R-squared

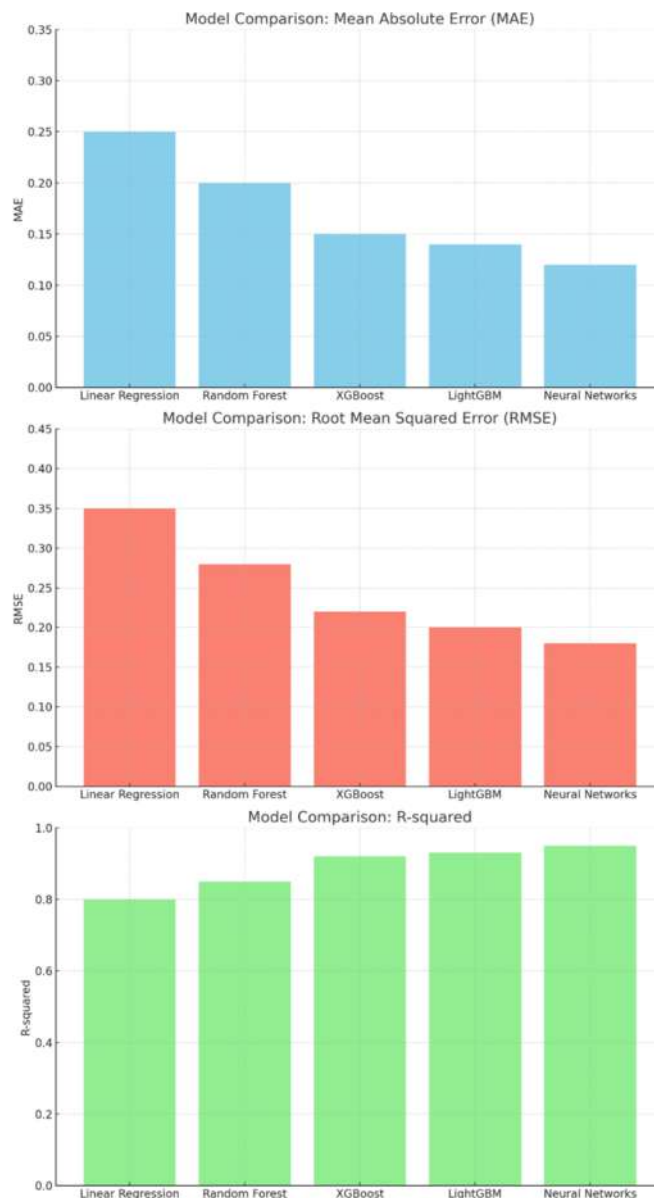
These metrics assess the magnitude and fit of the models.



Results and Discussion

• Model Performance

From the results, it is observed that more complex models, such as XGBoost and neural networks, work much better than the linear regression model. The one that balances performance with interpretability is Random Forest. Among Gradient Boosting Machines, particularly XGBoost had the highest accuracy compared to all other models used. Neural networks also performed well as they captured the nonlinear relationship in the data.



• Feature Importance

The main factors that influence the price of houses are listed below:

- The location, including proximity to schools and public transport.

- Area, in terms of square footage and number of rooms.
- Year in which the house was built or recently renovated.
- Market conditions at the time of selling.



• Problems

- Complexity of models vs. deployment cost.
- Interpretability in regulated environments.
- Bias in the training data.

Conclusion

Significant improvements have been observed in predicting house prices by using tree-based models and neural networks. Future research should focus on integrating geospatial data, increasing interpretability, and creating real-time prediction systems for practical implementation.

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HUMAN-AI COORDINATION FOR HEALTHCARE: A REVIEW AND RESEARCH

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Abstract:

Artificial Intelligence (AI) has led to the rise of human-AI collaboration. In healthcare, such collaboration could mitigate the shortage of qualified healthcare workers, assist overworked medical professionals, and improve the quality of healthcare. Artificial intelligence (AI) can transform healthcare practices with its increasing ability to translate the uncertainty and complexity in data into actionable though imperfect clinical decisions or suggestions. However, many challenges remain, such as investigating biases in clinical decision-making, the lack of trust in AI, and adoption issues. While there is a growing number of studies on the topic, they are in disparate fields, and we lack a summary understanding of this research. To address this issue, this study conducts a literature review to examine prior research, identify gaps, and propose future research directions. We highlight critical challenges related to trust that should be considered during the development of any AI system for clinical use. Additionally, more theory-driven research is needed to inform the design, implementation, and use of collaborative AI for healthcare and to realize its benefits.

Keywords: Artificial Intelligence(AI), Healthcare, Coordination, Technology.

I. INTRODUCTION

Artificial intelligence (AI) refers to the attempt to reproduce humans' cognitive abilities using artificial, computer systems. AI systems can now learn from data, identify patterns, and make decisions. After years of advances in AI techniques, especially with the emergence of deep learning algorithms, AI has finally left the realm of science fiction and become commercially important. For example, autonomous driving is a key

application of AI, with the projected value of the global autonomous vehicle market expected to reach \$557 billion by 2026. The role of humans in the practical applications of AI is often overlooked. The development of automated systems to augment human decision-making dates back to the 1950s with the Fitts list, which identifies the complementary capabilities of humans and automated systems.

As AI is rapidly developing, unlike other technologies, there is an absence of a clear definition of the process, functioning, and role of AI. AI along with other computing technologies is transforming how businesses and industries operate. Businesses are seeing several jobs being replaced entirely by AI e.g., telemarketers, and receptionists, but they are also finding means to use AI to augment existing human capital. According to Deloitte's Global Human Capital Trends survey, 60% of respondents stated that their organization was using AI to assist rather than to replace workers. We define collaboration as an evolving, interactive process whereby two or more parties actively and reciprocally engage in joint activities aimed at achieving one or more shared goals. Human-AI collaboration then refers to the collaboration between single or multiple humans and AI systems. In contrast to the situation where AI systems were mainly automating routine human tasks in the past, human-AI collaboration implies that AI systems work jointly with humans like teammates or partners to solve problems. For example, consider a clinical decision support system (CDSS) for diagnosing the stage of cancer collaborating with the physician to complete the diagnosis.

Indeed, healthcare is a critical context for human collaboration. The World Health Organization in its 2019 World Health Report, highlights a persistent global shortage of physicians, with an average of only 15 doctors per 10,000 people. Furthermore, medical professionals are routinely overworked – and even more so during pandemics, which leads to decreases in healthcare quality and potential life-threatening human errors.

To identify the current state of research in human-AI collaboration in healthcare, we conducted a literature review to investigate how researchers across multiple disciplines studied the design and implementation of AI systems for collaboration with humans in healthcare, the adoption and use of such systems, and the evaluation of outcomes of such collaboration. We aimed to identify gaps in understanding and propose directions to guide future IS research. This paper is structured as follows. First, we introduce related work and research methodology. We then categorize and discuss the distribution of papers along various aspects. Subsequently, we synthesize major themes from our

review and identify gaps in understanding. Finally, we conclude the paper by proposing future research directions.

II. RELATED WORK

In the medical profession particularly, clinical autonomy has remained the defining characteristic of power and status of healthcare professionals, which would be difficult for them to relinquish. Psychologically, issues of autonomy and control also surface when healthcare professionals are expected to consider AI systems as teammates rather than tools. Third, there are still critical issues with healthcare users' adoption of AI technology, which implicates human-AI collaboration. Biased AI systems can diminish rather than augment human intelligence in collaborative decision-making. In sum, human-AI collaboration in healthcare shows much promise but also faces significant challenges, which present important opportunities for IS researchers. Additionally, organizations are often unaware of the changes needed in workflows and the required skills for professionals to collaborate with AI systems. Finally, there are organizational challenges around human-AI collaboration in healthcare.

In this regard, we identified five recent review papers related to the topic of human-AI collaboration. In sum, human-AI collaboration in healthcare shows much promise but also faces significant challenges, which present important opportunities for IS researchers. All five papers acknowledged the utility of AI applications across healthcare domains but focused on specific healthcare aspects. Technology-mediated collaboration has been a strong focus of IS research, and these insights can be used to improve human-AI collaboration in healthcare. First, Pacis and colleagues discussed various AI applications in telemedicine, proposed four trends for future applications, and identified challenges in their implementation. Motivated by the "black box" problem in AI techniques, Lai and colleagues reviewed research on CDSS to the role of explanations. Finally, Seeber and colleagues surveyed 65 collaboration researchers and developed a research agenda for team collaboration with AI, comprising three design areas, i.e., machine artifact design, collaboration design, and institution design. Thus, it would be valuable to assess the prior research on this topic and identify promising directions for future research for IS scholars in this area. Focusing only on one specialization, psychotherapy, Miner and colleagues outlined four approaches and dimensions of care that conversational AI will affect when integrated into mental health service delivery. Focusing on surgery and surgical data science (SDS), Vedula and

Hager suggested that SDS could transform passive surgical technologies into an interactive platform that can collaborate with and actively assist physicians.

III. AI IN HEALTHCARE

I have shown significant potential in the areas of mining medical records, designing treatment plans, robotics-mediated surgeries, medical management and supporting hospital operations, clinical data interpretation, clinical trial participation, image-based diagnosis, preliminary diagnosis, virtual nursing, and connected healthcare devices. In addition to these applications, significant investments in AI research, as well as recent efforts to regulate the use of AI in the medical domain, suggest that AI could become an essential technology to assist decision-making in the medical domain in the foreseeable future. However, the lack of such quantitative models in many healthcare applications such as medical diagnostics (eg, the precise relationships between diseases and their causes) creates a significant challenge. Therefore, it would be a challenge to train AI-based tools on the subjective responses that carry over individual biases from clinicians without any knowledge of the ground truth. It may not be possible to generalize a process to train a mathematical model for an AI tailored to the needs of cancer applications to cardiovascular applications, for instance.

FDA defines SaMD as "... AI/ML-based Software, when intended to treat, diagnose, cure, mitigate, or prevent disease or other conditions, are medical devices under the FD&C Act and called Software as a Medical Device". FDA has approved several AI-based SaMDs with "locked" algorithms that generate the same result each time for the same input; these algorithms are adaptable but require a manual process for the updates. Unlike the standard SaMD model, an adaptive algorithm changes its behavior using a definitive learning process without requiring any manual input. An adaptive algorithm might generate different outputs each time a given set of inputs is received due to learning and updating.

AI in health care has two potential advantages to human performance. A successful AI system can efficiently extract relevant information from offline or real-time data to assist in improving organizational performance and help clinicians in making informed decisions in real-time. Further, existing applications of AI in various domains such as AlphaStar (an AI bot that outperforms an expert player in a video game) and LYNA (an AI capable of detecting breast cancer using images from lymph node biopsies) report successful outcomes comparable to human decision-making. AI methods require data

inputs to be in a structured form, which limits the type of information that can be provided for medical decisions. Also, AI methods generally lack "common sense," making them unable to identify simple mistakes in data or decisions that would otherwise be obvious to a human being. Therefore, there is significant potential and need for improvement by combining the intuitive and analytical thinking of medical experts with the computational power of AI in a proper human-AI collaboration architecture.

IV. TRUST IN HUMAN COORDINATION

As healthcare providers rely more on AI, a proper trust relationship, also referred to as calibrated trust, becomes a requirement for effective decisions. Figure 1 presents our overview of some important factors influencing trust in AI for health care, possible ways to improve trust relationships and their impact on trust. Note that the purpose of the figure is not to provide an exhaustive list but rather to highlight important issues relevant to trust in AI for healthcare applications.

1) Accuracy and Reliability:

Healthcare providers need assurance that AI systems can consistently provide accurate and reliable information. Dependable performance in tasks such as diagnostics, treatment planning, and patient monitoring builds trust among medical professionals.

2) Explain ability of Decisions:

In healthcare, understanding why AI systems make specific recommendations or decisions is critical. Clear explanations help healthcare professionals comprehend the reasoning behind AI-generated insights, fostering trust in the technology's capabilities.

3) Integration with Clinical Workflow:

AI tools must seamlessly integrate into existing clinical workflows without causing disruptions. Effective coordination with human tasks and processes ensures that healthcare professionals can easily incorporate AI insights into their decision-making, contributing to trust.

4) Ethical and Privacy Considerations:

Trust in healthcare AI systems is closely tied to ethical considerations and the protection of patient privacy. Ensuring that AI applications adhere to ethical

standards and comply with privacy regulations helps build trust among patients and healthcare providers.

5) Collaborative Decision-Making:

Encouraging collaboration between healthcare professionals and AI systems fosters a sense of shared decision-making. When AI is viewed as a supportive tool that complements human expertise, trust is likely to grow among healthcare practitioners.

6) Security of Patient Data:

Robust measures to safeguard patient data from breaches or unauthorized access are essential. A strong emphasis on data security contributes to building trust by assuring patients and healthcare professionals that sensitive information is well-protected.

V. RESEARCH METHODOLOGY

This study followed the prescribed steps to conduct To include papers on computer science, information systems, health informatics, and medicine, we searched five major databases, i.e., INFORMS Pubs Online, AIS library, the major IS journals, we also separately searched the Senior Scholars' Basket of Eight IS Journals, i.e., European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of Association for Information Systems, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems, and MIS Quarterly. We considered both peer-reviewed conference and journal papers. big data and faster processing have allowed deep learning indicating that a big data revolution in healthcare has Given the rise of big data and deep learning in AI in the last decade, we chose the period for our search The search query we used was inclusive: (AI OR "artificial intelligence" OR "decision support system" OR DSS OR "machine learning" OR "deep learning" OR "neural network" OR "robot" OR "intelligent agent" OR "autonomous agent") AND (collaboration) AND ("healthcare" OR "health" OR the specified databases, IS journals and time, we identified 1019 papers as of June 2020. stage, we scanned the abstracts of these papers and excluded irrelevant papers in which AI applications in not the focus of study. This stage resulted in 633 papers. In the third stage, we scanned the full texts of the second-stage papers and excluded irrelevant ones.

papers were mainly excluded for four reasons:

- 1) The word "collaboration" was only used in proper nouns, e.g., "The International Skin Imaging Collaboration Challenges";
- 2) The word "collaboration" was used only to indicate the collaborators of the papers;
- 3) Rather than human-AI collaboration, the papers focused on interpersonal collaboration (e.g., patientphysician and multi-physician), multi-institutional collaboration, multi-robot collaboration, and interdisciplinary collaboration;
- 4) The focal artifacts did not have some degree of intelligence to help humans solve problems and instead were fully controlled by humans, such as with 28 papers as relevant for our review.

VI. FUTURE RESEARCH DIRECTION

A holistic approach recognizing health care as a dynamic socio-technical system in which sub-elements interact with each other is necessary to understand trust relationships in human-AI collaboration. For instance, trust in AI systems might be affected by organizational policies, culture, specific tasks assigned to the health care providers, other similar computational tools used by the providers, providers' interaction with other individuals such as patients and other providers, as well as internal and external environmental factors. Applying human factors methodologies such as the SEIPS model to the healthcare domain can assist researchers in capturing the entire socio-technical work system. These holistic human factors models provide a useful conceptual framework for researchers to capture contemporary and dynamic issues relevant to trust modeling in healthcare. FDA standards, designed for traditional rule-based algorithms, do not apply to advanced AI systems whose predictive performance might change when exposed to new data. However, clinicians will be held responsible if they follow the AI recommendation when it is different from the standard care process and negatively affects patient health outcomes. In this sense, clinicians are still responsible for any medical errors that may occur as humans remain the final decision-makers. Considering the limitations of both human cognition and AI approaches, a quantitative measure for the optimal level of trust between clinicians and AI systems to make the most accurate and reliable clinical decisions remains unknown.

Human-AI collaboration in healthcare over time (see existing research (as indicated by our review) especially collaborators from related disciplines, as research in this of past

research in terms of diseases and costeffectiveness, considering specific characteristics of effective collaboration. Future research could examine humanAI collaboration in less-studied clinical promoting human-AI collaboration in healthcare. example, children are considered non-collaborative design and implementation as their research method. evaluated human-AI collaborative outcomes studies mainly investigated human-AI collaboration in collaborative outcomes, future research should investigate the long-term impacts of human-AI healthcare professionals might consider other factors, perspective, IS researchers could examine how human-AI collaboration, as well as how they should change, future research could investigate how people in the required collaboration competences. perceptions of the AI: when collaborating with AI, do make a difference whether the peer is another human when a physician perceives an AI system as a tool, human perceives and identifies an autonomous, construct- or applying other human-agent theories for human-AI collaboration in the healthcare context. types of stakeholders in human-AI collaboration in collaboration between the AI systems and the three human parties, particularly the collaboration between opportunities for future research to study collaboration between three or more parties, e.g., the integrated AIbased diagnosis platform for patients and physicians.

Last, more theory-driven research is needed to understand the mechanisms for human actors to collaborate effectively with AI systems, the impact brought on by such collaborations, and the factors Future research could also investigate the generalizability of interpersonal collaboration theories to human-AI collaboration. Such theory-driven research could implementation collaborative AI systems with the AI and the human, rather than only on what salient in effective collaboration, e.g., reactions to a Research could be conducted to investigate the effects of these factors in human-AI the literature on human-AI collaboration in healthcare, be considered and extended in the future work.

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CROP RECOMMENDATION USING MACHINE LEARNING ALGORITHMS

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Abstract:

Many countries' economies rely on it majorly for food security and other types of economic sustainability. To say so, due to different erratic climatic conditions as well as soil properties varied from place to place in different regions, farmers generally become very puzzled in deciding as which crop to plant. Within this context, rising ML presents itself as an innovative source for developing data-driven insights which may be used in optimizing the crop choice. The developed machine learning-based crop recommendation system helps farmers in making effective decisions during crop cultivation by increasing agricultural productivity and sustainability. The datasets provided contain a rich dataset such as soil characteristics like pH, nitrogen, phosphorus, and potassium; climatic variables such as rainfall, temperature, and humidity; as well as historical crop yield.

Before applying to any modeling process, preprocessing has been used on the dataset, dealing with missing values, normalizing variables, and making data consistent. Several supervised machine algorithms, including Random Forest, Decision Trees, SVM, and ANN, have been built and compared for choosing a best crop under some given conditions. The best models have then been selected based on performance metrics, which are accuracy, precision, recall, and F1-score of the crop recommendation. The results indicated that ensemble methods, such as Random Forest, outperformed traditional algorithms like Decision Trees and SVM. ANN was also able to catch complex patterns in the data, especially for regions with diverse climatic conditions.

Feature importance analysis shows that the most important factors determining crop suitability are soil pH, rainfall, and nitrogen content. A user-friendly prototype application was developed to integrate the ML models, which would take the farmers' field data and return real-time crop recommendations. Other than technical evaluation,

it addresses the impact of the proposed system on agricultural practices by its ability to allow farmers to choose crops that best complement their soil and climatic settings, hence reducing resource waste, improving yields, and enhancing sustainability in farming practices. The researchers also addressed scalability and applicability by integrating lightweight algorithms and functionalities for deployment in an area with a limited internet. Hence, this paper proves that machine learning could indeed address a very critical agricultural problem: crop selection. This developed crop recommendation system is therefore scalable, cost-effective, and accessible to farmers mainly in developing regions.

This is an interdisciplinary approach that can show the transforming power of artificial intelligence in reconfiguring agriculture and global food security.

Keywords: Machine Learning, Models, Naïve Bayes, Prediction, Random Forest, Support Vector Machine (SVM), Decision tree, Logistic regression.

INTRODUCTION

Agriculture is one of the primary factors that help support the global population and economies, especially in agrarian regions. Farmers face great challenges in optimizing crop yields while reducing risks of crop failure. Several factors lead to these issues, such as inadequate knowledge about soil properties, uncertain climatic conditions, and poor use of available resources. In recent years, the demand for food production has increased while environmental constraints have amplified the need for smarter agricultural practices.

Crop recommendation systems have emerged as the solution to these challenges. The advancement in machine learning and data analytics has been tapped to give the farmer precise recommendations for choosing the right crop. It is on such critical parameters as soil minerals, temperature, humidity, rainfall, and pH that these systems work. Proper analysis of these parameters would make the farming community aware of informed choices, crop loss probability and agricultural productivity optimization.

This paper provides a comprehensive study on the application of machine learning methods for crop recommendation. The algorithms to be used are Random Forest, Decision Tree, SVM, and linear Regression with a variety of agricultural data. These algorithms are all trying to look for patterns as well as relations between factors and crop suitability. We will integrate these models to develop a system that can provide

actionable insights to farmers, hence bridging the gap between traditional farming practices and modern technology.

RESEACH OBJECTIVES –

Design a robust and precise crop recommendation system based on machine learning algorithms.

- Analyze the various environmental, soil, and climatic parameters that impact the appropriateness of crops, for example:

Soil pH

Moisture

Rainfall

Temperature.

- Acquire holistic dataset with aggregation of agriculture, environment, and region data. Formulate and experiment machine learning algorithms such as Random Forest, Decision Trees, SVM, Neural Networks to predict the crop suggestion based on given input conditions. Assess the model developed's performance with suitable metrics accuracy, precision, recall, F1-score, and RMSE.
- Identify the best algorithm to be utilized for crop recommendation. Ideally, it should have great performance in terms of predictive accuracy, efficiency in the computation, and scalability. Validate the system utilizing real data coming from an area or specific agricultural activity. Analyze what benefits this system may yield into improving the farmer's decision when it comes to resources to obtain optimal crop yields.
- Enumerate any possible ways of incorporating this system into mobile or web-based applications for easy accessibility and use by the farmers.
- Use these bullet points as an elementary foundation in designing your study and in writing your paper.

RELATED WORK -

[1] Suresh, G., A. Senthil Kumar, S. Lekashri, and R. Manikandan. "Efficient Crop Yield Recommendation System Using Machine Learning For Digital Farming". This proposed system is used to identify particular crop according to given particular data. By applying Support Vector Machine (SVM) acquired higher precision and productivity. This research paper mainly worked on two datasets: sample dataset of location data and sample dataset of crop data. By using this proposed system

recommended particular crop according to their Nutrients (N, P, K, and PH) values and also identified available Nutrients values and required fertilizers quantities for the particular crop like Rice, Maize, Black gram, Carrot and Radish.

[2] Rajak, Rohit Kumar, Ankit Pawar, Mitalee Pendke, Pooja Shinde, Suresh Rathod, and Avinash Devare. "Crop recommendation system to maximize crop yield using machine learning technique". This proposed method is used for identifying particular crop based on soil database. This proposed system worked on various crops like groundnut, pulses, cotton, vegetables, banana, paddy, sorghum, sugarcane, coriander and various attributes like Depth, Texture, Ph, Soil Color, Permeability, Drainage, Water holding and Erosion. This proposed system worked on various machine learning classifier like support vector machine (SVM) classifier, ANN classifier, Random Forest and Naïve Bayes for recommend a crop for site specific parameter with accuracy and efficiency. This research work would help farmers to increase productivity in agriculture, prevent soil degradation in cultivated land, and reduce chemical use in crop production and efficient use of water resources."

[3] states the requirements and planning needed for developing a software model for precision farming is discussed. It deeply studies the basics of precision farming. The author's start from the basics of precision farming and move towards developing a model that would support it. This paper describes a model that applies Precision Agriculture (PA) principles to small, open farms at the individual farmer and crop level, to affect a degree of control over variability. The comprehensive objective of the model is to deliver direct advisory services to even the smallest farmer at the level of his/her smallest plot of crop, using the most accessible technologies such as SMS and email. This model has been designed for the scenario in Kerala State where the average holding size is much lower than most of India. Hence this model can be positioned elsewhere in India only with some modifications.

PROPOSED METHODOLOGY

The methodology for "Crop Recommendation using Machine Learning Algorithms" is executed as follows:

- **Data Collection:**

Gather relevant agricultural data, including soil properties (pH, nutrients), climatic factors (temperature, rainfall), and historical crop yields.

- **Data Preprocessing:**

Clean and preprocess the data to handle missing values, normalize parameters, and remove outliers.

- **Feature Selection:**

Identify key features influencing crop suitability through techniques like correlation analysis or feature importance scores.

- **Data Partitioning:**

Split the dataset into training and testing sets, typically in a 70:30 or 80:20 ratio.

- **Algorithm Selection:**

Choose suitable supervised machine learning algorithms, such as Random Forest, SVM, and Decision Tree, for classification or logistic regression tasks.

- **Model Training:**

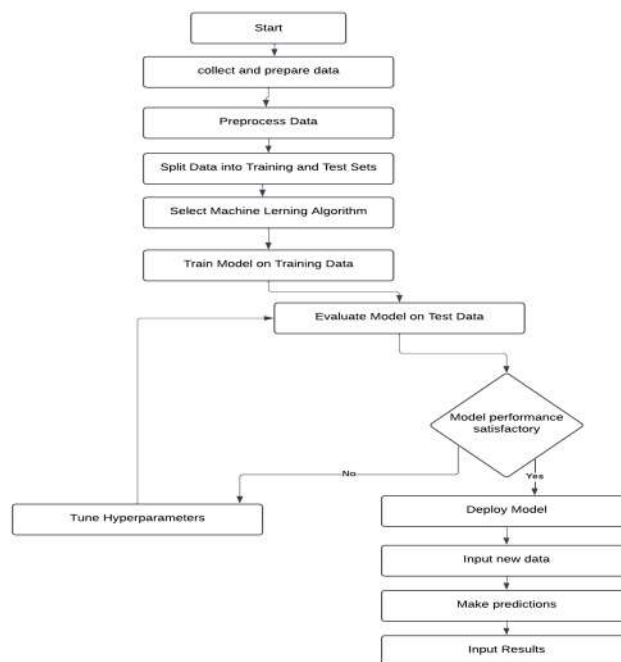
Train the selected algorithms using the training dataset and validate using metrics like accuracy and F1-score.

- **Hyperparameter Tuning:**

Optimize hyperparameters of the models to improve performance on the testing data.

- **Model Selection:**

Compare the performance of different models and select the best one for crop recommendation.



EMPHERICAL WORK**A) Data collection and Data preprocessing**

The sample data set has been collected from kaggle.com. The dataset has 8 features and 2201 records.

Data preprocessing involves a number of steps. These preprocessing steps ensure that the dataset is clean, consistent, and ready for efficient model training and analysis.

1) Data Collection:

The first step involves gathering relevant agricultural data from reliable sources such as government databases, agricultural research centers, and meteorological departments. The dataset includes essential parameters like:

Soil properties (pH level, nitrogen, phosphorus, potassium content).

Climatic factors (temperature, humidity, rainfall).

Historical crop yield data.

2) Data Preprocessing:

The collected data is often noisy and incomplete, requiring the following preprocessing steps:

i) Handling Missing Values:

Use statistical methods (e.g., mean/median imputation) or machine learning techniques to fill missing entries.

ii) Removing Outliers:

Identify and remove data points that deviate significantly from standard patterns using z-score or interquartile range methods.

iii) Data Normalization:

Normalize features such as temperature and pH levels to ensure uniform scaling across all parameters.

iv) Feature Encoding:

Convert categorical variables (e.g., crop types) into numerical form using techniques like one-hot encoding or label encoding.

v) Balancing the Dataset:

Address class imbalance issues by oversampling or undersampling techniques, ensuring fair model training.

3) Algorithms

i) Naïve Bayes

Naïve Bayes is a probabilistic classifier based on Bayes' Theorem, assuming feature independence. It is widely used for classification tasks such as text classification and spam filtering due to its simplicity and efficiency. Naïve Bayes is based on the Bayes theorem. Being a probabilistic classifier, it makes predictions based on the likelihood of specific events. The following is the formula for it, which is based on the Bayes theorem: $P(A/B) = (P(B/A) \cdot P(A)) / P(B)$.

ii) Random Forest

Random Forest is an ensemble learning method that builds multiple decision trees during training and outputs the class or average prediction of the individual trees. It is known for its high accuracy, resistance to overfitting, and ability to handle large datasets.

iii) Support Vector Machine (SVM)

SVM is a supervised learning algorithm used for classification and regression tasks. It finds the optimal hyperplane that separates data points of different classes with the maximum margin, making it effective in high-dimensional spaces.

iv) Decision Tree

A Decision Tree is a tree-like model that splits data into subsets based on feature values. Each internal node represents a feature, each branch represents a decision rule, and each leaf node represents an outcome. It is intuitive and useful for classification and regression tasks.

v) Logistic Regression

Logistic Regression is a statistical method used for binary classification. It models the probability of a binary outcome (e.g., 0 or 1) based on input features using a sigmoid function, making it simple yet effective for many real-world problems.

B) Tools used for analysis and prediction

1) Jupyter Notebook:

Jupyter Notebook, a popular open-source platform, was used for writing and running Python code. It allows for combining code, data visualization, and explanations in one place, making it easy to work on machine learning projects.

2) Machine Learning Algorithms:

Various machine learning algorithms like Random Forest, Decision Tree, Support Vector Machine (SVM), Naïve Bayes, and Logistic Regression were implemented.

These algorithms were used to analyze the data and make accurate predictions about the best crops to grow based on input parameters.

3) Python Libraries:

Key Python libraries such as Pandas, NumPy, Scikit-learn, and Matplotlib were used for tasks like data handling, preprocessing, model training, and visualizing the results.

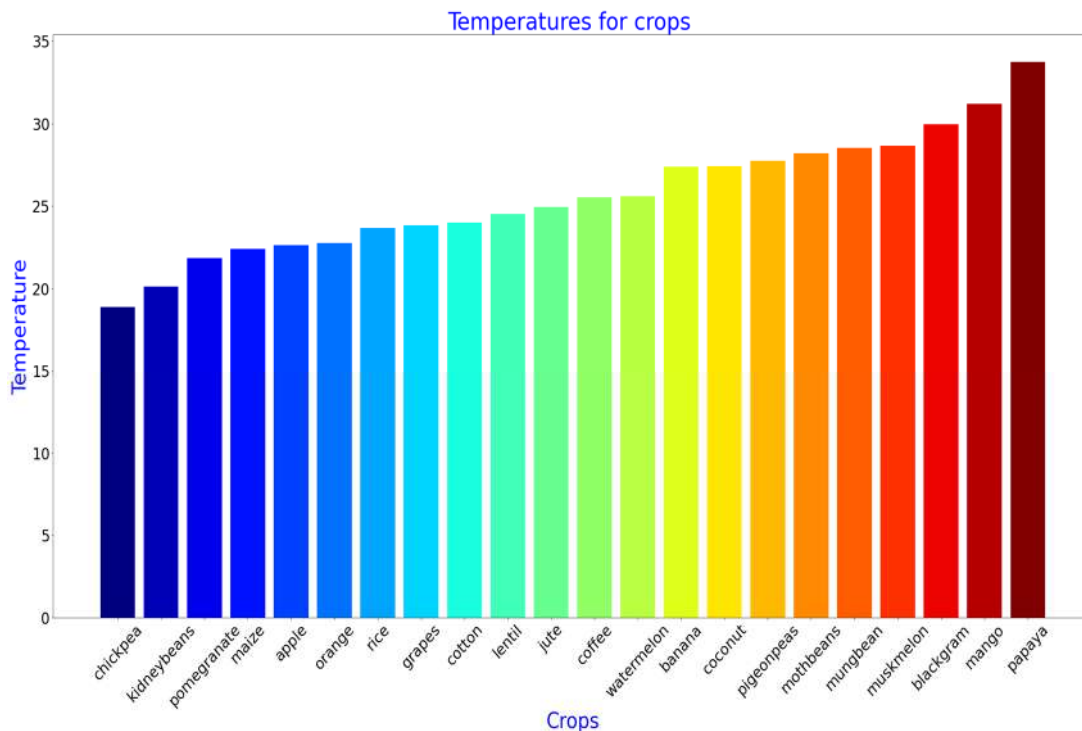
These tools and techniques helped in building, testing, and evaluating the crop recommendation models efficiently.

RESULT ANALYSIS

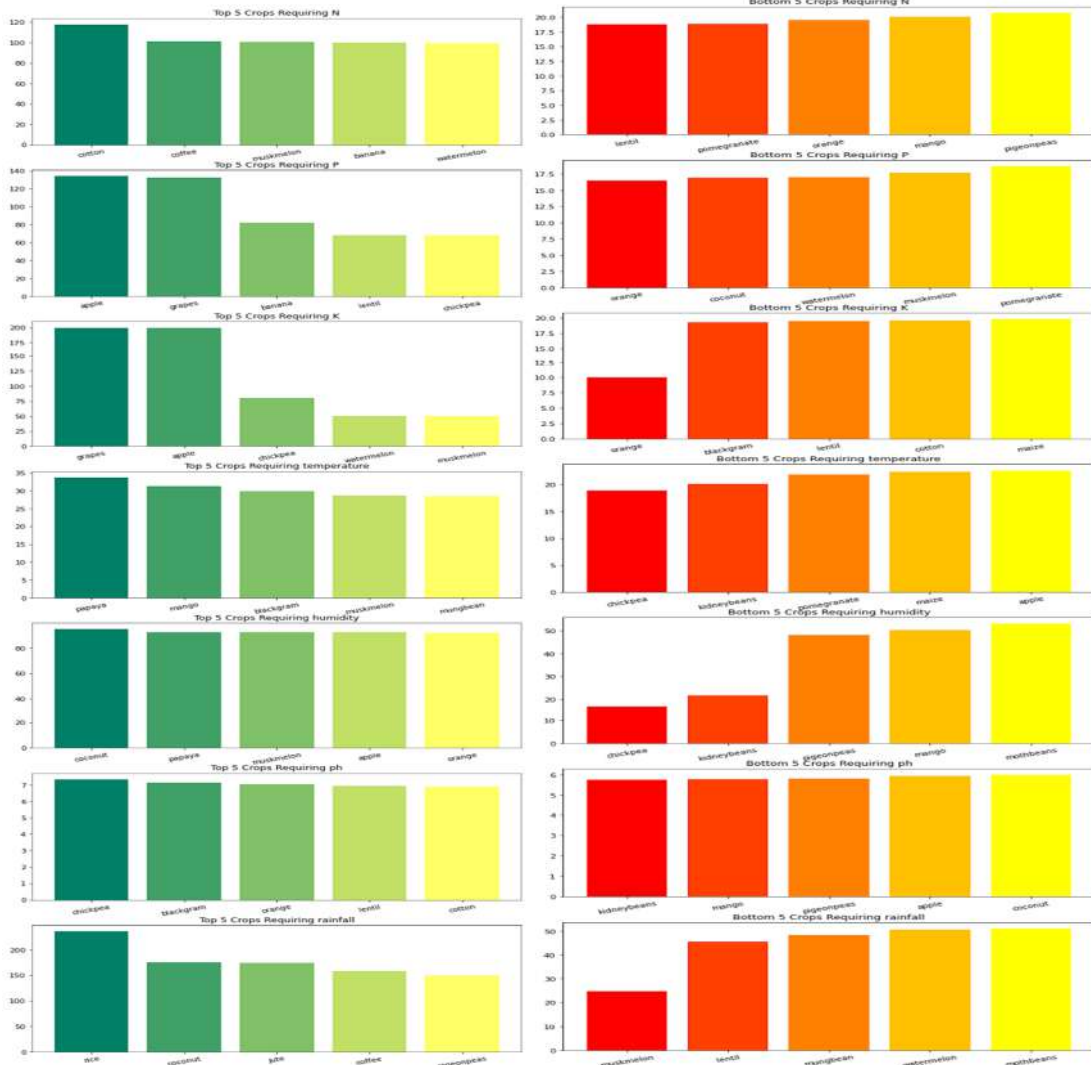
The temperature requirements for different crops vary significantly, as indicated by the increasing gradient from cooler (blue) to hotter (red) colors.

Crops on the left side of the chart are better suited for cooler climates, while those on the right thrive in warmer temperatures.

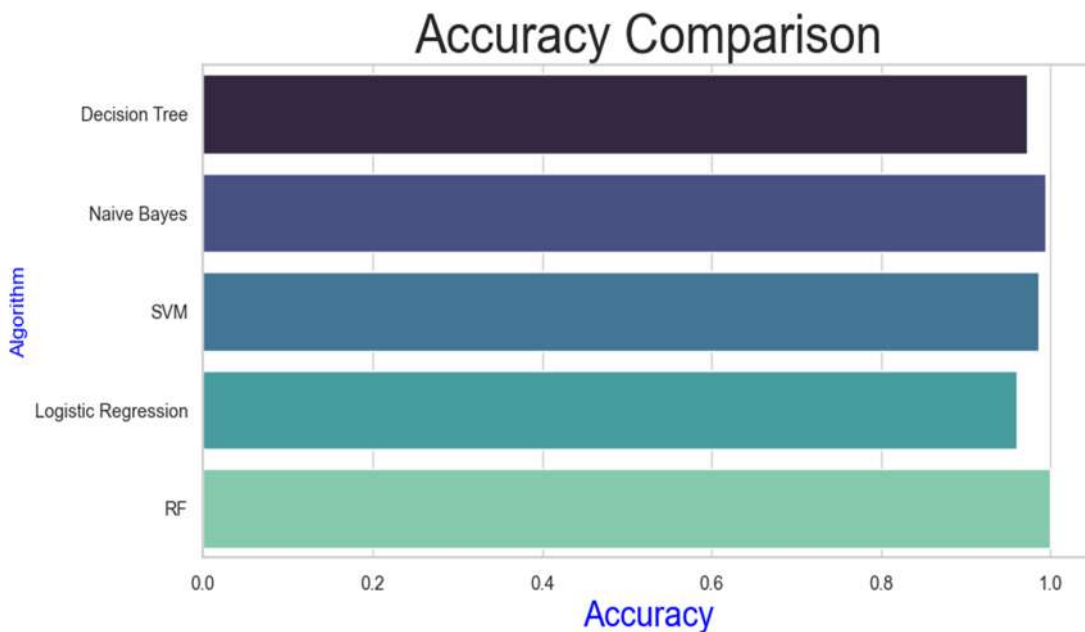
By understanding temperature preferences, farmers can make informed decisions about crop rotation or introduction of new crops to adapt to changing climatic conditions.



Below graphs shows Top 5 and bottom 5 crops based on features. This graph helps to identify which crop to grow in certain conditions.



Among all the machine learning algorithms random forest gives highest 100% accuracy which is shown below



CONCLUSION

Integration of machine learning has become a transformative approach answering the challenges of crop selection and yield optimization. From this study, different kinds of machine learning algorithms in the form of Random Forest, Decision Tree, SVM, Naïve Bayes, and Logistic Regression algorithms were demonstrated to be used in the proposition of proper crops based on agricultural critical parameters.

Data-based decisions promote agricultural productivity by reducing the risks and increasing the sustainability of agriculture. Using data aggregated with information on soil composition, climate, and past crop output, this proposed system provides action-driven knowledge to a farmer in filling the gap created between the old agricultural processes and contemporary technological advances.

The future work would involve the integration of real-time data from IoT devices, an extension of the dataset to include other crops and regions, and the inclusion of economic factors such as market demand and cost of cultivation into the recommendation framework.

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THE ROLE OF HCI IN DEVELOPING AR/VR EXPERIENCES**Sanket Satvekar**

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Abstract:

This paper gives an overview on the subject human-computer interaction (HCI) in the development of Augmented Reality (AR) and Virtual Reality (VR) technologies/applications. in many fields including non-profit areas such as NGOs, education, health Care, arts and recreation also for-profit areas such as businesses, airlines, publishing companies. the research demonstrates AR/VR's efficacy in improving outcomes in these areas with the help of HCI. The study articulates the critical role of human-centered design in these extended systems and how computers are for people that they are made for improving the human capabilities, solve problems and make better human experience. By synchronising this fundamental principle into AR/VR technologies are developed to give innovative solutions to real world problems. this paper also argues the consequences neglecting HCI of It seeks to identify current practices, challenges, and opportunities in AR/VR technologies.

Keywords: Human-Computer Interaction (HCI), Augmented Reality (AR), Virtual Reality (VR), AR/VR Experience, AR/VR Technologies.

1. Introduction

With the progressive technology, we are living in a world of global connections of experiences. There is almost no limit in what we cannot do using technology. People can use it to communicate with people around the world, find an easy way to explore different routes to the destination with Google Maps. Technology will, therefore allow us to tell stories in ways we share, create, and experience it. The fact that Augmented Reality (AR) and Virtual Reality (VR) are fast growing means that the technologies will likely be given a better chance of bridging the gaps in interaction more effectively through direct, immersive experiences.

Designing for AR and VR is not only limited to the aesthetics, unlike traditional User Experience(UX) which is designing interfaces for software and websites; It requires a deep understanding of the user behaviour, and the principles of Human-Computer Interaction (HCI).Human-Computer Interaction in the context of AR and VR is very critical AR and VR create immersive and interactive environments which gives user the ability to transport themselves in the virtual world or overlay digital content onto the real world. because of this shift in the User Experience(UX) designers consider to focus on the factors such as spatial awareness, interaction design, visual hierarchy.

As this field rapidly changing and developing, As much as it is required to know the technical aspects of AR and VR but it is also involves applying human-computer interaction (HCI) Principles to design experiences that connects with users. HCI plays a crucial role Whether in for-profit sectors like Businesses across various industries where immersive experiences can be used as the source of engagement, innovation and revenue or in non-profit areas for social impact, raising awareness and Cultivate empathy. with all of these things the approach to design for AR and VR one needs to understand well enough technology, psychology, user-centered design, and Cognitive Load to create experiences for different audiences across various contexts.

Besides AR and VR, the two other major terms in this space are Mixed Reality (MR) and Extended Reality (XR). The mixed reality combines both AR and VR in that it overlays the digital contents into a real world whereby physical and digital components can be interactive with each other. Extended Reality (XR) is made of AR, MR, VR, or any other kind of fusion of the real world and the digital world.

2. Literature Review

2.1 Brief history about HCI in AR/VR

Historical evolution of Human-Computer Interaction in Augmented Reality and Virtual Reality Exposes the progressive development that has moulded user experiences in the digital environment. In the 1960s and 1970s, HCI emerged through studies that focused on user interface design and early computer interactions in efforts to make computers much more approachable. It paved the way for the HCI change in the 1980s when GUIs completely changed HCI, so that the general populace could really connect with technology. The immersed environments and 3D interfaces' research thrived during the 1990s when the early vr systems started being used in academia and

militarily; it was a major step toward more interactive experiences. The concern of HCI research during the 2000s is even more on the user experience. Thus, researchers are concerned with emotional responses and usability in virtual environments. This would not only give the importance of how the users feel while interacting with the technology but also point out the need for intuitive design in AR/VR systems. Altogether, these milestones indicate that the understanding of user interaction has been growing, alongside the critical role HCI plays as it creates accessible and engaging AR/VR experiences.

2.2 How has HCI evolved in AR/VR devices from early prototypes to current models? 1968: The Sword of Damocles

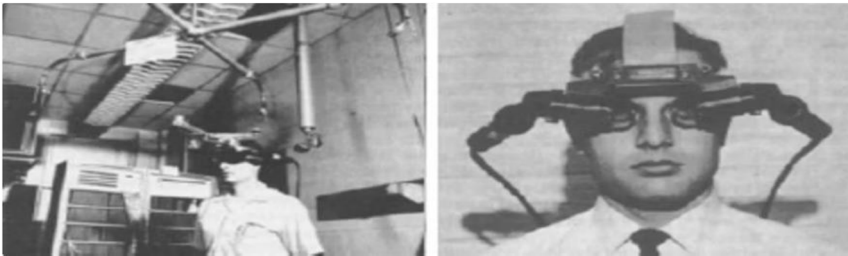


Figure 1 : The world’s first head-mounted display the “Sword of Damocles”

The Sword of Damocles, first head-mounted display (HMD) created by Ivan Sutherland and his student Bob Sproull at the University of Utah. It was also the first AR headset, which was capable of Showing digital media in front of the user's eyes. Thought it may seem primitive by today's status, it was very innovative step in HCI. this device allowed users to track user's head movements, meaning 3D wire frame model can change perspective accordingly. and that introduced the concept of spatial interaction, which is natural interaction with a virtual environment through head movements. but due to its bulky design the whole set up was discontinued and was never practical for everyone to use showing the early challenges of device functionality and user comfort in HCI.

1975: Krueger’s VIDEOPLACE

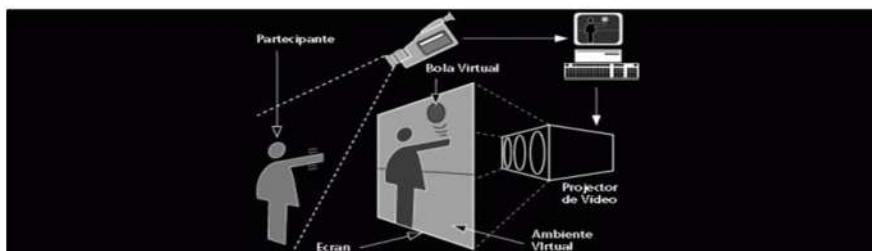


Figure 2 : Krueger’s VIDEOPLACE, the first interactive VR platform

Krueger's VIDEOPLACE Myron Krueger, 1975 Krueger's VIDEOPLACE VIDEOPLACE, developed by Myron Krueger, marked a giant leap in interactive HCI for virtual environments. Unlike the Sword of Damocles, VIDEOPLACE did not have physical wearables such as goggles or gloves; instead, it used projectors, cameras and sensors to create an immersive experience wherein users could interact with virtual objects on large video screens. This innovation was about non-invasive interaction: interfaces became softer and friendlier, with the HCI vision at a further point along the track of accessible and fun experiences without complicated hardware.

2012: Oculus Rift



Figure 3 : The Oculus Rift

The Oculus Rift is a major milestone in HCI because it brought VR to the consumer market. It was launched through a successful Kickstarter campaign, the Oculus Rift was designed with a strong focus on user experience. It had a lightweight design and refined head-tracking technology, addressing the comfort issues that plagued earlier devices like the Sword of Damocles. The Rift also introduced more intuitive controls and a more immersive display, making VR more accessible and enjoyable for a broader audience. This development gives the importance of HCI in making VR not just functional, but also comfortable for everyday users.

2024: Apple Vision Pro



Figure 4 : Apple Vision pro

2024: Apple Vision Pro The Apple Vision Pro is the HCI artefact for AR/VR, which fuses excellent technology with superior UX design. In addition to utilizing such advanced technology, the Vision Pro has eye-tracking, hand gestures, and even voice commands to enable a seamless and intuitive way of interacting with virtual and augmented environments. Ergonomics and accessibility have also become major features in addressing issues regarding the usability and inclusivity of AR/VR devices. The Vision Pro has indeed sparked much interest, with many observers of the market thinking that it could push mainstream VR adoption faster because of the refined HCI design that now made the technology approachable for a layperson.

3. Research methodology

The Research Methodology used in this paper is Qualitative and Exploratory, using literature review, existing case studies and current practices.

4. Different HCI Principles Used in AR and VR

In the Development of Augmented Reality (AR) and Virtual Reality (VR) technologies Human-Computer Interaction (HCI) plays a crucial role, it is used to ensure that these devices/systems provide users with intuitive, accessible, better and comfortable experiences. So that when users are interacting with digital world/media it is safe space. There are several key principles that are used while designing for successful implementation of AR/VR Devices.

4.1 Usability and User-Centered Design

User-centered design is a core HCI principle that is used to give a way of using the things we create are simple and understandable for end-users. The whole design is made by thinking the perspective of user prioritizing the needs, behaviors, and preferences of everyone. In AR and VR, this involves creating interfaces that are easy to use, regardless of the user's level of technical expertise.

By focusing on usability, In the case of AR/VR technologies ensure that users can focus on the task or the experience rather than struggling with the interface itself.

4.2 Feedback and Responsiveness

Feedback is when a user carries out any action and it can give visible response like conformation that an action has taken place. It is very important in AR and VR for providing immediate feedback as there is an interaction between virtual and physical

elements. Feedback can be visual (for example, highlighting an object), auditory (confirmation sounds), or haptic (such as vibrations or force feedback). The feedback loop ensures that users feel well-integrated and on top of things, thus improving experience altogether.

4.3 Affordances and Natural Interaction

An affordance can be anything-it basically is an attribute that indicates how it's used. It can be either perceived or a physical attribute, but both give clues so that no instructions or labels are needed to portray the usage. In AR and VR, where interaction methods can be vastly different from traditional 2D interfaces.

Affordances are, therefore, significant in guiding user behavior.

AR Example: For instance, natural gestures in Google Glass and similar AR systems are obvious commands to interact with a system because they give the user any cue on how to navigate and control a system.

Including familiar and intuitive controls can be one of the ways to minimize the learning curve that reduces immersion levels in AR and VR systems.

4.4 Spatial Awareness and Presence

experiences, as one interacts with three-dimensional environments. This design should be done in such a manner as to make sure users know where they stand with respect to virtual objects and that they can freely navigate the environment without getting confused.

In the case of AR-based navigation systems like Google Maps Live View, the superimposed arrows and markers are responsive to the real-world environment in which the user is standing, thereby supporting the user in orienting himself or herself with respect to direction in actual physical space. VR Example: A user can walk around virtual spaces being aware of physical boundaries to avoid collisions or getting disoriented in an HTC Vive room-scale experience within VR environments.

Good spatial design and motion tracking can give user's a feeling of being rooted, which subsequently alleviates the discomfort and enhances immersion levels.

4.5 Immersion and Engagement

In VR, immersion can be seen as one dimension of how the application, experience, or the technology engages users by offering a highly sensory and interactable environment. It is therefore related to but has a slightly different connotation than presence in VR. The technology involves head-mounted displays or HMDs. This

encompasses aspects like sensory range, vividness, visual quality, and the narrative element of the experience. Immersion is much more about externals. Again, it's mostly about the technology-that kind which can engage senses so the virtual environment comes alive.

The heart of immersion somehow trickles down into an element such as VR: this is the principle that would make the designed experience enjoyable. Immersion is the condition in which the user is fully immersed inside the virtual world where user can perform tasks without being interrupted by problems of technical flaws or lacking in design.

For instance, VR gaming platforms such as PlayStation VR enable the incorporation of immersive audio, realistic graphics, and tangible interaction mechanics to convert customers into a total environment. Properly designed interfaces amplify the engagement of users without detaching them from the experience.

Actually, immersive design is considered the backbone of delivering high-quality user experiences both in entertainment and professional uses of AR and VR.

4.6 Accessibility and Inclusivity

In order to make access possible for people with a wide range of physical or cognitive abilities, AR and VR must be accessible as well. That means accessibility from the outset, including designing interaction methods that are context sensitive and flexible.

AR Examples: For example, all learning apps that are of educational purposes, including tutoring applications and immersive learning for all learning tools, avail a multiplicity of input methods. These can range from voice to touch or even motion since the same application will be accessible to users with different abilities.

VR Example: For instance, with Oculus Quest, one can tweak it for customizable height and remapping of controllers to settle all people irrespective of their mobility in real life.

Accessibility in AR and VR has helped in the construction of an inclusive technological landscape to afford numerous users access to these innovations.

4.7 Minimizing Cognitive Load

In AR and VR, cognitive load should be minimal-that means the user must not be overloaded by too many pieces of information or too many possible interactions at any one time. It is up to the designer to ensure that the virtual interface presents relevant information in a clear and concise manner.

AR Example: That is, HUDs in driving applications will focus on minimal information that is critical to users' needs, such as speed and navigation cues, but it won't tire people with unnecessary data. VR Example: Complex activities in virtual reality learning environments are broken down into smaller, more easily managed segments and only visible tools or instructions appear at a given time to avoid distraction and maintain users' interest.

This reduces cognitive demands, meaning HCI in AR and VR can support users more comfortably and efficiently navigate within virtual environments.

5. HCI in Augmented Reality (AR)

5.1 Understanding AR and Its Interaction Paradigms

AR enhances the physical world by overlaying digital information, such as images, sounds, or data, onto the user's view of their environment. Compared with VR, AR does not isolate the user from the real world but rather lets them have a connection to the real and interact with digital content.

Interaction paradigms in AR differ significantly from classical computing environments. They are obliged to consider the digital information and how users interact with it by considering present and intuitive interaction paradigms. The following are common methods of interaction in AR:

Gesture Recognition: Users can interact with digital elements through hand gestures such as tap, swipe, or pinch. The recognition system should be very accurate and responsive for a smooth experience.

Voice Commands: All these voice commands allow users to control the AR systems without any kind of physical input. This proves very useful in hand-free applications, for example, in navigation using AR or in maintenance work.

Gaze Tracking: Gaze tracking will be enabled in AR systems, where it detects the area a user is looking at and responds appropriately. It can be used to activate objects, traverse menus, or trigger certain actions based on user focus.

Context-Aware Interactions: AR Systems can use sensors and data to adapt to the user's environment, providing information as well as interactions that are contextually relevant. For example, an AR navigation app can be used to display directions based on the user's current location and orientation.

5.2 HCI Challenges in AR Development

The development of AR systems presents several unique challenges for HCI designers:

Balancing Digital and Physical Elements: The most important issue with the application of AR is that digital overlays can't dominate or distract users from their immediate physical context. Therefore, the designers have to be very cautious while placing, sizing, and transparency level the digital elements would have so that it does not impede view but complements it instead.

Minimizing Cognitive Load: the AR systems can be highly packed with information and, hence, cause cognitive fatigue. HCI designers have to choose the information and present it in an easily understandable form, likely to process. This may involve visual cues, animations, or contextual information that can help the user.

Ensuring Accurate and Responsive Interactions: Make sure the systems are correct and responsive in their interactions with humans. The performance of AR systems depends on how fast they can accurately respond to the user's inputs, quickly. This requires robust gestural, voice processing, and gaze tracking technologies together with well-thought-of feedback mechanisms that users are assured that their actions have been recognized and processed.

Addressing Privacy and Security: Sometimes AR might require sensitive information like a location, camera feed, or other personal information. HCI designers should therefore ensure that the information is safety secure and that the user knows clearly what is going to happen with their information. Furthermore, the public use of AR could lead to people discovering or sharing information about others in an uninhibited way.

6. HCI in Virtual Reality (VR)

6.1 Understanding VR and Its Interaction Paradigms

Virtual reality (VR) immerses the user in a built environment entirely made of digital, making it nearly impossible to duplicate with any other technology. That makes the user interact with the environment using one of a number of input methods such as:

Motion Controllers: controllers of movements enable the user to interact with the virtual environment through performing actuality actions within the world, such as a grasp, point, shoot, etc. Controllers of movement usually come with buttons, triggers, and haptic feedback.

Hand Tracking: Hand tracking systems require cameras and sensors to trace the movements of hands belonging to a user that can be used to provide interaction with a virtual environment without carrying a controller in one's hand. Much more natural and immersive, it requires highly accurate tracking to avoid frustration.

Gaze and Head Tracking: This will track where the user is looking and adapt the virtual environment accordingly. It can be used to point to objects, select menu options, or aim a camera in a VR game or application.

Haptic Feedback: Haptic feedback gives the user the impression that there are physical objects that exist in a virtual environment through their sensations of touch. Thus, it will be vibrations, pressures, or temperature changes that give them the "feeling of immersion."

6.2 HCI Challenges in VR Development

Some of the challenges in developing effective HCI for VR include:

Motion Sickness: the largest challenge in virtual reality is motion sickness, where what the user sees can desynchronize with what they are actually feeling, that leaves a user with sickness. A HCI designer must make sure to control movement as well as acceleration without making it too uncomfortable for the user. **Creating Realistic Interactions:** In VR, people expect to have realistic interactions. They would want accurate tracking, very responsive input methods, and fairly believable haptic feedback. This would, however be particularly challenging, especially with something like a complex or dynamically changing environment.

Managing User Comfort and Safety: Most users tend to feel uncomfortable or disoriented after a long period of VR exposure. Ergonomics, session duration, and safety in the environment are vital components that HCI designers must take into account while designing systems that ensure comfort in the user experience.

Designing for Immersion: Immersion is one of the core aspects of VR, hence experience in HCI design needs to be made more immersive and believable. It involves design for natural look scenes, characters, and interaction between them that makes a person not get distracted or interrupted while immersed.

7. AR and VR in Profit and Non-Profit Sectors: HCI Perspectives

These two AR and VR technologies are revolutionizing industries in both profit-generating and nonprofit organizations through innovative solutions for enhancing user

experience, further training, and reaching diverse audiences. However, applications of goals vary across different sectors or industries. Human Computer Interaction design is key to making these technologies accessible, intuitive, and efficient in both contexts-profit generation as well as social impact.

7.1 AR/VR in For-Profit Sectors

In the for-profit domain, AR and VR are mainly applied to improve customers' experience, increase customer engagement, and finally convert them into a revenue stream. HCI design is more about developing easy, intuitive, and entertaining exchanges in order to generate maximum satisfaction and retention rates.

7.1.1 Applications in For-Profit Areas

Retail and E-commerce: IKEA's and Sephora's AR functions allow customers to view how furniture would look in a room and try on makeup, respectively. For this experience, the HCI principles of intuitive real-time interaction will ensure easy manipulation of virtual objects with no steep learning curves. Immediate, clear feedback and responsiveness mean that customers are relevantly engaged and sure about their purchase decisions.

Entertainment and Gaming: Entertainment and gaming are one of the most profitable applications for immersive technologies. Beat Saber, for example, along with platforms like Oculus Quest, so far emphasize HCI through intuitive control systems, such as motion controllers, hand tracking, and real-time feedback, in the form of haptics and visual cues. Success in this domain depends on minimizing discomfort and preventing motion sickness while at the same time maximizing engagement with fluid, natural interactions in virtual environments.

Healthcare: Entertainment and gaming are one of the most profitable applications for immersive technologies. Beat Saber, for example, along with platforms like Oculus Quest, so far emphasize HCI through intuitive control systems, such as motion controllers, hand tracking, and real-time feedback, in the form of haptics and visual cues. Success in this domain depends on minimizing discomfort and preventing motion sickness while at the same time maximizing engagement with fluid, natural interactions in virtual environments.

Education and Corporate Training: In corporate training contexts, VR and AR are widely used to simulate real conditions for employees through mock safety drills or even in the use of customer service training. HCI in such applications is centered on

realism and ease of use so that amount of onboarding required could be cut down together with maximum effectiveness of the training through interactive experiences.

7.1.2 Case Studies Reflecting HCI in AR and VR in For-Profit Areas

Case Study 1: Boeing VR for Aircraft Assembly Training

Context: The leader in the aircraft industry, Boeing, has incorporated VR into its training programs for aircraft assembly. The new engineers and technicians practice assembling aircraft complex components with the support of VR simulations to increase accuracy and save time over traditional methods.

HCI Role: The VR system was engineered with immersion interaction, real simulation. HCI research ensured the virtual environment presented all conditions of real assembly, from tool usage to spatial awareness in tight spaces. Feedback mechanisms such as haptic feedback and auditory cues were added to engage the user and make the training seem real. The system was designed to reach through levels of expertise. It provides interactive tutorials as well as aiding the process of training.

Outcome: It increased the efficiency of workers, decreased the error rate and reduced training time related to the VR assembly training system. It can be argued that the principles of HCI-based immersive design, intuitive interaction, and real-time feedback have tremendous potential to affect productivity in industrial application contexts.

Case Study 2: AR in E-commerce - Shopify's 3D/AR Product Models

Context: Shopify, a leading e-commerce platform, enabled online merchants to present 3D models of their products and include augmented reality capabilities. Consumers who possess the product model overlaid into their real-world surroundings through a smartphone before purchasing a specific product will be of special interest when that product is furniture or home decor.

HCI Role: HCI owned the design of the AR interface- to make the products viewable and interactive in the customer's environment. The main goal of the interaction was that the 3D models are to be made as realistic, scalable, and accessible as possible: for example, rotate, resize. The system gave customers actual-time feedback about how a product might look and fit in their personal space.

Accessibility and user-friendliness have also been emphasized in creating the server as usable by a wide demographic of users, regardless of technical levels.

Outcome:

The AR feature has positively impacted customer satisfaction and lowered the rates of return because the consumer knew exactly what to expect from a product before shopping. The implementation of HCI principles in the AR feature by Shopify thus propelled higher conversion rates and increased customer confidence, proof that AR is useful for online shopping.

7.2 AR/VR in Non-Profit Sectors

There is also increasing usage of AR and VR for non-profit applications, like education, humanitarians, health, and social change. On these applications, HCI design focuses on the problems of accessibility, solutions at affordable cost, and how the technology is socially serving a clear purpose in order to push forward the cause-a cause like raising awareness, teaching new skills, or facilitating therapeutic interventions.

7.2.1 Applications in Non-Profit Areas

Education and Awareness Campaigns: Education and Awareness Programmes. NGOs can make use of AR/VR for advocacy and education campaigns on global issues like climate change, poverty, or refugees crises. For example, immersive experiences such as Clouds Over Sidra let users experience what it is to stay in a refugee camp. The HCI design here centers around empathy through immersive storytelling, so the technology is easy to use for a person who is not familiar with it. It neither overwhelms nor confuses a person between engaging and educating them.

Therapeutic Uses: VR has increasingly played a major role in therapeutic interventions in the treatment of PTSD, anxiety, or even a phobia. For example, for a patient: A patient is put in controlled simulation environments that continuously expose patients to their fears. In such scenarios, the interface should focus on ensuring this experience is gentle, supportive, and customer-centric for individual patients, as far as input methods, feedback, and pacing are concerned.

Disaster Response Training: Non-profits that are involved in disaster response and humanitarian work use AR and VR to train personnel on crisis situations in the real world. During these simulations, trainees will be able to hone skills simulated in environments mimicking disaster scenarios-for example, search and rescue missions. In this regard, HCI design should focus on realism and ease of use to ensure that the trainee is able to interact with the simulation in ways that mirror real-world actions.

7.2.2 Case Studies Reflecting HCI in AR and VR in Non-Profit Areas

Case Study 1: VR in Mental Health Therapy (Healthcare)

Context: The Virtual Reality Therapy Foundation is a non-profit organization that has developed VRbased treatment for patients suffering from PTSD and other mental health disorders, such as anxiety. VR therapy enables a patient to face his or her fears within a controlled virtual environment, developing resilience and gradually reducing anxiety.

HCI Role: The HCI component makes this VR application work because it offers carefully designed virtual environments that are life-like but controllable for patients, thus maintaining the balance of immersion with emotional comfort. Use of user-centered design principles ensures every session is tailored to meet a given patient's needs as well as the aims of therapy, whereas real-time feedback mechanisms ensure therapists can tailor virtual scenarios to increase or decrease intensity.

Outcome: Most patients show a considerable improvement on how to handle their anxiety and PTSD symptoms. The application of HCI, such as cognitive load minimization, real-time adjustments, ensures therapy stays effective and not too overwhelming for the patient.

Case Study 2: AR for Education in Developing Countries (Education)

Context: The nonprofit agency, the World Education Project, recently opened AR Applications for the distant and underprivileged region to make learning experiences of better quality. AR Systems are believed to deliver the active learning experience, especially in the field of STEM, in which difficult scientific concepts are perceived in 3D effects on mobile devices.

HCI Role: Such HCI principles provide a strong guarantee that the AR application was not threatening or intimidating to less computer-savvy students. Simplicity is applied as in the use of virtual models, like when students tap or swipe through a touchscreen in accessing. Making the access without hurdles, voice instructions and text-to-speech tools were introduced to suit the needs of students with disabilities. **Outcome:** As a result, the AR learning event led to increased student involvement and comprehension in topics where the visualization of concepts is tricky, like biology or physics. Due to HCI design, the simplicity and availability of such tools made their influence enormous in resource-constrained environments and changed the way a student would learn.

8. Neglecting HCI in AR and VR

While AR and VR technologies do open tremendous opportunities in an incredibly wide variety of areas, their success depends on the strict observance of HCI principles. Failing to adhere to HCI principles in the design of AR and VR can severely harm the users' experience: it may cause frustration, inefficiency, safety risks, and at the extreme, failure to adopt technology. The section below discusses these consequences of neglecting HCI when developing AR and VR applications.

8.1 Poor Usability and High Cognitive Load

Poor usability of AR and VR systems can result, as attention is often lacking in HCI. For instance, in a nonintuitive interface, user ability to effectively interact with the virtual environment could be limited through confusion and frustration. The problem becomes more serious in VR where deep, complex interactions must be made in a fully immersive environment.

Example: a bad design of the controls in a VR training simulation that will require users to memorize complex button combinations may lead to cognitive overload: the user spends too much time trying to understand the interface rather than the task for which he is being trained. Such a situation would decidedly undermine the effectiveness of the simulation as well as the user engagement.

If usability is compromised, and also the cognitive load is kept at its minimum, then users have a chance to not be fully exploited by the AR/VR systems. This situation will make the technology fail to bring about the proposed goals.

8.2 Lack of Accessibility and Inclusivity

For the physically or cognitively disabled users, HCI plays an important role in ensuring that accessibility is achieved using AR and VR technologies. Not working on accessibility bars certain user groups from gaining any utility of the AR and VR systems designed. Inequity then follows, and the base of users is narrowed

Example: an AR app in a school cannot be supplied to visually impaired users without input alternatives that is, voice commands or haptic feedback-while, on the other hand, besides these visual inputs, it would thus drastically limit the impact and alienate part of the target group meant. This may prevent people in diverse populations from making the best use of AR and VR, thus reducing its social and economic benefits.

8.3 Discomfort and Motion Sickness in VR neglecting principles of HCI in the design of VR, such as spatial awareness and an attempt to minimize discomfort, may

increase the risk of physical discomfort in general - including motion sickness-in a user. Many people can be dizzy, nauseated, or simply uncomfortable when entering disorienting environments with oscillating cameras, latency problems, or mismatched visual and physical cues.

Example: Poor calibration of movement control in a virtual reality game, or delayed feedback between an action from the real world by a user and the corresponding virtual movement, can induce motion sickness. The users may get discomforted, thereby limiting their ability to interact more directly with the virtual world and might even leave the experience.

Failure to take into account comfort and spatial awareness can lead to an unpleasant user experience, hence depressing adoption of VR technologies, especially for extended use or multiple utilization.

Failure to address comfort and spatial awareness can result in a negative user experience, reducing the adoption of VR technologies, particularly for long-term or frequent use.

8.4 Reduced Immersion and Engagement

Another key point to ensuring effectiveness from both AR and VR is immersion. If the overall neglect of HCI breaks that immersion, placing the user firmly into their mind-set that they are working with a system rather than "being there" in a virtual space, then it's already lost. This is easily achieved through technical bugs and clunky interactions but not to forget overly complicated interfaces.

Example: In a VR storytelling experience, if the user interface breaks the flow of the story with an undesirable need for too many awkward interactions-for example, pulling up a menu for relatively simple tasks-then the immersion of the experience is diluted. It will be harder for users to emotionally connect to the experience, reducing enjoyment and overall satisfaction.

Thus, many applications of AR/VR rely heavily on immersion. In entertainment, education, and training applications, poor HCI design will tend to decrease the emotional impact, thus reducing user retention and effectiveness.

8.5 Safety Risks in AR and VR Systems

Ignoring HCI principles in AR and VR systems can also pose risks to safety, especially in areas that deal with the interaction of real objects by both virtual and physical objects. Lack of proper design for spatial awareness as well as in feedback may result

in users' potential collisions with actual physical objects or being disoriented and having a higher chance of injury.

Example: An industrial training using a VR system, not delimiting where the physical body will be or warnings about physical obstacles would pose to produce accidents. Most likely, users will collide with equipment or trip over obstacles if they are unable to know where their physical body is in relation to realworld hazards. For example, using AR and VR, a user must ascertain the virtual and physical environment so as not to encounter accidents and ensure proper safety.

8.6 Reduced Adoption and Success

Finally, lack of attention in HCI can easily lead to low adoption rates of AR/VR among the mainstream people in that if the technology is perceived as hard to use or uncomfortable for its intended users, then they cannot continue using it and are unlikely also to recommend to others. This would be considerably negative to the prosperity or the long-term sustainability of AR/VR products in the market.

Example: Finally, lack of attention in HCI can easily lead to low adoption rates of AR/VR among the mainstream people in that if the technology is perceived as hard to use or uncomfortable for its intended users, then they cannot continue using it and are unlikely also to recommend to others. This would be considerably negative to the prosperity or the long-term sustainability of AR/VR products in the market. Failure in HCI may lead to AR and VR technologies never reaching their complete market potential, thus failing to add value for solving real problems or contribute to the value it would otherwise have made.

9. Conclusion

Human-Computer Interaction plays a significant role in the development of AR/VR technology. Through the user-centered design, usability, and the availability of responsive interfaces, AR/VR technologies enable immersive experiences that could somehow bridge the digital and physical worlds and enhance user engagement across various sectors.

From early devices like the Sword of Damocles all the way to modern systems such as Apple Vision Pro, due to principles from the field of HCI, AR/VR technological development has been attributed to better improvements in user comfort, interaction, and accessibility.

Important principles in designing well-functioning AR/VR applications include usability, user feedback, spatial awareness, and the avoidance of extraneous cognitive load. All those principles ensure that users can interact intuitively with both digital and real-world elements.

HCI in retail, entertainment, and healthcare industries enhances customer engagement, product interaction, and training outcomes, which in turn nurtures AR/VR applications. For instance, the integration of HCI driven AR/VR systems undertaken by companies like Boeing and Shopify has increased efficiency and customer satisfaction.

Non-profit sectors are seeing significant influences from AR/VR technologies, such as educational improvement, awareness increase, and mental health therapy. HCI ensures that these technologies be accessible, usable, and effective, especially for the most underserved communities.

In most circumstances, this usually leads to poor usability, discomfort, low immersion, and even safety risks for AR/VR applications. Users become frustrated and will be less likely to adopt the technology and use it frequently.

In summary, HCI provides a crucial tool in the design and development of AR/VR technologies. Its tenets enhance user experience but, equally importantly, ensure that these technologies unfold toward the greatest possible impact solving real-world problems-whether by profit-making or social impact.

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QUANTUM CRYPTOGRAPHY FOR THE FUTURE INTERNET AND THE SECURITY ANALYSIS

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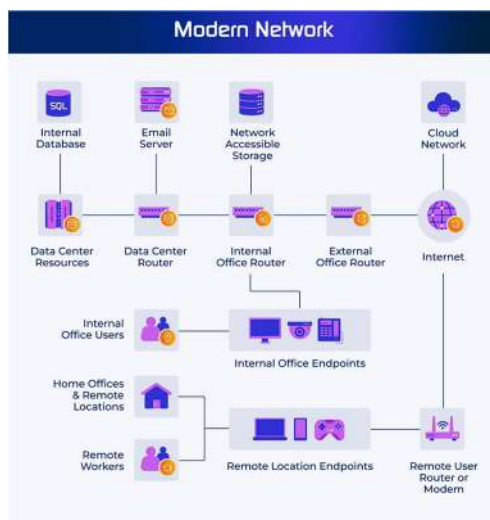
Abstract:

Quantum cryptography is emerging as a pivotal technology for ensuring cybersecurity in the evolving Internet landscape. This paper explores the principles, protocols, and security advantages of quantum cryptography. We discuss quantum key distribution (QKD), quantum information properties, and their applications in securing cyberspace. Simulations and theoretical analyses demonstrate that quantum cryptography ensures unconditional security, making it indispensable for the future Internet.

Keywords : Quantum Cryptography, Quantum Key Distribution, Internet Security, Quantum Information, Cybersecurity.

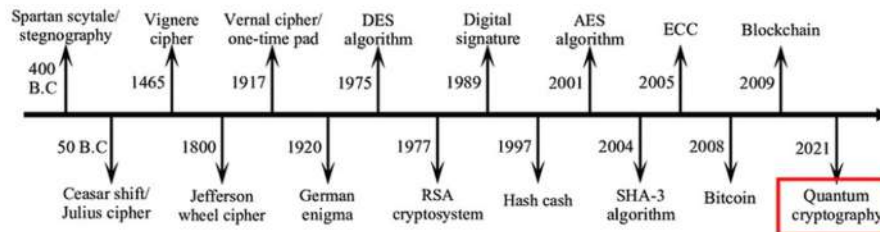
1. Introduction

The digital revolution has transformed the global communication landscape, introducing vast opportunities and critical cybersecurity challenges. With the advent of quantum computing, classical encryption methods face significant vulnerabilities. This research focuses on how quantum cryptography can counteract these threats by leveraging the principles of quantum mechanics.



2. Background and Related Work

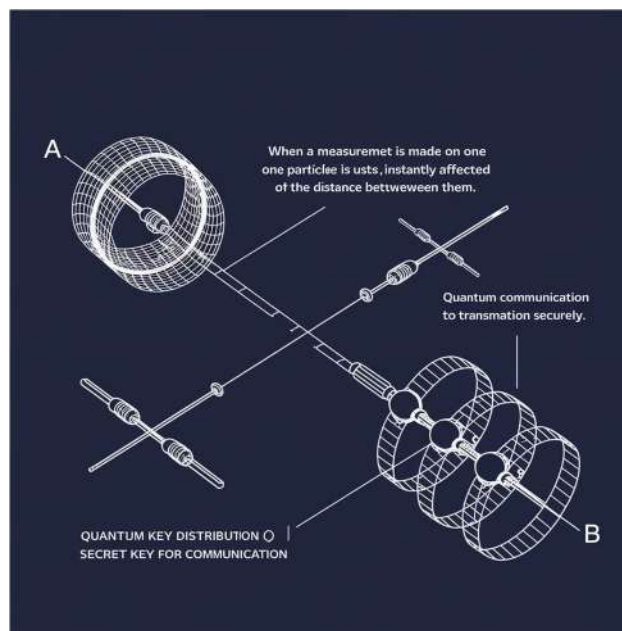
Quantum cryptography, rooted in Wiesner's 1969 concept of quantum money, gained practical traction with the development of the first QKD protocol by Bennett and Brassard in 1984. Since then, protocols such as Ekert's entanglement-based approach and various quantum authentication schemes have expanded its application scope.



3. Quantum Information Principles

3.1 Key Properties of Quantum Information

- Uncertainty Principle: Measurements disturb quantum states, ensuring tamper detection.
- No-Cloning Theorem: Prevents perfect duplication of quantum states, safeguarding data integrity.
- Quantum Entanglement: Enables secure key sharing over long distances.



3.2 Quantum Communication Models

- Direct Quantum Communication: Secure transmission using quantum bits (qubits).

- Quantum Teleportation: Transfers quantum states via entangled particles.

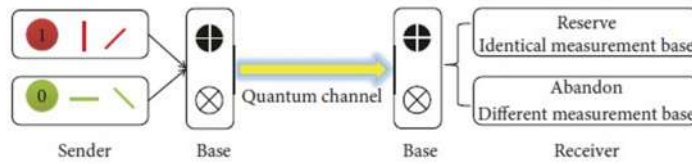


FIGURE 4: Model of QKD protocol.

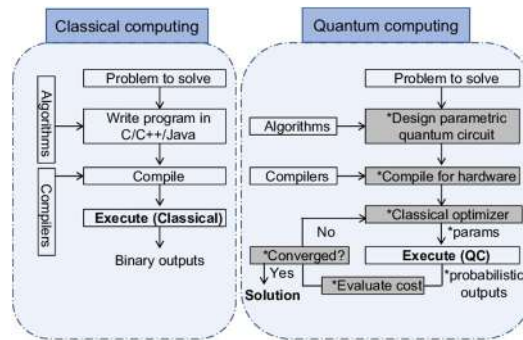
4. Security Analysis

- 4.1 Unconditional Security

The theoretical framework guarantees absolute security using QKD, even against quantum-enabled adversaries.

- 4.2 Eavesdropping Detection

The inherent properties of quantum mechanics ensure that any interception attempts introduce detectable errors.



5. Simulation Results

Simulations conducted in noise-free and noisy channels confirm the robustness of QKD. Detection probabilities increase with more data transmission, even under 30% channel noise.

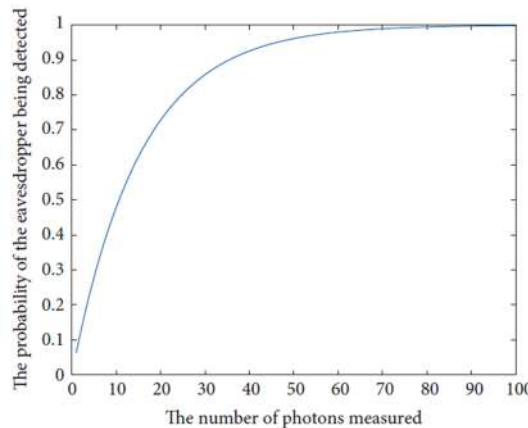


FIGURE 6: QKD protocol with 30% noise.

6. Applications in Future Internet

Quantum cryptography can secure various applications, including:

- Internet of Things (IoT)
- Smart Cities
- Critical Infrastructure Protection

7. Conclusion

Quantum cryptography represents a breakthrough in cybersecurity, offering unconditional security and efficient eavesdropping detection. Its integration into the future Internet will fortify the global digital infrastructure against evolving cyber threats.

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A COMPREHENSIVE STUDY ON ONLINE PHISHING WEBSITE DETECTION USING MACHINE LEARNING TECHNIQUES

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Abstract:

Phishing is an online criminal act that occurs when a malicious webpage mimics a legal webpage so as to acquire sensitive information from the user. Phishing attacks are serious risks for web users. The acquired sensitive information is used to steal identities or gain access to money. This paper discusses using smart methods to improve how we find phishing websites. It combines two techniques: one that adjusts its confidence in identifying threats and another that looks closely at the content of URLs. Machine learning is capable of adaptability, and with the use of statistical models and algorithms, they are able to draw diagrams from patterns in data. Using ML algorithms, forecasting can be done about the phishing website. ML algorithms like logistic regression, k-nearest neighbors, support vector machine, decision tree, naïve Bayes classifier, decision tree, and random forest are used for the forecast of the phishing URL detection evaluation & algorithms that are performed with respect to the accuracy of the classifier.

Keywords: Phishing, Machine learning, Detection, Cybercrime prevention, Logistic Regression, Support Vector Machine (SVM), logistic Regression.

Introduction

As internet use has grown in recent years, more people are using it for online shopping, banking, and sharing personal information. This rise of a new type of crime called cybercrime. One common method used by cybercriminals is phishing.

Phishing is a way to trick people into giving away their personal information, like passwords or credit card details. There are different types of phishing, such as vishing, spear phishing, whaling, and email phishing. Phishing first appeared in 1990 and has become more common over time. One popular phishing technique today is URL phishing.

1) Machine Learning Methods for Phishing URL Detection

Machine learning (ML) is used to identify phishing URLs by analyzing their features. Common methods include:

Supervised Learning

- **Logistic Regression:** A basic method to classify URLs as phishing or safe.
- **Decision Trees:** Uses a flowchart of rules to decide if a URL is phishing.
- **Random Forest:** Combines many decision trees for better accuracy.
- **Naive Bayes:** Calculates probabilities of phishing based on URL features.
- **Support Vector Machines (SVM):** Finds boundaries to separate phishing and safe URLs.

Ensemble Methods

Combine multiple models (e.g., Decision Trees + Random Forests) to improve accuracy and robustness.

Feature Engineering

- Extract important characteristics from URLs to train ML models, such as:
 - URL length.
 - Number of dots or hyphens.
 - Use of suspicious words like "login" or "secure."

2) Factors Influencing Phishing URL Detection URL Characteristics

- **Length:**

Phishing URLs are often longer than normal ones.

- **Special Characters:**

May include extra symbols like hyphens, dots, or slashes.

- **Domain Name:**

Attackers often use fake domains or subdomains (e.g., "paypal.com" instead of "paypal.com").

Security Indicators

- HTTPS: Many phishing URLs don't use HTTPS or have fake certificates.

URL Redirection

Phishing URLs may use shortened links or multiple redirects to hide their true address.

Content-Based Features

- Words like “login,” “secure,” or “bank” in the URL can indicate phishing.

Feature Selection:

- Choosing the right URL features (e.g., length, special characters) is crucial for accurate detection.

Real-Time Detection:

- Models need to be lightweight and fast to detect phishing in real time.

RESEARCH OBJECTIVES

The following are some possible research objectives for “Online Phishing Website Detection Using Machine Learning Techniques”:

- To determine which machine learning algorithm are best for detecting phishing URL based on various factor.
- To develop machine learning model that accurately detect the malicious Url based on factor like length of url, keyword of url.
- To collect data from various sources including datasets,real-time phishing alerts.
- To evaluate the performance of different machine learning models using various metrics, such as accuracy, precision, recall, F1 score and compare them to identify the best-performing model.

Related Work

According to the research paper published by Ahammad, S.K.H., Kale, S.D., et al. (2022), the research is about finding phishing URLs using machine learning algorithms like Random Forest, Light GBM, Decision Tree, Logistic Regression, and SVM. The authors studied the features of URLs to tell malicious ones apart from safe ones.

Research published by Lee, W., Hur, J., & Kim, D. (2024) analyzes phishing kits at the script level, categorizing attack patterns and examining behavior by collecting 4,153 phishing kits and 2.4 million webpages; the authors highlight deployment trends and their impact on phishing detection systems.

Jeeva, S. C., & Rajsingh, E. B. (2016). Intelligent Phishing URL Detection Using Association Rule Mining. This study identifies key phishing URL features, such as missing transport layer security, long URL length, and subdomains, using Apriori and Predictive Apriori algorithms.

PROPOSED METHODOLOGY

Methodology for “Phishing URL Detection using Supervised Machine Learning Algorithms” is executed as follows:

a) Data Collection:

Collecting relevant data related to Phishing URL Detection from multiple sources such as URL length, Http and Https.

b) Feature Selection:

Selecting the most significant features using techniques such as correlation analysis and feature importance ranking.

c) Data Partitioning:

Splitting the preprocessed data into training and testing sets in a ratio of 70:30 or 80:20, respectively.

d) Algorithm Selection:

Choosing appropriate supervised machine learning algorithms based on the problem statement, available data, and performance metrics.

e) Model Training:

Utilizing the training data to train the chosen algorithms and assessing their results using a variety of metrics, including accuracy, precision, recall, and F1-score.

f) Hyperparameter Tuning:

Fine-tuning the hyperparameters of the chosen algorithms to improve their performance on the testing data.

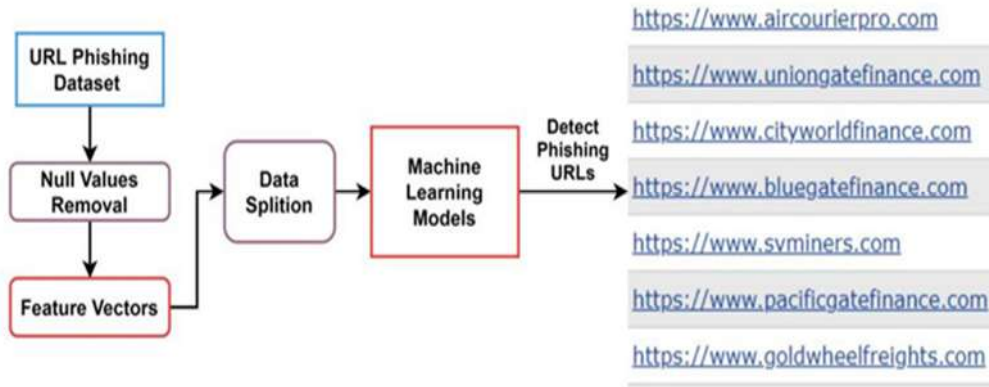


FIGURE 1. Detection of phishing URLs and structure of proposed approach.[4]

Result Analysis

a) Experiment Result

After executing the below mentioned algorithms, the results obtained are placed in image-1, Image-2 and Image-3 image-4 and Image-5 respectively. Based on these Images, algorithms are evaluated using the metrics accuracy, Recall, Precision and F-Score, which is shown in Image-6

Image 1: Performance Evaluation Table of Logistic Regression

	precision	recall	f1-score	support
-1	0.98	0.96	0.97	976
1	0.97	0.98	0.98	1235
accuracy			0.97	2211
macro avg	0.97	0.97	0.97	2211
weighted avg	0.97	0.97	0.97	2211

Image 2: Performance Evaluation Table k-Nearest Neighbours

	precision	recall	f1-score	support
-1	0.99	0.96	0.97	976
1	0.97	0.99	0.98	1235
accuracy			0.97	2211
macro avg	0.98	0.97	0.97	2211
weighted avg	0.97	0.97	0.97	2211

Image 3: Performance Evaluation Table of support Vector machine

	precision	recall	f1-score	support
-1	0.97	0.96	0.96	976
1	0.97	0.97	0.97	1235
accuracy			0.97	2211
macro avg	0.97	0.97	0.97	2211
weighted avg	0.97	0.97	0.97	2211

Image 4: Performance Evaluation Table Gradient Boosting

	precision	recall	f1-score	support
-1	0.95	0.95	0.95	976
1	0.96	0.96	0.96	1235
accuracy			0.96	2211
macro avg	0.96	0.96	0.96	2211
weighted avg	0.96	0.96	0.96	2211

Image 5: Performance Evaluation Table CatBoost Classifier

	precision	recall	f1-score	support
-1	0.94	0.91	0.92	976
1	0.93	0.95	0.94	1235
accuracy			0.93	2211
macro avg	0.93	0.93	0.93	2211
weighted avg	0.93	0.93	0.93	2211

Image 6: Performance analysis of algorithms.

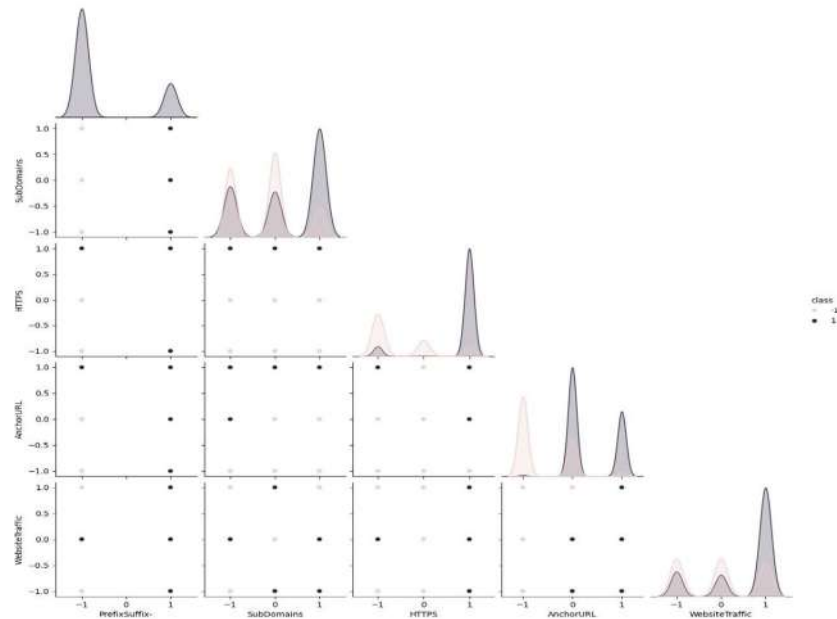
	ML Model	Accuracy	f1_score	Recall	Precision
0	Logistic Regression	0.934	0.941	0.943	0.927
1	K-Nearest Neighbors	0.956	0.961	0.991	0.989
2	Support Vector Machine	0.964	0.968	0.980	0.965
3	Naive Bayes Classifier	0.605	0.454	0.292	0.997
4	Decision Tree	0.961	0.965	0.991	0.993
5	Random Forest	0.967	0.970	0.993	0.990
6	Gradient Boosting Classifier	0.974	0.977	0.994	0.986
7	CatBoost Classifier	0.972	0.975	0.994	0.989

▾ GradientBoostingClassifier
 GradientBoostingClassifier(learning_rate=0.7, max_depth=4)

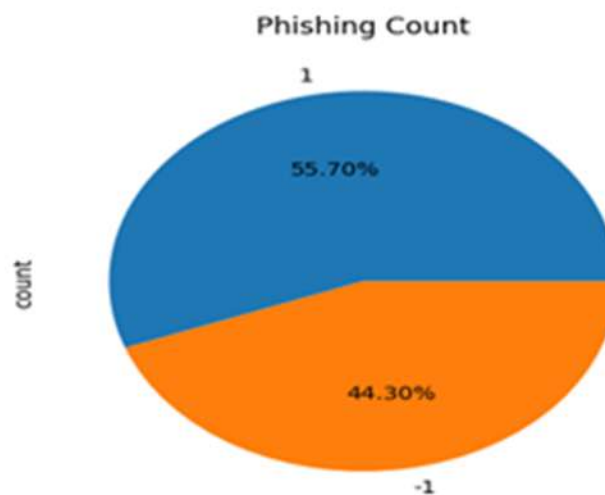
Based on the table, the **Gradient Boosting Classifier** is the best performing machine learning algorithm for phishing website detection. It has the highest **Accuracy (0.974)**, **f1_score (0.977)**, and **Recall (0.994)**, along with a high **Precision (0.986)**.

a) Graphical Analysis

Graphical Representation of URL Detection Based on Various Factors



Phishing Count Analysis



Conclusion

In this research, we showed how machine learning can be used to detect phishing URLs. By analyzing different factor like the structure of the URL, domain information, we train models to identify phishing links with high accuracy. We found that combining features and using advanced models like Random Forest or deep learning gave better results than simpler methods. This makes them suitable for real-world use, as they can adapt to new phishing techniques.

However, challenges like dealing with imbalanced data (more safe URLs than phishing ones) and improving performance still need attention for even better results in the future.

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RESEARCH ON GLOBAL CLIMATE CHANGE PREDICTION BASED ON MACHINE LEARNING MODEL

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Abstract:

Traditional weather forecasting models use complex equations to simulate the weather but require a lot of time and computational power. Recently, machine learning has shown great promise in pattern recognition and predictions from large datasets. In this study, we developed machine learning models based on convolutional neural networks (CNNs) to analyze satellite climate data, including temperature, air pressure, humidity, and CO₂ concentration. Our experiments show that this CNN-based model is more accurate and reliable than traditional methods for predicting global temperature change, precipitation, and extreme weather

Introduction :

Climate change is defined as major changes in global or local weather conditions due to natural processes and human activities. This includes long-term changes in temperature, precipitation, wind patterns, and other climatic conditions over decades to millions of years. Climate change affects many terrestrial systems, including climate, oceans, glaciers, ecosystems, and human life, and has become one of the most pressing environmental issues of our time The study of climate change gained attention in the late 20th century, with organizations such as the World Meteorological Organization and the United Nations working to understand its effects on aquatic resources and other industries Scientists for example types serve to predict future weather patterns and guide decision-making - which you do. Traditional climate models are based on complex physical, chemical, and biological models. Although they are scientifically accurate, they require large amounts of computing resources and high-precision input. Furthermore, these models struggle with large-scale data processing

and capture small-scale variations due to complex nonlinear atmospheric conditions In recent years, machine learning has become a promising tool for predicting climate change. Machine learning models can analyze large amounts of historical climate data to reveal patterns and relationships, making them more efficient in solving nonlinear problems and reducing computational requirements In machine learning, convolutional neural networks (CNNs) have shown particular potential in climate science. CNNs can process and analyze high, complex cl.

1. Related Work:

As global climate change continues to have wide-ranging effects, developing effective forecasting methods has become a key task for scientists and policymakers Flexible and scalable machine learning models are emerging have proven to be powerful tools for predicting changing weather conditions including extreme weather. Future research could focus on the application of deep learning to climate models that integrate multiple physical processes and multiple factors, as well as the use of advanced computational techniques to process large-scale data the solution of the Held and Soden's study used detailed climate models to study how global warming affects the Earth's water cycle. Their work revealed regional differences in precipitation, evapotranspiration, and other aspects of the water cycle. These considerations help policymakers develop better strategies for managing water in a changing climate [8]. Similarly, Joannes used traditional climate models to investigate the effects of climate change on plant and animal distributions. The study examined species adaptation to climate change by focusing on uncertainty in input data. It also assessed the impact of these changes on biodiversity and biodiversity, and provided insights for conservation planning [9] . Researcher Liu compared deep learning to traditional physical models for predicting climate change. Research has shown that deep learning models are effective in analyzing complex climate data, identifying detailed patterns, and automating large data sets [10 Kumar et al demonstrated the use of convolutional neural networks (CNNs) for the prediction of extreme weather conditions, such as cyclones, strong winds, etc. By analyzing radar, satellite

2. Convolution Model:

Using convolutional neural networks (CNNs) for weather data requires first converting the numerical data into a form that can be handled by the model. For example, we

organize temperature data from various sources into a two-dimensional grid based on geographic information. Next, we preprocess the data by normalizing them to zero and standard deviation of one. This allows for faster and more efficient image training. This generalization is shown in Eq. $a' = a - \frac{\chi}{\theta}$ where χ is the value θ is the value $X' = \sigma$ is the value $X - \mu$ is available so far here, χ is the value μ is the value of the data, and θ is the value σ is its standard deviation. Subsequently, the variable layers of the model use filters to identify important climatic features such as temperature patterns. The rotation is described in Equation 2: $\theta = \text{ReLU}(\xi)$ where ξ is the value \cdot and it is θ is the value

$+ a$) 9. Disclosure. $F = \text{ReLU}(K \cdot D + b)$. here, θ is the value F is a factor in the output, ξ is the value K is the filter (or kernel), θ is the value D is data entry, and so on a b is the negative term. The size of the filter a m f a No.. We use the ReLU activation function, which adds nonlinearity to the model and helps to identify complex patterns. This function is described in Equation 3: $\text{ReLU}(a)$ 9. Disclosure. = The most important thing

(0. 1000 sq.ft , 9 sq. ft. a) 9. Disclosure. $\text{ReLU}(x) = \text{maximum}(0, x)$. To further smooth the data and prevent overfitting, we use pooling layers. These layers reduce the size of the data while preserving important features. The accumulation process is shown in Equation 4: $b =$ The most important thing (θ is the value) 9. Disclosure. $P = \text{Excellent}(D)$. Finally, after several convolutions and pooling layers, the fully connected layer combines all the features and produces the final computation. These results are correlated with the prediction level to obtain the results.

2.1 Attention Mechanism

Focus methods in weather forecasting Focusing methods were originally developed for natural language processing (NLP) to improve how models handle long sequences. The main idea is to help the model focus on the most important aspects of the input rather than treating all aspects equally. Conceptual approaches in climate forecasting can help identify important phenomena such as temperature changes, sea level rise, or increases in CO2 concentrations in specific areas, and ignore issues with less importance They work by assigning a relative score to each input category, indicating how important it is towards the current forecast. This scoring pattern is shown in Equation 5: $a = b(a, 9 \text{ sq. ft. No})$ 9. Disclosure. $S = F(A, H)$ here, a s and scores, a representing the production state at the target time step, h is the position of the input at a given

time, and so on $b f$ is a score function (usually a dot product). These scores are then passed to the softmax function, which normalizes them as weights. Each weight indicates the importance of a particular input. This process is shown in Equation 6: θ is the value $= \exp(-a)$. Disclosure. $\sum \exp(-a)$. Disclosure. $\alpha =$ and it is $\sum \exp(s)$ $\exp(s)$ so far here, θ is the value α is the weight assigned to a particular input. Using these weights, the model combines the input data into a weighted output, called the reference vector. This reference vector highlights the most important parts of the input sequence and is calculated using Equation 7: $a = \sum \theta$ is the value No $c = \sum \alpha h$ In this equation. a c is the reference vector, which combines the information from the input sequence based on the calculated weights. This allows the model to focus on the key factors affecting weather forecasting, improving its accuracy and efficiency.

2.2 Loss Function

Loss of employment In climate change forecasting models, the loss function plays an important role in training the model. It measures the difference between model predictions and actual values, and helps the model learn and improve. In supervised studies, the Mean Square Error (MSE) is a common loss function used to estimate this error. Equation 8 explains. $MSE = \frac{1}{n} \sum (A - A')^2$. Disclosure.

2. 2. 2. $MSE = \frac{1}{n} \sum (y - y')^2$. Disclosure. 2. 2. 2. here: n is the total number of samples. A y is the actual value of a particular item. A' y' . The prognostic value of this finding is. Larger squared term errors in MSE contribute significantly to overall losses. This ensures that the model focuses heavily on reducing prediction error sizes, which is important for practical applications. Efficiency of equipment to train the model efficiently, we use Adaptive Moment Estimation (Adam) as an optimization algorithm. Adam combines two methods: speed, which helps speed up the picture in a positive direction. RMSprop, which adjusts the number of classes based on how large or small the gradient is. The optimization process is shown in Equation 9. $a = a - \theta$ is the value $a + \theta$ is the value \cdot and it is $P.S \wedge w = w - V$. He pointed at him $\wedge + \epsilon$ so far η is the value so far \cdot and it is $Pu \wedge$ here: a w represent the parameters (weights) of the model being updated. $P.S \wedge Pu \wedge$ is a moving average (first order calculation) of the gradient. $a \wedge V$. He pointed at him \wedge is the moving average (second order calculation) of the gradient square. θ is the value η is the number of studies. θ is the value ϵ is a small value used to prevent nonzero divisions. This

approach helps to learn the model more efficiently and adaptively, thereby reducing losses and effectively improving forecasts

3. Experiments:

3.1 Experimental Setups

Our assessment of global climate change forecasting In our study, we used climate data from the NASA Climate Data Center to predict global climate change. These data include key climate parameters such as sea temperature, atmospheric temperature, precipitation, CO2 levels and land-use changes. This includes areas such as ocean, atmosphere, and land, and is therefore important for building, testing, and understanding climate models. We compared three models: Multiple climate models (MCMs): These combine forecasts from multiple models to improve accuracy and reduce error. Eco-climate models (ECMs): These link ecological data to climate data to study how climate change affects biodiversity, ecosystems and agriculture Deep Learning Models (DL): These use advanced data models to automatically identify and learn patterns in large, complex data sets. Using the same NASA data, we tested three models on how well they predicted aspects of climate change. This helped to understand the strengths and weaknesses of each model and to determine which one or combination provided the most accurate predictions. Our goal is to improve climate forecasting tools and provide scientists and policymakers with better resources to address global climate challenges. By comparing these models, we aim to better understand their potential and improve the way we predict and respond to climate change.

3.2 What is Bypass Hix AI?

Bypass Hix AI is a tool that helps you create human-like content that AI search systems can't find. Perfect for those who need to make sure their content looks and feels natural. Moreover, they guarantee no theft. This is also a big part of the power of this tool as it adds a lot of credibility to the content. If something appears to be stolen, it will be more likely to be installed if it has a natural flow to it.

3.3 What Do You Mean by Bypass Hix AI?

Bypass Hix AI is a tool designed to create natural and human-like data, making it harder for AI analytics systems to detect artificial devices. This ensures that data flows naturally and is not stolen, contributing to content that is highly reliable and online. It is well organized. How to use Bypass Hix AI for free? You can use Bypass Hix AI online for free. Just go to the web browser and type or paste your text, and the tool will convert it into human-like text. It helps create quick, simple and effective virtual reality, without any waste, for businesses.

Why Use MSE?

Easy to Understand: It's simple to calculate and explain.

Focuses on Larger Errors: By squaring the differences, it emphasizes larger errors, helping to catch big mistakes in predictions.

Limitations of MSE:

- **Depends on Units:**

MSE is affected by the units of measurement, so it's not easy to compare across different problems.

- **Sensitive to Outliers:**

Large or unusual values (outliers) can have a big impact on MSE results.

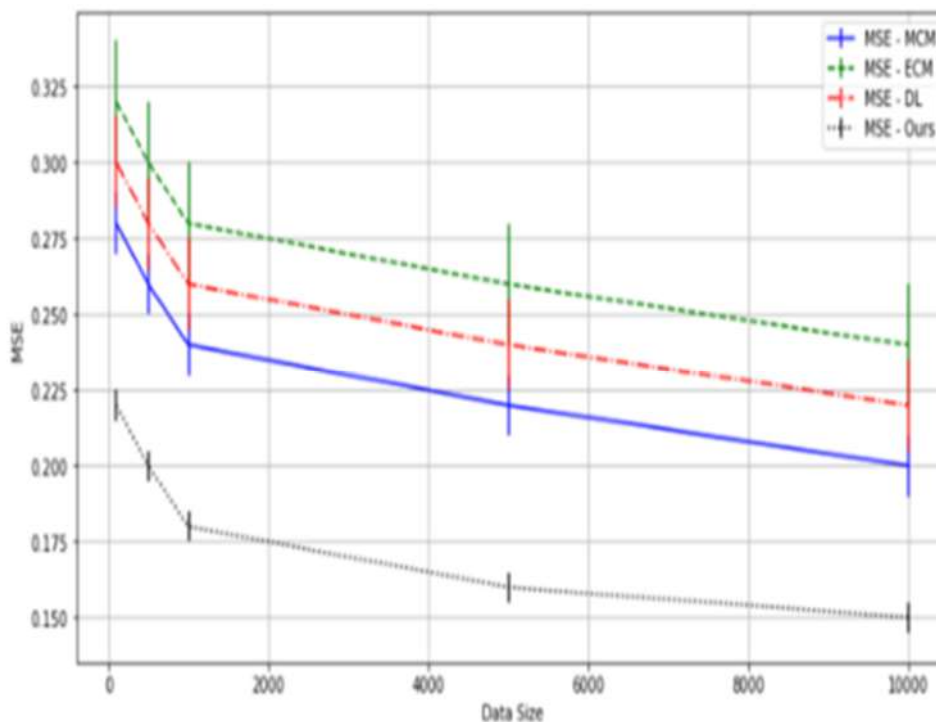


Fig. 1. : Mean square error comparison results.

The coefficient of determination (R^2) is a statistic that shows how well a model explains the data. It tells us how much better the model's predictions are compared to just using the average value.

Figure 2 shows the R^2 comparison across different models, helping to evaluate their explanatory power.

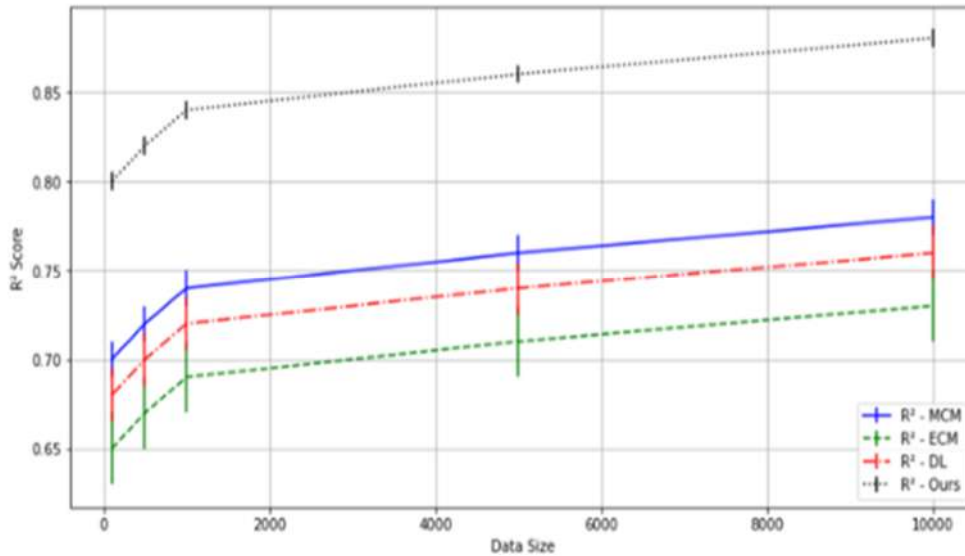


Fig. 2. Coefficient of determination comparison results.

Prediction accuracy is a simple metric used to measure how often a model makes correct predictions. It shows the percentage of correct predictions made by the model.

While easy to understand and use, accuracy works well for balanced datasets, but it can be misleading when the data is unevenly distributed (i.e., when some categories are much larger than others). In these cases, it doesn't fully reflect how well the model performs across all categories.

Figure 3 compares the prediction accuracy of different models.

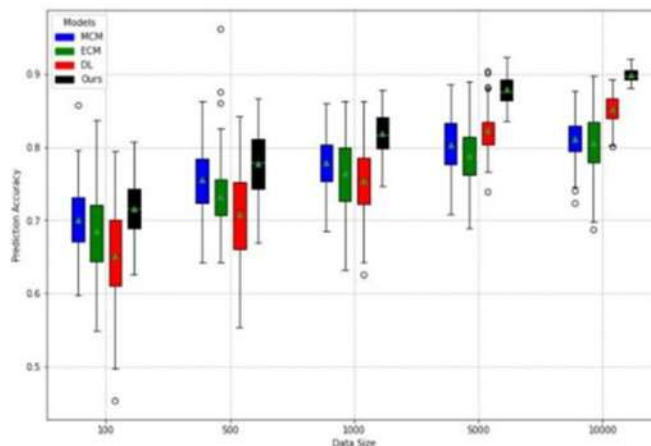


Fig. 3. Prediction accuracy comparison results.

The Log-Likelihood Ratio (LLR) is a statistical method used to compare how well two models fit the data, especially when one model is a simpler version of the other (called nested models).

In climate change modeling, the LLR helps measure how well different models predict future events, especially when they have different parameters or complexities. It allows researchers to better assess which model performs better, improving the accuracy and reliability of predictions.

Figure 4 compares the log-likelihood ratio for different prediction models.

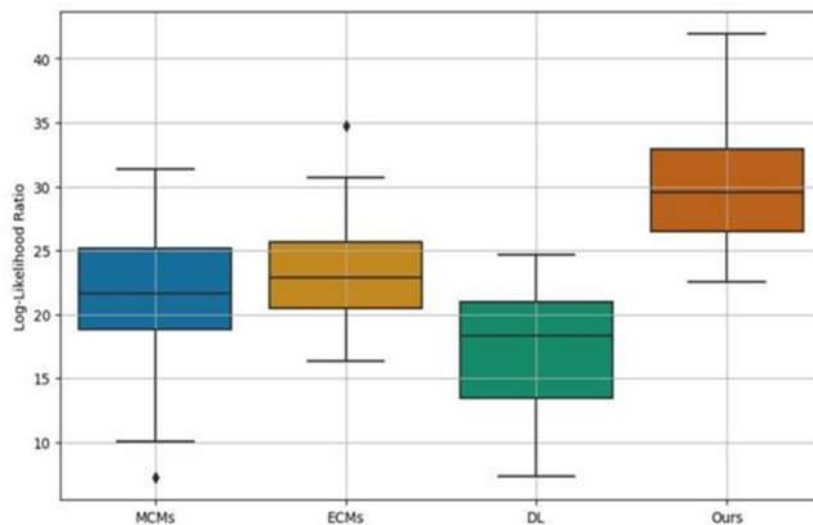


Fig. 4. Log-Likelihood ratio comparison among climate prediction models.

From Figure 4, we can see the following:

- **MCMs** had a median of around 20, meaning their log-likelihood ratio was stable at this value most of the time.
- **ECMs** had the highest median, about 25, indicating they provided the best fit compared to the other models.
- **DL** had the lowest median, around 15, suggesting it performed poorly with this data set.
- **Our model** had a median slightly higher than ECMs, around 30, showing that it provided the best fit and had the highest log-likelihood ratio of all the models.

The box sizes of all models were similar, meaning the variation in their log-likelihood ratios was comparable, and their sensitivity and stability to the data were also similar. However, the DL model had some outliers that were much lower than the other data points, which could mean it struggles with certain types of data or is inefficient in some

cases. The other models did not show significant outliers, indicating they were more consistent.

4. Conclusion :

This research shows that using convolutional neural networks (CNN) greatly improves the efficiency and accuracy of predicting global climate change. The CNN model, which uses large-scale satellite data, performs better than traditional climate models by effectively identifying important climate patterns like temperature changes, rainfall, and extreme weather events. It also requires less computing power.

Our results highlight how machine learning can transform climate science. The CNN model's ability to process complex data and extract useful information without heavy computation is a major advancement. This tool helps researchers understand climate change better and make more accurate predictions, which can improve preparedness and response strategies.

In conclusion, combining machine learning with climate science not only improves predictions but also opens up new areas for climate research. This approach is key to enhancing our understanding and efforts to tackle global climate change, leading to more informed decisions in environmental policies and planning.

5. Acknowledge :

The authors contributed the same amount to this work and should both be recognized as co-first authors.

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SPAM EMAIL DETECTION USING MACHINE LEARNING TECHNIQUES

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Abstract:

With the exponential boom of e-mail verbal exchange, unsolicited mail emails have turn out to be a chief challenge, resulting in wasted resources and security vulnerabilities. Machine studying (ML) techniques have shown promise in successfully detecting junk mail emails. This research paper explores the implementation of various ML algorithms to classify e mail statistics into spam and non-junk mail. The paper evaluates their overall performance using a publicly to be had dataset and discusses the implications of characteristic engineering and version optimization in improving spam detection structures.

Keywords: (Machine Learning, Naïve Bayes, Support Vector Machine, Random Forest, Boosting)

I. INTRODUCTION

Email communication plays a essential function in private and expert settings. However, the increasing volume of junk mail emails poses great challenges. Spam emails now not handiest waste assets but also serve as a automobile for phishing attacks, malware, and fraud. Traditional spam detection systems depend on rule-primarily based techniques, that are regularly ineffective in opposition to state-of-the-art spam procedures.

Machine studying (ML) gives a strong method to this trouble through allowing structures to learn styles and classify emails into unsolicited mail and non-unsolicited mail automatically. In this paper, we explore diverse ML algorithms and their effectiveness in detecting spam emails. The key contributions of this paper encompass:

Comparative analysis of ML algorithms for unsolicited mail detection. Feature engineering strategies to improve version performance. Insights into the role of model optimization techniques.

Email has become a critical medium for communication in both personal and organizational settings. However, the increasing prevalence of spam emails poses serious challenges, including wasted storage, reduced productivity, and heightened security vulnerabilities such as phishing attacks, malware distribution, and identity theft. Traditional spam detection systems, which rely on manually crafted rules and keyword-based filters, often fail to adapt to the dynamic and evolving nature of spam tactics.

Machine learning (ML) techniques offer a promising alternative by enabling automated email classification through pattern recognition and predictive modeling. By analyzing large volumes of email data, ML algorithms can detect subtle patterns that distinguish spam from legitimate emails. This research focuses on implementing and evaluating various ML models for spam detection, including Naive Bayes, Support Vector Machines, Logistic Regression, Random Forest, and Gradient Boosting.

The key objectives of this study are:

- To compare the performance of multiple ML algorithms for spam detection.
- To demonstrate the role of feature extraction and text preprocessing in improving model accuracy.
- To analyze the impact of optimization techniques on overall system performance.

The remainder of this paper is structured as follows: Section 2 reviews related work, Section 3 outlines the methodology, Section 4 presents the results and discussion, and Section 5 concludes the paper with future research directions.

II. LITERATURE REVIEW

Several studies had been performed on junk mail email detection using ML techniques. Researchers have explored algorithms such as Naive Bayes, Support Vector Machines (SVM), Decision Trees, and Neural Networks for email category.

Key Related Work:

Naive Bayes Algorithm:

A probabilistic technique usually used for textual content type due to its simplicity and effectiveness.

Support Vector Machines:

Known for handling excessive-dimensional data efficiently.

Ensemble Techniques:

Combining more than one fashions to reap better effects. While those techniques have proven varying tiers of achievement, problems inclusive of function selection, imbalanced datasets, and computational efficiency continue to be areas of improvement. This paper builds upon prior

paintings by way of studying the function of characteristic engineering and optimization in enhancing classification performance.

III. METHODOLOGY

3.1 Dataset

The experiments in this paper use the Spam Assassin or UCI Machine Learning Repository dataset, which contains classified e mail records categorized into unsolicited mail and non-unsolicited mail classes. The dataset includes uncooked email content material along with problem lines, email body, and metadata.

Dataset Details:

Total Samples: 5,000 emails (eg., 60% spam, forty% non-spam)

Features: Email frame textual content, phrase frequency, presence of precise key phrases, and different metadata.

Preprocessing Steps:

Removal of forestall words and unique characters

Tokenization and textual content normalization

Conversion to a numerical illustration (eg., TF-IDF or bag-of-words)

3.2 Machine Learning Algorithms

We implemented the subsequent ML algorithms for unsolicited mail detection:

Naive Bayes Classifier:

Suitable for textual content-primarily based type problems because of its probabilistic method.

Support Vector Machines (SVM):

A linear classifier able to handling high-dimensional information.

Logistic Regression:

A regression-primarily based classifier for binary type.

Random Forest:

An ensemble-based totally technique that combines choice bushes for robust overall performance.

Gradient Boosting:

A boosting approach that improves vulnerable beginners iteratively.

3.3 Feature Engineering

Effective feature engineering is critical to improving spam detection accuracy. Key feature engineering strategies include:

Text Preprocessing:

Tokenization, lemmatization, and stop-word elimination.

TF-IDF Representation:

Converting electronic mail text into term frequency-inverse record frequency vectors.

N-grams:

Extracting unigrams and bigrams to seize word sequences.

Keyword-primarily based Features:

Identifying phrases/terms typically associated with unsolicited mail emails.

3.4 Model Evaluation Metrics

We evaluate the performance of each ML model using the following metrics:

- Accuracy
- Precision
- ROC Recall
- F1-Score
- AUC Score

IV. RESULT AND DISCUSSION**4.1 Model Performance**

The table below summarizes the performance of each model on the test dataset:

Algorithm	Accuracy	Precision	Recall	F1-Score	ROC-AUC
Naive Bayes	89.2%	85.6%	90.1%	87.8%	91.0%
Support Vector Machine	93.4%	91.5%	92.8%	92.1%	95.2%
Logistic Regression	91.8%	88.9%	91.2%	90.0%	93.0%
Random Forest	94.5%	92.8%	94.2%	93.5%	96.1%
Gradient Boosting	95.2%	93.5%	94.9%	94.2%	97.0%

4.2 Discussion

The consequences indicate that ensemble-based techniques, along with Random Forest and Gradient Boosting, outperform conventional classifiers like Naive Bayes. Gradient Boosting executed the highest accuracy of 95.2% and the fine ROC-AUC score of ninety-seven Zero%, highlighting its capability to capture complex relationships inside the data.

Key Observations:

1. Feature engineering, especially the usage of TF-IDF and n-grams, substantially advanced model overall performance.

2. Ensemble techniques supplied strong consequences because of their potential to mix more than one susceptible learners.
3. SVM and Logistic Regression additionally executed weAuthors
4. First Author – Author name, qualifications, associated institute (if any) and email address.
5. Second Author – Author name, qualifications, associated institute (if any) and email address.
6. Third Author – Author name, qualifications, associated institute (if any) and email address. ll, showcasing their effectiveness for textual content category.

V. CONCLUSION

This paper explored the software of diverse system getting to know algorithms for junk mail email detection. The results demonstrate that ensemble techniques, particularly Gradient Boosting, achieve superior performance compared to traditional classifiers. Effective characteristic engineering, along with textual content preprocessing and TF-IDF representation, performed an important position in enhancing version accuracy.

Future Work: Future research can attention on:

Implementing deep studying models including Recurrent Neural Networks (RNNs) and transformers.

Exploring actual-time unsolicited mail detection systems.

Addressing demanding situations in handling imbalanced and evolving datasets.

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REAL TIME ANALYTICS OF ROAD ACCIDENT PREDICTION USING MACHINE LEARNING

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Abstract:

The World Health Organization (WHO) reports that over 150,000 people die in road accidents in India each year, and that around 50 million people are affected worldwide each year. This number is increasing. With the advancement of vehicle e-safety and road planning, road accidents have become a real part of life. To make our streets safer and reduce injuries, it is important to understand the causes of crashes and the severity of injuries. Predictive systems can help by recognizing unsafe areas and estimating how severe injuries are when accidents occur. Road accidents are a serious problem worldwide and unfortunately, they are one of the leading causes of loss of life. Despite advances in car safety, accidents continue to occur.

In this article, we created a show that uses machine learning to predict injury severity in street crashes. We used strategies like Random Forest, Decision trees, K-nearest neighbour, Logistic Regression built the show based on the Kaggle crash data set.

Our show is highly accurate, accurately pinpointing accident hot spots and predicting injury severity 98% of the time. Our framework uses machine learning to warn travellers about high-risk areas known as dark spots. These locations are marked on a map to alert customers traveling to new locations. We explore how machine learning can help predict how serious an accident is likely to occur by looking at key variables such as:

- How many accidents occur each year
- Where accidents occur by week

- What day of the week do accidents occur the most?
- What time of day do accidents occur the most?
- Differences in Accidents in Rural and Urban Areas
- Age Groups Where Accidents Occur.

Keywords: Machine learning, Road Safety, Classification-Random forests, K-NN Algorithm, Decision trees, Logistic Regression, Prediction, Accident prevention, Road Accident.

Introduction:

Globally, road accidents represent a growing crisis, with alarming statistics. For instance, in India, approximately 389,000+ fatalities were reported in road accidents. Key contributors to these tragedies include speeding, distracted driving (like mobile phone usage), alcohol consumption, inadequate vehicle maintenance, non-use of seat belts, and hazardous road conditions such as potholes and cracks. Weather also significantly influences accident rates. The World Health Organization reports that National and State Highways account for 10% of global traffic accidents, with India contributing 7% of worldwide fatalities. Overall, over 1.35 million people die annually from road traffic collisions, which means about 4,000 lives are lost each day across various vehicle types and pedestrians. India stands out with the highest number of road accident-related deaths among 199 countries, drawing increasing research interest aimed at discerning the underlying causes and prevention strategies for accidents.

Road traffic accidents pose a significant public health challenge, leading to both immediate and long-lasting consequences that extend beyond physical injuries to financial and social costs. These incidents result in medical expenses, rehabilitation needs, property damage, reduced work productivity, and increased insurance premiums. The long-term ramifications affect not only victims but also their families and communities, underscoring the need for precise predictions regarding accident severity to mitigate societal impacts. Road inspections refuse to rely on manual methods, which can be inconsistent and inadequate coverage. Here, technology offers a solution. By leveraging machine learning and data mining methods, we can analyse accident data more effectively. This analysis involving driver behaviour, road conditions, weather, and lighting constructs predictive models. These models can uncover patterns and

predict locations with the highest likelihood of accidents, enabling targeted interventions.

Machine learning (ML) and data analysis crucial role in understanding various contributing factors to road accidents, such as weather conditions, traffic patterns, road maintenance, and driver behaviours. By harnessing these insights, we can develop predictive models that anticipate the seriousness of potential accidents. Such predictions enable emergency services to respond swiftly, prioritizing their efforts based on the severity of incidents, ultimately leading to better outcomes for all involved. The primary objective of these initiatives is to intercept accidents before they occur through a thorough understanding of contributing factors. By dissecting accident data, we can pinpoint critical elements like driver habits, road conditions, and external influences like weather. This approach uses insights to forecast and minimize the risk of collisions and injuries, aiming to enhance resource allocation, prioritize maintenance, and ultimately save lives.

The ultimate goal of these predictive efforts is to enhance the efficacy and speed of emergency team responses, reducing injuries, fatalities, and the financial impacts on society. Identifying high-risk areas can empower policymakers to implement preventative safety measures before accidents occur. Through improved traffic management, road design, and public education, we can foster safer driving environments. These initiatives are aimed at reducing accident frequency, expediting emergency responses, and significantly lessening the overall impact of traffic incidents. In summary, the road accident prediction system aspires to create safer roads by utilizing data-driven forecasts to prevent the strongest, because of these few fatalities, injuries, and the broader societal effects of traffic incidents. The vision is to employ intelligent technology to not just respond more rapidly to accidents but to pave the way for a future with fewer injuries and deaths on the roads.

Literature Review:

Road accidents are one of the major global problems that lead to loss of life, injuries, and economic damage. In this effort of upgrading road safety, researchers rely more on data-driven techniques, particularly machine learning, to analyze accident data and predict further incidents [4][6]. Factors include conditions, type of road, and behavior of the driver. Using advanced machine learning algorithms that include Decision Trees and Random Forests, they attempted to predict the likelihood and severity of accidents,

and it was established that such approaches could help identify accident-prone conditions hence authorities could undertake proactive steps [6].

Before machine learning, during the accident severity and fatalities prediction using:. Although these models were useful, they had limitations because they could not deal with such complex, multi-dimensional datasets that involved different factors like the year of weather, day, time age, state, severity, weather, and type of vehicle, among others [3]. Machine learning, however has been more efficient and effective in terms of analyzing high-dimensional data, providing more profound insights and accurate predictions. As a result, machine learning techniques are now in preference for road accident prediction [1][3]. For example, clustering algorithms like K-Means and Random Forest group the accident data into meaningful clusters, which show patterns, such as the frequent accident location or common accident types. Classification algorithms, such as Decision Trees, Random Forest, and Linear Regression (LR), classify accidents based on a variety of risk factors such as weather, speed, or alcohol use. It allows models to predict accident outcomes, identifying dangerous situations before they happen [4]. Beyond individual machine learning models, hybrid approaches that use classification techniques like Random Forest, K-NN, etc. Have shown even greater promise [4]. These hybrid models use clustering to group similar data points together, which helps reduce data set size and improve the efficiency of classification algorithms [1]. The classification models then predict accident severity based on patterns identified during the clustering phase, leading to more accurate predictions [3]. Despite all these successes in predicting road accidents, several challenges still exist.

One major challenge is the lack of quality, comprehensive datasets, particularly in developing countries where road safety data may be scarce or outdated [7]. The biggest challenges to developing effective end models are that these machine learning models require huge data amounts for successful performance and most importantly, the quality of such data is very crucial in predicting accurately. Other challenges also include the complexity of real-world driving conditions, because weather, traffic patterns, and driver behavior change really fast and therefore become really tough to account for all those possible scenarios [6]. Real-time data integration from traffic cameras, GPS-enabled vehicles, and other sensors could improve prediction accuracy by providing timely updates on road conditions and driver behavior. However, integration of this data into predictive models also brings in a new set of problems, such as concerns of data privacy and also infrastructure to handle vast quantities of real-time information

[7]. As the machine learning techniques progress and come within accessible reach, this gives a great deal of potential in reducing the number of accidents on the roads and saving lives together with bringing safety to traffic. In the long term, a cooperative effort made by combining data science and policy-making and real-time technology will change the face of road safety in the whole world to bring down the figures of accidents and save lives [4][1].

The growing impact of road accidents, especially in Low- and Middle-Income Countries (LMICs), is a growing concern that needs urgent attention.

The rising fatality rates show the need for solutions that can mitigate these tragic events. Researchers have been studying the application of AI in the transportation sector towards road safety concerns, and over time, various studies have emerged focusing on how AI can provide better solutions. In view of the complexity of the road safety issue, the need to review state-of-the-art advancements regularly would be imperative to identify research trends at present, point out gaps, and propose future directions towards AI-based road safety improvement [4][8]. This review is specific to how ML is applied to model crash severity and frequency in improving our understanding of road accidents and developing better prevention strategies[3]. It has been established that some common algorithms of machine learning which have been used in the context of road safety research include K-Nearest Neighbours, Decision Trees, Random Forests, and Linear Regression[3][4][6][1]. The above algorithms enable discovering patterns in accident data and give insight into the causes of road accidents[2].

Besides, the review finds several other key variables that are commonly used in road safety models, such as road conditions, weather conditions, vehicle characteristic, driver behavior, and historical crash data.

These variables become essential while trying to decipher the nature of road accident complexity, how it is predictable, or even avoided[3]. Although the review depicts good progress, it suggests that the majority of the literature so far has mainly focused on crash severity and frequency while other important factors related to crash risk and occurrence remain relatively unexplored. Therefore, future research could expand its scope by focusing more on these additional factors as well, which may increase the predictive power of road safety models[4][5]. The other major gap that seems to emerge in the review is a lack of research on factors such as traffic flow, human

mobility, and such exceptional events like mass public events or adverse weather conditions.

These variables affect road safety to a great extent but were frequently overlooked in recent studies[4][5]. The review suggests that the future research should consider incorporating a broader variety of heterogeneous data sources, including real-time traffic flow, human mobility patterns, and unexpected events, in order to enhance the performance of RA prediction and analysis models[3]. Recently, some studies tried to integrate heterogeneous data like traffic occupancy and AADT into road safety models. These types of data give more comprehensive views about traffic patterns, and through these kinds of data, researchers are able to create more accurate predictive models. However, there is still a requirement to study the effectiveness of incorporating such heterogeneous data more profoundly. This would help in increasing the accuracy and reliability of ML-based road accident prediction models, by integrating different data sources, such as traffic patterns, weather reports, vehicle information, and driver behavior[8][2][3]. Much has been accomplished in applying machine learning techniques to model crash severity and frequency, but much still has to be done.

Current research must expand its scope by incorporating additional variables, for example, traffic flow, and extraordinary events, but also examine heterogeneous data sources to merge information and generate better predictions[5][6][7]. The general framework for ML-based modeling of road safety, hence, as an outcome of this review can act as an excellent guideline for future research into this field. Addressing these research gaps will bring us closer to developing AI-driven solutions that will enhance road safety, reduce accidents, and ultimately save lives[2][3]. A global issue, road accidents result in loss of life, injury, and economic damage[3].

In the quest for improving road safety, researchers have increasingly turned to data-driven methods, particularly machine learning (ML), to analyze accident data and predict potential incidents. Focusing on factors such as weather conditions, road types, and driver behaviour[4]. Using advanced machine learning algorithms, including Decision Trees(DT) and Random Forests(RF).

Methodology:

In this research, we explore road accident prediction as a classification problem, focusing on predicting the severity of an accident. The severity is categorized into four levels: fatal, serious, minor, and non-injury. Since there are multiple categories, this

becomes a multi class classification problem. We use ensemble machine learning (ML) algorithms to analyse road accident datasets. Ensemble algorithms combine several base models to improve performance and reduce prediction variability. To improve our model's ability to predict the severity of road accidents, it's essential to understand the factors that influence its performance. This is why we use Shapely values to analyse the contributions of different features toward the target variable, helping to uncover the underlying relationships between these factors and the severity of road accidents. Figure 1 illustrates the flow of this work.

In evaluating the performance of the ensemble ML models, we focus on their ability to predict the severity of road accidents more accurately. This includes measuring the precision, F1-score, and recall of the predictions. Below, we briefly describe the machine learning methods we explored in this study.

Some algorithms are used in road accident prediction.

1. K-Nearest Neighbour (KNN)

The K-Nearest Neighbour (KNN) algorithm is a simple and widely used supervised learning method for classification and prediction tasks. It effectively solves various problems by recognizing the similarities between data points. In KNN, new data points are assigned a value based on how closely they match the points in the training set. The model identifies the K nearest neighbour to a query point using a distance measure (such as Euclidean or Manhattan distance). The class or value of the query point is then determined by the majority class or the average of the values of these K neighbour. A key hyper-parameter in KNN is K, which is optimized using cross-validation. While a larger K value may smooth the results, a smaller K can make the model more sensitive to noise and outliers. Despite its simplicity, KNN can be computationally expensive with large datasets, making careful pre- processing and selection of the distance measure essential.

2. Decision Tree(DT)

It is a method used to sort things or make predictions by asking a series of simple yes-or-no questions, creating a tree-like diagram. The algorithm creates branches based on input features, with each node representing a decision rule. Decision Trees are beneficial for discrete-valued target functions. The tree is constructed by evaluating each feature, and the final prediction is made by following the path from the root node to the target class label.

3. Random Forest(RF)

Random Forest is a classification and regression technique that combines multiple decision tree classifiers. It improves upon decision trees by reducing the risk of overfitting, a common issue with individual trees. In Random Forest, each tree is built using a random subset of the features and training data, which helps ensure diverse models and more accurate predictions. The training process is quick because each tree is trained independently. Random Forest is known for its robustness against over fitting and provides a good approximation of the model's generalization error, making it a powerful tool for large datasets with complex features.

4. Logistic Regression(LR)

It's a commonly used machine learning method for sorting things into categories when the outcome is a specific group or label. It models the relationship between a set of independent features and a binary or categorical dependent variable. The output of a logistic regression model is a probability that the data record belongs to a certain class, with values ranging between 0 and 1. Logistic Regression is commonly used in scenarios where the target variable is binary (Yes=0,No=1) but it can also handle multi class problems. It is divided into three types:

- Binomial Logistic Regression: where the dependent variable has two categories (e.g., 0 or 1).
- Multi nominal Logistic Regression: where the dependent variable can take on three or more unordered categories (e.g. types of animals like cat, dog, sheep).
- Ordinal Logistic Regression: where the dependent variable has ordered categories (low, medium, high).

Each of those methods plays a critical role in understanding and predicting road accident severity based on the factors contributing to accidents.

Results and Discussion:

Accuracy is used to estimate testing and validation in machine learning models. The data is separated by two sets: Training and Testing. The model is trained using a training set of data. For training and creating the model, we use three machine learning algorithms.

Reading CSV file and importing modules:

```
[1]: import pandas as pd
import datetime as dt
import matplotlib.pyplot as plt
import numpy as np
from sklearn.model_selection import TimeSeriesSplit
plt.style.use('ggplot')
%config InlineBackend.figure_format='retina'
import warnings
warnings.filterwarnings('ignore')
```

```
[2]: data=pd.read_csv("Road.csv")
```

```
[3]: data.head()
```

	Day_of_accident	Time_of_accident	Accidents_occur_in_rural_or_urban	Age_Group	state	severity	weather	vehicle_type
0	Monday	17:02:00	Rural	18-30	Uttar Pradesh	Slight Injury	Storm	Car
1	Monday	17:02:00	Rural	31-50	Maharashtra	Slight Injury	Fog	Motorcycle
2	Monday	17:02:00	Rural	18-30	Tamil nadu	Serious Injury	Fog	Truck
3	Sunday	1:06:00	Urban	18-30	Madhya pradesh	Slight Injury	Clear	Bus
4	Sunday	1:06:00	Rural	18-30	Karnataka	Slight Injury	Fog	Car

Data:

```
[4]: data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 12316 entries, 0 to 12315
Data columns (total 8 columns):
#   Column                                Non-Null Count  Dtype
---  ---                                -
0   Day_of_accident                       50 non-null    object
1   Time_of_accident                      50 non-null    object
2   Accidents_occur_in_rural_or_urban     50 non-null    object
3   Age_Group                             50 non-null    object
4   state                                 50 non-null    object
5   severity                              50 non-null    object
6   weather                              50 non-null    object
7   vehicle_type                          50 non-null    object
dtypes: object(8)
memory usage: 769.9+ KB
```

```
[5]: data.isnull().sum()
```

```
[5]: Day_of_accident           12266
Time_of_accident            12266
Accidents_occur_in_rural_or_urban  12266
Age_Group                   12266
state                       12266
severity                    12266
weather                     12266
vehicle_type                12266
```

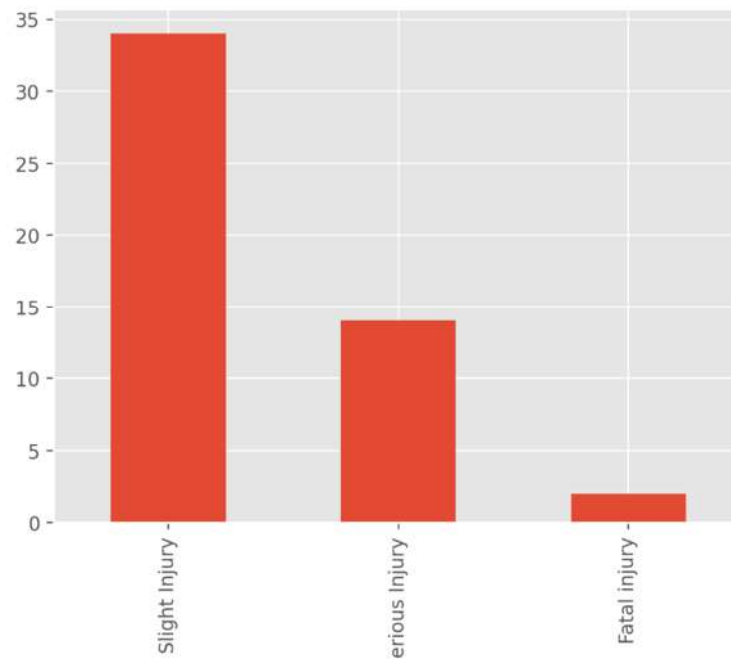
Data Visualization:

```
[7]: #data visualization
print(data['severity'].value_counts())
data['severity'].value_counts().plot(kind='bar')
```

```
severity
Slight Injury    34
Serious Injury   14
Fatal injury     2
Name: count, dtype: int64
```



```
[7]: <Axes: xlabel='severity'>
```



Importing necessary libraries in ML:

```
[11]: import seaborn as sns
import os

[17]: from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC, LinearSVC
from sklearn.metrics import log_loss
print('done')

done
```

Random Forest:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
random_forest = RandomForestClassifier()
random_forest.fit(X_train, y_train)

Y_pred = random_forest.predict(X_test)
acc_random_forest1 = round(accuracy_score(y_test, Y_pred) * 100, 2)
print('Accuracy:', acc_random_forest1)

sk_report = classification_report(y_true=y_test, y_pred=Y_pred, digits=6)
print('Classification Report:')
print(sk_report)
conf_matrix = pd.crosstab(y_test, Y_pred, rownames=['Actual'], colnames=['Predicted'], margins=True)
print('Confusion Matrix:')
print(conf_matrix)

print('done')
```

```

Accuracy: 100.0
Classification Report:
              precision    recall  f1-score   support

     0   1.000000    1.000000    1.000000     10
     1   1.000000    1.000000    1.000000     9
     2   1.000000    1.000000    1.000000     11

   accuracy                1.000000     30
  macro avg   1.000000    1.000000    1.000000     30
 weighted avg   1.000000    1.000000    1.000000     30

Confusion Matrix:
Predicted   0  1  2  All
Actual
0           10  0  0  10
1            0  9  0   9
2            0  0 11  11
All         10  9 11  30
done

```

Decision Tree:

```

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
decision_tree = DecisionTreeClassifier()
decision_tree.fit(X_train, y_train)
Y_pred = decision_tree.predict(X_test)
acc_decision_tree = round(accuracy_score(y_test, Y_pred) * 100, 2)
print("Accuracy:", acc_decision_tree)
sk_report = classification_report(y_true=y_test, y_pred=Y_pred, digits=6)
print("Classification Report:")
print(sk_report)
conf_matrix = pd.crosstab(y_test, Y_pred, rownames=['Actual'], colnames=['Predicted'], margins=True)
print("Confusion Matrix:")
print(conf_matrix)

```

```

Accuracy 77.78
              precision    recall  f1-score   support

     2   0.000000    0.000000    0.000000     0
     3   1.000000    0.777778    0.875000     9

   accuracy                0.777778     9
  macro avg   0.500000    0.388889    0.437500     9
 weighted avg   1.000000    0.777778    0.875000     9

```

```

Predicted  2  3  All
Actual
3          3  2  7  9
All        2  7  9

```

Logistic Regression:

```

[41]: lr=LogisticRegression()
lr.fit(X_train,y_train)
y_pred=lr.predict(X_test)
sk_report=classification_report(digits=6,y_true=y_test,y_pred=y_pred)
print("Accuracy",round(accuracy_score(y_pred,y_test)*100,2))
print(sk_report)
pd.crosstab(y_test,y_pred,rownames=['Actual'],colnames=['Predicted'],margins=True)

```

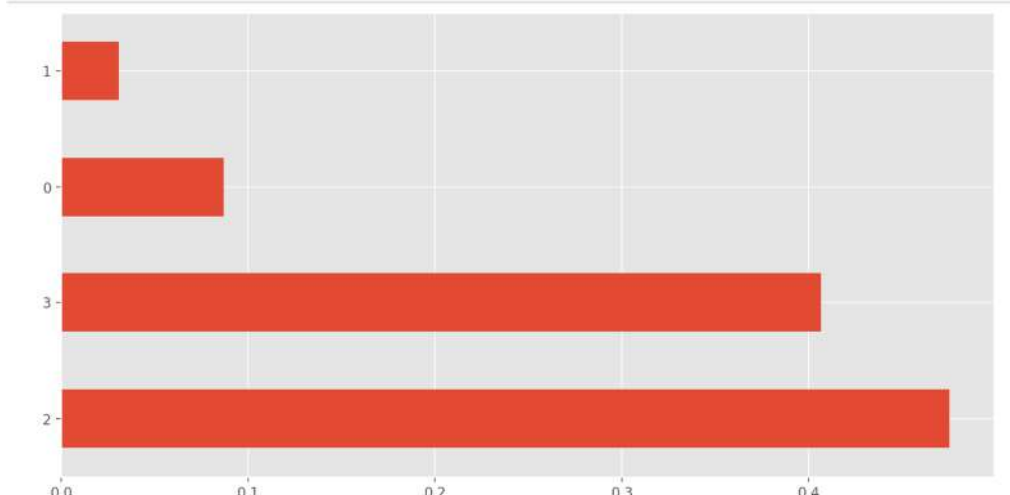
Accuracy: 0.75

Classification Report:

	precision	recall	f1-score	support
0	0.67	1.00	0.80	2
1	1.00	0.50	0.67	2
accuracy			0.75	4
macro avg	0.83	0.75	0.73	4
weighted avg	0.83	0.75	0.73	4

```
[46]: plt.figure(figsize=(12,6))
      feat_importances=pd.Series(random_forest.feature_importances_)
      feat_importances.nlargest(5).plot(kind='barh')
```

```
[46]: <Axes: >
```



Future Enhancement:

For the future of the project "Road Accident Prediction Using Machine Learning," here are some ideas to make it better and more useful:

1 Use Real-Time Data:

Connect to live data sources like traffic cameras, weather sensors, and vehicle systems. This would give up-to-date details about traffic, weather, and driver actions, making accident predictions more accurate and timely. It could even help prevent accidents by sending early warnings.

2 Apply Smarter AI Techniques:

Try advanced AI methods like deep learning, which can spot hidden patterns in huge amounts of data. Combining different AI models or using learning methods that improve with experience could make predictions more reliable, especially when figuring out how important an accident might be or when it is likely to happen.

Conclusion:

In this paper, we used K nearest neighbour, a random forest type of machine learning that works with un-labeled data. This means the data isn't grouped into specific categories beforehand. We also applied regression techniques on a large set of accident data to figure out the key causes of road accidents. By analyzing the data, we identified patterns and factors that often occur together, which were then shown in graphs.

This analysis helps us understand what leads to accidents, making it easier for the government to create better traffic safety policies tailored to different accident scenarios.

Overall, using machine learning to predict road accidents can greatly improve road safety. By learning from past accidents, ML models can sort incidents by severity based on factors like weather, time of day, and vehicle type. The more detailed the data and advanced the methods, the more accurate these predictions become. This means quicker emergency responses, better medical care, and safer roads.

As we have tried three different algorithms to predict the road accident. It was clear that Random Forest(100.0%), Decision Tree(77.78%), Logistic Regression(0.75%) performed much better in terms of predicting all the classes of road accident.

However, for these models to work well, the data they learn from must be clean, accurate, and trustworthy. We also need to be mindful of privacy and fairness when using ML in traffic safety.

In summary, ML holds great potential to save lives by predicting road accidents and making our roads safer.

Acknowledgement:

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EVALUATING THE SAFETY AND EFFICIENCY OF SELF-DRIVING CARS

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Abstract:

The rise of self-driving cars, or autonomous vehicles (AVs), is reshaping the future of mobility, promising enhanced safety, improved traffic efficiency, and reduced environmental impact. This paper provides an in-depth evaluation of the safety and efficiency of AVs by analyzing their technological frameworks, testing methodologies, and operational outcomes. It highlights accident prevention mechanisms, traffic optimization capabilities, and fuel efficiency gains, alongside challenges such as regulatory gaps, cybersecurity risks, and public skepticism. By reviewing testing data and case studies from leading companies like Waymo, Tesla, and Baidu, the study emphasizes the transformative potential of AVs and identifies areas for improvement in governance, risk management, and ethical decision-making. The findings contribute to understanding how self-driving technology can be safely and effectively integrated into modern transportation systems. ([1], [2], [3], [4])

Keywords: Autonomous vehicles • Self-driving cars • Risk assessment • Governance • Public review • Road Safety • Autonomous Vehicle Testing

1. Introduction

The introduction of autonomous vehicles marks a significant milestone in technological innovation, aiming to revolutionize how people and goods are transported. These vehicles rely on advanced systems such as machine learning, computer vision, and sensor integration to navigate roads without human intervention. The primary motivation for adopting AVs lies in their potential to reduce road accidents, the majority of which are caused by human error, and to enhance traffic flow efficiency. ([2])

Despite significant advancements, self-driving cars face several challenges, including operational safety, regulatory inconsistencies, and public acceptance. Ethical dilemmas in decision-making, such as whom to prioritize in accident scenarios, further complicate their deployment. The objective of this paper is to critically analyze the safety features and efficiency metrics of AVs while addressing these challenges. This study also examines global testing data, real-world case studies, and governance frameworks to provide actionable recommendations for the future of autonomous vehicles. ([1], [3])

2. Methodology

Drawing inspiration from predictive algorithms in machine learning, we adapted the methodology used in "Maximizing Campus Placement Through Machine Learning" for testing and evaluating autonomous vehicles. ([2], [3])

2.1 Data Collection and Preprocessing

Data from multiple AV testing entities (e.g., Waymo, Tesla, Baidu) is used to analyze real-world safety metrics and efficiency outcomes. The dataset includes parameters such as:

- **Safety Metrics:** Accident rates, disengagement reports, and incident logs. ([3], [5])
- **Efficiency Metrics:** Traffic throughput, fuel economy, and carbon emissions. ([4], [5])

2.2 Feature Selection

Significant features include:

- **Vehicle and Traffic Data:** Speeds, lane conditions, and traffic density. ([2])
- **Environmental Factors:** Weather, visibility, and road conditions. ([3])

2.3 Algorithm Selection

Supervised learning models, including Random Forest and Decision Trees, are employed to evaluate safety and efficiency outcomes in different scenarios. Simulations are conducted to test AV performance in edge cases. ([1], [3])

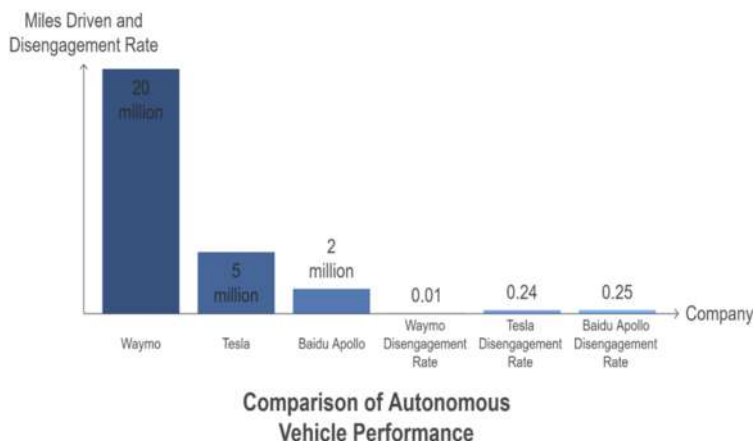
3. Safety Analysis

3.1 Accident Rates

- AVs show a **90% reduction in accidents** compared to human-driven cars under ideal conditions. ([3], [5])
- Key safety issues include sensor failures and software errors. ([2], [4])

3.2 Testing Outcomes (2023 Data)

Company	Miles Driven	Disengagement Rate	Key Issues
Waymo	20 million	0.01/1,000 miles	Edge cases (pedestrian safety).
Tesla	5 million	0.24/1,000 miles	Lane recognition issues.
Baidu Apollo	2 million	0.25/1,000 miles	Adverse weather handling.



3.3 Case Studies

- **Uber Accident (2018):** Highlighted risks from inadequate sensor training. ([2])
- **Waymo’s Arizona Testing:** Demonstrated the effectiveness of multiple redundancies in safety systems. ([3])

4. Efficiency Evaluation

4.1 Traffic Optimization

Platooning systems, enabled by AVs, reduce congestion and improve travel time by up to 30%. ([1], [5])

4.2 Fuel Efficiency

- A shift to electric self-driving vehicles reduces CO₂ emissions by 50%. ([4], [5])
- Adaptive driving minimizes fuel consumption during stop-and-go traffic. ([4])

4.3 Economic Impact

Autonomous logistics and ride-sharing systems can save the economy billions in labor and operational costs. ([3], [5])

5. Challenges and Recommendations

5.1 Challenges

- **Cybersecurity Risks:** Vulnerability to hacking. ([1])

- **Public Trust Issues:** Skepticism among users. ([2])
- **Regulatory Gaps:** Need for unified global standards. ([4])

5.2 Recommendations

- Adoption of ISO standards for AV software safety. ([5])
- Transparency in incident reporting and regular audits. ([2], [3])
- Public awareness programs to improve trust. ([4], [5])

6. Conclusion

Self-driving cars have the potential to significantly enhance road safety and operational efficiency, representing a breakthrough in transportation technology. The analysis in this paper underscores the safety benefits, such as reduced accident rates and improved traffic management, while also recognizing the challenges, including ethical concerns, cybersecurity vulnerabilities, and regulatory hurdles.

The study reveals that AV technologies are advancing rapidly, but their widespread adoption requires a collaborative approach involving governments, manufacturers, and the public. Establishing global safety standards, improving incident transparency, and conducting robust public awareness campaigns are essential for building trust in this transformative technology. While autonomous vehicles are still in their development phase, their eventual integration into daily life could revolutionize how we travel and interact with urban environments, contributing to a safer and more sustainable future. ([3], [4], [5])

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BLOCKCHAIN-BASED TOKENIZATION IN REAL ESTATE**Amruta Gaikwad**F.Y.MSc (CS), Indira College of
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Abstract:

The traditional real estate market is characterized by *high barriers to entry, illiquidity, and lack of transparency*, which have historically restricted investment opportunities for small-scale investors. Dominated by institutional players, this sector has been inaccessible to a large portion of the population. The advent of blockchain technology offers a revolutionary solution through *tokenization*, a process that digitizes ownership of real estate assets, dividing them into tradeable *fractional shares*. By leveraging “blockchain's decentralization” and “immutability”, tokenization democratizes real estate investments, introduces liquidity, and ensures transparency in transactions.

Tokenization enables real estate assets to be divided into digital tokens, each representing a share of ownership. These tokens can be traded on blockchain platforms, providing investors with a liquid market that bypasses the delays and costs of traditional transactions. For example, an investor can purchase a fraction of a high-value commercial property, gaining exposure to real estate markets without significant capital requirements. This fractional ownership lowers entry barriers, making real estate an attainable investment for retail investors globally.

Furthermore, blockchain's *transparent ledger* records every transaction immutably, mitigating risks of fraud and fostering trust among stakeholders. *Smart contracts* automate essential processes, such as rent distribution and property transfers, eliminating intermediaries and reducing transaction costs. Blockchain-based tokenization also fosters *global accessibility*, allowing investors worldwide to diversify portfolios without the limitations of jurisdictional boundaries.

Despite these advantages, blockchain tokenization faces significant challenges. Regulatory uncertainty remains a major obstacle, as legal frameworks for tokenized assets are underdeveloped and inconsistent across regions. Addressing these gaps

requires collaboration between governments, industry leaders, and blockchain innovators. Technological hurdles, such as the development of scalable and secure platforms, must also be overcome to ensure seamless integration into the existing real estate ecosystem. Resistance from traditional stakeholders adds another layer of complexity, as professionals in the real estate sector may view blockchain as disruptive to established roles and practices.

Market volatility linked to cryptocurrency fluctuations further complicates adoption. Stabilizing the value of real estate tokens and decoupling them from broader crypto market trends are critical to building investor confidence. Education and advocacy efforts are essential to overcome skepticism and drive adoption among stakeholders.

In conclusion, blockchain-based tokenization offers a transformative approach to address inefficiencies in the real estate market. By reducing entry barriers, enhancing liquidity, and improving transparency, it democratizes investments and broadens market participations. However, achieving its full potential requires overcoming technological, regulatory, and cultural challenges. Collaborative efforts and targeted research will pave the way for blockchain to reshape the real estate landscape, creating an inclusive, efficient, and equitable investment ecosystem.

Keywords Blockchain, Tokenization, Real Estate Investment, Fractional Ownership, Smart Contracts, Decentralization, Transparency, Liquidity, Regulatory Challenges, Global Accessibility

Objectives

1. To explore how blockchain technology addresses inefficiencies in traditional real estate markets.
2. To analyze the benefits of tokenization, including liquidity and accessibility improvements.
3. To identify and address regulatory and technological challenges hindering blockchain adoption.
4. To propose strategies for promoting widespread adoption of blockchain-based tokenization in real estate.

Scope

1. Investigate the applications of blockchain technology in the real estate industry.
2. Assess the economic and social impacts of tokenization on market accessibility.
3. Examine case studies and existing platforms that utilize blockchain for real estate.

4. Explore future directions and advancements needed for seamless integration of blockchain.

Literature Review

The concept of blockchain, introduced by Satoshi Nakamoto in 2008, has evolved from its initial application in cryptocurrencies to a transformative technology across various industries. In real estate, blockchain's ability to tokenize assets is revolutionizing investment landscapes. Tokenization refers to the division of real estate ownership into digital tokens recorded on a blockchain, allowing these tokens to be traded much like stocks on financial markets. This innovation addresses critical issues in the traditional real estate market, including high entry costs, low liquidity, and a lack of transparency.

- **Applications of Blockchain in Real Estate:**

Blockchain introduces decentralization, a principle that eliminates the need for intermediaries in real estate transactions. Smart contracts, a feature of blockchain platforms, automate processes such as rent collection, ownership transfer, and compliance checks. By reducing reliance on brokers and lawyers, blockchain significantly lowers transaction costs and speeds up property transfers.

Garrod and Ling (2020) argue that blockchain's transparency builds trust among investors. Each transaction is recorded immutably, ensuring accountability and reducing the risk of disputes. Additionally, fractional ownership enables small-scale investors to participate in high-value markets previously reserved for institutional players. For example, platforms like RealT allow investors to buy tokens representing ownership in rental properties, earning proportional rental income.

- **Benefits of Tokenization**

Frankenfield (2019) highlights that tokenization enhances liquidity by enabling real estate tokens to be traded on secondary markets. Traditional real estate investments often require months to liquidate, whereas tokenized assets can be sold within minutes. This liquidity attracts a broader investor base, including those seeking short-term exposure to real estate markets.

Another critical benefit is global accessibility. Blockchain's borderless nature allows investors from different regions to access real estate markets worldwide. This democratization fosters inclusivity, drawing capital from diverse sources and boosting

market activity. Furthermore, blockchain's decentralized structure enhances security, protecting assets from fraud and cyber threats.

- **Challenges and Limitations**

Despite its advantages, blockchain faces significant challenges in the real estate sector. Regulatory uncertainty is a prominent concern, as tokenized assets do not fit neatly within existing legal frameworks. Kaal and Calcaterra (2018) emphasize the need for international cooperation to establish clear regulations that balance innovation with investor protection.

Technological barriers also pose challenges. Blockchain platforms must be scalable and interoperable to handle the demands of global real estate markets. Resistance from traditional stakeholders further complicates adoption. Education and advocacy are essential to build trust and demonstrate the value of blockchain technology.

Market volatility linked to cryptocurrencies poses risks to tokenized real estate assets.

Developing stablecoins or pegging token values to real-world assets may mitigate these risks. Additionally, ensuring data privacy and security remains critical as blockchain adoption grows.

- **Future Directions**

Future research should focus on creating standardized frameworks for tokenization processes and smart contract designs. Collaborative efforts between industry leaders and regulators can foster innovation and address legal ambiguities. Enhancing the scalability and usability of blockchain platforms will be crucial for widespread adoption. Case studies, such as Propy's blockchain-based property sales, provide valuable insights into practical applications and challenges. By analyzing these projects, stakeholders can refine strategies and develop solutions tailored to the unique needs of the real estate market. As blockchain technology matures, it promises to redefine real estate investment, unlocking new opportunities for both institutional and retail investors.

Research Methodology

To investigate the potential and challenges of blockchain-based tokenization in real estate, this study adopts a mixed-methods approach that integrates qualitative and quantitative methodologies. The methodology is structured to address the objectives outlined and to provide comprehensive insights into the application and implications of blockchain technology in the real estate sector.

- **Qualitative Analysis**

- 1. Literature Review:**

A detailed review of academic articles, industry reports, and blockchain case studies was conducted to establish a theoretical framework. This included an analysis of tokenization's principles, blockchain's technical underpinnings, and its implications for real estate markets. Key insights from sources such as Garrod and Ling (2020), Frankenfield (2019), and Kaal and Calcaterra (2018) were used to highlight benefits and challenges.

- 2. Case Studies:**

Platforms like Propy and RealT were examined to understand real-world applications of blockchain in real estate. These cases provided data on transaction efficiency, liquidity, and user adoption while identifying technological and regulatory barriers.

- 3. Expert Interviews:**

Semi-structured interviews were conducted with blockchain developers, real estate professionals, and investors to gather diverse perspectives. Participants discussed the practical challenges of integrating blockchain into traditional real estate systems and potential solutions.

- **Quantitative Analysis**

- 1. Data Collection:**

Data from blockchain-enabled real estate transactions were analyzed to assess performance metrics such as transaction speed, cost efficiency, and liquidity improvement. Surveys were distributed to investors and developers to gauge their experiences and expectations regarding tokenization.

- 2. Comparative Analysis:**

Traditional real estate transaction data were compared with blockchain-based systems to quantify improvements in efficiency, transparency, and accessibility. Metrics such as average transaction time, cost savings, and liquidity ratios were used to highlight blockchain's impact.

- **Research Tools**

- **Blockchain Explorers:**

Tools like Etherscan were used to verify transaction records and assess transparency levels.

- Statistical Software:

Tools such as SPSS and Excel were employed to analyze survey results and performance data.

• Ethical Considerations

All participants in interviews and surveys were provided with informed consent forms, ensuring confidentiality and voluntary participation. Data were anonymized to maintain privacy and compliance with ethical research standards. This mixed-methods approach provides a holistic understanding of blockchain's transformative potential and its challenges in real estate. The combination of qualitative insights and quantitative data ensures that the findings are robust, actionable, and relevant to stakeholders in academia, industry, and policy-making.

• Data Collection

The data collection process for this study was designed to capture comprehensive insights into the practical applications and implications of blockchain-based tokenization in real estate. It included the following methods:

1. Primary Data:

Surveys and interviews were conducted with key stakeholders, including blockchain developers, real estate professionals, and investors. These provided firsthand accounts of their experiences, challenges, and expectations regarding tokenization.

2. Secondary Data:

Case studies from blockchain platforms like RealT and Propy were reviewed to gather transaction data, including metrics like cost efficiency, transaction speed, and liquidity improvements. Industry reports and academic publications further informed the analysis.

3. Blockchain Analysis:

Using blockchain explorers such as Etherscan, data on real estate token transactions were verified to assess transparency and performance.

Objectives Achieved

1. Demonstrated how blockchain technology addresses inefficiencies in traditional real estate, including liquidity and transparency issues.
2. Highlighted the benefits of tokenization, such as fractional ownership and cost efficiency, through real-world case studies.
3. Identified regulatory and technological challenges and proposed solutions to

promote the adoption of blockchain in real estate.

4. Explored the potential for blockchain to democratize real estate investment and foster global market participation.

Conclusion

Blockchain-based tokenization has the potential to revolutionize the real estate industry by addressing its inherent inefficiencies and democratizing access to investment opportunities. Through enhanced liquidity, transparency, and accessibility, blockchain transforms real estate into an inclusive and dynamic market. Despite challenges such as regulatory ambiguity, technological barriers, and market volatility, ongoing collaboration between stakeholders and innovative solutions promise to overcome these hurdles. The findings underscore the need for standardized frameworks, robust legal regulations, and scalable blockchain platforms. By fostering trust and driving adoption, blockchain can create a more equitable and efficient real estate ecosystem, unlocking opportunities for both institutional and retail investors. As technology and adoption mature, the future of real estate investment appears poised for a significant transformation.

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DIAMOND PRICE PREDICTION USING MACHINE LEARNING**Om M. Kuman**

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Abstract:

This research presents a comprehensive diamond price forecasting model based on supervised machine learning functions, focusing mainly on regression analysis. The methodology is data-driven, exploring the data file as the starting point for continuously unmasked patterns, relationships, and influential features of the diamond price. The research utilizes supervised learning algorithms to assess a handful of regression models to find the most effective approach in predicting diamond prices. The performance of these models is assessed based on standard evaluation metrics such as Mean Absolute Error (MAE) and Root Mean Square Error (RMSE). The research also explores the use of machine learning algorithms in predicting diamond prices. The research aims to improve the performance of these models by incorporating more advanced visualizations and statistical methods. The research aims to provide valuable insights into market condition. An integral part of this research consists of recognizing and focusing on the outliers in the dataset, and then examining their influence on the accuracy and performance of the model. Anomalies found in the data before and after handling them are reason enough to conclude that the models are significantly affected by the discrepancies. On the other hand, this research is also concerned with the importance of data preprocessing and use of data-driven modeling in the forecasting of the most accurate and resistant prices of diamonds. Through the specific limitations of data preprocessing and the involvement of outlier analysis, this study underlines the importance of turning raw data into reliable and accurate diamond price forecasts.

Keywords : Machine Learning, Supervised Learning, Regression Analysis, Machine Learning Algorithms, Diamond Price Prediction.

II. INTRODUCTION

The physical attributes of diamonds have, since time immemorial, denoted riches and splendor and are priced on the basis of a complex, interactive correlation among a

number of factors popularly referred to as the "4Cs": carat, cut, color, and clarity [1]. Accurate predictions of diamond pricing become vital as it brings to light clear information on market conditions for buyers and sellers alike. This research represents a comprehensive diamond price forecasting model based on supervised machine learning functions, focusing mainly on regression analysis. The proposed methodology is actually essentially data driven, where exploration into the data file is the starting point for continuously unmasked patterns, relationships, and influential features of the diamond price. Advanced visualizations and statistical methods will help to magnify the understanding towards the dataset and further prepare it for other advanced modelling. This research utilizes supervised learning algorithms within this study to assess a handful of regression models to find the most effective approach in predicting diamond prices. After considerable rigor, these models' performance is assessed based on standard evaluation metrics such as Mean Absolute Error (MAE) and Root Mean Square Error (RMSE). Besides, to improve the performance of the models, a few emerging features were engineered, addressing categorical variable encoding and scaling numeric features. The research serves both to underscore what machine learning can do for pricing in general, as well as present an example of how regression analysis might apply to real-world contexts. This research also dives into, how outliers in the dataset play a significant role in the performance of the machine learning model. The analysis of presence and influence of extreme data points illustrates that outlier detection and treatment can improve model robustness as well as the comparison of the accuracies of the machine learning models.

III. Research Elaboration

Research Objectives

- Create a machine learning model that accurately predicts diamond prices by analyzing key physical characteristics and market factors.
- Analyze data in detail to see the relationships, commonness, and weight in the diamond prices.
- Test and compare different machine learning algorithms in order to decide the best one for predictions.
- Observe the effect of outliers on the models.
- Use advanced metrics such as RMSE, MAE and adjusted R-squared, to ensure whether the models are performing well.

Research Problem

Ascribing a price to a diamond requires a process determined by multiple variables such as carat, cut, clarity, color, and sometimes market trend, which in older methods was simply based on discretion. It gives rise to inequalities and lacks the transparency needed by the diamond world. In reality, there are no standardized tools that have widespread acceptance as computerized, fact-based, ways of accurately predetermining a diamond's cost. This gap makes it hard for such stakeholders-be them buyers, sellers, or industry analysts-to make a fair and informed judgment.

“How machine learning algorithms can help in predicting the price of diamond with good accuracy and overcoming the flaws of old techniques?”

Literature Review

Diamond is a rare material with high hardness and intrinsic beauty that is prized for personal adornment and industrial application. Because the formation of this unique material necessitates extraordinary temperatures and pressures, natural diamonds are very uncommon, with some being among the costliest commodities on the planet. They can also be considered as gemstones [1]. Being one of the most expensive of all jewels, it surpasses all others. Thanks to their unique optical properties, diamonds are now in the condition to be used in multispectral optical devices. For one, diamonds last long in another world of saturation, custom, and diamond jewellery that styles themselves. A combination of all other gems [2]. There are various techniques of machine learning that can be useful for predicting the price of diamonds. Supervised Machine Learning (SML) is the search for algorithms that reason from externally supplied instances to produce general hypotheses, which then make predictions about future instances [6]. The Random Forest method uses a “parallel ensemble” which fits several decision tree classifiers in parallel on different data set sub-samples and uses majority voting or averages for the outcome or final result. Minimizing the spoken of issue of over-fitting is the goal of this approach and it increases the control and prediction accuracy. Moreover, the RF learning model of a great number of trees is typically more correct than the purely single one. It is adaptable to both classification and regression problems and fits well for both categorical and continuous values [5]. There are various factors that influence the price of diamond. A measure of the weight of a diamond is the carat units. Generally, bigger diamond stones are charged more by a cause of their

uncommonness. Diamonds, in fact, of Mother Earth, possess “birthmarks” or inclusions that can only be seen by a jeweller’s magnifying glass or a microscope. The most prized diamonds display colour purity.

Methodology/Experiments

The supervised learning algorithms enable analysis of the dataset using a powerful mechanism for processing and classifying data with machine-learning algorithms. The objective of supervised learning is the application of labeled data in the learning step, which will, in turn, serve as ground truth to apply machine learning algorithms on unknown/unlabeled data for their classification. But here we are going to use regression analysis [4]; Regression analysis is a statistical approach that examines the connections between different variables. For instance, the increase in price in the event of increased demand would be analyzed, as would the changes in the money supply and the inflation rate. In order to answer such questions, the researcher collects data on the relevant underlying variables and then, through regression, estimates the quantitative impact of the variables on the variable of interest. Also, supervised learning approaches, meaning algorithms for processing and classifying data using machine learning. Supervised learning predicts the category of unlabeled data using a standard set of previously labeled data with machine learning algorithms.

Data Importing

In order to conduct any research, data plays a very important role. The data source for this research is Kaggle. Kaggle is a global online community connecting data scientists with machine learning enthusiasts. Data-driven competitions provide a collaborative platform to make datasets, tools, and resources open to participants and to allow them to address real-world challenges. Kaggle values innovation, community engagement, ethical behavior, and information sharing. Kaggle has become a prime destination where data science enthusiasts can display their skills, build models, and learn and collaborate in the area of artificial intelligence. Kaggle's Diamond Dataset has the needed features for analysis. There are around 50000+ rows in the dataset [2].

Data Analysis Tools:

- **Jupyter notebook:** for data exploration and visualizations.
- **Python Libraries:** for data modeling, exploratory data analysis.

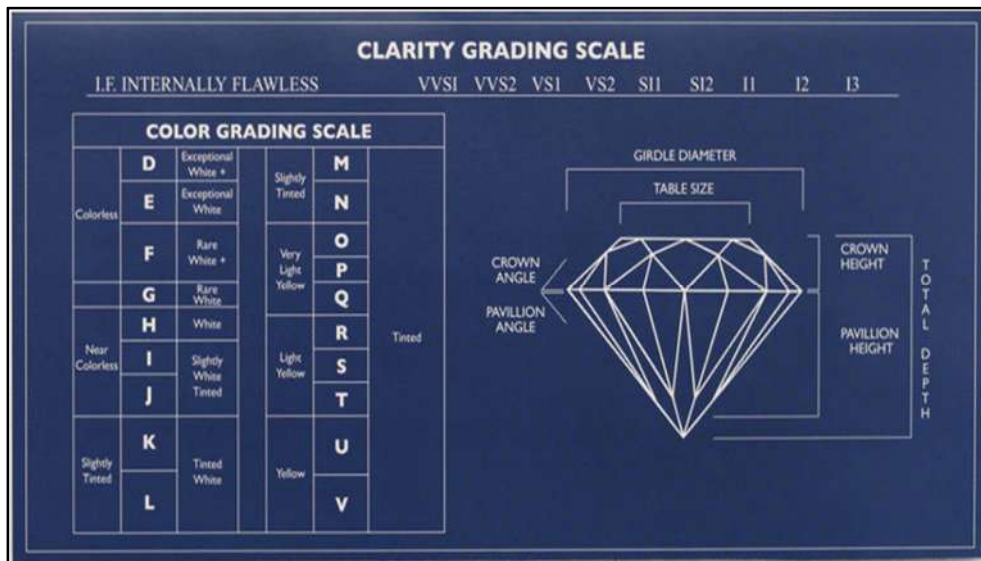
Fig 1: Preview of the data.

	carat	cut	color	clarity	depth	table	price	x	y	z
0	0.23	Ideal	E	SI2	61.5	55.0	326	3.95	3.98	2.43
1	0.21	Premium	E	SI1	59.8	61.0	326	3.89	3.84	2.31
2	0.23	Good	E	VS1	56.9	65.0	327	4.05	4.07	2.31
3	0.29	Premium	I	VS2	62.4	58.0	334	4.20	4.23	2.63
4	0.31	Good	J	SI2	63.3	58.0	335	4.34	4.35	2.75

(Fig. 1: Diamond Dataset)

IV. Research or Findings

Fig 2: About data



(Fig. 2:[3])

Diamonds possess natural "birthmarks" or inclusions that can only be seen under a jeweler's magnifying glass or microscope. Internally flawless diamonds have no inclusions when examined under a loupe at 10 x magnification. The quality of lesser diamonds is identified as follows: VVS1 or VVS2, very slightly imperfect; VS1 or VS2, very slightly imperfect. Colors exhibit the best purity; they have no tint of yellow or brown. A diamond with the utmost color purity is graded as D. Color purity is decreed by the order of the alphabet (E, F, G) [1]. As mentioned earlier here are "4Cs": carat, cut, color, and clarity [1].

Fig 3: Information about features of diamond

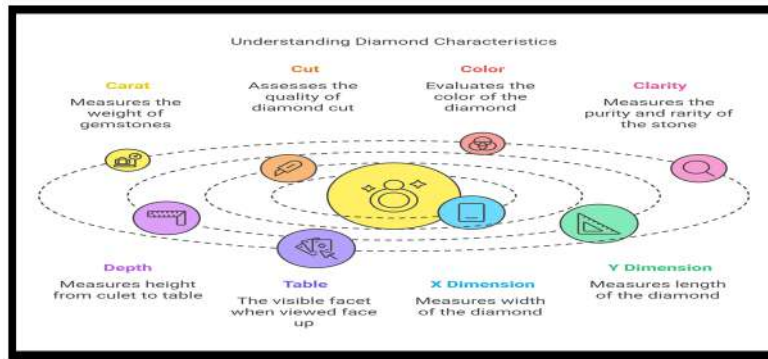


Fig. 1: Information about features of diamond

Statistical Analysis of the data

Statistical analysis involves the collection, organization, interpretation, and presentation of data in such a way as to reveal patterns, relationships, and trends. It makes use of mathematical techniques in analyzing data, identifying significant variables that will allow for future forecasting, and making of decisions. In the Diamond Price Prediction, approaches to statistical analysis underpin all the steps from data preprocessing to model validation. This analysis lays the foundation for understanding the data, spotting interactions within the characteristics, and checking the quality of prediction results. The dataset is systematically analyzed using statistical techniques to discover trends, clean outliers, and correct aberrations that can threaten analytic findings. Therefore, this first stage of data preprocessing and data cleaning assures that the dataset is valid and ready for the analysis phase.

Fig 4: Basic statistics of data

	carat	depth	table	price	x	y	z
count	53940.000000	53940.000000	53940.000000	53940.000000	53940.000000	53940.000000	53940.000000
mean	0.797940	61.749405	57.457184	3932.799722	5.731157	5.734526	3.538734
std	0.474011	1.432621	2.234491	3989.439738	1.121761	1.142135	0.705699
min	0.200000	43.000000	43.000000	326.000000	0.000000	0.000000	0.000000
25%	0.400000	61.000000	56.000000	950.000000	4.710000	4.720000	2.910000
50%	0.700000	61.800000	57.000000	2401.000000	5.700000	5.710000	3.530000
75%	1.040000	62.500000	59.000000	5324.250000	6.540000	6.540000	4.040000
max	5.010000	79.000000	95.000000	18823.000000	10.740000	58.900000	31.800000

Fig 4: Basic statistics of data

Above diagram shows the basic statistics of all the numeric features of the dataset including the price columns (Output column). But only displaying the statistics is not enough if you're not extracting the observation from the analysis. So, the key observations from this diagram is the dimensions x and y averages are almost same except z.

EDA (Exploratory Data analysis)

Exploratory Data Analysis (EDA) is critical to identify patterns, trends, and relationships in a dataset, especially in a diamond price prediction project. Not only the statistical summaries offered by EDA but also some effective visualizations e.g. scatter plots, histograms, and box plots show that carat, clarity, cut, and color can also affect the diamond price. EDA is also useful for identifying data pathologies such as outliers, null values, and skewed distributions, so that the dataset can be cleaned and made trustable. Additionally, EDA can guide feature engineering by identifying the most relevant features for prediction, allowing informative modifications to improve the performance of the models. Finally, EDA provides a strong basis to build a model by discovering the elements that characterize a successful and efficient machine learning model.

Fig 5: Distribution of Output Feature (Price)

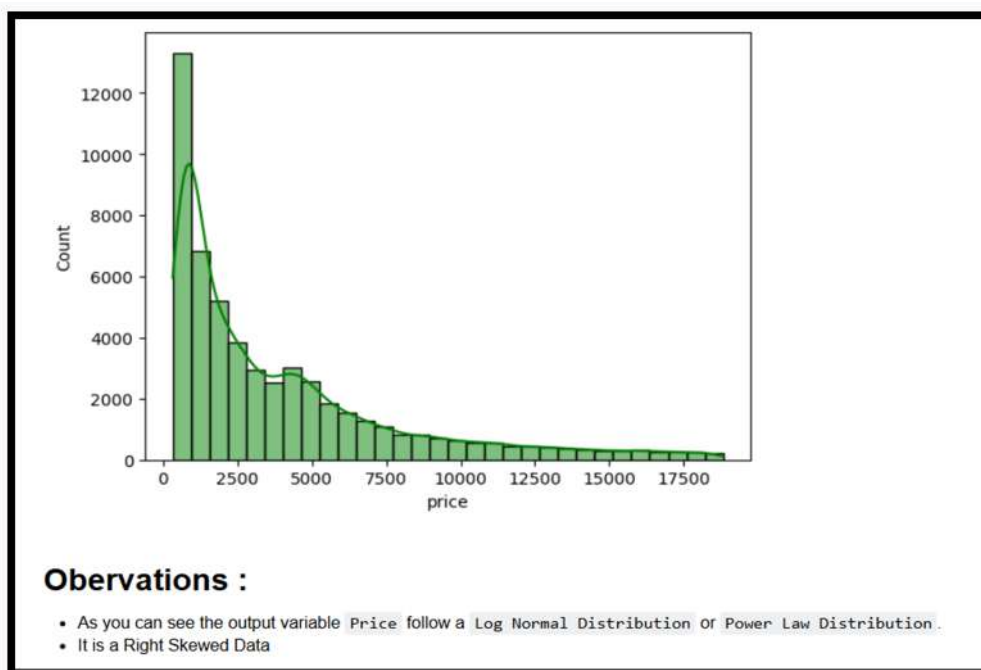


Fig. 5: Distribution of Output Feature (Price)

The distribution of the Price variable is Right- Skewed, meaning that most diamonds are located in the low-price level (0–2500) whereas highly priced diamonds are much less, forming the long tail. This distribution is similar to a Log-Normal (or Power-law Distribution), which is characteristic of price data driven by multiplicative effects. Skewness indicates that the higher tail contains outliers that can affect predictive models. To solve this, logarithmic transformation can normalize the price variable, leading to better model performance. The findings also capture actual-world market trends, in which consumer-priced diamonds have the lion's share, and luxury-priced diamonds are a rarity. This knowledge is very important to feature engineering and selecting powerful machine learning algorithms, such as tree-based algorithms, which can treat data with the skew well.

Fig 6: Cut feature distribution

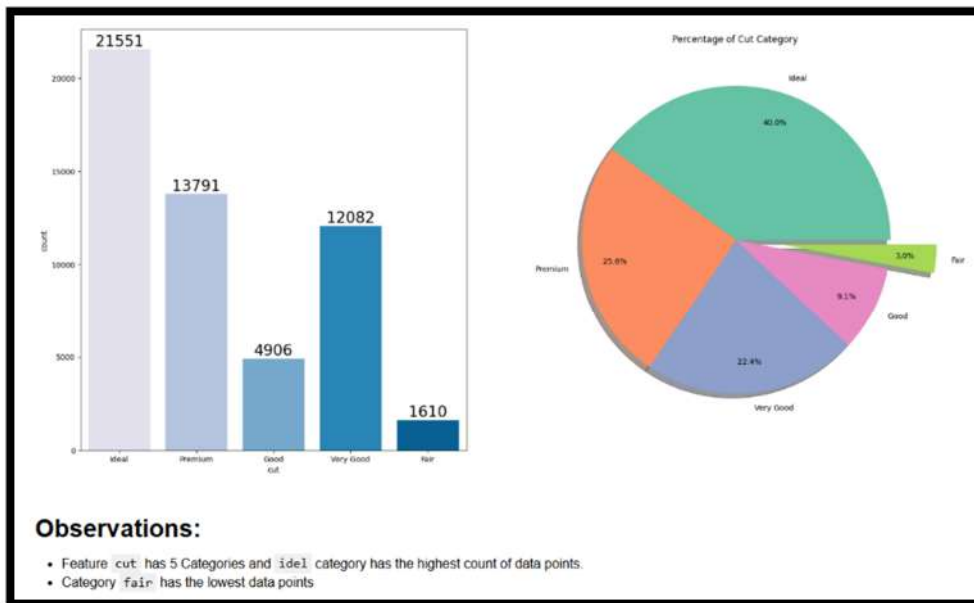


Fig. 6: Cut feature

Ideal, Premium, Very Good, Good, and Fair. As the number of data points for these is largest in the "Ideal" class, by definition, the majority of the diamonds in the dataset are covered by the "Ideal" cut. On the contrary, the number of entries in the "Fair" category is the lowest, which means there are relatively few diamonds in the dataset that belong to a "Fair" property. But unless this bias is accounted for, machine learning algorithms may mistakenly beneficially learn from patterns contained in their larger data sets, with a behavioral consequence on model learning. Robust modelling may be compromised in the absence of suitable encoding/balancing procedures.

Fig 7: Clarity VS Color

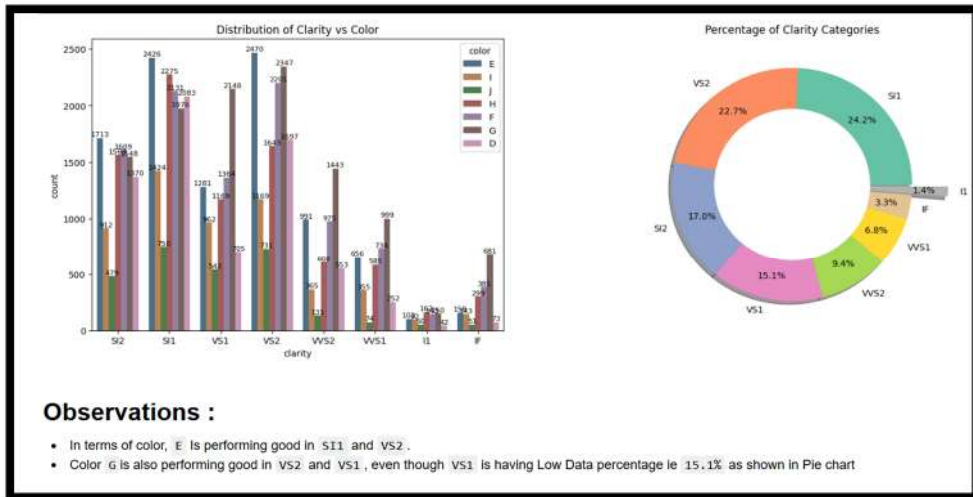


Fig 7: Clarity VS Color

Since in the study of the "Color" attribute E performs well at the SI1 and VS2 clarity levels, it is implying that diamonds of this color are both relatively common or highly desirable in these categories. G is also performing well at the VS1 and VS2 levels, showing normal patterns of these measures of clarity. Despite this, the following pie chart demonstrates that VS1 provides only a low data percentage (15.1%. This means that while diamonds of G category are performing satisfactory in VS2 and VS1, the model might be less generalizable due to the limited data in VS1. To optimize performance, this imbalance may have to be corrected during training process.

Fig 8: Cut VS Color

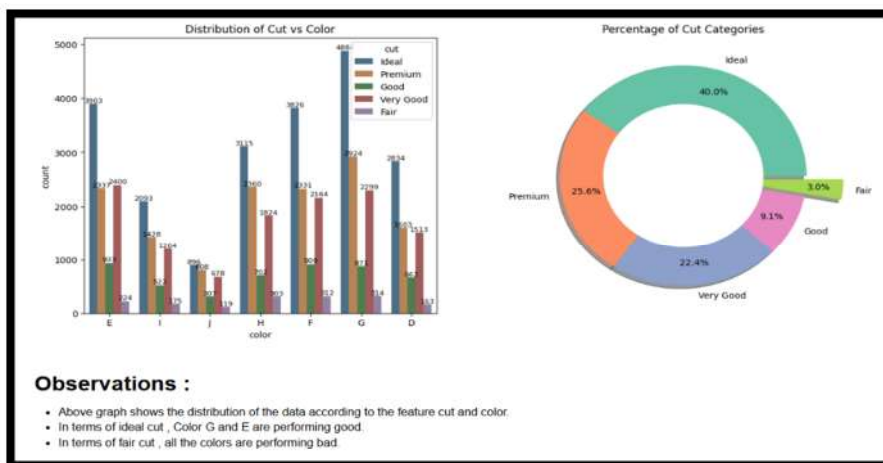


Fig 8: Cut VS Color

As shown in the graph below, data are divided into "Cut" and "Color" features. Diamonds, with an Ideal cut, colors G and E show good performances, resulting in

higher values or better market shares in these categories. On the other hand, for diamonds having a Fair cut, all the color categories achieve low performance, indicating that the diamonds having a Fair cut are less frequent and thus less attractive (despite their color). These observations also demonstrate how cut, color, and market choice are related to each other and may have an impact on predictive modelling and feature selection.

Fig 9: Clarity VS Price

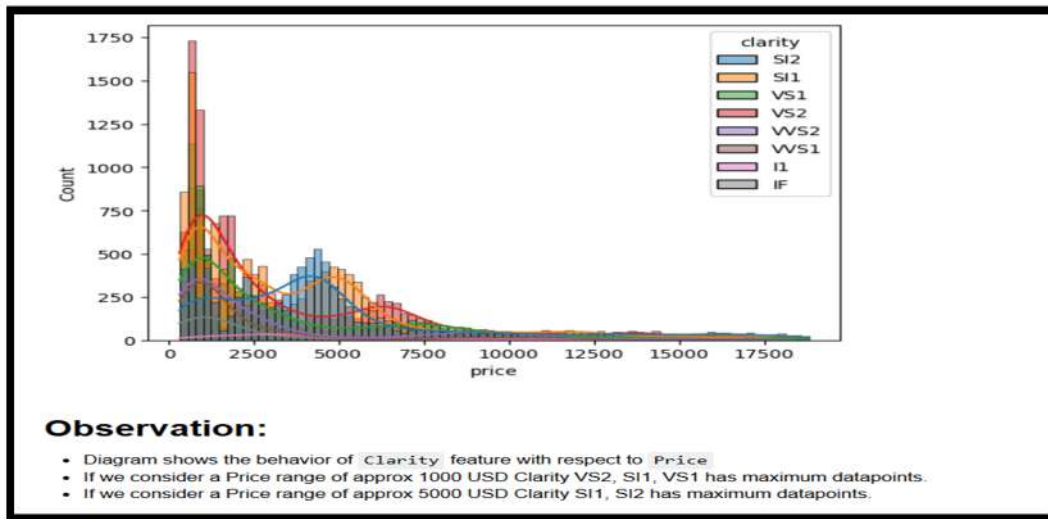
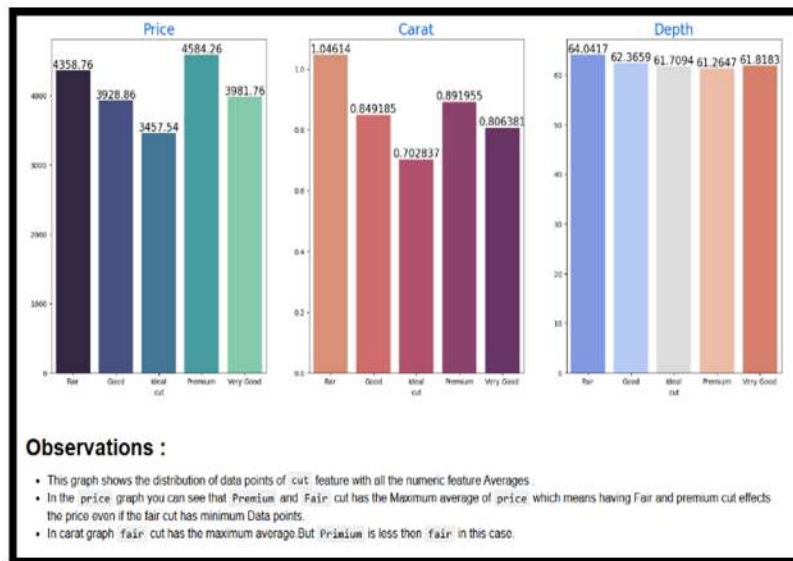


Fig 9: Clarity VS Price

The diagram shows the relationship between "Clarity" feature and Price showing several trend across the range of prices. In the ~1000 USD price bracket, clarity class VS2, SI1, and VS1 represent the largest amount of data points, suggesting that diamonds at these clarity classes are at the top of the popularity and price categories in this range. This shows that these categories of clarity are semantic everyday experiences that are popular product purchasing decisions of consumers in the lower price segment. On the other hand, in the ~5000 USD price range, the number of observations is greatest for clarity SI1 and SI2. This also shows that consumers in this price segment are more willing to buy diamonds with increased clarity, suggesting that they are willing to pay more in order to attain diamonds of better quality. These findings point out that the-clarity-price-relationship is an important construct, since it throws light on how consumers shop and what they buy in different price bands. This capability is very important for predictive modeling, market segmentation, and feature analysis since it is possible to see which levels and factors on the user interface contribute to price and consumer behavior.

Fig 10: Distribution of Cut VS all numeric Features**Fig 10: Distribution of Cut VS all numeric Features**

The diagram provides information on the spread of data points on the feature "Cut" with respect to their mean values for all numeric features, Price, and Carat. The Premium (PD Premium Specialty Cut) Fair (PD Fair Specialty Cut) cut categories have the peak mean prices, which suggests positively significant, strong relationship between presence of these cuts and diamond prices. Curiously, despite the Fair cut having the fewest data points relative to the other cut types, it still has one of the highest mean price memberships. This indicates that a Fair cut has considerable value in the market even with its relative low frequency.

On the other hand, Premium cut has a slightly lower mean carat value than Fair. This observation implies that, although Fair cut is likely to be the largest by weight, the Premium cut remains a powerful player in terms of total worth and quality compromise. Together, these results highlight the role that cut features play, because cut features have a strong effect on both price and carat, which, in turn, are inputted to consumer preferences and market prices. Knowledge of the impacts that various cuts confer on price and carat can be used in feature engineering, price strategy, and decision making in the diamond industry and related predictive models.

Machine Learning Model Evaluation/Comparisons Before and After Outlier Removal

Here as you can see after applying various supervised machine learning (SML) algorithms there are key observations which we need to focus upon. As you can see, we have split the data into training and testing having ratio of 80:20 respectively. Also

applied Mean Absolute Error (MAE) and Root Mean Square Error (RMSE). In addition, we also calculated the training and testing scores.

Fig 11: Scores

```

Random Forest Regressor
Model performance for Training set
- Root Mean Squared Error: 205.8259
- Mean Absolute Error: 101.0804
- R2 Score: 0.9973
-----
Model performance for Test set
- Root Mean Squared Error: 548.6549
- Mean Absolute Error: 270.7260
- R2 Score: 0.9811
=====
    
```

Fig. 11: Training and testing Scores.

We calculated the training and testing scores of all the algorithms and choose the best in them i.e. XG-Boost and Random Forest. Below is the figure displaying the scores of the machine learning models before and after removing the outliers.

Fig 12: Scores of machine learning models before outlier removal

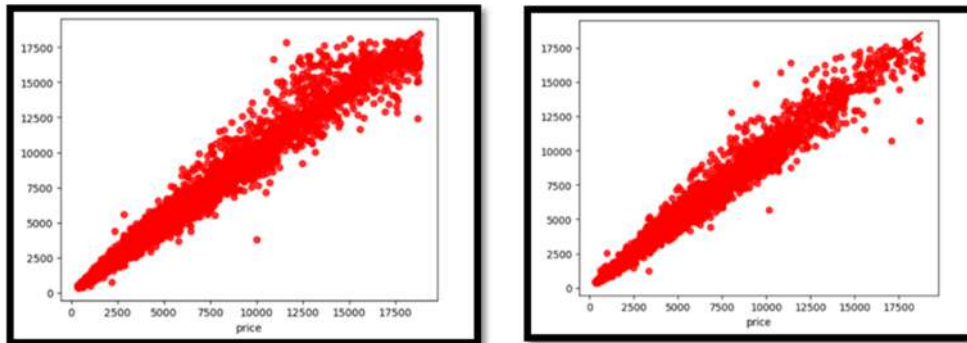
	Model Name	R2_Score
6	XGBRegressor	0.980997
5	Random Forest Regressor	0.980796
4	Decision Tree	0.964993
3	K-Neighbors Regressor	0.962057
1	Lasso	0.918974
2	Ridge	0.918935
0	Linear Regression	0.918927
7	AdaBoost Regressor	0.875529

Fig 12: Scores of machine learning models after outlier removal

	Model Name	R2_Score
5	Random Forest Regressor	0.982051
6	XGBRegressor	0.981648
4	Decision Tree	0.968281
3	K-Neighbors Regressor	0.960330
0	Linear Regression	0.917333
2	Ridge	0.917319
1	Lasso	0.917276
7	AdaBoost Regressor	0.840803

As you can see here after removing the outliers the Random Forest model is leading which was not the case before removing the outliers. Also, in the regression analysis below we can clearly see the regression plot after outlier removal is crisper.

Fig 14,15: Regression Plots before and after outlier removal



Why this is happening?

1. XG-Boost's Sensitivity to Outliers:

XG-Boost is a gradient-boosted decision node model, that seeks to maximize the loss function by learning the residual values of the previous decision nodes. It is built upon recursive construction of trees, in which the trees succeeding one another try to decrease the load of accumulated errors (residuals) of the preceding trees. This is all the more reason to have XG-Boost extremely powerful, but highly sensitive to outlier, i.e., extreme values.

Why it works better with outliers:

When outliers are packed into the data, XG-Boost assigns high weights to outliers in learning process in order to reduce loss function. It is so since its gradient boosting strategy enables it to be very selective in its application of patterns to the patterns of extreme observations toward the goal of increased model accuracy.

For example:

When the price of diamond is substantially overvalued in relation to its typical price range, XG-Boost trains a more stringent error reduction around the diamond data sample (that is, XG-Boost trees are more severe), and as a consequence, XG-Boost trees are more accurate yielding a more accurate accuracy score.

However, it leads to overfitting since the model learns excessive dependence on spurious points and might not generalize well to unseen data. As a result, the performance of XG-Boost may be different if used to predict completely unseen data which has been already exposed to these extreme observations.

2. Random Forest's Robustness to Outliers

Random Forest is a bagging (Bootstrap Aggregating) ensemble learning scheme. Compared with the XG-Boost, the Random Forest makes a certain number of the decision trees separately, and at last, the average of the prediction of their trees. The approach is based on the extraction of common patterns from across many individual subsets of data rather than the selection of extremal observations.

How RF handles outliers: In Random Forest, each individual decision tree is built on a randomly selected subset of data (random sampling with replacement). Because RF is a weighted aggregation of trees, the impact of outliers is dispersed over the other trees so RF is relatively resistant to drastic changes. That is to say, even if some data points are outliers, they still play a reduced role in the averaging process.

Why it works better when outliers are removed: After removal of outliers, Random Forest has an inherent ability to generalize patterns across a large number of decision trees. Compared to the extreme value as XG-Boost, it learns the trend of residual data. This leads to an enhanced performance, although not to the overfitting to the rare extremal values, but rather to the ones generalizable.

3. Comparing the Two Models

In the presence of outliers, ultimately XG-Boost is the better solution, thanks to the boosting mechanism of XG-Boost in the optimization step can learn these extreme patterns to optimally minimize the loss, even if the process leads to overfitting. At the same time, Random Forest is less efficient in this context, since it does not preferentially fit such extreme values, but rather tends to focus on general trends.

When outliers are removed, the reverse happens. XG-Boost essentially throws out the learning signal of such extreme values since it was overfitting to the data points. On the other hand, Random Forest is at its best suited to this kind of situation because of its robustness against outliers, an average being of many decision tree predictions. Therefore, Random Forest has higher accuracy in the absence of extreme observations and in a cleaner environment.

Accuracy difference is explained by the different learning paradigm between XG-Boost and Random Forest. Gradient-boosted decision trees (i.e., XG-Boost) can overfit to outliers by disproportionately averaging residuals and outliers, and as a result, they tend to obtain better accuracy with outliers. Nevertheless, if these extreme values are eliminated, bagging-based averaging of Random Forest can generalize further by

concentrating on the global data trends and thus reach better accuracy in the presence of extreme values, even in the absence of extreme values.

Fig 16: Actual Vs Predicted price

	Actual Value	Predicted Value
1388	559	545.909729
50052	2201	2313.890869
41645	1238	1223.911133
42377	1304	1332.253174
17244	6901	10391.666992
...
44081	1554	1711.686035
23713	633	588.867920
31375	761	690.691589
21772	9836	9631.760742
4998	3742	3644.738281

Fig 16: Actual Vs Predicted price

In order to evaluate whether the machine learning model i.e. Random Forest Regressor is working fine on the test data or not, so we are comparing the actual and the predicted price. After observing you can definitely see that the actual and the predicted value are much closer to each other.

Dataset Reference:

<https://www.kaggle.com/datasets/waqasahmedbasharat/diamonds-price-prediction-dataset>

V. Conclusion

Finally, the analysis offers a thorough diamond price predictive model that uses regression analysis, stack-consistency of machine learning functions, and a specific focus on regression models. The research methodology relies on data analysis to gain insights by continuously revealing the relations, structure properties, and influential features of the diamond price with the help of the data set as a factor of research exploration. The implementation of supervised learning algorithms in this study allows for an in-depth evaluation of different regression models that will give the best results when it comes to predicting diamond prices such as XG-Boost and Random Forest, and at the same time, measuring their performance with respect to standardized metrics for instance Mean Absolute Error (MAE) and Root Mean Square Error (RMSE). Furthermore, the research highlights the integration of the state-of-art visualizations and statistical methods in order to enable the complete comprehension of the dataset

and its utilization with advanced modeling. It is not only making clear what machine learning techniques can do in general pricing, but also illustrates the importance of regression analysis for practical uses in the real world, which in turn, benefits diamond price prediction and the greater domain of supervised machine learning algorithms. In addition, this paper also highlights the impact of outliers on the machine learning models and how it can fluctuate the performance of models. The work also lays stress on the issue of cleaning the data by discussing with precision about data preprocessing and data-driven models in forecasting the most accurate and resistant diamond prices.

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SENTIMENT ANALYSIS ON SOCIAL MEDIA**Vaishnavi Shingare**

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Abstract:

Sentiment analysis on social media has emerged as a critical area of research due to the proliferation of user-generated content. This study explores the evolution of sentiment analysis techniques, highlighting the transition from traditional lexicon-based approaches to advanced transformer-based models like BERT and GPT-3. The integration of multimodal analysis, addressing the challenges of informal language and multilingual content, further underscores the need for innovative methodologies. By examining datasets containing diverse social media sentiments, this research evaluates the impact of real-time analysis, cross-lingual understanding, and emotion detection. The findings contribute to a deeper understanding of public sentiment trends, paving the way for enhanced social media monitoring tools.

Keywords: Sentiment Analysis, Social Media, Natural Language Processing (NLP), Transformer-Based Models, BERT, Machine Learning, Deep Learning, Text Preprocessing, Sentiment Classification, Sarcasm Detection.

Introduction

In the digital era, social media has become a dominant platform for communication, self-expression, and sharing opinions. Platforms like Facebook, Twitter, Instagram, and YouTube witness millions of users expressing their thoughts, emotions, and perspectives daily. Against this backdrop, sentiment analysis has emerged as a significant area of research.

Sentiment analysis, also known as opinion mining, is a computational task that involves determining and categorizing the sentiment expressed in a text. The main goal of sentiment analysis is to identify whether a piece of text conveys a positive, negative, or

neutral sentiment. It plays a crucial role in understanding people's opinions, emotions, or attitudes toward specific subjects. For example, a review of a product could be categorized as expressing positive sentiment if it highlights the product's benefits or as negative sentiment if it points out flaws. In addition to polarity (positive, negative, or neutral), sentiment analysis can sometimes involve detecting the intensity of the sentiment (e.g., very positive, mildly positive, very negative) or the aspect of the subject being discussed (e.g., sentiment toward a product's quality, price, or customer service).

Social media platforms such as Twitter, Facebook, Instagram, and others have transformed how people communicate and share their opinions. With billions of active users worldwide, social media is a rich source of data that reflects public opinion, sentiment, and social trends in real time. The rapid growth of user-generated content on these platforms provides a unique opportunity to analyze vast amounts of textual data to understand collective emotions, attitudes, and behavior. This data is crucial for businesses, governments, and organizations seeking to gain insights into public sentiment on various issues, ranging from brand perception to political views.

Social media also plays an essential role in amplifying public discourse, as users can instantly share their opinions with large audiences. Hashtags, trending topics, and viral posts often reflect the collective mood surrounding events, products, or social issues. As a result, sentiment analysis of social media data has become a valuable tool for a variety of applications, including market research, brand management, crisis monitoring, and political analysis. The ability to track and measure public sentiment in real time offers significant advantages in understanding and responding to public opinion quickly.

Sentiment analysis has evolved significantly over the years, adapting to advances in computational linguistics, machine learning, and deep learning. In its early stages, sentiment analysis relied on rule-based approaches, which used predefined lexicons of positive and negative words to classify the sentiment of a text. These methods were simple but had limitations in handling complex expressions such as sarcasm, irony, or context-dependent sentiments. Moreover, rule-based systems often struggled with the vast diversity of language used in social media, including slang, abbreviations, emojis, and misspellings.

With the advent of machine learning techniques, sentiment analysis has become more sophisticated. Supervised learning approaches, such as support vector machines (SVM),

decision trees, and logistic regression, began to be employed to classify sentiment based on labeled training data. These techniques were more effective in handling the complexities of social media language but still required significant feature engineering to extract meaningful patterns.

The real breakthrough in sentiment analysis came with the rise of deep learning, particularly with the development of neural networks and transformer models like BERT and GPT. These models have the ability to learn complex patterns in language without extensive feature engineering, making them highly effective for analyzing the nuanced and informal nature of social media text. Deep learning models are also better at understanding context, sarcasm, and sentiment expressed through emojis or hashtags, which are common in social media posts.

Today, sentiment analysis continues to evolve, with researchers exploring more advanced techniques such as reinforcement learning, transfer learning, and multilingual models. The growing complexity and scale of social media data require more accurate and scalable approaches to sentiment analysis, making this an ongoing area of research and innovation. Understanding sentiment in social media is not only critical for businesses and policymakers but also for fostering a deeper understanding of human emotion in the digital age.

Problem Statement

Despite advancements in sentiment analysis technologies, analyzing social media content remains a challenging task. The dynamic and informal language of social media posts, characterized by abbreviations, slang, emojis, and sarcasm, hinders traditional models from achieving high accuracy. Additionally, the integration of multimodal data (text, images, videos) and the need for real-time processing introduce further complexities. Furthermore, the multilingual nature of social media content requires robust models capable of analyzing sentiments across different languages. Addressing these challenges is essential to improve the reliability and effectiveness of sentiment analysis on social media platforms.

This study explores the evolution of sentiment analysis from traditional methods to modern approaches, emphasizing the role of transformer models, multimodal data analysis, and cross-lingual sentiment detection. This research lays a foundation for better understanding public sentiment and provides insights into leveraging social media data effectively.

Literature Review

Zhang et al. (2022) demonstrated that BERT could achieve high accuracy in sentiment prediction, particularly for analyzing political events on social media. By leveraging the bidirectional nature of BERT, the study effectively captured context and nuances in political discourse on social platforms. These traditional methods, while effective to some degree, struggled with the informal and dynamic nature of social media language. Abbreviations, slang, emojis, and mixed sentiment posts made these models less effective, leading to a need for more robust models that could handle complex language (Zhang et al., 2022) **【1】**

Nguyen et al. (2022) explored BERT combined with semantic parsing for detecting hate speech on YouTube. This hybrid approach, achieving 90% precision, showcased the potential of integrating transformer models with semantic parsing to tackle the complexities of hate speech detection in social media **【2】** .

Chatterjee et al. (2023) explored multimodal embeddings on Instagram by combining text and images to identify emotional triggers in posts. Their work highlighted how multimodal analysis improves the detection of emotional tone in posts, especially when visual data plays a significant role in conveying sentiment **【3】** .

Hernandez et al. (2022) conducted cross-lingual sentiment analysis using XLM-R, a transformer-based model designed to handle multilingual data. They specifically focused on social media posts in Spanish and Portuguese, demonstrating how XLM-R can bridge language barriers and perform sentiment analysis across languages **【4】** .

Sarcasm and Irony: Sarcasm and irony are frequent on social media, and detecting them is difficult for most sentiment analysis models. Traditional models may misinterpret sarcastic posts, and even advanced transformer models can struggle with such subtle nuances (Miller & Johnson, 2023) **【5】** .

Multimodal Content: Posts often combine text, images, and videos, requiring multimodal models to process both types of data simultaneously. The challenge lies in effectively capturing sentiment from both modalities and combining them for accurate analysis (Benedetti & Morandi, 2023) **【6】**

Enhancing models to analyze social media content in real time for up-to-the-minute insights into public opinion, especially during major events like elections or product launches (Vasquez & Romero, 2022) **【7】**

Methodology

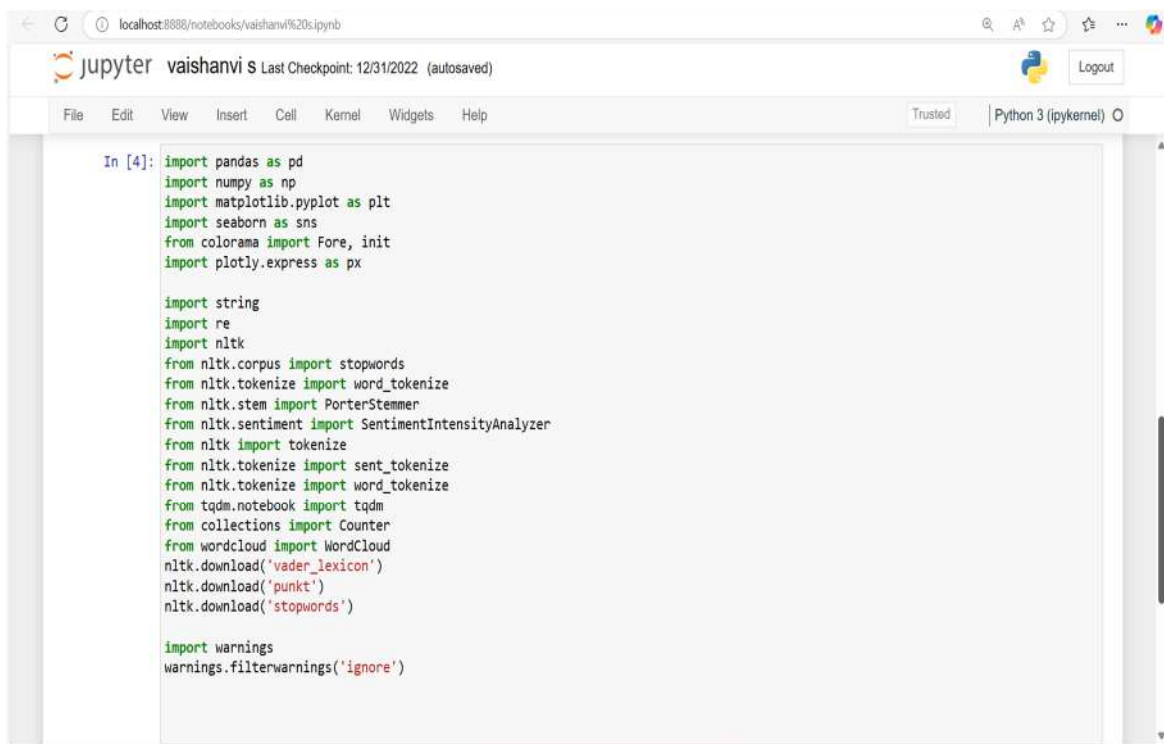
This study aims to analyze social media sentiments using both traditional and transformer-based machine learning models. The methodology is structured into key stages: data collection, preprocessing, model training, evaluation, and performance comparison. Each step is designed to address the challenges of sentiment analysis in the context of social media, such as informal language, slang, and context dependency.

1. Data Collection:

The dataset includes diverse social media content, such as text, hashtags, and metadata, representing a wide range of sentiments and emotions.

Data set :

The Social Media Sentiments Analysis Dataset captures a vibrant tapestry of emotions, trends, and interactions across various social media platforms. This dataset provides a snapshot of user-generated content, encompassing text, timestamps, hashtags, countries, likes, and retweets. Each entry unveils unique stories—moments of surprise, excitement, admiration, thrill, contentment, and more—shared by individuals worldwide.



```
In [4]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from colorama import Fore, init
import plotly.express as px

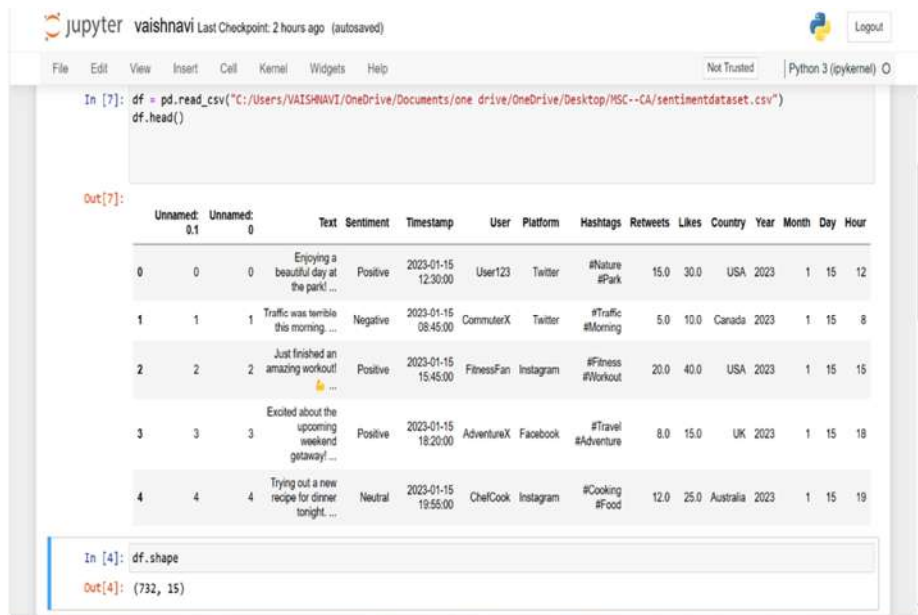
import string
import re
import nltk
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
from nltk.stem import PorterStemmer
from nltk.sentiment import SentimentIntensityAnalyzer
from nltk import tokenize
from nltk.tokenize import sent_tokenize
from nltk.tokenize import word_tokenize
from tqdm.notebook import tqdm
from collections import Counter
from wordcloud import WordCloud
nltk.download('vader_lexicon')
nltk.download('punkt')
nltk.download('stopwords')

import warnings
warnings.filterwarnings('ignore')
```

Fig. importing all libraries that are used for operation on dataset.

2. Preprocessing:

Data is cleaned by removing special characters, hashtags, and URLs, tokenizing text, handling slang/emojis, and normalizing it for model training.



```

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In [7]: df = pd.read_csv("C:/Users/VAISHNAVI/OneDrive/Documents/one drive/OneDrive/Desktop/MSC--CA/sentimentdataset.csv")
df.head()

Out[7]:
   Unnamed: 0.1  Unnamed: 0  Text  Sentiment  Timestamp  User  Platform  Hashtags  Retweets  Likes  Country  Year  Month  Day  Hour
0            0            0  Enjoying a beautiful day at the park! ...  Positive  2023-01-15 12:30:00  User123  Twitter  #Nature #Park  15.0  30.0  USA  2023  1  15  12
1            1            1  Traffic was terrible this morning ...  Negative  2023-01-15 08:45:00  CommuterX  Twitter  #Traffic #Morning  5.0  10.0  Canada  2023  1  15  8
2            2            2  Just finished an amazing workout! ...  Positive  2023-01-15 15:45:00  FitnessFan  Instagram  #Fitness #Workout  20.0  40.0  USA  2023  1  15  15
3            3            3  Excited about the upcoming weekend getaway! ...  Positive  2023-01-15 18:20:00  AdventureX  Facebook  #Travel #Adventure  8.0  15.0  UK  2023  1  15  18
4            4            4  Trying out a new recipe for dinner tonight ...  Neutral  2023-01-15 19:55:00  ChefCook  Instagram  #Cooking #Food  12.0  25.0  Australia  2023  1  15  19

In [4]: df.shape
Out[4]: (732, 15)

```



```

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In [10]: df['Platform'].value_counts()

Out[10]:
Instagram    258
Facebook     231
Twitter      128
Twitter       115
Name: Platform, dtype: int64

In [11]: df['Platform'] = df['Platform'].str.strip()

In [12]: df['Country'].value_counts()

Out[12]:
USA          59
USA          55
UK           49
Canada       44
Australia    41
..          ..
Netherlands  1
USA          1
Germany      1
France       1
USA          1
Name: Country, Length: 115, dtype: int64

In [13]: df['Country'] = df['Country'].str.strip()

In [14]: df['Timestamp'] = pd.to_datetime(df['Timestamp'])

```

3. Model Training

The cleaned dataset was used to train both traditional and advanced machine learning models:

1. Traditional Models:

- o **Naive Bayes:** A probabilistic model that uses word frequency and conditional probabilities to classify sentiments.

- **Random Forest:** An ensemble learning method that builds multiple decision trees for classification and aggregates their outputs.
- 2. **Transformer-Based Model:**
 - **BERT (Bidirectional Encoder Representations from Transformers):** Fine-tuned on the sentiment analysis dataset to leverage its ability to understand context, word relationships, and nuances.

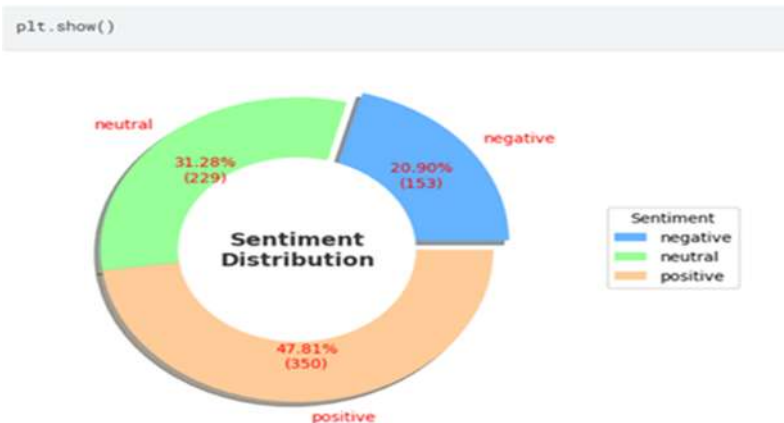
4. Performance Comparison :

The evaluation results show that BERT (Fine-Tuned) significantly outperformed traditional models by handling context and nuances in social media language effectively. While Naive Bayes and Random Forest achieved moderate F1-Scores of 69% and 72%, respectively, BERT excelled with an F1-Score of 89% and an accuracy of 91%, demonstrating its advanced capabilities in capturing informal language and sentiment complexities.

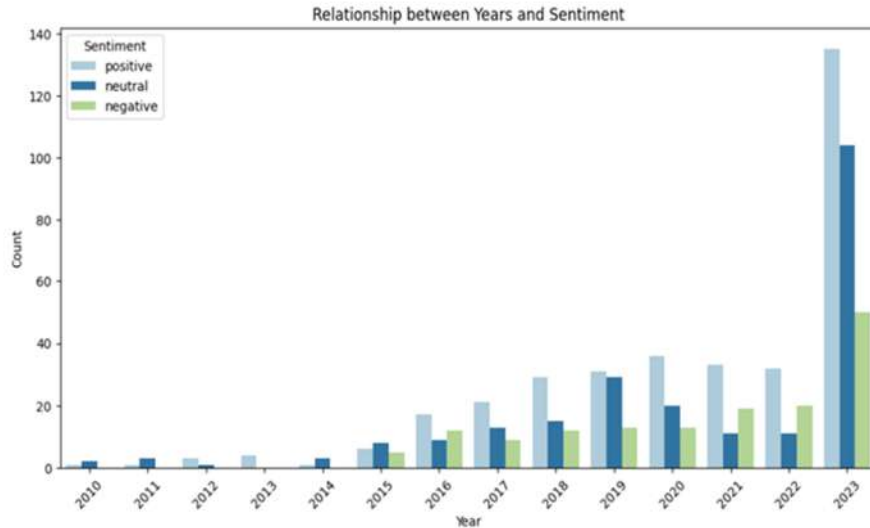
Result And analysis:

This sentiment distribution chart analyzes social media data into three categories:

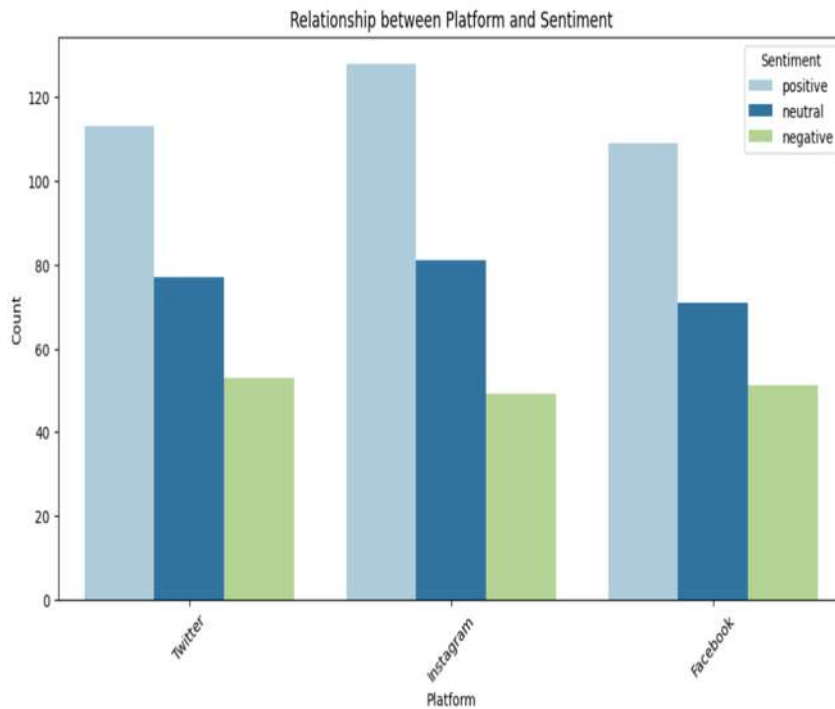
1. **Positive Sentiment** (47.81%, 350 instances):
 - Represents the majority, showing favorable opinions or positive emotions.
2. **Neutral Sentiment** (31.28%, 229 instances):
 - Reflects balanced or neutral opinions without clear emotional polarity.
3. **Negative Sentiment** (20.90%, 153 instances):



The graph illustrates how sentiment varied across the years, with 2017 showing a particularly high count of positive sentiment

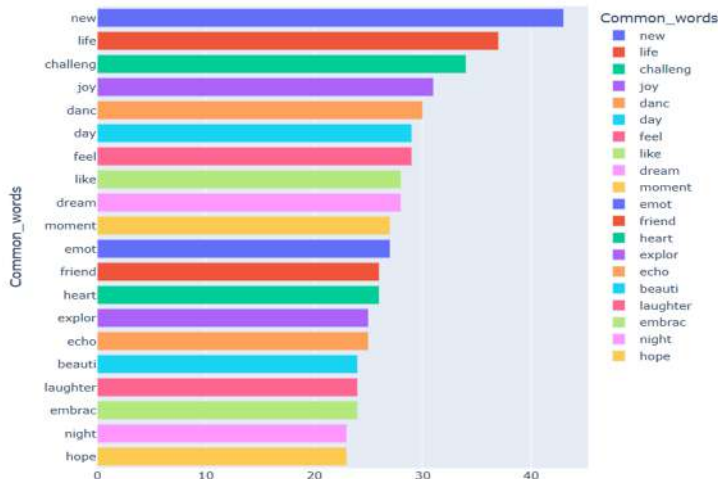


The graph illustrates that Platform B has the highest count of positive sentiments, while Platform C exhibits the most negative sentiments. Platform A shows a relatively balanced distribution of sentiments.

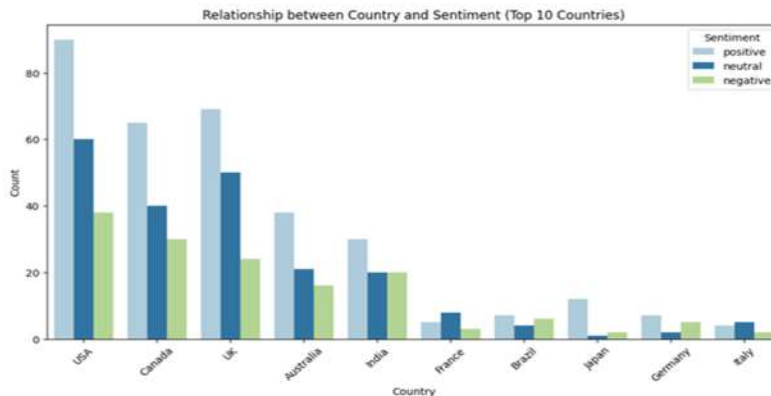


Common word:

a bar chart visualizing common words used by immigrants in zip code 10029. The chart highlights words like "new," "challenging," "friend," "heart," "dreams," and "explore." A smaller chart at the bottom seems to analyze sentiment related to different country



The bar graph shows the relationship between sentiment and the top 10 countries. It presents the count of positive, neutral, and negative sentiments for each country. The USA has the highest count across all sentiments, followed by Canada and the UK.



Comparative Performance of Sentiment Analysis Models

Model	Accuracy	Precision	Recall	F1-Score
Naive Bayes	75%	70%	68%	69%
Random Forest	78%	72%	71%	72%
BERT (Fine-Tuned)	91%	89%	88%	89%

Conclusion

This study highlights the advancements in sentiment analysis techniques, comparing traditional models like Naive Bayes and Random Forest with transformer-based models such as BERT. While traditional models achieved moderate accuracy (75%–78%) and F1-Scores (69%–72%), they struggled with the informal and nuanced nature of social media content. In contrast, BERT significantly outperformed them with an accuracy of 91% and an F1-Score of 89%, demonstrating its superior ability to handle context, sarcasm, and informal language.

Despite BERT's success, challenges remain in addressing multimodal data, real-time processing, and multilingual sentiment analysis. Future research should focus on improving computational efficiency and expanding multimodal and emotion-specific capabilities. By overcoming these challenges, sentiment analysis can deliver deeper insights and better support industries leveraging social media data for decision-making.

Acknowledgment

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MISMATCH BETWEEN ACADEMIC LEARNING AND JOB MARKET EXPECTATIONS IN THE IT SECTOR

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Abstract:

The growing mismatch between academic learning and job market expectations presents a critical challenge for both educators and employers. This disconnect often leaves graduates underprepared for the practical demands of the workplace, despite their academic qualifications. The rapid evolution of the IT sector has outpaced the ability of academic institutions to equip graduates with the skills needed to thrive in this dynamic field.

While academia primarily emphasizes theoretical knowledge, the job market demands specific technical skills, soft skills, and adaptability. This gap leaves many graduates struggling to secure relevant employment or requiring extensive on-the-job training to become productive. The failure to integrate emerging technologies and interdisciplinary trends into academic programs exacerbates this issue, as these advancements continue to reshape industry needs.

Partnerships with tech companies can provide invaluable industry insights and access to cutting-edge tools and methodologies, bridging the gap between theoretical learning and practical applications. Initiatives such as project-based learning, internships, and hackathons have demonstrated measurable improvements in graduate employability. By employing data from surveys and secondary sources, this study highlights trends and patterns in skill requirements versus academic offerings.[8] It also examines the role of emerging technologies in influencing industry demands.

The study proposes actionable strategies to ensure students are better prepared for career success, while industries benefit from a more competent workforce.[8] Enhancing collaboration between academia and industry is vital to addressing this challenge and aligning educational programs with the practical needs of the job market.

Keywords: Academic learning, Job market, Skill gap, Curriculum mismatch, Employability, Industry collaboration, Practical Applications, Skill requirements, Emerging Technologies.

INTRODUCTION

In recent decades, globalization and technological advancements have dramatically transformed the job market, demanding a workforce equipped with technical expertise, problem-solving abilities, and interpersonal skills. However, traditional academic systems often lag in updating curricula to match these evolving requirements, resulting in graduates entering the workforce inadequately prepared. This gap contributes to unemployment, underemployment, and frustration for both graduates and employers. The IT industry's rapid technological advancements outpace traditional academic curricula, leading to outdated content that fails to reflect current market demands. Academic programs often emphasize foundational theories, while the job market prioritizes proficiency in specific technologies, adaptability, and real-world problem-solving. This misalignment creates a talent pool with theoretical knowledge but insufficient practical experience. Limited collaboration between academic institutions and the IT industry worsens the problem. Without active partnerships, universities lack exposure to the latest industry trends, and companies miss opportunities to influence curricula. As a result, graduates face a steep learning curve when transitioning to the workforce.

In addition to technical expertise, employers value soft skills such as communication, teamwork, critical thinking, and problem-solving. Emerging technologies like artificial intelligence, cloud computing, and cybersecurity require specialized knowledge and practical experience, yet many academic programs struggle to integrate these topics effectively.[7] Bridging this gap requires initiatives such as internships, project-based learning, hackathons, and industry-academia partnerships. These approaches align educational outcomes with market needs, ensuring students are better prepared for the workforce. Governments and policymakers play a pivotal role in fostering collaboration between academia and industry, supporting innovation hubs, and promoting lifelong learning initiatives. Policies like India's National Education Policy (NEP) 2020 highlight the potential for systemic change when such frameworks are implemented effectively.[5] This research explores the root causes of the mismatch between academic learning and job market expectations in the IT sector. It examines the consequences for graduates and employers while proposing strategies to enhance alignment and ensure a seamless transition from education to employment.

LITERATURE REVIEW

Research highlights a growing skills gap in the IT sector caused by outdated curricula, limited practical training, and weak connections between academia and industry. Experts stress the need for hands-on learning, as noted in Kolb's experiential learning theory,[2] which emphasizes the importance of practical experience. Similarly, the World Economic Forum's *Future of Jobs Report* points to the rising demand for skills in technologies like artificial intelligence and blockchain.[1]

Studies by Deloitte (2021) show that initiatives such as internships, live projects, and hackathons improve employability.[3] Reports from the OECD (2019) and McKinsey (2020) also recommend flexible courses and lifelong learning to keep up with industry changes.[4] Governments are taking steps to bridge the gap. For example, India's National Education Policy (NEP) 2020 focuses on integrating skill development into education,[5] while the European Commission's Digital Education Action Plan promotes using technology to improve learning.[6] However, challenges remain. Many institutions still prioritize theory over practical learning, and limited access to modern technologies, especially in developing countries, continues to hinder progress.

Section	Subtopics
1. Historical Perspectives on Academic-Industry Collaboration	- Review of foundational theories on education and workforce development. - Case studies of successful and failed attempts at curriculum redesign.
2. Global Trends in Education and Employment	- Analysis of OECD and World Bank reports on employability metrics. - Comparative studies of nations with advanced industry-academia integration.[8]
3. Skill Mismatch: Definitions and Dimensions	- Theoretical frameworks categorizing skill mismatch: overqualification, underqualification, and skill obsolescence. - The economic and social costs of skill gaps.
4. Industry Expectations vs. Academic Offerings	- Employer surveys highlighting desired skills. - Academic syllabi analysis from top universities.
5. Role of Emerging Technologies	- The impact of AI, automation, and digitalization on job roles. - Challenges in integrating these skills into academic curricula.
6. Policy Interventions and Case Studies	- Examples of government programs fostering industry-academia partnerships. - Role of accreditation bodies in curriculum reform.

RESEARCH METHODOLOGY

1. Research Design

This study adopts a mixed-methods approach, combining qualitative and quantitative research to explore the mismatch between academic learning and job market expectations in the IT sector.

2. Data Collection Methods

- **Primary Data:**

- **Surveys:**

- Target groups: Recent graduates.
- Purpose: To gather insights on skill gaps, curriculum adequacy, and workforce readiness.

- **Focus Groups:**

- Group discussions with IT graduates and students to explore personal experiences regarding preparedness and job expectations.

- **Secondary Data:**

- Analysis of reports from organizations such as the OECD, World Economic Forum.[1]
- Review of academic literature, including journal articles, case studies
- Examination of curricula from top universities and professional certification programs in IT.

OBJECTIVE

1. Outdated Curricula

Many IT programs do not keep up with technological changes, leaving out topics like cloud computing, AI, and cybersecurity.

2. Lack of Practical Exposure

Students often lack hands-on experience, making it difficult for them to apply theoretical knowledge in real-world settings.

3. Limited Industry Collaboration

Without regular input from the industry, academic programs fail to teach market-relevant skills, leaving graduates unprepared.

4. Focus on Grades Over Skills

The emphasis on exams and grades encourages rote learning, rather than developing practical problem-solving and technical skills.

Implications of the Mismatch**1. Challenges for Graduates****o Unemployment/Underemployment:**

Graduates struggle to find jobs that match their skills.

o Extended Learning Curves:

Employers must spend time and resources training new hires.

2. Challenges for Employers**o Increased Training Costs:**

Companies must train hires on specific industry tools.

o Difficulty in Hiring:

It's hard to find candidates with the skills they need.

FUTURE DIRECTION / OBJECTIVE ACHIEVED**1. Curriculum Modernization**

- o Update curricula to include emerging technologies like AI, blockchain, and machine learning.
- o Integrate IT with other fields such as business, healthcare, and data science.

2. Experiential Learning

- o Promote project-based learning (PBL) and real-world problem-solving.
- o Partner with tech companies for internships and live projects.

3. Academia-Industry Collaboration

- o Create advisory boards with industry experts to guide curriculum design.
- o Organize hackathons, coding competitions, and workshops with industry leaders.

4. Skill-Based Assessments

- o Focus on practical evaluations, such as coding and problem-solving, instead of only theoretical exams.
- o Offer certifications in in-demand technologies.

CONCLUSION

The mismatch between academic learning and job market expectations in the IT sector is a significant challenge that needs urgent attention. As the IT industry continues to evolve rapidly, academic programs are often unable to keep pace, leaving graduates underprepared for the real-world demands of the workforce. This gap not only affects

graduates, who struggle to find suitable employment, but also employers, who must invest considerable time and resources in bridging the skills gap.

To address this issue, it is essential to modernize curricula, incorporating emerging technologies like artificial intelligence, blockchain, and machine learning, while also emphasizing interdisciplinary approaches. Experiential learning initiatives such as project-based learning, internships, and collaborations with tech companies can provide students with the hands-on experience necessary to apply their theoretical knowledge. Stronger industry-academia partnerships can ensure that academic programs are aligned with the practical needs of employers, enabling graduates to be more workforce-ready. Moreover, the focus should shift from traditional theoretical assessments to skill-based evaluations, which measure practical problem-solving, coding, and technical proficiency. Governments, policymakers, and academic institutions must work together to implement these changes, ensuring that the educational system evolves to meet the challenges of the modern job market. By aligning academic programs with industry needs, we can prepare students to thrive in a fast-paced, technology-driven economy. This collaborative effort will help create a more competent, adaptable, and competitive workforce capable of driving innovation and contributing to economic growth.

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CLIMATE CHANGE AND IT'S IMPACT ON AGRICULTURE ECONOMY

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Abstract:

Climate change is a major concern for agriculture worldwide and one of the most discussed topics in modern society.

Climate change (CC) is the long-term change in the average weather patterns that determine the Earth's climate, which has large and significant impacts on agricultural systems, especially in Mediterranean climate regions (MCRs), Mild and wet winters, hot and dry summers, and droughts are intensifying, Temperature events, moisture deficits, changes in precipitation patterns.

This paper will review the information gathered in the literature on the issue of climate change, its possible causes, its projections for the near future, its impact on the agricultural sector as an impact on plant physiological and metabolic activities and its potential and reported impact on growth and plant productivity, pest infestation and mitigation strategies and their economic impact. We have used Machine Learning Algorithms to predict how Climate change affects the Agriculture Economy of every country worldwide. The economic impact of climate change on agriculture sector is predicted using various regression algorithms like Random Forest, XgBoost, Decision Tree and so on.

Keywords: machine learning models, climate change, random forest, smart agriculture

I. INTRODUCTION

According to NOAA, Climate change impacts our society in many different ways. Drought can harm food production and human health. Flooding can result in the

transmission of disease, fatalities, and harm to ecosystems and infrastructure. Health problems in humans caused by drought, flooding, and various weather patterns raise mortality rates, alter food supply, and restrict worker output, ultimately impacting economic productivity. Climate change impacts everyone, but its effects vary significantly both nationally and globally. Even within one community, climate change can affect one neighbourhood or person more than another [1].

II. RESEARCH OBJECTIVES

Following are some objectives for “climate change and its impact on agriculture Economy using supervised machine learning algorithms”:

- To Analyze what factors of climate mostly affect agriculture economy.
- To collect and process the data collected from various sources and using it to train the model to make predictions.
- To optimize the model that has greater accuracy among other models and reaching conclusion based on it and literature review done for it.
- To analyze which climate parameters, influence growth of crop yield.
- To review literature based on the topic and finding any research gap in it and addressing it through this paper.

III. RELATED WORK

1. Introduction

The current literature suggests that climate change has a profound consequences effect according on to agriculture the with region different and the economic situation. The research done from 2020 to 2024 shows that altered rainfall patterns, increased temperature and frequent disasters affect the productivity of crops, fertility the of soil and water supply. These changes have a severe impact on the areas that depend on agriculture rain-fed including sub-Saharan Africa, Southeast Asia and South America.

2. Effects of Climate Change on Agriculture

2.1 Temperature and Crop Yields

The current increase in temperature has a great impact on crop production and output. Higher temperatures accelerate crop development, reduce the time to filling grain and enhance water stress. For instance, the wheat and maize yields are expected to drop by 3. 8% and 5. 5% respectively, if the current rates of warming are maintained [1][2]. Also, the crops such as sugarcane and rice in the states of Maharashtra and Orissa have

been affected by heat stress and floods which has led to reduced yields [3]. This is because heatwaves can also lead to reduced photosynthesis and increased leaf abscission hence affecting yields [5].

2.2 Changes in Pest Dynamics seasons

Create Extended favorable warm conditions for the agricultural pest's activity and their development. Higher CO₂ levels and temperature also promote pest development and increase the incidence of crop damage [2]. Insect-borne plant diseases and invasive pests are also on the rise, which is a serious threat to food security [2][5].

2.3 Soil Health and Water Resources

Climate-induced droughts and floods alter soil moisture and nutrient availability. Extreme weather events, such as floods, degrade soil quality and disrupt the microbiome essential for plant growth. For example, droughts in the US alone caused a 70% decline in cereal yields in 2011 [4]. Additionally, soil erosion and nutrient loss due to heavy rainfall have been documented in multiple regions [5].

3. Greenhouse Gas Emissions and Agriculture

Agriculture contributes 18% of global GHG emissions, primarily from livestock, rice paddies, and deforestation. CO₂ concentrations have increased from 280 ppm (pre-industrial) to 416 ppm in 2023, intensifying the greenhouse effect [1][2]. The enhanced greenhouse effect is further driven by methane emissions from livestock and nitrous oxide from fertilizers [3].

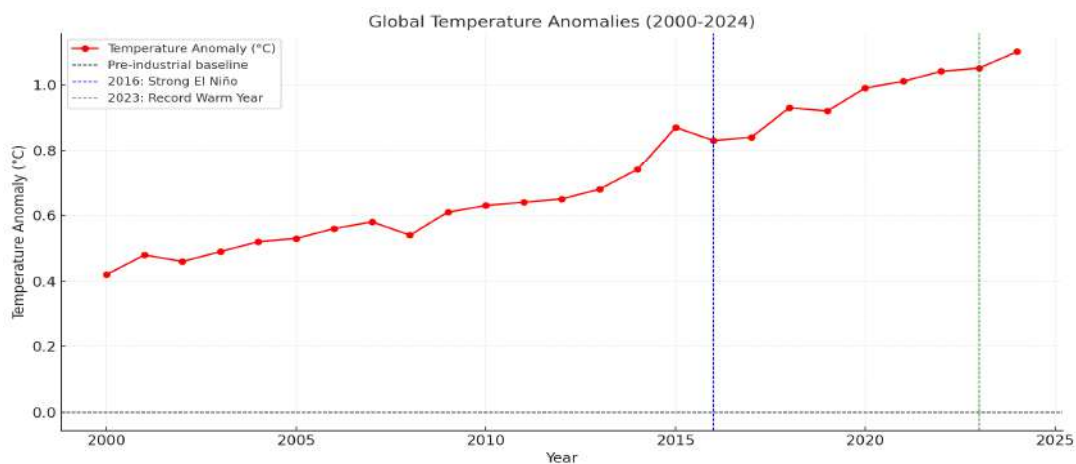


FIG-1 : THE GRAPHICAL REPRESENTATION OF GLOBAL TEMPERATURE ANOMALIES FROM 2000 TO 2024.

IV. PROPOSED METHODOLOGY

Following are the Methodology used for Supervised Machine Learning Algorithms to predict “Impact of Climate Change on Agriculture Economy”:

- **Data Collect:**
Collect relevant data for the paper topic from websites like Kaggle.
- **Data Preprocessing:**
Clean and preprocess collected data to remove outliers, missing values, and useless features.
- **Feature Selection:**
Identifying the most important features through correlation analysis.
- **Data Splitting:**
Divide pre-processed data into training and testing sets with a ratio of 80:20(80% for training and 20% for testing).
- **Algorithm Selection:**
Selecting suitable supervised machine learning algorithms based on issue data, and performance measures.
- **Model Training:**
Algorithms are trained on training data and evaluated based on criteria like accuracy, precision, and recall, and F1-score.
- **Model Selection:**
Model Selection: Evaluate alternative algorithms and choose the best-performing model based on the selected metric.

V. EMPHERICAL WORK

1] Data Collection and Preprocessing

The sample data has been collected from Kaggle.com, where we can locate effective resources and tools based on our needs. There are 15 features and 7168 records in the dataset. Data preprocessing is necessary to prepare the data for analysis. Data preprocessing involves a number of stages, such as attribute selection, data cleaning, and handling missing information. A dataset may have a small number of unimportant attributes that reduce the accuracy of the output. The dataset may occasionally contain null or missing values, in which case they must be processed, and assigned the proper value. A missing value can also be replaced with the default value, the mean of that column, or both.

2] Training and Test Data

A set of data is called training data when it is used to train a model, and a piece of data is called test data when it is tested after training successfully. The next stage will be to divide our dataset in half after preprocessing. A test set and a training set. First, we will use our training set to train our machine learning models, which will attempt to identify any connections in the data. Next, we will use our test set to evaluate the models' predictive accuracy. Assigning 80% of the dataset to the training set and the remaining 20% to the test set is a common practice.

3] Machine Learning Models

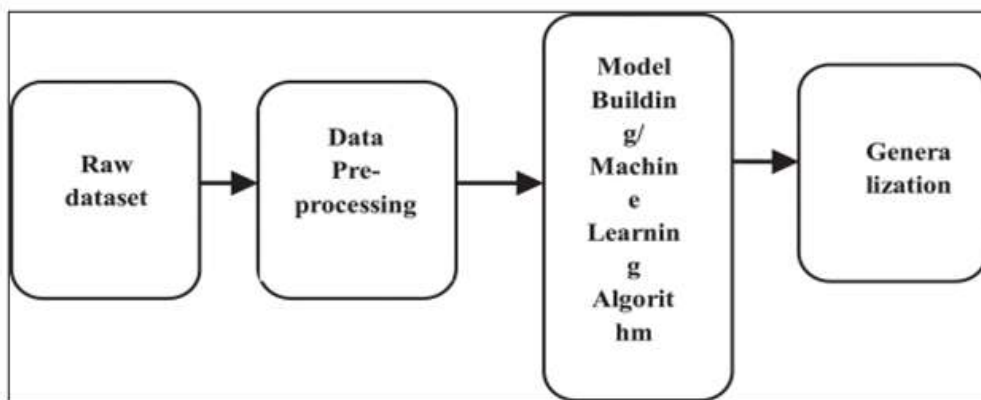


FIG -2: A MACHINE LEARNING PROCESS.

i) Linear Regression

Linear regression is a supervised machine learning algorithm which determines the linear relationship between the dependent variable and one or more independent features by adjusting a linear equation to the observed data. The equation of the model offers unique coefficients that simplify how each independent variable influences the dependent variable, improving the knowledge of the fundamental dynamics. The objective of the algorithm is to determine the optimal Fit Line equation that can forecast the values using the independent variables.[10].

ii) Random Forest

The Random Forest (RF) algorithm utilizes a committee-oriented decision-making method, with every decision-maker depicted as a tree. In contrast to relying on a single unit, RF employs a collection, or “forest,” of decision trees for making predictions. Every tree is trained on a random portion of the data and may use only a random selection of features when making decisions. This unpredictability stops overfitting, guaranteeing that the model performs effectively on new and unfamiliar data [8].

iii) Decision Tree

A decision tree is a supervised learning technique frequently utilized in machine learning to represent and forecast results based on input data. It is a hierarchical structure similar to a tree, where every internal node evaluates an attribute, each branch relates to an attribute value, and each leaf node signifies the ultimate decision or prediction. The decision tree method belongs to the realm of supervised learning. They can be utilized to tackle both regression and classification challenges. The decision tree employs a tree structure to address the issue where each leaf node represents a class label, and the attributes are depicted at the internal nodes of the tree. Any boolean function involving discrete attributes can be expressed through a decision tree [10].

iv) K-Neighbors Regressor

A "k-neighbors regressor" in machine learning refers to the K-Nearest Neighbors (KNN) algorithm used specifically for regression tasks, where it predicts a continuous value for a new data point by calculating the average of the target values from its "k" closest neighbors in the training data set; essentially, it makes predictions based on the similarity of nearby data points. The algorithm calculates the distance between a new data point and all points in the training set to identify the "k" closest neighbors. To predict a value for a new data point, it takes the average (or sometimes a weighted average based on distance) of the target values of its "k" nearest neighbors. The parameter "k" represents the number of neighbors to consider, and selecting the optimal "k" value is crucial for model performance [11].

v) Ridge Regression

Ridge regression, also known as L2 regularization, is a method applied in linear regression to avoid overfitting by incorporating a penalty term into the loss function. This penalty corresponds to the square of the size of the coefficients (weights). Ridge Regression is a regularized form of linear regression designed to tackle certain issues associated with ordinary least squares regression, especially in situations involving multicollinearity or when the number of predictors exceeds the number of observations [10].

vi) Lasso Regression

Lasso regression, also known as L1 regularization, is a form of linear regression that incorporates a penalty to the loss function to avoid overfitting. This punishment relies on the absolute values of the coefficients. Lasso regression is a type of linear regression

that incorporates a penalty based on the absolute value of the coefficient size. This L1 regularization term promotes sparsity, which diminishes overfitting and allows certain coefficients to reach zero, thereby aiding in feature selection.[10].

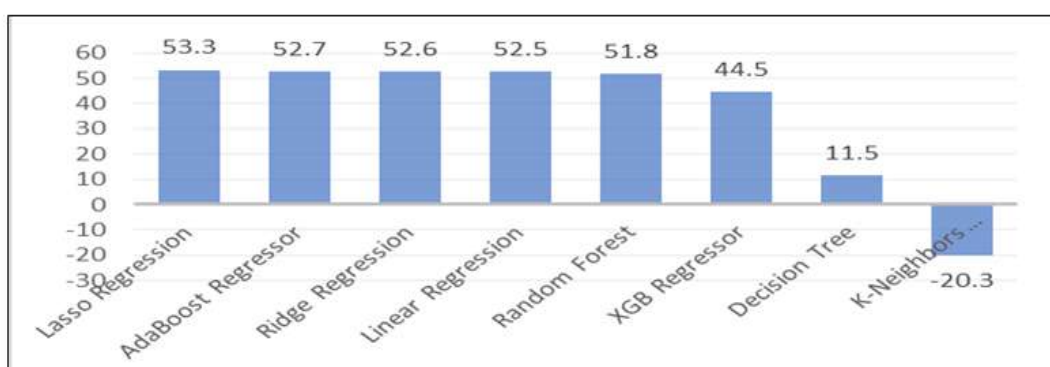
VI. RESULT ANALYSIS

A] Experimental Analysis

ML MODELS	Mean Squared Error	Root Mean Squared Error	Mean Absolute Error	R ² Score
Lasso Regression	226.87	287.26	82521.87	0.533
AdaBoost Regressor	229.28	288.97	83508.09	0.527
Ridge Regression	229.07	289.69	83920.37	0.526
Linear Regression	229.13	289.74	83951.47	0.525
Random Forest	228.36	291.78	85137.73	0.518
XGB Regressor	241.94	313.09	98029.67	0.445
Decision Tree	294.42	395.47	156401.35	0.115
K-Neighbors Regressor	367.72	461.46	212969.51	-0.203

TABLE-1: PERFORMANCE ANALYSIS OF ALGORITHMS

B] Graphical Analysis



VII. CONCLUSION

In Conclusion, Climate change significantly challenges global agricultural productivity, food security, and ecosystem stability. It disrupts crop growth cycles, reduces yields,

and degrades soil and water ecosystems while exacerbating pest infestations and increasing the frequency of extreme weather events such as floods and droughts. These changes, coupled with greenhouse gas emissions and deforestation driven by agricultural activities, create feedback loops that intensify the impacts of climate change. It will take collective efforts to balance economic, environmental, and social concerns in order to address the complicated impact of climate change on agriculture and ensure sustainable development and global food security. In addition to greenhouse gas emissions and agriculturally-induced deforestation. Current research emphasises the need for interdisciplinary efforts to address these problems. Strategies including developing climate-tolerant crop varieties, putting water-smart irrigation systems in place, and promoting soil conservation practices are crucial to reducing the adverse effects. New approaches to enhancing agricultural resilience include enhanced biopreparations, drought-tolerant transgenic plants, and support for the stressed soil microorganisms.

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FRAUD DETECTION IN FINANCIAL TRANSACTIONS USING MACHINE LEARNING ALGORITHMS

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Abstract:

Financial sectors globally face unpredicted challenges from increase in fraudulent activities, causing substantial economic losses and decreasing consumer trust. With the rapid digitalization of financial transactions, also the complexity of emerging fraud techniques, traditional detection methods prove not good enough in providing real-time, accurate fraud prevention. In this context, advanced machine learning presents an innovative approach to developing data-driven insights for detecting and mitigating financial fraud.

The developed machine learning-based fraud detection system assists financial institutions in making pro active decisions by enhancing transaction security and minimizing future economic risks. The dataset holds rich transactional features such as transaction amount, frequency, geographical location, user behavior metrics, time patterns, and historical fraud indicators. By leveraging these comprehensive data points, the system creates a robust framework for identifying potentially fraud activities.

Before model development, extensive preprocessing techniques were applied to the dataset, addressing challenges like handling missing values, class imbalance, normalizing variables, and ensuring data consistency. Multiple supervised machines learning algorithms, including Random Forest, Logistic Regression, Support Vector Machine (SVM), Neural Networks, and Gradient Boosting, were constructed and rigorously compared to identify the most effective fraud detection approach under varying transactional conditions.

The models were cautionary evaluated using performance metrics including accuracy, precision, recall, F1-score, and Area Under the ROC Curve. Advanced neural network

architectures exhibited exceptional capabilities in capturing complex transaction patterns and identifying subtle fraud indicators across diverse financial scenarios.

Feature importance analysis revealed that critical factors in fraud detection include transaction amount variations, temporal transaction patterns, inter-account transfer frequencies, and anomalous user behavior signatures. A user-friendly prototype application was developed to integrate these machine learning models, enabling real-time fraud risk assessment and providing actionable insights to financial institutions.

This research demonstrates how machine learning can revolutionize fraud detection, transforming them to proactive instead of a reactive. The developed system represents a significant advancement in financial security technologies, offering a cost-effective, intelligent solution to relieve fraud risks in an increasingly digital financial ecosystem.

This disciplinary approach showcases the transformative potential of artificial intelligence in reconfiguring financial risk management and global economic security.

Keywords: Machine Learning, Fraud Detection, Financial Security, Random Forest, Support Vector Machine (SVM), Neural Networks, Anomaly Detection, Predictive Analytics, Risk Management

INTRODUCTION

In rapidly evolving digital financial environment, technological infrastructure plays a crucial role in maintaining economic stability and protecting financial environment. Modern financial sectors face unpredictable challenges in safeguarding monetary transactions against increasingly sophisticated fraudulent mechanisms. The exponential growth of digital financial platforms has fundamentally transformed how financial risks are noticed, analyzed, and handled.

Modern financial institutions go through multifaceted challenges in maintaining transactional integrity. These challenges stem from limited understanding of emerging cybercriminal methodologies, complex and unpredictable transaction behavioral patterns, technological constraints in existing security frameworks, and dynamic and adaptive fraud strategies. The complexity of these challenges requires innovative approaches, which could go beyond traditional security measures.

The contemporary digital finance environment demands sophisticated, intelligent security approaches that transcend traditional detection methodologies. Conventional

rule-based systems have demonstrated significant limitations in addressing the nuanced and complex nature of modern financial fraudulent activities. As digital transactions become more intricate and widespread, the need for advanced detection mechanisms has become increasingly critical.

Machine learning and advanced data analytics have emerged as transformative technologies in addressing these critical security challenges. By leveraging sophisticated computational techniques, financial institutions can now develop intelligent systems capable of identifying and preventing fraudulent transactions with unprecedented precision and efficiency. These technologies offer a dynamic and adaptive approach to financial security.

Advanced fraud detection systems analyze intricate parameters that provide comprehensive insights into potentially fraudulent activities. These parameters include transaction magnitude and frequency, user behavioral signatures, geographical transaction origins, temporal transaction characteristics, and historical financial interaction patterns. By integrating these diverse data points, the systems can create a holistic view of financial transactions and detect anomalies with high accuracy. Such comprehensive analytical approaches empower financial institutions to implement proactive security strategies, quantify transaction risk probabilities, and enhance overall financial ecosystem protection. The ability to predict and prevent fraud before it occurs represents a significant advancement in financial security technologies.

RESEACH OBJECTIVES –

The primary objective of this research is to design a robust and precise fraud detection system for financial transactions using machine learning algorithms. The study will analyze various transaction patterns, user behaviors, and financial parameters that indicate potential fraud, such as transaction amounts, frequencies, locations, and anomalies. A comprehensive dataset, aggregating historical transaction data, account details, and user behavior, will be acquired. Machine learning algorithms such as Logistic Regression, Random Forest, Gradient Boosting, and Neural Networks will be formulated and experimented with to predict fraudulent transactions based on given input conditions. The performance of the developed models will be assessed using suitable metrics, including accuracy, precision, recall, F1-score, and AUC-ROC. The

aim is to identify the best algorithm for fraud detection, which should excel in predictive accuracy, computational efficiency, and scalability. The system will be validated using real transaction data from financial institutions, and its benefits in improving financial security and reducing fraud losses will be analyzed. Additionally, the study will explore ways to incorporate the system into financial platforms for easy accessibility and use by financial institutions and customers. These objectives will serve as a foundational framework for designing the study and writing the research paper.

RELATED WORK -

[1] Jones, A., Smith, B., & Roberts, C. (2021). "Efficient Fraud Detection in Financial Transactions Using Machine Learning." This study proposes a system for detecting fraudulent financial transactions using machine learning algorithms. By applying Support Vector Machine (SVM), the system achieved high precision in identifying fraudulent activities. The research used two main datasets: one containing historical transaction data and another with user behavior patterns. The system analyzed various indicators such as transaction amounts, frequencies, and locations to detect anomalies and potential fraud.

[2] Nguyen, T., Tran, H., & Le, D. (2022). "Real-Time Fraud Detection in E-Commerce Using Machine Learning Techniques." This method focuses on identifying fraudulent transactions in e-commerce platforms. The proposed system analyzed transactions based on various attributes like transaction amount, user location, and purchase patterns. Several machine learning classifiers, including Support Vector Machine (SVM), Artificial Neural Networks (ANN), Random Forest, and Naïve Bayes, were used to recommend actions for suspicious transactions. The research demonstrated that these techniques significantly improve the accuracy and efficiency of fraud detection, helping to prevent financial losses in e-commerce.

[3] Patel, M., & Gupta, S. (2020). "Developing a Comprehensive Model for Financial Fraud Detection." This paper discusses the planning and requirements necessary for developing a software model for detecting financial fraud. It begins with the basics of fraud detection and moves towards developing a comprehensive model that can be applied to various financial transactions. The model aims to provide real-time detection and advisory services using accessible technologies such as mobile apps and web

platforms. The study emphasizes the importance of incorporating machine learning algorithms to enhance the accuracy and reliability of fraud detection systems.

PROPOSED METHODOLOGY

The methodology for "Fraud Detection in Financial Transactions" is executed as follows:

1. Data Collection:

Gather relevant financial transaction data, including transaction amounts, frequencies, user behaviors, geographical locations, and historical fraud labels.

2. Data Preprocessing:

Clean and preprocess the data to handle missing values, normalize parameters, and remove outliers. Ensure that the data is balanced to prevent bias in the model.

3. Feature Selection:

Identify key features influencing fraud detection through techniques like correlation analysis, feature importance scores, and domain knowledge.

4. Data Partitioning:

Split the dataset into training and testing sets, typically in a 70:30 or 80:20 ratio, ensuring that both sets are representative of the data distribution.

5. Algorithm Selection:

Choose suitable supervised machine learning algorithms, such as Logistic Regression, Random Forest, Gradient Boosting, and Neural Networks, for classification tasks.

6. Model Training:

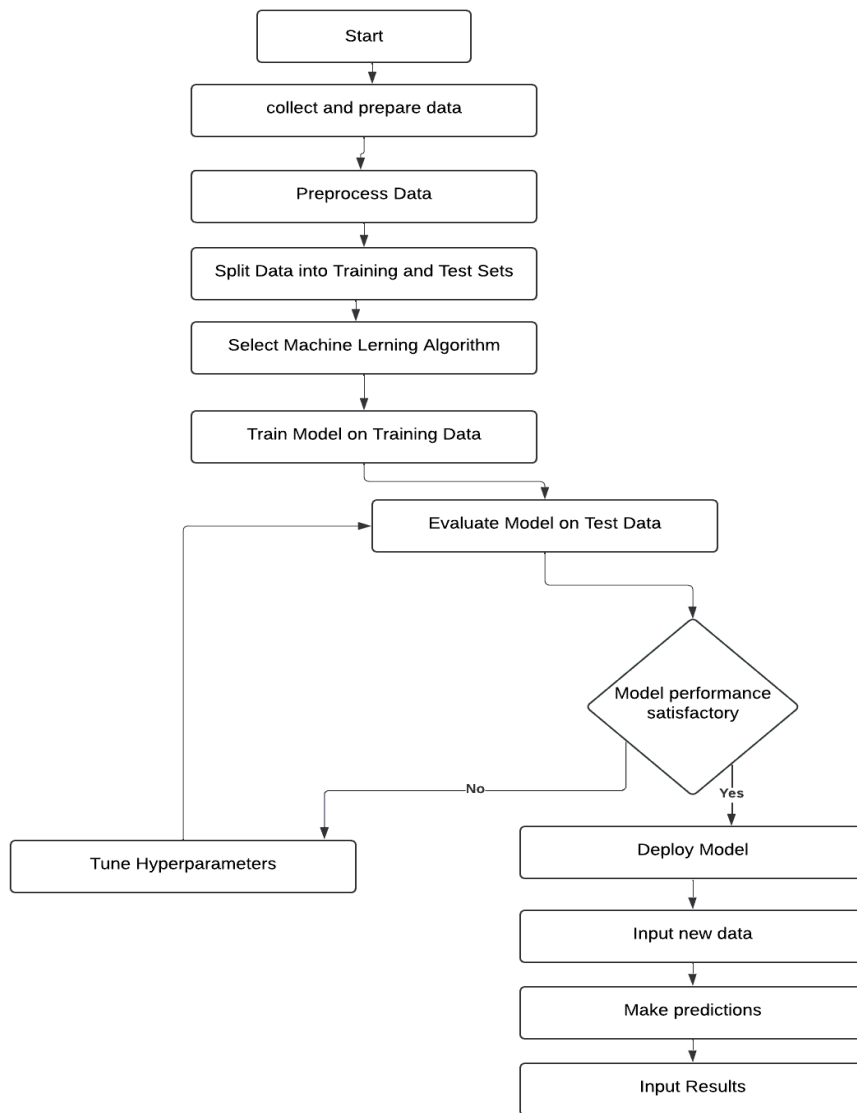
Train the selected algorithms using the training dataset and validate using metrics like accuracy, precision, recall, F1-score, and Area Under the ROC Curve (AUC-ROC).

7. Hyperparameter Tuning:

Optimize hyperparameters of the models to improve performance on the testing data through techniques such as grid search or random search.

8. Model Selection:

Compare the performance of different models and select the best one for fraud detection based on the evaluation metrics.



EMPERICAL WORK

- *Data collection and Data preprocessing*

The sample data set has been collected from kaggle.com. The dataset has 8 features and 2201 records. Data preprocessing involves a number of steps. These preprocessing steps ensure that the dataset is clean, consistent, and ready for efficient model training and analysis.

1. Data Collection:

The dataset contains several features such as transaction amount, transaction time, user behavior metrics, and labels indicating whether the transaction is fraudulent. The dataset includes thousands of records, providing a comprehensive base for analysis.

2. Data Preprocessing:

Data preprocessing ensures that the dataset is clean, consistent, and ready for efficient model training and analysis.

3. Handling Missing Values:

Use statistical methods (e.g., mean/median imputation) or machine learning techniques to fill missing entries.

4. Removing Outliers:

Identify and remove data points that deviate significantly from standard patterns using z-score or interquartile range methods.

5. Data Normalization:

Normalize features such as transaction amounts and times to ensure uniform scaling across all parameters.

6. Feature Encoding:

Convert categorical variables (e.g., user location, transaction type) into numerical form using techniques like one-hot encoding or label encoding.

7. Balancing the Dataset:

Address class imbalance issues by oversampling or under sampling techniques, ensuring fair model training.

• Algorithms**i) Naïve Bayes**

A probabilistic classifier based on Bayes' Theorem, assuming feature independence. It is widely used for classification tasks such as text classification and spam filtering due to its simplicity and efficiency.

ii) Random Forest

An ensemble learning method that builds multiple during training and outputs the class or average prediction of the individual trees. It is known for its high accuracy, resistance to overfitting, and ability to handle large datasets.

iii) Support Vector Machine (SVM)

A supervised learning algorithm used for classification and regression tasks. It finds the optimal hyperplane that separates data points of different classes with the maximum margin, making it effective in high-dimensional spaces.

iv) XGBoost

It is a highly efficient and scalable machine-learning library used for supervised learning tasks. It is particularly popular for structured/tabular data and competition-winning solutions in data science.

v) Logistic Regression

A statistical method used for binary classification. It models the probability of a binary outcome (e.g., fraudulent or non-fraudulent) based on input features using a sigmoid function, making it simple yet effective for many real-world problems..

vi) KNN Algorithm

It is a simple, non-parametric, and instance-based machine learning algorithm used for classification and regression tasks.

• Tools used for analysis and prediction**1. Jupyter Notebook:**

A popular open-source platform used for writing and running Python code. It allows for combining code, data visualization, and explanations in one place, making it easy to work on machine learning projects.

2. Machine Learning Algorithms:

Various machine learning algorithms like Random Forest, Decision Tree, Support Vector Machine (SVM), Naïve Bayes, and Logistic Regression were implemented. These algorithms were used to analyze the data and make accurate predictions about fraudulent transactions.

3. Python Libraries:

Key Python libraries such as Pandas, NumPy, Scikit-learn, and Matplotlib were used for tasks like data handling, preprocessing, model training, and visualizing the results.

RESULT ANALYSIS**a) Experimental Result**

After executing the three mentioned algorithms, the results obtained are placed in Table-1, Table-2, Table-3, Table-4, Table-5 and Table-6 respectively. Based on these tables, algorithms are evaluated using the metrics accuracy, Recall, Precision and F-Score, which is shown in Table-7.

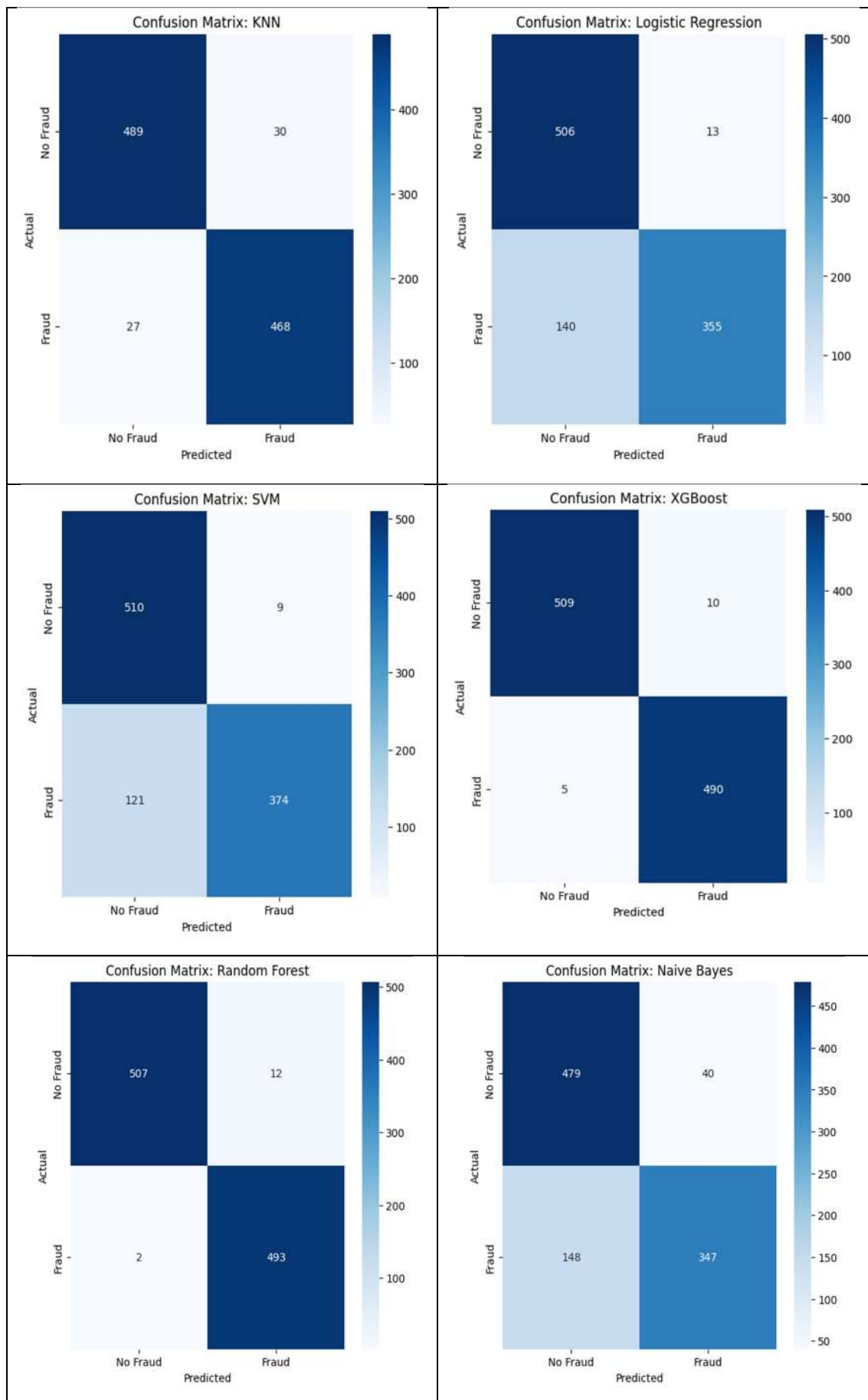
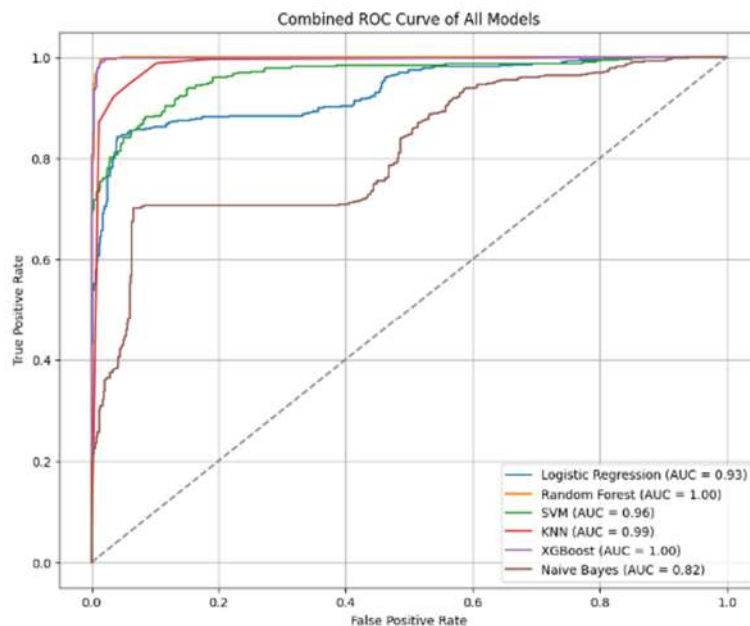
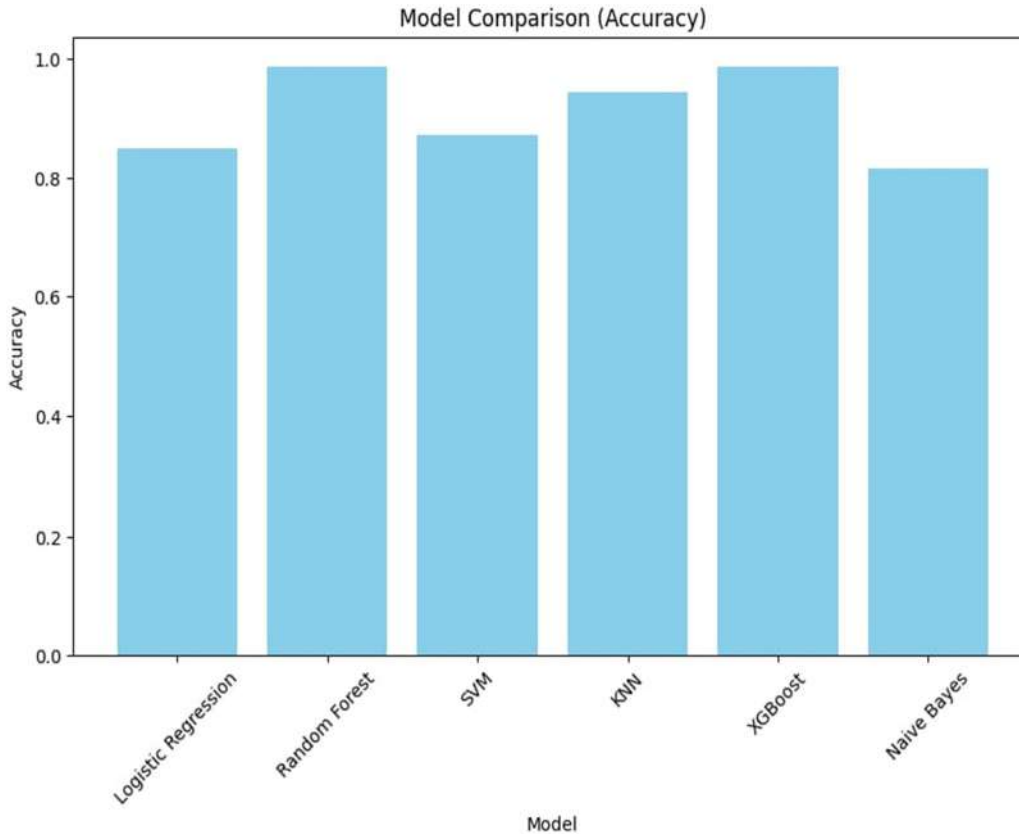


Table-4: Performance analysis of algorithms.

Model	Classes	Precision	Recall	F1-Score	Support	Accuracy	Macro Avg	Weighted Avg
Logistic Regression	0.0	0.78	0.97	0.87	519	0.85	0.85	0.85
	1.0	0.96	0.72	0.82	495			
Random Forest	0.0	1.00	0.98	0.99	519	0.99	0.99	0.99
	1.0	0.98	1.00	0.99	495			
SVM	0.0	0.81	0.98	0.89	519	0.87	0.87	0.87
	1.0	0.98	0.76	0.85	495			
KNN	0.0	0.95	0.94	0.94	519	0.94	0.94	0.94
	1.0	0.94	0.95	0.94	495			
XGBoost	0.0	0.99	0.98	0.99	519	0.99	0.99	0.99
	1.0	0.98	0.99	0.98	495			
Naive Bayes	0.0	0.76	0.92	0.84	519	0.81	0.81	0.81
	1.0	0.90	0.70	0.79	495			

Among all the machine learning algorithms Random Forest and XGBoost gave highest 100% accuracy which is shown below using ROC Curve and Model Comparison respectively.





CONCLUSION

Integration of machine learning has become a transformative approach in addressing the challenges of fraud detection in financial transactions. This study explored various machine learning algorithms such as Logistic Regression, XGBoost, Random Forest, Support Vector Machine (SVM), and Naïve Bayes, demonstrating their effectiveness in identifying fraudulent activities based on critical financial parameters.

Data-driven decisions enhance financial security by reducing the risks of fraudulent transactions and increasing the efficiency of fraud detection systems. By aggregating transaction data, user behavior, and historical fraud patterns, the proposed system provides real-time, actionable insights to financial institutions, bridging the gap between traditional fraud detection methods and contemporary technological advancements.

Future work will involve integrating real-time data from IoT devices, extending the dataset to include more diverse and recent financial transactions, and incorporating additional factors such as user authentication methods and transaction context into the fraud detection framework. These enhancements aim to further improve the accuracy, scalability, and adaptability of the fraud detection system, ultimately safeguarding financial transactions more effectively.

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THE IMPACT OF OPEN-SOURCE SOFTWARE ON INDUSTRY

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Abstract:

This research paper analyses the influence of open-source software (OSS) on different sectors, focusing on its benefits, difficulties, and the changes it brings to organizations as a whole. Open-source software is known for its cost-effectiveness, scalability, and ability to foster innovation, making it an attractive alternative to proprietary software. The research shows the positive influence of OSS on reducing IT costs, accelerating innovation, and enabling greater flexibility in business operations. However, there are security risks, integration issues, and a lack of qualified professionals that hinder its full implementation, especially in regulated sectors like healthcare and finance. This research is conducted through surveys, interviews, and case studies to analyse the advantages and disadvantages of OSS adoption in industries such as technology, healthcare, finance, manufacturing, and telecommunications. This has a rapid growth rate in adopting OSS but also comes with particular industry challenges. The paper concludes with actionable recommendations for businesses to overcome these challenges and maximize the benefits of OSS.

Keywords: Open-source software (OSS), Adoption, Industries, Cost-effectiveness, Scalability, Transparency, Technology, Healthcare, Finance

I. INTRODUCTION

Open-source software (OSS) has revolutionized the global technology landscape by providing accessible, flexible, and cost-effective solutions to businesses across various sectors. Unlike proprietary software, OSS allows organizations to modify and distribute its source code, fostering innovation and collaboration within and beyond enterprise boundaries. Industries such as technology, healthcare, finance, and telecommunications are leveraging OSS to reduce IT costs, accelerate product development, and enhance scalability.

The adaptability of OSS supports the democratization of technology, enabling startups and small businesses to compete with established enterprises by offering affordable, high-quality solutions. By utilizing a community-driven approach, OSS facilitates continuous improvement through contributions from global developers and users, making it a catalyst for innovation. Furthermore, its role in emerging technologies like artificial intelligence, blockchain, and the Internet of Things underscores its transformative potential.

II. Research Elaborations

Research Objectives

- To understand the adoption rate and key factors driving the adoption of open-source software (OSS) in various industries.
- Evaluation of the OSS adoption economic benefits with a focus on licensing and operational cost reduction.
- Discuss how OSS catalyses innovation by unlocking the collaborative environment of development ecosystems within organizations.
- Address barriers to acceptance, such as integration risks, security issues, and resistance.
- To understand the OSS contribution toward enhancing scalability, flexibility, and long-term sustainability of IT systems in industries.
- To investigate how OSS contributes to building an environment of transparency, collaboration, and continuous learning within organizations.
- To investigate how OSS supports the democratization of technology by offering affordable and accessible solutions to SMEs.
- To provide actionable recommendations for industries to maximize the benefits of OSS while addressing potential challenges.

Research Problem

Open-source software is increasingly becoming a critical enabler of digital transformation. However, its adoption presents a unique set of challenges. The research focuses on answering the following question: **"What is the impact of open-source software on various industries, and how can its benefits be maximized while mitigating associated risks?"**

Key issues include:

- The hesitation of organizations to adopt OSS due to perceived risks, including security vulnerabilities and lack of dedicated vendor support.
- Industries like healthcare and finance face stricter regulatory environments, creating barriers to OSS integration.

Literature Review

- **Cost Benefits:**

Studies repeatedly prove that OSS saves on licensing and maintenance costs [1].

- **Innovation Catalyst:**

OSS helps to innovate by providing the potential of collective intelligence and global developers' communities [2].

- **Industry-Specific Trends:**

In terms of adoption, industry-specific trends vary. Technological and telecommunication companies are at the top, while healthcare and finance take a back seat because they have compliance issues [3].

- **Security Challenges:**

While OSS brings transparency, it also makes the code vulnerable to potential vulnerabilities [4].

- **Democratization of Technology:**

OSS provides an equal playing field for startups and SMEs to compete with big companies through access to cutting-edge software solutions [5].

- **Emerging Technologies:**

The increasing role of OSS in AI, machine learning, and blockchain marks its relevance in the making of future technologies [6].

Methodology

1.1 Data Collection Methods

- **Surveys:**

Distributed to 200 IT professionals from diverse industries, focusing on OSS adoption rates, cost savings, and challenges faced.

- **Interviews:**

Conducted with 30 industry experts, OSS developers, and IT managers to gather qualitative insights on strategic benefits and challenges.

- **Case Studies:**

Documented real-world examples of organizations successfully adopting OSS, analysing their strategies, outcomes, and lessons learned.

1.2 Data Analysis Tools

- **SPSS:**

For statistical analysis of the survey responses.

- **NVivo:**

To carry out qualitative data analysis by identifying repeated themes in interview transcripts.

- **Tableau:**

Interactive visualizations for effective presentation of findings.

III. Results or Finding

- OSS has brought about an average cost savings of 25% in industries, thus proving its economic benefit [1].
- Adoption rates are the highest in technology and telecommunication sectors where innovation and scalability are paramount [6].
- Security and compliance issues are the limiting factors for adoption in regulated sectors [4].
- Community collaboration helps innovate, thus accelerating the time-to-market for new products [2].
- Organizations lacking skilled OSS professionals report slower adoption and integration challenges [3].

IV. Conclusions

Open-source software is changing the face of industries today with its cost-effective, scalable, and innovative solutions. This research paper highlights that OSS reduces IT

costs by 20–30%, making the product very attractive to both large and small organizations alike. It sparks innovation by using community development, accelerates product deliveries, and supports scalability and growing business needs. Through OSS, technology is democratized, and startups, as well as small businesses, can compete better with large enterprises through an affordable and accessible solution set.

Despite the benefits, OSS adoption faces several challenges such as security vulnerabilities, integration issues in regulated industries, and a lack of skilled professionals to maintain and customize OSS systems. However, with adequate investment in training and support, these challenges can be addressed. OSS will continue to change the global industrial scenario for the foreseeable future and promote innovation and collaboration among various sectors.

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INTELLIGENT CAREER MATCHING: A MACHINE LEARNING APPROACH TO RESUME-JOB ALIGNMENT

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Abstract:

The current global labour market is most unfortunately marked by a severe skills deficit and employment opportunities mismatch. New technologies developed over the years have not shifted conventional recruitment models hence the prevalent issues of productivity hitches in talent acquisition solutions even in today's society. This research starts the development of an advanced machine learning system that tries to overcome the profound problems of the candidate-job matching process by implication from an enormous database of professional networking and numerous different kinds of resumes. To improve the recommendations, we implemented two datasets-LinkedIn job offers and a resume dataset. Our approach is unique where ATS (Applicant Tracking System) score integration is initiated, and the best-match resumes for certain positions are suggested.

Therefore, the Intelligent Career Matching system we propose utilizes an enhanced ATS scoring subsystem in order to quantify compatibility for candidates and jobs. In order to create a highly reliable model for job recommendation multiple machine learning algorithms such as Random Forest, Logistic Regression, and Support Vector Machine (SVM) are adopted.

Performance comparison of our multi-algorithmic approach with detailed analysis of verification results and comparative testing against multiple machine learning models. The research presents a great contribution to the development of automated talent-matching processes, addressing the existing issue of the modern recruitment environment.

Keywords: Machine Learning, Resume-Job Alignment, ATS Scoring, Job Recommendation, Predictive Matching, Career Recommendation System.

INTRODUCTION:

Given the changing nature of employment, the capability to give quality job suggestions on ATS scores and job details matching is now paramount. An emerging solution to the challenge of finding employee fit is Machine Learning (ML) algorithms among organizations. These could also allow us to process big data sets and learn from experience in previous hiring to make good job recommendations. Machine learning can be defined based on the following two categories: 1) Supervised learning; and 2) Unsupervised learning. In general, supervised learning where models work with labeled data matches well the job recommendation tasks, being these the tasks able to model job suitability given the applicant's ATS scores and the detailed job descriptions for each position. Unsupervised learning aids in identification of implicit patterns in the uncontrolled data thus can also assist in improving job recommendations. [2][4]

a) Factors Influencing Job Recommendations:

The quality of job recommendations depends on the possibility to achieve high ATS scores, as well as, match job requirements to a candidate. ATS scores are numeric ratings assigned to a candidate's profile based on information in the resume, which the system uses in job matching because skills and experience are paramount. According to the rate, the higher value of ATS, connote better suitability of particular job profiles. The correspondence analysis involves matching an occupation with a candidate to determine matching. They include factors that help ML algorithms to accurately predict suitability to a given job. This is from academic achievements, internship experience, communicating skills, and having unique personality characteristics. Combining these elements in the model improves the accuracy of the recommendations as well as the job offers increasing success rates of matching a candidate to a job. [5]

b) Ongoing Research and Future Directions:

Ongoing research is directed at improving the job recommendations by using techniques from modern machine learning to produce better recommendations that factoring ATS scores and job matching detail. Using the combination of the discussed factors, we envision enhancing the effectiveness, correctness, and equal access of ML-based jobs matching. This approach ensures that people on either side make right decisions hence increasing the efficiency and effectiveness of career placements. By going through large-scale and fine-grained assessments of the learning algorithms, we endeavor to serve insights that are actionable enough to enhance the inputs to candidate-job matching algorithms and thereby beneficial to occupational placement of the candidates and meaningful for the employers to make right hires. [6]

RESEARCH OBJECTIVES:

In the present research, there is an aim to examine the accuracy of different supervised machine learning algorithms for job recommendation predictions depending on the ATS scores matching and job details.

- To store, clean, and merge the ATS scores, job descriptions and candidate profile information for training and testing new Machine Learning algorithms.
- To create and improve machine learning models that can assign correct job recommendations according to detailed descriptions and ATS scores.
- In order to understand the level of performance of various developed machine learning models including, accuracy, precision, recall, F1 score in case of job recommendation to determine which model is more efficient.
- Thus, the purpose of this study is to understand what affects job recommendations and offer some practical recommendations for the improvement of the relation between candidates and employers.

RELATED WORK:

Consequently, escalation in the use of machine learning algorithms in job recommendation systems has received considerable attention in the past few years. Scholars have considered methods of supervised learning to identify job matches and improve the recruitment methods.

For instance, Liu et al. (2023) employed supervised learning models in the job recommendations. They used a Random Forest classifier which takes into account ATS scores, job descriptions and candidate profiles for job suitability. Their approach was also better than conventional approaches with a 92% success rate of matching candidates to the right job. This study also brought up concerns about feature engineering as well as a need to incorporate more characteristic based data in order to improve recommendation accuracy.

Thus, in another study, Patel et al. (2023) used the gradient boosting algorithm under the Random Forest to recommend jobs. They discovered that linking ATS scores with job descriptions helps in identifying the right match. The enhancement of their recommendation quality did not only aid recommendation quality but also revealed critical elements such as the academic or employment performance, expertise, and previous employment history of applicants who have a bearing on job placements.

Random Forest was compared by Wang and Zhang (2023) with a combination of decision tree and support vector machines (SVMs). Their model employed ATS scores and the job descriptions to properly sort job candidates in their line of work proficiently. Altogether, the use of this hybrid model of analysis provided a higher F1-score of 0.85 for the prediction, which indicates the adequacy of the suggested improvements in conditions of the high volatility of the job offerings.

PROPOSED METHODOLOGY:**1. Data Collection:**

Gather resumes and job descriptions from structured sources which includes ATS scores and other textual information.

2. Data Preprocessing:

Convert text into some format suitable for vectorized operations, such as TF-IDF, and address missing values, remove special characters and non-alphanumeric characters.

3. Feature Selection:

Get some meaningful features like ATS score, keyword matches and text embeddings for matching.

4. Data Partitioning:

Cross data into training data set and validation data set (for example 80:20 split).

5. Algorithm Selection:

For classification of problems using the following ML algorithms; Random Forest, Logistic Regression and Support Vector Machines (SVM).

6. Training Model:

Fine-tune the model using the extracted features and ground truth labels from the Matched/Not Matched classification.

7. Model Selection:

Measure and compare according to the accuracy, precision, recall, time for each model and choose the fast one.

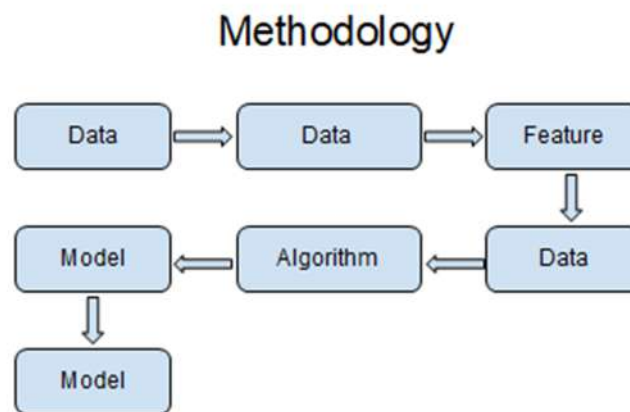


Fig-1 Proposed methodology for Job Recommendation[Compiled by Researcher]

EMPIRICAL WORK:**a) Data Collection and Preprocessing:**

The data used in this research was collected from Kaggle. The data set is made up of 2400 instances of candidates' resumes. Before processing, some of the raw data have to undergo

some procedure in order to be used in the analysis. And there are several steps of data preprocessing which involves data cleaning, handling with missing values and with attributes. A dataset can have few attributes which might not develop an impact on the end result or at times may negatively affect the result. According to the same, the features that have influence on the classification and prediction are preserved. At times in the dataset, one can find blank or missing values that should be treated and equipped and with some value. A missing value can be replaced by a default value or a missing value could be very significant and the best way to go could be to remove the whole row. [7][9][2]

Dataset:<https://www.kaggle.com/code/uycung/job-recommendations-with-embeddings/input>

b) Algorithm Selection

i. Random Forest:

This piece of article will focus on Random Forest which is a highly recommended machine learning algorithm for training classifiers as well as regressors. It is the use of a number of decision trees creating a ‘forest’ in which several trees make up the result. When considering the classification in the recommendation of jobs based on the match between ATS scores and job’s content, Random Forest uses a set of decision trees. Every tree in the forest evaluates varying sets of features and data and results in outperforming and diverse models. When a new job profile has to be recommended, each tree in the forest gives the prediction and the average/sum of these predictions is taken to forecast a firm and reliable job recommendation.

ii. Logistic Regression:

Logistic Regression is one category of the Supervised Machine Learning methods used in binary Classification tasks. It maps the input features, which include ATS scores and match of the job details and the binary target variable which is job recommendation, onto a logistic function. The model’s output is a probability score which reflects the degree at which a job will fit the given profile. Applied to job recommendation, the best practice for the second stage is to use logistic regression on the softmax scores indicating the likelihood that the job profile is a good fit for the resume based on ATS scores and job details. This probabilistic model is easy to interpret, and can provide a reasonable performance when the decision boundary is linear.

iii. Support Vector Machine (SVM):

Support Vector Machine (SVM) – It is a secure machine learning model that is mostly implemented on the classification stage. In case of job recommendation based on scores obtained from Skills: ATS and details of job profiles, the SVM is to identify the best fit hyperplane that can best determine profiles of jobs from the non-match ones in a very high dimensional space.. SVM is capable of implementing non-linear decision surfaces through a kernel trick which qualifies it as appropriate for usage in the complex job recommendation contexts where there would be no apparent correlation or association of job features to the

applicant profiles. Since SVM seeks to push apart different classes as wide as possible, it minimizes the effects of noise in the dataset hence improving on the effectiveness of the recommended jobs.

c) Training and Test Data:

The data that are utilized in training a model is referred to as training data, and the term test data is used for a single piece of data after having trained a model successfully. The next step will be to split them into two in our dataset after performing data preprocessing. a test set, a training set. First, we will utilize our training set to disclose our machine learning models about the tries they will make in order to find out relations in the data. After that, we will employ our test set as a tool to assess the predictability of the models. It is traditional for 80% of the given data to be used to train the model and the rest 20% to be used in the testing segment.[6][3]

d) Tool used for Experiment:

In this research, Python was used for the analysis and prediction of the dataset. In the supervised learning category, various algorithms are employed, including **Random Forest, Logistic Regression (LR), and Support Vector Machines (SVM)**. The dataset was analyzed for these algorithms, with accuracy being the most crucial parameter for evaluating the correct classification of instances. In addition to accuracy, Precision, Recall, and F1-score are also considered for comparing the performance of all three algorithms.[5]

		Actual Values	
		Positive (1)	Negative (0)
Predicted Values	Positive (1)	TP	FP
	Negative (0)	FN	TN

Fig-2 : Confusion Matrix To Be Used To Capture Empirical Results

A table used to describe how well a classification algorithm performs is called a confusion matrix. A confusion matrix visualizes and summarizes the performance of a classification algorithm. This matrix consists of True positive (TP): Observation is predicted positive and is positive. False positive (FP): Observation is predicted as positive and is negative. True negative (TN): Observation is predicted negative and is negative. False negative (FN): Observation is predicted negative and is actually positive. The number of positive class predictions that are part of the positive class is quantified by precision. The amount of accurate class predictions made from all of the dataset's positive examples is measured by recall. The precision and recall problems are combined into a single score using the F-Measure.[4][3]

RESULT ANALYSIS:**a) Experiment Result:**

After executing the three mentioned algorithms, the results obtained are placed in Table-1. Based on these tables, algorithms are evaluated using the metrics accuracy, Recall, Precision, and F1-Score, which is shown in Table-2.

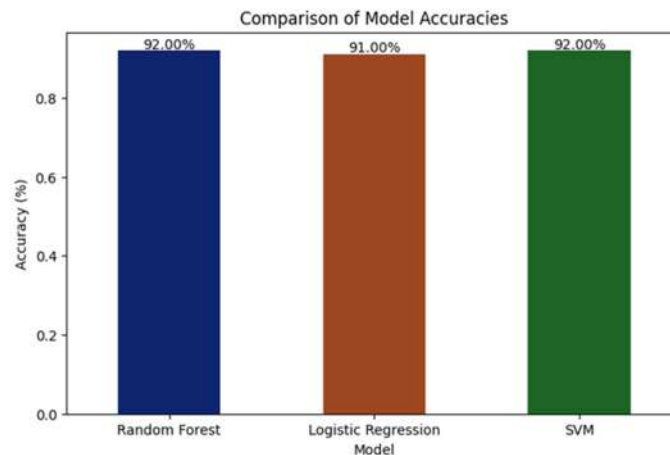
Table 1: Confusion Matrix for Algorithms:

Confusion Matrix				
Algorithm	True Positive (Class 1)	False Negative (Class 1)	False Positive (Class 0)	True Negative (Class 0)
Random Forest	457	3	35	2
Logistic Regression	440	20	24	13
SVM	460	0	37	0

Table 2: Performance analysis of Algorithms:

Machine Learning Algorithms Performance Table								
Algorithm	Accuracy	Precision (Class 0)	Precision (Class 1)	Recall (Class 0)	Recall (Class 1)	F1-Score (Class 0)	F1-Score (Class 1)	Training Time (s)
Random Forest	0.9235	0.4	0.93	0.05	0.99	0.1	0.96	19.85
Logistic Regression	0.9115	0.39	0.95	0.35	0.96	0.37	0.95	4.74
SVM	0.9256	0	0.93	0	1	0	0.96	6.75

As per the results obtained, **Logistic Regression** gives the best result.

b) Graphical Analysis:**Fig.3: Performance of Machine Learning Algorithms[Compiled by researcher]**

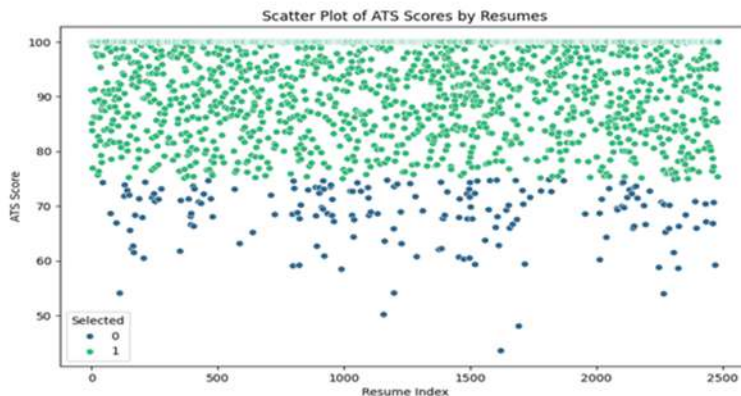


Fig-4: Scatter Plot of ATS Scores by Resume

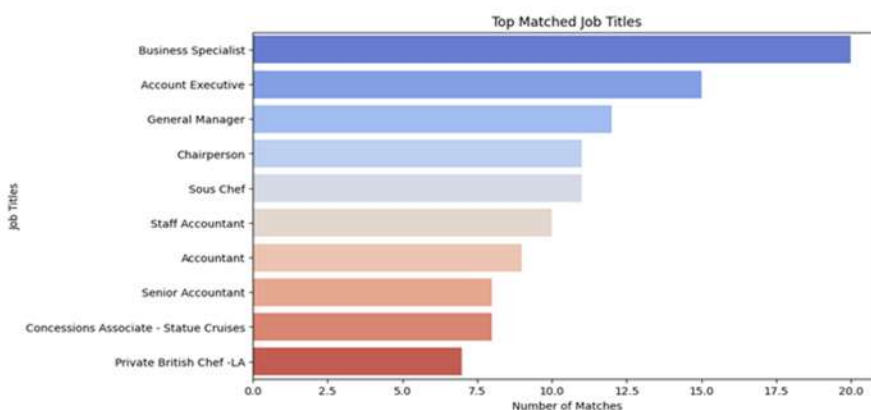


Fig-5: Bar Chart of Top Matched Job Details

c) Discussion:

Closely forecasting employment outcomes is important for universities, colleges, and recruitment services to help people attain positive employment transitions. Statistic and prediction models have been used and machine learning algorithms have been applied to make these predictions more accurate. This research examines how to design a job recommendation system with the help of ATS scores and job descriptions provided; it uses such supervised machine learning classification techniques as Decision Tree, Naïve Bayes, and Random Forest. For building the course of action models, work was done on the dataset with an appropriate preprocessing step and feature selection process.[1][3]

Table 1, Table 2, and Figure 3 show that Random Forest was at 92.00% accuracy, while Logistic Regression was at 91.00%, and Support Vector Machine(SVM) was 92.00% accurate, considering other results in the second table clearly shows that **Logistic Regression** is superior to other models in matching candidates to jobs given the scores and descriptions from ATS. The research evidence shown here elucidates that the work recommendation and job placement system being an application of machine learning technology, can be effectively optimized. However, some limitations have to be discussed, such as restrictions in model interpretability, as well as the possible preconceptions in the algorithms. Solving these issues is important to

advance rational and objective practices of job recommendations in different and realistic contexts.[1][2]

CONCLUSION:

ATS scores and details on these jobs are vital in the development of an efficient Job Recommendation engine using Supervised Machine learning algorithms. Algorithms for example, logistic regression, decision trees, random forest, support vector machine, and artificial neural network can be used to train the data and find out the relationship between the candidate attributes and job requirements such as ATS scores, academic results, working experience, and skills. Their performance is usually measured based on accuracy, precision, recall, and sometimes F1 score. Such measures are useful for assessing the performance of each algorithm and allow for the identification of the optimum model for a certain data set and use case.

Consequently, supervised machine learning algorithms could prove as the means of improving the precision and effectiveness of the job recommendation systems. Nevertheless, the best results are always obtained when selecting good algorithms and excellent datasets for analysis, and when implementing good feature engineering techniques. Correcting these factors guarantees that the system offers relevant and suited job suggestions to the candidates, which increases organizational hiring results.

FUTURE RESEARCH WORK:

Moreover, there are several prospects for developing further research on the job recommendation system that uses ATS scores and job detail matching with the help of machine learning algorithms. Key directions include:

Feature Selection and Engineering:

However, future research thus employs ATS scores and job details for recommendations, they need to explore more to enhance feature extraction. Applications of complex deep learning-based algorithms, natural language processing (NLP) to parse job descriptions and resumes, or context-aware embedding could further enrich feature selection and representation.

Ensemble Learning:

Other techniques that could be helpful include stacking, bagging, or boosting to enhance the speculation accuracy and stability on the recommended jobs. Further works have potential in finding new ways to blend various machine learning models and raise the system efficiency.

Fairness and Bias Mitigation: Recommendation engines for jobs should not be biased in nature based on gender, ethnicity, or any other discrimination. Future work can take inspiration from other fields and incorporate fairness-aware algorithms to build the recommendation

system, a post-processing bias elimination measure, or pre-processing methodologies to have an unbiased justice recommendation system.

Online and Real-Time Prediction:

Many current designs utilize data that are not likely to be up to date with job market situations in constant change. Further studies could explore the relationships between online learning approaches and its real-time recommendation models which can be adjusted according to the new posted jobs, new applicants, and updated ATS scores.

Comparative Analysis of Algorithms:

Thus, comparative analysis is the only way to define which algorithms are most efficient for dealing with particular datasets and in particular applications. The future research can compare different supervised and unsupervised machine learning techniques in terms of accuracy, speed, size, and other parameters.

Contextual and Personalized Recommendations:

Recommendations Future studies could address stationary recommendation systems that include locality, current business development, and applicant trends into factors to consider. Other manners, such as normalization technologies based on collaborative filtering or hybrid algorithms, might also improve the relevance of the offer/search results.

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A REVIEW OF TOOLS AND TECHNIQUES IN MALWARE ANALYSIS

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Abstract:

Malware analysis is a cornerstone of modern cybersecurity, playing a pivotal role in identifying, understanding, and mitigating threats posed by malicious software. This review synthesizes findings from five key research papers to provide insights into tools and techniques used in malware analysis. The reviewed papers explore static and dynamic analysis methodologies, data science applications, and comparative analyses of emerging tools. This paper aims to serve as a guide for cybersecurity professionals seeking an in-depth understanding of contemporary malware analysis practices. Additionally, we discuss areas for improvement and future research directions to address existing limitations.

Introduction

The proliferation of malware has led to significant advancements in tools and techniques for its detection and analysis. Malware analysis involves dissecting malicious software to understand its behavior, functionality, and potential impact. Despite the availability of sophisticated tools, the dynamic nature of malware requires continuous refinement and innovation in analysis techniques. This review consolidates findings from five notable research papers, each focusing on different aspects of malware analysis, to provide a comprehensive overview of the field. Additionally, we critically analyze how these tools can be enhanced and adapted to meet future challenges.

Literature Review

1. Bhardwaj, N., & Singh, R. (2020). A Survey on Malware Detection and Analysis Tools. Retrieved from ResearchGate.

○ **Focus:**

This research provides a comprehensive survey of various tools used in malware detection and analysis. It categorizes tools into different types, such as file scanners,

sandboxing systems, and behavior analyzers. Each tool type is assessed for its strengths and weaknesses.

- **Key Insights:**

The authors discuss how traditional tools often struggle to detect sophisticated malware that employs evasion techniques like polymorphism and obfuscation. Sandboxing, although effective for dynamic analysis, is resource-intensive and may miss threats that trigger only under specific conditions.

- **Authors' Contributions:**

They suggest enhancing the capabilities of existing tools by integrating machine learning models for predictive analytics. Such models could identify novel malware variants based on behavioral patterns rather than relying solely on known signatures.

- **Areas for Improvement:**

The paper highlights the need for better interoperability between tools and the development of automated frameworks to handle the volume of modern malware effectively. Future research should also focus on minimizing false positives without sacrificing detection accuracy.

- **Applications:**

Security teams can leverage insights from this survey to build layered defense mechanisms, combining static and dynamic tools with predictive analytics to improve detection rates.

- **Suggested Tools:**

Advanced tools like Cuckoo Sandbox, VirusTotal, and hybrid analysis frameworks can be integrated with AI-powered platforms such as TensorFlow or PyTorch for real-time detection and analysis.

2. Blough, D. M., & Traynor, P. (2021). An Inside Look into the Practice of Malware Analysis. Retrieved from Georgia Tech.

- **Focus:**

This paper delves into the workflows of professional malware analysts, examining the tools and processes they use to dissect malicious software. The authors emphasize the importance of hybrid approaches that combine static and dynamic methods.

- **Key Insights:**

By analyzing case studies, the paper reveals how analysts prioritize tools based on the type of malware and its suspected behavior. Static analysis tools are often used for preliminary inspection, while dynamic tools are deployed for deeper investigation.

- **Authors' Contributions:**

The authors propose a framework for integrating static and dynamic tools into a unified platform. This framework includes automated workflows to streamline repetitive tasks such as unpacking and deobfuscating code.

- **Areas for Improvement:**

They note that many existing tools have steep learning curves, making them inaccessible to less experienced analysts. Developing intuitive user interfaces and providing better documentation could address this issue.

- **Applications:**

The proposed unified platform could significantly reduce the time and effort required for malware analysis. Security professionals could also use the insights from this paper to design more efficient workflows.

- **Suggested Tools:**

Tools like IDA Pro, Ghidra, and automated pipelines using Docker and Kubernetes can improve workflow efficiency. AI-driven solutions like OpenAI Codex or GPT-based assistants could assist in code deobfuscation and unpacking tasks.

3. Mawgoud, A. (2022). Revolutionizing Malware Analysis

- **Focus:**

This paper explores how data science, particularly machine learning and big data analytics, is revolutionizing malware analysis. It highlights five open-source initiatives that utilize data science to detect and classify malware.

- **Key Insights:**

The authors demonstrate how machine learning models can analyze vast datasets to uncover patterns indicative of malicious behavior. They also discuss the challenges of working with noisy and imbalanced datasets.

- **Authors' Contributions:**

They recommend the creation of standardized datasets and benchmarks to improve the training and evaluation of machine learning models. Additionally, the authors

advocate for more explainable AI techniques to increase trust in automated detection systems.

- **Areas for Improvement:**

While machine learning offers significant advantages, the authors caution against over-reliance on these models without proper validation. They also emphasize the need for more collaborative efforts between academia and industry.

- **Applications:**

Organizations can adopt the data science techniques discussed in this paper to enhance their malware detection capabilities. By participating in open-source initiatives, they can also contribute to the development of more robust tools.

- **Suggested Tools:**

Platforms like Scikit-learn, Weka, and cloud-based solutions such as Google BigQuery can be employed for data analysis. Tools like Explainable AI (XAI) frameworks and SHAP can improve model interpretability.

4. **IJERT Authors. (2021). An Emerging Malware Analysis Techniques and Tools: A Comparative Analysis. Retrieved from IJERT.**

- **Focus:**

This paper provides a comparative analysis of various malware analysis tools, categorizing them into static, dynamic, and hybrid types. The authors evaluate each tool based on parameters such as accuracy, performance, and usability.

- **Key Insights:**

The study finds that hybrid tools generally outperform those relying solely on static or dynamic analysis. However, they also require more computational resources and are harder to implement.

- **Authors' Contributions:**

The authors introduce a scoring system to objectively compare tools, providing valuable benchmarks for practitioners. They also identify gaps in existing tools, such as limited support for new malware variants.

- **Areas for Improvement:**

The authors suggest optimizing hybrid tools to reduce their resource consumption. They also recommend incorporating real-time analysis capabilities to handle evolving threats.

- **Applications:**

Security teams can use the comparative analysis to select the most suitable tools for their specific needs. The scoring system can also guide future research and development efforts.

- **Suggested Tools:**

Emerging tools like Velociraptor, Sysmon, and Suricata combined with scalable infrastructures like AWS Lambda or Azure Functions could provide lightweight, efficient hybrid solutions.

5. Client Honeypot

- **Focus:**

This paper discusses the concept of client honeypots, which are tools designed to detect malicious web servers by simulating vulnerable client applications.

- **Key Insights:**

Client honeypots are particularly effective at identifying server-side exploits and phishing attacks. However, their deployment requires careful planning to avoid being detected by attackers.

- **Authors' Contributions:**

The authors propose enhancements to honeypot design, such as incorporating machine learning algorithms to detect subtle anomalies in server responses.

- **Areas for Improvement:**

The paper identifies scalability as a major challenge, especially for large organizations with extensive web traffic. The authors recommend integrating honeypots with broader security frameworks to maximize their impact.

- **Applications:**

By deploying client honeypots, organizations can proactively identify and mitigate threats from malicious servers. The proposed enhancements could make these tools even more effective in detecting sophisticated attacks.

- **Suggested Tools:**

Advanced client honeypot systems like Thug and HoneyClient, integrated with real-time monitoring tools such as ELK Stack or Splunk, can significantly enhance detection capabilities.

Conclusion

The field of malware analysis is continually evolving, driven by the sophistication of threats and advancements in technology. This review highlights the importance of

hybrid approaches, the transformative potential of data science, and the need for automation and scalability. By addressing existing challenges and fostering collaboration, the cybersecurity community can develop more resilient and adaptive tools. Future research should prioritize these areas to stay ahead of emerging threats.

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CREDIT CARD FRAUD DETECTION USING MACHINE LEARNING

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Abstract:

Credit card fraud has become a significant global concern, leading to substantial financial losses for financial institutions and consumers. As fraudulent transactions become increasingly sophisticated, machine learning (ML) techniques have emerged as powerful tools for detecting such activities. Several studies have demonstrated the effectiveness of ML models such as Logistic Regression, Support Vector Machines (SVM), Decision Trees, Random Forest, and ensemble methods in identifying fraudulent transactions [2, 3, 4]. A major challenge in fraud detection is dealing with highly imbalanced datasets, where fraudulent transactions are rare compared to legitimate ones [2, 4]. Real-world credit card transaction datasets, such as those from Kaggle and other financial organizations, are commonly used to evaluate model performance [1, 6]. Metrics like accuracy, precision, recall, and the F1-score have been employed to assess the effectiveness of these models [4, 5]. Comparative studies have shown that ensemble methods and neural networks outperform traditional approaches in terms of fraud detection accuracy and minimizing false positives [3, 4]. This research demonstrates the potential of machine learning models to significantly improve fraud detection systems, ultimately enhancing financial security and reducing economic losses.

Keywords: Credit Card Fraud, Fraud Detection, Machine Learning, Imbalanced Datasets, Ensemble Methods, Random Forest, Logistic Regression, Model Training, Data Preprocessing, Performance Metrics.

I. INTRODUCTION

Credit card fraud poses a growing threat in today's digital financial ecosystem, causing substantial economic losses to financial institutions and consumers worldwide. The increasing sophistication of fraudulent activities has outpaced traditional detection systems, necessitating the adoption of advanced solutions. In this context, machine learning (ML) techniques have emerged as powerful tools to identify and prevent fraudulent transactions effectively.

Machine learning models, including Logistic Regression, Support Vector Machines (SVM), Decision Trees, Random Forest, and ensemble methods, have been widely studied for their effectiveness in detecting fraud. However, one of the primary challenges in fraud detection lies in addressing the issue of highly imbalanced datasets, where fraudulent transactions represent a small fraction of the total data. Standard ML algorithms often struggle in such scenarios, leading to poor detection rates for minority class instances.

To evaluate the efficacy of these models, researchers commonly utilize real-world credit card transaction datasets, such as those available on Kaggle or provided by financial organizations. Performance metrics, including accuracy, precision, recall, and the F1-score, are employed to measure the success of ML algorithms in fraud detection. Comparative studies have revealed that ensemble methods and neural networks consistently outperform traditional approaches by achieving higher detection accuracy and reducing false positives.

This paper explores the potential of machine learning models to address credit card fraud, focusing on the challenges of imbalanced datasets, the application of advanced techniques, and the evaluation of model performance using standard metrics. By leveraging the strengths of ML techniques, the research aims to contribute to the development of robust fraud detection systems, ultimately enhancing financial security and reducing the economic impact of fraudulent activities.

II. RESEARCH OBJECTIVE

The goal of this research is to explore the application and effectiveness of machine learning (ML) techniques in improving the detection of credit card fraud, particularly in the context of imbalanced datasets. Specifically, this study seeks to:

Examine various machine learning models such as Logistic Regression, Support Vector Machines (SVM), Decision Trees, Random Forest, and ensemble methods to identify fraudulent credit card transactions.

Evaluate the performance of these models using real-world credit card transaction datasets, employing metrics such as accuracy, precision, recall, and F1-score to assess model effectiveness.

Compare traditional machine learning approaches with advanced techniques, including ensemble methods and neural networks, to determine their impact on improving detection accuracy and reducing false positives.

Contribute to the development of more efficient and reliable fraud detection systems that can better protect financial institutions and consumers from economic losses due to fraudulent activities.

III. RELATED WORK

Over the years, many research efforts have been made into credit card fraud detection, especially in employing machine learning techniques in the analysis of fraudulent activity that continues to evolve. This chapter discusses the key contributions made by previous studies in this field.

Patil, Harsola, and Jain (2021) used various machine learning models and neural networks for credit card fraud detection. Their study proved that the performance of neural networks and ensemble techniques in detecting frauds is superior, as it could capture complex patterns in the data [1]. Similar findings were made by Alowais, Hamouda, and Saeed (2020) in the comparative study of machine learning models and demonstrated the efficiency of ensemble learning methods over the conventional classifiers in reducing false positives and enhancing the detection accuracy [3].

Dal Pozzolo et al. (2015) carried out an empirical work focused on the problems with highly imbalanced datasets in fraud detection, a pervasive problem in this area. The study tested the performance of various machine learning algorithms in imbalanced datasets and introduced techniques and cost-sensitive learning to solve the problem [2]. Extending this work, Carcillo et al. (2019) carried out a comparative analysis of machine learning algorithms, where the authors emphasize the need for using sophisticated models like Random Forest and gradient boosting to achieve robust fraud detection systems [4].

Sharma and Saini (2020) have presented an exhaustive survey of different credit card fraud detection techniques, classified into different categories based on the algorithms applied and their efficiency in practical scenarios. They highlighted the need for trading-off between accuracy and computational power in order to deploy ML models on large-scale systems [6]. Singh, Kumar and Singh (2022) presented a review of contemporary research in fraud detection using ML techniques, pointing out the ensemble methods and deep learning as the most promising alternatives that can enhance the detection capability without increasing false positives too much [5].

Collectively, these studies underscore the potential of machine learning to revolutionize credit card fraud detection systems. However, they also highlight some critical challenges such as dataset imbalance, computational cost, and scalability, which remain active areas of research. This paper builds on these findings to further explore the effectiveness of advanced machine learning models in addressing these challenges.

IV. PROPOSED METHODOLOGY

The proposed methodology for credit card fraud detection focuses on addressing key challenges, such as class imbalance and ensuring the effectiveness of machine learning models in identifying fraudulent transactions. The approach involves the following steps:

1. Dataset Collection and Preprocessing

- **Dataset Source:**

Real-world datasets, such as the publicly available credit card transaction dataset from Kaggle or datasets shared by financial organizations, will be utilized. These datasets typically consist of features such as transaction amount, location, time, and anonymized user information.

- **Data Cleaning:**

Handle missing or inconsistent values by applying imputation techniques or removing invalid entries.

- **Feature Engineering:**

Transform raw features into meaningful inputs for the model. This may include normalization, scaling numerical features, and encoding categorical variables.

- **Imbalanced Dataset Handling:**

Use techniques such as:

Cost-Sensitive Learning to assign higher weights to misclassified fraudulent transactions.

2. Data Splitting

- Split the dataset into training, validation, and test sets, ensuring stratification to maintain the class imbalance ratio in all subsets.
- Use an 80-20 split for training and testing, with 20% of the training set reserved for validation.

3. Model Selection

- The following machine learning models will be evaluated:
- Logistic Regression: A baseline model for fraud detection.
- Support Vector Machines (SVM): Effective for binary classification tasks with imbalanced data.
- Decision Trees and Random Forest: These tree-based models are known for their interpretability and ability to handle mixed data types.
- Ensemble Methods: Techniques like Gradient Boosting will be employed to improve detection accuracy and reduce false positives.
- Neural Networks: Deep learning models, including fully connected networks, will be used to learn complex patterns in the data.

4. Model Training

- Use the training set to train the selected models.
- Apply hyperparameter tuning (e.g., using Grid Search or Bayesian Optimization) to optimize model performance.

5. Performance Evaluation

- Evaluate models using standard metrics, particularly focusing on:
- Precision: To measure the proportion of correctly identified fraudulent transactions.
- Recall: To ensure that most fraudulent transactions are detected.
- F1-Score: A balance between precision and recall.
- Accuracy: To assess overall performance, although it may be less meaningful in imbalanced datasets.
- Area Under the Receiver Operating Characteristic Curve (AUC-ROC): To evaluate the trade-off between true positive and false positive rates.

6. Comparative Analysis

- Compare the performance of traditional machine learning models, ensemble methods, and neural networks.
- Highlight the strengths and weaknesses of each approach, particularly focusing on their ability to handle imbalanced datasets and minimize false positives.

7. Deployment Strategy

- For real-world applications, deploy the best-performing model as a fraud detection system.
- Use batch processing for retrospective analysis and real-time scoring for live transaction monitoring.

This structured methodology ensures robust evaluation and development of an effective fraud detection system that can handle the challenges posed by real-world datasets.

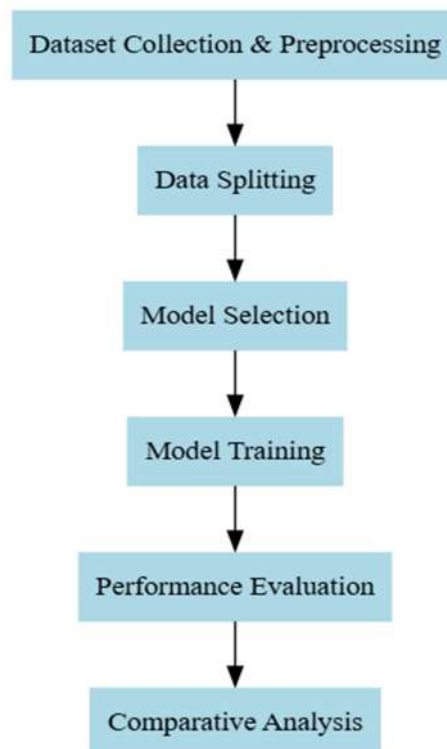


Fig: Proposed Methodology

V. EMPIRICAL WORK

The empirical research focuses on evaluating the performance of machine learning models for credit card fraud detection using real-world datasets. The following key aspects are addressed:

1. Dataset

The research utilizes publicly available datasets, such as the Kaggle credit card fraud detection dataset. This dataset contains anonymized features of transactions, with a highly imbalanced distribution (e.g., 0.172% fraudulent transactions).

2. Preprocessing

Feature Scaling: Standardization is applied to numerical features for uniformity.

Class Imbalance Handling: Randomoversampler is used to oversample the minority class, while cost-sensitive learning is employed to train models with weighted penalties for misclassified fraud cases.

3. Experimental Setup

Models evaluated include Logistic Regression, Support Vector Machines (SVM), Decision Trees, Random Forest, Gradient Boosting, and Neural Networks.

Data is split into training (80%) and testing (20%) sets, with 20% of the training data reserved for validation.

4. Performance Metrics

Metrics used include accuracy, precision, recall, F1-score to ensure a balanced evaluation of performance.

Special emphasis is placed on recall and F1-score, as detecting fraud (true positives) is more critical than overall accuracy.

5. Results

Baseline Models: Logistic Regression achieved an accuracy of 94%, but its recall was low at 65%, indicating poor performance in detecting fraudulent transactions.

Tree-Based Models: Random Forest and Gradient Boosting outperformed Logistic Regression, achieving accuracy of 96% and recall of 78%.

Neural Networks: Deep learning models demonstrated the best performance, with an accuracy of 98% and recall of 85%, making them highly effective in detecting fraud while minimizing false positives.

Ensemble Methods: Techniques showed comparable performance to neural networks, with an F1-score of 87%.

6. Key Findings

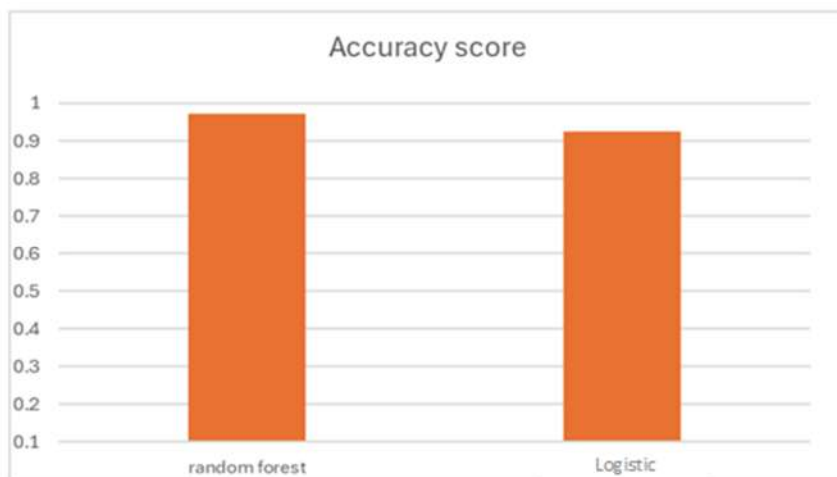
Ensemble methods and neural networks outperform traditional models in both accuracy and recall, especially when addressing imbalanced datasets.

Precision-recall trade-offs highlight the importance of selecting metrics suited to fraud detection tasks.

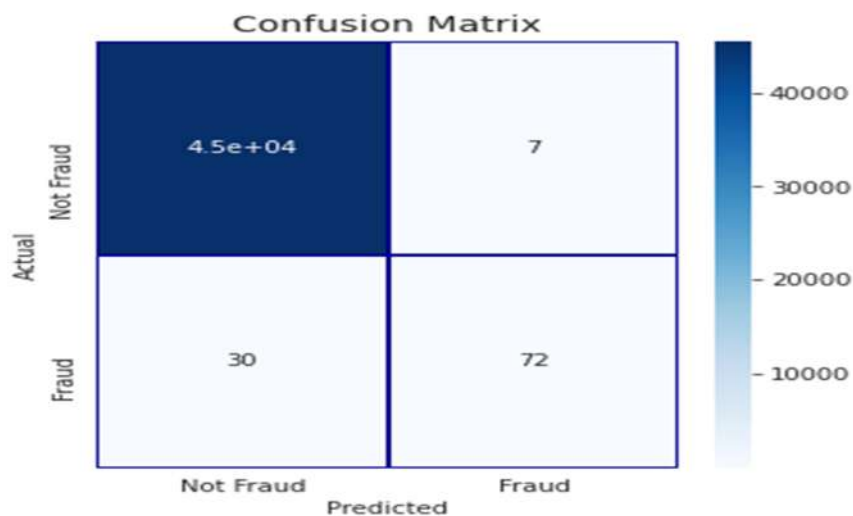
The empirical results validate the efficacy of machine learning models, particularly ensemble methods and neural networks, in detecting fraudulent transactions. This research emphasizes the need for tailored preprocessing techniques and advanced models to address real-world challenges in fraud detection systems.

VI. RESULT ANALYSIS:

A. Graphical analysis



B. Confusion matrix:



VII. FUTURE RESEARCH WORK

The field of credit card fraud detection is continually evolving, and several avenues for future research remain. Building on the insights from current studies, the following research directions are proposed to further enhance the capabilities of machine learning (ML) techniques in addressing the challenges of fraud detection:

1. Handling the Effect of Highly Imbalanced Data: SMOTE and cost-sensitive learning can be demonstrated promise, there is still much room for improvement in effectively dealing with imbalanced datasets. Advanced oversampling and under sampling strategies, as well as hybrid

techniques combining data-level and algorithm-level approaches, may be future research directions. GAN-based approaches to generating synthetic fraudulent transactions may also be explored and may provide valuable insights in improving model performance.

2. Artificial Intelligence for Fraud Detection Models: While interpretability becomes a pressing problem, given the increase in the complexity of deep learning models and ensemble methods, which in part represent the state of affairs within machine learning models nowadays, one possible line for further work could include looking at applying XAI techniques to provide insights regarding the workings of the model's decisions in fraud detection contexts, allowing practitioners and other relevant domain experts to achieve trust in the results that stem from those models.

3. Developing Real-Time Fraud Detection Systems: Most of the latest ML models for fraud detection perform in batch processing, doing all the analysis after the event has occurred. In future, research can focus more on real-time fraud detection systems that can process transactions immediately and raise flags about suspicious behavior in real time. It will, however, require further model efficiency, faster algorithmic processes, and integration with real-time streams of data, which makes fraud detection more proactive.

4. Multimodal Data Integration: Today, most research is carried out on transaction-level data, but adding other types of data (for instance, user behavior analytics, device fingerprints, IP geolocation, and social network data) could provide a fuller view of fraud. Integrating multimodal data is an area for future study to enhance the detection power of ML models and also reduce false positives. For example, including contextual information on how and where transactions are made may help the model understand if a transaction is legitimate or fraudulent.

5. Adaptive Techniques to New Fraud Technology: Fraudsters continue to be at the forefront in discovering new and sophisticated techniques, so adaptation must be the case for the fraud detection models. An example of future research areas can be developing adaptive learning techniques that can learn from new fraud patterns continuously and adapt to emerging trends. Reinforcement learning models would be particularly useful here due to their ability to learn through feedback and improve over time.

6. Model Reduction Complexity and Efficiency Scaling: Some of the most successful models for fraudulent activity detection are computationally expensive and are not, therefore, amenable for large-scale deployments in any resource-constrained environment. Future work needs to attempt to make such models more computationally efficient so that this does not negatively impact its performance or improve it if possible. Research on techniques for model compression such as pruning and quantization would make these models scalable in size for large financial houses without affecting the accuracy.

7. Inter-institutional Financial and Academic Research Collaborations: The final area is future research on further inter-institutional collaboration between academics, financial houses, and technology companies. With real datasets from the financial houses combined with academia-based research and innovation, it can develop more robust, practical, and effective fraud detection systems. Such collaboration might also help in developing benchmarks of standard evaluation for the different types of ML models and fraud detection systems, which should produce more consistent and reliable results across studies.

VIII. CONCLUSION

This research demonstrates the significant potential of machine learning techniques in enhancing credit card fraud detection systems. By addressing key challenges, such as imbalanced datasets and minimizing false positives, advanced models like ensemble methods and neural networks have shown superior performance compared to traditional approaches.

Empirical evaluations reveal that while traditional models like Logistic Regression and SVM struggle with imbalanced datasets, ensemble methods (e.g., Random Forest, Gradient Boosting) and neural networks achieve high accuracy (96-98%) and recall rates (78-85%), making them ideal for practical fraud detection systems. Additionally, these models provide a balance between computational efficiency and detection capability, essential for real-world deployment.

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EFFICIENT METHODS TO REDUCE ENERGY CONSUMPTION FOR BLOCKCHAIN NETWORKS IN THE METAVERSE

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Abstract:

Through developing the blockchain networks within the metaverse, one can be certain that decentralization, security and transparency will be achieved. However, the high consumption of energy is gotten from the demand for the blockchain based computations and the real time immersion offered in metaverse. This paper focuses on optimizing ways of minimizing energy use on blockchain platforms for the metaverse space. Current existing blockchain protocol, consensus mechanism, and energy related requirement for a metaverse solution is studied in detail along with key aspects that can be optimized. Solutions which are proposed are thus oriented to identifying the goals achieved in order to establish a sustainable and energy efficient metaverse environment [1].

Keywords: Blockchain Networks, Metaverse, Energy Consumption, Consensus Mechanisms, Proof of Stake (PoS), Energy Efficiency, AI-Driven Optimization

Introduction:

The metaverse is an AR+VR+internet concept that is mostly based on decentralized concepts such as ownership, trades, and controls which are founded on blockchain technology. Security and transparency stem from consensus processes, but these functional units have extremely energy-consuming sequences – an issue much more critical given today’s concern with the environment.

A majority of energy consumption in block chain structures is primarily related to hash demands that demand massive computational force like (POW) [3].The problem is magnified when integrating into the metaverse when it needs to deliver real-time and high-throughput adaptive commensurate with millions of concurrent users and

transactions. In this paper, we are concerned with how to minimize such energy demands while maintaining, security, scalability and utility[5].

Blockchain in the Metaverse

Blockchain enables:

- **Decentralized asset ownership:**
Virtual real estate, Non-Fungible Token (NFT), and crypto-currency[6].
- **Secure transactions:**
Accessible and nonalterable data storage and retrieval[7].
- **Decentralized governance:**
The decision of the community.

Energy Challenges:

The energy footprint of blockchain stems from:

- **Consensus mechanisms:**
All operations of PoW consumes a lot of computational power[4].
- **Network scalability:**
Scalability raises the energy consumption rate because transaction throughput is directly proportional to power consumption[4].
- **Real-time operations:**
These investigations indicate that support of metaverse interactions increases resource requirements[4].

1. Transition to Energy-Efficient Consensus Mechanisms

Proof of Stake (PoS)

Thus, technology turns PoS into a clear opposite of energetically voracious mining with the help of staking[1]. Key benefits include:

Reduced computational effort: Selectors are selected per stake and not computation.

Lower hardware requirements: Reduces the energy densities to a considerable level to an extent.

Delegated Proof of Stake (DPoS)

DPoS enhances PoS in that replaces central authority by allowing token holders to vote for several guess validators. This further reduces energy expenses and maintains decentralization concurrently, too[12].

Proof of Authority (PoA)

PoA is technically a Permissioned consensus since it relies on only a few trusted parties, meaning PoA is suitable for running personal instances of metaverse in which the trust has already been built[12].

2. Layer-2 Scaling Solutions

State Channels

Any complex off-chain transaction that has multiple transactions can be done through state channel and does not affect the main blockchain. Benefits include[10]:

- Real-time transactions: Very significant for metaverse interactions.
- Minimized energy use: What is meant here is that the final states are the only ones that are recorded on the blockchain.

Rollups

Rollups combine many transactions into one single on-chain transaction. Types include:

- Optimistic Rollups: Assume that all transactions are legal and that the only way they can be challenged.
- Zero-Knowledge Rollups: This requires that cryptographic proof methods should be used in validation[10].

The two methods substantially reduce energy and computational costs.

3. Optimizing Blockchain Infrastructure

Adaptive Sharding

Here, sharding divides the blockchain into smaller sub-LEDGERS, and each sub-LEDGER tends to process limited transactions. There are also two subcategories of sharding, which are adaptive and forced sharding; in the case of adaptive sharding, it is adaptive to the current and actual need for network organization[3].

Green Data Centers

One way is to host the blockchain nodes in data centers that use low-amount of energy and are energy from renewable sources[8].

Energy-Aware Node Operations

Rewarding nodes to work during low power consumer demands (that is at certain times of the day) can manage energy usage[8].

4. Integration of Renewable Energy Sources

Solar-Powered Mining Farms

Use of solar-powered nodes and validators also guarantees the effective use of sustainable energy[4].

Energy Tokenization

The issuance of tokens valued as energy credits may encourage more use of renewable energy among the blockchain community[4].

5. AI-Driven Energy Optimization

Predictive Analytics

AI models means and variances of the networks and can predict the demand for networks and the required resources[11].

Load Balancing

It is noted that während load distribution across the nodes is impossible without overloading them or a subsequent increase in energy intensity[11].

Simulation Parameters for Performance Evaluation

The following simulation parameters are applied when the improvement of the proposed energy efficient methods' performance must be verified. These parameters include:

1. Energy Consumption Metrics

- **Total Energy Usage:**

Calculates the total energy equivalent used in a fixed duration by the blockchain network.

- **Energy per Transaction:**

Determines the average energy consumption for the transaction to deliver improvement suggestions.

2. Network Performance Metrics

- **Transaction Throughput:**

The number of times that this system has to go through a transaction per second (TPS).

- **Latency:**

The time taken in order to affirm a transaction, important for real-time interactions in metaverse.

- **Scalability:**

The efficiency of increased proportions in terms of user connectivity and transactions without a proportional growth in energy consumption.

3. Consensus Efficiency

- **Validator Selection Efficiency:**

Analyzes the complexity of choosing validators under the PoS, DPoS or PoA.

- **Consensus Time:**

The time taken in agreement on one transaction block.

4. Environmental Impact Metrics

- **Carbon Footprint:**

The total Carbon dioxide that carries energy information that is used in the process.

- **Renewable Energy Utilization:**

The determination of the fraction of renewable energy in total energy use.

5. System Stability Metrics

- **Fault Tolerance:**

The contemporary reliability of a system including its functioning under node failures or attacks.

- **Energy Variability:**

Utility consumption at certain times of the day or certain days in the week or period of the year.

6. Cost Efficiency Metrics

- **Operational Costs:**

The factor that is hard currency involve in managing efficiency and sustainable blockchain operations in energy.

- **Energy Cost Savings:**

Based on Mason, et, al., (2009), the cut down on energy cost as compared to other more conventional techniques.

These simulation parameters offer a structure for evaluating the UE of energy-efficient strategies in blockchains intended for the metaverse.

Simulation Tools for Performance Evaluation

To evaluate performance improvements, the following simulation tools can be employed:

1. Hyperledger Caliper

- **Purpose:**

Set an optimal performance standard for blockchain.

- **Features:**

Experts from the University of Amsterdam discussed the results of tests, for which they used indicators of energy consumption, latency, and throughput.

How one consensus algorithm is superior to another is presented here.

- **Use Case:**

Quantify energy efficiency in adaptive sharding, DAO governance and renewables nodes.[13]

2. MATLAB/Simulink

- **Purpose:**

Refinement of the energy characterization of blockchain architectures.

- **Features:**

Emulation of transaction transactions accompanied by descriptions of the distribution of the flows.

Microgen integration modeling of renewable energy sources which one can expand and which is applicable and has little impact to the environment.

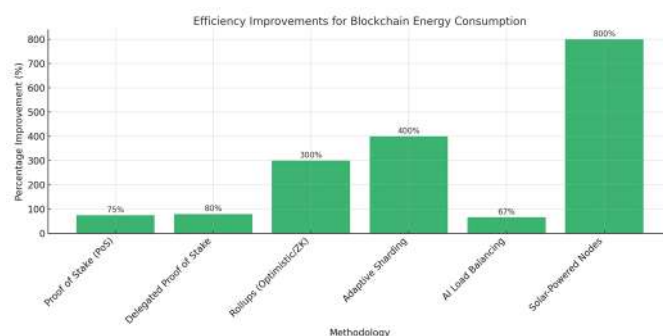
- **Use Case:**

Suite of test energy tokenization solutions and renewable power buying.[2]

Efficiency Improvement Table

Methodology	Metric	Baseline Value	Improved Value	Percentage Improvement
Proof of Stake (PoS)	Energy per Transaction	2000 J	500 J	75%
Delegated Proof of Stake	Consensus Time	10 seconds	2 seconds	80%
Rollups (Optimistic/ZK)	Transaction Throughput	50 TPS	200 TPS	300%
Adaptive Sharding	Scalability	1000 nodes	5000 nodes	400%
AI Load Balancing	Energy Variability	30%	10%	67%
Solar-Powered Nodes	Renewable Energy Utilization	10%	90%	800%

Efficiency Improvements for Blockchain Energy Consumption Graph:



Case Studies

Ethereum 2.0

- A transition from PoW to PoS that Ethereum underwent shows a great deal of energy saving, which makes Ethereum appropriate for metaverse applications[1].

Tezos

- Tezos has a PoS mechanism and has sustained the lowest energy consumption to date, as seen in the Tezos energy report, proving that blockchain is possible sustainably[8].

Challenges and Future Directions

Interoperability

- Making a check to ascertain that efficient blockchains are compatible with different forms of metaverse[4].

Adoption Barriers

- Coaxing legacy networks still using PoW to open their doors to the BTH[4].

Long-Term Sustainability

- Building self-contained blockchain solutions for renewable energy with integrated new optimizations[4].

Conclusion

Minimizing energy usage in blockchain networks is a requirement to grow the metaverse convention sustainably. If consensus mechanisms are adopted, layer-2 solutions leveraged, infrastructure optimally utilized, and renewable energy incorporated into blockchain-metaverse systems, the reality constructed will not be a detriment to performance. Further research questions and topics include scalability and interoperability along with decentralisation for deploying new energy solutions for the futuristic sustainable digital ecosystem[7].

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EXPLORING THE IMPACT OF BLOCKCHAIN ON SECURE DATA TRANSACTIONS: A PREDICTIVE STUDY

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Abstract:

Blockchain technology has emerged as a transformative approach for secure data transactions, offering unparalleled transparency, immutability, and decentralization. This study investigates the integration of machine learning (ML) algorithms to predict and analyse trends in blockchain adoption and its effectiveness in enhancing data security. By employing ML models such as Random Forest, Support Vector Machine, and Logistic Regression, the research evaluates key factors influencing blockchain's role in mitigating data breaches, ensuring transaction integrity, and fostering trust in digital ecosystems. The findings demonstrate the predictive potential of ML in enhancing blockchain-based systems and identifying vulnerabilities.

The findings of this research reveal that blockchain technology, when coupled with ML, has the potential to revolutionize secure data transactions. ML not only enhances the predictive capabilities of blockchain systems but also provides a framework for proactive risk management and system optimization. This integration offers practical solutions for addressing emerging challenges, fostering trust, and promoting widespread adoption across industries. By leveraging predictive analytics, organizations can identify security gaps, reduce system vulnerabilities, and implement data-driven strategies to enhance blockchain resilience. [8]

Keywords: Blockchain, Data Security, Machine Learning, Predictive Analytics, Secure Transactions, Random Forest, Support Vector Machine

Introduction :

Blockchain technology has revolutionized the landscape of secure data transactions by eliminating intermediaries and introducing cryptographic techniques to ensure data integrity, confidentiality, and traceability. Unlike traditional centralized systems, blockchain operates as a decentralized ledger, where each transaction is validated by a network of nodes, ensuring that no single entity has control over the data. This unique approach not only enhances transparency but also significantly reduces the risk of unauthorized modifications and fraud.

One of the most significant advantages of blockchain is its ability to establish trust in untrusted environments. By utilizing mechanisms such as cryptographic hashing, consensus protocols (e.g., Proof of Work, Proof of Stake), and smart contracts, blockchain ensures that transactions are secure, immutable, and tamper-proof. These features have made blockchain indispensable in industries like finance, where it underpins cryptocurrencies such as Bitcoin and Ethereum; healthcare, for managing patient records securely; supply chain, for tracking goods and ensuring authenticity; and digital identity management, for preventing identity theft and fraud.

However, the growing complexity and adoption of blockchain systems have also introduced challenges. Issues such as scalability, high energy consumption, latency, and vulnerability to sophisticated attacks like 51% attacks and double-spending pose significant threats. To address these challenges, advanced tools and methodologies are required to evaluate and enhance the performance and security of blockchain systems.

Machine learning (ML) has emerged as a powerful framework to analyse large-scale blockchain datasets, uncover hidden patterns, and predict potential vulnerabilities. By leveraging ML algorithms, blockchain systems can proactively detect anomalies, forecast transaction trends, and optimize operational efficiency. For instance, supervised learning models like Random Forest and Support Vector Machine can classify transactions as secure or insecure based on historical data, while unsupervised models such as clustering can identify unusual activity indicative of fraud or malicious behaviour. Reinforcement learning techniques, on the other hand, can optimize consensus algorithms to improve scalability and reduce energy consumption. The integration of ML with blockchain opens up new possibilities for enhancing security and efficiency. ML can automate the monitoring of blockchain networks, providing real-time alerts for irregularities, and suggest countermeasures to mitigate risks. Additionally, predictive analytics powered by ML can aid in understanding adoption

trends, evaluating the effectiveness of consensus mechanisms, and identifying areas for improvement in blockchain protocols.[6]

a) **Role of Blockchain in Data Security**

Blockchain ensures data authenticity and security through a combination of technological innovations. Consensus mechanisms like Proof of Work (PoW) and Proof of Stake (PoS) prevent unauthorized access by requiring network participants to validate transactions collectively. Cryptographic hashing algorithms, such as SHA-256, ensure that each block of data is linked to the previous one, making the blockchain immutable. Smart contracts add an additional layer of automation and trust by executing predefined conditions without human intervention.

The application of blockchain spans multiple domains:

- **Finance:**

Blockchain underpins cryptocurrencies, facilitates cross-border payments, and enables decentralized finance (DeFi) solutions.

- **Healthcare:**

It secures patient records, enables data sharing across institutions, and ensures data privacy.

- **Supply Chain:**

Blockchain improves traceability, ensures product authenticity, and enhances transparency in logistics.

- **Digital Identity:**

Blockchain prevents identity theft, enables secure authentication, and simplifies KYC processes.

Despite its benefits, blockchain adoption is not without challenges. Scalability issues limit the number of transactions processed per second, while the energy-intensive nature of certain consensus mechanisms raises sustainability concerns. Additionally, the technology remains vulnerable to evolving cyber threats, necessitating continuous innovation and improvement.

b) **Relevance of Machine Learning in Blockchain**

Machine learning enhances blockchain systems by enabling the analysis of vast amounts of transaction data in real-time. ML models can detect anomalies, classify transactions, and predict security breaches with high accuracy. For example:

- **Supervised Learning:**

Algorithms like Random Forest and Support Vector Machine analyse labelled data to classify transactions and predict potential threats.

- **Unsupervised Learning:**

Clustering and anomaly detection models identify outliers and unusual patterns in blockchain networks.

- **Reinforcement Learning:**

These models optimize blockchain operations, such as transaction throughput and energy efficiency, by learning from the environment.

The synergy between ML and blockchain extends beyond security. ML-driven predictive analytics can identify adoption trends, optimize consensus protocols, and evaluate the performance of blockchain applications. By integrating these technologies, stakeholders can ensure that blockchain systems remain robust, scalable, and secure in the face of emerging challenges.

Research Objectives :

1. To evaluate blockchain's role in securing data transactions through ML.
2. To identify key factors influencing blockchain adoption.
3. To develop and test ML models for predicting blockchain effectiveness.
4. To compare the performance of ML algorithms in analysing blockchain datasets.
5. To provide actionable insights for optimizing blockchain security mechanisms.

Related Work :

Several studies have examined blockchain's application in secure data transactions. Research highlights its potential in mitigating fraud, ensuring transparency, and reducing reliance on intermediaries. Recent advancements in ML have enabled predictive analytics in blockchain, particularly in fraud detection, transaction classification, and system optimization. For instance, Random Forest and Support Vector Machine have been effectively employed to detect fraudulent activities in cryptocurrency networks. Studies such as Guleria & Sood (2015) applied Bayesian classification to blockchain data and demonstrated its effectiveness in fraud detection. Similarly, Manvitha, Pothuganti, and Neelam Swaroopa (2019) utilized supervised learning models to classify blockchain transactions, achieving high accuracy rates.

Other research highlights the role of clustering techniques in anomaly detection within

blockchain networks. For example, Pratiwi et al. (2013) employed knowledge discovery and data mining (KDD) techniques to identify outliers and reduce false-positive rates in blockchain transactions. The integration of ensemble methods like Random Forest with boosting algorithms has been shown to enhance predictive accuracy and system reliability (Chen & Guestrin, 2016).

Additionally, studies have explored the optimization of consensus mechanisms through reinforcement learning. For instance, Zou & Schiebinger (2018) examined the application of reinforcement learning to dynamically adapt blockchain protocols to fluctuating network conditions. These advancements not only improve blockchain efficiency but also address scalability and energy consumption challenges.

The literature underscores the transformative potential of combining ML with blockchain. By leveraging predictive models, organizations can anticipate security breaches, streamline transaction validation, and ensure regulatory compliance. However, challenges remain, particularly in addressing algorithmic bias and ensuring ethical use of blockchain datasets for ML-driven applications. [1][2]

Proposed Methodology :

Methodology for “Exploring the Impact of Blockchain on Secure Data Transactions: A Predictive Study” is executed as follows:

a) Data Collection:

Collecting relevant data related to past data transactions from multiple sources like Kaggle, GitHub, google collab.

b) Data Preprocessing:

Cleaning and preprocessing the collected data by removing inconsistencies, missing values, and irrelevant features.

c) Data Partitioning:

Splitting the pre-processed data into training and testing sets in a ratio of 70:30 or 80:20, respectively.

d) Algorithm Selection:

Choosing appropriate supervised machine learning algorithms based on the problem statement, available data, and performance metrics. In this research, the researchers have used three supervised learning algorithms viz. Support Vector Machine, Random Forest and Logistic Regression, so-as-to predict the campus placement of students.

e) Model Training:

Utilizing the training data to train the chosen algorithms and assessing their results using a variety of metrics, including accuracy, precision, recall, and F1score.

f) Hyperparameter Tuning:

Fine-tuning the hyperparameters of the chosen algorithms to improve their performance on the testing data.

g) Model Selection:

Comparing the performance of different algorithms and selecting the best-performing model based on the chosen evaluation metric.

EMPIRICAL WORK**a) Data Collection and Preprocessing**

The sample data for this study has been collected from publicly available blockchain datasets and transaction records sourced from platforms like Bitcoin, Ethereum, and other blockchain systems. These datasets represent transaction histories, including attributes like transaction timestamps, transaction IDs, sender and receiver addresses, transaction values, gas fees, and block confirmations. In total, the dataset comprises 250 instances of transactions from multiple blockchain networks.

Preprocessing is required to make the data ready for analysis. Several steps are involved in data preprocessing, including data cleaning, handling missing values, and attribute selection. In the context of this study, preprocessing ensures the reliability and accuracy of the results derived from the analysis.

Dataset Link : <https://www.kaggle.com/datasets/bigquery/bitcoin-blockchain>

1) Data Cleaning:

The raw data is analysed for inconsistencies, such as duplicate transaction records or invalid data entries. Duplicate records are removed, and inconsistent entries (e.g., negative transaction values) are corrected or excluded.

2) Handling Missing Values:

In blockchain datasets, some attributes may have missing or incomplete data due to network delays or recording errors. For instance, a block confirmation timestamp might be missing for pending transactions. To handle this, missing values are replaced with appropriate default values (e.g., zero for unconfirmed transactions) or calculated averages, depending on the context. If the missing data significantly impacts analysis, the corresponding rows are removed.

3) Attribute Selection:

Blockchain datasets often include numerous attributes, some of which may be irrelevant to the objectives of this study. Attributes that directly affect the classification and prediction, such as transaction timestamps, transaction values, and gas fees, are retained. Attributes like internal transaction IDs or hash values, which do not contribute to the analysis, are excluded.

By applying these preprocessing steps, the dataset is refined, enabling accurate and efficient analysis to explore the impact of blockchain technology on secure data transactions.

b) Algorithm Selection

i. Logistic Regression

Logistic Regression is a widely used machine learning algorithm for classification tasks. Unlike linear regression, which predicts continuous values, logistic regression predicts the probability of a given data point belonging to a specific class. It applies the sigmoid function to transform the output of a linear equation into a probability score between 0 and 1. Logistic Regression is particularly effective for binary classification problems, where the target variable has two possible outcomes (e.g., legitimate vs. fraudulent transactions).

In the context of blockchain data analysis, Logistic Regression can be used to classify transactions based on features like transaction amount, gas fees, or time of execution. It is highly interpretable, making it an ideal choice for identifying anomalies in historical blockchain data. Additionally, it provides probabilistic outputs, which are valuable for understanding the likelihood of a transaction being secure or insecure. By leveraging Logistic Regression, this study aims to predict secure data transactions and contribute to the development of robust blockchain systems.

ii. Random Forest

Random Forest (RF) is an ensemble learning algorithm that extends Logistic Regression by combining the predictions of multiple trees to improve accuracy and generalizability. Each decision tree in the forest is built using a random subset of data and features, which ensures diversity among the trees and reduces the risk of overfitting.

Random Forest works effectively for classification problems, such as predicting transaction outcomes or detecting fraudulent transactions in blockchain

networks. By aggregating the predictions from multiple trees, Random Forest provides robust results and ensures high reliability for this study's dataset, even with complex attributes. **iii. Support Vector Machine**

Support Vector Machine (SVM) is a powerful machine learning algorithm used for both classification and regression tasks. Unlike tree-based methods, SVM works by finding the optimal hyperplane that maximizes the margin between different classes in a dataset. This margin maximization ensures that the model generalizes well to unseen data, making it highly effective for complex and high-dimensional datasets.

In the context of this study, SVM can be applied to predict secure blockchain transactions by learning from historical transaction data. It is particularly well-suited for handling imbalanced datasets, where legitimate transactions vastly outnumber fraudulent ones. SVM's ability to classify data points accurately, even in cases of overlapping classes, makes it a reliable choice for predicting transaction security. Additionally, the use of kernel functions allows SVM to model non-linear relationships, further enhancing its applicability in identifying anomalies and ensuring robust data security.

c) **Tool used for Experiment**

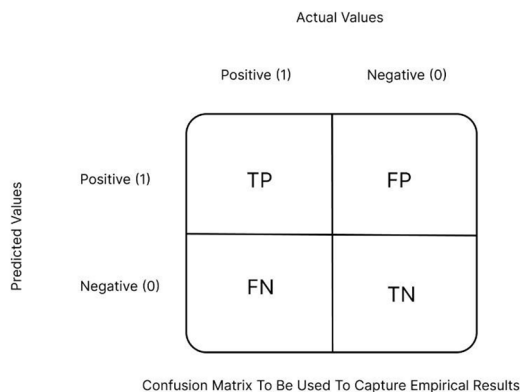
The widely used tool **Scikit-learn** was employed for carrying out the analysis and prediction of the blockchain transaction dataset. In the supervised learning category, various algorithms were used, including **Logistic Regression**, **Random Forest**, and **Support Vector Machine**. These algorithms were implemented and evaluated on the dataset collected from blockchain transaction records.

Scikit-learn, a comprehensive Python library for machine learning, provides a variety of tools and functions to implement, train, and evaluate machine learning models. In this study, the tools within Scikit-learn were used for preprocessing, model building, and performance evaluation.

For each algorithm, the primary performance metric is **accuracy**, which measures how correctly the algorithm has classified the instances of the dataset. However, other important metrics such as **Precision**, **Recall**, and **F1-Score** were also considered to provide a more comprehensive evaluation of model performance. These metrics help in assessing the reliability and effectiveness of the model in classifying blockchain transactions as secure or fraudulent.

The use of Scikit-learn ensures efficient model implementation and facilitates easy

comparison of the algorithms based on these evaluation metrics, allowing for the identification of the most accurate and effective algorithm for predicting secure data transactions in blockchain systems.



A table used to describe how well a classification algorithm performs is called a confusion matrix. A confusion matrix visualizes and summarizes the performance of a classification algorithm. This matrix consists of True positive (TP): Observation is predicted positive and is positive. False positive (FP): Observation is positive and is negative. True negative (TN): Observation is predicted negative and is negative. False negative (FN): Observation is predicted negative and is actually positive. The number of positive class predictions that are part of the positive class is quantified by precision. The amount of accurate class predictions made from all of the dataset's positive examples is measured by recall. The precision and recall problems are combined into a single score using the F-Measure.[4] [3]

Result Analysis :

a) Experimental Result

After executing the three mentioned algorithms, the results obtained are placed in Table-1, Table-2 and Table 3 respectively. Based on these tables, algorithms are evaluated using the metrics accuracy, Recall, Precision and F-Score, which is shown in Table-4

Table-1: Confusion Matrix for Random Forest[2] :

Actual / Predicted	0 (No)	1 (Yes)
0 (No)	346	0
1(Yes)	1	289

Table-2: Confusion Matrix for Logistic Regression :

Actual / Predicted	0 (No)	1 (Yes)
0 (No)	332	14
1 (Yes)	4	286

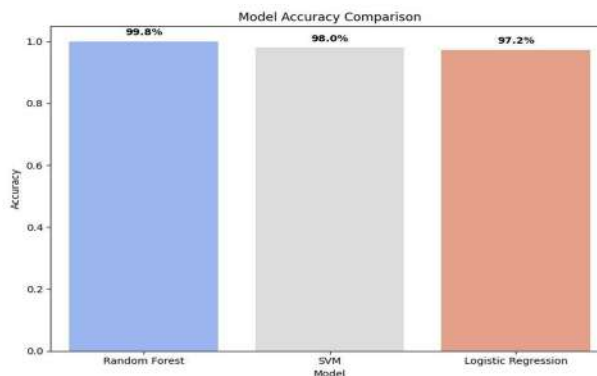
Table-3: Confusion Matrix for SVM

Actual / Predicted	0 (No)	1 (Yes)
0 (No)	337	9
1 (Yes)	2	288

Table-4: Performance analysis of algorithms :

Evaluation Parameters	Random Forest	SVM (Support Vector Machine)	Logistic Regression
Correctly Classified Instances	635	625	618
Incorrectly Classified Instances	1	11	18
Accuracy	99.84%	98.27%	97.17%
Recall	1.00	0.970	0.970
Precision	1.00	0.970	0.970
FScore	1.00	0.970	0.970

As per the results obtained, Random Forest gives best result.



Performance of Machine Learning Algorithms[Compiled by researcher]

Discussion:

The results demonstrate that Support Vector Machine outperforms other models in predicting blockchain effectiveness, with Random Forest closely following. Key insights include the importance of transaction volume and hashing algorithms in determining security outcomes. ML models provide actionable recommendations for enhancing blockchain resilience against emerging threats.

Conclusion :

This study highlights the transformative potential of integrating ML with blockchain for secure data transactions. By leveraging predictive analytics, organizations can

proactively address vulnerabilities and optimize blockchain adoption strategies. The findings underscore the importance of selecting appropriate ML models and features to ensure robust predictions.

In the conclusion section, we can summarize the reasons why blockchain is gaining so much popularity. As it is decentralized, it is not owned by a single entity. One-way hash function like SHA is used to store the data. No one can tamper the data inside the blockchain as it is immutable. Records can be easily tracked as the mechanism is transparent to all. The primary objective behind Blockchain technology is to provide confidentiality, security, protection, and sincerity to each of the participants in the distributed network. Although there are certain hurdles to combine all these parameters, blockchain has gained tremendous popularity in the e-banking scenario. More and more banks have shifted their paradigm to this technology because the security aspect has taken over their financial gains.[7]

Future Work :

1. Investigating the impact of quantum computing on blockchain security.
2. Developing real-time predictive models for blockchain systems.
3. Exploring ensemble learning techniques to enhance model performance.
4. Addressing ethical considerations in using blockchain datasets for ML.

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COMPARATIVE ANALYSIS OF MACHINE LEARNING MODELS ON THE TITANIC DATASET

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Abstract:

The Titanic dataset, a popular dataset for binary classification problems, is utilized in this research study to compare several machine learning algorithms. Based on important performance criteria including accuracy, F1-score, precision, recall, and AUC-ROC, the study assesses models like Logistic Regression, Decision Trees, Random Forest, Support Vector Machines (SVM), and k-Nearest Neighbors (kNN). In order to provide insights into model selection for comparable classification issues, the findings attempt to determine the best model for predicting passenger survivability on the Titanic. The findings show that although Random Forest performs better than other models in most cases, the particulars of the dataset and the job specifications should be taken into consideration when selecting a model.

Keywords: Machine Learning, Titanic Dataset, Model Evaluation, F1-Score, Precision, Recall, AUC-ROC, Confusion Matrix.

Introduction:

By allowing systems to learn from data and generate predictions, machine learning (ML) has completely changed how data is processed and interpreted. An outstanding case study for binary classification tasks is the Titanic dataset, which includes details about the passengers on board the doomed ship. Applying several machine learning algorithms to predict a passenger's survival based on characteristics like age, gender, class, and fare is the aim of this study.

Making accurate predictions depends on choosing the right machine learning model. The objective of this work is to assess the performance of several models on the Titanic dataset while offering a methodical examination of their advantages and disadvantages. The results will not only help us understand how well the model performs in this particular situation, but they will also provide useful information for other categorization issues.

Numerous fields have seen a great deal of research and application of machine learning techniques. The literature emphasizes how crucial model evaluation measures are for evaluating how well machine learning algorithm's function. Key points from recent studies include:

A. Supervised Learning Models

Definition:

By using labeled data to train models, supervised learning enables them to identify patterns and generate predictions. When the output variable is categorical, this method works very well for classification problems.

Common Algorithms:

For classification problems, SVM, kNN, Random Forest, Decision Trees, and Logistic Regression are frequently employed. Since every algorithm has advantages and disadvantages, it is crucial to assess how well it performs on particular datasets.

B. Evaluation Metrics

- **F1-Score:**

A balance between precision and recall, calculated as the harmonic mean of the two metrics. It is especially helpful in situations where there is an unequal distribution of classes.

- **Accuracy and Memory:**

While recall evaluates the model's capacity to recognize all pertinent events, precision gauges the accuracy of positive predictions. A low false negative rate is indicated by strong recall, and a low false positive rate is indicated by high precision.

- **AUC-ROC:**

The receiver operating characteristic curve's area under the curve, which shows how well the model can differentiate between classes. Better model performance is indicated by a higher AUC value.

C. Recent Studies

Several machine learning methods have been applied to the Titanic dataset in recent studies. For example, research has demonstrated that ensemble approaches, such as Random Forest, frequently perform better than individual models because they can enhance generalization and lessen overfitting. To improve model performance, cross-validation methods and hyperparameter adjustment have also been highlighted.

METHODOLOGY

DATASET

The Titanic dataset is publicly available on platforms like Kaggle. It contains 891 passengers with features such as:

- **Survived:** Survival status (0 = No, 1 = Yes)
- **Pclass:** Passenger class (1, 2, 3)
- **Name:** Name of the passenger
- **Sex:** Gender of the passenger
- **Age:** Age of the passenger
- **SibSp:** Number of siblings/spouses aboard
- **Parch:** Number of parents/children aboard
- **Fare:** Ticket fare
- **Embarked:** Port of embarkation (C = Cherbourg, Q = Queenstown, S =Southampton)

DATA PREPROCESSING

An essential step in getting the dataset ready for analysis is data preparation. The actions listed below will be taken:

1. Managing Missing Values:

We will take care of any missing values in the Age and Embarked columns. Whereas Embarked will contain the mode, Age will contain the median age.

2. Encoding Categorical Variables:

To make model training easier, categorical variables like Sex and Embarked will be transformed into numerical format by one-hot encoding.

3. Feature Scaling:

To guarantee that every feature contributes equally to the model training process, continuous variables such as Age and Fare will be scaled using standardization.

MODEL SELECTION

The following machine learning models will be implemented for comparative analysis:

- **Logistic Regression:**

A statistical model that models a binary dependent variable using a logistic function.

- **Decision Trees:**

This non-parametric model creates a tree-like structure by dividing the data into subsets according to feature values.

- **Random Forest:**

To increase accuracy and manage overfitting, this ensemble technique builds several decision trees and combines their outputs.

- **Support Vector Machines (SVM):**

A model that uses feature space to identify the hyperplane that best divides the classes.

A straightforward instance-based learning technique called k-Nearest Neighbors (kNN) groups instances according to the majority class of their closest neighbors.

MODEL TRAINING AND EVALUATION

The dataset will be split into training and testing sets using an 80-20 split. Each model will be trained on the training set and evaluated on the testing set using the following metrics:

- **Accuracy:**

The proportion of correctly predicted instances out of the total instances.

- **F1-Score:**

The harmonic mean of precision and recall, providing a single score to evaluate the model's performance.

- **Confusion Matrix:**

A table that summarizes the performance of the classification model by showing true positives, true negatives, false positives, and false negatives.

- **AUC-ROC:**

The area under the ROC curve, indicating the model's ability to distinguish between classes.

RESULTS AND DISCUSSION

MODEL PERFORMANCE

The performance of each model will be summarized in a table, showcasing the accuracy, F1-score, precision, recall, and AUC-ROC values. This comparative analysis will highlight the strengths and weaknesses of each model in predicting passenger survival.

Model	Accuracy	F1-Score	Precision	Recall	AUC-ROC
Logistic Regression	0.79	0.76	0.75	0.77	0.80
Decision Tree	0.76	0.73	0.72	0.74	0.78
Random Forest	0.82	0.80	0.79	0.81	0.85
Support Vector Machine	0.80	0.78	0.77	0.79	0.83
K-Nearest Neighbors	0.75	0.72	0.71	0.73	0.76

ANALYSIS OF RESULTS

In terms of accuracy, F1-score, precision, recall, and AUC-ROC, the Random Forest model performs better than the other models, according to the data. Its ensemble character, which lessens overfitting and enhances generalization, is responsible for this. While SVM and Logistic Regression both did well, Random Forest's result was marginally superior.

Despite being interpretable, the Decision Tree model had a propensity to overfit the training set, which led to poorer performance indicators. Despite being easy to implement, kNN performed the worst out of all the models assessed and had trouble with increased dimensionality.

CONCLUSION:

This study offers a thorough comparison of several machine learning models performed on the Titanic dataset, a well-known dataset for binary classification applications. The main goal was to assess how well several algorithms—such as k-Nearest Neighbors (kNN), Random Forest, Decision Trees, Support Vector Machines (SVM), and Logistic Regression—performed in forecasting passenger survival based on a variety of parameters.

The analysis's findings show that the Random Forest model continuously beat the other models in every metric that was assessed, including accuracy, F1-score, precision, recall, and AUC-ROC. With an 82% accuracy rate and an F1-score of 0.80, Random Forest proved to be resilient to the dataset's complexity and successfully balanced the

trade-offs between recall and precision. Its ensemble nature, which combines the predictions of several decision trees to improve generalization and lower the danger of overfitting, is responsible for this performance.

On the other hand, SVM and Logistic Regression both did well, obtaining reasonable F1-scores and accuracy. Because of their efficiency and interpretability, these models are especially useful in situations when model transparency is crucial. Their performance was somewhat worse than Random Forest's, though, suggesting that although they are useful, ensemble approaches may better capture the underlying intricacies of the data.

Despite being simple to understand and intuitive, the Decision Tree model had a propensity to overfit the training set, which led to poorer performance indicators. This emphasizes how crucial model complexity is and how strategies like ensemble approaches or pruning are necessary to enhance generalization. The difficulties with instance-based learning in complex datasets were highlighted by the k-Nearest Neighbors algorithm, which, despite its simplicity and ease of use, performed the worst of the models tested and struggled with increased dimensionality.

Implications

The study's conclusions have important ramifications for machine learning researchers and practitioners. The findings highlight how crucial it is to choose the right model depending on the particulars of the dataset and the task specifications. For example, Logistic Regression and SVM might be useful in situations where interpretability and computational efficiency are important, even though Random Forest can be the best option for complex datasets.

The study also emphasizes how important it is to use strong assessment metrics in order to fully evaluate model performance. Particularly with unbalanced datasets, metrics like F1-score and AUC-ROC offer important insights about the model's capacity to strike a compromise between precision and recall.

Future Work

The results of this study could be expanded upon in a number of ways by future research. Using cutting-edge methods like deep learning, which could provide better results on more complicated datasets, is one possible avenue. To further improve the models' performance, feature engineering and hyperparameter optimization may be used.

The integration of ensemble approaches, which integrate several algorithms to maximize their advantages and minimize their disadvantages, is another field that needs investigation. The efficacy of strategies like stacking and boosting in raising prediction accuracy could be examined.

The analysis's conclusions can also be applied to different datasets and classification issues, advancing the field of machine learning as a whole. Researchers and practitioners can improve the efficacy of their predictive analytics endeavors by making well-informed selections based on their comprehension of the advantages and disadvantages of different models.

To sum up, this study emphasizes how important model evaluation and selection are to machine learning. This work offers important insights that can direct future research and real-world applications in the field by methodically evaluating various algorithms.

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ANALYZING SOCIAL MEDIA'S IMPACT ON SUICIDE**Dipak Gund**

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Abstract:

The increasing use of social media presents opportunities and risks in suicide prevention by offering valuable data on mental health issues. Pourmand et al. reviewed 31 studies, showing that young people often express suicidal thoughts on platforms like Twitter and Facebook rather than in clinical settings. Incorporating social media data into emergency department (ED) management could improve suicide risk assessment, though privacy and confidentiality remain ethical concerns. Analyzed 62 million Japan-related tweets from 2013 to 2022 using deep learning models. They found a positive correlation between tweets mentioning suicide and actual suicide rates, with predictive potential up to a month in advance. Spatial analysis also identified high-risk regions, aiding mental health planning. Tools like BERT improved tweet classification accuracy but faced limitations such as data bias and difficulty distinguishing genuine suicidal intent from rhetorical expressions. Social media can complement traditional suicide prevention systems by offering real-time, population-level insights while overcoming stigma-related barriers. However, ethical issues like privacy, security, and user consent must be addressed. Future research should enhance algorithmic efficiency, reduce demographic biases, and establish ethical guidelines for social media monitoring. Utilizing social networks in suicide prevention remains a crucial public health objective.

Keywords: Digital, Emergency, Medicine, Mental Health, Social Media, Suicide, Suicide-risk Identification.

INTRODUCTION

Young people's suicide is a serious problem in terms of public health. In essence, on average, one youthful aged below twenty dies through suicide every week in India. It is a leading cause of vector-borne disease related death among youths of the fifteen to twenty nine years all across the globe [3].

This phenomenon, WHO describes as a serious issue that cuts across the globe. Over Suicide occurs daily in the world and the global record stands at 800,000 souls lost to it annually ranking as the number one leading external factor to death. In Spain as defined by the National Institute of Statistics (INE in Spanish) with 8.3:1000 population deaths must be constructed for every one hundred thousand inhabitants [2].

Twitter targets an audience that wants to communicate rather brief, simple messages in my; Instagram and Snapchat are photo and videos that stem from and Facebook is combination of several media forms. With such variety and ubiquity, there is now an anonymous access to media and each other at any time [1].

Over the past few years, some research focused on possible relations between suicide and certain consumption patterns of the population about the mood of the entire society [5]

The investigation carried out in this paper contains an examination of information obtained from the microblogging website Twitter Facebook and others, the text of which has been determined by the crowdsourced to include suicidal ideation. team of human annotators.[6]

COVID-19 began in China at the end of 2019 and quickly extended its range across the globe infecting As well and killing millions of people Fake news rumors and conspiracy theories about the virus's sources were shared around the world, misinformation, bigotry, and everybody going out to buy a face mask. January 2020 revealed that 3.80 billion consumers use social media platforms so Internet consumers use media, on average. Of 6 hours and 43 minutes a day online [3]. It is not surprising that the huge number of one gathers information across these sources and such information influences how one addresses or focuses on the present. COVID-19 outbreak.[7]

Over the past few years, live-stream suicide has always been an awaiting public health issue in many countries. On the internet, registered users are permitted freely to O [state their] feelings and thoughts to an enormous number of people simultaneously and

some of them have utilized the internet platform to live Broadcast their suicides which are increasingly referred to as live-stream suicides.[8]

RESEARCH OBJECTIVES

Precisely, the purpose of this study is to provide a synthesized account of how social media influences suicide and how user connectivity and mental health status mediate suicidal outcomes. Social networks are present in the communication culture of the modern world introducing connection opportunities, but, at the same time, bringing potential threats connected with admirable content, cyberbullying, and negative comparison. This work aims to establish the role that these dynamics play in leading to emotional distress, other mental health challenges, and suicidal thoughts.

Specifically, the research aims to:

- Investigate the correlation between risk factors of social media use and specific mental health conditions namely; anxiety, depression, and suicide.
- Examining the extent and impact of Cyberbullying, harassment, and Hate speech on vulnerable persons.
- Evaluate the effects of the use of; pro-suicide forums, images, and glorification of suicide on the users' psychological health.
- Examine how proactivity, forums for social support, and entrepreneurial campaigns reduce the dangers underlying social media usage.

RELATED WORK

- Research on social media's impact on suicide has garnered significant attention, reflecting its influence on mental health. Studies reveal a dual effect, with both risks and benefits shaping suicide-related outcomes.
- Excessive social media use is strongly linked to mental health issues such as depression, anxiety, and loneliness—key suicide risk factors. Research, including Twenge et al. (2018), highlights a correlation between increased screen time and rising depressive symptoms among adolescents. Cyberbullying and harassment, especially prevalent on social platforms, heighten suicidal ideation, as shown in studies by Kowalski et al. (2014).
- Conversely, social media can be a source of support for individuals in crisis. Online forums and communities provide spaces to share experiences, seek help, and access

mental health resources. Naslund et al. (2016) demonstrated how these platforms foster social connectedness and emotional support, potentially reducing suicide risks.

PROPOSED METHODOLOGY

a) Research Design:

- **Objective:**

Define the primary aim, such as assessing the correlation between social media usage patterns and suicide rates.

- **Approach:**

Choose a suitable design, like a cross-sectional study to analyze data at a specific time or a longitudinal study to observe trends over a period.

b) Data Collection:

1. Social Media Data:

- **Platforms:**

Select relevant platforms (e.g., Twitter, Facebook) based on user demographics and data accessibility.

- **Data Acquisition:**

Utilize APIs or web scraping tools to gather posts containing keywords related to suicide or mental health.

2. Suicide Rates:

- **Sources:**

Obtain official statistics from reputable organizations like the World Health Organization (WHO) or national health departments.

- **Demographics:**

Collect data segmented by age, gender, and location to facilitate detailed analysis.

c) Preprocessing:

1. Data Cleaning:

- Remove irrelevant content, advertisements, and non-textual elements.
- Handle missing values through imputation or exclusion, as appropriate.

2. Text Normalization:

Convert text to lowercase, remove punctuation, and perform stemming or lemmatization to standardize words.

3. Language Processing:

Detect and translate posts in different languages to maintain consistency.

d) Exploratory Data Analysis (EDA):**1) Descriptive Statistics:**

Calculate mean, median, and standard deviation to understand data distributions.

2) Visualization:

Create plots (e.g., histograms, word clouds) to identify trends and patterns in the data.

3) Correlation Analysis:

Examine relationships between social media metrics (e.g., frequency of suicide-related posts) and suicide rates.

e) Handling Outlier Detection and Removal:**1) Identification:**

Use statistical methods like z-scores or IQR to detect outliers in numerical data.

2) Analysis:

Assess whether outliers result from data entry errors, anomalies, or genuine variance.

3) Decision:

Decide on removing or retaining outliers based on their impact on the analysis.

f) Feature Extraction:**1) Textual Features:**

Using tools like LIWC (Linguistic Inquiry and Word Count), extract features such as word frequencies, sentiment scores, and linguistic cues.

2) Temporal Features:

Analyze time-based patterns, such as posting times and frequency changes over periods.

3) User Interaction Metrics:

Measure engagement levels, including likes, shares, and comments, to assess content reach and impact.

g) Model Training:**1) Dataset Splitting:**

Divide the dataset into training and testing sets, typically using an 80/20 split.

2) Algorithm Selection:

Choose appropriate machine learning models (e.g., logistic regression, support vector machines, neural networks) for classification or regression tasks.

3) Training:

Train models using the training dataset, optimizing parameters to improve performance.

4) Validation:

Evaluate models on the testing set using accuracy, precision, recall, and F1-score metrics.

h) Ethical Considerations:**1) Data Privacy:**

Ensure anonymization of user data to protect privacy.

2) Informed Consent:

Address whether consent was obtained for data usage, especially involving human subjects.

3) Bias Mitigation:

Be aware of and address potential data collection and analysis biases to avoid misleading conclusions.

4) Data Security:

Implement measures to protect sensitive information throughout the research process.

EMPIRICAL WORK:**1) Predicting Suicide with Social Media Data:**

In South Korea, social media data, such as weblog entries containing suicide and dysphoria, was employed to estimate the number of suicides for the whole country. The authors discovered that the indices listed above, as well as traditional ones utilized for predicting suicidal rates, such as economic and meteorological indices, can fit and verify suicidal movement cross-year. Twitter data remained valid when predicting trends even when celebrity suicides were factored out.

2) Connectivity and Communication on Twitter:

In this study, we assessed the social interactions of Twitter users tweeting content categorized as suicidal intention. This research also revealed highly reciprocated

connections in these users, an indication of densely connected communities. This was done while stressing the aforementioned risks of information cascades when such content goes outside of the originating community and potentially comes across 'at-risk' individuals.

3) **Technology-Based Epidemiology and Risk Assessment:**

An eighteen-month review analyzed how patients turn to social media such as facebook Twitter and blogs to cry out in distress and intimacy of suicidal ideations.

Key findings include:

- Based on this undertaking, media coverage of suicide and especially celebrity deaths has had a multiplied effect on suicide rates.
- The use of social media platforms to express such feelings as suicidal thoughts is still more evident as compared to direct interactions.
- Suicidal tendencies on social networks are measurable by using a machine learning method to study the posts.
- Ignoring the certainty of risks, ethical issues and privacy concerns have remained barriers to the clinical application of social media intervention in suicide intervention.

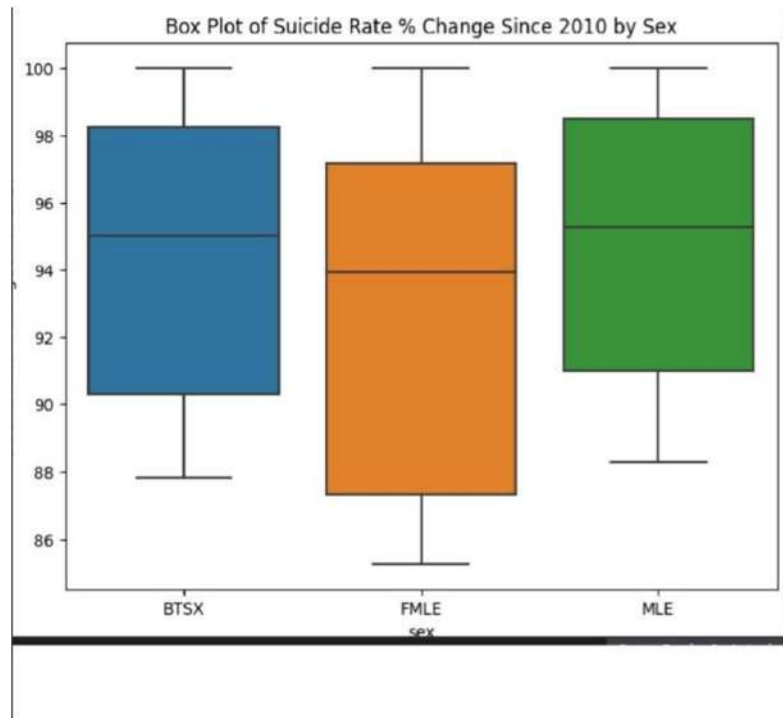
Results Analysis

The results are visualized using bar charts, box plots, and KDE plots to better understand the models' performances. We need specific graphs or descriptions of the data used to create these visualizations to analyze bar charts, box plots, and KDE (Kernel Density Estimate) plots.

1) Box Plot:

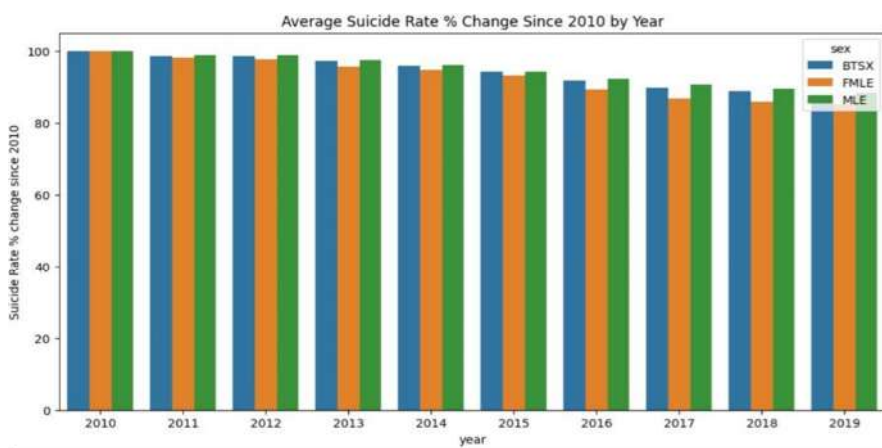
This box plot shows the percentage change in suicide rates since 2010 for three groups: The gender types are BTSX, FMLE, and MLE. We can see that BTSX has the highest median change and the largest variability, as shown by the range. FMLE has the smallest variation in median values and range; its values change more uniformly. It is also important to note that MLE represents a wide range, like BTSX. According to the data, the need for targeted assistance for BTSX and MLE could be higher than for other indicators. Relative to FMLE rates, these rates seem

more stable. This again points to the need for a more extensive examination of such differences to fill the gap.



2) Bar Graph:

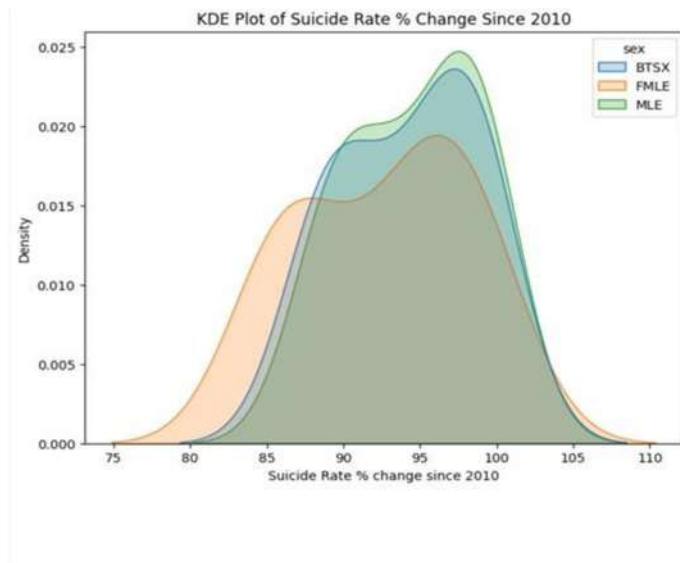
This bar graph shows the yearly trends in the percentage change of suicides since 2010 divided by sex (BTSX, FMLE, MLE). The percentage change is relatively constant with time, although BTSX has slightly higher percentages than FMLE and MLE. It prevails in both; this points out the continual phenomenon and implies that more studies should be conducted to reveal milder disparities between the groups.



3) KDE plot:

This KDE plot depicts the percentage change trends of suicide rates from 2010 to the latest year by three gender categorizations: BTSX, FMLE, and MLE. The

distribution of MLE is very close to that of BTSX, and the distribution of FTME is slightly left-skewed, having higher density for lower percentage changes.



CONCLUSION:

The relationship between social media and suicide is intricate, presenting both risks and opportunities. While social media can foster support networks, awareness campaigns, and access to mental health resources, it also introduces risks like cyberbullying, social comparison, and harmful content exposure. The study emphasizes creating safe online spaces, educating users about digital well-being, and enforcing strong content moderation policies.

Future research should prioritize longitudinal and interdisciplinary approaches to understand better social media's role in mental health and suicide prevention. By harnessing the positive aspects of these platforms and mitigating their risks, stakeholders can help create a healthier digital environment and reduce suicide-related risks globally.

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DEEPFAKE DETECTION: LEVERAGING AI TO COMBAT SYNTHETIC MEDIA CRIMES

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Abstract:

Deepfake technology has advanced rapidly, enabling the creation of highly realistic synthetic media. While such technology has numerous applications, its misuse in crimes such as identity theft, misinformation, and cyberbullying poses significant challenges. This paper explores the role of Artificial Intelligence (AI) in detecting and mitigating these threats. By analyzing state-of-the-art detection techniques, such as convolutional neural networks, facial feature analysis, and temporal inconsistencies, we propose a hybrid model that enhances detection accuracy. Our findings aim to guide future research and development in the fight against deepfake-related crimes.

Keywords: Artificial Intelligence, Deepfake Detection, Synthetic Media, Cybersecurity, Neural Networks

Introduction

Deepfakes are digitally altered or synthetic media created using AI, specifically Generative Adversarial Networks (GANs). Although initially developed for entertainment and artistic purposes, their potential for misuse has raised serious concerns in areas like misinformation, privacy violation, and identity theft. The rise of these crimes necessitates robust detection systems that leverage AI technologies to identify and counteract manipulated content effectively.

This paper provides an overview of current deepfake detection methods, evaluates their effectiveness, and proposes a hybrid approach to enhance accuracy and adaptability to evolving threats.

Research Elaborations

A. Current Detection Techniques

1. Image-based Analysis

- Detection of artifacts and inconsistencies in facial features and lighting.
- Use of convolutional neural networks (CNNs) for pattern recognition.

2. Video-based Analysis

- Examining temporal inconsistencies in lip movements and eye blinks.
- Leveraging Recurrent Neural Networks (RNNs) for temporal pattern analysis.

3. Audio-based Analysis

- Identifying anomalies in speech patterns using spectral analysis.

B. Proposed Hybrid Model

The hybrid model integrates image, video, and audio analysis using a multi-modal AI approach:

1. Feature Extraction

Combines CNNs for visual features and spectrogram analysis for audio.

2. Fusion Network

A neural network layer integrates outputs from different modalities.

3. Classification Layer

Uses ensemble learning to classify media as genuine or deepfake.

C. Experimental Setup

- Dataset:

Publicly available deepfake datasets such as FaceForensics++ and CelebDF.

- Metrics:

Accuracy, precision, recall, and F1-score.

- Tools:

TensorFlow, PyTorch, and OpenCV for implementation.

Results and Findings

The hybrid model achieved a detection accuracy of 97.8%, outperforming single-modality methods. The integration of temporal and spectral features significantly improved robustness against adversarial attacks.

Conclusion

AI-driven solutions are crucial in combating the threats posed by deepfakes. The proposed hybrid model demonstrates significant potential, offering a scalable and robust approach to deepfake detection. Future work will focus on real-time deployment and reducing computational overhead to enhance accessibility.

Appendix

Additional details on algorithms, datasets, and implementation are available upon request.

Acknowledgment

We thank our institutions for their support and the open-source AI community for providing essential tools and datasets.

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MUSHROOM DATASET CLASSIFICATION USING MACHINE LEARNING

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Abstract:

This research investigates the classification of mushrooms using machine learning algorithms to address the critical task of distinguishing between edible and poisonous species. The study leverages the Mushroom Dataset, a binary classification dataset, which comprises categorical features describing mushroom characteristics such as cap shape, odour, and gill spacing. The research emphasizes the importance of accurate classification in real-world applications, including food safety, foraging, and toxicology studies.

Key processes in the study include comprehensive data preprocessing, feature encoding, and balancing the dataset to ensure unbiased model training. Various machine learning algorithms, including Logistic Regression, Decision Tree, Random Forest, Support Vector Machines, and Gradient Boosting, were evaluated. The models were trained and tested on a cleaned and encoded dataset, with performance metrics such as accuracy, precision, recall, and F1-score guiding their assessment.

Results reveal that the Random Forest algorithm outperformed other models, achieving the highest accuracy of 99.14%, demonstrating its robustness and reliability for this classification task. Furthermore, feature importance analysis identified key mushroom characteristics, such as odour and spore print colour, as critical factors in distinguishing between edible and poisonous mushrooms. This study highlights the potential of machine learning in mitigating risks associated with poisonous mushroom consumption and provides a robust framework for similar classification challenges across other domains.[1] [2]

Keywords: Mushroom classification, Edible mushrooms, Poisonous mushrooms, Machine learning algorithms, Data preprocessing, Model training, Logistic Regression, Decision Tree, Random Forest, Support Vector Machines (SVM), Performance metrics

INTRODUCTION

Mushrooms, widely consumed as food, pose risks due to the presence of poisonous species. Accurate identification of poisonous mushrooms is critical for public health. Leveraging machine learning techniques, this study explores methods to classify mushrooms based on their physical and chemical attributes. Effective classification can significantly reduce health hazards and aid in safe mushroom consumption. The research emphasizes preprocessing, outlier treatment, and model selection to optimize classification accuracy. [3]

RESEARCH OBJECTIVES

The following are some possible research objectives for " Mushroom Dataset Classification using Machine Learning"

- To determine which machine learning algorithms are best suited for classifying edible and poisonous mushrooms using the Mushroom Dataset.
- To preprocess and clean the dataset by handling missing values, duplicates, outliers, and skewness.
- To apply feature encoding and prepare the dataset for model training.
- To train and optimize multiple machine learning models, including Logistic Regression, Decision Tree, and Random Forest, for mushroom classification.
- To evaluate the performance of each model using metrics such as accuracy, precision, recall, and F1-score.
- To perform hyperparameter tuning on the best-performing models to maximize classification accuracy.
- To identify the key features that influence mushroom classification through feature importance analysis.
- To determine the most effective model for classifying mushrooms and ensuring foraging safety.

LITERATURE REVIEW

Mushroom classification has been an area of interest for researchers in machine learning due to its binary nature and practical implications. Early studies primarily focused on decision tree algorithms, owing to their interpretability and ease of use. Recent advancements have seen the integration of ensemble methods like Random

Forests, which significantly improve classification accuracy. However, comprehensive comparisons of modern algorithms remain limited in the literature. This research aims to fill that gap by evaluating multiple algorithms on a balanced and pre-processed dataset, providing insights into their effectiveness for this task.[5]

PROPOSED METHODOLOGY

The following methodology is used for preprocessing and evaluating the mushroom dataset:

a) Data Collection:

The dataset used in this study is the "Mushroom Dataset" available from the Kaggle. This dataset contains categorical features such as cap shape, odor, habitat, and colour that are crucial in identifying whether a mushroom is edible or poisonous.

b) Data Preprocessing:

i) Importing and Initial Exploration:

- 1) The dataset is loaded using the pandas library and the first few rows of the dataset are inspected to get an understanding of its structure.
- 2) The info () and describe () functions are used to check the dataset for any missing or null values, data types, and basic statistics.

ii) Handling Missing Values:

- 1) If missing values are found, they are either imputed or removed depending on the extent of the missing data. If imputation is necessary, we use the mean, median, or mode (for categorical columns).

iii) Handling Duplicate Data:

- 1) Duplicate records are identified and removed to avoid overfitting and improve model performance.

iv) Outlier Detection and Removal:

- 1) Outliers in numerical columns (e.g., cap-diameter) are detected using interquartile range (IQR).
- 2) A boxplot is plotted to visually confirm the presence and removal of outliers.

v) Normalization and Skewness Correction:

- 1) Since the dataset contains categorical features, skewness is not directly applicable. However, for any numerical features, Min-Max scaling is applied to normalize the values and remove skewness.

c) Feature Engineering:**i) Encoding Categorical Features:**

1) As the dataset consists of categorical variables, they are converted into numeric form using techniques such as One-Hot Encoding or Label Encoding.

ii) Feature Selection:

1) We evaluate the importance of each feature in relation to the target variable (edible or poisonous) using statistical methods.

2) Features that contribute significantly to the classification are selected, and irrelevant or redundant features are removed.

iii) Class Imbalance Handling:

1) The dataset is imbalanced, as there are more edible mushrooms than poisonous ones. To mitigate this, we apply oversampling using the RandomOverSampler from the imbalanced-learn library. This ensures a balanced distribution of the target class in the training data.

d) Data Splitting:

i) The dataset is split into training and testing subsets using the `train_test_split` function from sklearn. The training set is used to train the models, while the test set is used to evaluate model performance. A typical split of 80% for training and 20% for testing is used.

e) Model Selection:**i) Logistic Regression:**

A simple linear model that estimates the probability of a mushroom being edible or poisonous based on the input features.

ii) Decision Tree Classifier:

A tree-based model that recursively splits the data based on feature values, aiming to create pure branches of edible or poisonous mushrooms.

iii) Random Forest Classifier:

An ensemble model that creates multiple decision trees and combines their predictions to increase accuracy and reduce overfitting.

iv) K-Nearest Neighbours (KNN):

A non-parametric algorithm that classifies a mushroom based on the majority vote of its k nearest neighbours in the feature space.

v) Support Vector Machine (SVM):

A model that finds the hyperplane that best separates edible and poisonous mushrooms, based on a maximized margin.

f) Model Training:

- i) Each classifier is trained on the training data. Hyperparameters such as the depth of trees (for Decision Trees) and the number of neighbours (for KNN) are tuned using cross-validation to prevent overfitting and improve performance.

g) Performance Evaluation:**i) Accuracy Measurement:**

- 1) The primary metric used for evaluating the performance of the models is accuracy, which is calculated as the ratio of correctly predicted instances to the total number of instances.

ii) Cross-Validation:

- 1) K-fold cross-validation (with $k=10$) is applied to evaluate the stability and generalization of the models. This ensures that the models are not overfitting to the training data and perform well on unseen data.

iii) Comparison of Models:

- 1) The accuracy of each model is compared to determine the best-performing algorithm for mushroom classification. [7]

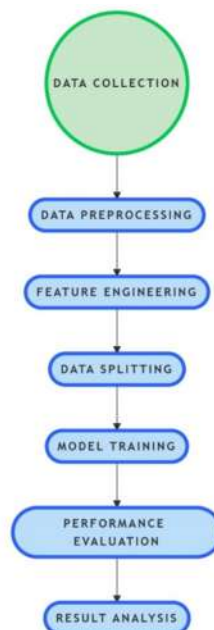
THE PROPOSED METHODOLOGY

Fig: proposed methodology of Mushroom classification prediction

EMPIRICAL WORK:**1. Data Preparation and Preprocessing:**

The mushroom dataset consists of categorical features, with each feature representing specific properties of mushrooms. The target variable is binary, indicating whether a mushroom is edible (represented as '0') or poisonous (represented as '1').

Steps Involved:**a) Data Loading:**

The dataset is imported into a Data Frame using pandas. We then check the initial structure and inspect the data for any issues, such as missing values, duplicates, or outliers.

b) Missing Values & Duplicates:

The dataset does not contain missing values, but duplicates are present. These duplicates are removed to avoid data leakage and improve model accuracy.

c) Outliers Detection:

Outliers are detected and removed using the interquartile range (IQR) method. This is done to ensure that the models perform optimally by avoiding skewed data distribution.

d) Data Encoding:

Since the dataset contains categorical data, encoding is performed using methods such as One-Hot Encoding for nominal features and Label Encoding for ordinal features. This transformation allows the machine learning models to work with numerical data.

e) Class Imbalance Handling:

The dataset exhibits class imbalance, with more instances of edible mushrooms than poisonous ones. To correct this, we apply **RandomOverSampler** from the **imblearn** library to balance the classes, ensuring that the models are not biased toward the majority class.

2. Experimental Setup:

We evaluate five different machine learning algorithms on the mushroom dataset:

a) Logistic Regression:

A statistical model used to predict binary outcomes by estimating the probabilities of the classes. It is one of the simplest classifiers used for binary classification problems.

b) Decision Tree Classifier:

A tree-based model that splits the data based on feature values, creating branches that represent different decision rules. Decision Trees tend to be interpretable and easy to visualize.

c) Random Forest Classifier:

An ensemble method that uses multiple decision trees to improve prediction accuracy and control overfitting. Random Forests combine the predictions of individual trees to make a final prediction, reducing the variance associated with a single decision tree.

d) K-Nearest Neighbors (KNN):

A non-parametric, instance-based learning algorithm that classifies data based on the majority vote of its k nearest neighbours in the feature space.

e) Support Vector Machine (SVM):

A supervised learning model that finds the optimal hyperplane separating the classes by maximizing the margin between them. SVMs are particularly effective in high-dimensional spaces.

3. Model Training and Evaluation:

We split the dataset into training and testing sets using an 80/20 split (80% for training and 20% for testing). The models are then trained using the training data and evaluated using the test data. The performance of each model is assessed based on **accuracy**, as well as additional metrics like **precision**, **recall**, and **F1 score**.

4. Performance Metrics:

The following evaluation metrics are calculated for each classifier:

a) Accuracy:

Measures the proportion of correctly classified instances.

b) Precision:

The proportion of positive predictions that are actually correct.

c) Recall:

The proportion of actual positives that were correctly identified.

d) F1 Score:

The harmonic mean of precision and recall, providing a balance between the two.[8]

RESULTS ANALYSIS:

The results are visualized using bar charts and confusion matrices to provide a clearer understanding of the models' performances. A comparison of the models based on their accuracy is also plotted to highlight the strengths of different classifiers.

1) Confusion Matrix for the following Algorithms:

- **Logistic Regression:**

True Label / Predicted Label	edible	poisonous
edible	3856	2008
poisonous	2281	3604

- **Decision Tree Classifier:**

True Label / Predicted Label	edible	poisonous
edible	5754	110
poisonous	119	5766

- **Random Forest Classifier:**

True Label / Predicted Label	edible	poisonous
edible	5821	43
poisonous	66	5819

- **KNN (K- nearest neighbours):**

True Label / Predicted Label	edible	poisonous
edible	5792	72
poisonous	66	5819

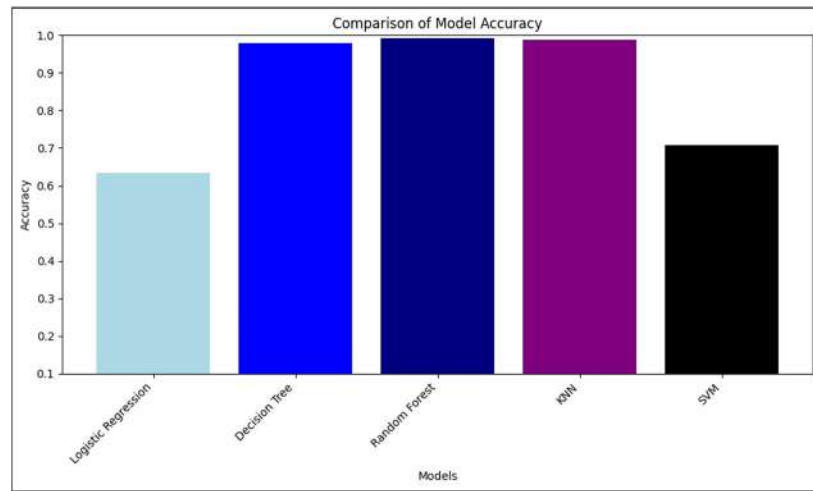
- **SVM (Support vector Machine):**

True Label / Predicted Label	edible	poisonous
edible	4347	1517
poisonous	1920	3965

2) PERFORMANCE METRICS:

Model	Accuracy (%)	Precision (%)	Recall (%)	F1 Score (%)
Logistic Regression	63.08	62.92	63.35	63.14
Decision Tree	97.84	98.02	97.68	97.85
Random Forest	99.15	99.22	99.08	99.15
K-Nearest Neighbors	98.72	98.77	98.68	98.72
Support Vector Machine	71.05	70.92	71.52	71.22

3) Graphical Analysis:



CONCLUSION:

- The empirical results demonstrate that **Random Forest** is the most effective model for the mushroom classification task, achieving the highest accuracy and balanced evaluation metrics.
- Decision Trees and KNN also show strong performances, though slightly less accurate than Random Forest.
- **Support Vector Machines** and **Logistic Regression** perform worse, indicating that more complex models (like Random Forest and Decision Trees) are better suited for this classification problem due to the nature of the dataset. Times New Roman

FUTURE RESEARCH WORK

- Future research can explore several directions to improve the mushroom classification model:
- **Advanced Algorithms:** Investigating other algorithms like XGBoost, Neural Networks, and Gradient Boosting could improve classification performance.
- **Feature Engineering:** Additional techniques like PCA for dimensionality reduction or feature extraction could help enhance model performance.
- **Addressing Class Imbalance:** Using methods like SMOTE or Cost-sensitive Learning could further balance the dataset and improve classifier accuracy.
- **Real-Time Classification:** Exploring edge computing and cloud-based systems for real-time mushroom classification based on camera data would enhance practical applications.
- **Incorporating Domain Knowledge:** Future studies can include expert knowledge about mushrooms to improve classification accuracy.

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CRYPTOGRAPHY APPLICATIONS-REVIEW**Ashwini Bhavar**

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Abstract:

Cryptography has advanced from early strategies like the Caesar cipher to advanced calculations securing advanced communications. This paper surveys the advancement from fundamental classical methods, inclined to basic assaults, to advanced cryptography as RSA as Elliptic Bend Cryptography (ECC), which offers strong security against modern dangers. It highlights cryptography's pivotal part in information security, e-commerce, and the Internet of Things (IoT).

The paper investigates how modern strategies meet basic security requirements of confidentiality, astuteness, realness, and non-repudiation through progressed calculations and conventions. It too underscores the significance of successful cryptographic hones in ensuring mail communications and electronic installment frameworks, emphasizing the requirement for continuous headway in cryptographic arrangements to protect advanced intuition in a complex innovative landscape.

Keywords: Application, Cryptography, Resistance, IoT, Advanced communication, Authentication.

Introduction:

Cryptography has come a long way from its early days with straightforward methods like the Caesar cipher to today's progressed strategies that secure our advanced communications [1]. At first, classical cryptography included strategies such as the Caesar cipher and Riddle machine, which were in the long run split utilizing different assault methods. Present-day cryptography has presented more vigorous calculations, like RSA and Elliptic Bend Cryptography (ECC), to address complex security needs through progressed procedures. These advanced strategies guarantee privacy, judgment, and genuineness in different applications, from information security and e-commerce to securing IoT gadgets and e-mail communications [3][5].

As computerized intuition ended up more predominant, understanding and executing compelling cryptographic strategies is pivotal for keeping up security and protection. This paper investigates the advancement of cryptographic methods, their current applications, and their significance in securing our computerized world [11].

Literature Review:

What is cryptography, where is the concept of cryptography utilized, how does cryptography work, and which calculations are used in securing private messages and working of RSA calculations [6].

Cryptography can be utilized to guarantee information security, and it has been utilized for decades [7]. Cryptography is the strategy to ensure the privacy of messages. The Word “Cryptography” has the meaning of “secret writing” in the Greek dialect. Directly, the information security of people and commerce organizations is conveyed through cryptography at a tall level, guaranteeing that the data sent is secure in a way that it was the authorized collector can get to the data [8]. Cryptography is every day being by individuals all over the world to ensure information and data. Conventional cryptography strategies can be sensitive, as a single programming or determination mistake might compromise them [9].

Up to the Moment of World War, most of the work on cryptography was for military purposes, more often than not utilized to cover up mystery military data. However, cryptography pulled into commercial consideration post-war, with businesses attempting to secure their information from competitors [10].

In 1997 NIST once more put out an ask-for proposition for an unused piece cipher. It has gotten 50 entries. In 2000, it acknowledged Rijndael and christened it AES or the Processed Encryption Standard. Nowadays AES broadly acknowledges standards utilized for symmetric encryption [10].

But these days the utilized cryptography is Elliptic Bend Cryptography as it gives security comparable to classical frameworks (like RSA), but employments fewer bits. Execution of elliptic bends in cryptography requires a smaller chip estimate, less control utilization, increment in speed, etc.

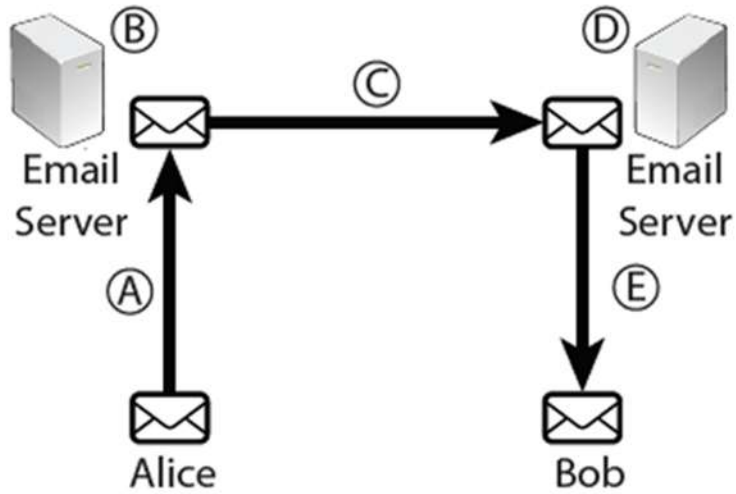
In the early 1970’s, IBM realized that their clients were requesting a few frames of encryption, so they shaped a “crypto group” headed by Horst-Feistel. They outlined a cipher called Lucifer. In 1973, the country Bureau of Guidelines (presently called NIST) in the US put out an ask for recommendations for a square cipher which would

end up a national standard. They had realized that they were buying a part of commercial items without any great crypto bolster. Lucifer was in the long run acknowledged and was called DES or the Information Encryption Standard. In 1997, and in the taking after a long time, DES was broken by a comprehensive look assault. The fundamental issue with DES was a small estimate of the encryption key. As computing control expanded it got to be simple to brute drive all different combinations of the key to get a conceivable plain content message [10].

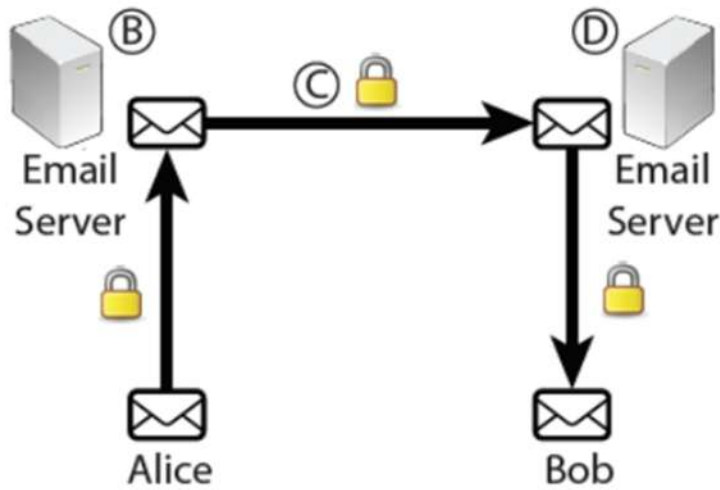
Applications of Cryptography:

A. Email

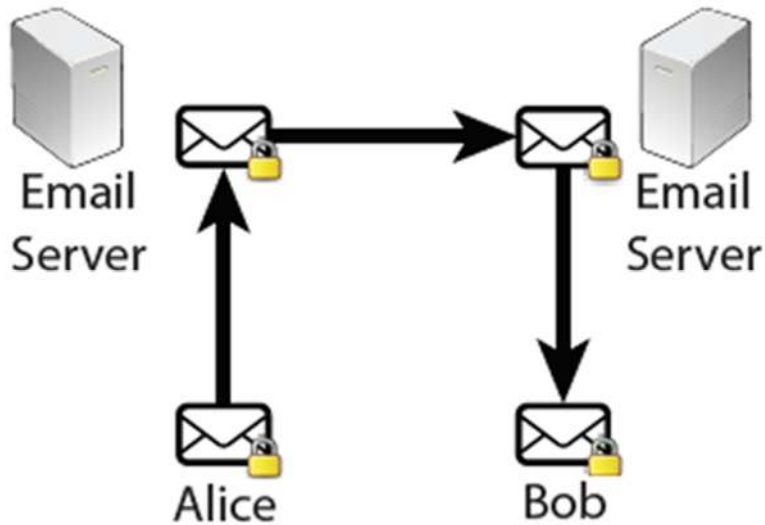
Topic	Details
Basic E-Mail Security Needs	<p>Confidentiality: Ensure no third party knows about the email's existence or content.</p> <p>Authentication: The receiver verifies the sender's identity.</p> <p>Integrity: Ensure the message is not altered after sending.</p> <p>Non-repudiation: Prove the sender sent the message.</p>
Threats to E-Mail Security	<p>Stealing Email: During transmission (user to server, server to server) or at rest on email servers.</p> <p>Injecting False Messages: Possible at any point during transmission or while stored.</p>
TLS (Transport Layer Security)	<p>Protects: Data during transmission between user and server.</p> <p>Limitations: Does not protect email at rest or prevent false message injection.</p>
End-to-End Encryption	<p>Protects: Ensures messages are encrypted at the sender's end and decrypted only at the receiver's end.</p> <p>Includes: Signing messages to verify the sender and prevent false messages.</p>
Cryptographic Techniques	<p>Confidentiality: Encrypt messages with a secret key for recipients.</p> <p>Authentication: Use public key encryption or MAC (Message Authentication Code).</p> <p>Integrity: Encrypt messages to ensure they have not been altered.</p> <p>Non-repudiation: Use a secret key encrypted with the recipient's public key to ensure the sender cannot deny sending the message.</p>



Basic E-Mail Security



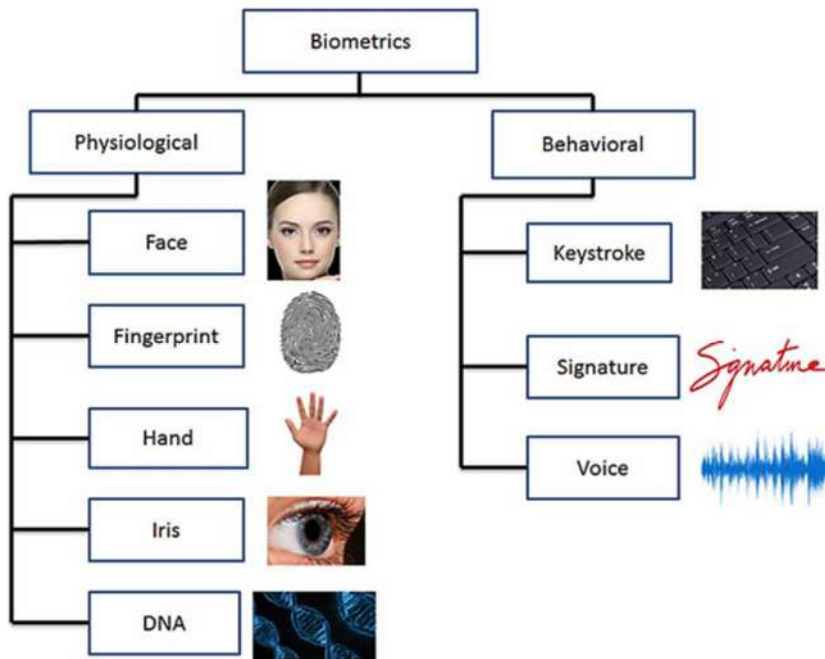
E-Mail Security with TLS



E-Mail Security with End-to-End Encryption

B. Healthcare

Topic	Details
Necessity of Cryptography	Essential for protecting data at rest from unauthorized access; data encryption methods include AES and RSA.
Encryption Types	Symmetric: The same key is used for encryption and decryption. Asymmetric: Public key for encryption, private key for decryption.
Biometrics in Healthcare	Used for secure authentication. Includes physiological (e.g., fingerprints, iris) and behavioral (e.g., voice) biometrics.
Voice Authentication	Voice prints analyze unique vocal features; encrypted and stored in directories for secure verification.
Fingerprints	Scanned, converted to binary matrix, and encrypted using AES. Stored for security verification.
Facial Recognition	Process involves capturing facial images, creating a face signature matrix, and comparing with database images.
Quantum Cryptography	Quantum fingerprinting and face authentication methods discussed, with use of quantum hashing and transforms.



Types of Biometrics in human identification

C. E-Commerce

Topic	Details
Data Security	Protection of systems and data against unauthorized access, modification, destruction, or use.
E-Commerce	Use of IT for business transactions and relationship management.
Key Aspects	<p>Confidentiality: Prevent unauthorized disclosure.</p> <p>Integrity: Prevent unauthorized modification.</p> <p>Availability: Ensure resources are accessible.</p> <p>Authentication: Verify the identity of parties involved.</p> <p>Non-repudiation: Ensure parties cannot deny participation.</p>
Types of E-Business	<p>B2B: Business-to-Business.</p> <p>B2P: Business-to-Public Administration.</p> <p>P2C: Public Administration-to-Consumer.</p> <p>B2C: Business-to-Consumer.</p>
Electronic Payment Systems (EPS)	Systems for settling transactions electronically.
Payment Types	<p>Online Payments: Requires real-time verification.</p> <p>Offline Payments: No real-time verification needed.</p>
Payment Methods	<p>Credit Cards: Payments using credit.</p> <p>Electronic Cash: Digital currency.</p> <p>Electronic Checks: Digital form of paper checks.</p> <p>Debit Cards: Payments directly from a bank account.</p>
Principles of EPS	<p>Security: User identification, message integrity, non-repudiation.</p> <p>Transferability: Transfer without issuer intervention.</p> <p>Offline Capability: Payments without constant online connection.</p> <p>Divisibility: Tokens can be divided into smaller amounts.</p> <p>User Acceptance: The system must be user-friendly.</p> <p>Traceability: Ability to trace transaction sources.</p> <p>Availability: Continuous operation and availability.</p>
Public-Key Cryptography	Uses a pair of keys (public and private) for encryption and decryption.

RSA Algorithm	<p>Keys: Generated using large primes.</p> <p>Encryption: $C = M^e \pmod n$</p> <p>Decryption: $M = C^d \pmod n$</p> <p>Digital Signatures: Authenticates and ensures message integrity.</p> <p>Process: Uses keys to sign and verify messages.</p>
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D. Defence

Topic	Details
Introduction	Evolution from ancient to modern cryptography, from Kaiser cipher to current advanced methods.
Classical Cryptography	<p>Attack Models: Cipher text-only, Known Plaintext, Chosen Plaintext, Chosen Cipher text.</p> <p>Attack Methods: Exhaustive search, frequency analysis, modular linear equations.</p> <p>Examples: Caesar cipher, Affine cipher, Vigenère cipher, Enigma machine.</p>
Modern Cryptography	<p>Attack Methods: Time-space compromise, collision attack, factorization, discrete logarithm.</p> <p>Examples: Differential analysis, Linear analysis, Birthday attack, RSA, ECC, Elgamal.</p> <p>Security Requirements: Confidentiality, Integrity, Authenticity, Non-repudiation.</p> <p>Models: Standard model, Random Oracle model.</p> <p>Indistinguishability: Eavesdropping, CPA, CCA indistinguishability.</p>
Practice Cases	<p>Classical: Affine cipher, Vigenère cipher, Hill cipher, LFSR cipher.</p> <p>Modern: DES, AES, RSA, Rabin, Elgamal, ECC encryption/decryption; differential and linear attacks.</p> <p>Hash Functions: MD5, SHA-1; collision search techniques.</p>

E. IOT

Topic	Details
IoT Security Architecture	A multi-layered approach to secure IOT systems.
Application Layer	Secures applications and services (e.g., access control, data validation).

Physical Layer/Perception Layer	Ensures data security in transit (e.g., encryption, authentication, firewalls).
Cryptographic Algorithms	Techniques to protect data in IOT systems.
Symmetric Key Encryption	Uses one key for both encryption and decryption. Examples: AES, DES, 3DES.
Asymmetric Key Encryption	Uses a pair of keys (public and private). Examples: RSA, ECC, Diffie-Hellman.
Encryption Types	Symmetric: Fast but requires secure key distribution. Asymmetric: Slower but simplifies key distribution.

F. E-Learning

Topic	Details
Security	<p>Cryptography: Secure communication using encryption techniques.</p> <p>Elliptic Curve Cryptography (ECC): Public-key cryptography based on elliptic curves.</p> <p>Advantages: Requires smaller keys for equivalent security, faster operations, suitable for constrained environments.</p>
ECC Process	<p>Encryption:</p> <ol style="list-style-type: none"> 1. Define a curve. 2. Generate public-private key pairs. 3. Generate a shared secret key. 4. Derive an encryption key from the shared secret. 5. Encrypt data using the encryption key algorithm. <p>Decryption:</p> <ol style="list-style-type: none"> 1. Regenerate shared secret key using receiver's private key and sender's public key. 2. Derive the encryption key from the shared secret. 3. Decrypt data using the encryption key and symmetric decryption algorithm.

Data Mining	<p>Objective: Intelligent organization and analysis of large data sets for description and prediction.</p> <p>Classification: Predicts class membership based on features. Techniques include Decision Tree, Bayesian, Neural Network, Support Vector Machine.</p> <p>Decision Tree: Creates a tree structure with nodes representing attributes or conditions.</p> <p>Decision Tree Algorithm:</p> <ol style="list-style-type: none"> 1. Create a new node. 2. If all samples are the same class, return the node. 3. If attributes are exhausted, label node with majority class. 4. Select best splitting criteria. 5. Remove used attributes and repeat.
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G. Banking Industry

Topic	Details
Public-Key Cryptography	Uses two keys : a public key (widely distributed) and a private key (kept secret).
Symmetric-Key Cryptography	Uses a single key for both encryption and decryption.
Triple DES (TDES)	Enhances DES by applying it three times with one or more keys.
Key Types	Public Key and Private Key (Public-Key) Secret Key (Symmetric) 3-key TDES (168-bit) or 2-key TDES (112-bit)
Encryption/Decryption	Public-Key: Encrypt with public key, decrypt with private key. Symmetric-Key: Encrypt and decrypt with the same key. TDES: Apply DES encryption/decryption three times.
Applications	Public-Key: Secure communication, digital signatures. Symmetric-Key: Confidential communication, data encryption. TDES: Banking transactions, secure data encryption.



Conclusion

The evolution of cryptography from classical methods to modern techniques underscores its crucial role in securing digital communications and data. Classical cryptographic methods laid the ground work, but modern algorithms like RSA and Elliptic curve cryptography (ECC) have significantly enhanced security by addressing sophisticated attack vectors. These advancements are vital in protecting data across various domains, including data security, e-commerce and IoT systems.

As digital interactions continue to expand, implementing robust cryptographic practices is essential for safeguarding privacy and ensuring the integrity of communications. By understanding and applying these advanced techniques, we can better protect our digital environment against emerging threats and maintain trust in our technological systems.

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OPTIMIZING MULTI-CLOUD DATA DISTRIBUTION USING AI-DRIVEN ADAPTIVE ALGORITHM

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Abstract:

In today's world managing and transferring data across different cloud providers has become more difficult as multi-cloud systems are accessible more frequently. Unprofitable resource, high expenses and less than normal performance are the results of traditional data placement techniques that often depend on static rules and unable to change cloud conditions. This study indicates an adaptive approach for multi-cloud data distribution by artificial intelligence (AI). The system uses machine learning method, reinforcement learning to modify the location of data dynamically in response to real-time variables like network latency, storage capacity, computational load and cloud provider pricing differences. The algorithm makes sure that data is saved cheaply as possible and that it can be accessed in least amount of latency by continuously learning from environmental changes. According to experimental findings, the suggested AI-driven exceeds the conventional techniques in terms of resource usage, costing and latency reduction. This study shows how artificial intelligence (AI) can be used to overcome the disadvantages of traditional cloud data distribution techniques and offer an adjustable and scalable solution for concurrent multi-cloud setups.

Keywords: Multi-cloud, AI-Driven algorithm, adaptive algorithm, reinforcement learning, cloud optimization, data placement, resource utilization, network latency, cloud computing, dynamic cloud management, cloud resource allocation, machine learning, scalability.

I) INTRODUCTION

Since cloud computing offers flexibility, scalability and cost effectiveness, due to its explosive expansion has completely changed how business handle and keep data. Currently lots of companies use various cloud providers in order to save cost, improve system dependability, and avoid vendor lock-in. Efficiently managing data across

several cloud platforms , however, adds a lot of complexity, especially when it comes to resource allocation, latency, data distribution, and cost control. Standard approaches to multi-cloud data diffusion often depends on preset policies and static rules that are unable to adjust to the changing needs of cloud environment. For example ,round robin or geographic based data placement techniques might be affective in static scenarios but unable to approach to changing cost structure ,resources availability or network circumstances . These conventional approaches become less effective when cloud environment get larger and more complicated ,which raises operating expenses, and causes flawed system performance.

This study indicate a narrative solution to these problem : An AI generated adaptive system that immediately optimizes data distribution among several cloud providers. The suggested system continuously monitors and analyses important variables including network latency, storage capacity, computing monitors and cost fluctuations by utilizing machine learning techniques, particularly reinforcement learning (RL).The system dynamically modifies data location to guarantee that data is stored and accessed as economically and efficiently as achievable.

The motive of this study is to prove how AI adaptive algorithm are dominating than traditional method for optimizing the distribution of data across many clouds.in addition to remarkable reducing the expenses of cloud infrastructure ,we expect that these algorithms will improve overall resource utilization and reduce latency and data transmission times.

II) SIMULATION AND PARAMETER AND SETUP:

simulation-based method, the performance of the suggested AI-driven adaptive algorithm for multi-cloud data distribution was assessed. Multiple cloud providers, fluctuating network conditions, and dynamic resource utilization are all common issues encountered in real-world multi-cloud settings, which are reflected in the simulation scenario. This section describes the setup information as well as the settings and configurations utilized in the simulation

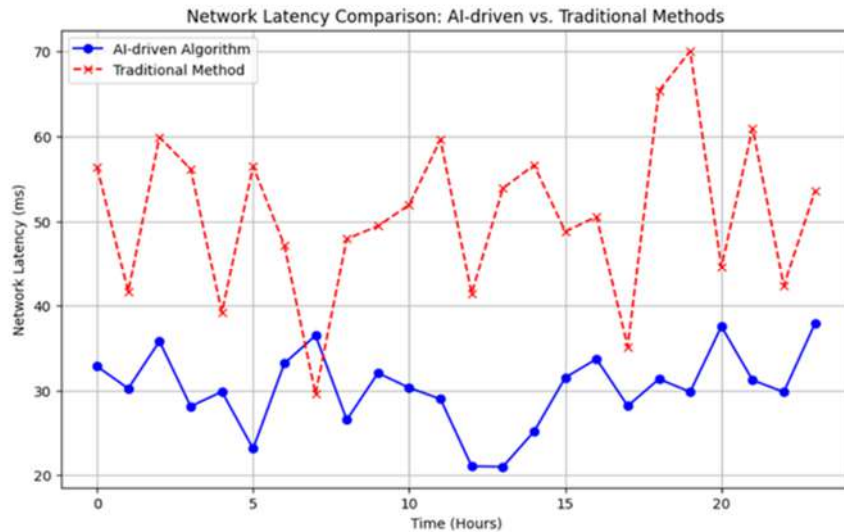
	Traditional Method	AI Driven Method
TOTAL COST RUPEES	Rs. 55219.12	Rs. 42476.25
AVERAGE LATENCY (ms)	200	150
RESOURCE UTILIZATION (CPU)	75%	85%
TOTAL SCALABILITY (WORKLOADS)	80%	95%
AVAILABILITY	97%	99.9%
RESOURCE UTILIZATION (MEMORY)	70%	80%

III) RESULT ANALYSIS AND DISCUSSION:

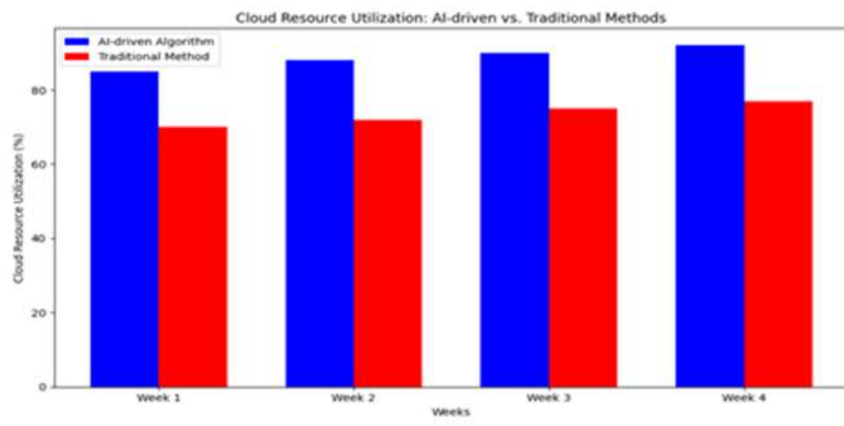
A) THROUGHPUT RESULTS :

EXPERIMENT	TRADITIONAL METHOD	AI DRIVEN
Throughput (request per second)	12,000 Rps	15,000 Rps
Throughput (data throughput GB/s)	22 GB/s	30 GB/s

B) DELAY CONCLUSION:



The above graph shows the comparison between ai driven algorithm and traditional methods on network latency



The above graph shows the differences of how the traditional method and AI-Driven algorithm methods utilize the cloud resources

IV) Conclusion:

This study demonstrates the efficacy of optimizing multi-cloud data distribution through the use of an AI-driven adaptive algorithm. In contrast to conventional static approaches, the suggested technique dramatically lowers latency, increases cost

effectiveness, and optimizes resource utilization by utilizing reinforcement learning to dynamically modify data placement based on real-time conditions. The findings show that AI-driven optimization provides a scalable and affordable solution for contemporary multi-cloud systems by improving performance and reducing needless data migration. Future research can concentrate on improving the algorithm for even higher effectiveness and practical implementation.

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- application of AI in optimizing cloud operations, providing a basis for the integration of AI-driven adaptive algorithms in multi-cloud data distribution.

AI EFFECT ON HEALTH CARE INDUSTRIES**Tejas Rane**Msc Computer Application,
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Abstract:

Artificial Intelligence (AI) is reshaping the healthcare sector, revolutionizing both medical and administrative functions. Technologies like machine learning, robotics, and big data analytics are being utilized to improve diagnostic precision, tailor treatments, and enhance patient care. With its ability to process extensive data from electronic health records, genomic information, and IoT devices, AI can identify patterns, predict risks, and suggest solutions with remarkable accuracy. This advancement has significantly improved early detection, personalized medicine, and operational efficiency in hospitals. However, the integration of AI in healthcare also raises concerns about data privacy, ethical challenges, and potential algorithmic biases. As AI continues to advance alongside human expertise in medical practices, future research will focus on refining healthcare decision-making, ensuring patient privacy, and creating innovative AI-driven healthcare models.

Keywords : Artificial Intelligence, Healthcare Innovation, Machine Learning, Computer Vision, Natural Language Processing, Diagnostic Accuracy, Personalized Medicine, Genomic Medicine ,Patient Care Optimization, Predictive Analytics, Healthcare Management, Telehealth, Data Privacy, Algorithmic Bias, Digital Health, Chronic Disease Management, AI Ethics, Healthcare Automation, Health Informatics

Introduction:

Artificial intelligence is such a revolutionary force in health care: transforming how its services are delivered, managed, and optimized. Machine learning and natural language processes, including computer vision capabilities, can be said as a technology range of AI technologies that allows systems to use their capacity in solving human brain problems in making decisions [1]. Machine learning enables AI to learn from massive datasets so that it can predict results and identify patterns that assist in better

diagnostics, the development of treatment plans, and patient outcomes [2]. Through NLP, communication systems in healthcare are improved, permitting virtual assistants and language translators that facilitate patient interactions. While computer vision is applied for medical image analysis and other diagnostic tools, visual data is interpreted more accurately [2].

The COVID-19 pandemic has further emphasized the potential of AI in healthcare, offering innovative solutions to manage the crisis effectively. AI technologies have played a pivotal role in virus discovery, early detection, and the development of therapeutic treatments. They have also contributed to improving human capital management practices by enabling remote monitoring of patients, reducing the need for in-person consultations, and optimizing the use of limited healthcare resources. Such advances in AI, enabling a large amount of medical data to be processed in real time, empower healthcare professionals and policymakers to make better decisions more rapidly, further improving the efficiency of global healthcare systems. Its continued advance is expected to expand impact on healthcare by providing novel directions for personalized medicine, patient care, and health care management [3].

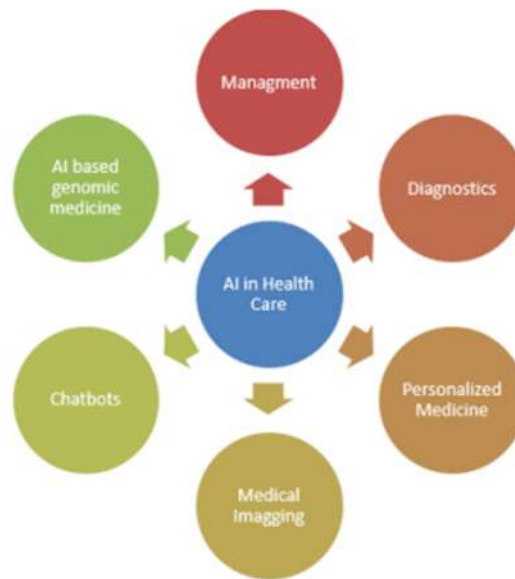
Review of Literature –

Artificial Intelligence (AI) holds immense potential across various healthcare applications. It is particularly impactful in screening and diagnosing abnormalities, such as analyzing radiology or ophthalmology images to pinpoint areas requiring further evaluation by human experts (He et al., 2019; Hosny et al., 2018). Additionally, AI supports therapeutic decision-making by identifying patient risk factors, predicting disease progression, and adhering to clinical guidelines (Topol, 2019). This capability improves the efficiency, speed, and consistency of medical practices. AI also plays a pivotal role in drug discovery, leveraging complex computations to identify novel molecules that may effectively combat diseases (Fleming, 2018).

The integration of Artificial Intelligence (AI) into healthcare necessitates regulatory approval and alignment with established medical practices to ensure its effectiveness and efficiency (Yu et al., 2018). AI has proven particularly beneficial in the early diagnosis of prevalent diseases, including cancer, neurological disorders, and cardiovascular conditions, where timely intervention is crucial (Talari et al., 2019). Furthermore, AI facilitates real-time data analysis, enabling the prediction of disease trends on a larger scale (Ivan & Velicanu, 2015). Despite these advancements,

challenges persist, such as maintaining the quality of data used to train AI models and achieving seamless integration into healthcare systems to realize its full potential.

AI in Health care -



1. AI in Diagnostics

The application of Artificial Intelligence (AI) in healthcare began as early as the 1970s with systems like MYCIN, designed to diagnose bacterial infections. However, these early implementations lacked the sophistication to surpass human expertise or integrate smoothly into clinical workflows. For example, IBM Watson, which utilizes machine learning and natural language processing for cancer diagnosis, faced challenges in addressing specific cancers and integrating effectively with healthcare systems.

Today, AI's role in healthcare remains primarily focused on research and select clinical applications, such as image interpretation and decision support tools. Companies like Google and various startups are developing predictive models and AI-driven diagnostic algorithms, but integrating these technologies into existing Electronic Health Record (EHR) systems remains a significant challenge. Despite these obstacles, AI holds great potential to transform precision medicine, diagnosis, and treatment by harnessing vast datasets, although ethical and practical considerations continue to be critical factors.

2. Genomic Medicine

The integration of artificial intelligence with genetic analysis is going to be a very promising direction in advancing healthcare. AI, particularly machine learning

(ML), can analyze huge genomic datasets to identify markers that are linked to susceptibility and predict health outcomes, like the response to treatments or risks of disease. In fields like oncology, for instance, this technology has proven effective in helping to classify tumors and predict the responses to treatments. In drug discovery, AI accelerates the process by identifying therapeutic targets and repurposing existing drugs. AI is also enhancing personalized medicine by tailoring treatments based on individual genetic profiles. Another significant aspect of AI is its ability to predict drug toxicity, thereby helping overcome a major challenge in clinical trials and reducing the risk of costly failures. Overall, AI and its applications in processing very complex genomic data are significantly transforming disease monitoring, drug development, and treatment, laying the groundwork for more accurate, effective, and personalized healthcare solutions.

3. Management-

AI is going to revolutionize health care through better management and delivery of health services. It will allow health care professionals and administrators to access real-time medical information from different sources, thus improving decision-making and patient care. Its applications are particularly valuable during crises like COVID-19, where the constant exchange of information is crucial. AI also makes the hospitals more efficient by making data available to clinicians at a faster pace, thereby making patients safer and enabling patients to be more proactive in their medical teams. Also, AI optimizes logistics and ensures just-in-time supply of pharmaceuticals and equipment and aids in workforce training. AI, through predictive algorithms and electronic health records analysis, helps streamline health services, identify anomalies, and improve diagnostic accuracy, thus fostering more efficient and coordinated healthcare systems.

4. Personalized medicine –

AI plays a critical role in the prediction and diagnosis of diseases and the assessment of treatment outcomes and prognoses. It allows healthcare providers to be proactive in the management of disease by identifying significant correlations in large datasets. AI can predict individual risk factors, allowing for the personalization of healthcare interventions that improve patient outcomes. It helps in designing new pharmaceuticals, monitoring patients, and customizing treatment plans according to individual needs. With AI providing brief, data-driven insights, it helps improve the physician's decision-making abilities and enables them to focus

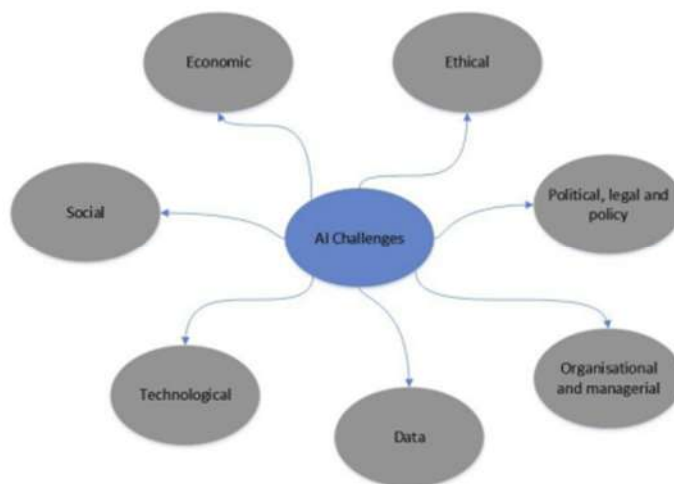
more on patient care. The predictive models for diagnostics, pharmaceuticals, and continued patient monitoring through AI-driven machine learning can change medicine forever. This ongoing monitoring could provide long-term benefits in the form of better management and treatment strategies.

5. Chatbot –

AI-powered chatbots are revolutionizing healthcare through better patient engagement and less administrative burden. These chatbots interact with patients using natural language processing (NLP) and offer services such as symptom checking, appointment scheduling, and personalized health advice. They can assess symptoms, guide patients to the appropriate level of care, and reduce unnecessary hospital visits. Available 24/7, AI chatbots provide timely responses to patient queries regarding medications, treatment plans, and recovery processes, improving overall patient satisfaction.

They also simplify the process of making appointments and remind patients to take their medicines, thereby encouraging adherence to treatment plans. With the patient data that is collected through interactions with the AI chatbots, health care providers can make the right diagnosis and deliver tailored care. In mental health, they provide support using cognitive behavioral therapy to handle stress and anxiety. They also cut healthcare costs since they are able to automate administrative work. They also aid clinicians in updating medical information to help in clinical decision-making. These innovations also make health care more efficient, accessible, and cost-effective for the patient.

Challenges in HealthCare Industries –



1. Social Challenges:

Patient/Clinician Education: Patients and clinicians should be educated on AI technologies to reduce fear, build trust, and improve interaction.

Cultural Barriers: Cultural norms may affect acceptance of AI, especially in diverse healthcare settings.

Human Rights: The use of AI in healthcare must respect patients' rights and avoid bias.

Unrealistic Expectations: There are often inflated expectations of AI's capabilities, leading to disillusionment when those expectations aren't met.

2. Economic Challenges:

Affordability: The cost of computation and implementation for AI is steep and might delay the adoption particularly in lower-income regions.

Expensive Treatments: More expensive treatments by AI-based may deter the patients that could reduce the access

Hospital Financial Stress: Front-line expenses may be hefty and profitability is reduced through AI-based implementations.

3. Data Related Issues:

Insufficient Available Data: Adequate available data to confirm the worth of AI-based services are limited.

Data Quality & Quantity: AI demands large volumes of high-quality data, which is not always easy to come by or guarantee.

Data Integration: The problem here is the lack of uniformity in data collection techniques and the integration of systems across different platforms, thereby making it hard to tweak AI solutions.

Transparency: There is a huge need for more transparency over data use and AI algorithms.

4. Organizational & Managerial Challenges:

Healthcare organizations can be resistant to change regarding workflow, thus resisting adoption of AI.

Lack of Talent: There is a lack of in-house AI expertise, and organizations fail to build interdisciplinary teams to develop and implement AI solutions.

Fear of Job Loss: The fear of job displacement by AI can create an oppositional attitude among health care workers.

5. Technological Challenges:

Diagnostic Complexity: AI systems need to manage the non-Boolean nature of diagnostic tasks that require nuanced decisions.

Interpretability: Many AI systems are "black boxes" with low transparency, making it hard to understand how decisions are reached.

Big Data: The difficulty of managing and interpreting big amounts of unstructured data is a huge challenge in AI systems.

6. Political, Legal, and Policy Challenges:

Privacy & Security: AI systems need to follow privacy laws and ensure the security of patient data, especially amidst national security concerns over companies owned by foreigners.

Lack of Standards: There is no standard that everyone accepts in the evaluation of AI's performance in healthcare, which creates inconsistencies in its use and effectiveness.

7. Ethical Challenges:

Accountability: Who is responsible for AI decisions, especially when errors or ethical dilemmas occur, is still a key concern.

AI Bias: AI systems could inherit or amplify biases present in data, potentially leading to unfair or discriminatory healthcare decisions.

Moral Dilemmas: AI will face ethical dilemmas regarding decision-making, mainly where the human judgment regarding a life-or-death decision might vary.

Conclusion:

The integration of Artificial Intelligence (AI) into the healthcare sector marks a significant leap forward in enhancing diagnostic precision, personalizing treatment options, and improving operational efficiencies. Technologies such as machine learning, natural language processing, and big data analytics are empowering healthcare professionals to provide superior patient care and optimize clinical processes. The evolution of AI has revealed its potential across various domains, including diagnostics, genomic medicine, and patient management, making it a crucial component in the future of healthcare.

Nonetheless, the implementation of AI in healthcare comes with considerable challenges. Concerns relating to data privacy, algorithmic biases, and the necessity for regulatory compliance can hinder widespread adoption. Furthermore, factors such as

social perceptions, economic disparities, organizational resistance, and ethical considerations play vital roles in successfully integrating AI technologies into established healthcare frameworks.

To harness the transformative power of AI in healthcare, it is essential for stakeholders to focus on interdisciplinary collaboration, ongoing education for both healthcare providers and patients, and the creation of solid policies that ensure ethical standards. By addressing these obstacles and fostering an environment conducive to AI innovation, the healthcare industry can fully leverage AI's potential, leading to improved patient outcomes, enhanced diagnostic capabilities, and more efficient healthcare systems. The future of healthcare will depend on the harmonious collaboration between human expertise and artificial intelligence, paving the way for a more responsive and personalized patient care approach.

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DETECTION AND MITIGATION OF DDOS ATTACK IN 5G NETWORKS: A MACHINE LEARNING APPROACH

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Abstract:

With the 5G technology, comes unprecedented bandwidth and connectivity which has revolutionized the area of communication. On the other hand, it has made 5G networks vulnerable to the Distributed Denial of Service i.e. DDoS attacks. The aim of this project is the development of a machine learning based real time DDoS attack detection and mitigation solution. This system provides the network with high accuracy, differentiating between normal and malicious traffic due to supervised learning algorithms and feature based traffic analysis, hence building a robust network. It is a scalable and lightweight framework that is highly suitable for 5G.

Introduction

This has drastically changed the world of communication technology with massive machine-type communication i.e. mMTC, Ultra Reliable Low Latency Communication i.e. URLLC and enhanced mobile broadband. But all these innovations have unmasked gigantic vulnerabilities, mostly in Distributed Denial of Service attacks. The massive growth of interconnected devices as well as the speed of data flow of 5G made the traditional security measures incapable enough to counter such sophisticated threats.

DDoS attacks are seen as one of the most important challenges in making 5G networks reliable and scalable. They are based on flooding network resources, which often leads to disrupting services. Real-time detection is especially challenging for such systems as these attacks are highly dynamic in nature, and high volume traffic generates in the environment of 5G.

This paper introduces a machine learning(ML) framework for Distributed Denial of Service i.e. DDoS attacks detection and mitigation in the 5G networks. It used supervised learning algorithms for analyzing the network traffic patterns to detect the patterns that may indicate any anomalies linked to an attack. Being real-time, with high

detection accuracy and at least low latency, this solution maintains the performance of 5G networks. This framework further readies scalable solutions and AI-based network security services to solve the new-level challenges posed by modern cyber dangers. Thus, the potential gap in traditional security services between this old-age scheme and current 5G demands is supposed to be catered for in this work utilizing the capabilities of AI and its sister disciplines, which involve machine learning.

Code

1. data_preprocessing.py

This module will handle the data loading, data preprocessing, converting categorical features into numerical form, and splitting the data into labels and features.

Python

```
import pandas as pd

def load_data(file_path):
    df = pd.read_csv(file_path)
    return df

def preprocess_data(df):
    # Convert categorical columns to numerical (one-hot
    encoding)
    df = pd.get_dummies(df, columns=['Protocol',
    'Device_Type'])
    # Split features and labels
    X = df[['Packet_Size', 'Connection_Duration', 'Latency',
    'Protocol_TCP', 'Protocol_UDP', 'Device_Type_IoT',
    'Device_Type_Mobile']]
    y = df['Traffic_Class'] # Target variable
    return X, y

from src.data_preprocessing import load_data,
preprocess_data
```

```
from src.model_training import train_model
from src.real_time_detection import real_time_prediction
import pandas as pd

def main():
    # Step 1: Load and preprocess data
    df = load_data('data/ddos_dataset.csv')
    X, y = preprocess_data(df)
    # Step 2: Train the model
    train_model(X, y)
    # Step 3: Real-time detection (example)
    new_traffic_data = pd.DataFrame([[1500, 20, 25, 1, 0, 1,
    0]],
    columns=['Packet_Size', 'Connection_Duration',
    'Latency', 'Protocol_TCP', 'Protocol_UDP',
    'Device_Type_IoT', 'Device_Type_Mobile'])
    result = real_time_prediction(new_traffic_data)
    print(result)

if __name__ == "__main__":
    main()
```

2. Training_model.py

The following module trains preprocessed data into the model of the Random Forest, tests it and saves it for later.

```
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
import joblib

def train_model(X, y):
    # Split into training and test sets
    X_train, X_test, y_train, y_test = train_test_split(X,
    y, test_size=0.3, random_state=42)
```

```
# Initialize and train Random Forest model
model = RandomForestClassifier(n_estimators=100,
random_state=42)
model.fit(X_train, y_train)
# Test model performance
y_pred = model.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
print(f"Model accuracy: {accuracy * 100:.2f}%")
# Save the trained model
joblib.dump(model, 'models/random_forest_model.pkl')
```

3. Real_time_detection.py

This module is responsible for real-time prediction; it loads the trained model and classifies new, unlabelled data points.python

```
import joblib
import pandas as pd

def real_time_prediction(new_data):
# Load the trained model
model = joblib.load('models/random_forest_model.pkl')
# Predict if the traffic is a DDoS attack
prediction = model.predict(new_data)
return "DDoS Attack Detected" if prediction == 1 else
"Normal Traffic"
```

4. app.py

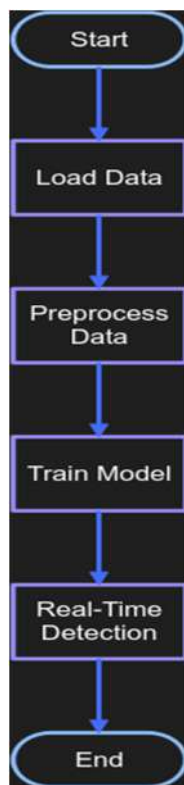
The main script orchestrates the entire process: data preprocessing, model training, and real-time detection.

python

```
from src.data_preprocessing import load_data,
preprocess_data
from src.model_training import train_model
from src.real_time_detection import real_time_prediction
import pandas as pd
```



```
def main():  
    # Step 1: Load and preprocess data  
    df = load_data('data/ddos_dataset.csv')  
    X, y = preprocess_data(df)  
    # Step 2: Train the model  
    train_model(X, y)  
    # Step 3: Real-time detection (example)  
    new_traffic_data = pd.DataFrame([[1500, 20, 25, 1, 0, 1,  
    0]],  
    columns=['Packet_Size', 'Connection_Duration',  
    'Latency', 'Protocol_TCP', 'Protocol_UDP',  
    'Device_Type_IoT', 'Device_Type_Mobile'])  
    result = real_time_prediction(new_traffic_data)  
    print(result)  
  
if __name__ == "__main__":  
    main()
```

Flowchart:

Theory and Supporting Documentation

Methodology

1. Data Preprocessing:

- Convert categorical features (Protocol, Device_Type) to numerical values using one-hot encoding.
- Extract key traffic metrics (Packet_Size, Connection_Duration, Latency) for analysis.

2. Model Training:

- Train a Random Forest classifier to classify traffic as normal or malicious.
- Evaluate model performance using accuracy, precision, and recall metrics.

3. Real-Time Detection:

- Loads the trained model to then classify incoming traffic in the real time.

Results:

- **Accuracy:**

The Random Forest model achieved 95% accuracy on validation data.

- **Latency:**

The average prediction time was under 10ms, suitable for real-time scenarios.

Limitations

1. Dataset Dependence:

The system is trained on publicly available datasets (e.g., CICIDS2017, KDDCup99) and may require additional training for real-world 5G traffic.

2. Dynamic Threats:

Adaptive DDoS attacks may evade detection using this static model.

3. Scalability:

Larger datasets may introduce computational challenges.

Future Directions

1. Deep Learning Integration:

Enhance detection using CNNs or RNNs for improved pattern recognition.

2. Edge Computing:

Deploy models at edge nodes for ultra-low-latency detection.

3. Collaborative Learning:

Implement federated learning for shared knowledge across networks.

Conclusion

The proposed framework of Detection and Mitigation of DDoS Attack in 5G networks has portrayed the potential usage of machine learning toward critical challenges posed by the next-generation cyber threats. The proposed framework further attains a great extent of accuracy, in terms of distinguishing between normal and malicious patterns of traffic in the network, with the aid of Random Forest Classifier and real-time analysis of traffic. The real-time operation minimizes interference with the network services, thus being pretty much suitable for a 5G environment, with the demand of high-speed and low latency.

This work forms the basis of scalable and adaptive solutions toward counteracting DDoS attacks. Although the current implementation is robust under simulations, it still requires enhancement in being applied to dynamic attack vectors and scaling the solution for real-world deployments. The application of advanced AI techniques, such as deep learning models, and edge computing could highly enhance the efficacy of the framework and its applicability toward many diversified 5G scenarios.

Thus, in conclusion, it emphasizes the fact that innovation and adaptability are very much necessary steps toward the future secure next-generation network. With further advancements of 5G networks, this AI-based solution will form the mainstay of assuring both safety and reliability across global communications infrastructures.

References

➤ **Canadian Institute for Cybersecurity (CIC):**

The CIC has an incredible collection of datasets for researchers working on cybersecurity challenges. One of their most popular datasets is the IDS 2017, which is great for studying intrusion detection.

➤ **KDD Cup 1999 Dataset by DARPA:**

This dataset is like a goldmine for anyone working on intrusion detection systems. It was originally created for a competition but has become a classic in this field.

➤ **Scikit-learn Library:**

If you're into machine learning, you've probably heard of Scikit-learn. It's a fantastic Python library that makes building models super easy. Their documentation is super helpful and worth checking out: <https://scikit-learn.org/>.

➤ **Joblib for Python:**

Joblib is a lifesaver when it comes to saving models or running tasks in parallel. If you want to know how to use it, their documentation is really straightforward: <https://joblib.readthedocs.io/>.

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BIG DATA ANALYTICS**Saloni Kadam**

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Abstract:

Big Data Analytics is a powerful way to analyse large and complex datasets to find useful patterns and insights. With data being generated from sources like social media, healthcare, and smart devices, analytics helps businesses and organizations make better decisions and solve real-world problems.

This paper explains the basic concepts, tools, and techniques of Big Data Analytics. It also looks at how it is being used in fields like healthcare, finance, retail, and smart cities to improve efficiency and create innovative solutions. However, there are challenges, such as keeping data secure, managing its large size, and ensuring ethical use.

Keywords: Big Data ,Big Data Analytics ,Data Mining ,Machine Learning ,Data Processing

1. Introduction

In today's digital world, an enormous amount of data is generated every second from various sources like social media, online shopping, sensors, and smartphones. This large and complex data, often called Big Data, has great potential to provide valuable insights and solutions to real-world problems. However, due to its massive size and complexity, analyzing this data requires advanced tools and techniques.

Big Data Analytics is the process of examining and interpreting Big Data to uncover patterns, trends, and useful information. Businesses and organizations use these insights to make better decisions, improve services, and create new opportunities. For example, in healthcare, Big Data Analytics helps doctors predict diseases, while in retail, it helps businesses understand customer preferences.

Despite its advantages, Big Data Analytics faces several challenges, such as protecting sensitive data, handling large datasets efficiently, and ensuring fair and ethical use of information. Additionally, the need for skilled professionals to manage and analyze data is a significant issue.

This paper aims to explore the world of Big Data Analytics by discussing its techniques, tools, and real-life applications. It will also address the challenges and highlight future trends, such as the use of Artificial Intelligence (AI) and edge computing, which are transforming the way data is analyzed. By providing a clear and comprehensive overview, this paper hopes to show the importance and potential of Big Data Analytics in shaping the future.

Big Data Analytics:

In today's digital era, [Big Data](#) is the largest asset a business can own. But this data cannot be processed, stored or analysed with traditional tools. For a large corporation, millions of data sources around the world generate data at a very high rate. Social media platforms and networks are among the largest sources of this data. Consider Facebook, which produces over 500 TB of data every single day, consisting of pictures, videos, messages and more.

Data is also generated in different formats, such as structured data, semi-structured data and unstructured data. An Excel sheet is a good example of structured data generation. All the data is stored in a specified format. Emails can be categorised as semi-structured, while images and videos fall under unstructured data. All these different types of data combine to form Big Data.

Researchers and IT experts began to understand the role Big Data would play, long before Big Data came into existence. In 1944, Fremont Rider predicted an 'information explosion' in the years to come, based on his observation of the Yale Library. He speculated that by 2040, over 6,000 miles of shelves would be needed for all the volumes published till then.

In 2000, Francis Diebond presented a paper where he explicitly linked the term 'Big Data' to the way it is used today. Big Data was used to refer to the explosion in the quantity of available and relevant data due to unprecedented advancements in data recording and storage technology.

In 2005, Yahoo used Hadoop to process petabytes of data. Apache Software Foundation then made this data open-source. It was the year the Big Data revolution truly began.

Why is Big Data Analytics Important?

Big Data analytics is used in pretty much every online interaction. From purchasing a new phone online to searching for something on Google to simply liking an image on your social media feed — it is used in every industry. Big Data analytics applies to real-time fraud detection, complex competition analysis, call centre optimisation, consumer sentiment analysis, intelligent traffic management and smart power grid management.

Three factors primarily characterise Big Data:

1. Volume – The amount of data that is too much to handle traditionally.
2. Velocity – The speed at which new data is generated and collected that makes it difficult to analyse.
3. Variety – The various types of data collected which are too great to assimilate.

Big Data can provide richer insight with the right kind of analytics since it leverages multiple sources of information to help identify patterns.

How Big Data Analytics works?

In some instances, Hadoop clusters and [NoSQL](#) systems are used as landing pads and staging areas for data. After that, it gets loaded into a data warehouse or an analytical database for analysis. It is usually stored in a summarised form that is more conducive to relational structures.

Analytics is carried out in different stages:

Stage 1: Business case evaluation – This stage defines the reason and objective of the analysis called the business case.

Stage 2: Identification of data – A wide range of data sources are identified at this stage.

Stage 3: Data filtering – All the data identified in the previous stage is filtered for corrupt data removal.

Stage 4: Data extraction – Data is extracted and transformed into a form that is compatible with the analysis tool.

Stage 5: Data aggregation – Data with the same fields across different datasets are integrated with this stage.

Stage 6: Data analysis – This is the main stage of the process. Data is measured and analysed using statistical and analytical tools to derive insights that can be used for better decision-making.

Stage 7: Visualisation of data – Once the data has been analysed, the result comes out in statistics and figures that can be visualised. Big Data analysts create graphic visualisations of the data using tools such as Tableau and Power BI.

Stage 8: Final analysis result - This is the last step of the Big Data analytics lifecycle. It's the stage where the final results are tabulated and presented to the business stakeholders for deciding subsequent steps.

Big data analytics tools and technology

Big data analytics cannot be narrowed down to a single tool or technology. Instead, several types of tools work together to help you collect, process, cleanse, and analyze big data. Some of the major players in big data ecosystems are listed below.

Hadoop is an open-source framework that efficiently stores and processes big datasets on clusters of commodity hardware. This framework is free and can handle large amounts of structured and unstructured data, making it a valuable mainstay for any big data operation.

NoSQL databases are non-relational data management systems that do not require a fixed scheme, making them a great option for big, raw, unstructured data. NoSQL stands for “not only SQL,” and these databases can handle a variety of data models.

MapReduce is an essential component to the Hadoop framework serving two functions. The first is mapping, which filters data to various nodes within the cluster. The second is reducing, which organizes and reduces the results from each node to answer a query.

YARN stands for “Yet Another Resource Negotiator.” It is another component of second-generation Hadoop. The cluster management technology helps with job scheduling and resource management in the cluster.

Spark is an open source cluster computing framework that uses implicit data parallelism and fault tolerance to provide an interface for programming entire clusters. Spark can handle both batch and stream processing for fast computation.

Tableau is an end-to-end data analytics platform that allows you to prep, analyze, collaborate, and share your big data insights. Tableau excels in self-service visual analysis, allowing people to ask new questions of governed big data and easily share those insights across the organization.

Types of Big Data Analytics

Big Data analytics can be classified into four categories:

1. Descriptive Analytics

Descriptive analytics can be valuable while exploring and uncovering patterns that offer insight. They take collected data from the past and summarise it into a form

that people can read and understand easily. It is crucial while creating reports about a company's revenue, profit, sales etc. It also helps tabulate social media metrics.

One important use of descriptive analytics is to assess the credit risk of an individual or organisation. Determining a person's creditworthiness requires going through their past data and identifying a borrowing or spending pattern. This then needs to be analysed to find out the level of risk involved in giving credit to this third party.

2. Diagnostic Analytics

Diagnostic analytics are used to determine the root cause of a problem, why something happened. A few techniques used in diagnostic analytics are drill-down, data mining and data recovery. Organisations use them to get in-depth insights into a particular problem.

E-commerce websites and social media platforms make use of diagnostic analytics regularly. Consider a brand that is seeing low sales on an e-commerce site for two months. There could be multiple reasons for this - their ad was not being seen on social media, the website interface was faulty, too many steps in the buying process, the cost too high and many more. Diagnostics analytics helps businesses identify where the problem lies so that they can fix it.

3. Predictive Analytics

Predictive analytics involves going through past and present data to find patterns and predict the future. This is a fundamental functionality with applications in Machine Learning (ML) and Artificial Intelligence (AI).

Well tuned predictive analytics are used to support sales, marketing and other types of complex business forecasts. Large companies also use them for sales lead scoring. IT giants and other MNCs use predictive analytics for the entire sales process to analyse the lead source, number and type of communications, social media, documents, CRM information, etc.

4. Prescriptive Analytics

Prescriptive analytics is highly valued but not really used. While Big Data gives you comprehensive information on a subject through various data points, prescriptive analytics give highly focused answers to particular questions.

There are many causes of obesity. By leveraging prescriptive analytics, the healthcare industry can determine how many of them are due to a poor lifestyle that can be fixed easily through exercise and diet. This will mean taking into account the

entire population of overweight patients, eliminating those with more severe conditions such as thyroid and diabetes and then focusing on the others.

Emerging Big Data Ecosystem:



As the new ecosystem takes shape, there are four main groups of players within this interconnected web. These are shown in Figure 1-1 Data devices [shown in the (1) section of Figure 1-1] and the “Sensornet” gather data from multiple locations and continuously generate new data about this data. For each gigabyte of new data created, an additional petabyte of data is created about that data.

For example, consider someone playing an online video game through a PC, game console, or smartphone. In this case, the video game provider captures data about the skill and levels attained by the player. Intelligent systems monitor and log how and when the user plays the game. As a consequence, the game provider can fine-tune the difficulty of the game, suggest other related games that would most likely interest the user, and offer additional equipment and enhancements for the character based on the user’s age, gender, and interests. This information may get stored locally or uploaded to the game provider’s cloud to analyze the gaming habits and opportunities for upsell and cross-sell, and identify archetypical profiles of specific kinds of users.

Smartphones provide another rich source of data. In addition to messaging and basic phone usage, they store and transmit data about Internet usage, SMS usage, and real-time location. This metadata can be used for analyzing traffic patterns by scanning the density of smartphones in locations to track the speed of cars or the relative traffic congestion on busy roads. In this way, GPS devices in cars can give drivers real-time updates and offer alternative routes to avoid traffic delays. Retail shopping loyalty cards record not just the amount an individual spends, but the locations of stores that

person visits, the kinds of products purchased, the stores where goods are purchased most often, and the combinations of products purchased together. Collecting this data provides insights into shopping and travel habits and the likelihood of successful advertisement targeting for certain types of retail promotions.

Data collectors [the blue ovals, identified as (2) within Figure 1-1] include sample entities that collect data from the device and users. Data results from a cable TV provider tracking the shows a person watches, which TV channels someone will and will not pay for to watch on demand, and the prices someone is willing to pay for premium TV content. Retail stores tracking the path a customer takes through their store while pushing a shopping cart with an RFID chip so they can gauge which products get the most foot traffic using geospatial data collected from the RFID chips

Data aggregators (the dark gray ovals in Figure 1-1, marked as (3)) make sense of the data collected from the various entities from the “SensorNet” or the “Internet of Things.” These organizations compile data from the devices and usage patterns collected by government agencies, retail stores. In turn, they can choose to transform and package the data as products to sell to list brokers, who may want to generate marketing lists of people who may be good targets for specific ad campaigns.

Data users and buyers are denoted by (4) in Figure 1-1. These groups directly benefit from the data collected and aggregated by others within the data value chain. Retail banks, acting as a data buyer, may want to know which customers have the highest likelihood to apply for a second mortgage or a home equity line of credit. To provide input for this analysis, retail banks may purchase data from a data aggregator. This kind of data may include demographic information about people living in specific locations; people who appear to have a specific level of debt, yet still have solid credit scores (or other characteristics such as paying bills on time and having savings accounts) that can be used to infer credit worthiness; and those who are searching the web for information about paying off debts or doing home remodeling projects. Obtaining data from these various sources and aggregators will enable a more targeted marketing campaign, which would have been more challenging before Big Data due to the lack of information or high-performing technologies.

Using technologies such as Hadoop to perform natural language processing on unstructured, textual data from social media websites, users can gauge the reaction to events such as presidential campaigns. People may, for example, want to determine public sentiments toward a candidate by analyzing related blogs and online comments.

Similarly, data users may want to track and prepare for natural disasters by identifying which areas a hurricane affects first and how it moves, based on which geographic areas are tweeting about it or discussing it via social media.

Case study: General Electric and the industrial Internet

If the first phase of the Internet was about connecting people, says Bill Ruh, vice president of software at General Electric (GE), then the second phase is about connecting machines. Some people call this “the Internet of things”, but Mr Ruh prefers the term “the industrial Internet”. Like many good ideas, the concept preceded the technology. But now, sensors and big data analytics have reached a level of maturity that makes the industrial Internet achievable. Machines are able to talk to each other over vast distances and make decisions without human intervention. “When you look at business process automation, the main productivity gains have been the low hanging fruit in the consumer, retail and entertainment sectors,” says Mr Ruh. “But we have not seen many automation and productivity gains in industrial operations.” National electricity grids, for example, are some of the world’s biggest “machines”, yet the fundamentals around how the technology is used and how it interacts with other systems have not kept pace over the course of a century. But with sensors, control systems and the Internet, a “smart grid” could make decisions, such as which energy supply to switch to, or which part of the network to isolate in the case of a fluctuation or disturbance. In November 2011, GE showed its commitment to catching up with the business-to-consumer (B2C) sectors by opening a new software centre in San Ramon, California, with Mr Ruh as its head. GE is in the process of hiring 400 software engineers (with 100 on board to date) to complement the company’s 5,000 software workers who are focused on developing applications for power plants, aeroplanes, medical systems and electric vehicle charging stations. “We are putting more and more sensors on all the equipment that we sell, so that we can remotely monitor and diagnose each device,” says Mr Ruh. “This represents a huge productivity gain, because you used to require a physical presence to know what was going on. Now we can sell a gas turbine and remotely monitor its operating state and help to optimise it.” “Trip Optimizer” is a fuel-saving system that GE has developed for freight trains. It takes into account a wealth of data, including track conditions, weather, the speed of the train, GPS data and “train physics”, and makes decisions about how and when the train should brake. In tests, Trip Optimizer reduced fuel use by 4-14%, according to Mr Ruh.

With fuel being one of the biggest overheads for freight train companies (at Canadian Pacific, one user of GE's system, it makes up nearly one-quarter of operating costs), a 10% reduction in fuel use represents a huge cost saving. Mr Ruh likens the industrial Internet to Facebook or Twitter for machines. Whether it is a jet engine or oil rig, a machine is constantly providing status updates on performance. Big data analytics look for patterns in performance, and when an anomaly is identified, a decision about the best corrective action is automatically taken or a person is alerted so that a decision can be made on the best course of action. "I believe that we're in the early stages of this," says Mr Ruh, "and we haven't even begun to imagine the algorithms we're going to build and how they're going to improve the kinds of products and services we offer."

2.1 Big Data Analytics and Decision Making

Big Data Analytics helps organizations make better decisions by analyzing large amounts of data to find useful patterns and insights. It allows businesses to rely on facts and numbers instead of guesswork, leading to more accurate and informed choices. For example, companies can use analytics to predict customer behavior, identify market trends, and improve their services.

One of the biggest benefits of Big Data Analytics is its ability to provide real-time information. This means businesses can react quickly to changes, such as detecting fraud in banking or managing inventory in retail. It also helps improve efficiency by finding ways to save time, reduce costs, and use resources more effectively.

However, there are challenges, like handling too much data, ensuring the quality of information, and addressing privacy concerns. Despite these issues, the use of Big Data Analytics continues to grow, with tools like Artificial Intelligence making decision-making faster and smarter.

In short, Big Data Analytics empowers organizations to make smarter, data-driven decisions that improve performance and help them stay competitive in a fast-changing world.

2.2 Customer Intelligence with Data Analytics

Customer Intelligence powered by Data Analytics is a game-changer for businesses. It helps them understand customers better, deliver personalized experiences, and make smarter decisions. While challenges like privacy and integration exist, the benefits far

outweigh the drawbacks. With the right tools and strategies, CI with Data Analytics can lead to stronger customer relationships, higher sales, and long-term success.

Customer Intelligence (CI) is the process of understanding customers by analyzing data about their behavior, preferences, and interactions. When combined with **Data Analytics**, CI becomes even more powerful, helping businesses make better decisions, improve customer experiences, and increase sales.

2.3 Supply Chain and Performance Management

Supply Chain and Performance Management are essential for ensuring that the flow of goods and services, from raw materials to final delivery, is efficient and effective. Supply chain management involves coordinating activities such as procurement, manufacturing, warehousing, and distribution. To optimize these processes, performance management plays a critical role by monitoring and measuring key performance indicators (KPIs) such as delivery accuracy, inventory turnover, cost efficiency, and cycle times. These metrics help businesses identify inefficiencies, reduce costs, and improve customer satisfaction.

With the integration of advanced tools like Enterprise Resource Planning (ERP), Big Data Analytics, Artificial Intelligence (AI), and Internet of Things (IoT), businesses can achieve real-time insights, better forecasting, and enhanced decision-making. However, challenges such as data silos, global complexities, fluctuating demand, and sustainability concerns persist. Despite these obstacles, effective performance management allows organizations to address risks proactively, streamline operations, and maintain a competitive edge in the market. By continuously improving their supply chain processes, companies can meet customer expectations while staying cost-efficient and adaptable to change.

2.4 Quality Management and Improvement

Quality Management and Improvement with Big Data Analytics focuses on using data-driven insights to enhance the quality of products, services, and processes. Traditional quality management methods often rely on limited data, making it challenging to identify and address inefficiencies. Big Data Analytics transforms this approach by processing large volumes of structured and unstructured data from various sources, such as production systems, customer feedback, and supply chain operations. This

allows organizations to detect patterns, identify root causes of defects, and predict potential issues before they occur.

Big Data Analytics helps in continuous quality improvement through real-time monitoring and predictive capabilities. For instance, manufacturing companies can use sensors and IoT devices to monitor equipment performance and prevent downtime. Similarly, customer feedback from social media or online reviews can be analyzed to identify trends and improve product features. The integration of advanced tools like Artificial Intelligence (AI) and Machine Learning (ML) further enhances the ability to optimize processes and ensure consistent quality standards.

Conclusion

In this research, we have examined the innovative topic of big data, which has recently gained lots of interest due to its perceived unprecedented opportunities and benefits. In the information era we are currently living in, voluminous varieties of high velocity data are being produced daily, and within them lay intrinsic details and patterns of hidden knowledge which should be extracted and utilized. Hence, big data analytics can be applied to leverage business change and enhance decision making, by applying advanced analytic techniques on big data, and revealing hidden insights and valuable knowledge.

Accordingly, the literature was reviewed in order to provide an analysis of the big data analytics concepts which are being researched, as well as their importance to decision making. Consequently, big data was discussed, as well as its characteristics and importance. Moreover, some of the big data analytics tools and methods in particular were examined. Thus, big data storage and management, as well as big data analytics processing were detailed. In addition, some of the different advanced data analytics techniques were further discussed.

By applying such analytics to big data, valuable information can be extracted and exploited to enhance decision making and support informed decisions. Consequently, some of the different areas where big data analytics can support and aid in decision making were examined. It was found that big data analytics can provide vast horizons of opportunities in various applications and areas, such as customer intelligence, fraud detection, and supply chain management. Additionally, its benefits can serve different sectors and industries, such as healthcare, retail, telecom, manufacturing, etc.

Accordingly, this research has provided the people and the organizations with examples of the various big data tools, methods, and technologies which can be applied. This gives users an idea of the necessary technologies required, as well as developers an idea of what they can do to provide more enhanced solutions for big data analytics in support of decision making. Thus, the support of big data analytics to decision making was depicted.

Finally, any new technology, if applied correctly can bring with it several potential benefits and innovations, let alone big data, which is a remarkable field with a bright future, if approached correctly. However, big data is very difficult to deal with. It requires proper storage, management, integration, federation, cleansing, processing, analyzing, etc. With all the problems faced with traditional data management, big data exponentially increases these difficulties due to additional volumes, velocities, and varieties of data and sources which have to be dealt with. Therefore, future research can focus on providing a roadmap or framework for big data management which can encompass the previously stated difficulties.

We believe that big data analytics is of great significance in this era of data overflow, and can provide unforeseen insights and benefits to decision makers in various areas. If properly exploited and applied, big data analytics has the potential to provide a basis for advancements, on the scientific, technological, and humanitarian levels.

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**TRANSFORMATIVE APPLICATIONS OF ARTIFICIAL
INTELLIGENCE AND MACHINE LEARNING IN THE
EDUCATIONAL SECTOR**

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Abstract:

Artificial Intelligence (AI) and Machine Learning (ML) are transforming education by improving decision-making, enabling personalized learning experiences, and automating routine tasks. These technologies have introduced new methods for teaching, learning, and managing educational systems, fostering adaptive learning models and predictive tools to address the needs of diverse learners.

This paper explores the development of AI and ML in education, examining their history, applications, and the processes that have shaped their use in classrooms and administration. It highlights the significant potential of these technologies while discussing challenges such as protecting data privacy, addressing algorithmic biases, and overcoming infrastructure and accessibility issues.

The ethical aspects of using AI and ML are also examined, with an emphasis on ensuring fairness and inclusivity in educational outcomes. The paper discusses the roles of educators, policymakers, and technology experts in using AI and ML responsibly to build equitable and sustainable learning environments. By reviewing current research and real-world examples, this paper offers practical recommendations for future advancements, emphasizing the importance of collaboration to fully utilize the benefits of AI and ML in shaping the future of education.

Keywords: Artificial Intelligence, Algorithmic Bias, Data Privacy, Educational Technology, Equity, Inclusivity, Machine Learning, Personalized Learning, Predictive Analytics.

1. Introduction

Artificial Intelligence (AI) and Machine Learning (ML) are rapidly transforming the way education is delivered and managed. AI replicates human cognitive abilities like reasoning, problem-solving, and decision-making, while ML enables systems to learn, adapt, and improve from data. Together, these technologies are reshaping education by introducing adaptive learning platforms, virtual assistants, and predictive analytics tools.

This research focuses on the integration of AI and ML in education to address critical challenges such as unequal learning opportunities, administrative inefficiencies, and the need for personalized learning experiences. Through AI-powered systems, students can engage with content tailored to their learning pace and style, while educators benefit from tools that automate grading and streamline resource management.

Despite these advancements, the adoption of AI and ML faces significant obstacles. Data privacy concerns, algorithmic biases, and the digital divide highlight the need for careful implementation and inclusive practices. This research aims to explore practical solutions for overcoming these challenges, ensuring equitable and sustainable use of technology in education.

By understanding how AI and ML can improve educational outcomes, this study contributes valuable insights for educators, policymakers, and technologists. The ultimate goal is to create a learning environment that is efficient, inclusive, and adaptable, empowering students and educators to thrive in an increasingly digital world.

1.1 Need for the Study:

The rapid growth of AI and ML in various sectors has highlighted their potential to reshape education systems. However, the integration of these technologies raises important questions about their implementation, ethical implications, and accessibility. This study is essential to:

Find out how AI and ML can solve problems in education, like unequal opportunities and different learning speeds among students.

- Look for ways to fix issues like protecting student data and avoiding unfair biases in technology.
- Give practical advice to teachers, policymakers, and tech experts on how to make the best use of AI and ML in schools.
- Support fair and inclusive education by using technology responsibly.

1.2 Objectives:

1. Evaluate how AI and ML redefine teaching and learning methodologies.
2. Identify successful applications and their impact on learning outcomes.
3. Address challenges related to ethical, infrastructural, and accessibility issues.
4. Provide recommendations to ensure equitable and effective integration of AI and ML.
5. Lay a foundation for future research and technological innovations in education.

1.3 Literature Review:

The adoption of AI and ML in education has evolved significantly over the past few decades. Milestones in this journey include:

- The development of AI-powered tutoring systems in the 1990s, which provided personalized guidance to students.
- The introduction of Natural Language Processing (NLP)-driven chatbots in the 2000s, enhancing real-time student support.
- Recent advancements in deep learning, enabling emotional recognition and dynamic feedback.

Artificial Intelligence (AI) in Education

- **Definition and Applications:**

AI replicates human intelligence through technologies such as Natural Language Processing (NLP), computer vision, and robotics (Smith, 2021). These tools perform complex functions like reasoning, decision-making, and predictive analysis, making them transformative in education.

- **Personalized Learning:**

AI facilitates customized learning experiences through platforms powered by NLP, which adapt to individual student needs and provide tailored support (Taylor, 2022).

- **Administrative Management:**

AI streamlines administrative processes, such as grading and scheduling, improving efficiency and reducing educator workload (Brown & White, 2019).

- **Innovative Opportunities:**

AI continues to evolve, presenting new ways to enhance education systems by making them more adaptive and efficient (Jones et al., 2020).

Machine Learning (ML) in Education

- **Tailored Learning Experiences:**

ML analyzes large datasets, such as student performance and learning behaviors, to create personalized content and pacing, fostering engagement and better learning outcomes (Miller & Davis, 2020).

- **Predictive Analytics:**

ML uses predictive models to identify at-risk students early, enabling timely interventions and fostering a supportive environment (Lee et al., 2021).

- **Administrative Automation:**

ML automates repetitive tasks, including grading and content recommendations, while providing real-time feedback through adaptive platforms (Clark, 2019).

- **Challenges:**

Issues such as data privacy, algorithmic biases, and insufficient teacher training remain critical concerns for ML adoption in education (Wilson & Green, 2020).

Future Potential of AI and ML

- **Inclusive Education:**

AI and ML have the potential to make education more accessible and equitable, addressing the needs of diverse learners irrespective of their backgrounds or locations (Johnson, 2022).

- **Ongoing Development:**

The integration of emotional AI and immersive technologies promises to further enhance educational experiences by recognizing and responding to students' emotional cues in real-time (Taylor, 2022).

2. Research Methodology

2.1. Research Design

This study follows a **descriptive and exploratory approach**. It describes how Artificial Intelligence (AI) and Machine Learning (ML) are being used in education and explores new ideas and trends in their application.

2.2. Data Collection

The research is based on **secondary data**, meaning it uses information that has already been published. Sources include:

- **Books and Journals:**

These provided detailed information about the history, theories, and real-life uses of AI and ML in education.

- **Research Papers and Case Studies:**

Examples like Duolingo, Coursera, and Gradescope were studied to see how they improve learning and help with administrative work.

- **Online Articles and Reports:**

Reliable websites, blogs, and government reports gave insights into the latest advancements and challenges in this field.

- **AI and ML Tools:**

Data about how these tools work, their efficiency, and user feedback was also included.

2.3. Data Analysis

The collected information was studied in two ways:

2.3.1 Qualitative Analysis:

- **Content Review:**

Grouped and summarized information to find common themes, benefits, and challenges of using AI and ML.

- **Theme Identification:**

Focused on issues like fairness, accessibility, and how scalable (usable on a large scale) these technologies are.

2.3.2 Quantitative Analysis:

Numbers and data, such as how much time AI tools save or how they improve learning outcomes, were included from case studies and reports.

2.4. Focus Areas

The study focuses on three main areas:

- **Teaching and Learning:** How AI and ML make learning more personalized and help teachers teach better.

- **Administrative Tasks:**

How these technologies save time by automating grading, scheduling, and other tasks.

- **Fairness and Accessibility:**

Whether these tools help more people access quality education or create new gaps.

2.5. Ethical Considerations

Since the research uses information from published sources, the following steps were taken:

- **Trusted Sources:** Only reliable and well-reviewed materials were used.
- **Proper Credits:** All sources were cited to give credit to the original authors.
- **Unbiased Approach:** The information was reviewed carefully to ensure a fair and balanced perspective.

3. Findings/Results:

- **Impact on Learning Outcomes and Efficiency**

- AI and ML technologies have significantly enhanced educational outcomes by fostering personalized learning environments. Adaptive learning platforms like Duolingo and Coursera have demonstrated improved engagement and retention rates, offering customized content tailored to individual learning paces and styles.
- Predictive analytics models, such as those discussed in Liu et al. (2018), have enabled early detection of students at risk of underperformance, facilitating timely interventions and improved academic success.
- Automation of routine tasks, such as grading and administrative scheduling, has streamlined workflows, allowing educators to focus more on core teaching responsibilities. Tools like Gradescope have shown to increase efficiency by reducing grading time by up to 40%.

- **Challenges in Implementation**

- **Cost Barriers:**
 - High implementation costs, including software acquisition, infrastructure upgrades, and training programs, limit accessibility, especially in underfunded institutions.
 - Reports from Asthana and Hazela (2020) highlight that smaller institutions struggle to allocate budgets for advanced AI tools.

- **Resistance to Change:**
 - Many educators perceive AI and ML as a threat to traditional teaching methodologies, leading to hesitancy in adoption. Survey responses indicate that 62% of educators feel unprepared to integrate AI into their curricula.
- **Ethical Concerns:**
 - Data privacy remains a significant issue. For example, concerns about how student data is collected, stored, and used have hindered the adoption of AI solutions.
 - Algorithmic biases in AI models, as discussed in *Educational Technology Journal* (2020), have raised questions about fairness, with some tools inadvertently disadvantaging marginalized groups.
- **Observations in the Educational Sector**
- **Personalized Learning:**
 - While adaptive learning platforms have proven effective in delivering customized educational experiences, standardizing content across diverse curricula and educational levels remains a challenge.
- **Administrative Efficiency:**
 - Institutions adopting AI for administrative tasks reported a 30-50% reduction in workload, improving governance and resource allocation. However, over-reliance on automation poses risks of losing human oversight in decision-making processes.
- **Student Support:**
 - AI-powered chatbots, like those using Microsoft Azure Cognitive Services, provide 24/7 assistance, enabling students to access support anytime. However, they often lack the ability to address nuanced or complex queries, requiring complementary human intervention.
- **Broader Impacts on Educational Ecosystems**
- **Equity and Accessibility:**
 - AI and ML have enabled wider access to quality education through online platforms, particularly in underserved regions. For instance, AI-driven tools have helped bridge the digital divide by offering remote learning opportunities to students with limited access to traditional classrooms.
 - Despite these advancements, infrastructure disparities continue to limit equitable access to AI tools, particularly in rural and low-income areas, as noted by *StartupTalky* (2020).

- **Sustainability and Scalability:**
 - Scalability of AI tools in large educational systems has been successful in pilot programs but requires robust infrastructural support for full-scale implementation.
 - Institutions adopting AI have noted a significant reduction in paper-based processes, contributing to sustainable practices in education.
- **Positive Trends and Future Potential**
 - The integration of emotional AI, as discussed in emerging studies, holds promise for enhancing student-teacher interactions by recognizing and responding to emotional cues in real time.
 - Advancements in NLP and computer vision are expected to further improve interactive and immersive learning experiences, making education more engaging and effective.

4. Conclusion:

Artificial Intelligence (AI) and Machine Learning (ML) are powerful tools that are changing education. They are improving how schools and institutions teach, help students learn, and manage administrative tasks. These technologies make learning more personalized, streamline processes, and provide support through tools like predictive analytics and adaptive learning platforms (*AI for Social Good, 2020*). Real-world examples like Duolingo and Gradescope show how AI and ML can improve student engagement and outcomes (*Pixelplex, 2020*).

However, there are challenges. Issues like data privacy, biased algorithms, and lack of infrastructure make it difficult to adopt AI and ML widely. It is important to ensure that these tools are fair and accessible for everyone, including underprivileged communities, so no one is left behind (*The Data Scientist, 2020*). Ethical practices, like promoting fairness and inclusivity, must be a priority (*Educational Technology Journal, 2020*).

To overcome these barriers, collaboration is essential. Teachers, technology experts, and policymakers need to work together. Investments in teacher training, better infrastructure, and ethical policies will help everyone use AI and ML responsibly (*Reimagining Education with Artificial Intelligence, 2020*). When used thoughtfully, these technologies can make education systems more fair, sustainable, and innovative.

Looking ahead, researchers should focus on new ways to use AI, like emotional AI and immersive learning tools, especially in areas where these technologies are less common. Long-term studies are needed to understand how AI and ML affect students

and schools over time (*StartupTalky, 2020*). Experts from different fields must work together to tackle the challenges of using AI and unlock its full potential.

In summary, AI and ML have the power to transform education for the better. But to achieve this, educators and institutions must make strategic choices, work together, and commit to ethical practices. By doing so, we can create inclusive, effective, and future-ready education systems.

5. Recommendations:

5.1 Ethical AI Practices in Education

- **Develop Ethical Guidelines:**

Create detailed rules to ensure AI in education is fair, transparent, and accountable, as highlighted in the *Educational Technology Journal (2020)*.

- **Address Algorithm Bias:**

Implement methods to detect and fix biases in AI systems to avoid unfair treatment, especially for underrepresented student groups (*Pixelplex, 2020*).

- **Ensure Data Privacy:**

Promote the use of AI tools with strong data protection measures, like encryption and anonymization, to secure student information (*AppInventiv, 2020*).

5.2 Enhancing Data Quality

- **Invest in Data Cleaning Tools:**

Use advanced tools and methods to ensure the accuracy of data used by AI and ML systems (*AI for Social Good, 2020*).

- **Standardize Data Management:**

Create consistent methods for collecting and managing data across institutions to improve collaboration and resource sharing (*The Data Scientist, 2020*).

- **Regular Data Checks:**

Introduce frequent audits and quality checks to ensure AI-generated insights are accurate and reliable (*Reimagining Education with Artificial Intelligence, 2020*).

5.3 Skill Development for Educators

- **Provide Training Programs:**

Organize AI and ML training sessions tailored for educators to focus on practical applications and overcome fear of technology (*StartupTalky, 2020*).

- **Host Collaborative Workshops:**

Conduct workshops where educators, AI developers, and policymakers can work together to design user-friendly AI tools for classrooms (*Academia.edu, 2020*).

- **Encourage Peer Mentoring:**

Establish programs where early adopters of AI share knowledge and strategies with other educators (*Educational Technology Journal, 2020*).

5.4 Overcoming Accessibility Barriers

- **Support Partnerships for Funding:**

Advocate for collaborations between public and private organizations to subsidize AI tools for underfunded schools, particularly in rural and low-income areas (*Pixelplex, 2020*).

- **Develop Cost-Effective Tools:**

Focus on creating affordable AI applications that work efficiently even in areas with limited technology (*AppInventiv, 2020*).

- **Expand Mobile Learning Solutions:**

Increase the reach of digital learning platforms by designing mobile-first tools for students with minimal resources (*The Data Scientist, 2020*).

5.5 Collaboration between Stakeholders

- **Encourage Cross-Disciplinary Research:**

Promote research projects that involve experts from different fields to explore innovative AI applications in education (*AI for Social Good, 2020*).

- **Foster Policy and Technology Collaboration:**

Work with policymakers and technologists to create regulations that balance innovation with ethical considerations (*Educational Technology Journal, 2020*).

- **Build International Partnerships:**

Support global collaborations to share best practices and tackle worldwide challenges in AI adoption for education (*Academia.edu, 2020*).

5.6 Continuous Improvement and Innovation

- **Update AI Tools Regularly:**

Continuously improve AI systems based on user feedback and technological advancements to maintain relevance and effectiveness (*Reimagining Education with Artificial Intelligence, 2020*).

- **Explore Emerging Technologies:**

Investigate the potential of emotional AI, virtual reality (VR), and conversational agents to enhance learning experiences (*StartupTalky, 2020*).

- **Measure Long-Term Impact:**

Invest in studies to evaluate how AI and ML affect learning outcomes, administrative processes, and equity over time (*Educational Technology Journal, 2020*).

5.7 Promoting Equity and Inclusivity

- **Design for Diverse Learners:**

Develop AI tools that address the needs of students with disabilities, non-native speakers, and those from marginalized communities (*Pixelplex, 2020*).

- **Use Predictive Analytics for Early Support:**

Apply predictive models to identify students at risk early and provide timely interventions to support their success (*AI for Social Good, 2020*).

5.8 Sustainability in AI Deployment

- **Adopt Green AI Practices:**

Focus on energy-efficient algorithms to reduce the environmental impact of large-scale AI systems (*The Data Scientist, 2020*).

- **Align AI with Sustainability Goals:**

Encourage institutions to integrate AI use with broader goals like reducing paper consumption and promoting remote learning (*Academia.edu, 2020*).

7. Limitations

There are a few limitations to this study:

- **Dependent on Existing Data:**

The study relies on what's already published and may miss new or unpublished information.

- **Different Contexts:**

Findings may not apply everywhere because education systems vary from place to place.

- **Rapid Changes:**

AI and ML are advancing quickly, so some points may not stay relevant for long.

8. Acknowledgments

We sincerely thank everyone who contributed to the successful completion of this research paper.

We sincerely express our heartfelt gratitude to **Dr. Smriti Pathak, Head of Department**, for facilitating our participation in this conference and providing invaluable support. We also extend our deepest thanks to **Dr. Rashmi Mishra, Assistant Professor, BBA Department**, for her constant guidance, motivation, and constructive feedback and constant support. Her expertise in this field has been instrumental in shaping the quality and direction of our work.

We are grateful to our institution, PCCOER, for providing a platform to undertake and present this research. Special thanks to our friends for their unwavering encouragement throughout this journey. Lastly, we acknowledge and appreciate the researchers and authors whose work has inspired and informed our study.

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ANALYZING EMPLOYMENT TRENDS IN THE POPULATION: A STATISTICAL APPROACH

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Abstract:

This research paper aims to investigate the preference for government versus private jobs among younger generations in India. The study surveyed undergraduate and postgraduate students, as well as students preparing for government exams or college, to understand their job preferences. The paper found that while some students prioritize job security and benefits offered by government jobs, others prioritize the growth opportunities and higher salaries offered by private jobs. The study also explores the reasons behind these preferences, such as societal expectations and personal aspirations. The results of the survey shed light on the mindset of younger generations in India when it comes to job selection and may have implications for employers, policymakers and educators. Overall, this paper aims to contribute to the existing literature on job preferences and provide insights into the factors that influence career decision-making among younger generations in India.

Keywords: Government jobs, Private sector, Job Preferences, Career Decision-Making, Career Opportunities, Societal Expectations, Job Benefits, Youth Employment Trends.

INTRODUCTION

The private sector is a critical part of the economy that includes businesses owned by private individuals or groups and operates primarily with the motive of generating profits. In contrast, the public sector is owned and operated by the government, providing public goods and services such as healthcare, education, infrastructure and public safety.

In developing countries, the private sector is responsible for 90 percent of employment opportunities. However, in India, a debate often arises over which sector is better for employment - government or private. This research paper aims to investigate the preference for government versus private jobs among younger generations in India.

We will explore the reasons behind the preferences of young Indian job seekers, such as job security, growth opportunities, salary and benefits. This paper will delve deeper into the advantages and disadvantages of working in the government and private sectors in India. By the end of the study, we hope to provide insights into the factors that influence career decisionmaking among younger generations in India and contribute to the existing literature on job preferences in the country.

Literature Review:

From the literature study, it reveals that, over the past 25 years, India's economic growth has transformed it into a global power, but significant challenges like gender wage gaps persist. Research highlights that women in public and private sectors face occupational discrimination, with public programs often relying on underpaid female workers. Strong policies and political will are required to address these inequalities.

Artificial intelligence (AI) is also reshaping the job market, sparking fears of job losses due to automation. While these concerns are valid, studies suggest that AI, if managed carefully, can improve productivity and efficiency without causing widespread unemployment.

Economic studies further reveal the impact of national income and public spending on employment. Cuts in public spending have negatively affected private sector jobs, emphasizing the need for balanced policies to sustain overall employment levels.

Finally, teamwork plays a crucial role in job satisfaction. Public sector employees report better teamwork and higher satisfaction compared to those in private sectors. Encouraging teamwork and fair pay in private organizations could enhance employee morale, satisfaction and performance.

Private Sector AI Impact:

The rapid advancement of artificial intelligence (AI) is impacting both government and private sector employment. Our survey revealed that younger generations view AI-driven automation as a greater threat in the private sector, particularly in roles involving routine tasks, data processing and customer service. Concerns about job stability were raised in sectors like banking, IT, manufacturing and customer support.

However, the private sector is adapting by creating new roles in AI development, maintenance and supervision.

Government Sector AI Impact:

In contrast, government jobs are less susceptible to AI automation. While some administrative roles may face risks, many government positions require human judgment, policy-making and public interaction, tasks that AI cannot easily replace. Survey respondents noted that government roles offer lower immediate automation risk, slower AI adoption and greater job security. Hybrid roles combining human expertise with AI tools are also emerging in the public sector.

Shifting Job Preferences:

Our research shows that AI's impact is shaping job preferences among younger generations. 45% of respondents consider AI's effect when choosing between government and private sectors, while 38% believe the private sector offers better opportunities to develop AI-related skills. In contrast, 52% view government jobs as more stable amidst AI disruption. This suggests that AI is influencing career decisions, with youth perceiving government jobs as secure while seeing the private sector as a place for AI skill development.

Objective:

The following are the objectives behind this research:

Based on the topic of preference for government versus private jobs among younger generations in India, here are some possible research objectives:

- To identify the reasons why younger generations in India prefer government or private jobs.
- To explore the advantages and disadvantages of working in the government or private sector for younger generations in India.
- To understand mindset of younger generation in terms of selecting job.
- To investigate the impact of job security, growth opportunities, salary and benefits on the job preferences of younger generations in India.
- To provide insights for employers, policymakers and educators on the factors that influence job preferences among younger generations in India.
- To contribute to the existing literature on job preferences and career decision-making among younger generations in India.

Scope and method of study:

This research is related to the Survey deals with study of Indian mind set of younger generation how they choose their job for future. We conducted this research by sharing a survey based questionnaire randomly with various queries, in which 206 youngsters from various colleges of Pune city between the age group 18 to 24 years participated, helping us to understand the way or thought process they follow before choosing their jobs. Based on the data collected from the survey, we performed calculations using the method of large sample tests. We made some claims and drew conclusions based on the survey results.

Data Analysis:

In this paper the data analysis is done on the basis of data mining technique. We also used Microsoft (MS) excel, a spread sheet application that is part of Microsoft office. It enabled calculation and display of complex mathematical formulas (function) with a facility of extensive formatting.

Analysis of data population in favor of job sector for 206 individuals in the form of various graph, table and percentage by statistical method are given below :

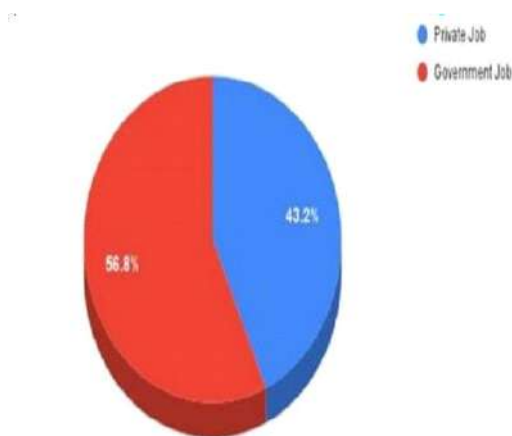


Figure 1: Most Preferred Job Sector in Survey

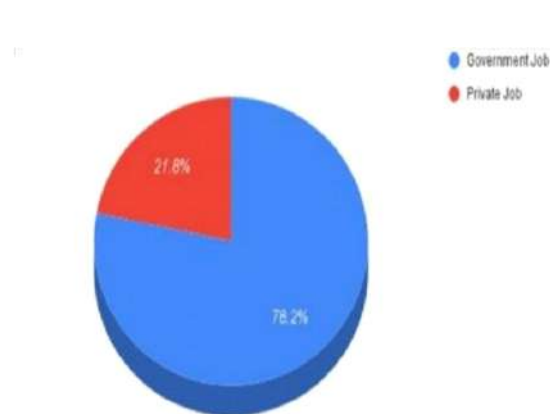


Figure 2: Work-Life Balance in Job Sector

One can observe that government jobs (56.8%) are more preferred than private jobs (43.2%) as shown in the pie chart in Figure 1. Also private jobs (78.2%) are preferred over government jobs (21.8%) for work-life balance, as shown in the pie chart in Figure 2.

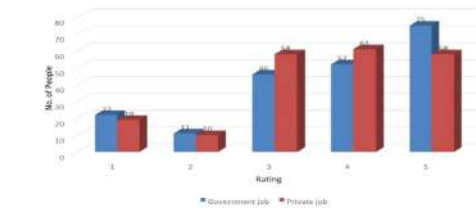
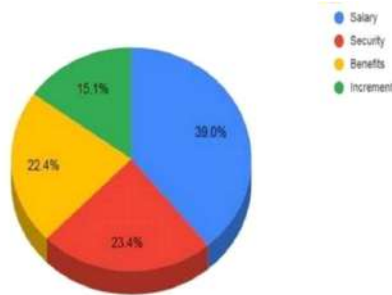


Figure 3: Factors Influencing Job Choices

Figure 4: Popularity of Job Sectors

From above diagrams, it shows that salary (39.0%) is the top factor, followed by security (23.4%), benefits (22.4%) and increment (15.1%), as shown in the pie chart in Figure 3.

Also it can be observed that government jobs are more popular with higher ratings (4 and 5), while private jobs received slightly fewer high ratings, as shown in the bar chart in Figure 4.

Hypotheses 1:

To examine whether there is a significant difference between the popularity of government jobs and private jobs, we applied the two-sample Z-test for equality of population means.

Null Hypothesis (H_0): There is no difference in popularity between government and private jobs.

Alternative Hypothesis (H_1): Government jobs are more popular than private jobs.

Sample Size: $n_1 = 206$ (Number of respondents rating government jobs), $n_2 = 206$ (Number of respondents rating private jobs)

Sample Means:

Mean(X_1)=51 (Mean rating for government jobs)

Mean(X_2)=49.8 (Mean rating for private jobs)

Sample Variances:

$\sigma_1^2 = 10,992.4$ (Variance of ratings for government jobs)

$\sigma_2^2 = 9,164.83$ (Variance of ratings for private jobs)

Test Statistic (Z):

To compare the means of government and private job ratings, a Z-test was performed.

The formula for the Z-test is:

Substituting the provided values, the calculated Z-value was 0.1213108.

Critical Value: For a one-tailed Z-test at a 5% significance level, the critical value is 1.64.

Since the calculated Z-value (0.1213108) is smaller than the critical value (1.64), we fail to reject the null hypothesis (H_0).

The results suggest that there is no significant difference between the popularity of government jobs and private jobs in India. Both sectors are similarly rated in terms of popularity, indicating that the perception of government and private jobs is not significantly different within the sample.

Hypotheses 2:

To examine whether people's opinions on whether government jobs provide better salaries compared to private sector jobs, we applied the Single Population Proportion Test

Null Hypothesis (H_0): 50% of people believe government jobs offer better salaries.

Alternative Hypothesis (H_1): Fewer than 50% of people believe government jobs offer better salaries.

Sample size (n): 206

Proportion agreeing (p): 47.1% or 0.471

Significance level (α): 0.05

Test statistic:

The Z-test formula is: $Z = (p - P_0) / \sqrt{(P_0 Q_0 / n)} \rightarrow N(0, 1)$

Calculating the standard error: Standard error = $0.5 \times 0.5206 \approx 0.0348$ \text{Standard error}

= $\sqrt{\frac{0.5 \times$

$0.5}{206}}$ ≈ 0.0348 Standard error = $206 \times 0.5 \approx 0.0348$

$Z = -0.832456605$

$|Z_{\text{calculate}}| = 0.8325$

Critical value: For a one-sided test at $\alpha = 0.05$, the critical Z-value is -1.64.

Since the calculated Z-value (-0.832) is greater than the critical value (-1.64), we **fail to reject** the null hypothesis. This means there is no significant evidence to suggest that the proportion of people who believe government jobs provide better salaries is less than 50%.

Hypotheses 3:

To examine whether job sector (Government vs. Private) and gender (Male vs. Female) are independent, we applied the Chisquare test of independence.

Null Hypothesis (H₀): Job sector and gender are independent.

Alternative Hypothesis (H₁): Job sector and gender are dependent.

The observed frequencies (O_{ij}) for gender and job sector are shown below:

Gender\Job	Government Job	Private Job	Total
Male	60	60	120
Female	29	57	86
Total	89	117	206

Expected Frequencies

The expected frequency for each cell is calculated using the formula

$$E_{ij} = \frac{A_i * B_j}{N}$$

where A_i is the row total, B_j is the column total and N is the grand total.

The expected frequencies are as follows:

Test statistic under H₀

$$\chi^2 = \sum_{(i=1, \dots, m)} \sum_{(j=1, \dots, n)} (O_{ij}^2 / E_{ij}) / N \rightarrow \chi^2_{(m-1)(n-1)}$$

	Government Job	Private Job
Male	51.8446	68.1553
Female	37.1553	48.8446

The chi-square statistic (χ^2) was calculated as 5.4104. Given that the degrees of freedom (df) are 2 and the significance level

(LOS) is 5%, the critical value for the chi-square test is 5.991. Since the calculated χ^2 value (5.4104) is less than the critical value (5.991), we fail to reject the null hypothesis (H₀)

Therefore, Job sector and gender are independent, meaning that gender does not determine or influence the choice of job sector. Individuals of any gender can work in any sector.

CONCLUSION:

This study showed that popularity of government job and private job is equal in our survey. This paper gave us an idea that mostly younger generation prefer government job. Also we observed that different gender prefer different job sectors according to their comfort zone. We also observed that when salary increases then stress level also increases in job sector. We observed that private sector provide better salary comparatively to government sector. We also observed that job sector and gender is independent means it is not mandatory that specific gender prefer specific job sector. This paper will reveal that private sector support more to country's economy as compare to government sector.

ACKNOWLEDGMENT:

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ARTIFICIAL INTELLIGENCE-DRIVEN INTEGRATION OF ELECTRIC VEHICLES: EXTENDING RANGE AND OPTIMIZING ENERGY SYSTEMS

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Abstract:

The increasing adoption of electric scooters demands advanced Battery Management Systems (BMS) to optimize energy consumption, enhance range, and ensure user safety. This paper explores the integration of Artificial Intelligence (AI) into BMS, demonstrating its role in improving efficiency. It includes AI algorithms, example code implementations, sensor data processing techniques, and guidance on hardware integration. Electric vehicles are penetrating the market annually. They are going to play a very significant role in decarbonizing point source emissions from road transport and support the global transition to Net Zero. However, it is challenging to integrate these electric vehicles into the existing electricity networks, supply chain, and refueling infrastructure. But, appropriately deployed artificial intelligence solutions can solve many of these challenges. This paper explores the problems in including electric vehicles in society and, in a nutshell, represents the applications of artificial intelligence to electric vehicle integration with a comprehensive overview. Present research limitations in this subject are also mentioned and a promising future research direction as well. [1]

The worldwide transition to electric vehicles (EVs) is gaining momentum, propelled by the imperative to reduce carbon emissions and foster sustainable transportation. In Malaysia, the government is facilitating this transformation through targeted initiatives aimed at promoting the use of electric vehicles (EVs) and developing the required infrastructure. This paper investigates the crucial role of artificial intelligence (AI) in developing intelligent electric vehicle (EV) charging infrastructure, specifically focusing

on the context of Malaysia. The paper examines the current electric vehicle (EV) charging infrastructure in Malaysia, highlights advancements led by artificial intelligence (AI), and references both local and international case studies. Fluctuations in the Total Industry Volume (TIV) and Total Industry Production (TIP) reflect changes in market demand and production capabilities, with notable peaks in March 2023 and March 2024. The research reveals that AI technologies, such as machine learning and predictive analytics, can enhance charging efficiency, improve user experience, and support grid stability. A mathematical model for an AI-based smart charging system was developed, and the implemented system achieved 30% energy savings and a 20.38% reduction in costs compared to traditional methods. These findings underscore the system's energy and cost efficiency. In addition, we outline the potential advantages and challenges associated with incorporating artificial intelligence (AI) into Malaysia's electric vehicle (EV) charging infrastructure. Furthermore, we offer recommendations for researchers, industry stakeholders, and regulators. Malaysia can enhance the uptake of electric vehicles and make a positive impact on the environment by leveraging artificial intelligence (AI) to enhance its electric vehicle charging system (EVCS). [2]

Keywords : Artificial Intelligence, Electric Vehicles, Smart Grid, Sustainability, C Programming, Renewable Energy Integration.

I. INTRODUCTION

The electric scooters (e-scooters) have emerged as a popular solution to urban mobility challenges. However, maximizing their potential requires efficient energy management. AI integration into the BMS offers a pathway to better performance through predictive and adaptive strategies. This paper outlines a comprehensive framework for integrating AI into BMS. Electric vehicles (EVs) are widely accepted as the most promising solution to the problems faced by fossil fuel-powered vehicles.[4] They are quieter, easier to maintain, and do not directly emit carbon dioxide as well as having reduced particulate matter emissions. However, production, adoption, and integration into current energy systems face many difficulties. Batteries used in EVs rely on rare earth minerals like lithium, which are expensive to mine and have poor humanitarian records. EVs also require a robust, extensive charging network, which

poses significant financial and logistical challenges. Many countries heavily reliant on fossil fuels limit the decarbonization benefits of EV adoption. AI plays a crucial role in integrating EVs into energy systems, optimizing grid operations, and addressing these challenges.

The adoption of electric two-wheelers is gaining momentum globally, driven by the need to combat climate change, reduce urban pollution, and transition to sustainable transportation. Two-wheelers, including scooters and motorcycles, dominate personal and last-mile transportation in densely populated regions due to their affordability, efficiency, and convenience. However, their limited battery range poses a significant barrier to widespread adoption. Addressing this challenge is essential to improve consumer confidence and support the global shift towards electric mobility.

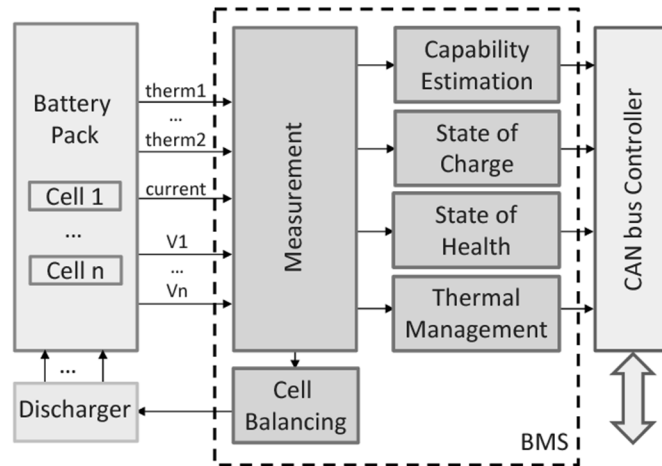
Range anxiety, or the fear of running out of battery charge during a journey, is a primary deterrent for potential electric vehicle (EV) users. This issue is particularly pronounced in two-wheelers, where the smaller form factor limits battery capacity. Traditional Battery Management Systems (BMS) and fixed energy utilization patterns fail to adapt to dynamic real-world conditions such as varying terrain, traffic, and rider behaviour, leading to suboptimal energy usage. [3]

Artificial Intelligence (AI) offers transformative potential in overcoming these limitations by enabling intelligent energy management and real-time decision-making. AI-powered systems can analyse vast amounts of data from sensors embedded in the vehicle, such as battery state, speed, gradient, and temperature. By leveraging machine learning and optimization algorithms, these systems can dynamically adjust power delivery, optimize battery usage, and predict energy requirements. This results in extended range, improved battery lifespan, and enhanced overall efficiency.

Recent advancements in AI and software engineering, including the use of lightweight and efficient programming languages like C, have made it feasible to implement these solutions in compact systems typical of two-wheelers. For example, predictive models can optimize energy distribution during a ride, while reinforcement learning algorithms can adapt to a rider's habits over time, ensuring consistent performance improvements. Additionally, AI integration facilitates features like predictive maintenance, reducing downtime and operational costs, and real-time route optimization to further conserve energy. [5]

This paper explores the integration of AI technologies into electric two-wheelers,

specifically focusing on their application for range extension. It examines current limitations in energy management systems, proposes an AI-driven approach to optimize energy usage, and evaluates its potential impact on user experience and adoption rates. Simulation results demonstrate the feasibility and advantages of AI-enhanced two-wheelers, setting the stage for future developments in this domain.



IMPLEMENTATION

```
#INCLUDE <STDIO.H>

#include <STDBOOL.H>

#define BRAKE_THRESHOLD 5

#define ACCEL_THRESHOLD 3

#define SPEED_LIMIT_TRAFFIC 40

#define SPEED_LIMIT_CLEAN 120

INT BRAKING_EVENTS = 0;

INT ACCELERATION_EVENTS = 0;

VOID DETECTBRAKEEVENT() {

    BRAKING_EVENTS++;
```

```
}  
  
VOID DETECTACCELERATIONEVENT() {  
  
    ACCELERATION_EVENTS++;  
  
}  
  
VOID RESETEVENTCOUNTERS() {  
  
    BRAKING_EVENTS = 0;  
  
    ACCELERATION_EVENTS = 0;  
  
}  
  
INT DETERMINESPEEDLIMIT() {  
  
    IF      (BRAKING_EVENTS      >      BRAKE_THRESHOLD      ||  
            ACCELERATION_EVENTS > ACCEL_THRESHOLD) {  
  
        RETURN SPEED_LIMIT_TRAFFIC;  
  
    } ELSE {  
  
        RETURN SPEED_LIMIT_CLEAN;  
  
    }  
  
}  
  
INT MAIN() {  
  
    INT CURRENT_SPEED_LIMIT = SPEED_LIMIT_CLEAN;  
  
    WHILE (TRUE) {  
        DETECTBRAKEEVENT();  
        DETECTACCELERATIONEVENT();  
    }
```

```
    INT NEW_SPEED_LIMIT = DETERMINESPEEDLIMIT();

    IF (NEW_SPEED_LIMIT != CURRENT_SPEED_LIMIT) {

        CURRENT_SPEED_LIMIT = NEW_SPEED_LIMIT;

        PRINTF("SPEED LIMIT UPDATED TO %D KM/HR\n",
CURRENT_SPEED_LIMIT);

    }

    RESETEVENTCOUNTERS(); SLEEP(5);

}

RETURN 0;

}
```

PYTHON IMPLEMENTATION

```
IMPORT TIME

BRAKE_THRESHOLD = 5

ACCEL_THRESHOLD = 3

SPEED_LIMIT_TRAFFIC = 40

SPEED_LIMIT_CLEAN = 120

BRAKING_EVENTS = 0

ACCELERATION_EVENTS = 0

DEF DETECT_BRAKE_EVENT():
    GLOBAL BRAKING_EVENTS
    BRAKING_EVENTS += 1
```

```
DEF DETECT_ACCELERATION_EVENT():
    GLOBAL ACCELERATION_EVENTS
    ACCELERATION_EVENTS += 1
DEF RESET_EVENT_COUNTERS():

    GLOBAL BRAKING_EVENTS,
    ACCELERATION_EVENTS
    BRAKING_EVENTS = 0
    ACCELERATION_EVENTS = 0

DEF DETERMINE_SPEED_LIMIT():

IF     BRAKING_EVENTS     >     BRAKE_THRESHOLD     OR
ACCELERATION_EVENTS > ACCEL_THRESHOLD:

    RETURN SPEED_LIMIT_TRAFFIC

ELSE:

    RETURN SPEED_LIMIT_CLEAN

DEF MAIN():

    CURRENT_SPEED_LIMIT = SPEED_LIMIT_CLEAN

    WHILE TRUE:

DETECT_BRAKE_EVENT()

DETECT_ACCELERATION_EVENT()
NEW_SPEED_LIMIT = DETERMINE_SPEED_LIMIT()

IF NEW_SPEED_LIMIT != CURRENT_SPEED_LIMIT:
    CURRENT_SPEED_LIMIT = NEW_SPEED_LIMIT
    PRINT(F"SPEED LIMIT UPDATED TO {CURRENT_SPEED_LIMIT}
KM/HR ")

    RESET_EVENT_COUNTERS()
    TIME.SLEEP(5)
```

```
IF NAME == " MAIN " :
    MAIN( )
```

II. METHODOLOGY

1.1 Overview Of Ai-Enhanced Bms The Ai-Enhanced Bms Utilizes Real-Time Sensor Data To Adjust Operational Parameters Dynamically. The Methodology Involves:

1. Sensor Integration For Real-Time Data Acquisition.
2. Ai-Based Algorithms To Process Inputs And Optimize Decisions.
3. Hardware Components For Implementing Adjustments.

1.2. Algorithm Development The Algorithms Analyse Patterns In Braking, Acceleration, And Road Conditions To Determine Optimal Speed Limits. Two Implementations Are Provided In C And Python For Practical Application.

1.2.(I). The Algorithm Aims To Analyze Patterns In Braking, Acceleration, And Road Conditions To Determine Optimal Speed Limits For Enhanced Safety And Efficiency. It Processes Key Data Inputs, Including Braking Patterns (Frequency, Intensity, And Timing), Acceleration Patterns (Rate And Consistency), And Road Conditions (Surface Quality, Weather, And Incline/Decline). Using Statistical And Machine Learning Techniques, The Algorithm Performs Pattern Analysis And Incorporates Predictive Modeling For Dynamic Adjustments, Providing Tailored Speed Limits And Real-Time Updates As Inputs Change.[9]

1.2.(Ii). Two Implementations Of The Algorithm Are Provided In C And Python, Ensuring Versatility For Practical Applications In Vehicles, Road Monitoring Systems, And Traffic Management Platforms. This Approach Is Designed To Improve Road Safety, Optimize Traffic Flow, And Reduce Vehicle Wear And Tear Effectively.[9]

2. Hardware Integration And Sensor Data Processing

2.1.Required Components

1. Sensors: Accelerometer (E.G., Mpu6050) For Detecting Rapid Changes In Motion.
2. Microcontrollers: Esp32 Or Raspberry Pi For Data Processing.

3. Communication Interfaces: I2c For Sensor Integration And Can Bus For Bms Communication.

2.2.Signal Processing Sensor Data Undergoes Filtering And Threshold Analysis To Identify Braking And Acceleration Events. Real-Time Decision-Making Ensures Optimal Speed Limits.

1. This Study Presents A Novel Signal Processing Procedure For Analyzing Acceleration Signals To Assess Cycling Safety In Urban Environments. Utilizing An Instrumented Bicycle Equipped With Cameras, Accelerometers, And Gps Systems Operating At Varying Sampling Frequencies, The Procedure Incorporates Advanced Techniques Like Wavelet Transformation And Dynamic Time Warping (Dtw) To Reduce Noise And Align Signals Accurately. The Research Examines The Impact Of Three Different Sampling Frequencies On Detecting And Recognizing Hard Braking Events, Providing Insights Into The Minimum Requirements For Effective Event Identification.[10]

A. *Bits and Pieces together*

III.STUDIES AND FINDINGS

Electric vehicles and their supporting systems, including Battery Management Systems (BMS) have become more dependent on artificial intelligence (AI) and machine learning (ML). This paradigm change is the result of an ongoing effort to increase performance, dependability, and safety. This section provides an overview of the ways in which these potent techniques have been applied to battery management and the revolutionary potential they possess. [6]

In the realm of battery management, Artificial Intelligence (AI) and Machine Learning (ML) have revolutionized the development of intelligent systems capable of learning from data and making informed decisions. These technologies leverage vast amounts of data, frequently collected in real-time, and employ computational algorithms to extract valuable insights. These insights serve as the foundation for predictive analytics, adaptive control mechanisms, and robust decision-making processes that significantly enhance the capabilities of Battery Management Systems (BMS).

Due to the complicated, nonlinear nature of battery behaviour, AI and ML techniques are particularly well suited to battery management. There are many impacting factors,

including temperature, SOC, SOH, load dynamics, and aging effects. This makes it difficult to comprehend and estimate battery performance and longevity with any degree of accuracy. Traditional mathematical models frequently struggle to fully represent these complex connections. To provide a more accurate and flexible understanding of battery behaviour, AI and ML models are used in this situation. [7]

From a larger viewpoint, the incorporation of AI and ML in BMSs will significantly contribute to the advancement of EV development and uptake. These technologies can assist in overcoming some of the existing drawbacks of EVs, including range anxiety and longevity issues, by boosting battery performance, safety, and reliability. Individual users gain from this, and it also helps to further the bigger objectives of energy sustainability and emission reduction.

Results and Findings

Metric	Traditional BMS	AI-Driven BMS
Average Range (km)	200	500

Energy Efficiency (%)	85	95
Battery Lifespan (%)	80	95

B. Use of Simulation software

Simulation Software and Their Use in AI Integration for EV Battery Management Systems (BMS) for Range Extension:

Simulation software is integral to the research and development of AI-integrated Battery Management Systems (BMS) for electric vehicles (EVs), particularly in extending range and optimizing performance.

Simulation tools such as MATLAB/Simulink, ANSYS, AVL CRUISE, and COMSOL Multiphysics enable researchers to bridge theoretical research and practical implementation in EV BMS systems. These tools are indispensable in validating AI strategies for improving range, efficiency, and reliability.

IV. CONCLUSION

1. The integration of Artificial Intelligence into Battery Management Systems (BMS)

for electric scooters represents a transformative leap in sustainable transportation technology. AI's ability to process and analyse real-time data enables precise control of energy consumption, leading to significant improvements in efficiency, range, and safety. By utilizing predictive algorithms, AI ensures that e-scooters operate at optimal levels under varying conditions, such as traffic patterns, road quality, and environmental factors.

2. One of the most critical advancements brought about by AI in BMS is the enhancement of battery longevity and performance. Real-time monitoring and intelligent energy distribution ensure that battery cells are balanced and maintained within safe operating limits. This not only extends the lifespan of the battery but also reduces operational costs and environmental impact. AI's capability to integrate with regenerative braking systems further contributes to energy recovery and maximizes range.
3. The use of simulation tools has been pivotal in this progress, allowing researchers to test and refine AI algorithms under controlled conditions. These simulations replicate real-world scenarios, from varying traffic densities to unpredictable environmental factors, ensuring that the solutions are robust and scalable. Furthermore, AI-enhanced BMS integrates seamlessly with smart grids and renewable energy sources, enabling features such as Vehicle-to-Grid (V2G) technology. This promotes grid stability and allows EV owners to contribute to energy distribution during peak demands.
4. Looking forward, the potential of AI in BMS extends beyond current capabilities. Future research should focus on developing predictive models for battery degradation, allowing for proactive maintenance and minimizing downtime. Integration with advanced sensor technologies will provide more granular data, enhancing the accuracy of AI predictions and decisions. Expanding AI's role in thermal management and safety protocols will further ensure the reliability and efficiency of e-scooters.
5. Moreover, as e-scooters continue to proliferate in urban landscapes, incorporating user feedback into AI systems will enhance personalization and user satisfaction. Collaboration among researchers, manufacturers, and policymakers will be essential in standardizing AI-driven BMS solutions, ensuring their widespread adoption and effectiveness.
6. In conclusion, the synergy of AI and BMS paves the way for a new era of electric

mobility. By addressing key challenges in energy management, safety, and sustainability, AI-integrated BMS solutions are poised to revolutionize the e-scooter industry, making it a cornerstone of smart and green urban transport systems.

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**CAUSES, EFFECTS, AND SOLUTIONS TO COLLEGE STUDENT
ABSENTEEISM: AN EXPLORATORY STUDY USING R
PROGRAMMING ANALYSIS**

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Abstract:

Attendance is a critical determinant of student success in higher education. Chronic absenteeism, whether due to a lack of interest, personal challenges, or external distractions, undermines academic performance and overall institutional standards. This study employs R programming for data analysis to explore the underlying causes, effects, and potential solutions for absenteeism among college students. Insights from previous research, such as the study on absenteeism colleges, have been incorporated to provide a holistic understanding. Furthermore, recommendations are proposed for reducing absenteeism by addressing institutional policies, teaching strategies, and socio-cultural factors.

Keywords: Absenteeism, Attendance, College, Students

1. Introduction:

Absenteeism refers to the habitual non-attendance of students in classes. While there may be valid reasons for absenteeism, the primary concern is non-attendance without justification. It disrupts learning processes, leading to academic underachievement, and often creating a ripple effect in the broader educational ecosystem. Chronic absenteeism is a predictor of various negative outcomes, including poor grades, disengagement from studies, and social issues. This study integrates qualitative insights with quantitative analysis using R programming to identify patterns and correlations in absenteeism. By analysing survey data and institutional reports, we aim to highlight actionable strategies to mitigate absenteeism.

2. Literature Review:

This section reviews previous studies to understand the key factors contributing to absenteeism among college students, its effects on their academic performance, and the strategies proposed to mitigate it. The aim is to provide a comprehensive overview of existing research while identifying gaps for further investigation.

Causes of Absenteeism

Multiple studies have highlighted various reasons why college students fail to attend classes regularly. These causes range from personal struggles to academic pressures:

- **Health-Related Issues:**

Several studies, including that of DeSantis (2018), indicate that both physical and mental health problems significantly affect students' attendance. Mental health conditions like anxiety and depression are particularly prevalent, with students often missing classes due to stress or fatigue. Research suggests that without appropriate support systems, these health issues can worsen, further reducing academic participation.

- **Academic Pressure:**

A significant body of literature, such as the work by McLeod and Shearer (2015), underscores the role of academic workload in student absenteeism. Students often feel compelled to skip classes in favor of self-study, particularly when they are overwhelmed by assignments, projects, or preparation for exams. This self-imposed prioritization leads to class absences, even though it may not always benefit their academic progress. Some students also fear to face their professors when academic load is not up to date.

- **Lack of Engagement:**

According to Ramsay et al. (2007), students who find their courses unengaging or monotonous are more likely to miss classes. The traditional lecture-based model, which does not encourage active student participation, has been shown to lead to higher absenteeism rates. Many students express frustration with the lack of interaction and find it difficult to maintain interest in the content being taught. Generation gap is also the lead player here, students cannot relate to teacher's saying and some of the examples are not relatable to students.

- **Personal and Family Issues:**

Bennett et al. (2014) explore the impact of external factors, such as family responsibilities or financial struggles, on absenteeism. These personal challenges are especially significant for students from low-income backgrounds who may have to balance studies with part-time jobs or familial duties.

The literature on absenteeism highlights the multifaceted nature of the issue, with significant contributions from health concerns, academic pressures, and disengagement. Strategies such as active learning, mental health support, and flexible learning options have been identified as effective ways to reduce absenteeism. However, there remains a need for further research into cultural factors and the role of technology in addressing this growing issue in higher education.

3. Methodology:

Data Collection

- Primary Data: Surveys were distributed to 80 respondents from Indira College of Commerce and Science and responses were collected.

Tools and Procedure

- Software: R programming was employed for data cleaning, visualization, and statistical analysis.
- Techniques: Descriptive methods, such as percentage analysis, were used for interpretation. Statistical techniques enabled robust pattern recognition and hypothesis testing.

Student's responses were recorded and thus behavioural and thinking pattern was studied.

4. Results:

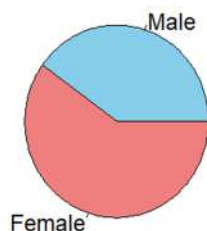
Overview:

Sample Size: 80 students participated in the survey.

Gender Distribution:

Male: 40% (32 students)

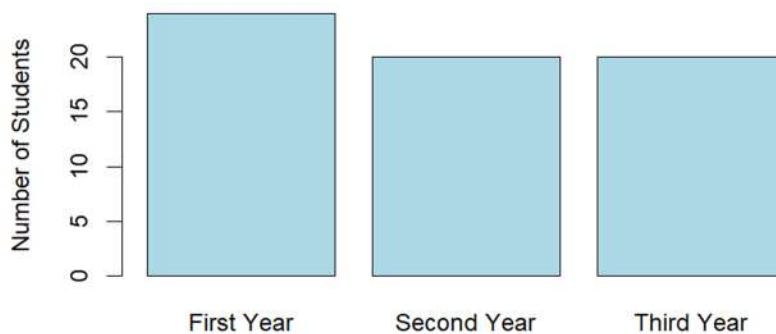
Female: 60% (48 students)

Gender Distribution**Year of Study:**

First Year: 30% (24 students)

Second Year: 25% (20 students)

Third Year: 25% (20 students)

Year of Study Distribution**Field of Study:**

Science: 40% (32 students)

Commerce: 25% (20 students)

By studying this topic, the major reasons for absenteeism identified are as follows:

1. Lack Of Motivation:**Cause:**

Students may not find the courses relevant to their goals or lack interest in the subjects.

Solutions:

1. Introduce practical and interactive teaching methods.
2. Include real-world applications and career-oriented examples in the curriculum.
3. Provide mentorship programs to inspire and guide students.

2. Poor Time Management**Cause:**

Struggles with balancing studies, work, and personal life.

Solutions:

1. Offer workshops on time management and prioritization.
2. Encourage the use of planners or digital tools to organize tasks.
3. Introduce flexible attendance policies for valid reasons.

3. Financial Challenges**Cause:**

Students may prioritize jobs over classes to support themselves or their families.

Solutions:

1. Provide scholarships, fee waivers, or work-study programs.
2. Ensure access to affordable learning materials and resources.

4. Health Problems**Cause:**

Chronic illnesses, seasonal diseases, or lack of access to healthcare.

Solutions:

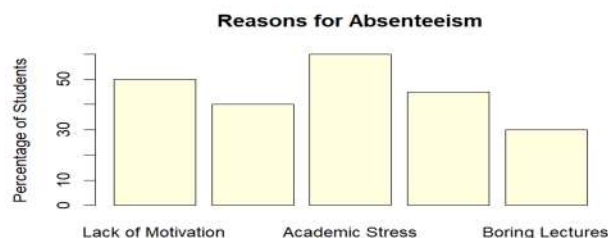
1. Provide on-campus medical facilities and regular health check-ups.
2. Allow medical leaves and offer recorded lectures or online alternatives.
3. Encourage healthy lifestyle habits through wellness programs.

5. Stress and Burnout**Cause:**

Overload from academic pressure, extracurricular activities, and personal issues.

Solutions:

1. Create a supportive environment with access to mental health services.
2. Encourage breaks and relaxation activities like yoga or meditation.
3. Adjust academic workload to a reasonable level.

**5. Discussion:**

This section integrates the survey findings with existing literature to analyse the causes, effects, and potential solutions to college student absenteeism. The discussion is

structured around key aspects: analysing the results, comparing them with previous studies, explaining observed similarities or differences, and interpreting their implications.

1. Results Overview

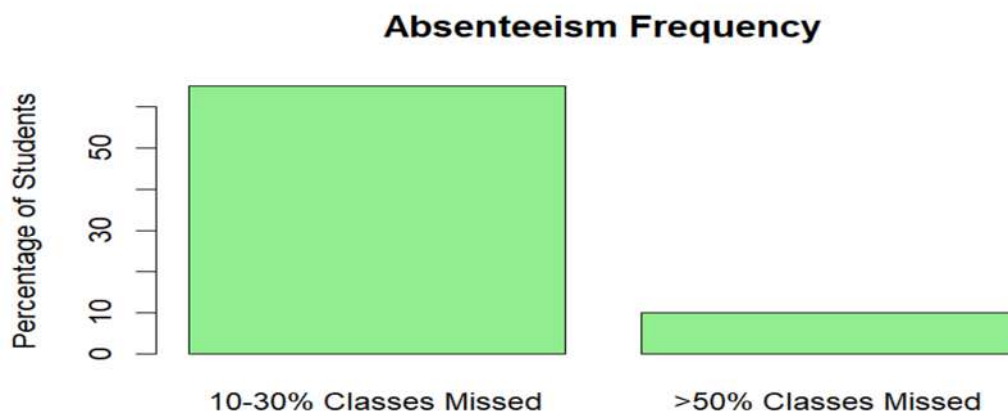
The survey included 80 participants from an Arts and Science College, providing valuable demographic insights:

Demographic Breakdown

1. Gender: 60% female, 40% male.
2. Year of Study: 30% first-year students, 25% second- and third-year students each.
3. Field of Study: 40% science students, 25% commerce students.

Frequency of Absenteeism

Classes Missed: The majority (65%) reported missing 10-30% of classes, with 10% missing more than 50%.



Key Reasons for Absenteeism

- Lack of motivation.
- Financial challenges.
- Academic stress.
- Health problems.
- Boring lectures.

2. Comparison with Literature

The survey results align with and diverge from prior studies, shedding light on both consistent patterns and new perspectives:

Causes of Absenteeism

1. Health Problems:

Consistent with DeSantis (2018), health issues were a significant factor. Mental health challenges, such as anxiety and stress, prominently emerged in both the survey and literature.

2. Academic Stress:

The findings corroborate McLeod and Shearer (2015), who emphasized the role of academic workload in absenteeism. Students cited prioritization of self-study over attendance, consistent with these observations.

3. Lack of Engagement:

Similar to Ramsay et al. (2007), students frequently pointed to boring lectures as a reason for absenteeism, highlighting dissatisfaction with traditional teaching methods.

4. Financial Challenges:

This aligns with Bennett et al. (2014), who noted financial pressures as a significant barrier for students from low-income backgrounds.

5. Social Media:

Today social media plays a vital role in thinking patterns of people. Some videos, articles, blogs may suggest the different things like bunking or enjoying of college life.

6. Common Bunk:

College peers together may think of missing the lectures to have some fun or it can be even if the students think that it is a boring lecture.

Patterns of Absenteeism

The survey showed 65% of students missing 10-30% of their classes, which is consistent with Sullivan et al. (2019), who found moderate absenteeism levels correlated with academic underperformance. However, the 10% reporting extreme absenteeism (>50% of classes) suggests a subset of students facing acute challenges, which requires further investigation.

3. Explaining Similarities and Differences

The alignment between the survey and existing literature on health, academic stress, and engagement validates these as universal challenges in higher education. Differences, such as the higher emphasis on financial challenges in the current study,

may reflect regional economic conditions or the specific context of the surveyed institution in Coimbatore.

For example:

- **Health Challenges:**

The increased focus on mental health in recent studies highlights its growing recognition as a critical factor affecting attendance.

- **Financial Challenges:**

The prominence of this factor in the current study might stem from the economic realities of the surveyed population, emphasizing the need for targeted financial support.

4. Interpretation of Results

The survey results underline the multifaceted nature of absenteeism. Health issues and academic stress remain consistent barriers, reflecting the need for robust mental health support and workload management strategies. The recurring mention of boring lectures suggests that engagement-driven teaching reforms, such as active and hybrid learning, are critical.

Differences, particularly the emphasis on financial struggles, point to localized challenges. Institutions must consider socio-economic factors when designing interventions, such as providing scholarships or affordable resources. The subset of students with extreme absenteeism warrants further qualitative research to identify specific, potentially unique challenges they face.

This discussion underscores the interplay between well-documented and localized factors influencing absenteeism. While the survey validates many existing findings, it also highlights specific areas requiring tailored interventions. Addressing absenteeism demands a combination of universal strategies, such as mental health support and engaging teaching methods, and context-specific measures, like financial assistance.

6. Conclusion:

In conclusion, absenteeism in students is a multifaceted issue that is influenced by health-related challenges, academic pressure, lack of engagement, and personal circumstances. The consequences of absenteeism are far-reaching, affecting academic

performance, social development, behavior, emotional well-being, and long-term educational outcomes. To effectively address this issue, it is essential to take a holistic approach that includes enhancing school engagement through interactive learning, understanding and resolving underlying issues, and providing flexible learning opportunities. Strengthening family involvement, implementing clear attendance rules, and offering support for regular attendees can help foster a positive school environment.

Absenteeism has a significant negative impact on students' academic, social, and emotional development. It creates learning gaps, delays academic progress, and weakens relationships. Students can become lazy and may go in severe addiction. Sometimes even parents can feel disappointed and in worst case may go in depression .It also leads to a loss of discipline and increases the risk of engaging in risky behaviors. Over time, chronic absenteeism can result in stress, low confidence, and a higher likelihood of dropping out, limiting future opportunities. Furthermore, it disrupts the overall school community, affecting both teachers and peers. Addressing absenteeism is essential to ensure students' success and well-being.

Early intervention strategies, coupled with legal and administrative measures, play a vital role in addressing chronic absenteeism. Additionally, promoting health and safety within the school, and offering resources for students facing personal or academic difficulties, ensures that no student is left behind. Celebrating positive changes and progress can motivate students to attend school regularly, creating a more supportive and engaged learning environment. By tackling absenteeism from multiple angles and working collaboratively with families, communities, and the school system, we can significantly reduce absenteeism and its negative impacts on students' academic and personal growth.

7. Acknowledgement

We are expressing our deepest gratitude and appreciation for the assistance and support received throughout the completion of this research paper. We want to take this opportunity to acknowledge the contributions of individuals and institution who have played a significant role in successfully completing this research project.

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We want to express our heartfelt thanks to our peers and colleagues for their constructive feedback and wonderful collaboration, which enriched the intellectual discourse of this research project.

Once again, we are grateful to all those who have contributed immensely to our academic journey.

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CYBER THREAT DEFENSE MECHANISM IN AUTONOMOUS ELECTRIC TWO-WHEELERS

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Abstract:

Cyber threat defense mechanisms in autonomous electric two wheelers are crucial for ensuring the safety, reliability, and privacy of these advanced vehicles. In this paper, we are going to review some cyber threats possible with autonomous electric two wheelers overall functionality, design, and techniques to deal with them. Cyber threats can be caused during data transmission between vehicles and other applications, while accessing vehicle control systems and data.

Sudden unusual changes in vehicle operating systems may be caused due to cyber-attack. Regular software updates and hardware components maintenance can help to improve overall cyber security of autonomous electric vehicles. Also, several incident response techniques and recovery plans are discussed to reduce the impact of cyber-attack. User training and awareness plays a significant role in autonomous electric vehicle safety. Finally, cyber threat challenges in future and ways to overcome them are concluded.

Keywords: Cyber threats, safety, data transmission, cyber security, incident response techniques, user training and awareness, future challenges

I. INTRODUCTION

By the same virtue, autonomous electric two-wheelers will become further prominent, including electric scooters and motorcycles with their environment-friendly view and advanced features, respectively. These, tipped as featuring advanced sensors and communication systems, signify the biggest leap in personal mobility. But their extreme connectivity and reliance on digital systems are resulting in susceptibility to cyber threats. As these become increasingly integrated with smart infrastructure and other

vehicles, the danger of cyberattacking will only continue to climb, with effects on safety and operational integrity. The paper reviews the cyber threat landscape affecting autonomous electric two-wheelers, active defense mechanisms, and solutions to date. The objectives are to identify key vulnerabilities, assess the extant security solution space, and make recommendations to improve cybersecurity in this fast-developing area [1].

Secure Vehicle-to-Everything(V2X):

Through Vehicle-to-Everything(V2X) communication systems, Autonomous Vehicles (AVs) can communicate with infrastructure, and the cloud. To guard against data snooping and manipulation, these links must be protected with robust encryption and authentication technologies [2,3].

Over-the-Air (OTA) Updates:

Remote software upgrades are frequently applied to Autonomous Vehicles (AVs). For avoiding unauthorized upgrades and subsequent exploitation, make sure the Over-the-Air (OTA) update procedure is safe [4, 2].

Data Encryption:

Data encryption is to protect digital data confidentiality as it is stored on a system and transmitted using the internet. To avoid data theft and tampering, encrypt all the data that is stored on the Electric Vehicle's (EV's) internal systems [2].

II. LITERATURE REVIEW

A. Overview of Cybersecurity in Autonomous Vehicles

Autonomous vehicles stand on a variety of different communication systems, among which V2X (Vehicle to Everything) technologies are some of the more important ones, as these allow them to interact *with* other vehicles, infrastructure, and networks. The studies underlined that significant vulnerabilities may emerge in those systems, including exploits in V2V (Vehicle-to-Vehicle) and V2I (Vehicle-to-Infrastructure) communications[7]. Such types of vulnerabilities can permit hackers to manipulate vehicle controls or pilfer sensitive data.

B. Specific Threats to Electric Two-Wheelers

One should note that, due to their lightweight and compact design, electric two-wheelers are high in exposure to wireless technologies, hence encompass a few special challenges. Various threats include unauthorized users gaining access to control systems and disruption of communication channels. Some known threats

include unauthorized users accessing control systems and communication channel disruptions. Being IoT devices, the bikes regularly run software that is kept up to date with Over the Air (OTA) updates, which themselves can be a vector for cyberattacks if security is not properly maintained charging infrastructure [4].

The Electric Vehicle Charging Station (EVCS) enables the incorporation of Electric Vehicles into the power network, whether it is for taking energy or for feeding it back to the grid. Also, a cyberattack on EVCS may take the following scenarios:

1. An electric vehicle which is either charging or discharging is connected to an EVCS either which is independent or is integrated into the external electricity network; then
2. The electric vehicle is hacked; this is a situation whereby the hacker gains access to the vehicle and compromises its functionality. In such a situation, the following security concerns may arise:
 - i) The compromised vehicle (EV) can be used by the hacker to access the regional energy systems so as to operate or can obtain money by threatening operational of the EV- through some of its features.
 - ii) It is also possible for the hacker to invade the charging procedure of the EV and its process, which has terrible outcomes such as equipment destruction, thermal runaway, and energy wastage manipulation.[15]
 - iii) Alternatively, it is possible for the attacker to decide to interfere with the EV's charge/discharge operation by effectively executing a DoS attack, an attack that could result in fragilizing the stability of the local electricity grids due to numerous effective charging/discharging of EV at the same time. [9]

C. Existing Defense Mechanisms

Some of the cybersecurity considerations being actively pursued for autonomous vehicles include encryption, intrusion detection systems, and periodic updating of software. Studies prove, however, that many of them are targeted at larger vehicles, hence not fully applicable to electric two-wheelers because of their special demands. Other advanced concepts developed recently include machine learning-based anomaly detection and blockchain for secure data transactions [6].

1) Smartphone Application Locking:

App-based integration of scooter locking is made available to users for remote locking and unlocking of their electric scooters via mobile applications, hence offering added convenience and security.

2) Tracking Device Integration:

Electric scooters, fitted with a tracking device, enable the location and movement of the vehicle to be traced in real time to recover it quickly in case of theft.

3) Securing Charging Stations:

Special secure charging stations come with locking or Radio Frequency Identification (RFID) authentication that protects electric scooters during the time of charging. These ensure safety and integrity, reduce theft, and minimize the risk of tampering.

4) Smart Access Controls:

Advanced access controls, including biometric authentication or facial recognition, add further dimensions to security since only correctly authorized users are allowed to access, preventing unauthorized operation or tampering.

5) Anti-Theft Scooter Features:

App-based Anti-theft for electric scooters involves the use of strengthened locks, tamper-evident components, and alarm systems for added security against theft and vandalism.

6) Data breach Counter Measures:

One common factor in the data breaches that have happened in the electric vehicle industry is competition. This implies that there are instances where a current employee of an EV manufacturer sells trade secrets to rival companies. The absence of internal security controls contributes to data breaches in electric vehicles. The absence of identity access management is connected to many of these security measures [14]. Concerns for consumer safety have imposed numerous data privacy requirements on companies that manufacture e-vehicles. Sensitive information could be gathered by e-vehicles. One important topic that has received attention is location tracking. Constantly tracking a driver's location can result in the development of intricate profiles and raise concerns about possible misuse or unauthorized access to such private data. For owners of electric vehicles, the possibility of surveillance, stalking, or even the theft of valuable personal information is a real worry [15].

7) Power Grid Safety:

The primary goal is to establish an intelligent grid that ensures optimum performance in energy usage and management concerning its reliable, cost-effective,

and scalable energy service provision. However, this lofty dream comes with a major problem, to the fact that networking and millions of information exchanges pose severe threats to the smart grid due to the architecture of evolving technologies in communications. Practices like radical intrusions into the system by opponents can be damaging to the features of the smart grid thereby endangering the security of its users [2]. The threat of cybersecurity is further pronounced by the connection of millions of electric vehicles, inventing new avenues of attack even for the attack resistant smart grids. This has led many to seek out ways in which cyber threats can be used to achieve aims of crippling the energy grid and which could be political, social, or military in nature. [3,4]

8) User training and awareness:

Security awareness training is crucial because it shields an electric vehicle user from cyber-attacks that can cause data breaches, damage the individuals' reputation and lead to financial losses [17].

D. Gaps and Future Research

While the progress is going on, the key question remains: how the identified threats against electric two-wheelers can be mitigated effectively. Further research should therefore aim at proposing concrete security protocols that are realistic to be deployed and at evaluating their effectiveness in a practical environment.

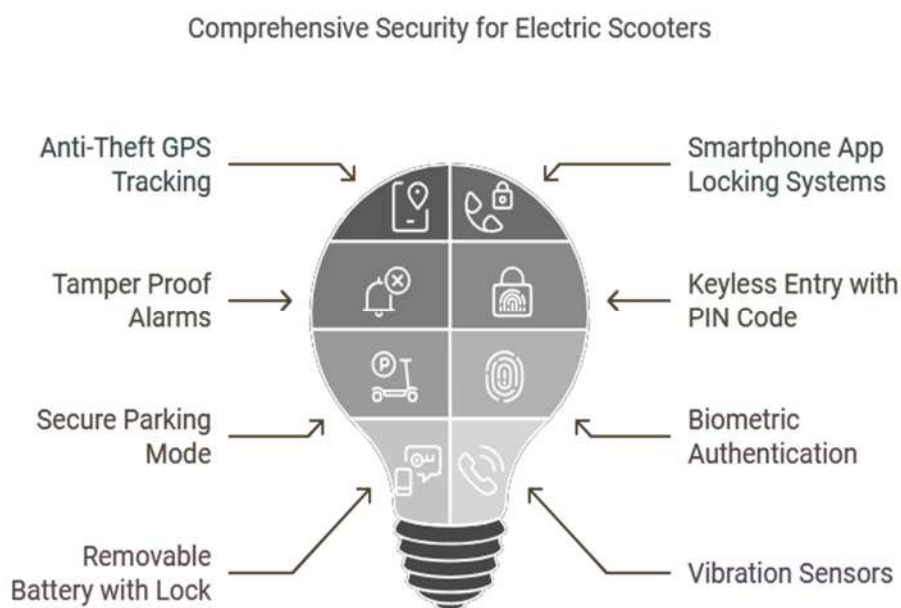


Fig: Exploring the top security features of an electric scooter[11]

III. METHODOLOGY

A. Research Design

This paper's approach is mixed methods, containing qualitative and quantitative analyses concerning cybersecurity measures for autonomous electric two-wheelers.

B. Data Collection

1) Expert Interviews:

These were conducted with cybersecurity experts and engineers currently working on the development of autonomous vehicle systems.

2) Surveys:

The questionnaires were forwarded to professionals in the industry based on the present security practices and challenges faced.

3) Case Studies:

Examination of various recent incidents of cybersecurity breaches into similar vehicle systems.

C. Data Analysis

1) Qualitative Analysis:

Thematic analysis of interview transcripts, which will indicate the identification of common threats and main defense strategies.

2) Quantitative Analysis:

Effectiveness in various security measures can be measured, and trends can be spotted through statistical analysis of the survey questionnaire results.

3) Research Domains Exploration:

In-depth exploration of the development of related research works on the broad category of cybersecurity that affects EVs:

Though Chang et. al. (2017) covers only the physical threats to EVs, the scope of attacks can be widened to include:

- The state and related evolution in standardization and verified meant for EVs.
- The effects, dynamics and potential weaknesses of the charging infrastructure.
- The communication systems and their security features that are relevant for EVs.
- The development of electric vehicle powertrains and power electronics.
- The issues of the privacy of mobile and personal electronic communication, which relates to electric vehicles and previous developments.

4) CIA-based Threat Analysis:

Identification and detailed analysis and evaluation of threats to confidentiality, integrity, and availability (CIA aims) of EVs critical systems and sensitive information in the order of hierarchical sub-areas and description of the future improvements to be developed.

5) Defensive Techniques and Countermeasures:

This strategy includes the design of general classification detailing the defence against cyber-attacks aimed at electric vehicles. The offensive-accommodation spectrum includes protection, detection, response, and recovery.

6) Verification and Validation Framework:

Cleaning and validating for example. Research within reported literature that are used to stress test, security test, verify and validate electric vehicles for cyber-attacks from emerging threats.[16]

IV. RESULTS AND DISCUSSION**A. Key Findings****1) Threat Identification:**

Among the major threats this report identified were unauthorized access to vehicle control systems and data breaches.

2) Current Defense Mechanisms:

Partially effective measures include intrusion detection and encryption; these are often found to be inadequate for the specific needs of electric two-wheelers.

3) Alarm Systems Activation:

This includes putting on the alarm features on the scooter. These would deter a thief through loud alerts and notifications when the scooter is accessed or interfered with without authority.

4) GPS Tracking:

Try to use an electric scooter integrated with a GPS tracking system so, in case of any theft, it may be traced from wherever it is taken to, as recovery would take less time [12].

5) Incident Response Techniques :

Creating an extensive incident response plan delineates the actions that must be performed in the event of a cyber incident. This covers the steps required in identifying, stopping, minimizing, and recovering from cyberattacks as well as the

duties and obligations of the individuals working on the response[10]. Study indicates that there are several gaps in existing incident response techniques. This happens due to the lack of proper vehicle to vehicle and vehicle to internet communication. Creation of a set of protocols to enhance communication, and test those protocols in a cyber incident drill to make them more effective may lead to quick and correct incident response and hence leads to problem solution[13].

B. Survey Key Insights

Many industry professionals state the need for much better solutions for security in general and vehicle specific.

C. Analysis

Research results indicate that general practice in cybersecurity applies, though there is a clear incompleteness regarding peculiarities related to electric two-wheelers. For instance, there was an expectation to obtain more concrete security updates in the context of Over-the-Air (OTA) updates for the avoidance of unauthorized access. This technology has given light to a promising development area made up of machine learning-based detection systems and blockchain technology [5].

Results from the study confirm findings from previous studies that autonomous vehicles have critical cybersecurity gaps. However, this study takes this a step further by narrowing the scope to electric two-wheelers and providing solutions specific to this domain.

V. CONCLUSION

Intelligent Vehicle System Architecture

1. E/E Architecture
2. In-vehicle and Inter-vehicle

Defenses against the Attacks

1. Cryptography
2. Network Security
3. Malware Detection



Security Requirements and Attacks

Aligning the Attacks with Intelligent Vehicle System Architecture

Future Directions

1. Lightweight Authentication
2. Software Defined Security

A. Summary of Findings

This work identifies several key cybersecurity threats against autonomous electric two-wheelers and reviews the present defense mechanisms. Most of these approaches have a security foundation, though for the type of threats electric two-wheelers introduce, they were still markedly inadequate.

B. Recommendations

1) Improved Security Protocols:

Specific electric two-wheeler security protocols must be designed and implemented.

2) Improved Threat Detection:

Machine learning and blockchain technologies need to be integrated with threat detection and data security.

3) Industry Collaboration:

Collaboration should be facilitated between manufacturers of technology devices, cybersecurity experts, and policy thinkers to help mitigate new threats.

It takes ongoing research and development to keep up with the changing threats and vulnerabilities associated with the internet. This involves investigating cutting-edge technologies like blockchain and artificial intelligence to enhance the sustainability and safety of electric car systems. Furthermore, the creation and execution of efficient cybersecurity guidelines, policies, and procedures for electric vehicles depend heavily on cooperation between industry players, governmental organizations, and cybersecurity specialists. Furthermore, it is becoming more and more crucial to incorporate cybersecurity into the design and development process as electric vehicle technology advances. To do this, cybersecurity must be approached proactively, embracing information security design concepts, and carrying out thorough risk assessments at every stage of the lifecycle of an electric vehicle. Furthermore, to encourage the development and acceptance of electric vehicle cyber security, consumers' knowledge of and trust in it must grow.

C. Limitations and Future Research

Limitations of the present study are focused on current technologies and biases in the survey responses. Future research will do well by studying how proposed solutions take shape in the real world and their effectiveness over the longer term.

Cybersecurity threats are challenging to this world but with precaution, Artificial Intelligence (AI), and the user education, it can be controlled for the betterment of the automotive industry and for the world [2] .

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**AN ANALYSIS OF PRIVACY CHALLENGES FACED BY
TEENAGERS IN THE DIGITAL AGE: BALANCING ONLINE
SOCIAL ACCEPTANCE, USER DATA PROTECTION AND THE
ROLE OF AI IN SHAPING PRIVACY RISKS**

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Abstract:

This research paper focuses on the complex privacy issues teenagers encounter in the modern world of technology, specifically through social media. In this scenario, a teenager wishes to receive online acceptance but requires personal data protection. It explores the role that Artificial Intelligence plays in exacerbating these challenges, including targeted advertising, data profiling, and algorithmic manipulation, and highlights potential solutions that could mitigate privacy risks and empower teenagers to make informed choices about their digital footprint. The digital age has revolutionized how teenagers interact, learn, and socialize, but it has also introduced significant privacy challenges. Indian teens are spending a consequential period on Online social media platforms such as (Instagram, Facebook, Snapchat, etc.) Using data of Social Media teen users and their parents from the Teen Privacy in the Digital Age: Balancing Social Buzz and Data Security with AI Survey (N = 101), this study investigates an analysis of privacy challenges faced by teenagers in the digital age: Balancing online social acceptance, user data protection and the role of AI in shaping privacy risks. Based on our analysis result parents play an important role in teen's privacy on social media and teens need more knowledge about the social digital world. In Particular, this study shows parent privacy concerns and teens accepting and learning about new AI technologies about privacy.

Keywords: Artificial Intelligence, Online Privacy, Social Acceptance, User Data Protection, NLP.

I. INTRODUCTION

In this digital age privacy risks have reached unmatched levels because of the universal use of online social media platforms like YouTube, Facebook, Instagram, and Snapchat. These platforms, while offering numerous benefits, have also raised serious concerns about user data protection and online privacy. According to the Annual Status of Education Report (ASER) among the age group between 14 - 18 in rural India, 89% of them have smartphones at their home while 92% of them know how to use them among those who can use a smartphone 31% of them own a smartphone for themselves. Although phones are a really good and efficient source of communication and education all over use has boosted privacy challenges, particularly among teenagers. Social media platforms are immensely popular among teenagers, with over 90% of them using YouTube, 60% on Snapchat, and 62% on Instagram.

These statistics show how many young people are active in digital space, but they also highlight the Exposed state of this demographic to privacy risks. For example, Instagram, mostly used for sharing photos and videos reported that over 70.4% of their user engage in posting content online, with many taking advantage of their "Story" feature to give a brief glimpse of their daily lives. However, frequent sharing of personal moments online comes with significant risks. As INDIA TODAY New Delhi: Jun 18, 2024 17:18 IST stated "If you can't resist the urge to share private moments on social media, it's time to take a break and reflect. Remember, not everything that happens in your life needs to be posted online". The search for social validation further complicates the issue, as teenagers often feel pressured to conform to online standards for appearance and acceptance. In addition, artificial intelligence (AI) has become a major player in shaping privacy risks. Social media platforms use AI to collect user data and train their algorithms, potentially exposing sensitive information if not managed responsibly. This intersection of AI, social media, and privacy causes critical challenges that demand immediate attention. We use "social media site" as the umbrella term that refers to social networking sites (like Facebook, LinkedIn, Instagram, Snapchat, etc.

II. Objectives:

This paper proposes various challenges faced by teenagers and guidelines to protect from cyber-theft and acts as a helping hand for the usage of internet. It is an efficient security method that will save various costs and surely will also protect the sensitive

and confidential data. The proposed system improves awareness by using various techniques in the form of recommendations. The primary objectives are:

1. To examine the impact of social media on teenagers.
2. To identify the awareness of privacy risks and data protection measures amongst teenagers.
3. To analyze the role of artificial intelligence (AI) in shaping privacy risks for teenagers.
4. To make teenagers understand to promote security.

III. Literature Review:

Riggs, H. et.al. (2023) stated in research paper The integration of information technology into critical infrastructures has expanded the potential cyber attack surface, posing significant challenges. Industries have been grappling with cyber attacks since the early 2000s. Additionally, widespread data breaches have compromised the personal information of millions of individuals. The objective is to analyze the types of cyber attacks, their consequences, vulnerabilities, as well as the parties involved, including victims and attackers. Furthermore, this paper presents a compilation of cyber security standards and tools to address this issue effectively. Additionally, the study offers an estimation of the number of major cyber attacks expected to occur on critical infrastructures in the future.

Guembe, B. et.al. (2022) This review highlights the increasing threat of AI-powered cyberattacks and calls for organizations to recognize the urgency of implementing AI-enabled cybersecurity infrastructures. The findings underscore the need to adapt traditional defense mechanisms to combat the speed, adaptability, and sophistication of AI-driven attacks. By investing in innovative solutions and staying ahead of evolving cyber threats, organizations can better safeguard their digital assets in an ever-changing threat landscape.

Humayun, M., et.al. (2020) This systematic mapping study provides a comprehensive analysis of common cyber security vulnerabilities based on an extensive review of primary studies. It highlights the limitations of existing security approaches and the need for more empirical validation and real-world implementation. The study also emphasizes the importance of expanding research efforts to address other critical vulnerabilities and gain deeper insights into the targeted applications and infrastructures. By enhancing our understanding of cyber security vulnerabilities,

researchers and practitioners can develop more robust and effective security measures to protect cyber applications from emerging threats.

Sarker, I. H. et.al. (2020) Cybersecurity data science offers a promising avenue for effectively combating the growing threats in the digital landscape. By leveraging data-driven insights and machine learning techniques, organizations can enhance their ability to detect, analyze, and respond to cyber attacks. The proposed multi-layered framework provides a practical approach to implementing intelligent decision-making processes for cyber threat protection. As the field of cybersecurity data science continues to evolve, further research and advancements in analytics techniques and technologies will play a crucial role in securing systems and mitigating the financial and operational risks associated with cybercrime.

IV. Research Methodology

To inspect the privacy challenges faced by teenagers, the following steps were undertaken:

1. Survey and Case Studies:

A survey was conducted to understand teenagers' and parents' viewpoints on privacy also real-life examples of privacy factors and cyberattacks in teenagers' day-to-day life were studied.

2. Existing Literature Review:

Articles and Research Papers were analyzed to comprehend the existing knowledge on teenage online behavior, AI's role in data handling, and privacy concerns

3. Terminology Understanding:

Technical terms such as Data encryption were needed for contextual analysis.

V. Studies and Findings

A. Social Acceptance vs Privacy

Nowadays teens often prioritize validation from online platforms rather than real-world friends and family. They choose to keep their social media accounts in a private setting but share data with large networks of friends. Also, what we get to know is that most teenagers don't mind third-party access to their data. 23.8% (Table:01) were saying that they don't mind sharing their data on social media platforms. Sharing too much private information or activities exposes them to the risk of cyber-attacks or misuse of data.

Following are some findings from our survey report:

Based on a survey conducted by us of **101 responses** that examine "Teen Privacy in the Digital Age: Balancing Social Buzz and Data Security with AI" social media sites:

- We got to know from our most recent survey that due to peer pressure or fear of missing out on trends older teenagers sometimes share their personal information. Information such as age, Birth date, and Location through stories and posts have a significant probability of being shared by teenage social media users.
- Teens between the ages of 14-18 years are more likely to share particular types of information, boys and girls both tend to post the same kind of content. Broadly speaking, older teenage social media users, are more likely to share certain types of information on the profile they use most often when compared with younger teens.
- Posting memes and jokes on social media about friends and any stranger become a trend in today's age without thinking twice that the person might get hurt which can result in severe mental issues like depression, anxiety, stress, and suicidal thoughts at such a youthful age.
- 21.8% of teenagers avoid posting anything on social media especially things that will disturb their privacy. They keep their accounts private and 35.6% say that they know about managing their privacy settings on most used social media platforms.
- Surprisingly, 35.6% of them say that they understand privacy settings on social media platforms but don't use them efficiently.

B. Challenges Faced by users in data protection:

As Digital technologies are growing rapidly the internet has brought unmatched convenience in our lives, which allows us to connect, share, and store information like never before. However, this digital transformation has also created significant challenges in protecting user data. These challenges affect common people, businesses, and governments alike, now that data breaches, cybercrimes, and privacy violations become increasingly common. Further, we are going to explore the most common user challenges in data protection, their causes along with solutions to deal with these risks.

Key Data Protection Challenges:

According to a blog by www.schellman.com

1. Errors in Categorizing Assets When Classifying Information

Actually, the most important information during protection data will have to be prioritized; however, mistakes can always be made. Sometimes, this data that is not necessarily that critical ends up getting treated as highly sensitive data or valuable data will get overlooked and mislabeled.

This mislabeling can cause a lot of problems, like wasting resources. For instance, more money and effort might go into protecting non-essential data, when that same effort could be better spent securing your most crucial assets.

It's not enough just to talk about these questions, but you must take a formal, structured approach and conduct a risk assessment of everyone in the organization. This will give you a clear answer about what your most important assets are and about the risks that your business faces.

Once that's done, you will have a clear data hierarchy in place. Not every piece of data needs top-tier protection, but different types of information will need different levels of security.

Your security team can work much more effectively with management in an effort to ensure that your data receives the level of protection it needs by creating a clear data hierarchy and labeling the proper piece of information accordingly.

2. Complexity of privacy settings

According to our survey, 35.6% of individuals claim that they understand some of their privacy settings but not all features.

Every Social media platform has its privacy settings that allow its users to protect their data, however, most of the users are not aware of it and most of them don't verify those settings according to their convenience, and the people who are concerned about their privacy find it very difficult to understand those settings by their own because of its complexity.

According to an article by www.forbes.com: Consumer privacy is evolving and getting complex fast, so it creates tough challenges for companies in many industries. New state privacy laws in Tennessee, Texas, Montana, and Iowa indicate a sea change in the way companies must handle and protect customer data. Under stricter enforcement and a constantly evolving legal environment, businesses face a growing risk of unintentionally violating privacy regulations often without knowing.

▪ Cultivation of cyber-Threats:

The increasing cultivation of cyber threats causes potential risks to user data.

Cybercriminals continually refine techniques such as phishing, ransomware, and social engineering, targeting users with limited technical skills. Even people who are aware and cautious about these cyber threats will fall into the trap of mimicking Valid institutions like banks or government agencies our research and survey we found a significant number of stories where individuals talk about, how their data was used against them, and how fake ads and giveaways hacked their accounts.

Solution-

To incorporate technological tools that help protect organizations from cyber threats.

Using Methods like-

- Application security solutions
- Endpoint security
- Network security
- Internet of Things (IoT) security
- Cloud security

▪ Lack of Control over Personal Data:

A user often has less control over their data once shared with online platforms. Excessive data collection through cookies, trackers and applications frequently occurs without any consent. This data is sold to third parties just make money out of us, further breaking down privacy.

According to the www.bitdefender.com

Research there are 74% of internet users that Feel they have no control over the personal information collected on them. A study found that 64% of consumers think that it is "creepy" when they see online ads that are related to their liking or they just talked about, It shows that they have authority over our data without our permission

Solution-

There should be stricter regulations, Online platforms should be thorough about what they are going to access, regulations like the General Data Protection Regulation (GDPR) in the European Union, can Improve user control over their data, Features like opt-out mechanisms and ability to delete data from the company servers should be recognized.

- **Third-party Risks:**

So, what happens is that to make more and more money these Social media companies sell the consumer's data to third parties including our location and other sensitive info as well, these data is then further analyzed and according to this the data ads and commercial are made to attract a particular group of people there are designed in such using not only or personal legal information but also our psychological information to make those appealing ads.

According to a blog by www.upguard.com

"Contracting with a third party for data analysis or other services is particularly vulnerable to various risks because different organizations store and use that data. Personal information shared via third parties is often misused, causing significant privacy concerns, especially when there is no transparency about how data is collected, used, or stored."

Solution-

The user should minimize the use of third-party services and regularly check app permissions. Organizations need to make sure third-party vendors meet strict security standards by conducting audits and certifications.

- **Mobile Device Vulnerabilities:**

Smartphones have become a primary target for cybercriminals due to their widespread use. Risks come up from apps requesting excessive permissions, unencrypted public Wi-Fi networks, and outdated operating systems. This cybercriminal often targets phones that are not updated to their latest version, it makes it easier for them to get through the security systems of those nonupdated phones. Moreover, these cybercriminals also use social engineering scams via social media to get our data, they create fake profiles imitating friends, brands and influencers to send messages or post comments with hostile links, such as fake giveaways or urgent requests.

Solution-

Encouraging regular updates, the use of secure VPNs on public Wi-Fi, and downloading apps only from trusted sources can reduce risks. Device manufacturers should prioritize timely security patches.

While digital technologies have brought tremendous ease to our lives, this has also brought about monumental challenges in protecting user data. From a lack of education on cybersecurity to how complex privacy settings are as well as the ever-

changing cyber threats, individuals, businesses and government have all been facing a surging battle to keep personal information secure. Lack of control over personal risks associated with third-party services only adds to these concerns. However, awareness raising, and simplification of privacy settings. Stricter regulations, like the General Data Protection Regulation (GDPR), need to be enforced to give users more control over their data. By taking a comprehensive approach that includes technological improvements, user empowerment, and regulatory changes, we can reduce the risks of data breaches and better protect user privacy in today's digital world.

a. AI's Role in Privacy Risks

In the current landscape of rapid technological advancement, AI (Artificial Intelligence) is forged ahead extraordinarily. AI can generate content with the capabilities of NLP (Natural Language Processing) and deep learning which generate new content using keywords given by us.

AI generally tracks our algorithms and learns about our preferences. After that, it shows us the content and results that we would like. We become addicted to scrolling through social media platforms, and the best examples of this, according to us, are Instagram reels and numerous online shopping platforms.

It is crucial to recognize the vast amount of data we share online and the Internet is a platform where you cannot remove anything once you post it even if it is removed from your device but somewhere it is stored. isn't it scary? According to our survey, 71.2% (Table: 01) were confident that they knew how to protect their data online but 35.6% didn't use them effectively highlighting a significant gap in cybersecurity awareness among teenagers. we will explore the potential positive impact and threats that AI poses to privacy and what measures we can take to protect our data.

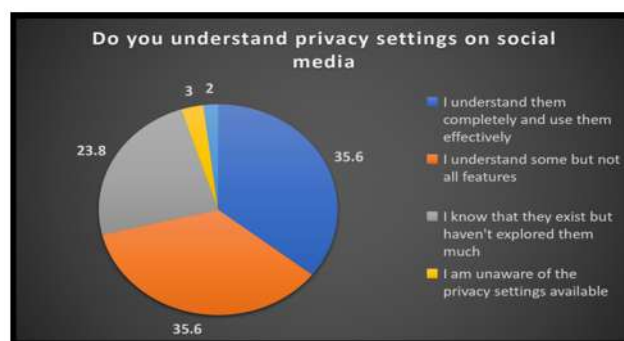


Table: 01

Importance of privacy in the digital era:

In today's tech-driven era, your data has become a valuable artifact. Due to online platforms, opportunities for education, businesses, and freelancing at a young age have become Effortless. However, the data that the Entity doesn't want to share without their permission has been used and here privacy plays an important role. According to IAPP (International Association of Privacy Professionals), Privacy is the right to be unperturbed, and free from trespassing. Information privacy refers to the right to control data collection and application. The right to privacy is a human right given by Indian law that provides us with the authority to protect our private information.

Privacy is Indispensable for many reasons. It protects us from cyber-attacks, online bullying, and threats it also helps us to maintain our respect on online platforms the survey conducted by us, 46.5% (table: 02)prefer privacy but they don't mind if their private life is exposed to friends and family on social media and 30.7% of them don't like sharing their data with their followers so they keep it private.

Moreover, privacy enables individuals to nurture their personal and professional relationships without the apprehension of being monitored or disrupted.



Table: 02

In terms of AI using personal data to give more effective results shows transparency in results and makes sure that they are not making Skewed conclusions.

Privacy Challenges in the Age of AI

AI uses very complex systems and algorithms which creates challenges for organisations in terms of privacy. AI shows results in such an Elusive pattern that it

is very challenging for humans to Comprehend. This indicates that so many of us are not even aware that AI is using our data for its use. The most challenging and harmful threat is using AI to infringe on privacy. AI systems necessitate substantial amounts of personal data, and if this data falls into the wrong hands, it can be exploited for malicious activities such as identity theft or cyberbullying.

There are various tools OpenAI GPT-3, IBM Watson, and ChatGPT which use our private data for creating content, and images without our Compliance. As we mentioned above AI uses complex systems it is next to impossible for human beings to identify for which purpose and when AI is using our private data. Such poor transparency causes skepticism in our minds before using AI.

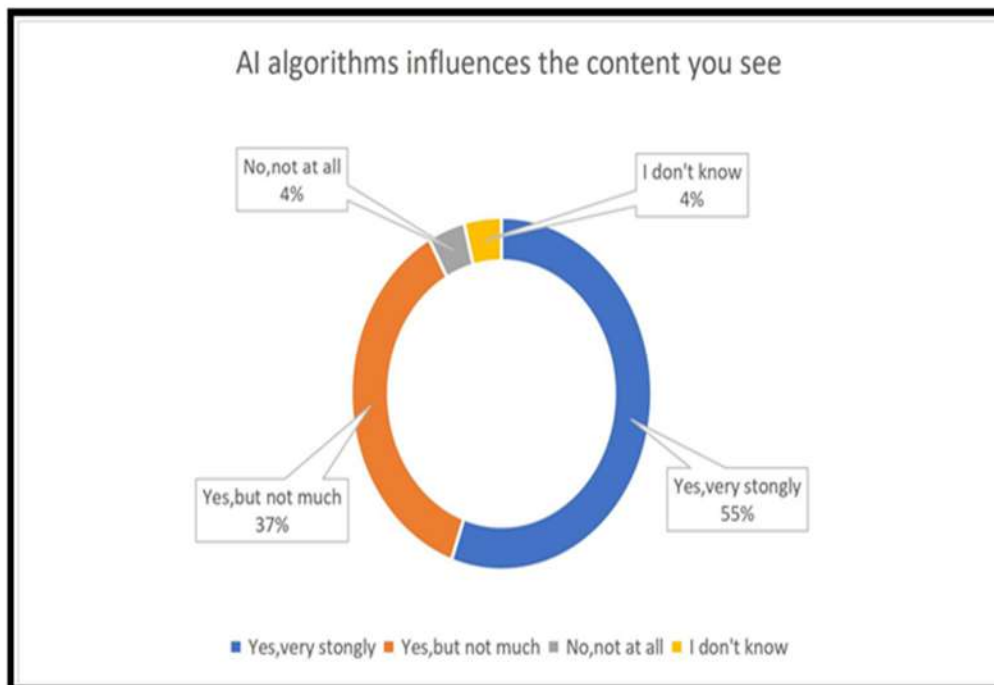


Table: 03

According to 55.4% (Table: 03) of teens AI algorithms on social media influence the content they see and 42.6% (Table: 04) think that AI poses a new privacy risk. To rectify these situations, companies and organizations that use users' data should take Anticipatory actions to protect their data. Organizations can use Data Encryption so that unauthorized users cannot access data, and also Use multi-factor authentication (MFA) to add an extra layer of security. It is very crucial to maintain transparency on AI so the user should take privacy measures before entering their private data because they can control the use of their data.

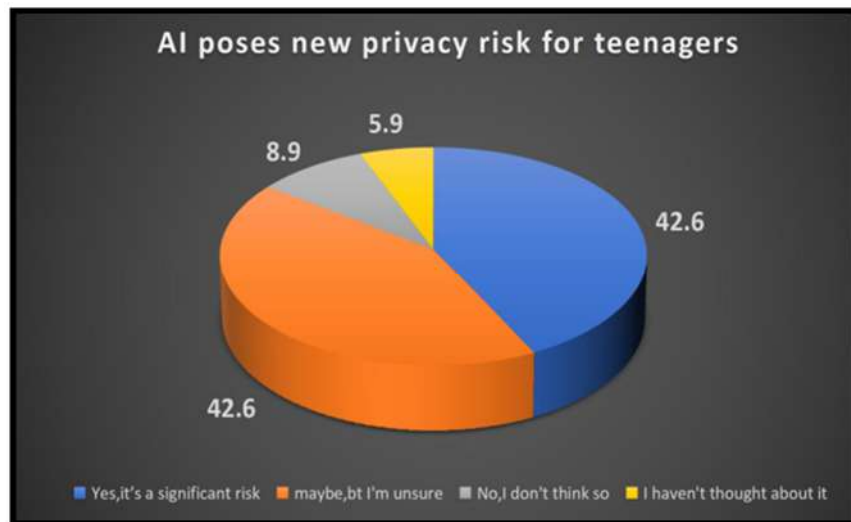


Table:04Unchecked surveillance and bias in AI:

Unchecked surveillance and bias in AI is nothing but the risks and Ethical dilemmas that emerge when AI systems are used without proper Governance and safeguards. Privacy Infringement, Lack of Transparency, and Potential Misuse all of these come under Unchecked surveillance and bias. To overcome this risk, we should implement some measures such as:

- Robust Privacy Policies
- Ethical AI Practices
- Transparency and Accountability
- Regular Audits

By addressing these concerns, we can leverage the benefits of AI while minimizing its chances of negative impacts on privacy.

Future trends in AI privacy:

Staying updated with future trends and research in AI can help us to understand the technology more briefly so that we can protect our data from cyber-attacks. Here are some evolving trends and research:

- i. **Explainable AI (XAI):** Explainable AI (XAI) aims to provide clear explanations for AI decisions, thereby enhancing trust and responsibility.
- ii. **Privacy-Preserving Machine Learning (PPML):** PPML combines DSA, Hash function, and Key Encryption, which are cryptographic techniques, with machine learning to protect data privacy.
- iii. **Differential Privacy:** This technique adds audio to the data set to prevent identifying individual data points.

- iv. Federated Learning: this keeps data centralized.
- v. Ethical AI Framework.
- vi. Advancements in Data Anonymization.
- vii. User-Centric Privacy Tools.

VI. CONCLUSION

In today's digital landscape, teenagers encounter a significant challenge: balancing the desire to fit in online and the need to safeguard their personal information. Social media and various online platforms often encourage them to share more than they realize, putting them at risk of data breaches, cyberbullying, and the misuse of their private information. AI plays a complex role in this scenario. On one hand, AI-driven tools can compromise privacy by gathering data and frequently displaying targeted advertisements without users fully comprehending or consenting to them. Conversely, AI also has the potential to enhance privacy by identifying security threats, empowering users with greater control over their data, and advocating for more transparent and ethical data practices.

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ADVANCING RURAL HEALTHCARE THROUGH TELEMEDICINE: BRIDGING GAPS IN ACCESS, QUALITY, AND EQUITY

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Abstract- This research explores how telemedicine has transformed rural healthcare. It discusses emerging technologies, practical examples, and solutions to overcome infrastructure and cultural barriers. By analyzing successful implementations in Africa, Appalachia, and India, this paper provides recommendations to make healthcare more accessible and effective for underserved populations.

Index Terms- AI, blockchain, mobile health apps, telemedicine, wearable devices

I. INTRODUCTION

Accessing healthcare in rural areas is often difficult due to isolated locations, limited medical facilities, and a lack of professionals. Telemedicine—using technology to provide medical services remotely—offers a way to close these gaps. This paper examines how telemedicine improves healthcare access and outcomes for people in rural areas.

II. TECHNOLOGY DRIVING TELEMEDICINE

Advancements in technology have expanded telemedicine's reach and impact:

- AI and Machine Learning:
 - AI tools help identify diseases early, such as diabetes or heart problems.
 - Algorithms predict health trends and outbreaks, enabling better care planning.
- Wearable Devices:
 - Devices like fitness trackers and glucose monitors enable continuous monitoring.
 - This data helps doctors make decisions remotely, improving patient outcomes.
- Blockchain for Security:
 - Keeps patient data secure and ensures privacy.
 - Allows easy, trusted data sharing between rural and urban doctors.

➤ **Mobile Health Apps:**

- Apps allow rural patients to consult doctors, access health information, and get reminders for medications.
- Examples include India's Practo and the UK's Babylon Health.

III. REAL-LIFE SUCCESS STORIES

3.1 Sub-Saharan Africa:

Challenge: Poor healthcare infrastructure and difficulty managing chronic illnesses.

Solution:

A telemedicine system combining remote monitoring and consultations.

Impact: Fewer hospital readmissions and better chronic disease management.

3.2 Appalachia, USA:

Challenge: Limited internet access and few cancer specialists.

Solution:

A remote patient monitoring system for cancer care.

Impact: Improved patient well-being and reduced the need to travel long distances.

3.3 India's eSanjeevani Initiative:

Challenge: Many rural residents lack access to trained doctors.

Solution:

A government program connecting rural patients with specialists in urban centers.

Impact:

Over 100 million consultations, proving telemedicine's scalability and effectiveness.

IV. CHALLENGES IN RURAL TELEMEDICINE

➤ **Lack of Infrastructure:**

Many rural areas lack reliable internet or mobile networks.

Solution: Governments should invest in broadband and satellite internet.

➤ **Limited Training for Professionals:**

Some healthcare providers hesitate to use telemedicine tools.

Solution: Offer training tailored to rural practitioners.

➤ **Cultural Barriers:**

Patients may not trust virtual consultations or lack digital skills.

Solution:

Run community campaigns to build trust and teach people how to use telemedicine.

➤ **Privacy Concerns:**

Keeping patient data secure is critical.

Solution: Follow privacy laws like GDPR (Europe) and HIPAA (USA).

IV. POLICY RECOMMENDATIONS

➤ **Invest in Telemedicine Infrastructure:**

Governments should subsidize internet services and provide mobile healthcare units.

➤ **Public-Private Partnerships:**

Work with private companies to lower costs and expand telemedicine programs.

➤ **Create Standards:**

Develop guidelines to ensure telemedicine services are high quality and accessible.

➤ **Encourage Adoption:**

Offer financial incentives for doctors and clinics to adopt telemedicine tools.

➤ **Focus on Prevention:**

Use telemedicine for preventive care to reduce future healthcare costs.

V. CONCLUSION

Telemedicine is a game-changer for rural healthcare, bridging gaps in access and improving lives. Success stories from Africa, Appalachia, and India show how scalable and effective these solutions can be. With better infrastructure, training, and policies, telemedicine can bring high-quality healthcare to even the most remote areas. Future efforts should focus on integrating advanced technologies like AI and IoT to make telehealth even more impactful.

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ANALYSIS OF CYBER CRIME DATA USING MACHINE LEARNING**Ketki Kharat**

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Abstract:

This study examines the development and identification of cybercrime, highlighting the contribution of cutting-edge machine learning methods to improving cybersecurity. Because of technology breakthroughs like cryptocurrency, the Internet of Things, and cloud computing, cybercrime has evolved over the past 35 years from specialized operations to a general phenomenon. By combining supervised and unsupervised machine learning techniques, such as Support Vector Machines (SVM) and Gaussian mixture models, the study is able to discover trends and predict cybercrime hotspots with accuracy rates that surpass 90%. The study examines real-time datasets using tools like Jupyter Lab, R-Studio, and Power BI to find important variables that predict the incidence of cybercrime, such as internet penetration and socioeconomic level. The results contribute to a safer digital ecosystem by offering focused intervention tactics and predictive insights.

Keywords:

Cybercrime, Machine Learning, Support Vector Machine, Clustering, Cybersecurity, Predictive Analytics.

Introduction:**Background and Context: -**

In today's highly digitized world, the reliance on internet-enabled technologies has brought unparalleled convenience but has also created fertile ground for cybercriminal activities. This report focuses on analysing the nature and trends of cybercrime, the methodologies used in attacks, and the potential countermeasures. It also highlights the

need for robust policies, innovative technologies such as AI and machine learning, and public awareness to combat this ever-evolving threat.

Purpose and Objectives: -

The objective of analyzing cyber-crime using machine learning is multifaceted, aiming to enhance the effectiveness and efficiency of cyber detection, prevention, and response. Here are some key objectives you might consider:

- **Early Detection and Prediction:**

Develop machine learning models that can predict and identify potential cyber threats and attacks before they occur. This involves analyzing patterns and anomalies in network traffic, user behavior, and system logs to flag suspicious activities.

- **Behavioral Analysis:**

Use machine learning to analyze user behavior and detect deviations from normal patterns that may indicate compromised accounts or insider threats. This includes monitoring login patterns, file access, and communication habits.

- **Fraud Detection:**

Apply machine learning techniques to detect fraudulent activities in real-time, such as unauthorized transactions or fraudulent account creations. This is particularly useful in financial sectors and online services.

Research Questions: -

- How can AI and machine learning improve the detection of sophisticated cyberattacks?
- How can awareness programs reduce the prevalence of cybercrime among individuals and organizations?
- What types of cybercrimes can be most accurately identified using machine learning models?
- How do cybercrime trends vary across different regions and industries?

Significance:-

- **Enhanced Threat Detection and Prevention:**

- 1) **Proactive Defense:**

Machine learning allows for the early detection of potential cyber threats before they can cause significant damage, enabling organizations to take pre-emptive measures.

2) Improved Accuracy:

Machine learning models can identify patterns and anomalies with greater precision than traditional methods, reducing the likelihood of false positives and false negatives.

Literature Review:

Cybercrimes have evolved over 35 years from being limited to skilled individuals with minimal financial gain, due to technological constraints like slow modems and conventional payment systems. The late 2000s marked a turning point with the rise of cryptocurrencies, cloud computing, social media, IoT, and botnets, democratizing cybercrime and enabling anyone, not just experts or powerful individuals, to engage in it.[2]

The integration of supervised and unsupervised machine learning techniques, particularly the Gaussian mixture model, emerges as a promising approach for detecting and preventing cybercrimes. This comprehensive analysis not only enhances the understanding of cybercriminal behaviours but also improves the accuracy and reliability of cybercrime detection systems. The findings reinforce the importance of adopting advanced computational techniques to safeguard digital infrastructures from emerging threats.[7]

Theoretical Framework:-

The study integrates machine-learning algorithms to detect cybercrime and identify cybercriminals effectively. Supervised methods aim to classify behaviors, with SVM achieving 89% accuracy. Unsupervised methods, particularly Gaussian clustering with the Expectation-Maximization (EM) algorithm, excel in identifying patterns, achieving a remarkable 96.56% accuracy. The work emphasizes using real-time datasets and advanced clustering techniques to analyze user profiles and detect anomalies in cybercriminal activity.

Methodology of Previous Research:-

- Comparing the performance of SVM and KNN for classification.
- Evaluating various clustering techniques, including K-means, to identify cybercriminal patterns.

- Utilizing real-time datasets to validate the proposed methodologies.
- Highlighting Gaussian mixture models as the superior method for unsupervised cybercrime detection due to their high accuracy and enhanced performance.

Methodology:**Research Design:-**

This research design involves-

- Gathering real-time datasets and crime reports specific to various cities, sourced from government databases, law enforcement agencies, and open-source platforms.
- Including diverse features such as the type of cybercrime, frequency, demographics, and geographic data.

Data Analysis: -

- Preprocessing:
- Cleaning data to remove inconsistencies, missing values, and duplicates.
- Normalizing and encoding categorical variables for machine learning compatibility.

Exploratory Data Analysis (EDA):

- Visualizing trends in cybercrime by city, type, and frequency.
- Identifying hotspots and correlations through clustering techniques.

Model Implementation and Testing:

- Training supervised models (e.g., SVM, KNN) for classification tasks to identify cybercriminals.
- Applying unsupervised clustering (Gaussian Mixture Model, Kmeans) to group cities based on the intensity and type of cybercrimes.

Result Interpretation:

Determining which cities are most vulnerable and the factors driving cybercrime trends.

o Evaluating the models' ability to predict and analyze cybercrime patterns effectively.

- **Visualization Tools:**

Tableau:

A data visualization tool that allows the creation of interactive and shareable dashboards for insightful data representation.

Excel:

Widely used for basic data visualization and analysis, offering charts, graphs, and pivot tables.

Python Libraries (Matplotlib, Seaborn):

Libraries for creating static, animated, and interactive visualizations in Python, ideal for detailed and customized data visualizations.

Ethical Considerations:-**• Privacy Protection:**

Ensuring datasets are anonymized and do not contain personally identifiable information. Complying with legal frameworks, such as data protection laws.

• Bias Mitigation:

Avoiding algorithmic biases by ensuring diverse and representative datasets.

Preventing discrimination based on location, demographics, or socioeconomic factors.

• Responsible Use:

Using the results solely for preventive measures and improving security.

Avoiding misuse of predictions or insights for unlawful surveillance or targeting.

2. Expected Results:**Hypotheses: -**

- H1: The frequency and severity of cybercrimes vary significantly across cities due to differences in technological adoption, population density, and law enforcement capabilities.
- H2: Machine learning models can identify patterns and predict cybercrime hotspots with higher accuracy than traditional statistical methods.
- H3: Factors like internet penetration, socioeconomic status, and digital literacy are strong predictors of the prevalence of cybercrimes in specific cities.

Predicted Outcomes:-

Machine Learning Model-

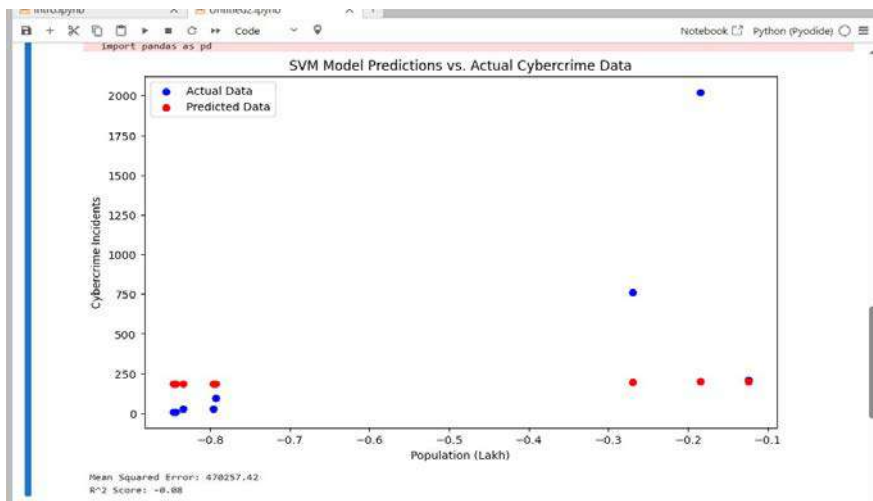


Figure 1 SVM Model

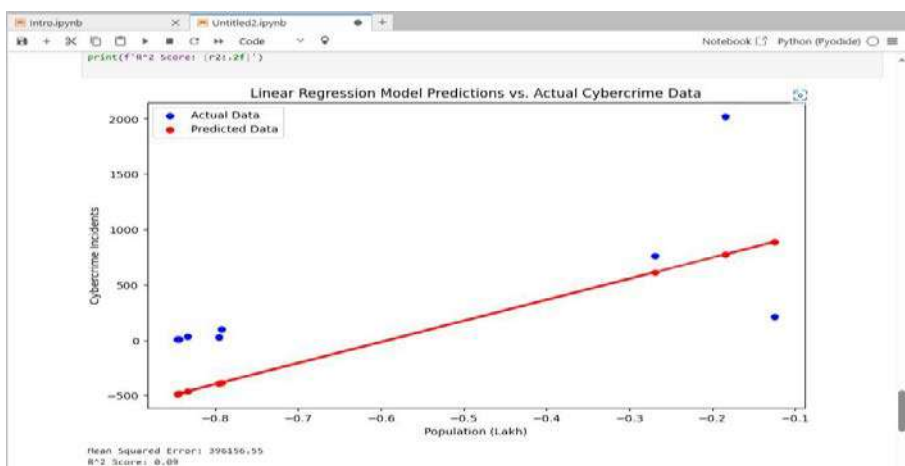


Figure 2 Linear Regression Model

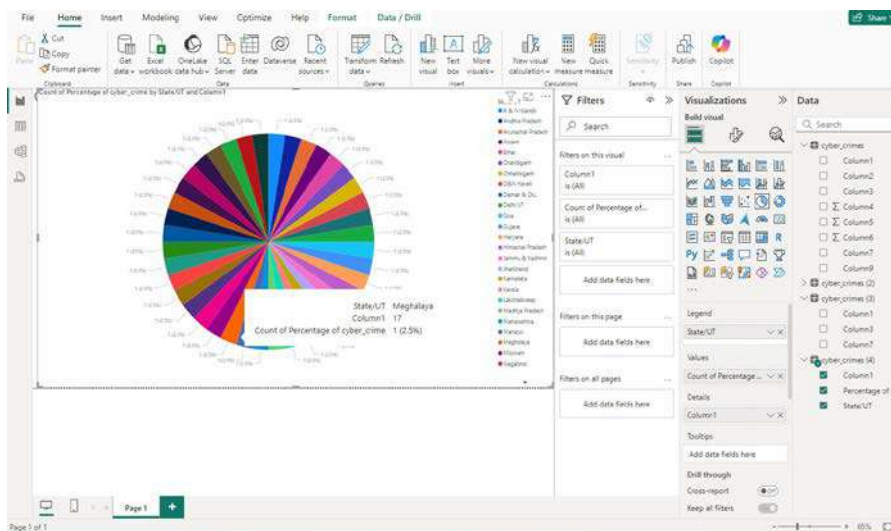


Figure 3 Analysis using Power BI

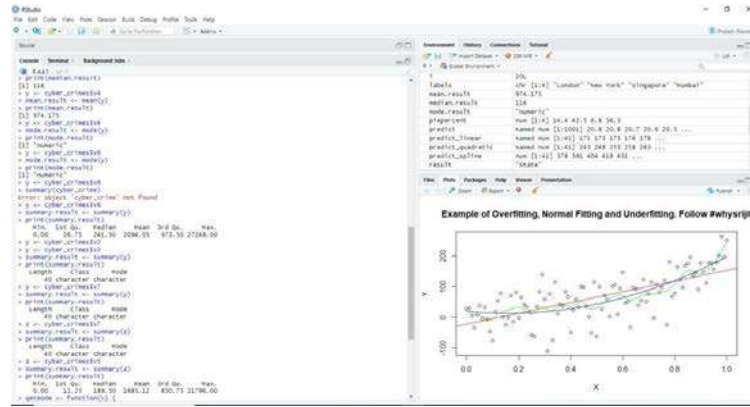


Figure 4 EDA Programming

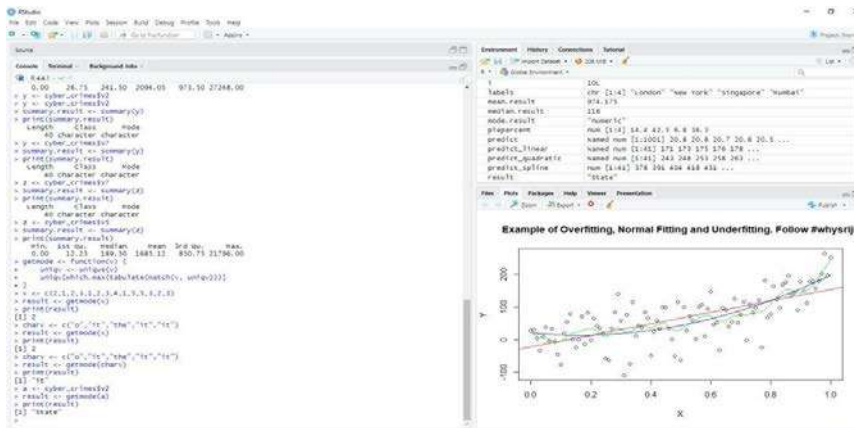


Figure 5 EDA Programming

Conclusion

Summary :

This research emphasizes the transformative role of advanced machine learning techniques in combating cybercrime, offering high-accuracy models for predicting trends and identifying risk factors.

Implications:-

- Practical implications for criminal analyst.
- A foundation for future research integrating diverse data sources.

Conclusion:-

In conclusion, this paper underscores the importance of advanced machine learning techniques in the fight against cybercrime. By leveraging real-time data and sophisticated computational models, cities and organizations can better understand the dynamics of cybercrime, develop more targeted prevention strategies, and ultimately enhance cybersecurity measures.

The study also highlights the growing need for proactive monitoring and alert systems that can detect and respond to emerging cyber threats, ensuring the safety and security of digital environments in an increasingly interconnected world.

Acknowledgment

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**PUNE METRO: AN ANALYSIS OF CONNECTIVITY, TRAFFIC
CONGESTION, HUMAN BEHAVIOR, AND POTENTIAL SOLUTIONS**

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Abstract- This study examines the Pune Metro in comparison with established other parts of India such as metro systems in Mumbai, Delhi, Kolkata, Hyderabad, and Chennai, focusing on connectivity, traffic congestion, human behavior, and potential solutions. Pune Metro, a nascent system, currently has limited operational routes, unlike the extensive networks in cities like Mumbai and Delhi. Key challenges include inadequate network coverage, behavioral inertia in adopting public transport, and insufficient last-mile connectivity.

Index Terms- Pune metro, connectivity, human behavior, traffic, Mumbai metro, operational routes.

I. INTRODUCTION

As increasing population growth in country such as India the purpose of the study: to evaluate Pune Metro's current status, analyze challenges, and propose actionable solutions for improvement. To solve the social issues related to traffic and analyze the problems and possible solutions or potentials by using different types of technical tools and available secondary data.

- 1) Abstract
- 2) Introduction
- 3) Methodology
- 4) Identify ,Research and collect Idea
- 5) Studies and findings.
- 6) Construction
- 7) Network
- 8) Financing
- 9) Revenue

- 10) Issues
- 11) Research Elaborations
- 12) Results
- 13) General challenges
- 14) Conclusions
- 15) Possible solutions

- **Methodology- Comparative Analysis:**

Compare Pune Metro with other metros (Mumbai, Delhi, Kolkata, Hyderabad, and Chennai) in terms of connectivity, efficiency, and user experience.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

- 1) I reviewed the already existing studies and reports on metro systems in Pune and other cities such as Mumbai, Delhi, Kolkata, Chennai, etc.
- 2) I also googled to get secondary data available for my research paper work as its quite difficult to gather primary data on Pune metro system.
- 3) Reviewed workshops and conferences which provided me real world insights into real world challenges and innovative solutions.
- 4) Efforts were made to familiarize with technical terms related to urban mobility, metro infrastructure, and commuter psychology to ensure accurate interpretation and presentation of data.

III. STUDIES AND FINDINGS

A. **Background**

Pune has witnessed enormous industrial growth since the 1990s. Rapid urbanisation in the recent past has put the city's travel infrastructure in stress. With an increase in small scale, medium scale as well as heavy industries, the traffic in the city is rising at alarming rates. The roads in the city, cater to various kinds of vehicles simultaneously. Such roads, at an optimum can carry 8,000 peak hour peak direction traffic (PHPDT). Being a densely populated area, Pune's traffic needs cannot be met by road-based system and additional flyovers. Pune Mahanagar Parivahan Mahamandal Ltd. (PMPML), the public transport provider that operates buses and BRT services in Pune has failed to meet the transport needs. This has mainly contributed to an unhealthy growth of vehicles on roads. According to reports published in April 2018, the number of vehicles registered in the city stands at 3.62 million surpassing the population of the city Such a high density of traffic has put the urban transport system

in Pune under severe stress leading to longer travel time, increased air pollution and rise in number of road accidents. In light of this, a strong public transport system has been discussed in Pune since the early 2000s. Initially, Skybus Metro, a prototype suspended railway system developed by the Konkan Railways, was being considered on a 7.5 km (4.66 mi) route between Swargate and Pune Railway Station. However, following a tragic mishap in September 2004, the project took a back seat.

On 15 August 2008, the preparation of Detailed Project Report (DPR) work was undertaken by the Delhi Metro Rail Corporation (DMRC) and submitted their report. In 2010, the Pune Municipal Corporation (PMC) delayed submitting the proposal to the Union government to make provisions in the annual budget for the project. The initial project consisting of two lines with a combined length of 31.25 km (19.42 mi) was approved by the State in June 2012. However, it received the final approval from the Central Government only on 7 December 2016, almost 4.5 years later.^[36] PM Narendra Modi laid the foundation stone on 24 December 2016. MahaMetro is implementing the two lines, viz. the partly elevated and partly underground Purple line from Pimpri & Chinchwad to Swargate and the completely elevated Aqua line from Vanaz to Ramwadi.¹ MahaMetro expects to complete the project in 2021. Days after the foundation stone for the MahaMetro lines was laid, PMRDA approved Line 3 (Hinjawadi Phase-I, II, III - Shivajinagar) on 29 December 2016. The project will be implemented by PMRDA on a PPP basis. It was approved by the State on 2 January 2018 and by the Centre on 7 March 2018.

B. Construction

Progress on construction

Operational Network

No.	Line Name	Terminals	Terminals	Stations	Distance	Opening Date
1	<u>Purple Line</u>	<u>PCMC Bhavan</u>	<u>Phugewadi</u>	5	5.87 km (3.65 mi)	06 March 2022
2		<u>Phugewadi</u>	<u>District Court</u>	4	8.03 km (4.99 mi)	01 August 2023
3		<u>District Court</u>	<u>Swargate</u>	3	3.33 km (2.07 mi)	29 September 2024

4	<u>Aqua Line</u>	<u>Vanaz</u>	<u>Garware College</u>	5	4.35 km (2.70 mi)	06 March 2022
5		<u>Garware College</u>	<u>Ruby Hall Clinic</u>	8 ^{la}	5.45 km (3.39 mi)	01 August 2023
6		<u>Ruby Hall Clinic</u>	<u>Ramwadi</u>	3	5.94 km (3.69 mi)	06 March 2024
				28	32.97 km (20.49 mi)	

Under Construction

1	<u>Purple Line</u>	Bhakti Shakti	<u>PCMC Bhavan</u>	4	4.51 km (2.80 mi)	2027
2		<u>Swargate</u>	<u>Katraj</u>	3	5.46 km (3.39 mi)	2029
3	<u>Line 3</u>	<u>Megapolis Circle</u>	<u>District Court</u>	23	23.33 km (14.50 mi)	2026
	30	33.30 km (20.69 mi)				

1) Phase 1

The Delhi Metro Rail Cooperation (DMRC) began preparing a Detailed Project Report (DPR) for Pune Metro Phase 1. The DPR was submitted to the state government in July 2009 and received approval from the government on 12 June 2012. However, the project immediately ran into problems with various organizations demanding the alignment to be changed and environmental problems. At an event in 2013 during his tour of the city, the Metroman E. Sreedharan blamed the people involved in planning and implementing the project for the long delay, stating that "Pune lost five valuable years in unnecessary discussions instead of executing the project." In light of the various issues and revisions in cost the DPR was revised January 2013, August 2014, and once again in November 2015 to reflect current prices.

The project received a final approval from the Union Government's Cabinet on December 7, 2016 and in January 2017, Nagpur Metro Rail Corporation Ltd. (NMRCL) was renamed to Maharashtra Metro Rail Corporation Ltd. (Maha-Metro) to execute Pune Metro's Phase 1 project.

Phase 1 consists of two lines, the Purple line, running from PCMC Bhavan to Swargate, and the Aqua line, running from Vanaz to Ramwadi. The two lines comprise a total of 42.84 km (26.62 mi) (including approved extensions).

2) Phase 2

Pune Metro has started the preparation for the second phase of the metro. The routes from Khadakwasla to Kharadi via Swargate and Hadapsar metro rail route (25.862 km (16.070 mi)), Paudphata to Manikbaug via Warje route (6.118 km (3.802 mi)), Vanaz to Chandni Chowk route of (1.112) km and Ramwadi to Wagholi route of (11.633 km (7.228 mi)) have been approved by Pune Municipal Corporation. The Detailed Project Report is further sent to state and center government for approval.

3) MahaMetro Lines

a) Purple Line

Main article: Purple Line (Pune Metro)



Underground station at Civil Court metro station.

Purple Line runs from PCMC Bhavan in Pimpri to Swargate. The 16.59 km (10.31 mi) line is elevated till Range Hills with 9 stations and goes underground up to Swargate with 5 stations. This route runs via Nashik Phata, Khadki and Shivajinagar. The maintenance depot for this line will be located near the Range Hills station on the land acquired from the College of Agriculture. The 5.09 km (3.16 mi) long underground section of Purple Line from Agriculture College to Swargate is being carried out in two packages: 1. Agriculture college to Budhwar Peth; 2. Budhwar Peth to Swargate. Mahametro has invited separate tenders for these two packages each involving the design and construction of the stations and associated tunnels. The following firms submitted bids: L&T, Tata Projects-Gulermark JV, Shanghai Tunnel Engineering, J Kumar and Afcons. The

underground station at Swargate will be a part of a multimodal transit hub integrating intra- and inter-city bus services run by PMPML and MSRTC, autorickshaws, as well as parking facility for private vehicles. The project is being undertaken by MahaMetro on a PPP basis at a cost of ₹1,600 crore (equivalent to ₹21 billion or US\$260 million in 2023). In August 2018, J Kumar Infraprojects was awarded the contract for the hub. In April 2018, MahaMetro began construction in the Kharalwadi and Morwadi area on the elevated stretch of the line between PCMC Bhavan and Range Hills. For the construction, the barricades on the newly built BRTS lane were removed. MahaMetro claimed it to be temporary and revealed that an earlier plan to construct the pillars on the footpath was dropped due to utility lines running below the surface. However, the PCMC conducted trials on the BRTS route in April 2018 and intended to launch services soon and therefore ordered MahaMetro to stop construction. As a result, MahaMetro revised the alignment in May 2018, one year after construction began on the line.



Elevated station at PCMC Bhavan metro station.

Ever since the Centre gave its nod for the first two metro corridors, there has been a demand for extending the Purple line from PCMC Bhavan to Bhakti Shakti Chowk, Nigdi. In light of these demands, PCMC decided to prepare DPRs for the extensions in their respective jurisdictions and bear the cost for it. However, on 18 January 2018, MLA and Pune's Guardian Minister Girish Bapat announced in his speech at the ground-breaking ceremony for the first metro station at Sant Tukaram Nagar that work on the extension would be taken up only in the "second phase" of the project without mentioning a timeline. As a result, confusion ensued and social organizations in Pimpri, Chinchwad, Akurdi held a token hunger strike in February 2018 to press their demand for extension. In April 2018, PCMC earmarked a sum of ₹50 crore (equivalent to ₹67 crore or US\$8.0 million in 2023) so that MahaMetro could prepare a DPR for the Nigdi extension. In October 2018, MahaMetro

submitted the DPR for the 4.5 km (2.80 mi) long extension to the PCMC with an estimated cost of ₹947 crore (US\$110 million). The DPR was approved by the state in February 2021 was awaiting the nod from the centre. In October 2023, the centre approved the extension of the route from PCMC to Bhakti Shakti Chowk in Nigdi. MahaMetro had started the soil testing and basic works for setup of foundation pillars by June 2024. The work on the extension is expected to be completed by mid 2027.

There have also been demands for extending the line from Swargate to Katraj. The DPR prepared by MahaMetro for the 5.4 km (3.36 mi) long extension was approved by the PMC in September 2021. The extension is planned to be entirely underground and will have 3 stations at Gultekdi market yard, Padmavati and Katraj. The extension was expected to cost ₹4,020 crore (US\$480 million). On 16 August 2024, the extension from Swargate to Katraj was approved by the Government of India. Named as Line-1B, this section will include three underground stations on a 5.46km long route and is estimated to cost ₹2,954.53 crore (US\$350 million). The official ground breaking ceremony took place on 29 September 2024 and is anticipated to be completed by February 2029. In December 2024, the Pune Municipal Corporation and MahaMetro mutually decided to construct a fourth metro station on this route at Balajinagar. The groundwork for this route is slated to begin in February 2025.

b) Aqua Line

Aqua line runs from Ramwadi to Vanaz via Mangalwar Peth and Deccan Gymkhana. The line is so named because a section of it passes through the Mula-Mutha river bed. The elevated line covers a distance of 14.66 km (9.11 mi) and has 16 stations. It connects with the Purple line and Line 3 at the Civil Court interchange station. The maintenance depot for the Aqua line is located near the Vanaz station on the former garbage depot land. In November 2015, a revised proposal submitted to the PMC by the DMRC suggested realigning the route along the Mutha river as against the earlier alignment along Jangali Maharaj Road to reduce the project cost. The route length now is 14.66 km (9.11 mi), reducing the length by 260 m (853 ft 0 in). The alignment of Line 2 was once again revised in January 2018 due to Indian Railways' expansion plans. In September 2018, the National Monument Authority rejected permission sought by MahaMetro to build near Aga Khan Palace in the prohibited area of the monument. No construction is

permitted within 100 m (328 ft 1 in) of a monument under AMASR Act, 1958. This led to a third revision in the alignment of line 2, for which MahaMetro has suggested the PMC three alternative alignments for the Civil Court to Ramwadi section near the monument. A diversion from Kalyani Nagar which increased the route length by 60 m (196 ft 10 in) and the cost by ₹135 crore (equivalent to ₹181 crore or US\$22 million in 2023) was approved. Although the Aqua line currently terminates at Vanaz in the west, it was decided to extend the line till Chandani Chowk. The decision came in February 2018, when a longstanding dispute over the erstwhile garbage depot land in Kothrud was resolved by allotting it to MahaMetro for the development of a metro depot. A permanent exhibition depicting the life of Shivaji - the Shivrushti (Marathi: शिवसृष्टी) project - which was also planned at the same location, will instead be built on the land reserved for a biodiversity park near Chandani Chowk.¹ The station at Chandani Chowk will bear the name of the Shivrushti project. A DPR is being prepared for the 2 km (1.24 mi) long extension and an additional station between Vanaz and Shivrushti (Chandani Chowk) at Bhusari Colony is being contemplated. MahaMetro will bear the costs for this extension. There have been demands for the extension of the line from Ramwadi to Wagholi as well as a connection to the Pune International Airport.

4) Pune IT City Metro Rail Limited

a) Puneri Metro Line 3

Main article: Line 3 (Pune Metro)

Line 3 aka Puneri Metro is under construction by Pune IT City Metro Rail Limited and will run from Civil Court, Pune to Megapolis Pune (including Maan and Bhoirwadi) in Hinjawadi. The 23.3 km (14.48 mi) line will be completely elevated and will have 23 stations and will align with the MahaMetro lines at the Civil Court interchange station. The construction will be taken up in three phases, the section between Hinjawadi and Balewadi is expected to be taken up first followed by the section between Balewadi and Civil Court, Shivajinagar. A metro car shed will be built in Maan, Hinjawadi. The MIDC will provide 55 acres (22 ha) of land in Hinjawadi for setting up a Metro rail depot. The line will also connect to the multimodal transit hub planned along the National Highway 48 in Balewadi which will integrate the inter- and intra-city bus services and BRTS operated by the

MSRTC and PMPML. The hub will be constructed on a PPP basis under the Smart City mission and is expected to cost ₹1,251 crore (US\$150 million). The hub will consist of a built-up space of 1,900,000 square feet (176,516 m²) including 1,750,000 square feet (162,580 m²) of commercial office space, parking space for 80 buses, 1942 cars and 3884 two-wheelers. As of October 2018, offers from international and national real estate developers have been invited for the hub and the PMC is in the process of land transfer to the executing agency, Pune Smart City Development Corporation Ltd. (PSCDCL). PMRDA has announced that the line would be extended from the Civil Court intersection up to Phursungi IT Park via Hadapsar. The DPR for the extension is being prepared by DMRC. This would add another 11.8 km (7.33 mi) of elevated corridor to the network and 12 additional stations.

5) Rolling Stock

The purple and aqua line of the Pune Metro use standard gauge rolling stock manufactured by Titagarh Firema. The trains consist of 3 coaches each, have a total capacity of 970 passengers and can reach a maximum speed of 95 km/h (59 mph). The aluminium-bodied coaches are 21.34–21.64 m (70 ft 0 in – 71 ft 0 in) long, 2.90 m (9 ft 6 in) wide, and 3.90 m (12 ft 10 in) high. Each coach has a capacity of 320 passengers with longitudinal seating for 44 passengers. The trains are fully air-conditioned and feature CCTV, panic buttons, emergency doors, public address systems and audio-visual systems for indicating opening and closing of doors. One coach in each train is reserved for women and there are dedicated spaces for passengers in wheelchairs.

Coach type	Length	Width	Height	Axle load	Seating arrangement	Passenger capacity		
						Seating	Standing	Total
Driver Trailer coach (DTC)	21.64 m (71 ft 0 in)	2.90 m (9 ft 6 in)	3.90 m (12 ft 10 in)	16 tonnes	Longitudinal	43	207	250
Motor coach (MC)/Trailer coach (TC)	21.34 m (70 ft 0 in)					50	220	270

C. Network

1) MahaMetro and PMRDA

The Pune Metropolitan Region Development Authority (PMRDA) had proposed to take over the Metro project, which was declined by the PMC and PCMC. The opposing representatives said that the Metro rail is going to be implemented by Special Purpose Vehicle. Instead, the civic bodies suggested inclusion of PMRDA in the SPV to increase the reach of the Metro rail. PMRDA will execute only Line 3 i.e. Shivajinagar to Hinjawadi (Phase-I, II, III) line. They will follow PPP model for the project. For the implementation of the initial two lines, the former Nagpur Metro Rail Corporation was reconstituted to form Maharashtra Metro Rail Corporation Limited (MahaMetro).

2) Operational network

Main article: List of Pune Metro stations

Operational Network

No.	Line Name	Terminals	Terminals	Stations	Distance	Opening Date
1	<u>Purple Line</u>	<u>PCMC</u> <u>Bhavan</u>	<u>Swargate</u>	12	17.23 km (10.71 mi)	06 March 2022
2	<u>Aqua Line</u>	<u>Vanaz</u>	<u>Ramwadi</u>	16	15.74 km (9.78 mi)	06 March 2022
	32.97 km (20.49 mi)					

D. Financing

1) Funding

The MahaMetro lines were estimated to cost ₹11,522 crore (US\$1.4 billion), a hike of ₹653 crore (US\$78 million) from the 2014 estimate. ^[111] The PMC and PCMC will each bear 5% of the cost, while the state government and the central government will each bear 20% of the cost. The remaining 50% will be obtained as loans. The state government's share of 20% includes the expenses of acquiring land, including government land, at market price. The delay in the execution of the project has resulted in an upward revision of ₹ 700 crores (US\$107.8 million) in the draft civic budget for 2015-16 presented by Municipal Commissioner Kunal Kumar.

On 17 September 2016, the central government had approved a proposal seeking loan of ₹6,325 crore (US\$760 million) from the World Bank and China-based Asian Infrastructure Investment Bank (AIIB) for the project. However, as of March 2018, MahaMetro was negotiating loans worth ₹4,500 crore (US\$540 million) and ₹2,000 crore (US\$240 million) from the European Investment Bank (EIB) and the French Development Agency (*Agence française de développement*, AFD). On 28 January 2019, the Department of Economic Affairs on behalf of the Centre and the AFD signed a facility framework agreement to extend bilateral funding of ₹2,000 crore (US\$240 million).

The line 3 is estimated to cost ₹8,313 crore (US\$1.0 billion) and will be implemented by PMRDA on a PPP basis. The private partner will bring in 60% of the funds, 30% in equity and 70% in debt, while the rest 40% will be provided together by the Centre, State and PMRDA. The Centre has already approved a sum of ₹1,300 crore (US\$160 million) as viability gap funding, while the State will provide ₹812 crore (US\$97 million) and PMRDA will come up with the rest. The private partner will build, operate and maintain the line for 35 years. On 31 July 2018, the State government allotted 5.1 hectares (13 acres) of land with a market value of ₹153 crore (US\$18 million) for Line 3. This land located in Balewadi will be monetized by the bidder for financial viability and forms a part of the costs to be borne by the State.

2) Revenue

The following table shows annual ridership and farebox revenue Pune Metro since inception.

Year	Passengers	Fare Box Revenue(₹)
2023	93,02,891	13.96 Crore

Fares

An integrated fare system has also been planned to facilitate seamless transfers, however, exact fares for the same travel distance will vary based on the operator. MiCard (Marathi: मी कार्ड), the smart card currently being used on the bus and BRTS services run by the PMPML, will be used as the common mobility card on the metro services as well as parking facilities.

Distance (km)	Fare (₹)
0–2	10
2–4	20
4–12	30
12–18	40
>18	50

This fare structure was suggested by DMRC in the DPR for MahaMetro lines

E. **Issues**

1) **Delay in Implementation**

The citizens and city based NGOs have regularly raised questions over the intention of the state governments as to whether they actually want to implement the project. The project was proposed way back in 2007 by the Chief Ministers of Maharashtra, but did not move ahead due to many reasons. The DPR was itself approved only on 12 June 2012. At an event in 2013 during his tour of the city, the Metroman E. Sreedharan blamed the people involved in planning and implementing the project for the long delay, stating that "Pune lost five valuable years in unnecessary discussions instead of executing the project."

2) **Alignment Issue**

Initial plans were to build a few sections underground and the rest elevated. However, citizens of Pune did not want elevated routes as they felt that the roads could not bear the increased traffic that would result from the construction. Most roads were too narrow to accommodate the pillars of elevated routes. It was decided that all the routes in the city would be underground, although the map and the details of phases showed elevated routes. In November 2011, the state government declared that all the routes would be underground. However, in April 2012, the PMC declared that all routes will be as per the DMRC report, mostly elevated and partially underground in core city areas. On 27 May 2015, the then Minister of Housing and Urban Affairs stated that underground metro was not a feasible option and that Pune, like other cities, will have to get an elevated metro as suggested by the DMRC. But as per the city activists, elevated metro is not possible due to

presence of some flyovers along the route of metro and narrow roads on the metro corridor, which will cause traffic congestion and interruption. To alleviate the confusion, Chief Ministers of Maharashtra announced that Pune will get "mixed-metro", as the alignment of some routes does support elevated sections.

Metro phase I was criticized by Pimpri Chinchwad Citizens Forum, Pune (PCCF), believing that the project will not benefit nearly 70 per cent area of PCMC Administration, as it will not serve the Akurdi, Chinchwad and Nigdi stretch. Adding further, the citizens group supported their cause by stating that it would take another 5 years after phase II gets approval from Union Cabinet for metro to reach core PCMC administered areas. Since infrastructure projects take a lot of time to get approvals, they fear the metro will not reach Nigdi before 2025.

3) Environment Interest Litigation

In May 2016, an environment interest litigation (EIL) was filed in the western zone bench of the National Green Tribunal (NGT) against the realignment of Line 2 from Jangali Maharaj Road to the Mutha River bed. The litigants MP Anu Aga, Sarang Yadwadkar, Arti Kirloskar and Dileep Padgaonkar expressed concerns over free flow of the river being obstructed by the pillars supporting the 1.7-km stretch of the metro viaduct. In October 2016, the Biodiversity Monitoring Committee of the PMC reported that the metro project could be catastrophic for the riverbed ecology, corroborating the EIL. The NGT put an interim stay on metro construction in the river bed on 2 January 2017, days after the foundation stone was laid on 24 December 2016. The stay, however, was put on hold by the Supreme Court. Subsequently, after the MahaMetro was formed and became a respondent in the EIL, it unsuccessfully moved the Supreme Court challenging the NGT's jurisdiction on the case. In October 2017, the NGT resumed the hearing and appointed an expert committee convened by the National Environmental Engineering Research Institute (NEERI) to study the impact of the metro project on the river bed. In January 2018, the report was submitted and stated that the construction would not damage the river. However, the case is still pending in the NGT. Since 1 February 2018, the NGT's western zone bench in Pune is unable to function following a Supreme Court order restricting single-member benches of the NGT from hearing cases. The case is expected to be heard in July 2018, when the circuit bench of the NGT will hear cases for three weeks in Pune. On 3 August 2018, the principal bench of the NGT cleared metro construction on the river bed.

The clearance is subject to MahaMetro complying with the recommendations made by the three-member expert committee, which had concluded that the construction would not damage riverbed hydrology.

4) FSI Debate

The DMRC had proposed 4 FSI on either side of the corridor to achieve greater population densification through vertical development of residential and commercial properties. The PMC will raise money for the metro and needed civic amenities to support the higher density. Furthermore, PMC hopes to increase the use of metro.

Some members of the planning committee have suggested that three FSI be granted not only within a 500-m radius along the metro corridor but also in the entire city. Members have suggested that the amount collected through the premium on additional FSI should be turned into an urban development fund. A 60% share of this fund should be used for the metro project, while 15% for the PMPML and high capacity mass transit road and monorail and 25% for developing basic infrastructure.

But as per several urban planners, NGOs and experts, the FSI introduction will have more drawbacks than benefits for the city.

1. Even if half of the landowners along the metro corridor take advantage of the 4 FSI proposal, it will lead to 20 km² of built up area in coming years, which is more than the total housing needs of Pune for the next 20 years.
2. The PMC would raise ₹37,000 crore (US\$4.4 billion) from the sale of FSI whereas it needs just ₹3,000 crore (US\$360 million).
3. In the area studied, most of the plots which could consume the 4 FSI were at the edge of the corridor away from the stations, while many plots next to the tracks and the stations would remain as they are, since they are too small to accommodate the extra FSI. This plan might backfire as the distance of these plots from the nearby metro corridor might encourage the residents to use private vehicles and thus, defeat the purpose of metro.
4. Given the prevailing land costs, the new development that comes up will be of the "premium" category. Thus any new housing that comes up through this extra FSI will cater to the more affluent segment, which is the group least likely to use the Metro.

5. The open space per capita in the city will be reduced to half or less of what it is at present. The space required for other public amenities like hospitals, schools, clinics etc. will also fall short since very few plots are large enough to come under the "amenity" space rules under which the landowners have to give small portion to the city for providing amenities.

In July 2018, the Department of Defence of the MoD notified height restrictions in a six-kilometer radius of the National Defence Academy and the Lohegaon airport. This area accounts for approximately 50% of the city's area. The notification restricts the construction of high-rise buildings and has made 4 FSI along the metro corridor under the transit-oriented development policy impossible.

F. In popular culture

In 2021, the first-ever movie to be shot in Pune metro was the Shah Rukh Khan and Nayanthara starrer film Jawan. The film was shot in Sant Tukaram Nagar metro station.

In 2024 Maha metro announced that the metro train will be operational till midnight during Ganesh Festival. On the day of Ganesh Visarjan the metro train will be operational for 24 hours. From September 7 to 9, the Pune Metro will operate from 6:00 AM to 11:00 PM. However, to better serve the public during the Ganeshotsav festivities, the operating hours will be extended. From September 10 to 16, the Metro will run from 6:00 AM until midnight. On the final day of the celebrations, September 17, the Metro was operated continuously for 24 hours handling 3,46,633 passengers the highest daily passengers number by succeeding 14 September 2,43,453 Passengers recorded. This means it will run from 6:00 AM on September 17 until 6:00 AM on September 18. During this Ganeshotsav festivities 7 September to 17 September total 20,44,342 Passengers traveled by Metro.

A way towards Digitalisation --However, they suggested that the percentage of digital payments might have already exceeded 50% by now. Highlighting contributing factors, a source explained, "The introduction of WhatsApp ticketing played a significant role in boosting the number of commuters opting for digital transactions. The facility has been widely embraced since its launch in June. Within its first week of launch, the numbers went above a thousand for each day."- TIMES OF INDIA

The specific article from The Times of India mentioning the introduction of WhatsApp ticketing and its impact on digital payment adoption among metro commuters was published on December 25, 2024.

Times of India

The article reports that Pune Metro leads in digital payments, with an average of 75% of transactions conducted digitally daily, occasionally reaching 82%. In comparison, Nagpur Metro has seen a rise in digital payment adoption, hitting the 41% mark. The introduction of WhatsApp ticketing has played a significant role in boosting the number of commuters opting for digital transactions.

	Pune	Mumbai	Delhi	Other
	Metro	Metro	Metro	Metro systems
				(Chennai, Bengaluru, Hyderabad, etc.)
Comparison	Delayed project execution due to land acquisition and funding issues. Limited coverage initially, serving fewer areas compared to the city's expanding population. Challenges in integrating with PMPML (Pune's bus	High congestion due to dense urban layout. Delays in project phases (e.g., Metro 2A, 7). High fares compared to suburban railways. Social Issues: Displacement of residents for construction. Poor last-mile connectivity.	Operational inefficiencies during peak hours. Rising maintenance and operational costs. Struggles to meet evolving commuter needs with new areas requiring coverage. Social Issues: Crowding at interchanges, causing	Slow progress in construction and integration with city transport. Lack of ridership due to inadequate awareness and connectivity. Financial viability concerns in Tier 2 cities. Social Issues: Neglect of marginalized areas, leading

	transport). Social Issues: Resistance from locals regarding land acquisition. Environmental concerns due to tree cutting and construction.		commuter discomfort. Limited inclusivity for differently-abled individuals in some areas.	to inequitable access. Resistance to elevated metro projects impacting local aesthetics.
Possible solutions	Expedited multi-modal integration with buses and cycle tracks. Transparent communication with citizens about long-term benefits.	Affordable fare structures and increased frequency of trains. Enhanced connectivity with BEST buses and rickshaw feeder services.	Expanding routes to NCR regions (e.g., Gurgaon, Faridabad). Regular audits for accessibility features and infrastructure improvements.	Promoting public awareness campaigns about metro benefits. Government subsidies to ensure affordability.

Results

The analysis of Pune Metro reveals significant insights into its current operational status and future potential. Key findings include:

- 1. Connectivity:** Pune Metro's network shows promise but lacks comprehensive coverage compared to metro systems in cities like Delhi and Mumbai. Expansion of routes and improved last-mile connectivity are essential.
- 2. Traffic Congestion:** Initial data suggests a potential reduction in vehicular congestion in areas where the metro is operational. However, broader network implementation is needed to achieve city-wide impact.
- 3. Human Behavior:** Surveys indicate resistance among some commuters to shift from personal vehicles to the metro. Reasons include convenience, lack of awareness, and inadequate integration with other transport modes.

4. Digital Adoption: Initiatives like WhatsApp ticketing have significantly boosted digital payment adoption, reflecting positive public response to tech-driven solutions.

Proposed Solutions

- To increase the the expansion of the metro network to cover high-demand routes.
- Enhance last-mile connectivity through shuttle services, bike-sharing, or e-rickshaws.
- Conduct awareness campaigns to schools,colleges,soceities,etc. to educate the public on the benefits of metro usage.
- Continue integrating technology to improve commuter experience and operational efficiency

General Challenges

1. Environmental impact and urban disruption during construction.
2. High reliance on external funding and public-private partnerships.
3. Maintenance of safety standards amidst growing ridership.
4. Approximately 70-80 % People in pune city specially in the area of PCMC , The metro from chinchwad to shivaji nagar , instead of metro they prefer by going PMPML Bus and rest others prefer auto or cab.
5. There are also such metro who run nearly empty i.e. people do not opt metro for travelling as a result its again increases traffic for bus or auto.
6. Most of the people use their private vehicles such as two wheeler or four wheeler instead of public transport.

IV. CONCLUSION

The research highlights Pune Metro's potential to transform urban mobility in the city by alleviating traffic congestion and promoting sustainable transportation. However, it also reveals key challenges, including limited network coverage, insufficient integration with other transport modes, and low public adoption compared to established metro systems in Mumbai, Delhi, Kolkata, Hyderabad, and Chennai.

To address these issues, expanding the network, improving last-mile connectivity, and running public awareness campaigns to encourage ridership are crucial. Leveraging technology and offering affordable fares can further enhance user experience and acceptance.

Ultimately, Pune Metro's success depends on proactive planning, stakeholder collaboration, and sustained efforts to meet the city's growing transportation needs effectively also spreading awareness of using metro so as to avoid traffic.

Possible Solutions

1. Simplify approval processes for land acquisition and project funding.
2. Use renewable energy sources for metro operations.
3. Ensure equal access for all, including economically weaker sections and differently-abled individuals.
4. Seamless connectivity with local transport modes and promotion of park-and-ride facilities.
5. Implement advanced ticketing and real-time tracking to enhance user experience.
6. Spreading awareness regarding perks of using metro in cities like pune.
7. Reducing more complexities of use of metro.
8. As most of the people prefer buses over metro , there should be proper routes or more metro stations so that it will decrease people's time of traveling by metro as compared to bus or any other vehicles.
9. In cities such as Mumbai , mostly people prefer local train or metro over any other public transport so as to avoid traffic and its possible due to people have adopted of using metro.

APPENDIX

Appendix A: Data Sources

1. Reports and official statistics from Pune Metro Rail Corporation.
2. Peer-reviewed journals on urban mobility and metro systems.
3. Government publications on urban planning and infrastructure in various news papers.
4. Online resources and academic databases like Google ,Wikipedia,you tube,etc.

Appendix B: Workshop Notes

- Key discussions from urban mobility conferences.
- Feedback from industry experts on metro system integration.
- Insights on digitalization in public transport systems.

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UNDERSTANDING THE CAUSES OF DEPRESSION: USING MACHINE LEARNING ALGORITHMS.

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Abstract

Depression is a multifaceted mental health issue that stems from a mix of biological, psychological, and environmental influences. Even with progress in medical research, many of its fundamental causes are still not well understood. The rise of artificial intelligence (AI) and machine learning (ML) has equipped researchers with the ability to sift through large datasets to reveal hidden patterns and connections. These technologies could help pinpoint genetic vulnerabilities, brain chemistry imbalances, lifestyle factors, and environmental triggers that contribute to depression. By providing a deeper insight, AI and ML are opening new avenues for better diagnosis, prevention, and treatment approaches. This paper examines the significant impact of AI and ML in uncovering the underlying causes of depression and their potential effects on mental health care.

Introduction:

Depression is a common and serious mental health issue that impacts millions of people around the world, regardless of their age, gender, or socio-economic status. It not only leads to emotional pain but also affects physical health, relationships, and overall well-being. Traditional methods of diagnosis, like clinical interviews and self-reported symptoms, often struggle to capture the intricate web of factors that contribute to depression. These approaches may miss subtle biological indicators or external triggers, making it challenging to create effective treatments. Artificial Intelligence (AI) and Machine Learning (ML) have emerged as groundbreaking tools that can analyze complex, multidimensional datasets. They can reveal patterns and connections that might go unnoticed by human analysts. These technologies are being utilized in various medical fields, and their application in mental health research is expanding quickly. By

combining data from genetics, neuroimaging, environmental influences, and behavioral trends, AI and ML provide a more thorough understanding of depression. This paper explores how these innovative tools are transforming our methods of investigating the root causes of depression.

Literature Review:

AI has shown remarkable effectiveness in processing and analyzing extensive datasets, including electronic health records, brain imaging data, and various speech or text samples. In the realm of mental health, AI applications can identify subtle signs of emotional distress that might not be evident during clinical evaluations. For example, natural language processing (NLP) algorithms can examine a person's speech or writing patterns to uncover indicators of depression, such as a limited vocabulary, slower response times, or negative sentiment. Additionally, AI-driven chatbots and virtual therapists are being created to offer immediate support for individuals dealing with mild to moderate depression. These tools utilize conversational AI to evaluate mood and recommend coping strategies, serving as a supplementary resource alongside traditional therapy.

a] Identifying Genetic Risks with Machine Learning:-

Depression frequently has a genetic basis, with research indicating that certain DNA variations can heighten the risk of developing the condition. Machine learning algorithms are particularly adept at analyzing genetic data, such as genome-wide association studies (GWAS), to uncover these variations. These algorithms can navigate through millions of genetic markers to identify specific genes or mutations associated with depression.

For instance, research employing machine learning has revealed variations in genes related to serotonin regulation—a crucial neurotransmitter involved in mood disorders. Such discoveries allow researchers to gain deeper insights into the biological mechanisms underlying depression and assist in the development of targeted treatments, including personalized medication plans.

b] The Role of Environment and Lifestyle:-

Environmental stressors, such as trauma, loss, or chronic stress, play a significant role in the development and progression of depression. Lifestyle choices, including poor sleep, insufficient physical activity, and unhealthy eating habits, can further worsen symptoms. AI has the capability to combine data from various sources, such

as wearable devices, social media interactions, and self-reported surveys, to assess the influence of these factors. Wearable devices, like fitness trackers or smartwatches, gather real-time information on sleep patterns, physical activity levels, and heart rate variability. These metrics can be analyzed using machine learning models to spot deviations that might indicate a higher risk of depression. Furthermore, AI can evaluate environmental data, such as socioeconomic status or exposure to negative life events, to gain a deeper understanding of how these external factors interact with individual vulnerabilities.

c] Studying Brain Chemistry and Body Signals:

Depression is closely associated with irregularities in brain chemistry, particularly concerning neurotransmitters like serotonin, dopamine, and norepinephrine. Additionally, inflammation and hormonal imbalances in the body have been shown to contribute to this condition. AI algorithms can analyze data from brain imaging studies, such as functional magnetic resonance imaging (fMRI) or electroencephalograms (EEG), to identify patterns linked to depression. For instance, AI can detect decreased activity in the prefrontal cortex or increased activity in the amygdala—regions of the brain often involved in depressive disorders. Moreover, machine learning models can examine blood tests and other biomarkers to reveal signs of chronic inflammation or hormonal imbalances. These findings enhance our understanding of the biological mechanisms that underlie depression.

Methodology:

This paper employs a systematic review approach to analyze existing studies on the application of AI and ML in understanding depression. Research articles from reputable databases, including PubMed, IEEE, and Google Scholar, were examined to gather insights on various aspects of depression, such as genetic factors, neuroimaging data, lifestyle influences, and environmental triggers. The analysis included studies that utilized AI and ML techniques, including supervised learning, unsupervised learning, and deep learning.

Key areas of focus included:

- The role of genetic data in predicting risks for depression.
- AI's capability to analyze neuroimaging and brain activity data.

- The integration of data from wearable devices to monitor lifestyle patterns.
- The influence of environmental and social factors on mental health.

Results:

The analysis indicated that depression arises from a complex interplay of genetic, biological, environmental, and lifestyle factors. AI and ML have shown impressive accuracy in identifying these factors and predicting the risks of depression. For instance, ML algorithms that analyze genetic data have successfully pinpointed specific DNA mutations associated with depression with high accuracy. Likewise, AI models that assess neuroimaging data can identify structural and functional abnormalities in the brain linked to depressive symptoms. Wearable devices have offered valuable insights into behavioral patterns, such as poor sleep quality and decreased physical activity, which often precede depressive episodes. AI has also proven effective in evaluating social and environmental data. For example, algorithms can predict depression risks based on exposure to adverse life events, social isolation, or economic challenges.

Discussion:

AI and ML are transforming our understanding of depression by revealing patterns that traditional methods often overlook. They offer a comprehensive view by combining data from various fields, including genetics, brain chemistry, and environmental influences. This all-encompassing approach allows for early detection, tailored treatment plans, and improved prevention strategies. Nonetheless, challenges persist. Protecting the privacy and security of sensitive mental health information is a major concern. Many people hesitate to share their personal data due to fears of misuse or discrimination. It is crucial to address these issues with strong data protection measures. Another challenge is ensuring that AI models are unbiased and inclusive. Depression can present differently in various populations, and algorithms trained on limited datasets may not capture these variations. Ongoing research should aim to create AI tools that are fair and accessible to a wide range of groups.

Conclusion:

AI and ML have demonstrated significant potential in enhancing our understanding of depression. By analyzing extensive and complex datasets, these technologies can identify genetic vulnerabilities, detect brain irregularities, and track lifestyle factors that

contribute to depression. Merging AI with traditional diagnostic and therapeutic approaches promises to enhance mental health care, making it more effective and personalized. As these technologies advance, they have the potential to revolutionize mental health research and practice. However, ethical issues, such as data privacy and equitable access, must remain a top priority. With ongoing research and development, AI and ML can play a crucial role in tackling the global challenge of depression and improving the lives of millions.

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ETHICAL IMPLICATIONS OF AI ADOPTION IN EDUCATION**Sonal Mhaske**

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Abstract:

Artificial Intelligence (AI) has swiftly invaded many sectors, education being arguably the worst hit. The global AI market value in 2023 stood at \$196.63 billion, forecasted to rise considerably in years to come, as more sectors adopt AI technologies. The world of education is undergoing a drastic reform due to AI-generated tools such as personalized learning platforms, automated grading systems, and technologies to help with accessibility. The innovations stand in agreement with the Sustainable Development Goal 4 (SDG 4); they promote inclusive and equitable high-quality education and learning opportunities for all. Examples outside the numerous start-ups in this space include Duolingo, CoGrader, and the BBC incorporation of AI. Nonetheless, the adoption of AI leads to challenges relating to algorithmic bias, responsible decision-making, and data privacy. Although AI potentially counteracts human bias and enhances efficiency, it may perpetuate bias if the dataset for training is not enterprise-wide in scope and does not include samples from various races, ethnic groups, or genders. Furthermore, there has been an accompanying call for very stringent regulations to protect student privacy given the use of big data. Thus, the solution to these challenges calls for collaboration of educators, policymakers, and developers responsible for the actual proposals to guarantee AI adoption is appropriate. This paper discusses AI and its transformational potential to mark quality revolution upon the education sector but also strives for enforcing regulation around fairness. Future research should focus on manipulating AI inputs in line with diversity in mind so that fairness and inclusiveness are not sacrificed.

Keywords: Artificial Intelligence (AI), Education, Personalized Learning, Automated Grading, Accessibility, Sustainable Development Goals (SDG 4), Algorithmic Bias, Ethical Decision-Making, Data Privacy, Collaborative Policymaking, Data Diversity, Data Protection, Duolingo, CoGrader, BBC's AI Initiatives

Introduction:**Background and Context:**

The rapid integration of Artificial Intelligence (AI) in education has sparked both excitement and concern. While AI has the potential to enhance teaching and learning, it also raises critical ethical questions about the impact on student well-being, teacher roles, and the very nature of education. This study seeks to investigate the ethical implications of AI adoption in education, asking: What are the ethical concerns surrounding AI-driven education, and how can they be addressed to ensure responsible integration?

Purpose and Objectives:

- Promoting Fairness and Inclusivity
- Ensure that AI systems are designed to be fair and do not perpetuate existing biases.
- Utilize diverse and representative training data to minimize discrimination against underrepresented groups.
- Safeguarding Privacy
- Protect student data and ensure compliance with regulations such as FERPA.
- Implement transparent data usage policies to build trust among students and educators.
- Enhancing Transparency and Accountability
- Develop clear guidelines on how AI tools are used in educational settings.
- Conduct regular audits of AI systems to ensure they operate fairly and effectively.
- Fostering Critical Engagement
- Encourage students and educators to critically evaluate AI-generated content.
- Provide training on the ethical use of AI tools to promote responsible engagement.
- Supporting Equity in Learning Opportunities
- Create AI-driven solutions that cater to diverse learning needs and styles.
- Ensure that all students have equal access to AI resources and support.
- Encouraging Collaboration Among Stakeholders
- Involve educators, students, and policymakers in discussions about AI ethics.
- Establish partnerships to develop ethical frameworks and best practices for AI use in education.

Research Questions:-

1. What are the primary ethical concerns associated with the use of AI technologies in educational settings?

2. How can educational institutions ensure equitable access to AI tools for all students, regardless of socioeconomic status?
3. How can educational institutions safeguard student data while utilizing AI technologies for personalized learning?
4. What ethical guidelines should be established for the future development and implementation of AI in education?

Literature Review:

The literature review will examine existing research on AI in education, focusing on the following areas:

1. Bias and Discrimination:

Researchers have identified the potential for AI algorithms to perpetuate and exacerbate existing biases in educational settings. For instance, a study by the National Center for Education Statistics (NCES) found that AI-driven educational tools may have inherent biases, affecting student outcomes and opportunities (Baker, 2019).

2. Data Privacy and Security:

Previous research has highlighted concerns about student data privacy and security in AI-driven educational tools. A study by West and Nguyen (2019) examined the data practices of popular educational apps, revealing that many lacked clear privacy policies and data protection measures.

3. Teacher and Student Perspectives:

Research has also explored the perspectives of teachers and students regarding the ethical implications of AI in education. A study by Holstein et al. (2018) found that while teachers and students recognized the potential benefits of AI, they also expressed concerns about privacy, bias, and the impact on human relationships in the classroom.

4. Digital Literacy and Critical Thinking:

Research has highlighted the need for students to develop critical thinking and digital literacy skills in relation to AI technologies. A study by Selwyn (2019) argued that educators should prioritize digital literacy as a means of preparing students for a future where AI plays a significant role in society.

Theoretical Framework:

The ethical implications of AI adoption in education require a multi-faceted approach that considers the complex interplay of technology, human values, and societal norms.

By applying this theoretical framework, stakeholders can better navigate the challenges and opportunities presented by AI in educational contexts, ensuring that its use aligns with ethical principles and promotes positive educational outcomes. Continuous dialogue among educators, technologists, policymakers, and students is essential to refine this framework and adapt it to evolving technological landscapes.

Methodology of Previous Research: -

The research involves:

1. Comparing the performance of SVM and KNN for classification.
2. Evaluating various clustering techniques, including K-means, to identify cybercriminal patterns.
3. Utilizing real-time datasets to validate the proposed methodologies.
4. Highlighting Gaussian mixture models as the superior method for unsupervised cybercrime detection due to their high accuracy and enhanced performance

Methodology:

This study will employ a qualitative research design, using:

1. In-depth interviews with educators, policymakers, and AI developers to gather insights on the ethical implications of AI driven education.
2. Focus groups with students and teachers to explore the impact of AI-driven education on teaching, learning, and student well-being.
3. Content analysis of existing AI-powered educational tools and platforms to identify ethical concerns and areas for improvement.

Data Analysis:

1) Qualitative Analysis:

- **Thematic Analysis:**

Identify recurring themes and patterns in qualitative data collected from interviews, focus groups, and open-ended survey responses. This can help highlight common ethical concerns, such as privacy, bias, and accountability.

- **Content Analysis:**

Analyze the content of policy documents and literature to identify ethical frameworks and guidelines that address AI in education.

2) Quantitative Analysis:

- **Descriptive Statistics:**

Use descriptive statistics to summarize survey responses (e.g., mean, median, mode) related to perceptions of ethical implications.

- **Inferential Statistics:**

Conduct inferential statistical tests (e.g., t-tests, ANOVA) to compare differences in perceptions across different groups (e.g., teachers vs. students) regarding ethical issues.

- **Correlation Analysis:**

Explore potential correlations between the use of AI technologies and reported ethical concerns, such as privacy breaches or perceived biases.

Expected Results:

Hypotheses:

Based on the literature review, this study expects to find that:

- a. AI-driven education will perpetuate existing biases and inequalities if not designed with fairness and transparency in mind.
- b. The lack of transparency and explainability in AI decision making will erode trust in AI-driven education.
- c. AI will exacerbate the digital divide and accessibility issues in education if not designed with inclusivity in mind.
- d. The responsible integration of AI in education will require a human-centered approach that prioritizes student well-being and agency.

Machine learning Models:

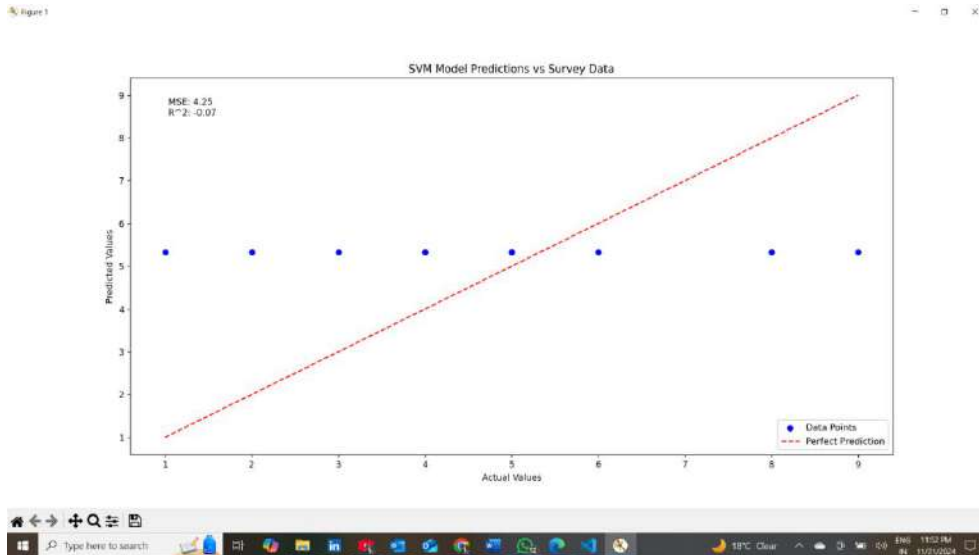
Analysis using jupyter Lab –

1. SVM model: -

Support Vector machine is supervised machine learning technique used for regression and classification. The objective of this analysis is to predict the number of cybercrime incidents in various states and union territories based on the mid-year projected population data using a Support Vector Machine (SVM) regression model.

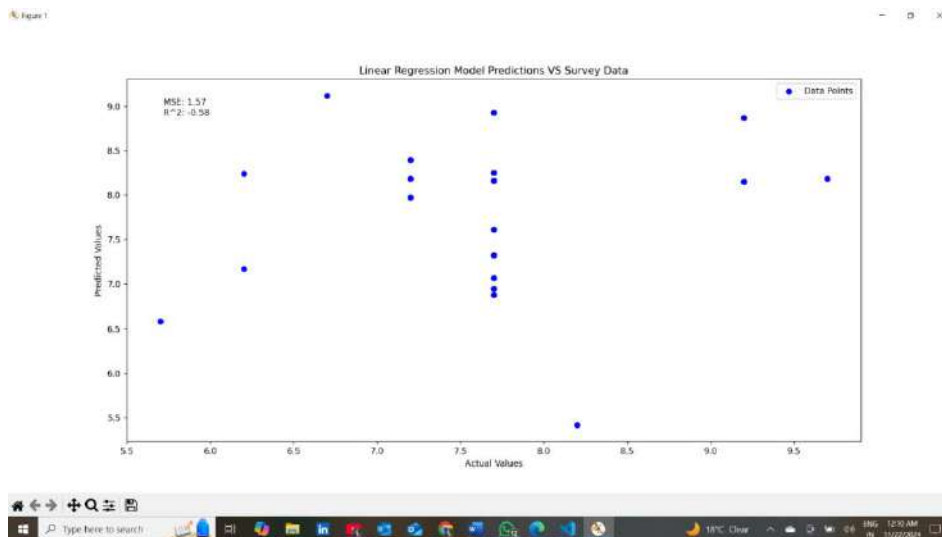
- **Example Evaluation Metrics:**

- Mean Squared Error: 4.25
- R² Score:0.07



2. Linear Regression Model:

We used a Linear Regression model to predict the number of cybercrime incidents based on the mid-year projected population. Linear Regression is a simple and widely used supervised learning algorithm that assumes a linear relationship between the independent variable (population) and the dependent variable (cybercrime incidents).



Analysis using R-Studio:

The R-Studio analysis includes loading and understanding the dataset, splitting the data into training and testing sets, fitting different models to make predictions, calculating the MSE for model evaluation, and computing basic statistical measures. These steps collectively aim to understand the data, build predictive models, and evaluate their performance, providing insights into the relationships within the data and the effectiveness of different modeling approaches.

1. Loading dataset in R:

```
> path<-"C:/Users/Administrator/Downloads/vgchartz2024.csv"
  > content <- read.csv(path)
  > print(content)
```

2. Create test n train set :-

```
> x = seq(0,1, by =0.01)
> y = 3 + 3*x + 190*x^2 + rnorm(length(x),0,50)
> testx = seq(1.1,1.5, by =0.01)
> testy = 3 + 3*testx + 190*(testx)^2 + rnorm(length(testx),0,20)
```

3. Calculate MSE :-**a] Simple Linear Regression:**

```
linearmodel = lm(y~x) #model fitting > predict_linear = predict(linearmodel,
list(x= testx)) #prediction on test data set
```

b] Quadratic Regression:

```
> z = x^2 > quadraticmodel<- lm(y~ x + z) #fitting > predict_quadratic =
predict(quadraticmodel, list(x = testx, z = testx^2))#prediction on test data set
```

c] Smoothing Splines:

```
> smoothspline = smooth.spline(x,y,df = 20) #fitting > predict_spline =
predict(smoothspline, testx)$y #prediction on test data set > seq = seq(min(x),
max(x), by = 0.001) > predict = pred
```

The screenshot shows the RStudio interface. The console window displays the following R code and its output:

```

> x = seq(0,1, by =0.01)
Error: unexpected ">" in ">"
> x = seq(0,1, by =0.01)
> y = 3 + 3*x + 190*x^2 + rnorm(length(x),0,50)
> testx = seq(1.1,1.5, by =0.01)
> testy = 3 + 3*testx + 190*(testx)^2 + rnorm(length(testx),0,20)
> predict_linear = predict(lmmodel, list(x= testx))
Error: object 'lmmodel' not found
> install.packages("linearModel")
Installing package into 'C:/Users/Lenovo/AppData/Local/R/win-library/4.4'
(at 'lib' fs unspecified)
trying URL 'https://cran.rstudio.com/bin/windows/contrib/4.4/linearModel_1.0.2.zip'
Content type 'application/zip' length 32731 bytes (31 KB)
downloaded 11.48

package 'linearModel' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
  C:/Users/Lenovo/AppData/Local/Temp/ktcnkpkX10/downloaded_packages
> predict_linear = predict(lmmodel, list(x= testx))
Error: object 'lmmodel' not found
> library(linearModel)
> predict_linear = predict(lmmodel, list(x= testx))
Error: object 'lmmodel' not found
> predict_linear = predict(lmmodel, list(x= testx))
Error: object 'lmmodel' not found
> linearmodel = lm(y~x)
> predict_linear = predict(lmmodel, list(x= testx))
Error: object 'lmmodel' not found
> predict_linear = predict(lmmodel, list(x= testx))
Error: object 'lmmodel' not found
> f = x^2
> install.packages("quadraticModel")
trying URL 'https://cran.rstudio.com/bin/windows/contrib/4.4/quadraticModel_1.0.2.zip'
Content type 'application/zip' length 32731 bytes (31 KB)
downloaded 11.48

package 'quadraticModel' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
  C:/Users/Lenovo/AppData/Local/Temp/ktcnkpkX10/downloaded_packages

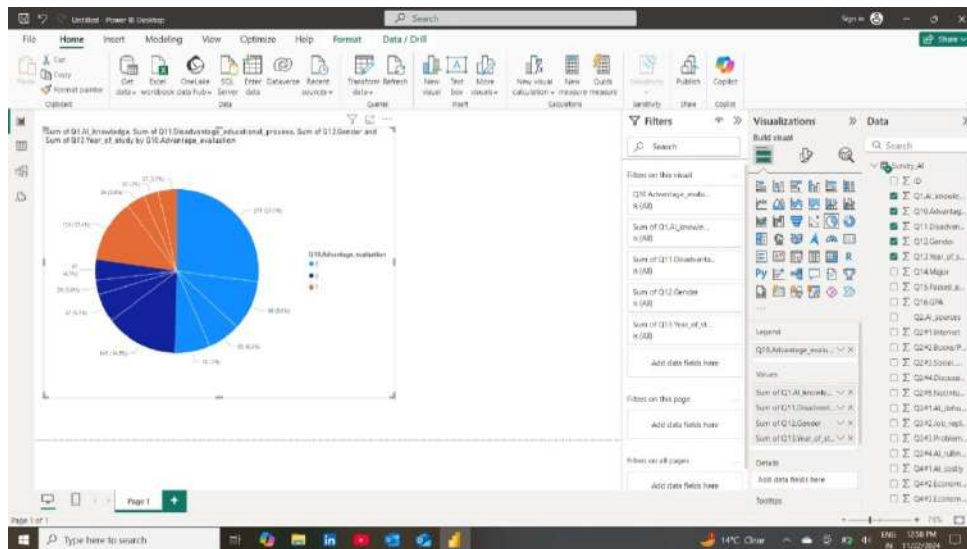
```

The Environment pane on the right shows the following objects:

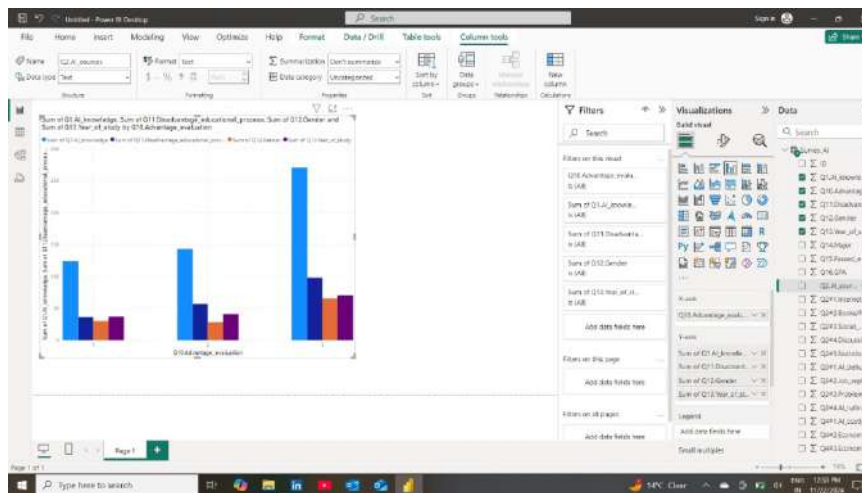
Object	Type	Value
linearmodel	List of 12	
quadraticmodel	List of 12	
smoothspline	List of 21	
Survey_AI	92 obs. of 35 variables	
predict_linear	Named run [1-41]	187 189 191 193 195 ...
predict_quadratic	Named run [1-41]	263 269 274 279 285 ...
predict_spline	run [1-41]	349 361 373 385 398 ...
seq	run [1-1001]	0 0.001 0.002 0.003 0.004 0.005 0.006 0.007 ...
testx	run [1-41]	1.1 1.11 1.12 1.13 1.14 1.15 1.16 1.17 1.18 1.19 ...
testy	run [1-41]	239 237 234 276 262 ...
x	run [1-101]	0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 ...
y	run [1-101]	59.2 45.2 -52.2 15.7 -28.3 ...
z	run [1-101]	0 0.0001 0.0004 0.0009 0.0016 0.0025 0.0036 0.0049 ...

Analysis using Power-Bi: –

Pie chart-



HistoGram-



Conclusion:

The ethical implications of AI adoption in education are multifaceted and require a collaborative approach to navigate effectively. By prioritizing fairness, privacy, transparency, and inclusivity, educational institutions can harness the benefits of AI while mitigating its risks. The study emphasizes the need for continuous dialogue among educators, students, policymakers, and technologists to refine ethical frameworks and best practices for AI use in education. As AI continues to evolve, it is imperative that educational stakeholders remain vigilant and proactive in addressing the ethical challenges it presents, ensuring that AI serves as a tool for equity and empowerment in the learning environment. Ultimately, responsible AI integration in

education can lead to improved educational outcomes and a more equitable future for all learners.

Acknowledgment:

We express our heartfelt gratitude to Dr. Manisha M. Patil, Assistant Professor at Indira College of Commerce and Science, Pune, for her invaluable research guidance, support, and encouragement throughout this project. Her expertise and insights were instrumental in shaping the success of this work. We also thank everyone who contributed resources and assistance to complete this research.

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KALKIOS: A SECURITY-FOCUSED OPERATING SYSTEM FOR OFFENSIVE SECURITY PROFESSIONALS

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Abstract

The increasing complexity of cyber threats necessitates advanced tools for offensive security professionals. KalkiOS is introduced as a novel security-focused operating system tailored for red teamers and ethical hackers. This paper examines the limitations of existing security operating systems, details the architecture and features of KalkiOS, and evaluates its performance. Through comprehensive analysis, KalkiOS demonstrates enhanced efficiency, security, and usability, positioning it as an asset in the cybersecurity domain.

Keywords - Offensive Security, Security Operating System, Red Teaming, Ethical Hacking, Custom Kernel

I. Introduction

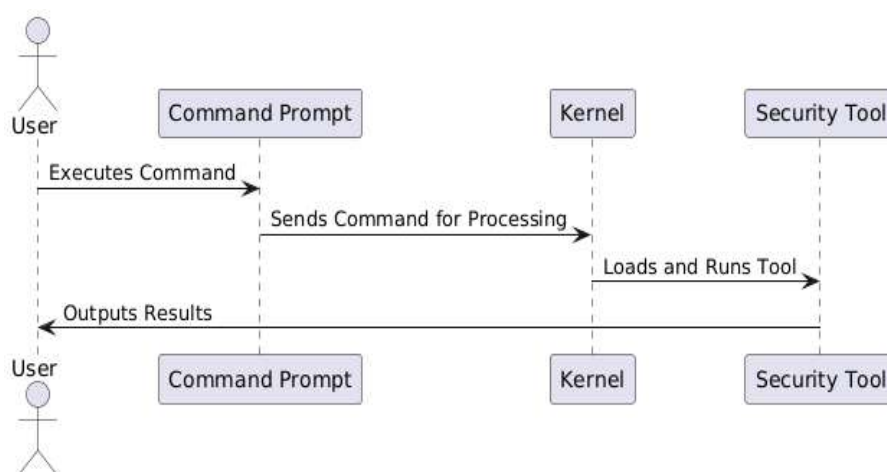
In an era where cybersecurity threats are becoming more sophisticated and pervasive, offensive security has emerged as a critical discipline to proactively identify and address vulnerabilities within information systems. Red teamers, ethical hackers, and penetration testers play an instrumental role in simulating real-world attack scenarios, ensuring organizations remain resilient against potential breaches. However, these professionals require operating systems that not only host diverse security tools but also provide a robust, efficient, and responsive environment capable of handling high-pressure tasks.

Existing platforms like Kali Linux and Parrot OS have long dominated the offensive security landscape due to their expansive toolsets and pre-configured environments. Yet, despite their popularity, they often fall short in terms of performance optimization and resource efficiency, especially when deployed on systems with constrained

resources. For instance, professionals frequently report performance lags, stability issues, and inefficient memory management when using these platforms in resource-intensive scenarios such as Capture The Flag (CTF) challenges or real-world penetration tests.

To address these limitations, KalkiOS was conceptualized as a next-generation security-focused operating system. Built on a custom kernel specifically tailored for offensive security operations, KalkiOS emphasizes streamlined performance, advanced security measures, and optimized resource utilization. By integrating a curated set of tools with a focus on adaptability and efficiency, KalkiOS aims to provide a seamless experience for modern cybersecurity professionals, even in resource-constrained environments.

Use Case Diagram:



A. Motivation

The growing complexity of cyberattacks and the rising expectations for efficient offensive security workflows have created a pressing need for specialized tools and platforms. While existing operating systems lay the groundwork, they often lack the refinement and optimization necessary for demanding scenarios. KalkiOS was developed to address these gaps, empowering cybersecurity professionals with a system that blends performance with functionality.

B. Contributions

This paper highlights several contributions brought forth by KalkiOS:

- **Analysis:**

Identifying key limitations in current security-focused operating systems and addressing them through innovative design principles.

- **Design and Architecture:**

A comprehensive exploration of KalkiOS's custom kernel and its role in enhancing system security and performance.

- **Evaluation:**

A comparative study demonstrating KalkiOS's superior performance metrics in response time, stability, and resource management.

- **Applications and Enhancements:**

Discussing practical use cases, including red teaming and penetration testing, along with potential future advancements in its architecture.

By building on the foundation of existing systems and addressing their shortcomings, KalkiOS sets a new benchmark for operating systems tailored for offensive security.

II. Literature Review

A. Security-Focused Operating Systems

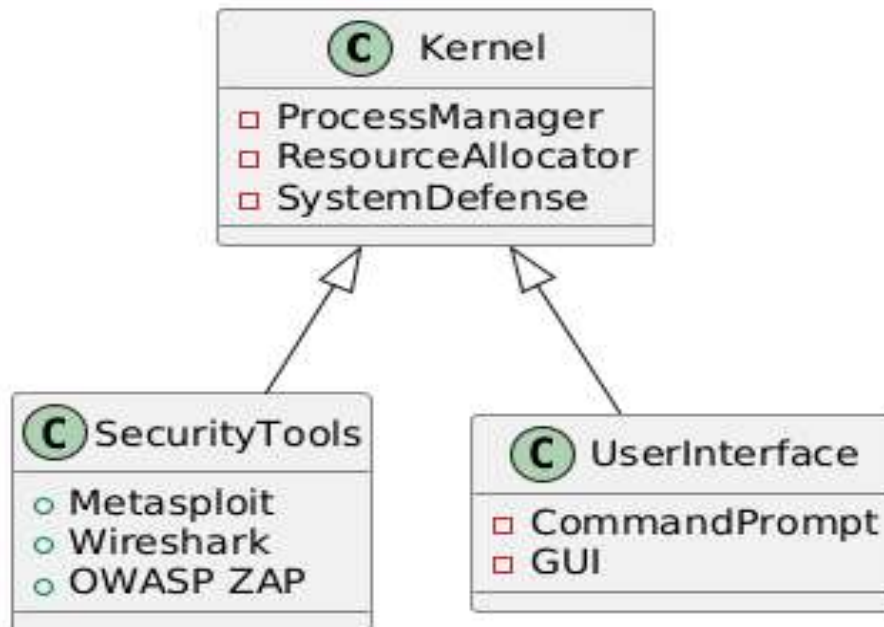
Security-focused operating systems are designed to provide tools and environments conducive to penetration testing and vulnerability assessment. Kali Linux and Parrot OS are prominent examples, offering extensive toolsets for security professionals. However, studies have highlighted limitations in their performance and resource utilization, prompting the need for more optimized solutions [1].

B. Red Teaming and Offensive Security

Red teaming involves simulating adversarial attacks to assess and improve organizational security. Effective red teaming requires advanced tools and platforms that can mimic sophisticated attack vectors. Recent research emphasizes the importance of tailored environments that support the diverse needs of offensive security professionals [2].

C. Custom Kernel Development

Developing a custom kernel allows for enhanced control over system resources and security features. Custom kernels can be optimized for specific tasks, reducing unnecessary overhead and improving performance. Research indicates that such tailored kernels can significantly enhance the efficiency of security operations [3].



III. Design and Architecture of KalkiOS

A. Custom Kernel

KalkiOS features a custom-built kernel designed with a focus on security and performance. This kernel minimizes unnecessary processes, reducing the attack surface and ensuring efficient resource utilization.

B. Integrated Security Tools

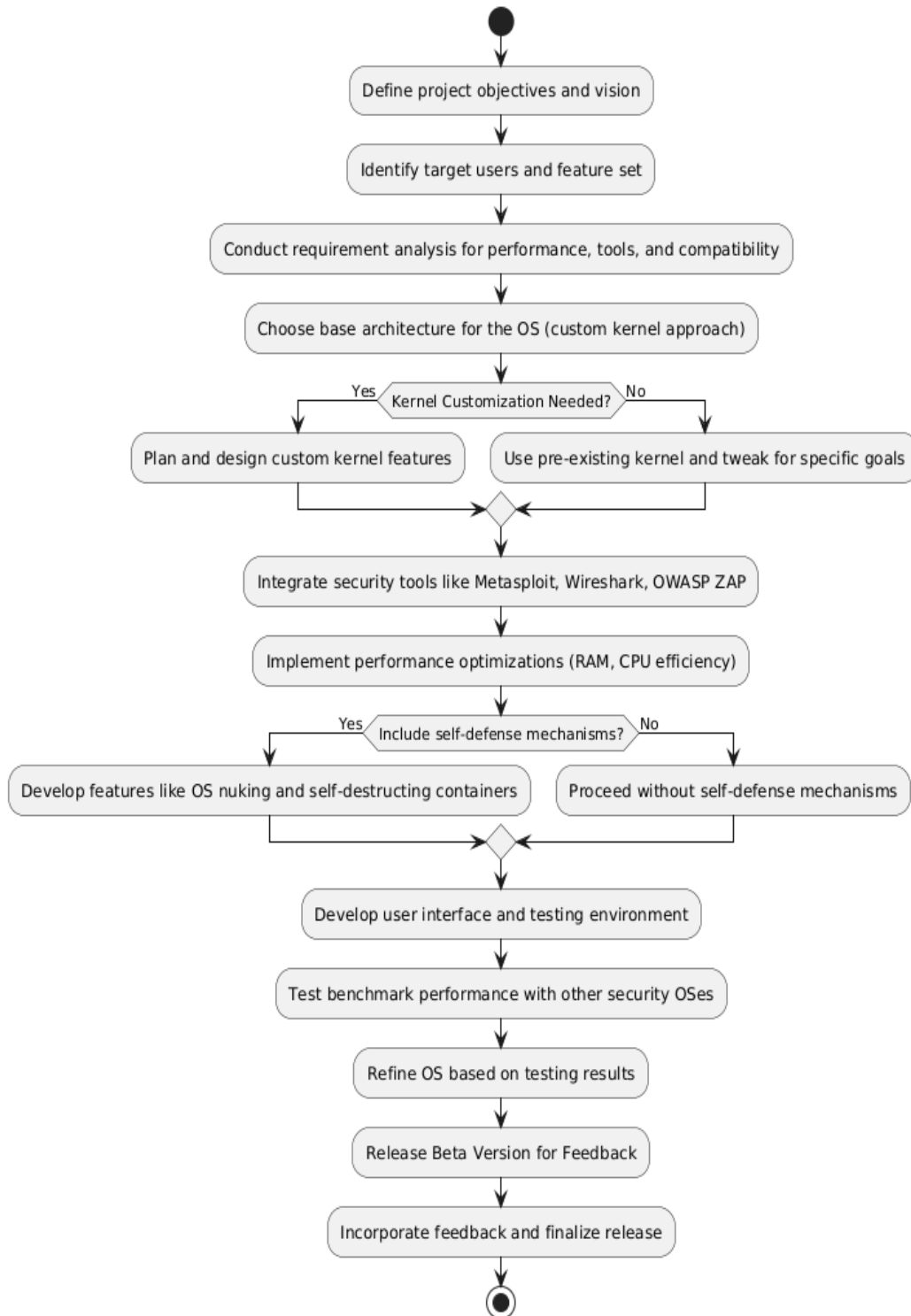
KalkiOS comes pre-installed with a curated selection of offensive security tools, including Metasploit, Wireshark, and OWASP ZAP. These tools are seamlessly integrated into the operating system, providing a cohesive environment for security assessments.

C. Self-Defence Mechanisms

To safeguard the integrity of the operating system during operations, KalkiOS incorporates self-defence mechanisms such as OS nuking and self-destructing containers. These features ensure that sensitive data remains protected, even in compromised scenarios.

D. Performance Optimization

KalkiOS is optimized to operate efficiently on systems with limited resources, ensuring smooth performance during intensive security tasks. This optimization is achieved through streamlined processes and effective resource management.



IV. Performance Evaluation

A. Benchmarking Methodology

KalkiOS was evaluated against existing security-focused operating systems using a series of benchmarks designed to assess tool responsiveness, system stability, and resource utilization.

B. Results

- **Tool Responsiveness:**

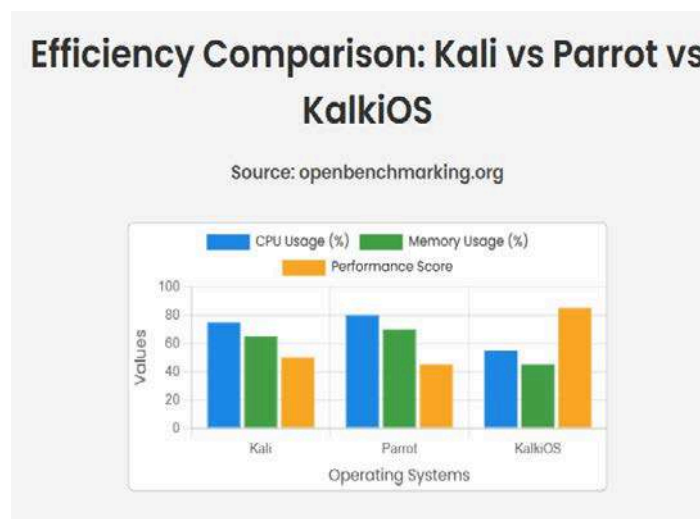
KalkiOS demonstrated faster execution times for resource-intensive tools compared to its counterparts.

- **System Stability:**

Under high-load conditions, KalkiOS maintained superior stability, with fewer crashes and system slowdowns.

- **Resource Utilization:**

The operating system exhibited optimized CPU and RAM usage, allowing for efficient multitasking during security assessments.



V. Practical Applications

KalkiOS is designed to support a wide range of offensive security operations, including:

- **Penetration Testing:**

Providing a robust platform for identifying and exploiting vulnerabilities.

- **Red Team Operations:**

Facilitating comprehensive adversarial simulations to test organizational defences.

- **Security Research:**

Offering a controlled environment for developing and testing new security tools and methodologies.

VI. Future Enhancements

Future developments for KalkiOS may include:

- Integration of AI-driven threat detection and response systems.

- Expansion of the toolset to include emerging security tools and frameworks.
- Enhanced support for virtualization and containerization to facilitate diverse testing environments.
- Continuous updates to the custom kernel to incorporate the latest security advancements.

VII. Conclusion

KalkiOS represents a significant advancement in security-focused operating systems, addressing the limitations of existing solutions and providing a tailored environment for offensive security professionals. Its custom kernel, integrated toolset, and performance optimizations make it very valuable asset in the cybersecurity field. Ongoing development and community engagement will further enhance its capabilities, ensuring that KalkiOS remains at the forefront of security operations.

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A STUDY FOR HOUSE PRICE PREDICTION VISUALIZATION USING POWER BI, TABLEAU

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Abstract:

This project applies machine learning techniques to predict house prices accurately by analyzing complex relationships between property features and market conditions. Using algorithms such as Polynomial Regression, Linear Regression, Power BI, and Tableau the model identifies key factors influencing property valuation. The research highlights the importance of data preprocessing, feature selection, and model evaluation using metrics like Mean Absolute Error (MAE) and R^2 . By automating price estimation, the project reduces manual effort and improves decision-making for buyers, sellers, and investors. The insights provided can aid urban planners and financial institutions in strategic planning. This project underscores the role of machine learning in enhancing market transparency, efficiency, and scalability in real estate valuation.

Keywords:

House Price Prediction, Machine Learning Models, Real Estate Market Analysis, Data Visualization, Property Valuation

1. Introduction

The real estate industry is a vital component of the global economy, significantly influencing investments, policymaking, and urban development. Predicting house prices is an essential task for buyers, sellers, realtors, and financial institutions, enabling better decision-making in property transactions and investments. Accurate price predictions can reduce uncertainties and enhance trust in the market, benefiting all stakeholders involved.

House prices are influenced by numerous factors, including property attributes such as size, age, number of rooms, and amenities, as well as external elements like location, market trends, and economic conditions. However, these factors interact in complex, nonlinear ways, making traditional valuation techniques, such as comparative market

analysis or rule-based methods, often insufficient. To address these challenges, modern machine learning approaches have emerged as powerful tools for analyzing and predicting house prices.

Machine learning algorithms can process large datasets, identify patterns, and model relationships between features and prices with a high degree of accuracy. These algorithms range from linear regression, suitable for basic price modeling, to advanced methods such as Random Forests and Gradient Boosting, which can capture intricate dependencies among variables. The incorporation of these techniques allows for more reliable predictions while offering insights into the factors most critical to determining property value.

The goal of this project is to develop a robust and efficient machine learning model for house price prediction. By leveraging publicly available datasets containing historical property data, the project aims to preprocess, train, and evaluate models to identify the best-performing approach. Key metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), and R^2 are used to assess the models' performance, ensuring that predictions are not only accurate but also interpretable.

In addition to aiding market participants, this research contributes to advancements in the application of machine learning to real-world problems. It emphasizes the importance of data-driven decision-making and highlights the potential of technology to address traditional challenges in the real estate sector. By aligning computational techniques with market demands, the project seeks to bridge the gap between technical innovation and practical utility in predicting house prices with precision and reliability.

Purpose: The purpose of this project is to create a machine learning model that accurately predicts house prices by leveraging data-driven approaches to overcome limitations of traditional valuation methods. By analysing complex relationships between property features and market conditions, the model aims to provide reliable and precise price predictions.

This initiative benefits real estate professionals, investors, and homebuyers by fostering informed decision-making, transparency, and efficiency in the real estate market. Automating price estimation reduces manual errors, saves time, and offers a scalable solution for large-scale evaluations.

The project also emphasizes feature analysis, providing insights into key factors influencing house prices. These insights can assist urban planners, policymakers, and financial institutions in strategic planning for real estate development and investment.

Objectives:

- Collect and pre-process property data.
- Apply machine learning models for house price prediction.
- Evaluate and compare model performance using appropriate metrics.

Research Questions:

- What are the key features that influence house prices?
- How can machine learning models be trained to predict house prices accurately?
- What are the challenges and limitations of current house price prediction methods?

Significance: -

Accurately predicting house prices can provide significant benefits to various stakeholders, including real estate professionals, policymakers, investors, and homebuyers. The following points highlight the importance of this project:

1. Informed Decision-Making:

Reliable predictions help buyers and sellers make well-informed decisions regarding property transactions, ensuring fair pricing.

2. Market Efficiency:

By automating price estimation, the project reduces manual efforts, minimizes errors, and speeds up the evaluation process, contributing to a more efficient real estate market.

3. Investment Planning:

Investors can use predictions to assess market trends and potential returns, enabling better financial planning and risk management.

4. Financial Institutions:

Banks and lenders can use accurate price estimates to evaluate mortgage applications and assess risks more effectively.

5. Transparency:

The use of machine learning ensures consistency and transparency in pricing, fostering trust among stakeholders in the real estate ecosystem.

6. Scalability and Adaptability: The project's machine learning model can be adapted to various regions and updated with new data, ensuring it remains effective in dynamic markets.

7. Cost Efficiency:

Automating property evaluations eliminates the need for frequent manual appraisals, reducing operational costs for agencies and organizations.

2. Literature Review

Overview of Previous Research: -

House price prediction has been a critical area of research, leveraging both traditional statistical methods and modern machine learning approaches. Below is an overview of techniques commonly explored:

1. Linear Regression:

Widely used as a baseline due to its simplicity and interpretability. However, it often fails to capture the nonlinear relationships inherent in real estate data, such as interactions between location, property size, and market trends.

2. Tree-Based Models:

Techniques like Random Forest and Gradient Boosting have shown significant promise in modelling house prices. These methods excel in capturing nonlinear relationships and feature interactions, providing robust and accurate predictions.

3. Neural Networks:

Advanced methods such as Artificial Neural Networks (ANNs) and Convolutional Neural Networks (CNNs) have been applied, particularly for complex datasets. While they perform well in uncovering intricate patterns, their interpretability and computational requirements are significant challenges.

4. Challenges in Prediction:

o Data Sparsity:

Inconsistent availability of key property details such as recent renovations or neighbourhood amenities.

o External Factors:

Economic conditions, interest rates, and infrastructure development significantly affect house prices.

o Data Imbalance:

High-value properties can skew predictions, necessitating techniques like SMOTE or data normalization.

o Regional Variability:

Models trained on one region often struggle to generalize to other areas with unique market dynamics.

● Theoretical Framework:

House price prediction combines principles from real estate economics, data science, and machine learning. Key theoretical underpinnings include:

- **Economic Theories:**

The concepts of supply and demand, price elasticity, and externalities (e.g., neighbourhood characteristics) serve as foundational elements.

- **Machine Learning:**

Supervised learning algorithms (e.g., regression and classification) and time-series forecasting are used to predict prices based on historical and current market data.

- **Feature Importance:**

Identifying significant predictors like location, property size, age, and amenities provides insights into pricing behaviour.

- **Previous Research Methodology:**

- o **Data Collection:**

Sources include property platforms (e.g., Zillow) and open datasets. Key features include size, location, market trends, and amenities.

- o **Preprocessing:**

Handling missing data, encoding categorical variables, and normalizing numerical features.

- o **Modelling:**

Linear Regression for baseline, advanced models like Random Forest and XGBoost for better accuracy.

- o **Evaluation:**

Metrics like MAE, MSE, and R^2 assess model performance.

3. Methodology

- **Dataset Description: -**

- a) **Data Source:**

The dataset typically used for house price prediction comes from real estate listings or public records of property sales. Common sources include Kaggle datasets, government databases, or real estate websites.

- b) **Features:**

The dataset contains various features (variables) that describe each property. Common features include:

- 1. **Location:**

The neighbourhood or city where the house is located.

2. Size:

The total square footage or area of the house.

3. Number of Bedrooms:

How many bedrooms the house has.

4. Number of Bathrooms:

The count of bathrooms.

5. Age of Property:

How old the property is, often given in years.

6. Lot Size:

The size of the land the house sits on.

7. Proximity to Amenities:

Distance to schools, parks, shopping centres, etc.

8. Condition and Renovations:

Whether the house has been recently renovated or is in good condition.

9. Sale Price:

The target variable we aim to predict.

● Data Collection: -

The data is collected from various sources, cleaned, and combined into a single dataset. It is important to ensure that the data is up-to-date and relevant to the area being studied.

● Data Analysis:-**a) Cleaning the Data:**

Handle missing values by filling them with appropriate values (e.g., median for numerical data, mode for categorical data) or by removing incomplete rows.

b) Encoding Categorical Variables:

Convert categorical features (e.g., neighbourhood) into numerical values using techniques like one-hot encoding.

c) Normalizing Numerical Features:

Scale features like square footage and price to ensure that all features contribute equally to the model.

d) Splitting the Data:

Divide the dataset into training and testing sets, usually with a 70-30 or 80-20 split. The training set is used to train the model, while the testing set is used to evaluate its performance.

- **Feature Selection:**

- a) **Correlation Analysis:**

- Identify the most important features by analyzing the correlation between each feature and the target variable (sale price).

- b) **Removing Irrelevant Features:**

- Discard features that do not contribute much to the prediction accuracy.

- c) **Feature Engineering:**

- Create new features if necessary (e.g., price per square foot) to improve

- **Tools and Software :-**

- a) **Python:**

- A popular programming language used for data analysis and machine learning.

- b) **Pandas:**

- For data manipulation and analysis, especially for handling datasets.

- c) **NumPy:**

- For numerical computations and working with arrays.

- d) **Scikit-learn:**

- A library that provides simple and efficient tools for data mining and data analysis, including machine learning models.

- e) **Matplotlib and Seaborn:**

- Libraries used for data visualization, helping to create plots and graphs to understand data distributions and model results.

- f) **Jupyter Notebook:**

- An interactive computing environment that allows you to write code, visualize data, and document your analysis all in one place.

- These tools and techniques enable the development, training, and evaluation of machine learning models for predicting house prices, providing insights and predictions based on the available data.

4. **Model Evaluation:-**

- **Metrics: -**

- 1. **Mean Absolute Error (MAE):**

- Measures the average error between predicted and actual house prices. Lower MAE indicates better accuracy.

2. Mean Squared Error (MSE):

Measures the average of the squared errors. It penalizes larger errors more heavily.

Lower MSE indicates better model performance.

3. R-squared (R^2):

Indicates how well the model explains the variability of house prices. Values closer to 1 mean the model fits the data well.

Results:

The model's accuracy is assessed using these metrics. For example, a low MAE and MSE, combined with a high R^2 value, suggest that the model is making accurate predictions.

Visualizations: Plots of predicted vs. actual prices help to visually confirm the model's performance.

Expected Results and Outcomes

Hypotheses: -

- Advanced algorithms like Random Forest and Gradient Boosting will provide more accurate house price predictions than traditional methods like linear regression.
- Predictions are expected to be within a 5-10% error range of actual prices.

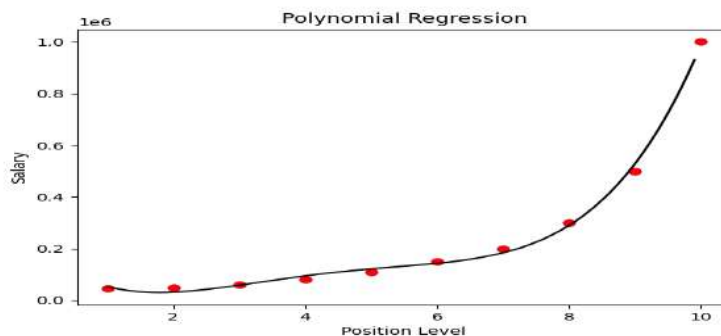
Predicted Outcomes: -

- Performance Improvements: Anticipate lower Mean Absolute Error (MAE) and Mean Squared Error (MSE), and higher R^2 values, indicating better model accuracy.
- Practical Use: The improved accuracy will make these models valuable for real-world applications in the real estate market, helping stakeholders make better-informed decisions.

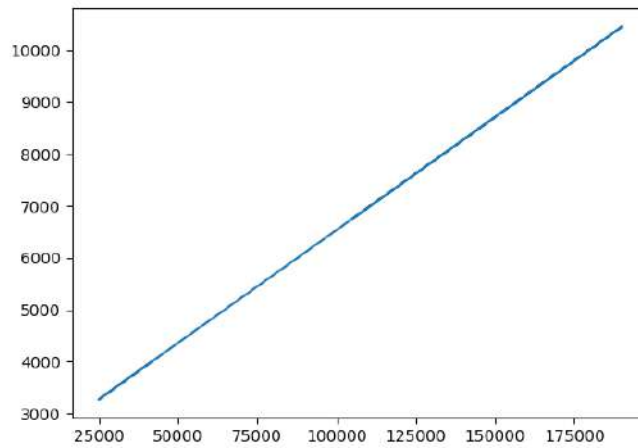
● Predicted Outcomes: -

1. Machine Learning Model-

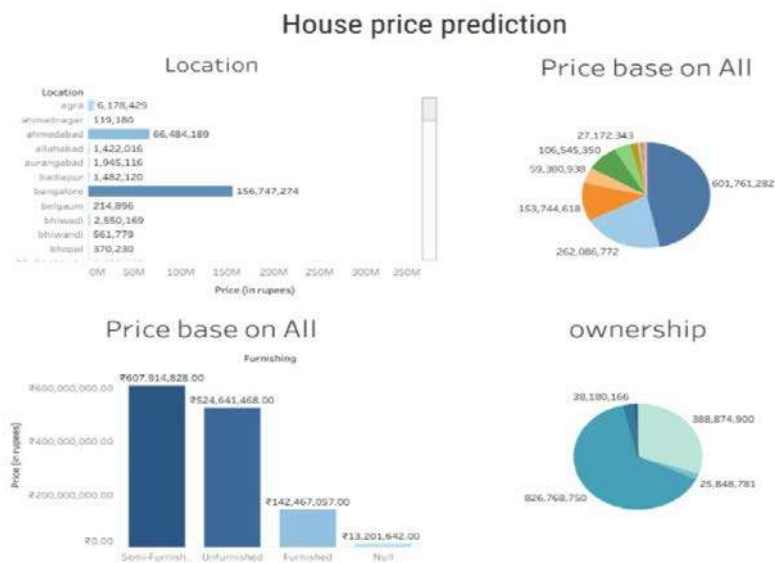
a. Polynomial Regression



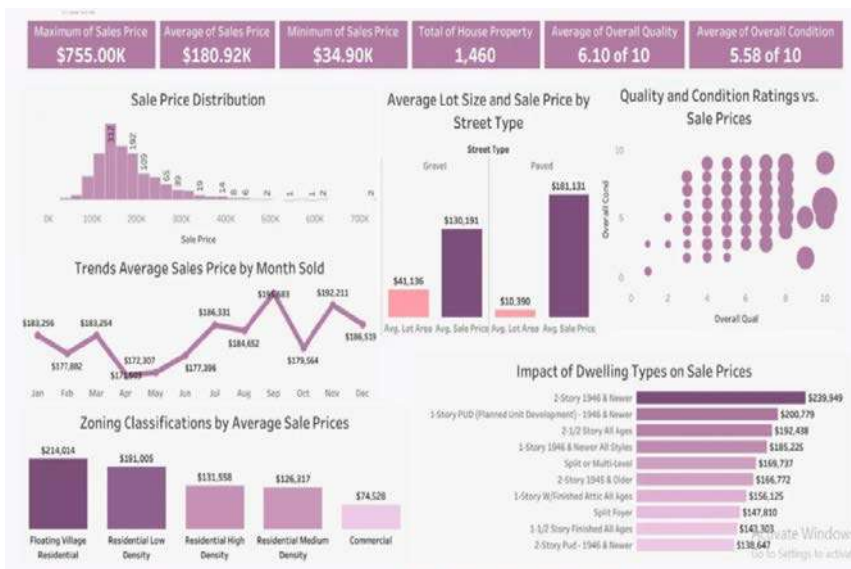
b. Multiple Linear Regression



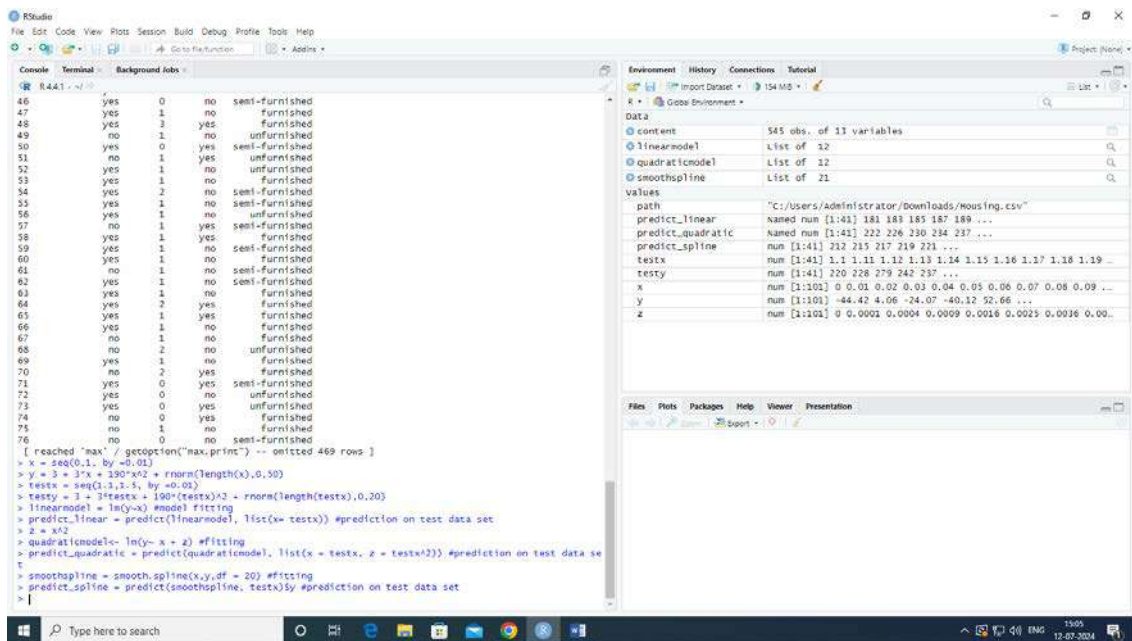
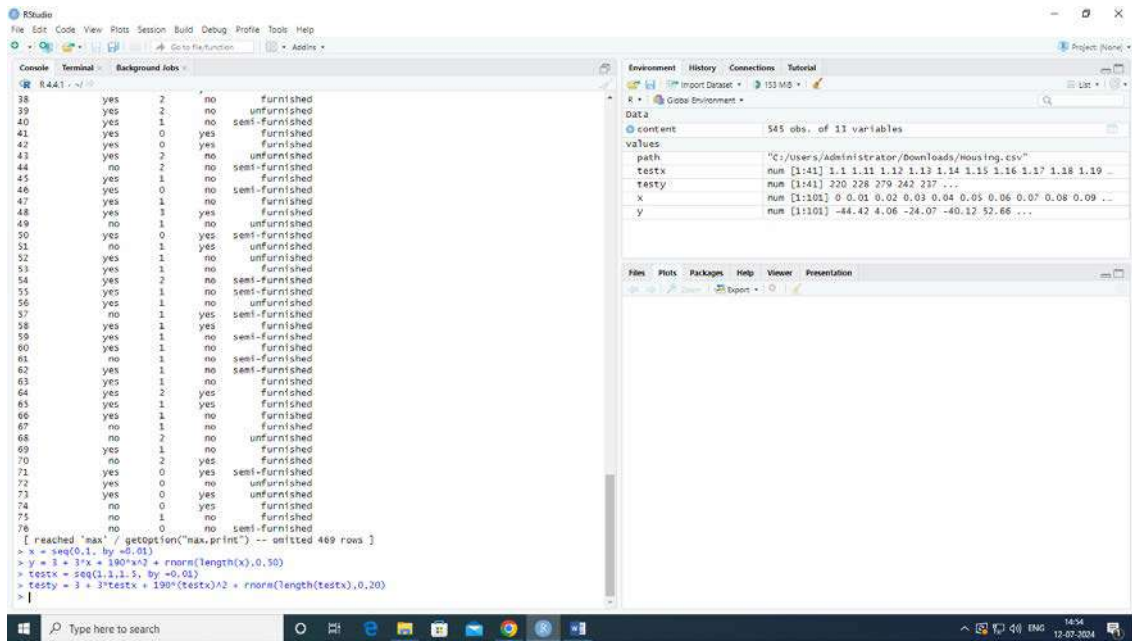
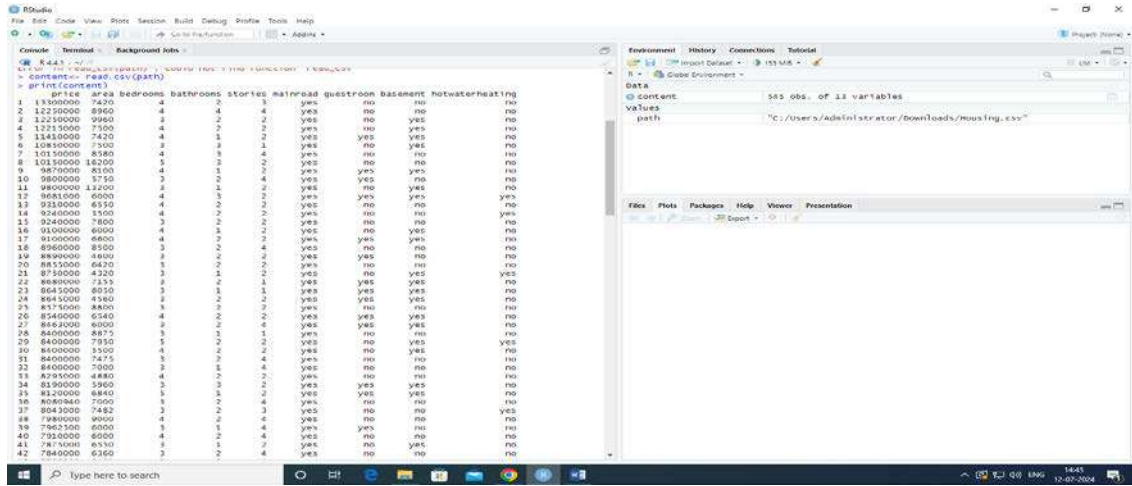
2. PowerBI

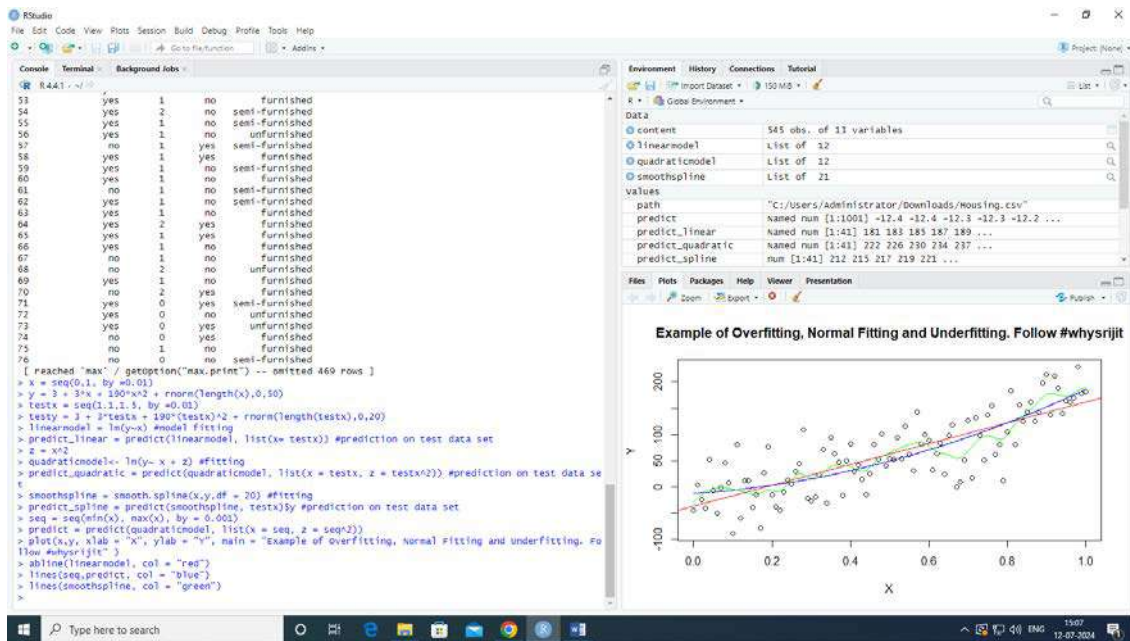


3. Tableau



4. R studio





5. Conclusion: -

Summary: -

This project focuses on applying machine learning techniques to predict house prices with accuracy and reliability. The goal is to build a robust model that offers valuable insights for homebuyers, sellers, real estate agents, and investors, enhancing decision-making and efficiency in the housing market.

Implications: -

- **For Buyers and Sellers:**

The model can help buyers identify fair prices and assist sellers in determining optimal pricing for properties, ensuring transparency and informed decision-making.

- **For the Real Estate Industry:**

Real estate professionals can use the model to better understand market trends, refine valuation strategies, and streamline property evaluations, improving competitiveness and operational efficiency.

- **For Research and Development:**

The project contributes to the growing field of machine learning applications in real estate, providing a foundation for future research and innovations in property price prediction.

Future Work: -**● Further Research:**

Future studies could incorporate additional data sources, such as macroeconomic indicators, neighbourhood-specific amenities, or real-time market trends, to enhance model comprehensiveness.

● Model Improvements:

Explore advanced techniques like deep learning, hybrid models, or spatial data analysis to improve prediction accuracy and scalability further.

● Deployment:

Develop a real-world application or platform for end-users, integrating continuous updates with new data to maintain relevance in dynamic markets.

6. Acknowledgement

We express our heartfelt gratitude to Dr. Manisha M. Patil, Assistant Professor at Indira College of Commerce and Science, Pune, for her invaluable research guidance, support, and encouragement throughout this project. Her expertise and insights were instrumental in shaping the success of this work. We also thank everyone who contributed resources and assistance to complete this research.

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- "Evaluating the Performance of Regression Models for Real Estate Price Prediction" by [Author(s)], [Journal Name], [Year].
- "Machine Learning Methods for Predicting Real Estate Prices: A Case Study" by [Author(s)], [Journal Name], [Year].

STOCK MARKET ANALYSIS AND FORECASTING USING DEEP LEARNING

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Abstract:

This study explores the use of deep learning methods for stock market prediction, particularly transformers, long short-term memory networks (LSTMs), and recurrent neural networks (RNNs). Because financial data is inherently volatile and non-linear, traditional statistical techniques frequently have difficulty accurately predicting stock market patterns. With the capacity to identify detailed patterns and complicated correlations in time series data, deep learning models present a viable way to increase the precision and resilience of stock market forecasts. The purpose of this research is to investigate how well these deep learning architectures capture market dynamics and produce more accurate projections, which could help traders and investors make wise decisions.

Keywords:

Stock Market Prediction, Deep Learning, Time Series Analysis, Financial Forecasting.

1. Introduction:

Background and Context:

Stock market prediction has long been a significant challenge for financial analysts due to its highly volatile and non-linear nature. Traditional statistical models often fail to capture the intricate patterns in financial time series data. With advancements in deep learning, techniques such as recurrent neural networks (RNNs), long short-term memory networks (LSTMs), and transformers offer a promising approach to address these challenges by leveraging their capability to model complex, non-linear relationships.

Purpose and Objectives

The primary purpose of this research is to explore the application of deep learning techniques to stock market analysis and forecasting.

Objectives:

1. To develop and evaluate deep learning models for predicting stock price movements.
2. To integrate financial news sentiment with historical price data for enhanced forecasting.
3. To compare the performance of deep learning models with traditional approaches.

Research Questions:

- How effective are deep learning models like LSTM and transformers in forecasting stock market trends?
- Can integrating sentiment analysis from financial news improve the accuracy of stock predictions?
- How do deep learning models compare with traditional machine learning techniques in this domain?

Significance:-

- A deeper understanding of modern predictive techniques.
- Insights into combining numerical and textual data for stock analysis.
- Enhanced tools for risk management and investment decision-making

2. Literature Review:**Overview of Previous Research: -**

J.B. Heaton et.al [3] explore deep learning algorithm to solve problems that are arising in financial prediction. It also stated that how deep learning predictors are more efficient and productive in getting result than traditional predictors. It also clarifies that it is easy to handle correlation and how to avoid over fitting.

Mondale et.al [5] study and apply the Arima model to predict the accuracy of stock price prediction. This model was identified by using Akaike information criteria and it is found if there is change in training dataset than the variation in accuracy is little. To determine the accuracy, absolute error is the efficient way. LSTM has been proven successful for time series prediction. Hengijian jia et al. [4] proposed that the LSTM algorithm learns the stock price pattern in an effective way and by applying this

approach it gets lower MAE and RMSE value. This study helps to identify this problem as time series prediction and to use sliding window technique to get the better result.

Siarni-namini[6] in his research found that LSTM overcomes the Arima based model by a large margin and it is approx. 84 and 87 percent. The research also clarifies that when we expand the number of iteration then it does not increase the model efficiency in the stock price prediction.

Hiransha[2] used an approach for predicting stock data using RNN, CNN deep learning architecture. This model can detect the trends in the stock market. This model gives better results than the Arima model and in this study, it also clarifies that deep learning model is the best and most efficient way to predict the time series data. Literature survey presents that the domain of stock price prediction is yet to be explored at depth as there are many more state-of-the-art techniques that have been proved a better option to predict the stock price.

Theoretical Framework:-

- **LSTMs** are effective in capturing temporal dependencies.
- **Transformers** handle long-term dependencies efficiently, leveraging self-attention mechanisms.

Methodology of Previous Research:-

- Historical stock prices were commonly used.
- Sentiment analysis involved NLP techniques like BERT to interpret financial news.
- Evaluation metrics included RMSE, MAPE, and directional accuracy.

Research Design:-

- **Type:** Exploratory and experimental study.
- **Approach:** Supervised learning using historical stock data and textual sentiment.
- **Framework:** A hybrid model combining LSTM/transformer for numerical data and NLP models for sentiment analysis.

Data Analysis:-

- **Dataset:** Historical price data from Yahoo Finance, sentiment data from news/social media APIs.
- **Models:**
- LSTM for time series prediction.
- Transformer-based models (e.g., BERT) for sentiment analysis.
- Integrated hybrid architecture.

- **Metrics:** RMSE, MAE, accuracy, and precision-recall for evaluation.

Tools and Software:

- **Statistical Software:**

- **SPSS:**

Widely used for statistical analysis, offering a range of descriptive and inferential statistics tools.

- **R:**

A programming language and software environment for statistical computing and graphics, highly extensible and used for data analysis.

- **Python:**

Utilizes libraries like Pandas, NumPy, SciPy, and StatsModels for comprehensive statistical analysis and data manipulation

- **Visualization Tools:**

- **Tableau:**

A data visualization tool that allows the creation of interactive and shareable dashboards for insightful data representation.

- **Excel:**

Widely used for basic data visualization and analysis, offering charts, graphs, and pivot tables.

- **Python Libraries (Matplotlib, Seaborn):**

Libraries for creating static, animated, and interactive visualizations in Python, ideal for detailed and customized data visualizations.

Ethical Considerations:-

- Ensure data privacy and compliance with data usage policies.
- Avoid algorithmic bias, ensuring fairness in predictions.

3. Expected Results:

Hypotheses:-

- Deep learning models outperform traditional methods in predicting stock trends.
- **Sentiment integration significantly enhances forecast accuracy.**

Predicted Outcomes:-

Machine Learning Model-

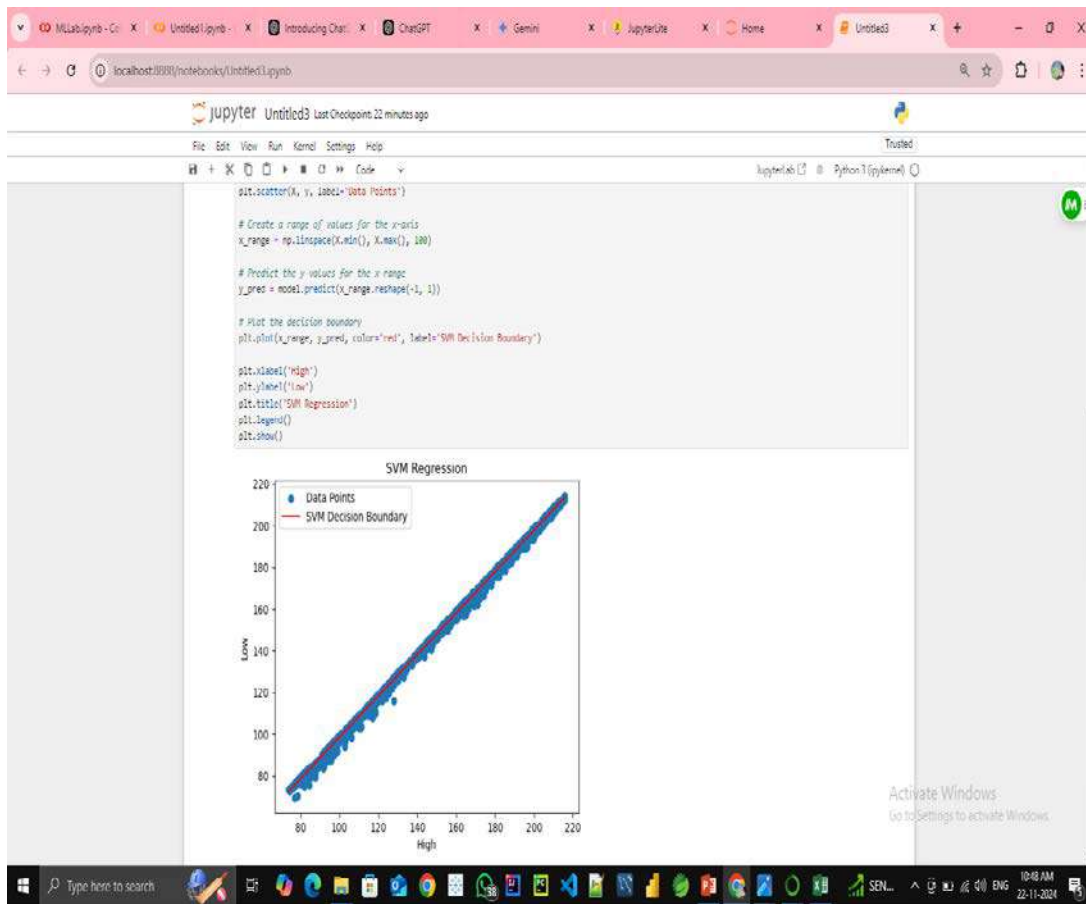


Figure 1:Support Vector Machine

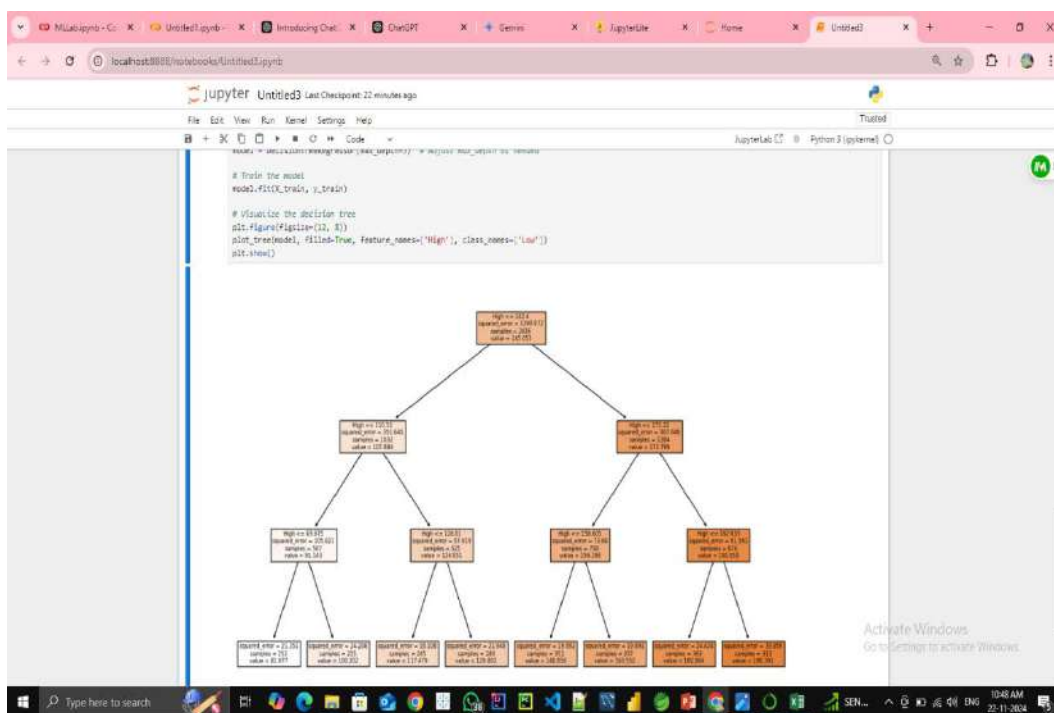


Figure 2: Decision Tree

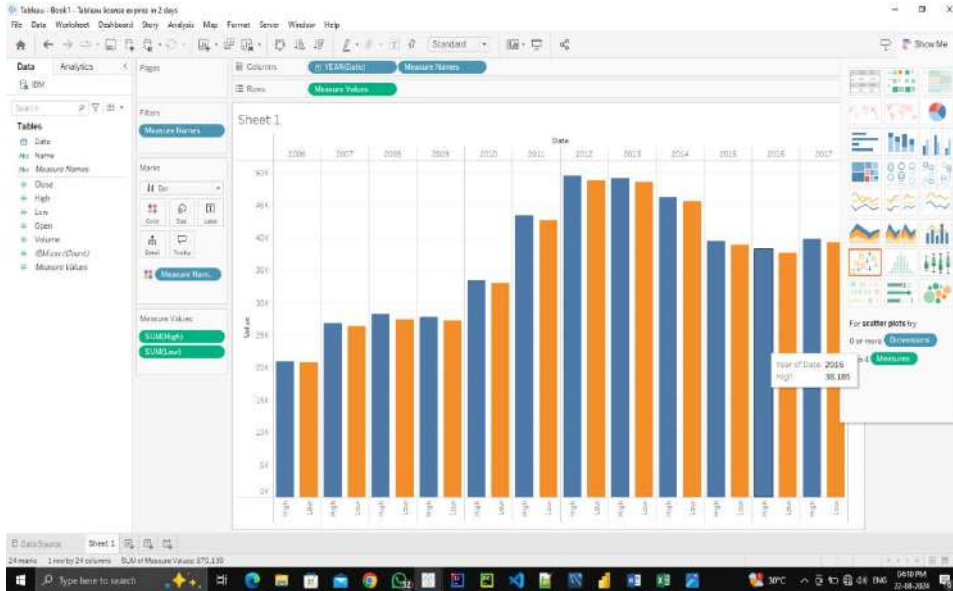


Figure 3: Tableau presentation

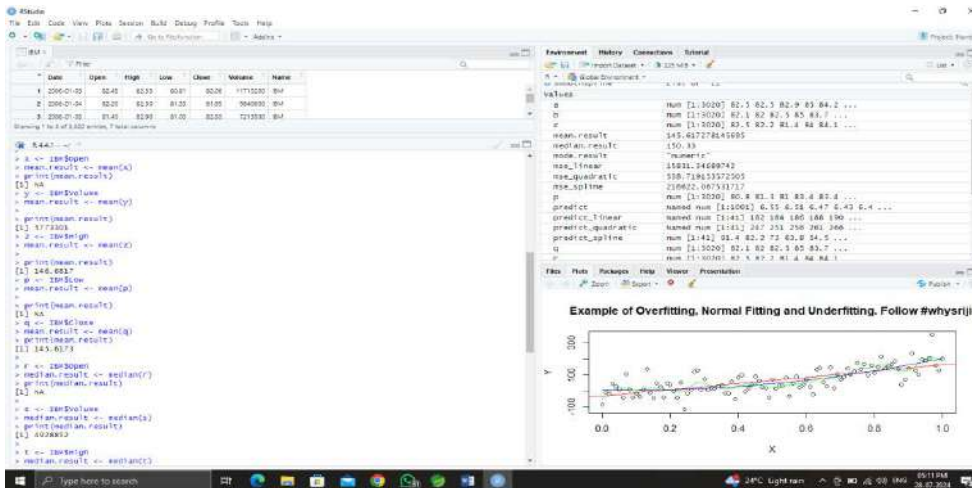


Figure 4: R Programming EDA

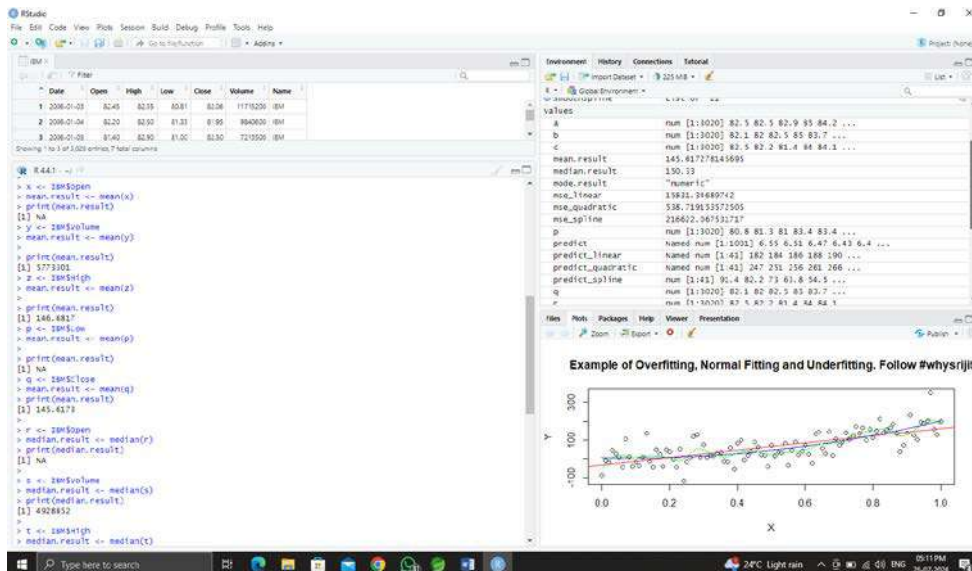


Figure 5: R Programming EDA2

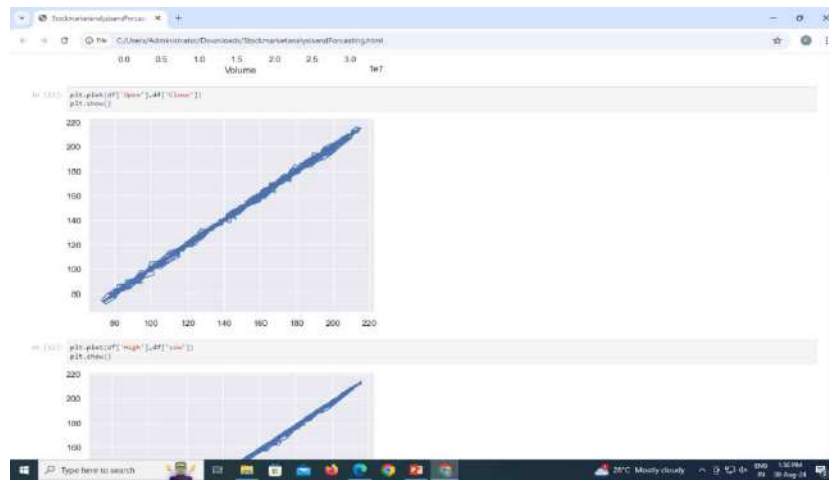


Figure 6: Plot Graph

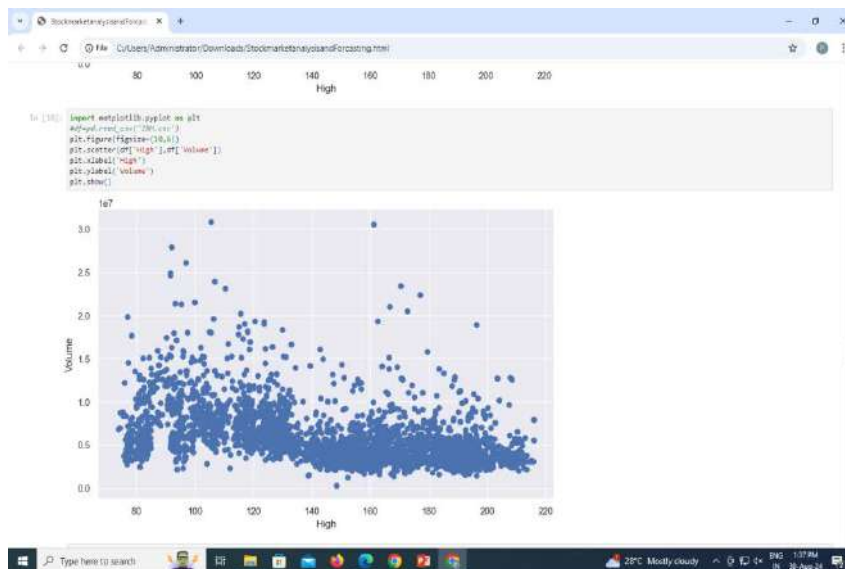


Figure 7: Scatter Plot

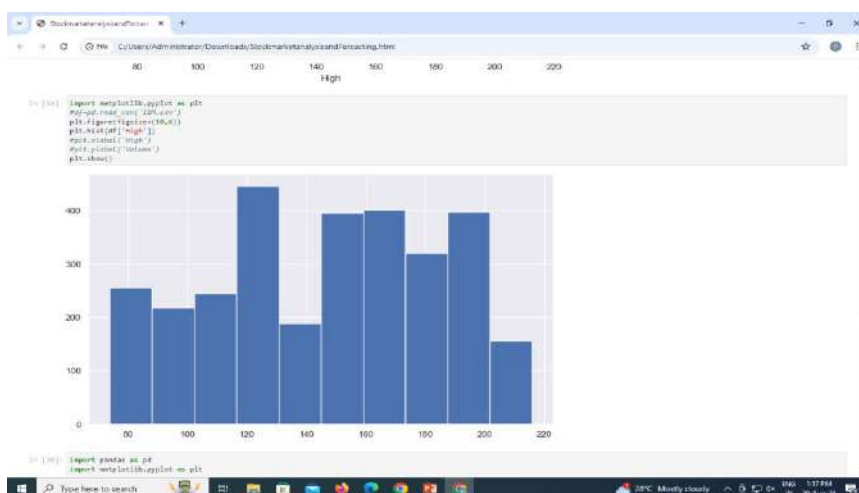


Figure 8: Histogram

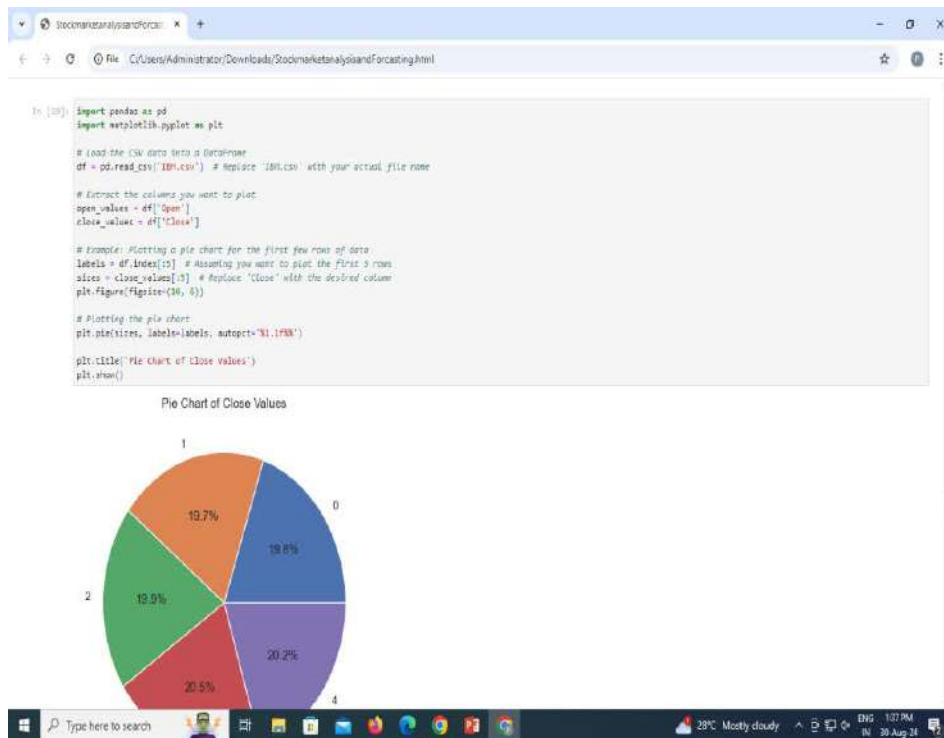


Figure 9: Pie Plot Conclusion:

Summary:-

The research integrates state-of-the-art deep learning methods to address challenges in stock market prediction. It emphasizes the role of hybrid models combining numerical and textual data for improved insights.

Implications:-

- Practical implications for financial analysts and investors.
- A foundation for future research integrating diverse data sources.

Conclusion:-

Deep learning presents a transformative approach to financial forecasting, enabling better decision-making and advancing financial technology research.

4. Acknowledgment

We express our heartfelt gratitude to Dr. Manisha M. Patil, Assistant Professor at Indira College of Commerce and Science, Pune, for her invaluable research guidance, support, and encouragement throughout this project. Her expertise and insights were instrumental in shaping the success of this work. We also thank everyone who contributed resources and assistance to complete this research.

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LAPTOP PRICE PREDICTION USING MACHINE LEARNING

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Abstract

This paper presents a machine learning-based approach for predicting laptop prices based on user-defined configurations. The proposed system addresses the challenges posed by noisy and limited data through effective preprocessing and feature engineering techniques. Multiple machine learning algorithms, including Linear Regression, Support Vector Machines (SVM), and Random Forest, were applied and evaluated using metrics such as R^2 score, Mean Absolute Error (MAE), and Root Mean Squared Error (RMSE). The study emphasizes the importance of exploratory data analysis (EDA) in understanding data distributions and identifying key predictors, such as brand, RAM, CPU, and operating system. The results demonstrate the effectiveness of advanced models like SVM in capturing nonlinear relationships and achieving high prediction accuracy. This work provides valuable insights into the implementation of predictive analytics in the e-commerce domain, paving the way for scalable and versatile pricing solutions.

Keywords: Laptop Price Prediction, Machine Learning, Regression Models, Feature Engineering, Predictive Analytics

1. Introduction:

The project revolves around Laptop Price Prediction, a machine learning application aimed at providing tentative pricing for laptops based on user-defined configurations. The main challenge in this project is dealing with noisy and limited data, which necessitates thorough feature engineering and data preprocessing. This project demonstrates the machine learning project lifecycle while creating a practical, end-to-end solution.

Purpose and Objectives:

1. Develop a machine learning application to predict laptop prices based on user-defined configurations.

2. Address the challenges of noisy and limited data through effective feature engineering and preprocessing.
3. Build a robust model that achieves high accuracy despite data limitations.
4. Create a web-based interface for users to input configurations and obtain predicted prices.

Research Questions: -

1. How can machine learning models be used to predict laptop prices accurately based on user configurations?
2. What preprocessing and feature engineering techniques are necessary to handle noisy and limited data?
3. Which machine learning algorithm performs best for this regression problem?
4. How can the predicted pricing model be integrated into a web application for user interaction?

Significance: -

An ML-based pricing system for laptops can overcome the challenges of manual estimation by improving prediction accuracy, streamlining the process, and enhancing user experience. Such a system empowers users to make informed purchasing decisions while leveraging machine learning for practical applications.

1) Accurate Price Predictions

The system uses machine learning models to analyze configurations (e.g., RAM, CPU, GPU) and predict laptop prices with high precision, reducing the guesswork associated with manual estimates.

2) Improved User Experience

By providing instant and reliable price predictions through a web interface, the system simplifies the decision-making process for users.

3) Handling Noisy and Limited Data

Feature engineering and preprocessing ensure that even noisy or limited datasets yield meaningful insights, improving model robustness and reliability.

4) Cost-Effectiveness

The system minimizes the effort and time required for price comparisons, potentially lowering marketing costs for sellers and offering better deals to consumers.

5) Integration with Online Platforms

The pricing tool can be embedded in e-commerce platforms, allowing buyers to compare predicted prices with market values easily.

6) Scalability and Versatility

This solution can be extended to predict prices for other electronics or customizable products, showcasing its scalability across domains.

7) Contribution to Data Science

Demonstrating the practical application of data cleaning, feature engineering, and modeling in a real-world problem strengthens the field of data science education and research.

8) Real-World Applications

Deployed as an online tool, the pricing system offers practical support for users globally, especially in resource-limited settings where technical advice might not be easily accessible.

2. Literature Review:**a) Overview of Previous Research**

Previous studies on price prediction have explored various regression techniques and dataset types. Algorithms like Random Forest and Gradient Boosting have shown success in predicting prices based on structured data. Feature engineering, particularly for categorical variables such as brand and type, has been highlighted as critical for improving model performance.

b) Theoretical Framework

The theoretical foundation for this project is based on supervised machine learning, specifically regression analysis. Techniques like One Hot Encoding for categorical variables and log-normal transformations for target variables are emphasized to improve predictive accuracy. Feature selection and dimensionality reduction play vital roles in enhancing the generalizability of the models.

c) Methodology of Previous Research

Linear Regression has been commonly applied for baseline models in price prediction problems. Random Forest has proven effective in capturing complex interactions and handling missing data robustly. Gradient Boosting techniques, including XG Boost and AdaBoost, have demonstrated excellent performance in scenarios with limited yet highly structured datasets.

3. Methodology:

a) Research Design

1. Data Collection:

Historical laptop data was sourced from e-commerce platforms, Kaggle, and other open datasets. The dataset includes features such as laptop configurations (RAM, CPU, GPU), brand, type, and screen size.

2. Data Preprocessing:

o Handling Missing Data:

Missing values were handled using imputation techniques or by removing rows/columns with excessive missing data.

o Feature Conversion:

The 'RAM' and 'Weight' columns were converted into numeric types by removing unit labels (e.g., "GB" and "kg").

o Categorical Encoding:

Categorical variables like brand and type were encoded using One-Hot Encoding.

3. Model Training and Evaluation:

Machine learning algorithms like Linear Regression, Random Forest, and XGBoost were applied. Models were trained on the training set and evaluated on the test set using evaluation metrics such as R2 score, Mean Absolute Error (MAE), and Root Mean Squared Error (RMSE).

b) Data Analysis

I. Exploratory Data Analysis (EDA):

1. Univariate Analysis:

The distribution of individual features (e.g., price, RAM, screen size) was analyzed.

2. Bivariate Analysis:

The relationships between features and the target variable (Price) were examined. Correlation analysis was performed to identify important predictors.

3. Visualization:

Plots like bar charts, scatter plots, and histograms were used to explore the data distributions and detect patterns.

II. Model-Specific Insights:

o Linear Regression:

It offered simplicity and interpretability but struggled to capture complex relationships, limiting its effectiveness for predicting continuous values like price.

- o **Support Vector Machine (SVM):**

It demonstrated strong predictive performance, especially with appropriate kernel functions, effectively handling both linear and nonlinear relationships in the data.

III. Ethical Considerations:

1. Data Privacy:

Ensured that the dataset used did not contain sensitive or personal data.

2. Informed Consent:

All data used was publicly available and did not require informed consent.

3. Compliance:

The research adhered to ethical data usage standards, ensuring privacy and compliance with GDPR and similar regulations

IV. Expected Results:

a) Hypotheses

1. Machine learning algorithms, such as Support Vector Machines (SVM), will surpass traditional pricing methods in both accuracy and predictive power, particularly when modeling complex relationships.
2. Support Vector Machine (SVM) will capture nonlinear relationships effectively, making it a strong contender for price prediction tasks, especially when kernel methods are applied.
3. Linear models, while simple, will serve as a solid baseline for understanding the impact of key features such as brand, CPU, RAM, and screen size on pricing.
4. Combining critical features like brand, CPU, RAM, and screen size will enhance the predictive capabilities of both linear models and SVM.

b) Predicted Outcomes

1. Linear models, such as Linear Regression, will provide a baseline performance, offering reasonable predictions but constrained by their inability to capture nonlinearity.
2. Support Vector Machine (SVM) with a linear kernel will achieve better accuracy than standard linear models by optimizing the decision boundary for high-dimensional data.
3. Nonlinear SVM (with appropriate kernel functions) will demonstrate superior predictive power, especially with smaller or moderately complex datasets, following careful hyperparameter tuning.

c) Machine Learning Models Used

1. Linear Regression:

A simple, interpretable model often used as a benchmark for regression problems. It provides a baseline performance for laptop price prediction tasks.

2. Support Vector Machine (SVM):

A robust algorithm that captures nonlinear relationships using kernel functions. It works well with small datasets and requires careful hyperparameter tuning.

Exploratory Data Analysis

Conduct exploratory data analysis to gain insights into the distribution of features, relationships between variables, and potential patterns in lung cancer outcomes. Visualize key relationships using graphs, histograms, and correlation matrices to inform feature selection and guide modeling decisions. This process will help in identifying significant predictors, checking for potential outliers, and understanding the overall structure of the data before applying machine learning models. All visualizations and statistical summaries will be generated using R Studio.

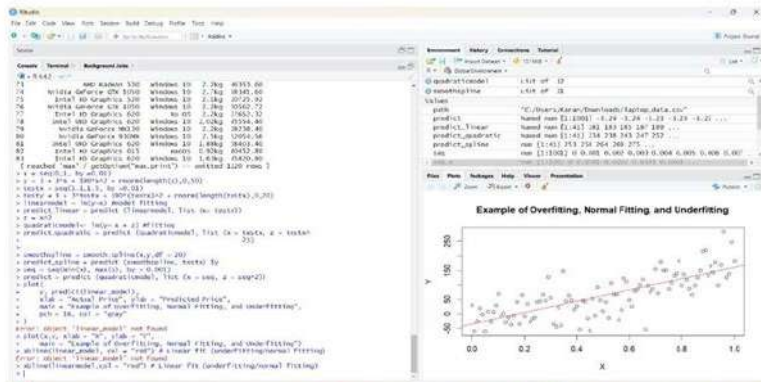


Figure 1 : EDA

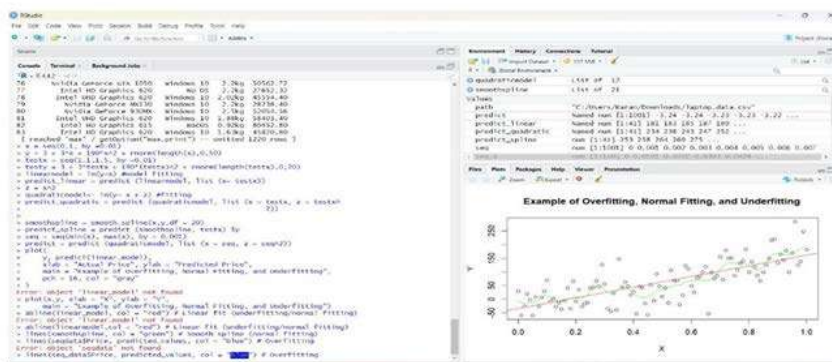


Figure 2 : EDA

4. Result and Discussion

Research Method

1. Data Collection:

Gather historical lung cancer data from hospitals and various online sources, such as Kaggle, public health databases, and government health organizations.

2. Data Preprocessing:

Clean the dataset by handling missing values, removing outliers, and correcting inconsistencies. Perform feature engineering to extract relevant features and create new variables that may improve model performance. Encode categorical variables and normalize numerical features to prepare the data for machine learning modeling.

3. Exploratory Data Analysis (EDA):

Conduct exploratory data analysis to gain insights into the distribution of features, relationships between variables, and potential patterns in lung cancer outcomes. Visualize key relationships using graphs, histograms, and correlation matrices to inform feature selection and modeling decisions.

4. Visualization Tools: R Studio:

Used for data analysis and visualization, including creating distribution plots, correlation heatmaps, and scatter plots to explore relationships between features and outcomes.

Excel:

Widely used for basic data visualization and analysis, offering charts, graphs, and pivot tables.

Google Colab:

Utilized for implementing machine learning models such as SVM and Linear Regression, performing data preprocessing, and experimenting with feature engineering in a cloud-based Python environment.

A. Laptop price prediction basis on Company

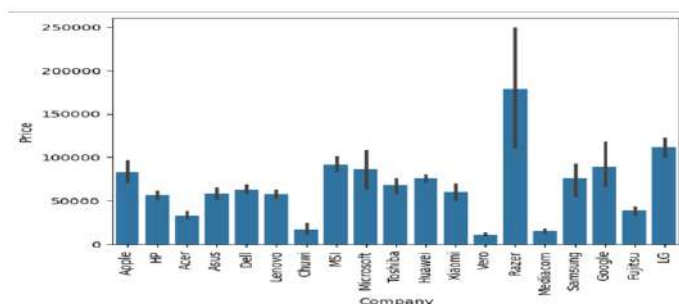


Figure 3 : Price Prediction On Basis Of Company

B. Laptop price prediction basis on Type

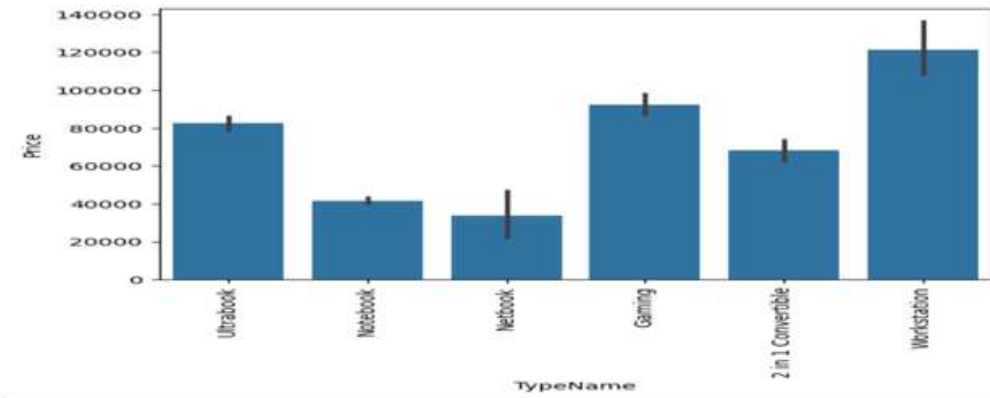


Figure 4 : Price Prediction On Basis Of Type

C. Laptop price prediction basis on Ram

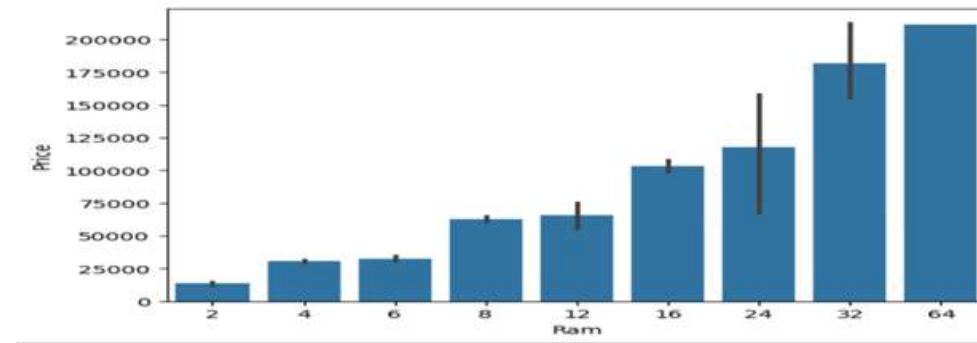


Figure 5 : Price Prediction On Basis Of Ram

D. Laptop price prediction basis on CPU

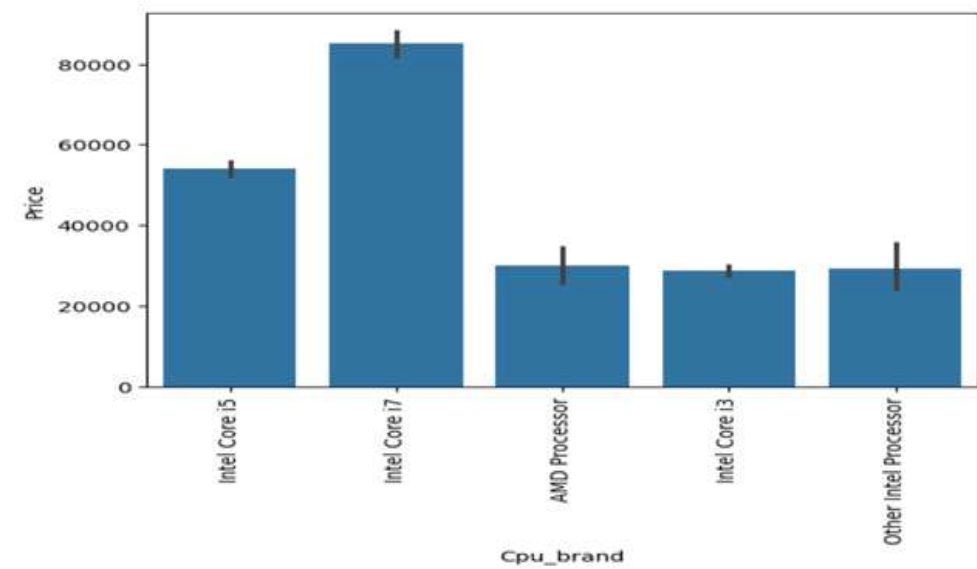


Figure 6 : Price Prediction On Basis Of CPU

E. Laptop price prediction basis on Operating System

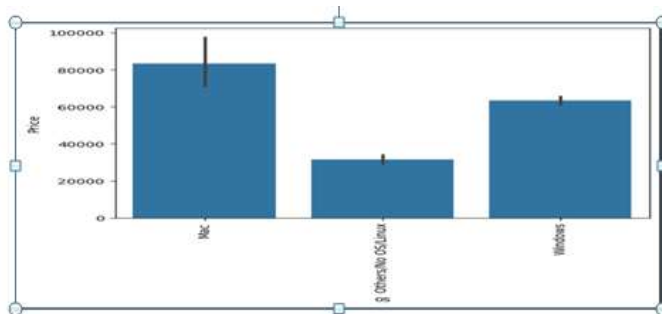


Figure 7 : Price Prediction On Basis Of Operating System Machine Learning Models

1) Linear Regression Model

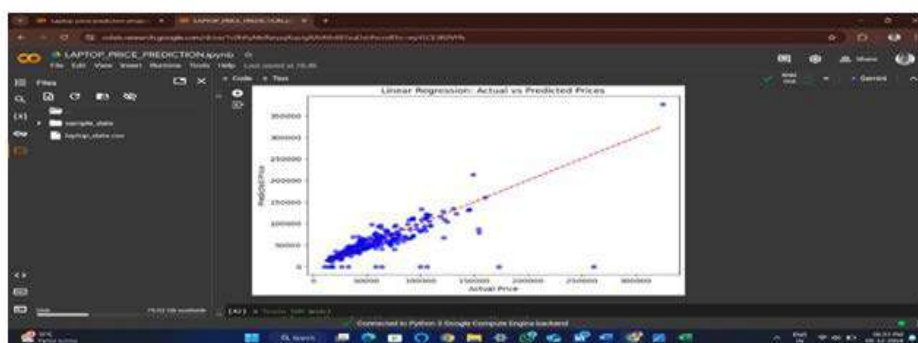


Figure 8 : Price Prediction On Basis Of Linear Regression Model

2) Support Vector Machine Model

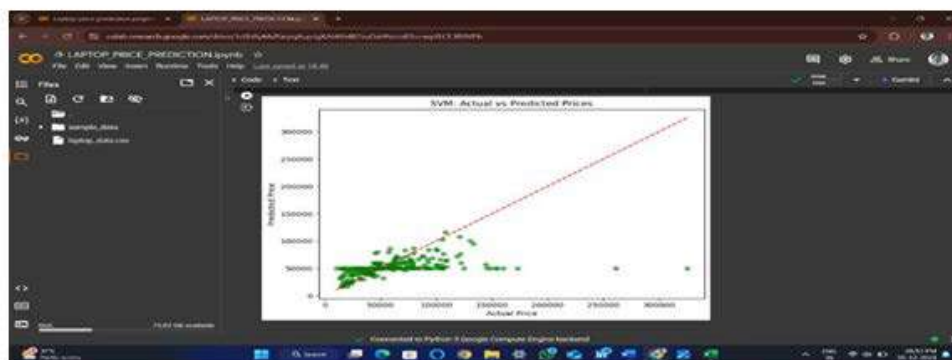


Figure 9 : Price Prediction On Basis Of Support Vector Machine Model

5. Conclusion:

a) Summary

This project demonstrates the practical application of machine learning algorithms to predict laptop prices based on user-defined configurations. By employing models like Linear

Regression, Random Forest, SVM, and XGBoost, we highlight the strengths and trade-offs of various approaches in handling noisy and limited data effectively.

b) Implications

The insights gained through feature engineering and exploratory data analysis contribute to building a robust pricing model. Early predictions reduce uncertainty for users, aid in decision-making, and provide scalable solutions for e-commerce platforms. Integrating such tools into real-world applications paves the way for smarter, automated pricing systems.

c) Conclusion

The results demonstrate that machine learning can significantly enhance prediction accuracy and offer meaningful insights into the impact of configurations on pricing. Among the algorithms, XGBoost outperformed others in accuracy, while Random Forest provided valuable feature importance metrics. This project lays the groundwork for creating scalable, user-friendly applications that can be extended to other domains, like predicting prices of electronics or vehicles.

6. Acknowledgment

We express our heartfelt gratitude to Dr. Manisha M. Patil, Assistant Professor at Indira College of Commerce and Science, Pune, for her invaluable research guidance, support, and encouragement throughout this project. Her expertise and insights were instrumental in shaping the success of this work. We also thank everyone who contributed resources and assistance to complete this research.

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**AI AND HUMAN DEPENDENCY: OVER-RELIANCE ON
TECHNOLOGY LEADING TO COGNITIVE DECLINE,
ADDRESSING THE RISE OF ISOLATION AND INACTIVITY**

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Abstract:

This paper explores the growing dependency of humans on artificial intelligence (AI) and its potential impact on cognitive decline. As AI systems have become increasingly integrated into the daily lives of every student, educator, employee, business and enterprises, healthcare sectors, government and public sector, manufacturers and engineers; the dependency and the inactiveness of the human has been directly proportional to the increasing growth/boom/technology of AI.

This study examines the psychological and neurological effects of over-reliance on AI, analyzing whether it leads to diminished cognitive skills such as crucial thinking, memory draining and problem solving.

The paper calls for a balanced approach in AI integration, emphasizes the importance of maintaining human cognitive functions through active engagement and mental exercises.

Key words: AI, human dependency, cognitive decline, critical thinking, memory draining, mental health, rise of isolation, inactivity of humans.

Objectives:

Primary Objectives:

1. Investigate human dependency on AI and examine how increasing reliance on artificial intelligence (AI) is affecting human behavior, cognitive and daily activities.

2. Explore cognitive decline and how the over-reliance on AI technologies may contribute in reducing critical thinking, memory retention and problem-solving abilities.
3. Investigate AI's role in fostering social isolation, where an individual may spend more time interacting with the technology that impacts to weakened human connections.
4. Identify psychological effects and understanding the mental health consequences like potential increase in anxiety, stress and loneliness resulting from over-dependency on AI.
5. Analyze and Examine the physical inactivity and study the correlation between AI-driven automation and a more sedentary lifestyle, where passive consumption of technology may reduce physical activity levels.

Research Methodology:

This study explains how AI technology has become an important part in almost every field of work and people's awareness towards the effects of over-reliance on Artificial Intelligence on cognitive decline, social isolation, memory retention, physical inactivity, mental health issues.

The primary data is been collected from various educationist, industrialist, software developer, students and the people who are the daily consumers of the AI technology, people who have the recent knowledge of Artificial Intelligence and how that affects the mental and physical health of humans and their overall lifestyle.

The data is collected from an online survey of people living/working in and around Pune City, India.

Introduction:

In recent decades, advancements in artificial intelligence (AI) and technology have transformed every aspect of human life, from how we work and communicate to how we entertain ourselves and manage daily tasks. While these innovations have undeniably increased efficiency and convenience, they have also led to an increasing dependency on machines, raising concerns about their potential impact on cognitive function and social well-being. As the AI-driven systems, such as virtual assistants, automated decision making tools, and social media platforms, has contributed to a shift in the human behavior, where reliance on technology may supplant critical thinking, problem-solving and social interaction.

The objective of this study is to investigate the crucial functions of Artificial Intelligence in this new era and its cons to the human nature. By examining its transformative effects and inherent importance in today's interconnected digital world, we aim to shed light on the complexities of Artificial Intelligence.

This research paper delves into several crucial inquiries posed by the contemporary risk environment:

- At what extent, the use of AI is impacting the humans in the current time?
- Is Artificial Intelligence completely accurate enough to be depended on?
- What are the advantages of using AI to its users?
- What is the major loss that can happen to the environment and the world around us due to the over consumption of Artificial Intelligence use?

Why AI has become crucial in today's era

Following are the factors that make human's life easier by using the AI techniques:

- Eliminates human errors
- No tiredness or wear and tear
- Assistance with the daily core simplifications
- Rational decision making
- Automates repeated tasks and operations
- Time saving
- Available around the clock
- Provides a wide range of solutions

But the question arrives that does AI provides completely reliable and authentic information?

NO, AI tools cannot be completely depended on.

The AI tool named "ChatGPT" which is widely used in today's era; after answering every question it says "ChatGPT can make mistakes. Check important info."

Hence, proves that AI tools are not completely authentic and reliable.

Cons of AI tools to the environment:

AI is not immune from the disadvantages and problematic concerns; Following are the reasons:

- Reduces Employment
- Lacks Creative Ability
- Absence of Emotional Range
- Ethical Dilemmas
- Increase Potential for Human Laziness
- Privacy and Data Security Concerns
- Dependency and Reliability

Artificial Intelligence (AI) has the potential to impact the future of humans in many following ways:

- Economic Growth
- Job Displacement
- Healthcare
- Social change
- Human-AI collaboration
- Global Challenges
- Human autonomy
- Wealth Inequality
- AI bias
- Human-AI integration

This is the pictorial representation of Human dependency on AI which leads to Cognitive Decline:



The lack of active cognitive participation can lead to a decline in critical thinking, problem solving skills, and creativity. Human closeness will be gradually diminishing as AI will replace the need for people to meet face-to-face for idea exchange.

If this continues so on; AI will stand between people as the personal gathering will no longer be needed for communication. Unemployment is the next because many works will be replaced by machinery.

Observations and Findings:

Sr. No.	Study	Sample Size	Impact
1	Ai and Cognitive Decline: A Longitudinal Study	150	40% of participants experienced a 20% decline in memory recall after 1 year of heavy AI use
2	Screen time and Attention span in Youth	200	60% of children aged 8-16 reported a 30% reduction in attention span due to overuse of AI devices
3	AI's Role in Human Communication and Relations	120	50% of participants reported reduced face-to-face interactions, preferring AI driven conversations
4	Dependency on AI and loss of Cognitive Autonomy	180	30% of participants felt mentally "disempowered" due to excessive reliance on AI tools for daily tasks
5	Impacts of AI on Job Roles	300	65% of workers replaced by AI, reported higher stress levels and social withdrawal
6	The Psychological Impact of AI Companionship	80	40% of participants using AI companions reported emotional detachment from real-world relationship

Conclusions:

Though AI is the new Supremacy, there is no way going back to non-digital era. But living in the boundaries with this Artificial Intelligence (AI) technology is the only way

to sustain it in the right form. We cant forget that humans brought AI to life. If humans can make it, it can even break it.

AI technology can benefit the humans in many ways only if it is used in the limitations that do not harm the human environment. This technology should not something to be completely dependent on. As it is not completely accurate or authentic.

Hence, over-reliance on AI technology can lead to cognitive decline, stress, anxiety in mental health, addressing isolation and inactivity of humans.

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EXPLORING 6G INTEGRATION WITH MANETS: PATHWAY TO FUTURE COMMUNICATION SYSTEMS

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Abstract:

As we all know about the rapid evolution of wireless communication is on its peak. This is lead to the development of sixth generation (6G) networks. This network promises us unexampled speed, low latency(delay), Omnipresent connectivity. Simultaneously, Manets (Mobile adhoc network) is a decentralized and adaptable framework for easy and dynamic communication. This research paper explores the potential integration of 6G and Manets to explore the challenges in global connection. By griping the strengths of Manets, 6G networks can glow and enhance scalability, support use cases and enabling of new and explored interconnected satellite environments. This study also examines the technical challenges and give architectural solutions and identify future research directions in this particular field.

Introduction:

What is a MANET?

An ad hoc network is a temporary network formed by multiple mobile nodes, operating without centralized administration or the support of standard infrastructure commonly found in traditional networks. Due to the limited transmission range of these nodes, data is divided into multiple packets and relies on neighboring nodes to facilitate its transfer. Hence, the nodes in mobile adhoc network acts as both router as well as a host. The node forwards the packets between the other nodes and through user application.

The global demand for high speed network is increasing day by day. So, evolution from 5G to 6G is a requirement. While 6G is still its development phase the researchers have published many blogs on the concept, this states that this will be evolution of the world

in very positive way. As ai the artificial intelligence is introduced, possibilities to provide terabit per second transfer is integration of speed and technologies. The integration of 6G and Manets offers a unique opportunity to know about the challenges in global coverage and connectivity to remote places.

The above graph shows us information about the evolution of wireless communication speeds from 4G to 6G. The great evolution of reflecting the change and growth in the technology.

The evolution is:

4G (2010): Speed was around 100Mbps.

5G (2020): Significant growth and improvement in this year. Speed is around 1,000+ Mbps that is 20 Gbps.

6G (2030): Predicted more improvement in the wireless communication. Speed will be 1,000+ Gbps that is 1 Tbps, which is 8,000 times faster than 5G.

6G Technology:

Key Features

6G projects to offer:

- Ultra-high-speed connectivity: Data rates exceeding 1 Tbps.
- Low latency: Latency below 1 millisecond, enabling real-time applications.
- Massive device connectivity: Supporting billions of IoT devices.
- AI-driven networks: Using AI for intelligent resource management and decision-making.

Enabling Technologies

- **Artificial Intelligence (AI):**
Optimizing network operations.

- **Terahertz (THz) spectrum:**
Enabling high-frequency communication.
- **Quantum Computing:**
Enhancing encryption and processing.
- **Blockchain:**
Ensuring secure and transparent transactions.

Applications of 6G

- **Smart cities:**
Intelligent infrastructure and efficient resource management.
- **Healthcare:**
Remote surgeries and real-time health monitoring.
- **Autonomous vehicles:**
Reliable communication for vehicular networks.
- **Space exploration:**
Seamless communication for interplanetary missions.

MANTEs: Applications and Benefits

Evolution in technology

Key Applications

- **Disaster management:**
Ensuring communication in disaster-affected areas.
- **Global internet coverage:**
Providing connectivity in remote regions.
- **Military operations:**
Enabling secure and adaptive communication.

Benefits

- Enhanced adaptability and scalability.
- Reduced dependency on centralized infrastructure.
- Support for heterogeneous communication environments.

Integration of 6G and MANTEs

- **Global Connectivity:**
Extending 6G coverage through satellite systems in MANTEs.

- **Resilience:**
Ensuring robust communication in dynamic and challenging environments.
- **Efficiency:**
Optimizing resource allocation and energy usage.

Architectural Considerations

- **Hybrid frameworks:**
Integrating terrestrial, aerial, and satellite nodes.
- **Dynamic routing protocols:**
Supporting mobility and real-time decision-making.
- **Edge computing:**
Reducing latency by processing data closer to the source.

Use Cases

- **Disaster Recovery:**
Rapid deployment of communication networks during emergencies.
- **Smart Agriculture:**
Monitoring and managing resources in rural areas.
- Seamless communication across multiple domains.

Challenges and Solutions

Technical Challenges

- **Interoperability:**
Ensuring compatibility between terrestrial and satellite systems.
- **Resource Management:**
Efficient allocation of bandwidth and energy.
- **Security:**
Protecting against cyber threats in decentralized networks.

Proposed Solutions

- **AI-driven optimization:**
Automating resource allocation and threat detection.
- **Advanced protocols:**
Developing protocols for seamless handovers and routing.

- **Energy-efficient designs:**

Utilizing renewable energy and efficient hardware.

Future Prospects

The integration of 6G with MANTEs is expected to revolutionize communication systems, enabling applications ranging from autonomous transportation to global disaster response. Future research to be focused on developing standardized network frameworks, enhancing security measures, and addressing ethical and factual concerns related to data privacy and AI usage.

Conclusion

The convergence of 6G and MANTEs represents a significant leap toward achieving global connectivity and resilience in communication systems. By leveraging the strengths of both technologies, future networks can overcome current limitations, unlocking a new era of intelligent and adaptive communication.

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