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Crime Prediction and Classification using Deep Learning

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Abstract

Nowadays, the prediction of crime occurrence is seeking attention in field of research with deep learning and data analytics. A systematic technique to identifying and evaluating criminal patterns and trends is analysis of crime. In many ways, it gravely cost our community. We frequently travel to different locations for daily needs, and we frequently deal with multiple safety issues like hijacking, kidnapping, and harassment. In general, we observe that the first thing we do when we need to travel somewhere is search for Google Maps. Google Maps provides one, two, or more routes that can be used to reach the desired location, but we consistently choose the shortest one because we don't fully comprehend the path scenario. The research paper employed supervised machine learning, which relies on previously labelled data, even though there may not always be labelled data in real-world circumstances. The primary difficulties encountered by the researchers while conducting some of the investigations have also been covered. We believe that this research paves the door for additional study to aid governments and nations in combating crime and reducing it for improved safety and security.

Keywords: Deep Learning, Crime Prediction, Deep belief networks.

I. INTRODUCTION

Crime is increasing considerably day by day. Crime is among the main issues which is growing continuously in intensity and complexity [1]. Crime patterns are changing constantly because of which it is difficult to explain behaviours in crime patterns [2]. Crime is classified into various types like kidnapping, theft murder, rape etc. The law enforcement agencies collect the crime data information with the help of information technologies(IT). But occurrence of any crime is naturally unpredictable and from previous searches it was found that various factors like poverty, employment affects the crime rate [3]. It is neither uniform nor random [4]. With rapid increase in crime number, analysis of crime is also required. Crime analysis basically consists of procedures and methods that aims at reducing crime risk. It is a practical approach to identify and analyse crime patterns. But, major challenge for law enforcement agencies is to analyse escalating number of crime data efficiently and accurately. So it becomes a difficult challenge for crime analysts to analyse such voluminous crime data without any computational support. A powerful system for predicting crimes is required in place of traditional crime analysis because traditional methods cannot be applied when crime data is high dimensional and complex queries are to be processed. Therefore, a crime prediction and analysis tool were needed for identifying crime patterns effectively. This paper introduces some methodologies with the help of which it can be predicted that at what place and time which type of crime has a higher probability of occurrence. Classification helps in extracting features and predict future trends in crime data based on similarities.

II. RELATED WORK

Many researches have been done which address this problem of reducing crime and many crime-predictions algorithms has been proposed. The prediction accuracy depends upon on type of data used, type of attributes selected for prediction. The mobile network activity was used to obtain human behavioural data which was used to predict the crime hotspot in London with an accuracy of about 70% when predicting that whether a specific area in London city will be a hotspot for crime or not. The data collected from various websites, newsletter was used for prediction and classification of crime using Naive Bayes algorithm and decision trees and found that former performed better. A thorough study of

various crime prediction method like Support Vector Machine(SVM), Artificial neural networks(ANN) was done and concluded that there does not exist particular method which can solve different crime datasets problems. The various supervised learning techniques, unsupervised learning technique on the crime records were done which address the connections between crime and crime pattern for the purpose of knowledge discovery which will help in increasing predictive accuracy of crime. The different approach for predicting like Data mining technique, Deep learning technique, Crime cast technique, Sentimental analysis technique were discussed and it was found that every method has some cons and pros. Every method gives better result for a particular instance. Clustering approaches were used for detection of crime and classification method were used for the prediction of crime, In machine learning, a deep belief network (DBN) is a generative graphical model, or alternatively a class of deep neural network, composed of multiple layers of latent variables ("hidden units"), with connections between the layers but not between units within each layer. When trained on a set of examples without supervision, a DBN can learn to probabilistically reconstruct its inputs. The layers then act as feature detectors. After this learning step, a DBN can be further trained with supervision to perform classification. DBNs can be viewed as a composition of simple, unsupervised networks such as restricted Boltzmann machines (RBMs) or auto encoders, where each sub-network's hidden layer serves as the visible layer for the next. An RBM is an undirected, generative energy-based model with a "visible" input layer and a hidden layer and connections between but not within layers. This composition leads to a fast, layer-by-layer unsupervised training procedure, where contrastive divergence is applied to each sub-network in turn, starting from the "lowest" pair of layers (the lowest visible layer is a training set). The prediction accuracy for all three methods was between 79% to 81%.

III. METHODOLOGY

Predictive modelling was used for making predictions since it has the method which is able to build a model and has the capability to make predictions. This method consists of different algorithms of Deep Learning that can study properties from the data used for training which is used for producing predictions.

The correlation coefficient is measured on a scale that varies from + 1 through 0 to – 1. Complete correlation between two variables is expressed by either + 1 or -1. When one variable increases as the other increases the correlation is positive; when one decreases as the other increases it is negative.

The Kruskal-Wallis H test (sometimes also called the "one-way ANOVA on ranks") is a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. It is considered the nonparametric alternative to the one-way ANOVA, and an extension of the Mann-Whitney U test to allow the comparison of more than two independent groups

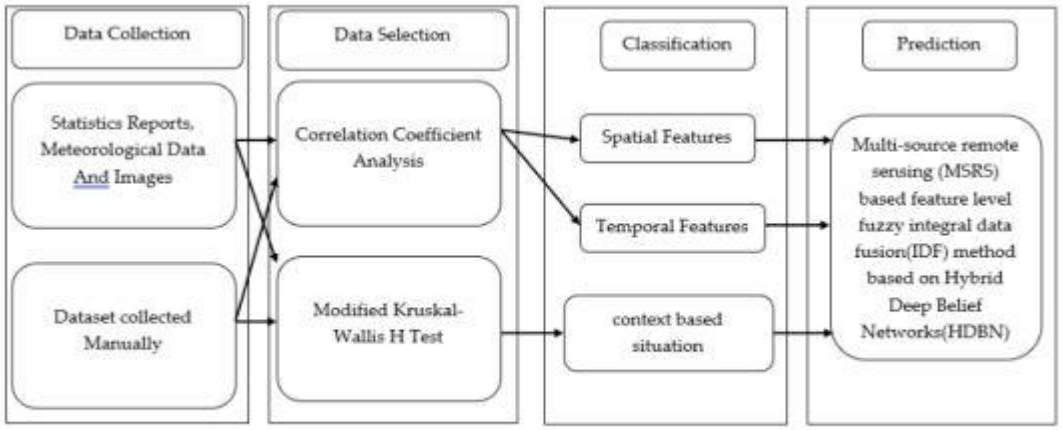

Figure 1: Architecture of the proposed System

IV. IMPLEMENTATION

A. Data collection The crime data set of San Francisco city is taken from kaggle.com in csv format which was derived from incidents derived from SFPD Crime Incident Reporting system. the attributes of the data set are Date,category of crime, description, DayofWeek, Police Department District, Address, Latitude and longitude and contained 884k data points.

B. Data Pre-processing In this step all the null values are remove. The categorical attributes are converted into numeric using Label Encoder which can be understood by the classification models. There exist some samples which are considered to be outliners, those samples have been removed after checking location of each point and if not in San Francisco range then it was removed. There also exist two features Descript and Resolution are considered redundant as they do not exist in testing values so they were removed. The data was imbalanced as it contained crime with different frequencies. So, to solve this problem, two techniques were used one was to Replicate data having small frequency (lower than 1000) and second is to put more weights on the data having smaller frequency. There are features from data that are not numbers, so they are converted into numbers so that we can train the models on them by using Label Encoding and One-hot Encoding. Onehot Encoding might produce very high number of dimensions due to lot of data labels in very feature but even then this is better because problem with the Label Encoding technique is that it assumes higher the categorical value, better is the category which results in more errors.

C. Model evaluation and Metrics

For evaluating classification models that were implemented for the purpose of classification and prediction. The metrics used are accuracy, fbeta-score. Precision is a measure which identifies positive cases from all the predicted cases.

$$q = tv (tv + fv)$$

Next is recall it measure which correctly identifies positive cases from all the actual positive cases.

$$rc = tv (tv + fnv)$$

Accuracy is one of the most commonly used metric which measure all the correctly identified value without caring about the wrongly identified values. So, instead of using accuracy the measure that is used to check the performance is F-beta score.

accuracy = tv + tnv (tv + fv + tnv + fnv)

Fbeta-Score is the harmonic mean of Recall and precision which gives a better measure of incorrectly classified cases than that of Accuracy Metric.

$$F - betascore = (2 * (rc * q)) (rc + q)$$

Here tv stands for true positive, fv stands for false positive, fnv stands for false negative, tnv stands for true negative,rc stands for recall and q stands for precision.

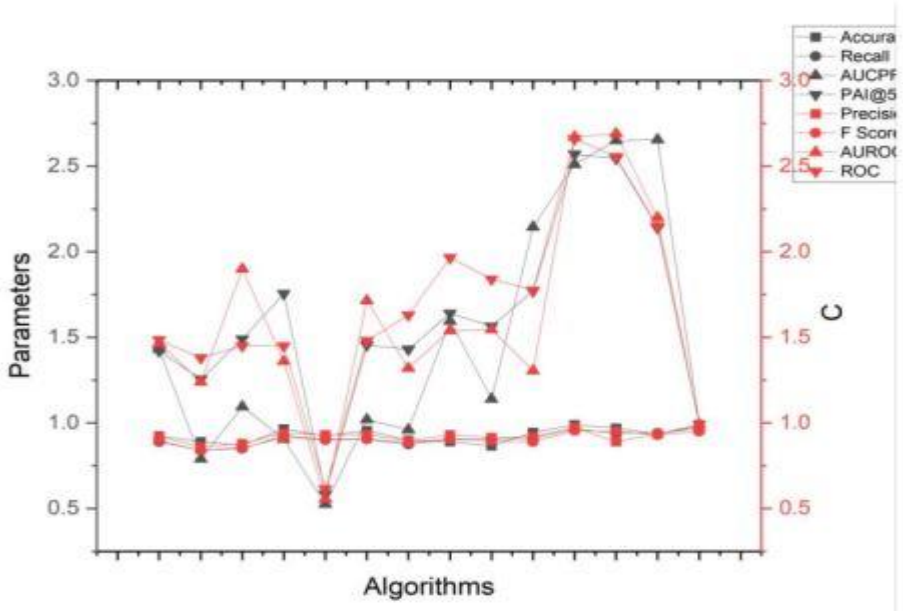

Figure 2: Accuracy, Precision, Recall, F Score for different crime types

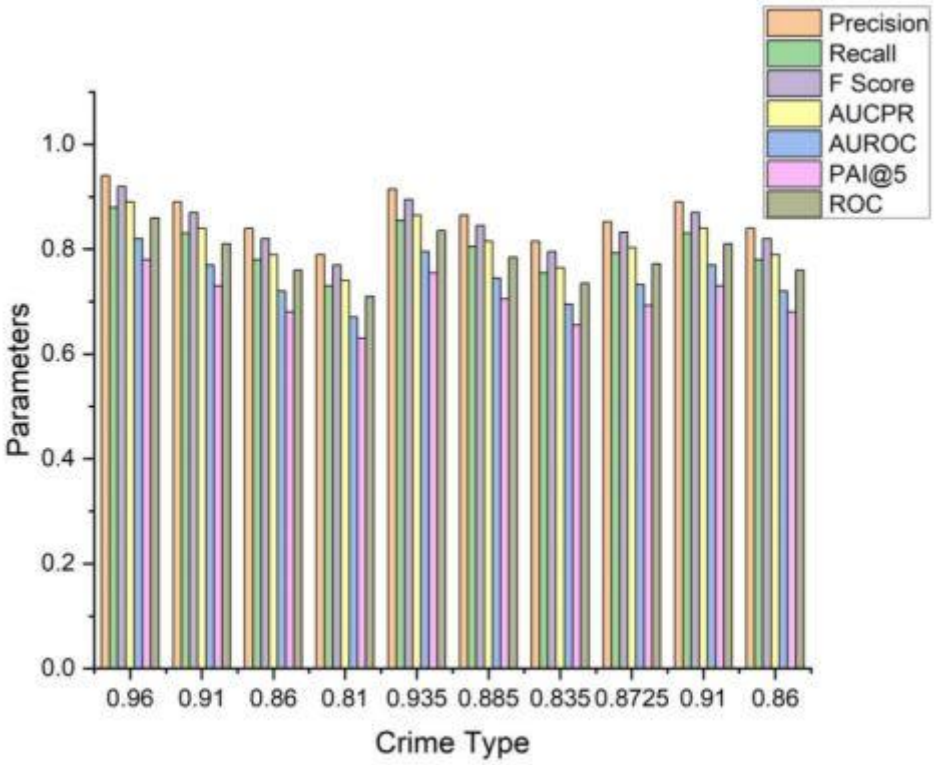

Figure 3: Classification of various crime types parameters considered

IV. DISCUSSION

Crime solving is very difficult work which requires experience and intelligence of human along with Artificial intelligence approaches which assist them in problems of crime detection. Other than that predicting future patterns of crimes basically involves the changes in the rate of crime in next year and applied methods of prediction to help discover those changes in upcoming years. The prediction of crime with the help of artificial neural network is usually better in accuracy and evaluate the target Fig. 2. test-time of different models function much faster. Same is seen with the case of San Francisco data set in which neural networks performed better for testing data set than the other algorithm. The problem lies in finding out techniques which can analyse efficiently the growing data set of crime. The accuracy for predicting crime is basically depending upon on the crime data set used. If used training data set is very large, then model will be trained with very good accuracy while if the data set used for training purpose is having less size, then small degree of training is attained. Also, the prediction accuracy also dependent on dimension of training data set. This will give more right results if the model is highly trained and will not give good results if the model is not trained properly.

V. CONCLUSION

Crime prediction is one the current trends in the society. Crime prediction intends to reduce crime occurrences. It does this by predicting which type of crime may occur in future. Here, analysis of crime and prediction are performed with the help of various approaches some of which are context-based situation-oriented information, Multi-source remote sensing, Decision trees, Extra trees and Deep belief network. From the results obtained we saw that the training time of SVM is very high thus it should be avoided for this dataset. For MLP we saw that its accuracy is very low hence MLP is not working good for this dataset. Here we can see that for this data set Deep belief network are working best with optimal training and good accuracy. However which model will work best is totally dependent on the dataset that is being used.

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