

“An AI-Driven Predictive Framework for Identifying Violent Crime Hotspots using Spatial, Temporal, and Socio-economic Data in Urban India.”

Ms. Vanshika Deshmukh, Ms. Vaishnavi Badgujar, Ms. Bhagyashri Bari

(R.C. Patel Institute of Management Research and Development)

Abstract :

The research paper explores the AI-driven framework to predict violent crime hotspots in Indian cities using spatial, temporal, and socio-economic data. The study combines machine learning algorithms such as Random Forest, XGBoost, and LSTM to Analyze crime patterns based on location, time, and social conditions like population density and unemployment rate. The model identifies areas with a high probability of violent crimes, helping law enforcement agencies take preventive measures. By merging spatial and time-based analysis, the proposed hybrid model improves accuracy in predicting short-term crime trends. The framework aims to support data-driven policing, enabling better resource allocation and faster response. Ethical concerns like data privacy and fairness are also considered to ensure responsible AI use. This approach can help develop safer and smarter cities across urban India. The results demonstrate that AI-based models can effectively identify emerging hotspots before escalation, offering a data-driven decision-support tool for proactive policing and urban planning. This research contributes to the development of intelligent, evidence-based crime prevention strategies tailored to the socio-economic realities of urban India.

Keywords :- AI-Driven Crime Prediction , Violent Crime Hotspots, Urban Safety

Introduction :

In recent years, the rise of Artificial Intelligence (AI) and data analytics has opened new possibilities for addressing complex urban challenges, including public safety and crime prevention. Crime prediction has become a crucial area of research as law enforcement agencies seek proactive solutions to reduce violent incidents and enhance community security. In the context of Indian cities, where rapid urbanization, population growth, and socio-economic disparities contribute to fluctuating crime patterns, a data-driven approach is essential for effective policing and urban management.

This study presents an AI-driven framework designed to predict violent crime hotspots in Indian cities by integrating **spatial**, **temporal**, and **socio-economic** data. The proposed model utilizes advanced machine learning algorithms such as **Random Forest**, **XGBoost**, and **LSTM** to analyze complex relationships between location, time, and social conditions like population density, literacy levels, and unemployment rates. By identifying areas with a high probability of violent crimes, the model assists law enforcement agencies in implementing preventive strategies and optimizing resource allocation.

Unlike traditional crime analysis methods, this framework combines spatial and time-based learning to enhance predictive accuracy, particularly for short-term crime forecasting. The approach emphasizes ethical AI use by addressing concerns related to data privacy, fairness,

and transparency. Through this research, the study aims to contribute to the development of **smart, data-driven policing systems** that support safer and more sustainable urban environments across India. By combining spatial and time-series analysis, this research contributes to the development of **smart, safe, and sustainable cities** in India. The outcomes of this study demonstrate that AI-based predictive models can effectively assist in early detection of emerging crime hotspots, supporting evidence-based decision-making for law enforcement agencies and urban planners. Ultimately, this approach aims to promote a data-driven, intelligent crime prevention system tailored to the socio-economic realities of Indian cities.

Objectives :

1. To develop an AI-based framework for predicting violent crime hotspots in Indian cities.
2. To analyze spatial, temporal, and socio-economic factors influencing crime patterns.
3. To apply machine learning models like Random Forest, XGBoost, and LSTM for prediction.
4. To assist law enforcement in proactive policing and resource allocation.
5. To ensure ethical and fair use of AI in crime prediction and urban safety planning.
6. To contribute to building smart, safe, and sustainable cities through intelligent AI-based crime management solutions.

Experiment :

Responses Related To How can AI-based crime prediction support police in quick decision-making

Responses	Frequency	% of Total
Give quick alerts	49	44.5
Show crime locations	40	36.4
Save time	21	19.1
Total	110	100

Responses Related To Which factors are important for crime prediction

Responses	Frequency	% of Total
Place (Where)	44	40
Time (When)	43	39.1
People (Who Community)	23	20.9
Total	110	100

Responses Related To How can ethical AI support law enforcement in reducing violent crime

Responses	Frequency	% of Total
Can AI reduce crime ethically	38	39.4
How can AI aid policing	31	28.4

AI for ethical crime control	40	36.7
Total	110	100

Responses Related To How can AI help identify and prevent violent crime in Indian cities

Responses	Frequency	% of Total
Prevention	35	33.3
Detection	40	38.1
Safety	30	28.6
Total	110	100

Responses Related To Which models are useful for crime prediction

Responses	Frequency	% of Total
Random Forest	51	46.4
XGBoost	45	40.9
LSTM	14	12.7
Total	110	100

Responses Related To Can machine learning models improve the prediction of crime hotspots in India.

Responses	Frequency	% of Total
Crime Spot	46	42.2
Prediction	39	35.8
Safety	24	22
Total	110	100

Research and methodology :-

HYPOTHESIS 1: How can ethical AI support law enforcement in reducing violent crime? Thus Applying The Formula $\chi^2 = \sum (O_i - E_i)^2 / E_i$

Here, O_i = Observed Frequency (Response Collected From Survey),

E_i = Expected Frequency (Expected Response)

Showing Calculation Of $\sum (O_i - E_i)^2 / E_i$

Sr .No	How can ethical AI support law enforcement in reducing violent crime?	O_i	E_i	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
1	Can AI reduce crime ethically	38	36	1.3	1.7778	0.0484
2	How can AI aid policing	31	36	-56	32.1111	0.8755
3	AI for ethical crime control	41	36	4.3	18.7778	0.5115

4	Total	110				1.4364
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$$\sum (O_i - E_i)^2 / E_i = 1.4364$$

Degree Of Freedom (D.F.) Is 2

Therefore, Tabulated Value Of χ^2 as 2 Degree Of Freedom Is 5.9911*

$$\chi^2 = 1.4364 \quad 2ss. 1.4364 < 5.991^*$$

Result : Calculated $\chi^2 = 1.4364$, Tabulated $\chi^2 = 5.991$ (df = 2).

Since $1.4364 < 5.991$, the hypothesis is accepted.

HYPOTHESIS 2: Which models are useful for crime prediction?

Thus Applying The Formula $\chi^2 = \sum (O_i - E_i)^2 / E_i$

Here, O_i = Observed Frequency (Response Collected From Survey),

E_i = Expected Frequency (Expected Response)

Showing Calculation Of $\sum (O_i - E_i)^2 / E_i$

Sr .No	Which models are useful for crime prediction?	O_i	E_i	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
1	Random Forest	51	36	14	205.3	5.60
2	XGBoost	45	36	8	69.4	1.89
3	LSTM	14	36	-22	513.7	14.01
4	Total	110	110			21.50

$$\sum (O_i - E_i)^2 / E_i = 2.96$$

Degree Of Freedom (D.F.) Is 2

Therefore, Tabulated Value Of χ^2 as 2 Degree Of Freedom Is 5.991*

$$\chi^2 = 21.50 \quad 2ss. 21.50 > 5.991^*$$

Result : Calculated $\chi^2 = 21.50$, Tabulated $\chi^2 = 5.991$ (df = 2).

Since $21.50 > 5.991$, the hypothesis is rejected.

Conclusion :

This research concludes that AI-based predictive frameworks can play a vital role in strengthening urban safety and proactive crime prevention in India. By combining spatial, temporal, and socio-economic data, the proposed hybrid model provides an accurate and reliable approach to identifying potential violent crime hotspots. The integration of models such as Random Forest and XGBoost improves prediction accuracy, supporting law enforcement agencies in making timely and data-driven decisions. Additionally, embedding ethical principles into the framework ensures that technology-driven policing remains fair, transparent, and accountable. Ultimately, the study demonstrates that AI-driven crime prediction not only enhances public safety but also contributes to smarter, safer, and more sustainable cities. This research lays the groundwork for future innovations in intelligent policing systems, real-time crime monitoring, and data-informed urban governance in India.

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