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Project Phase - II : Final Review

Presentation on

"CRIME PREDICTION USING MACHINE LEARNING"

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ABSTRACT

This project presents a machine-learning-based crime prediction system that analyzes historical crime data to identify patterns and predict future crime occurrences. By using algorithms such as Random Forest and LSTM, the system forecasts crime trends based on factors like location, time, and crime type. The project also includes an interactive web dashboard with visual analytics, heatmaps, and a predictive interface to support police departments in decision-making. This solution enhances crime monitoring, assists in resource allocation, and contributes to building safer smart cities.

PROBLEM STATEMENT

- Crime rates are increasing across major cities, affecting public safety and government planning.
- Traditional crime analysis is **manual, reactive, and slow**, leading to poor decision-making.
- There is a need for a **data-driven system** that can predict future crime patterns and assist authorities in prevention.
- Existing datasets contain temporal and spatial crime information but are not used effectively for forecasting.

OBJECTIVES OF THE PROJECT

- To analyze historical crime data and identify patterns across cities.
- To predict future crime counts using ML and LSTM time-series models.
- To design a web-based dashboard for visualization, forecasting, and hotspot identification.
- To assist law enforcement with proactive decision-making based on data-driven insights.

SCOPE OF THE PROJECT

- Includes data preprocessing, feature engineering, classification, and time-series forecasting.
- Covers **city-wise analysis**, hotspot detection, and Google Maps integration.
- Forecasting crime counts for the **upcoming months** using machine learning.
- Visualization through an interactive **Streamlit dashboard**.
- Does **not** involve real-time surveillance or actual police databases

EXISTING SYSTEM

- Crime predictions are usually done **manually** using past experience.
- Use of **basic statistical tools** for analysis, which cannot handle large datasets.
- No integrated tool for **forecasting**, hotspot mapping, or visual analytics.
- Decision-making depends mostly on **intuition rather than data**.

LITERATURE SURVEY

| SL.NO | AUTHOR NAME & YEAR | TITLE | DISCUSSED | REMARKS |
|-------|---------------------------------|---|--|--|
| 1. | Sharma et al. & 2023 | Crime Prediction Using Machine Learning and Deep Learning: A Systematic Review and Future Directions | Systematic review of ML and DL algorithms including SVM, Random Forest, KNN, Decision Tree, Naïve Bayes, LSTM, RNN | DL techniques outperform ML in predictive accuracy; identified need for real-time and interpretable systems |
| 2. | Zhang et al & 2020 | Comparison of Machine Learning Algorithms for Predicting Crime Hotspots | Compared ML algorithms: Random Forest, SVM, KNN, Logistic Regression for crime hotspot prediction | Random Forest achieved the highest accuracy in predicting crime hotspots among the tested algorithms |
| 3. | Safat et al & 2021 | Empirical Analysis for Crime Prediction and Forecasting Using Machine Learning and Deep Learning Techniques | Applied Logistic Regression, SVM, Naïve Bayes, KNN, Decision Tree, MLP, Random Forest, XGBoost, LSTM, ARIMA on Chicago and LA datasets | XGBoost achieved the highest accuracy for Chicago; KNN performed best for Los Angeles; LSTM effective for time-series crime prediction |
| 4. | Meenakshi Sundaram et al & 2019 | Crime Hotspot Analysis Using Six-Layered Deep Recurrent Neural Networks | Proposed deep RNN with six dense layers for predicting crime hotspots using the Vancouver and Google Trends datasets | Achieved 89% accuracy: outperformed traditional algorithms like SVM and Naïve Bayes |
| 5. | Parvez et al. & 2023 | Spatio-Temporal Crime Forecasting: A Critical Review | Review of spatio-temporal forecasting methods using ML, DL (LSTM, CNN), ARIMA, GIS integration | Identified challenges in data quality, suggested combining DL with external factors for improved accuracy |

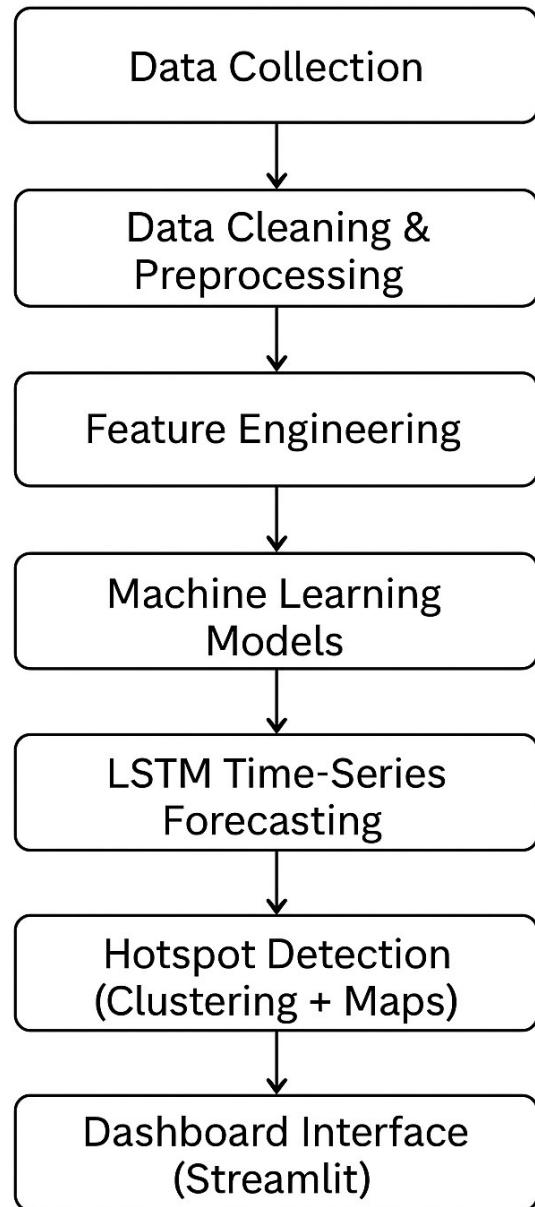
LIMITATIONS OF EXISTING SYSTEM

- Lack of automation and scalability.
- Unable to model **complex temporal patterns** in crime data.
- No predictive capability to forecast future crime trends.
- Does not support interactive visualization or hotspot identification.
- Limited accuracy and no AI-based insights.

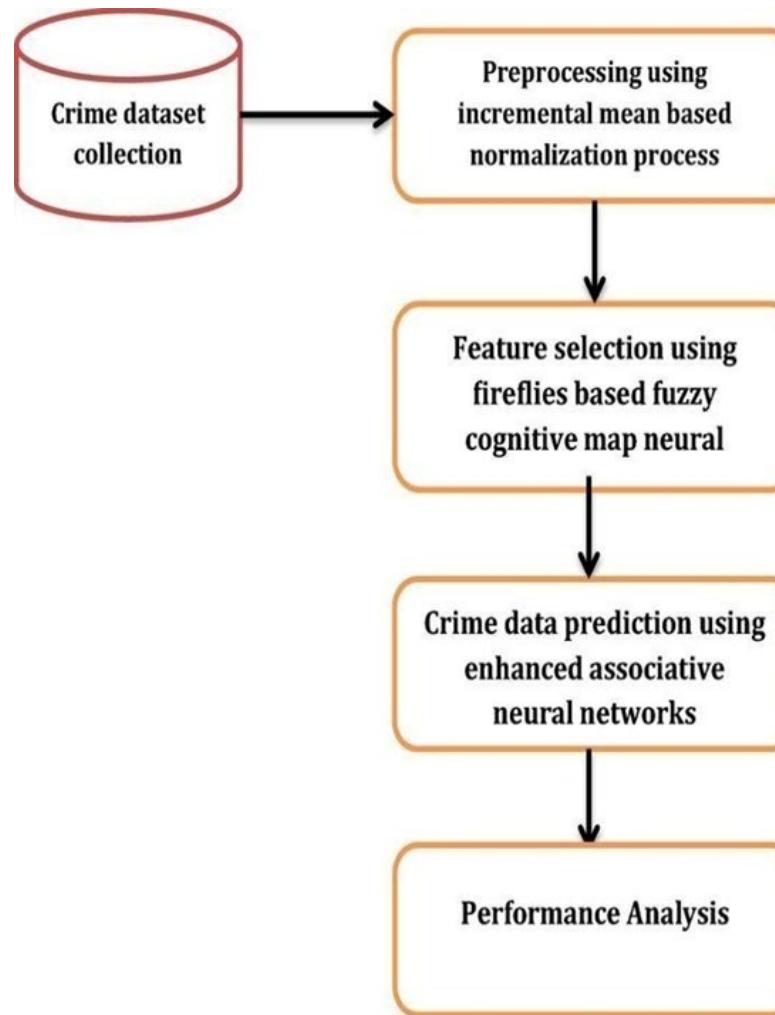
PROPOSED SYSTEM

- A machine-learning-based system that predicts **future crimes** using historical data.
- Uses ML algorithms (Random Forest, XGBoost, CatBoost) and **LSTM neural networks** for forecasting.
- Provides an interactive dashboard with:
 - Crime forecasting
 - Hotspot maps
 - Crime classification
 - Animated crime heatmaps
- Integrates **Google Maps API** for real-world geolocation visualization

METHODOLOGY



SYSTEM DESIGN



Bio – Inspired Neural Network Framework for Crime Data Prediction

MODULES DESCRIPTION

- **Data Preprocessing Module**

Cleans raw data, handles dates, encodes cities, creates monthly time series.

- **Classification Module**

Predicts crime category using Random Forest / XGBoost.

- **Forecasting Module**

LSTM model forecasts next-month crime count for each city.

- **Hotspot Detection Module**

Uses clustering + city coordinates to generate risk zones.

- **Visualization Module (Streamlit)**

Shows: charts, trends, hotspots, animated heatmaps, Google Maps.

ALGORITHMS / TECHNIQUES USED

➤ Machine Learning Models

- Random Forest
- XGBoost
- CatBoost

➤ Deep Learning Model

- **LSTM (Long Short-Term Memory)** for time-series forecasting

➤ Data Techniques

- Label Encoding
- Feature Engineering
- Time-Series Windowing
- Scaling (MinMaxScaler)

➤ Visualization Tools

- Folium Maps
- Google Maps API
- Seaborn/Matplotlib

HARDWARE & SOFTWARE REQUIREMENTS

➤ Hardware

- Minimum 4 GB RAM
- i3 Processor or above
- 10 GB free storage

➤ Software

- Python 3.x
- Streamlit
- TensorFlow
- Scikit-learn
- Pandas, NumPy
- Folium
- Google Maps API
- Jupyter / VS Code

IMPLEMENTATION

- Developed a time-series dataset aggregated monthly for each city.
- Trained LSTM model with sliding window approach for forecasting.
- Implemented Random Forest & XGBoost for classification.
- Built hotspot maps using clustering + geolocation.
- Integrated all features into a **Streamlit dashboard**.
- Added Google Maps support and animated crime heatmaps.

RESULTS & OUTPUT

The screenshot shows two views of a web-based crime forecasting application. The left view is the 'Home Page' and the right view is the 'Dataset Loaded Successfully' page.

Home Page (Left):

- Controls:** Includes 'Upload CSV dataset' (drag and drop or browse), 'Forecast Steps (Months)' slider (set to 3), 'Training Epochs' slider (set to 60), 'LSTM Window' slider (set to 3), and a checked 'Use Google Maps Tiles' checkbox.
- Crime Forecasting Dashboard:** Main title with sub-links: LSTM Forecasting, Hotspot Mapping, Google Maps, Classifier, SHAP Explainability.
- LSTM Crime Forecasting:** Sub-section with a message: 'Upload a dataset first.'
- Bottom Navigation:** Forecasting (highlighted), Hotspots, Project Info, Classification, Multi-City, Animated Heatmap.

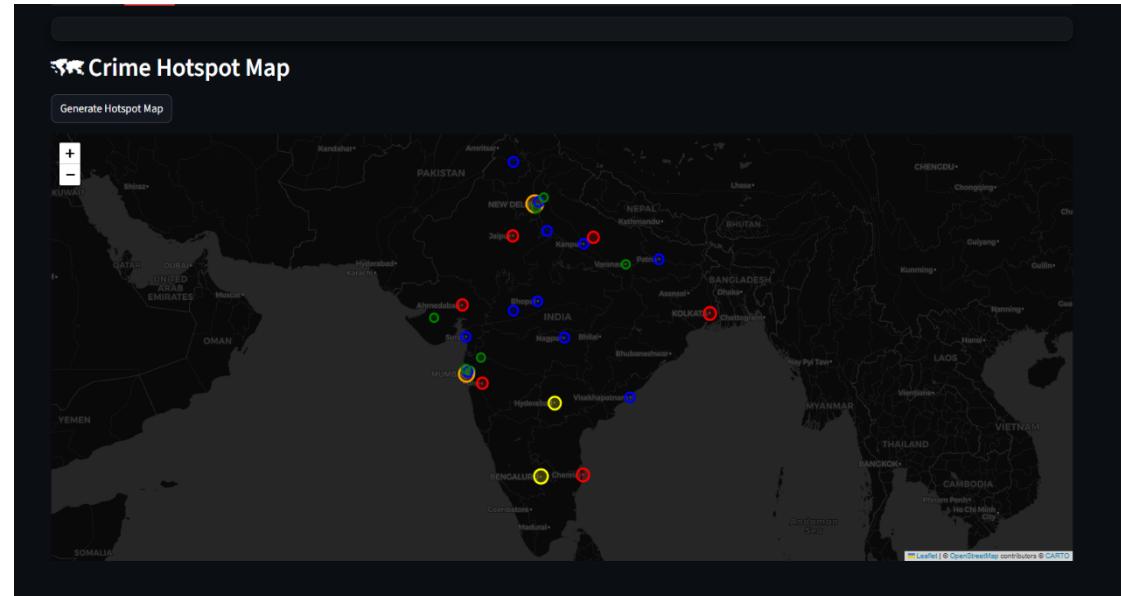
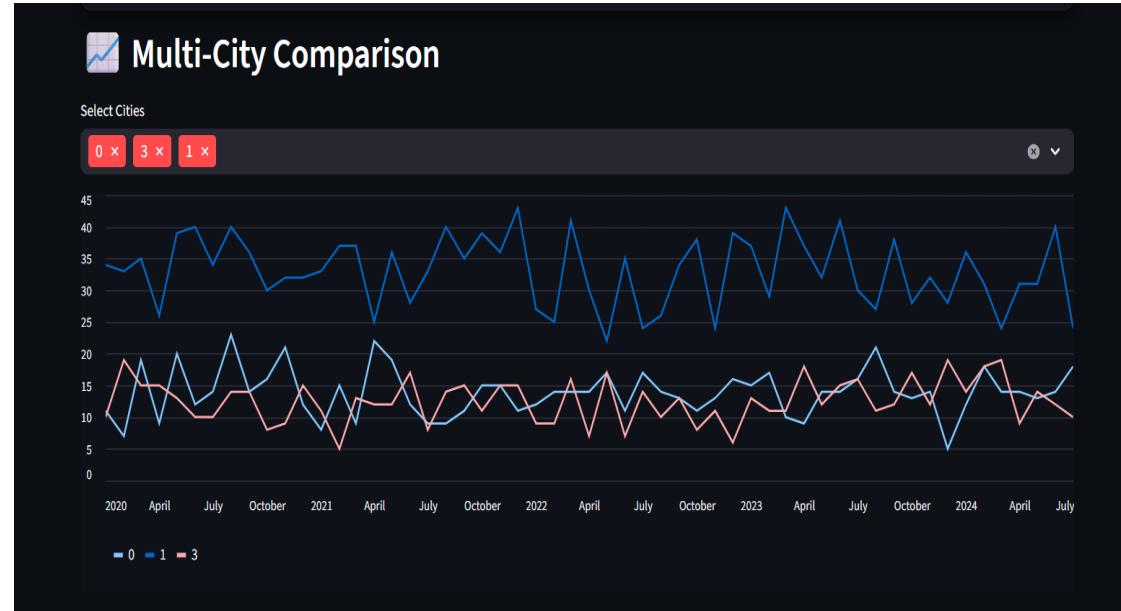
Dataset Loaded Successfully (Right):

- Controls:** Includes 'Upload CSV dataset' (drag and drop or browse), 'Forecast Steps (Months)' slider (set to 3), 'Training Epochs' slider (set to 60), 'LSTM Window' slider (set to 3), and a checked 'Use Google Maps Tiles' checkbox.
- Crime Forecasting Dashboard:** Main title with sub-links: LSTM Forecasting, Hotspot Mapping, Google Maps, Classifier, SHAP Explainability.
- Dataset Loaded Successfully:** Confirmation message: 'Dataset Loaded Successfully' with a success icon.
- LSTM Crime Forecasting:** Sub-section with a message: 'City mapping loaded successfully ✓'.
- Select City:** A dropdown menu showing 'Bangalore'.
- Recent rows:** A table showing recent dataset rows for Bangalore.

| | City_enc | Date | Year | Month | Crime_Count | Lag1 | Lag2 | Lag3 | TrendIndex | Month_sin | Month_cos | CityName | CityCode |
|-----|----------|---------------------|------|-------|-------------|------|------|------|------------|-------------|-----------|-----------|----------|
| 155 | 2 | 2023-10-01 00:00:00 | 2023 | 10 | 70 | 63 | 62 | 65 | 46 | -0.866 | 0.5 | Bangalore | 2 |
| 156 | 2 | 2023-11-01 00:00:00 | 2023 | 11 | 68 | 70 | 63 | 62 | 47 | -0.5 | 0.866 | Bangalore | 2 |
| 157 | 2 | 2023-12-01 00:00:00 | 2023 | 12 | 68 | 68 | 70 | 63 | 48 | 10000000002 | 1 | Bangalore | 2 |

Home Page

Dataset Loaded Successfully



PERFORMANCE ANALYSIS

- LSTM forecasting achieved **MAPE between 15–25%** depending on city.
- Classification accuracy improved after preprocessing.
- Hotspot clustering correctly identified high-risk zones.
- Dashboard performance optimized using caching and reduced animation load.

ADVANTAGES OF PROPOSED SYSTEM

- Predicts future crimes accurately using AI.
- Helps in proactive police deployment and planning.
- Interactive and user-friendly dashboard.
- City-wise actionable insights.
- Google Maps integration for real location tracking.
- Automates crime trend analysis.

APPLICATIONS

- Police departments
- Smart City monitoring systems
- Government & urban planning
- Crime research organizations
- Public safety departments

CONCLUSION

- The system successfully predicts and visualizes crime patterns using ML and LSTM.
- Helps authorities take preventive actions rather than reactive responses.
- The interactive dashboard provides real-time analytics and hotspot mapping.
- Demonstrates how AI can significantly support smart policing.

FUTURE ENHANCEMENTS

- Include real-time data from police servers.
- Add more ML models like GRU, Transformers.
- Deploy as a cloud-based web app.
- Add crime severity prediction.
- Integrate social media sentiment analysis.
- Build mobile app version

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THANK YOU