Deep Learning Model for Enhancing Child Safety: A Case Study

Aby Rose Varghese[1], Dr. N. V. Chinnasamy[2]

[1]Research Scholar, Karpagam Academy of Higher Education, abyrosev@gmail.com
[2]Asst. Professor, Karpagam Academy of Higher Education, Coimbatore, chinnasamy.nvaiyapuri@kahedu.edu.in

Child safety is one of the major issues in Kerala where the rate of crime against children is huge. Deep learning can be used to address the children who are at risk of being victims of crime. In this paper, we focus on a case study of deep learning for child safety in Kerala. We use a dataset from the National Crime Records Bureau to develop a deep learning algorithm aimed at forecasting the likelihood of child abuse. LSTN,RNN and GRU algorithm to identify children who are at risk of being abused and can provide them support and protection. The result shows that deep learning can be a powerful tool for child safety. Future crimes can be reduced and can ensure justice for the victims. The use of deep learning for child safety is a promising area of research. We hope that our findings will help to provide awareness of this issue and to promote the use of deep learning to protect children.

Keywords: Deep learning, Child Safety, Crime prevention, Kerala.

1. Introduction

Children are the most vulnerable members of society. They depend on an adult for their care, protection, and well-being. But crime against children is persisting in our society. It's threatening their safety, innocence, and overall development. These offenses not only result in substantial harm to the victims but also have long-lasting repercussions which extend to individuals, families, and society at large. Crime is defined as an act or the commission of an act that is forbidden, or the omission of a duty that is commanded by a public law and that make the offender liable to punishment by that law. The purpose of this paper is to shed light on the alarming issue of crime against children, examine the various forms these crimes take, and explore the impacts they have on the lives of young individuals. This paper aims to identify potential solutions and inventions to safeguard children and create a safer environment for their growth. Crimes against children encompass a wide range of offenses including physical and sexual abuse, neglect, exploitation, child trafficking, child labour etc. Each of these crimes leaves long lasting scars on the lives of the survivors often leading physical, emotional and psychological trauma. This crime may have disrupt their education, social development and hinder their future prospects and vulnerability. Understanding the

root cause and contributing factors behind crime against children is essential to effectively combat this issue. Socioeconomic disparities, lack of education, health care, familial dysfunction etc. play significant role in perpetuating these crimes. By examining these factors, we can develop prevention strategies and implement comprehensive interventions that address the root causes and protect children from harm. This paper will explore the legal and social frameworks in place to address crime against children. It will critically evaluate the efficacy of existing policies and support systems in providing justice to victims. It will also discuss the importance of raising awareness, promoting child protection initiatives, and fostering collaboration among stakeholders, including government agencies, educators, and communities to create a collective response to this issue.

Crime against children is a grave threat to the well-being and future of young individuals. To tackle this problem, it is crucial to understand the nature of these crimes, identify the root cause, and implement strategies to protect children and overall well-being. By addressing crime against children at all levels from prevention and detection to prosecution and rehabilitation, we can work towards creating a safe society to empower to reach their full potential.

2. Literature Survey

Artificial intelligence is extensively utilized in forecasting criminal activities. Many studies concentrate on predicting crime types based on different factors such as time location. Ying-Lung Lin et al., [1] in their paper "Using Machine Learning to Assist Crime Prevention" predicted the crime hotspot and accumulated data with different time scales for improving model performance. They used deep learning algorithms, random forest, and naive Bayes for better prediction. Nisha Sharma et al., "A machine learning approach to predict Crime using Time Location data" [2] used machine learning classification algorithms like SVM, RF, Decision Trees, and KNN. Data are so complex because a huge amount of data has to be pre-processed. Machine learning algorithms have been shown to perform badly on this kind of data whereas deep learning techniques perform well compared with machine learning as shown in papers by Yong Zhang, Mathew Almeida, Mellissa Morabito, and Wei Ding in "Crime Hot Spot Forecasting: A Recurrent Model with Special and Temporal Information"[4]. They predict the crime hot spot with the RNN method. Trung T Nguyen, Amartya Hatua, and Andrew H Sung [6] built a machine learning classifier for crime prediction despite having insufficient data. They also used the deep learning approach. Souglman Kabirou and Keshav Kishore [7] demonstrate the efficacy of utilizing leveraging machine learning and Recurrent Neural Networks (RNN) to enhance the effectiveness of crime detection and prevention. Machine Learning and Recurrent Neural Networks (RNN) for efficient crime detection and prevention. Their findings indicate that the RNN classifier outperforms both Artificial Neural Networks (ANN) and Random Forests (RF). Narayan Bhat, V Santhosh Kumar, Saravanan C [9] the projected crime against women in India used different machine learning algorithms for the analysis and prediction of crime. They proved Linear regression algorithm gave a better prediction accuracy rate compared to another algorithm. N.Shahi, Ashwani K Shahi, Riyan Phillips, Gabrielle Shireka, Daniel M, Lindberb, and Steven L [8] used deep learning and natural language processing model to

detect child abuse showcasing the identification of a specific NLP tool tailored for this purpose. [17] Das et al devised a graph-based clustering approach to determine the specific area where crimes are concentrated. They also implemented a community detection algorithm based on crime trends. In [18] Sunil et al consider a lot of factors in account, they used visualization and analysis and give more focus on the visualization part. The authors used Matplotlib and linear regression algorithms for the analysis. [19] Mowaf et al. (2018) implemented a technique to predict the crime type from the unstructured text. They used the Scikit-learn Python Toolkit for the implementation. In [20] Tabedzki et al proposed a machine learning method for the prediction of crime in Philadelphia, US. They also used data mining techniques to check the occurrence of crime. For training the dataset they used logistic regression, KNN, ordinal regression tree methods etc. They presented a predictive crime map detailing the occurrence of crime across various regions during a specific time frame.

3. METHODOLOGY

This section would explain the methodology and the principle employed in this paper. Aim of this paper is to examine and forecast crimes against children in Kerala. Dataset is collected from the National Crime Records Bureau (NCRB). The sample dataset is shown in fig 1.

CRIME HEAD	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
INFANTICIDE	1	1	3	0	0	0	1	0	5	6	1	6
INFANTICIDE	0	0	0	0	0	0	0	0	0	0	0	0
INFANTICIDE	0	5	0	0	1	0	0	0	0	0	0	0
INFANTICIDE	0	0	0	0	2	0	2	2	0	2	5	2
INFANTICIDE	7	29	5	12	0	15	11	6	2	0	10	5
INFANTICIDE	0	0	0	0	0	1	0	0	0	1	0	0
INFANTICIDE	2	0	0	1	6	0	7	0	0	0	0	0
INFANTICIDE	0	3	0	1	0	0	1	5	0	0	0	0
INFANTICIDE	0	0	3	0	0	0	0	0	0	0	0	0
INFANTICIDE	0	0	0	0	0	0	0	0	1	0	0	0
INFANTICIDE	0	0	0	0	0	0	0	0	0	2	0	0
INFANTICIDE	6	2	0	2	1	1	0	3	0	1	1	1
INFANTICIDE	1	1	0	2	0	1	3	0	0	1	1	0
INFANTICIDE	7	9	4	6	9	17	10	1	9	8	12	13
INFANTICIDE	13	9	9	4	2	3	5	6	0	0	9	12
INFANTICIDE	0	0	0	0	0	0	0	0	0	0	0	0
INFANTICIDE	0	0	0	0	1	0	0	0	2	0	0	0
INFANTICIDE	0	0	0	0	0	0	0	0	0	0	0	0
INFANTICIDE	0	0	0	0	0	1	1	0	0	0	0	0

Fig1.Sample dataset

This data was used to predict the rate of crime against child and its severity in the coming years, in different areas of the state based on the previous year records of state.

1. Data Requirement Selection
2. Data Collection
3. Data Pre-processing
4. Data Analysis
5. Prediction Model
6. Visualization

All these are in the model. We need around 5 years of data for this major work. The dataset should specify the type of crime committed against children. The data pre-processing is done

to convert data input to some understandable data. The dataset collected consist of real world data, which may often incomplete or inconsistent. Errors in the raw data can manifest due to a variety of reasons, including missing data, inconsistencies introduced during data merging, inaccuracies resulting from flawed data entry procedures and other contributing factors. Therefore, it is essential to clean and make it ready for our algorithm so that it becomes easy to make precision. It enables our algorithm to perform more effectively resulting better outcomes. Partitioning the dataset into training and testing set is a crucial step, as it facilitates the model's learning process on the training data followed by a robust evaluation of its performance on previously unseen data during testing. Fig2 shows the architectural diagram of the system which shows the overall operation from data collection to predicting the crime.

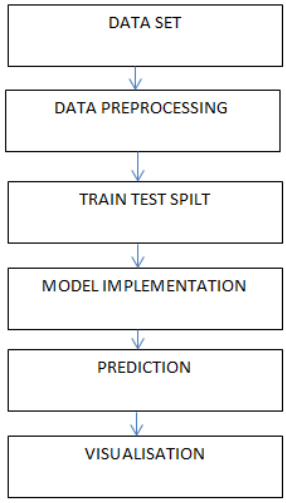

Fig2. Architectural diagram

We used historical data for training and recent data for testing the model's predictive performance. Model creation is done using LSTM and GRU models using a deep learning library like TensorFlow or Keras. LSTN and GRU prove well suited for processing time series data, as they possess the capability to capture extended temporal dependencies and recognize patterns within sequential data.

Long Short-Term Memory (LSTM) stands out as a variant of Recurrent Neural Networks (RNNs) proficient in acquiring knowledge from long-term sequences effectively addressing the challenge of long-term dependencies that RNNs often encounter. It works very much like RNN.LSTN consists of three gates namely the forget gate, input gate, and output gate each fulfilling a specific function. These gate components control the flow of data both in and out of the LSTM cell. Similar to RNN, short-term memory is denoted as the hidden state in LSTMs whereas long-term memory is identified as the cell state. The forget gate determines whether to retain or discard information from the preceding time step. The input gate assesses the significance of new data. In the subsequent time step, the output gate combines the current input, the previous short-term memory, and the newly calculated long-term memory to produce a new short-term memory which is then transmitted to the cell.

GRU (Gated Recurrent Unit) is the same as RNN only a difference in the operation and gate associated with the unit. Two operational mechanisms known as the update gate and rest gate are present in a GRU. The update gate plays a crucial role in deciding the extent of past information that should be carried forward to the next state. On the other hand, the reset gate is employed to determine the amount of information to be omitted. It stores the relevant information to the new state.

Train the LSTN and GRU models on the training data using a time series sequence. During training, the model will learn to understand the temporal patterns in the data. After the training, models evaluate the trained LTM and GRU models on the testing set and evaluation metrics. These metrics provided insights into the model's accuracy in predicting crime rates. Hyper parameter tuning has been done with different hyper parameters such as the number of LSTM and the number of epochs to optimize patterns GRU units, learning rate, dropout, batch size, and the number of epochs to optimize the model performance.

This paper emphasizes the importance of using deep learning to forecast future crime rates accurately. We are adding an LSTM layer to the model.

LSTN is a specialized form of RNN; demonstrates a remarkable proficiency in handling textual or sequential data. It employs the Rectified Linear Unit (ReLU) activation in the hidden layers of deep neural networks. Additionally, the activation function employed in the output layer is a sigmoid function. The sigmoid function is responsible for squeezing the output values within the range of 0 to 1. This enables us to interpret the output as the possibility associated with a positive class. This model can aid in law enforcement and policy decisions to prevent and address crime effectively.

4. Result

This work focuses on predicting future crime rates using algorithms and crime datasets. The study aims to analyse crime rates in various crimes. Fig 3 illustrates the data analysis conducted to comprehend the dataset and the frequency of past incidents categorized by the type of crime.

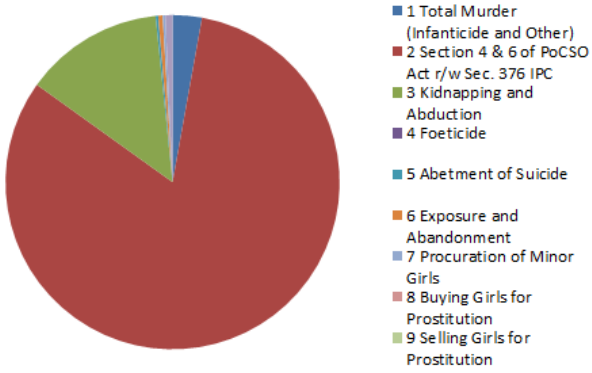

Fig 3. Data analysis

Algorithms model the behavior of past crime values to predict future trends. Fig 4 shows

trends of crimes in each year

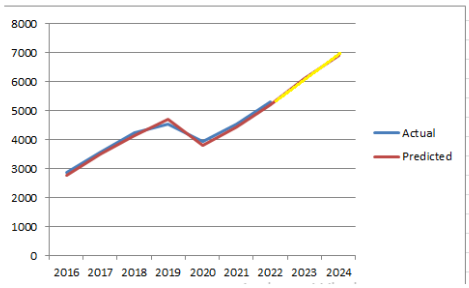

FIG 4.Crime Trends

The accuracy table compares the performance of two algorithms for crime rate prediction: LSTN RNN and GRU. The result indicates that LSTN provides the most precise crime rate forecast with an accuracy of 0.814 for the years 2016 to 2022. This session's performance metrics were compared based on calculations derived from the confusion matrix. The chosen performance metrics encompass accuracy, precision, recall, and F1 score. Accuracy represents the ratio of the total number of correct predictions to the total number of samples. Precision measures the ability or precision of the classifier to predict positive instances. Recall is defined as the number of true positives correctly predicted while the F1 score serves as a measure of test accuracy representing the weighted harmonic mean of the test's precision and recall

Table 1. Performance Table

Algorithm	Accuracy (%)	Precision (%)	F1 Score (%)	Recall(%)
LSTN RNN	0.814	0.87	0.811	0.76
GRU	0.811	0.86	0.801	0.75

The result shows the performance of each classifier based on the performance metrics. The RNN LSTN achieves high accuracy. The GRU shows slightly lower accuracy compared to LSTN.

5. Conclusion

This paper sheds light on the proactive measures in identifying and preventing criminal activities involving children. Through the exploration of various predictive models and data analysis techniques, it is evident that early intervention and targeted prevention strategies are

crucial to combat child crime effectively. Utilizing advanced data analytics and deep learning algorithms can aid law enforcement agencies and policymakers in identifying at-risk children and allocating resources to potential crime hotspots. The paper emphasized the ethical considerations associated with crime prediction, especially in dealing with children. Striking a balance between crime prevention and individual privacy and ensuring fairness in decision-making is essential to building public trust in predictive policing initiatives. The quality and availability of data, algorithm bias, and interpretability issues demand continuous refinement and transparency in the development and deployment of predictive systems, etc. are some challenges faced in this predictive system. This system provides valuable insight into the domain of crime rate prediction on crime against children and creates a brighter future for the next generation. Through social support, preventive programs can work towards a society that safeguards its children and nurtures their wellbeing, ultimately contributing to a reduction in crime against children

References

1. Yin Ying-Lung Lin, Liang-Chih Yu, Tenge-Yang Chen: "Using Machine Learning to Assist Crime Prevention". 6th IIAI International Congress on Advanced Applied Informatics, 2017.
2. Nishat Shama and Dr. Mahbub Alam Majumdar: "A Machine Learning Approach to Predict Crime Using Time and Location Data", 2015.
3. Ashwini B. Bais, Rajesh Babu, Jayant Adhikari: "An Intelligent Analysis of Crime through Newspaper Articles – Clustering and Classification". International Journal on Recent and Innovation Trends in Computing and Communication Volume: 5 Issue: 2, 2017.
4. Yong Zhuang, Matthew Almeida, Melissa Morabito, and Wei Ding:" Crime Hot Spot Forecasting: A Recurrent Model with Spatial and Temporal Information". IEEE International Conference on Big Knowledge, 2017.
5. Amit Gupta, Ali Syed, Azeem Mohammad, Malka N.Halgamuge: "A Comparative Study of Classification Algorithms using Data Mining: Crime and Accidents in Denver City the USA". (IJACSA) International Journal of Advanced Computer Science and Applications, 2016.
6. Trung T. Nguyen, Amartya Hatua, and Andrew H. Sung: "Building a Learning Machine Classifier with Inadequate Data for Crime Prediction". Journal of Advances in Information Technology Vol. 8, No. 2, May 2017.
7. Souglman Kabirou Kanlanfeyi, Keshav Kishore "Using machine learning and recurrent neural networks for efficient crime detection and prevention" Department of Computer Science and Engineering, 1AP Goyal Shimla University, Shimla (HP), India
8. N. Shahi, A.K. Shahi, R. Phillips et al, "Using deep learning and natural language processing models to detect child physical abuse", Journal of PaediatricSurgery,https://doi.org/10.1016/j.jpedsug .2021.03.007
9. V. Narayan Bhat, V Santhosh Kumar, Saravanan C: "Analysis and Prediction of Crime against women in India using machine learning algorithms". 2021 JETIR June 2021, Volume 8, Issue 6, Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org
10. Shraddha Ramdas Bandekar, C. Vijaylakshmi, "Design and Analysis of Machine Learning Algorithms for the reduction of crime rate in India", The 9th world Engineering Education Forum (Weef2019)(Procedia Computer Science: January 2020)
11. Kumar Abishek, Anshul Khairwa, Tej Pratap, Surya Prakash, "A stock market prediction

model using Artificial Neural Network" Computing Communication & Networking Technologies (ICCCNT), 2012 Third International Conference on, pp. 1-5, 2012

12. Zeijan Shi, Minyong Shi, Chinfang Li "The Prediction of Character Based on Recurrent Neural Network Language Model" Computer and Information Science (ICIS), 2017 IEEE/ACIS 16th International Conference on, pp. 613-616, 2017
13. Shamsuddin, N. H. M., Ali, N. A., & Alwee, R. (2017, May). "An overview on crime prediction methods". In Student Project Conference (ICT-ISPC), 2017 6th ICT International (pp. 1-5). IEEE
14. Luís Filipe da Cruz Nassif and Eduardo Raul Hruschka ―Document Clustering for Forensic Analysis: An Approach for Improving Computer Inspection‖ IEEE Transactions On Information Forensics And Security, Vol. 8, No. 1, JANUARY 2013
15. Shah, N., Bhagat, N. & Shah, M. Crime forecasting: a machine learning and computer vision approach to crime prediction and prevention. Vis.Comput. Ind. Biomed. Art 4, 9 (2021).https://doi.org/10.1186/s42492-021-00075-z
16. Priyanka Das, Asit Kumar Das, "Crime analysis against women from online newspaper reports and an approach toapply it in dynamic environment", (ICBDAC) 2017 (IEEE Xplore :October 2017)
17. Sunil Yadav, Meet Timbadia, AjitYadav, Rohit Vishwakarma, NikhileshYadav, "Crime pattern detection, analysis &prediction", (ICECA) 2017 (IEEE Xplore : December 2017)
18. M. Mowafy, A. Rezk and H. El-bakry, "Building Unstructured Crime Data Prediction Model: Practical Approach," International Journal of Computer Application, vol. 4, 2018.
19. Tabedzki C, Thirumalaiswamy A, van Vliet P (2018) Yo home to Bel-Air: predicting crime on the streets of Philadelphia. In: University of Pennsylvania, CIS 520: machine learning