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Crime Prediction using Machine Learning Algorithms

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***Abstract*—Technology improvements have changed how crimes are solved, which has led to more collaborative study into how criminals act. "Prophet," an additive model-based method for predicting complicated, nonlinear time series data, such as crime actions, is presented. It does a good job of capturing time trends like holiday and seasonal affects. Using Prophet along with machine learning methods like Bayesian Regressor, Logistic Regression, Decision Tree, Gradient Boosting, Random Forest, Voting Regressor, KNN, LSTM, and Neural Network makes it more accurate at predicting crimes. With these tools, police can proactively decide how to use their resources and stop crime, which means that neighborhoods will be better. This essay shows how new technologies and models that are based on data are changing the way crimes are solved, starting a new era of preventing crimes and keeping communities safe.**

***Index Terms*— Crime- solving Strategies, Interdisciplinary Research, Community Safety, Time Series Data, Prophet Model, Machine Learning Algorithms, Crime Prediction Accuracy.**

I. INTRODUCTION

There is no stopping the march of technology, which has changed every aspect of human life, including how crimes are solved. This article talks about "Prophet," a new additive model-based method for predicting time series data. Prophet is very good at figuring out complicated, non-linear trends, such as seasonality on a monthly, weekly, daily, and holiday level. The work of Borowik et al. [1] shows that time series analysis has become an important way to predict crimes in recent years. As shown by Shah et al.'s method that uses both machine learning and computer vision [4] and Cesario et al.'s autoregressive models [5], machine learning techniques are very important. McClendon and Meghanathan [7] use machine learning methods to look at crime data in more detail. According to Srivastava et al. [8] and Vinoth Kumar. This wide range of study is also used for many other purposes besides predicting crime. For example, chest X-rays can be used to find pneumonia. As the field of crime prediction changes, these studies help build stronger and more useful systems. . As the field of crime prediction changes, these studies help build stronger and more useful systems by mixing different types of technology to deal with the difficult problems that come with detecting and stopping illegal actions.

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II. LITERATURE SURVEY

In the past few years, there has been a lot more writing about how to predict and analyze crime using different tools and methods. This study gives a broad look at the most important works in this area, showing the variety of methods and ways experts use.

A number of studies stress how useful time series analysis is for predicting crime [1]. In their work, Grzegorz Borowik, Zbigniew M. Wawrzyniak, and Paweł Cichosz from Poland's Warsaw University of Technology looked into this method and showed that time series analysis could be used to predict crime trends. Feng et al. also suggested an expandable system that uses big data to predict crimes and look at how they are related.

[2]. Their work shows how important it is to use big datasets to make crime predictions more accurate. A lot of people are also interested in using deep learning to classify and predict crimes.

[3]. Panagiotis Stalidis, Theodoros Semertzidis, and Petros Daras looked at different deep learning models for crime research. This showed what these advanced methods can do. Neil Shah, Nandish Bhagat, and Manan Shah also used machine learning and computer vision to predict and stop crime.

[4], showing how different technologies can be used together to deal with how complicated crime is by Cesario, Catlett, and Talia. [5] looked into autoregressive models and showed that these models can be useful for predicting crimes. Their work shows how important it is to use mathematical models for predictive analytics in the study of crime. Wilpen, Andreas, and Yvonne also worked on the time part of crime forecasts.

According to McClendon and Meghanathan [7], they used machine learning methods to look at crime data. This shows how important AI is for finding trends in very large datasets. This is in line with the larger trend of using complex computer tools to study and predict crime.

In their paper [9], They talk about how chaotic neural networks can be used to protect wireless sensor networks. This shows how crime prevention research can be done across different fields. In later studies, the authors build on their earlier work by showing better safe designs [10] and using chaotic neural networks to use chest X-rays to find pneumonia [11].

Praharsha Sarma, Utkarsh Kumar, and Vinoth Kumar suggested an IoT and Python OpenCV-based solution [12] for finding and stopping accidents. This shows how technology and public safety are connected even more.

A lot of experts have taken their knowledge and applied it to other areas, like healthcare. Baranidharan and Vinoth Kumar, for example, did a full performance study of classifier models for identifying coronary artery disease [13]

It's also important to recognize the efforts of the business. PredPol, software for predictive police, says it has reduced crime by 14 percent, showing how predictive analytics can be used in real life in law enforcement.

To sum up, the literature review includes a wide range of methods, from old-fashioned statistical models to cutting-edge technologies like deep learning and chaotic neural networks. Using big data, machine learning, and advanced analytics together shows how crime prediction is changing. Researchers and practitioners are always pushing the limits to make the public safer.

III. METHODOLOGY

A. System Architecture

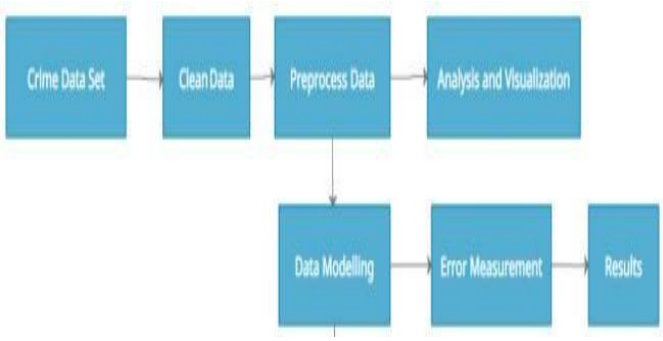

Fig 1: System Architecture

B. Proposed work

The suggested method uses cutting-edge technology to improve how crime data is analyzed in Indian towns. It uses the Prophet model, which is a strong tool for predicting time series. This lets it find complex temporal crime

trends like changes in crime rates during different seasons and holidays. Adding machine learning techniques like Bayesian Regressor, Logistic Regression, Decision Tree, Gradient Boosting, Random Forest, Voting Regressor, KNN, LSTM, and Neural Network to this method makes it even more accurate at predicting crime. It deals with racism and ethics problems in data analysis at the same time, making sure that improving public safety is done in a fair and responsible way..

C. Dataset Collection

The dataset includes a lot of information about time, showing how illegal actions change over time. .Key factors include exact timestamps of events that were recorded, which makes it possible to pull out complex temporal trends like holiday and seasonal effects. The collection also includes a lot of different types of crimes, which helps us understand illegal behavior in a more complete way.

D. Pre-Processing

During the data discovery phase, At first, the module's job is to load raw data into the system. After that, the processing engine reads the loaded data and uses methods to clean, verify, and change it into a standard file that can be used for analysis. This includes things like dealing with lost numbers, finding outliers, and making sure that the data is normal.

E. Algorithms

1. Bayesian Regressor:

Bayesian regression expands linear regression with Bayesian ideas. It models variable connections using probability distributions to capture uncertainty. Bayesian regression updates parameter beliefs based on observed data to create posterior distributions, unlike classical regression. Better forecasts and uncertainty quantification are possible with this method.

2. Logistic Regression:

Logistic regression is a popular binary classification approach. Despite its name, it predicts class membership likelihood. A linear combination of input characteristics is mapped to a 0–1 output using the logistic function.

3. Decision Tree:

For classification and regression, decision trees are flexible and intuitive machine learning models. A tree-like structure is created by recursively partitioning the feature space by the most informative properties. Each internal node represents a feature based judgment, and each leaf node predicts a result. Decision trees may overfit despite their interpretability and flexibility.

4. Gradient Boosting:

Gradient boosting combines the outputs of numerous weak learners, commonly decision trees, to create a powerful prediction model. Each new model fits the residual errors of the combined ensemble to repair prior mistakes. Gradient boosting captures complicated interactions and over fits less than individual models.

5. Random Forest:

Random Forest trains numerous decision trees and combines their predictions. Random Forest is strong and adaptable for classification and regression applications because its unpredictability improves model resilience and lowers over fitting.

6. Voting Regressor:

Voting Regressors integrate numerous regressor predictions to create a more stable and accurate model. This ensemble method improves prediction and generalization by combining model strengths.

7. KNN (K-Nearest Neighbors):

KNN is a basic yet powerful regression and classification technique. KNN assumes comparable situations have similar results. KNN is simple to construct, its performance depends on the distance metric and k.

8. LSTM (Long Short-Term Memory):

Recurrent neural networks (RNNs) like LSTM overcome the vanishing gradient issue in classical RNNs. It captures long-term dependencies in sequential data well, making it ideal for natural language processing and time-series analysis.

IV. EXPERIMENTAL RESULTS

A. Comparison Graphs

The metrics that are used for predicting the crime rate are:

- R-Squared: In the context of a regression model, R^2, also known as the coefficient determination, serves as a statistical metric indicating the proportion of variability in the dependent variable that can be elucidated by the independent variable.
- Mean Absolute Error: The average difference between the important values in the dataset and the predicted values in the same dataset is the mean absolute error (MAE).
- Root Mean Square Error: Root-mean-squared error (RMSE) is common ways to measure how well a model works. If you have a set of n data (yi, i=1,2,..., n) and n model forecasts (ˆy), the MAE and RMSE are.
- Mean squared error (MSE): finds out how much mistake there is in statistical models. It looks at the average squared difference between what was seen and what was expected

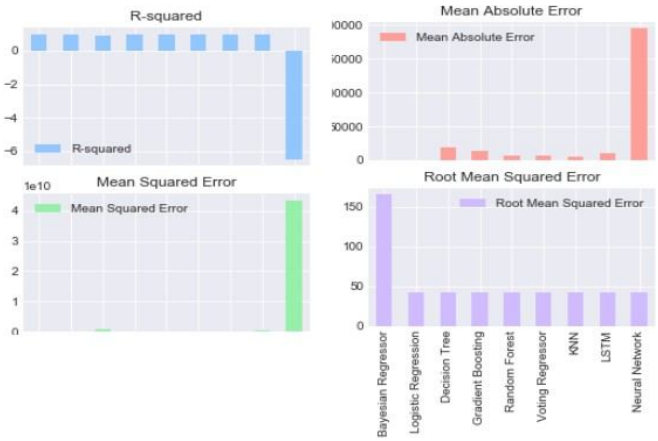

Fig 2: Performance Evaluat ion Table

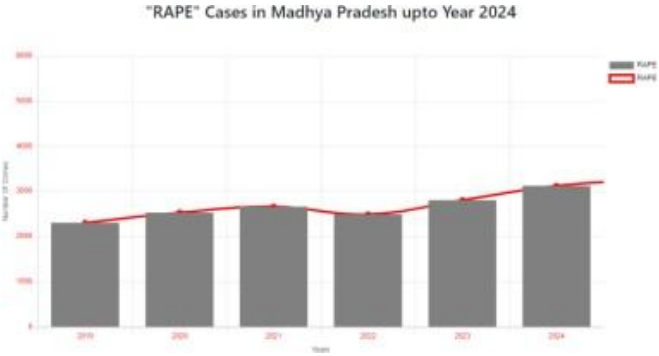

Fig 3: Rape Cases

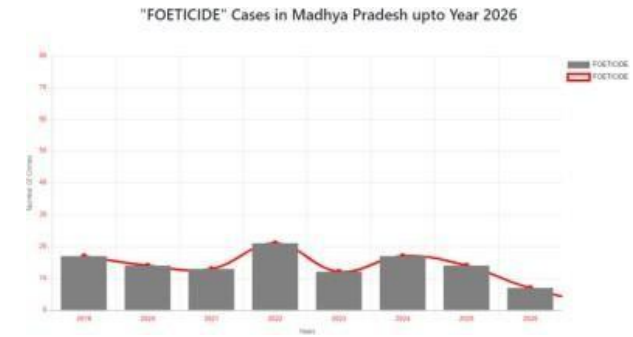

Fig 4: Foeticide Cases

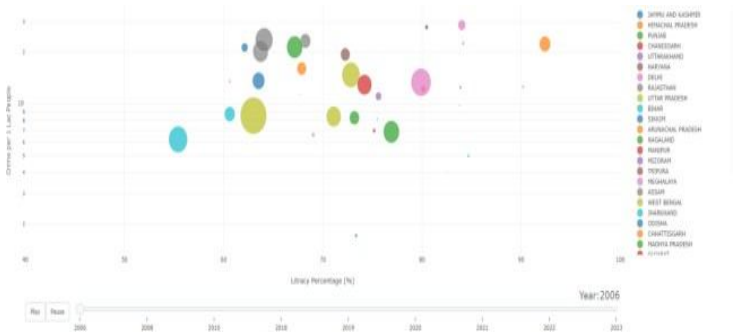

Fig 5: Crime Prediction Graph

V. CONCLUSION

In conclusion, the constant improvement of technology has definitely changed the way crimes are solved, giving police departments a huge range of powerful tools and information. With the help of "Prophet," a new additive model-based method, illegal actions can now be predicted by figuring out complicated time trends. This is a very useful tool for law enforcement. Adding different machine learning methods to crime prediction models has also made them more accurate, which has led to better use of resources and more proactive crime prevention tactics. These major changes represent a big step forward in our understanding of crime behavior and hold great promise for making communities safer. Moving forward, it is clear that the combination of cutting-edge technology and data-driven prediction models will be very important in not only solving crimes but also stopping illegal behavior and keeping society safe. This essay stresses how these new ideas could completely change how police work and how much crime there is.

VI. FUTURE WORK

The use of technology in solving crimes in the future has a huge amount of room for growth. Better realtime data analysis, the use of AI for pattern recognition, and the creation of smarter prediction models are some of the things that could lead to progress. If police and tech experts work together, they might be able to make more complete records of crimes, which would help make predictions that are more accurate. Additionally, social concerns and personal protections will become very important when these tools are used. The development of technology in solving crimes offers not only better ways to investigate, but also a more preventive and preventative way to keep the community safe. This will usher in a time when police tactics are smarter and more effective.

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