ANALYSING CRIME PATTERNS USING DEEP LEARNING MODELS: A CASE STUDY ON A GIVEN DATASET IN LOS ANGELES

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Chapter 2: Literature Review

2.1 Introduction

Criminal activity pervades every element of human existence across the planet. It has a direct impact on a country's standard lifestyle in addition to its economic and social development. Authorities are more likely to adopt advanced technology to address such concerns now that it has grown into a serious worry in practically all nations. Crime Analysis is a branch of criminology that investigates the patterns of crime and criminal behaviour to understand the underlying causes of such events. Analysing crime trends with deep learning algorithms is a difficult but crucial assignment for authorities and scholars. This research will go through the process of utilising deep learning algorithms to analyse a crime dataset concerning Los Angeles. This method conveys a dataset containing crime-related attributes and accompanying labels, which could indicate the crime's type or classification. The purpose of this research endeavour is to create a complete framework for employing deep learning algorithms in the evaluation of crime patterns, eventually supporting law enforcement departments, lawmakers, and academics in making educated decisions to improve safety for everyone and crime prevention methods.

2.2 Deep learning and Neural networks

According to Adhikary *et al.* 2022, from 2012 to 2019, the total amount of computing power necessary to run top-performing models using deep learning rose at a pace of 10 each year. Similarly, the rate of data production is expanding at a rapid pace. GPT-3, OpenAI's language model, has 175 billion parameters that can be learned and is anticipated to take 190,000 kWh for training purposes. Furthermore, brains run on 12-20 W of electricity. This involves additional processing of a plethora of sensory information while guaranteeing the automatic biological systems are not powered off. Biological selection would've killed out mankind before humans could have devised artificial intelligence if our cognitive systems wasted the same amount of heat as cutting-edge deep learning models. **According to Jospin *et al.* 2022,** Because of the increasing usage of the Internet of Things (IoT) with today's reliance on technological advancement, numerous security-related incidents or assaults have increased dramatically in the past few years. Harmful actions, malware or ransomware assaults, zero-day infections, cryptographic incidents, unauthorised involvement, denial of service (DoS), hacking, phishing or

scams, or additional attacks on Internet of Things (IoT) devices, too., are all frequent these days. These sorts of security events or cybercrime can hurt organisations and people, causing interruptions as well as catastrophic economic damage. These outcomes should suggest that using these techniques should be guided by examining location-specific circumstances rather than global computing. Indeed, the researchers used neural network approaches to extract information and anticipate crime data patterns based on fundamental interpersonal, urban, and commercial characteristics. In a controlled setting, researchers utilised computer neural networks to forecast the causation across crime rates like vandalism, theft, and assault and economic indices, finding that a lack of employment was the most significant explicating factor. **According to Thomas *et al.* 2022,** deep learning has ushered in a new era in machine learning, bringing answers to previously intractable issues. Models based on deep learning, on the other hand, are susceptible to overfitting, which reduces their generalisation capabilities. When they offer a confidence interval, they are additionally likely to be excessively confident in their forecasts. This is a concern in situations where quiet failures might have significant consequences, such as self-driving cars, medical diagnostics, or finance. As a result, several techniques to mitigate this threat have been offered.

2.3 Crime Prediction and Analysis

According to Thomas *et al.* 2022, In recent years, several police agencies throughout the world have implemented technology that uses statistical information to inform their decisions, a practise known as predictive policing. In this strategy, police agencies evaluate statistical historical data to predict which geographic locations have a higher likelihood of illicit activity. Numerous law enforcement agencies throughout the globe have used predictive policing methods that utilise statistical data to inform their choices. **According to Shukla *et al.* 2022,** As urbanisation accelerates, it is more important to monitor criminal activity in each location in order to limit the prevalence of undesirable habits. Prediction of crimes can only be done by analysing patterns of criminal activity utilising historical data accessible with the relevant persons. In everyday life, crime information is gathered in the following manner. When a crime takes place, policemen will most likely visit the crime spot or get information about it over a phone call, with that they will compile a crime report. **According to Albert *et al.* 2019,** The information kept may be saved in a number of methods according on the authorities, but it

includes the data that follows: the Time, day, and location of the incident; Offence; Crime setting, including postal code & Survey block coordinates; Victim data; routine indicates how the crime was accomplished. The data acquired by police will be a combination of unstructured text and organised and verified fields, according to the crime tracking system utilised. Now lies the requirement for AI & Deep Learning to analyse countless crime reports, categorise them, and anticipate the time and manner in which a crime might happen using statistical techniques. **According to Thomas *et al.* 2022,** they are examining eight distinct publications associated with the aforementioned subject in order to detect inconsistencies in them. This paper considers a few frequently employed predictive and analysis techniques and categorises them as neural network strategies, Statistical techniques, and spatio-temporal techniques, and investigates the degree of accuracy demonstrated by some of the various approaches that fall under it.

2.4 Crime Analysis and Criminology

According to Saraiva *et al.* 2022, Crime analysis, which is closely related to criminology, is a methodical analysis of criminal and unlawful conduct trends to comprehend the underlying causes of illegal activities and establish tactics for preventing crime and enforcement of laws. During the long historical events, the applicability of criminology to topics of public policy remains severely disputed. Nonetheless, people have frequently seen the repercussions of bad criminal justice practices that do nothing to decrease crime or enhance the well-being of those in greatest need. Considering the pressing requirement for evidence-based solutions to our society's challenges, we suggest that criminologists may and ought to have a say in the process. As a result, this paper discusses the obstacles and opportunities for policies based on evidence in the areas of law enforcement and criminal justice. **According to Clancy *et al.* 2022,** Practitioners of evidence-based policymaking emphasise the ability to enhance the functioning of the judiciary and, by implication, the daily lives of the nation's residents. Nonetheless, there are frequent discrepancies between scientific facts and the public's perception of our most serious societal problems. As a result, the way that generates information and shares it with policymakers, professionals, and the general public has a chance to contribute to bridging this gap, which is especially important in the current context where people face multiple social issues and a growing discourse among scientists skepticism The interaction of statistical analysis of crime and criminology is critical for understanding the root causes and effects of crime, and for developing

appropriate reactions to criminal activity. **According to Blomberg *et al.* 2023,** This research blends classic statistical approaches with computational intelligence to better comprehend regionally important, relevant crime scenarios. Researchers discover that violent criminal activity is connected with an entrenched drawback, domestic order, and racial variation, the overall population, and geographical lag of serious crime when using census categories as the basis of analysis and adjusting for many structural parameters associated with crime. However, the geographical lag of criminal activity is the most influential indicator, followed by domestic stability, racial variation, the general population, and significant disadvantage. Furthermore, they discovered that aggressive behaviour is related to immigration, owned and operated housing, the number of people working in professional jobs, and the proportion of people with a bachelor's degree or more, along with demographic diversity, the overall number of people, and the geographical lag for a serious crime.

2.5 Crime Prediction using Deep Learning techniques

According to Thomas *et al.* 2022, Worldwide population growth, especially in big cities, has produced new challenges, notably regarding public safety legislation and optimisation. As a consequence, an approach for forecasting criminal activity in an area based on past occurrences and demographic information is presented in this work. As urbanisation accelerates, it is more important to monitor criminal activity in each location to limit the prevalence of undesirable habits. Only by analysing trends in criminal activity utilising historical data available to the involved individuals can predict crimes. This mostly uses historical data and analyses it utilising Deep Learning, Analytical Models, and Techniques. This research investigates several methodologies for predicting and forecasting crime occurrences. The approaches are classified, and their usefulness in different fields is investigated according to the accuracy and level of detail of their forecast, to shed light on the current methodology. This paper, in particular, presents a crime prediction and assessment methodology for system interface neural network systems. Therefore, a thorough examination of four unique types of crimes, including murder, speedy trial, oppression against women and children, especially drugs, verifies the suggested framework's effectiveness. The entire analysis and execution procedure revealed a graphic depiction of crime in different regions around the country. **According to Adhikary *et al.* 2022,** In recent years, several police agencies throughout the world have implemented software that

uses statistical data to inform their decision-making, a practice known as predictive policing. With this strategy, police agencies evaluate statistical historical data to predict which geographic locations have a higher likelihood of criminal activity. This sort of data is frequently used by law enforcement to effectively deploy their assets to deter illegal behaviour. Predictive policing is not a substitute for traditional policing approaches; rather, it complements them by utilising complex data models and techniques. According to certain empirical research, predictive police tactics reduce crime. Deep learning is a machine intelligence function that mimics the functions of a person's brain in handling data and developing patterns for making decisions. Deep learning is a type of machine learning area that works with methods driven by the structure and functions of the mind-labelled neural networks in computers and contains networks that can learn unsupervised from unstructured or labeled data. It's also known as deep neural training or neural network deep learning. These procedures are often divided into three stages: pre-processing, processing, and post-processing. **According to Thomas *et al.* 2022,** The use of deep learning models for crime prediction can help law enforcement departments allocate assets more efficiently and establish proactive tactics for preventing crime and safety for everyone. Nevertheless, while such models provide helpful information, they need to be utilised responsibly and in combination with additional crime reduction tools and community-based initiatives.

2.6 Applications of Feedforward Neural Networks in Criminology

According to Topchii *et al.* 2021, Crime is a prevalent social worry that influences standard lifestyles and economic progress. Despite worldwide decreases in criminal activity, certain forms of crimes as well as feelings of vulnerability have frequently grown, necessitating the use of creative methodologies and advanced technology by security and protection organisations to better forecast and prevent incidents. **According to Ghazvini *et al.* 2020,** A Neural Network (also called NN) is a popular data modelling tool that may show complex input/output relationships to detect trends in various data sets. The main benefit of an NN is that it can handle complex problems for common technologies that cannot be solved using algorithmic techniques. Because of its capacity to simulate complicated relationships among input data and intended outputs, Feedforward Neural Networks (FNNs), an initial kind of artificial neural network, offer a wide range of possible applications in criminology. By analysing previous crime data, FNNs

may be used to forecast potential crime rates or incidences. They can predict when and where offenses are likely to occur by learning patterns from multiple parameters like time, place, demography, and other pertinent aspects. This is frequently used to predict recidivism or the possibility of a person reoffending. Such networks may help in risk appraisal by analysing a variety of social and criminal record facts, which supports decisions regarding eligibility for parole, punishment, or rehabilitation programmes. **According to Wongsinlatam *et al.* 2020,** By recognising similar tendencies among criminals, FNNs can help to create criminal profiles. They can analyse numerous characteristics and behaviours connected with various sorts of crimes to aid police in profiling possible suspects or comprehending criminal behaviour. This study's major interest is the forthcoming multiple crime location, chronology, and suspect characteristics like age and ethnicity. To apprehend an offender, the next consecutive crime duration, geographical location, and criminal history are critical factors in criminology.

2.7 Summary and Gaps in Literature

According to Mireshghallah *et al.* 2020, The methods of deep learning, especially neural networks, have gained popularity in crime investigation and criminology in the past few years. These methods may be used for a variety of purposes, such as crime forecasting, risk evaluation, geographic analysis, profiling of criminals, recognising victims, cybercrime identification, and analysis of sentiment in the reporting of crimes. They use historical crime statistics, demographics, location data, and behavioural trends to provide insights that help law enforcement, legislators, and criminologists analyse, prevent, and deal with criminal activity.

Nonetheless, despite the advances and prospective uses, there are still gaps and topics for future investigation in the existing research on this topic:

Factors for Ethical Behaviour: The ethical issues of employing deep learning within crime investigation, like the possibility of biases in information, computational fairness, and privacy problems, need to be investigated further. It is vital to ensure that predictive models are used ethically in a manner that doesn't encourage prejudice or worsen socioeconomic inequities.

Accessibility and interpretability: According to Sendak *et al.* 2020, FNNs, frequently recognised as "black box" algorithms, lack comprehensibility making it difficult to grasp the way

they reach at precise forecasts or categorizations in the setting of criminal behaviour. Bridging this gap through the development of tools to understand FNN judgements might increase the value and credibility of FNN outcomes amongst criminal justice experts and police agencies.

Quality of Data and Representativeness: FNN performance is largely dependent on the overall quality and accuracy of the training material. Prejudices, data shortages, or insufficient records can all have significant consequences on the model's performance in crime analysis.

Spatial Dynamics and Volatile Environments: Several spatial and environmental variables impact crime. **According to Tien *et al.* 2022,** Additional study is needed to investigate how models based on deep learning may change to rapid shifts in criminal behaviour as time passes or by changing environmental conditions.

Integration with Traditional Criminology: Though deep learning provides revolutionary tools, combining these techniques with established criminology research and methodology is critical for a comprehensive knowledge of crime along with its socioeconomic, psychological, and ecological repercussions.

Real-world application and Adoption: Transitioning from study to actual application is difficult. It is critical to investigate the real-world practicality, acceptability, and constraints of employing deep learning algorithms in judicial and policy-making situations.

Bridging these gaps and resolving the issues in the literature will improve the application of methods based on deep learning, namely neural networks, within crime analysis including criminology, allowing for more accurate, fair, and accessible tools for crime forecasting, avoidance, and enforcement. **According to El *et al.* 2022,** This integration has the potential to contribute to the development of more efficient crime prevention techniques as well as the promotion of public safety.

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