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Crime Prediction and Analysis Using Multi Layer Perceptron

Hirithik B, Aakash S Baskar, Hariharan S
Mathumathi.M M.E
Assistant professor CSE / KRCT

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ABSTRACT
One of our society's most important problems is crime. It is the most pervasivepart of our culture. It's also pervasive in society. As a result, one of the most important jobs is to prevent crime. The investigation of crimes should be done in a systematic manner. As a result of the analysis, it is critical in the detection and prevention of crime. The analysis identifies patterns in the investigation and aids inthe discovery of crime trends. The main focus of this study is an examination of the effectiveness of criminal investigation. The model is intended to detect crime patterns based on inferences. The inferences are gathered from the crime scene, and the study uses these inferences to show the perpetrator's forecast. The machine learning approach can better help in the prediction and analysis of the crime. Regression techniques are provided by the machine learning methodology. The classification procedures assist in achieving the investigation's goal. Multi-linear regression and other regression techniques are statistical methods. This strategy aidsin the discovery of a relationship between two numerical values or variables. Based on the independent factors, this method predicts the values of the dependent variables. Machine learning algorithm provide less accuracy in crime prediction. So implement the deep learning algorithm named as Multi-layer perceptron algorithm to classify the datasets and predict the crimes with improved accuracy rate.

Keywords: Crime data, Machine learning, Deep learning, Data science and Engineering, Multi-layer perceptron

I. INTRODUCTION

Aggressive urbanization is causing a rapid increase in the size and population of large cities across the world. This massive population growth in cities is causing total crimes to rise sharply, making it difficult for the police department to keep up with it. It is not possible for the police department to station police officers in everystreet corner, so they need some intelligent system that can predict the likelihood of crimes occurring in different parts of the city at different times of the day. Also, thereis a large volume of emergency 911 calls and crime reports coming at every moment of the day. These reports need to be sorted to identify the more imminent threats, so the police department could allocate their resources accordingly and respond to more alarming situations before addressing the rest. These difficulties stimulated a lot of research work in recent times related to predicting future crimes to help the police department allocate their resources. Crime is a common problem in nearly all societies. Several important factors like quality of life and the economic growth of asociety are affected by crime. There are many reasons that cause different types of crimes. In the past, criminal behavior is believed to be the result of a possessed mindand/or body and the only way to exorcise the evil was usually by some torturous means. A person's criminal behavior can be analyzed from different perspectives like his/her socio-economic background, education, psychology, etc. Researchers have done exhaustive research on these factors. Data mining and analytics have contributed to the development of many applications in medical, financial, business,science, technology and various other fields. Likewise, to obtain a better understanding of crime, machine learning can be used for crime data analytics.

Demanding services on irregular time is one of the problem of police manpower assignment. Until recent years there were no modern tools and techniquesemployed to facilitate the handling and processing of records. Some of the generalized statistical records that associate with crime are kept in a computerized way but the detailed data we need for our research is stored manually. The criminal records, which is used for this study, contains information about the type of crime

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committed by each criminal, specific date and time, and also specific place. Criminals are sent manually to the commission by filling the criminals profile form. Only the crimes that has given heavy weight will be recorded in the commission's criminal record list. Data mining turns out to be a stepping stone for predictive policing. By using data and data mining technologies, predictive policing has the potential to provide the best evaluation of what will happen. Researches have shown that data mining can greatly improve crime analysis and aid in reducing and preventing crime. Police districts in most of developed countries "prediction" has become the new watchword for innovative policing. Using predictive analytics, high-powered computers, and good old-fashioned intuition, police are adopting predictive policing strategies that promise the holy grail of to stop crime before it happens. Computer vision is a branch of artificial intelligence that trains the computer to understand and comprehend the visual world, and by doing so, creates a sense of understanding of a machine's surroundings. It mainly analyzes data of the surroundings from a camera, and thus its applications are significant. It can be used for face recognition, number plate recognition, augmented and mixed realities, location determination, and identifying objects. This research incorporates a set of closely related crime events from both the immediate and longer-term past, with more recent crimes given a heavier weight in order to develop predictive model usingdeep learning algorithm.

II. LITERATURE SURVEY

S Prabakaran and Shilpa Mitra, et.al,…[1] implemented a data miningprocedure is to analyze data from an informational collection to change it into a reasonable structure for additional utilization. It predicts future patterns and also enables the organization to make the learning driven decision. Generally utilized strategies for mining of data are artificial neural networks, decision tree, rule induction, nearest neighbor method and genetic algorithm. They are applied in manyfields. One such interesting application is crime investigation. A crime is an unlawful activity for which a man can be penalized by law. Crime against a person is called personal crime like murder, robbery, etc. Property crime means theft of property. Crime analysis is a law implementation task which includes an organized analysis that recognizes and determines the pattern of crime. Crime can be classified into different types but, in this, we focused on four types of crime i.e. Fraud detection, traffic violence, violent crime, web crime and sexual offense. The various techniques used for different crimes have been discussed with an introduction to the concernedcrime.

Ying-Lung Lin, Meng-Feng Yen, et.al,…[2] implemented two traditional approaches such as spatial-temporal models and empirical models. Spatial-temporal models are commonly used for crime prevention, including Kernel Density Estimation (KDE) and Time Series. However, these two methods only consider time or space independently, but crime is affected by more than one factor. Empirical models are similar in some ways to machine-learning models. When we consider each person's experience as a model, we can use machine learning to consider certain issues, such as the amount of training time required for the models, the effectiveness of model learning, and the various types and scope of learning. Training a senior police officer takes significant amounts of time, and is restricted by limited time and learning capacity. In random decision forests, a given tree only deals with certain features. A senior police officer who is familiar with their own jurisdiction can effectively work to prevent and investigate crime. However, an officer without this local knowledge and familiarity must develop it. This analogy helps to promote a holistic perspective for crime prevention, which is beyond the scope of any single empirical model. Thus, how can empirical models best be used to guide policing? A commonly used approach is to expose police offers to key features from typical cases, but this approach is time- and labor-intensive, and outcomes are dependent on individual learning capacity. The requirements of citywide crime prevention emphasize the difficulty of integrating empirical models.The value of empirical models is beyond question, as is their ability to assess complex heterogeneous data, but we hope to make more efficient use of individual experience by gradually transforming the experience of front-line law enforcement officers and criminology theory into machine-processible features.

Sarah Brayne and Ange`le Christin, et.al,…[3] concluded by discussing the implications of these findings for research on technology and in-equality in criminal justice. Whereas the current wave of critical scholarship on algorithmic bias often leans upon technological deterministic narratives in order to make social justice claims, here we focus on the social and institutional contexts within which such predictive systems are deployed and negotiated. In the process, we show that these tools acquire political nuance and meaning through practice, which can lead to unanticipated or undesirable outcomes: forms of workplace surveillance and the

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displacement of discretion to less accountable places. We argue that this sheds new light on the transformations of police and judicial discretion – with important consequences for social and racial inequality – in the age of big data. Given the rationalizing impetus that guides the adoption of algorithmic technologies in the criminal justice context, these profound changes lead us to raise the question of thereception of predictive algorithms in the context of law enforcement and criminal courts. Although there is strong theoretical work in surveillance studies that focuses on the possibilities, good and bad, of new forms of algorithmic decision-making, there is a dearth of empirical work on the social contexts of their reception in policing and courts.

Angel Gonzalez-Prieto, Antonio Br, et.al,…[4] propose a hybrid model that combines the statistical prediction methods with the ML method, permitting authorities to implement a smooth transition from the preexisting model to the ML- based model. This hybrid nature enables a decision-making process to optimally balance between the efficiency of the police system and aggressiveness of the protection measures taken. Despite the apparent regular occurrence of crime, as it was already recognized in the 19th century, it has defied the predictability provided by the scientific method in the Natural Sciences. Surprisingly, it is easier to accurately predict where a rocket will be after its launch in its way to a distant planet than to foresee the next victim of an offense. The unpredictable nature of crime arisesthe question of whether the classical scientific method can be a solving tool instead of only a descriptive framework. Given a large amount of structured data about IPVAW cases, we will apply ML techniques to develop novel models of risk assessment of recidivism of a victim, understood as the probability that a female victim, who has been offended and has reported her case, is aggressed again. In our case, the data will be provided by the Spanish VioGen system, a governmental program for tracking and controlling gender violence, but the approach and applied methods are general and can be straightforwardly translated to other data sources.

Andriy Krysovatyy, et.al,…[5] implemented method of detecting a fictitious enterprise based on the Support Vector Machine is proposed, which allows to quickly track fictitious enterprises, which is useful for public sector employees to prevent economic crimes. Fictitious business – is the creation or acquisition of business entities in order to cover up illegal activities or activities that are prohibited.

Investigation of economic crime takes a lot of time for law enforcement officers, so in this regard, the development of an algorithm for detecting a fictitious enterprise based on the classic method of machine learning, namely Support Vector Machine Classification, will develop a single software environment for rapid detection of economic crimes. A fictitious enterprise in Ukraine should be understood the following: a business entity that is registered in violation of the established procedure (legal norms) of registration with state bodies, the constituent documents of which do not comply with applicable law, or to carry out activities contrary to law or constituent documents, or violation of the procedure for tax accounting and deadlines for filing tax returns and financial statements, or violation of the deadlinesfor submission of information to government agencies about the change of name, organizational form, form of ownership and location. The main reasons for the emergence and existence of economic crime and fictitious entrepreneurship are: imperfection of legislation governing economic activity, high levels of corruption, bondage of taxes, control of corrupt individuals in major industries, low professional level of law enforcement officers in detecting, documenting, investigating these crimes. However, the investigation of economic crime often takes a lot of time for law enforcement officers, so in this regard, the development of an algorithm for detecting a fictitious enterprise based on the classical method of machine learning, namely Support Vector Machine Classification, will develop a single software environment that is one of the most promising areas for the rapid detection of economic crimes

III. EXISTING METHODOLOGIES

Comparative study was carried out between violent crime patterns from the Communities and Crime Normalized Dataset versus actual crime statistical data using the open source data mining software Waikato Environment for Knowledge

Analysis (WEKA). Three algorithms, namely, linear regression, additive regression, and decision stump, were implemented using the same finite set of features on communities and actual crime datasets. Test samples were randomly selected. The linear regression algorithm could handle randomness to a certain extent in the test samples and thus proved to be the best among all three selected algorithms. The scope of the existing system was to prove the efficiency and accuracy of ML algorithms in predicting violent crime patterns and other applications, such as determining

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criminal hotspots, creating criminal profiles, and learning criminal trends

Linear Regression - The algorithm uses linear regression for prediction and uses the Akaike criterion to select models; the algorithm could work with weighted instances. This method of regression is simple and provides an adequate andinterpretable description of how the input affects the output. It models a variable Y (a response value) as a linear function of another variable X (called a predictor variable);

Additive Regression - This is a Meta classifier algorithm that could enhance the performance of a regression base classifier. Each iteration of the algorithm fits a model for the residuals from the previous iteration of the classification process. Prediction is accomplished by adding the predictions of each classifier. Reducing the shrinkage (learning rate) parameter helps to prevent over-fitting and has a smoothing effect but increases the learning time. Each input feature makes a separatecontribution to the output, and they are just added together

Decision Stump - This algorithm is a class for building and uses a decision stump along with a boosting algorithm. The algorithm does regression (based on mean- squared error) or classification (based on entropy). The missing values are treated as separate values. Decision trees have a robust nature that allows them to work well with large datasets and helps algorithms to make better decisions about the variables.A stump stops after the first split. They are typically used in population segmentation for large data and in smaller datasets to aid in making decisions in simple yes/no models.

Random Forest (RF): RF is an ensemble learning method for classification,regression and other tasks that operate by constructing a multitude of decision treesat training time and outputting the class that is the mode of the classes or mean prediction of the individual trees. Random decision forests correct for decision trees'habit of over fitting to their training set

K Nearest Neighbor (KNN): In KNN, the object is classified by the majority vote of their neighbors with assigning the object to the most common class in the nearestposition in neighbors

Decision Tree (DT): A decision tree text classifier is a tree that begins with a root node, all nodes receive a list of features as input and the root will receive the entire training set, each node will ask true or false question about one of the features and based on the answer the data will be partition into two subsets then these subsets become the input to the two child nodes until it reaches into an unmixed labels with no uncertainty and no question can be asked at that point a leaf will be added which confirm 100% the label .

Naive Bayes (NB): NB is the probabilistic classifier based on applying Bayes' theorem with strong (naive) independence assumptions between the features

IV. PROPOSED METHODOLOGY

Predictive modeling is the way of building a model that is capable of making predictions. The process includes a machine learning algorithm that learns certain properties from a training dataset in order to make those predictions. Predictive modeling can be divided further into two areas: Regression and pattern classification. Regression models are based on the analysis of relationships between variables and trends in order to make predictions about continuous variables. In contrast to regression models, the task of pattern classification is to assign discrete class labels to particular data value as output of a prediction. Pattern classification tasks can be divided into two parts, Supervised and unsupervised learning. In supervised learning, the class labels in the dataset, which is used to build the classification model, are known. In a supervised learning problem, we would know which training dataset has the particular output which will be used to train so that prediction can be made for unseen data. In this paper, we can input the crime datasets and create the model file using deep learning algorithm named as Multi- layer perceptron algorithm. It is a layered feed forward neural network that has layers, or subgroups of processing elements. A layer of processing elements makes independent computations on data that it receives and passes the result to another layer. The next layer may in turn make its independent computations and pass on the result to yet another layer. Finally, a subgroup of one or more processing elements determines the output of the network. Each processing element makes its computation based upon a weighted sum of its inputs. The first layer in the input layer and the last layer is the output layer. The layers that are in between these two layers are the hidden layers. The processing elements are seen units that are similar to neurons working in the brain, and hence, they are referred to as cells, neuromines,or artificial neurons.

DATASETS ACQUISITION

A data set (or dataset, although this spelling is not present in many contemporary dictionaries like Merriam-Webster) is a collection of data. Most commonly a data set corresponds to

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the contents of a single database table, or a single statistical data matrix, where every column of the table represents a particular variable, and each row corresponds to a given member of the data set in question. The data set lists values for each of the variables, such as height and weight of an object, for each member of the data set. Each value is known as a datum. The data set may comprise data for one or more members, corresponding to the number of rows. The term data set may also be used more loosely, to refer to the data in a collection of closely related tables, corresponding to a particular experiment or event. In this module, we can upload the datasets which year, month, day, hour, minutes, latitude and longitude values

PREPROCESSING

Data pre-processing is an important step in the [data mining] process. The phrase "garbage in, garbage out" is particularly applicable to data mining and machine learning projects. Data-gathering methods are often loosely controlled, resulting in out-of-range values, impossible data combinations, missing values, etc. Analyzing data that has not been carefully screened for such problems can produce misleading results. Thus, the representation and quality of data is first and foremost before running an analysis. If there is much irrelevant and redundant information present or noisy and unreliable data, then knowledge discovery during the training phase is more difficult. Data preparation and filtering steps can take considerable amount of processing time. In this module, we can eliminate the irrelevant values and also estimate the missing values of data. Finally provide structured datasets.

FEATURES SELECTION

Feature selection refers to the process of reducing the inputs for processing and analysis, or of finding the most meaningful inputs. A related term, feature engineering (or feature extraction), refers to the process of extracting useful information or features from existing data. Filter feature selection methods apply a statistical measure to assign a scoring to each feature. The features are rankedby the score and either selected to be kept or removed from the dataset. The methods are often uni-variate and consider the feature independently, or with regard to the dependent variable. It can be used to construct the multiple crimes. In this module, select the multiple features from uploaded datasets. And train the datasets with multiple crime type's murder, violence, abuse, vehicle thefts and so on.

CLASSIFICATION

In this module implement classification algorithm to predict the crime types. And using deep learning algorithm such as Multi-layer perceptron algorithm to predict the crimes. A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate outputs. It (MLP) consists of multiple layers of nodes in a directed graph, and each layer is fully connected to the next one. Each node is a neuron with a nonlinear activation function except for the input nodes. MLP utilizes a supervised learning technique called back propagation for training the network. MLP is a modified form of the standard linearperceptron and can distinguish data that are not linearly separable. If a multilayer perceptron (MLP) has a simple on-off mechanism i.e. linear activation function in all neurons ,to determine whether or not a neuron fires, then it is easily proved withlinear algebra that any number of layers can be reduced to the standard two-layer input-output model. The gradient techniques are then applied to the optimization methods to adjust the weights to minimize the loss function in the network. Hence, the algorithm requires a known and a desired output for all inputs in order to computethe gradient of loss function. Usually, the generalization of Multilayer Feed Forward Networks is done using delta rule which possibly makes a chain of iterative rules to compute gradients for each layer. Back Propagation Algorithm necessitates the activation function to be different between the neurons. The ongoing researches on parallel, distributed computing and computational neuroscience are currently implemented with the concepts of MultiLayer Perceptron using a Back Propagation Algorithm. MLP Back Propagation Algorithm has also gained focus in pattern recognition domain. They are so convenient in research, because of their ability in solving complex problems, and also for their fitness approximation results even withcritical predictions. MLP is one of the Neural Network models, has the same architecture of Feed-Forward back Propagation for Supervised training. The multilayer perceptron is the most known and most frequently used type of neural network. User can provide the features and automatically predict the crime types with improved accuracy rate.
Steps in neural network algorithm:

Step 1: Randomly initialize the weights and biases.
Step 2: feed the training sample.
Step 3: Propagate the inputs forward; compute the net input and output of each unitin the hidden and output layers.

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Step 4: back propagate the error to the hidden layer.
Step 5: update weights and biases to reflect the propagated errors.

Training and learning functions are mathematical procedures used to automatically adjust the network's weights and biases.

Step 6: terminating condition

Based on these steps, neural network algorithm outperforms than the traditional machine learning algorithms.
The proposed architecture can be shown as follows:

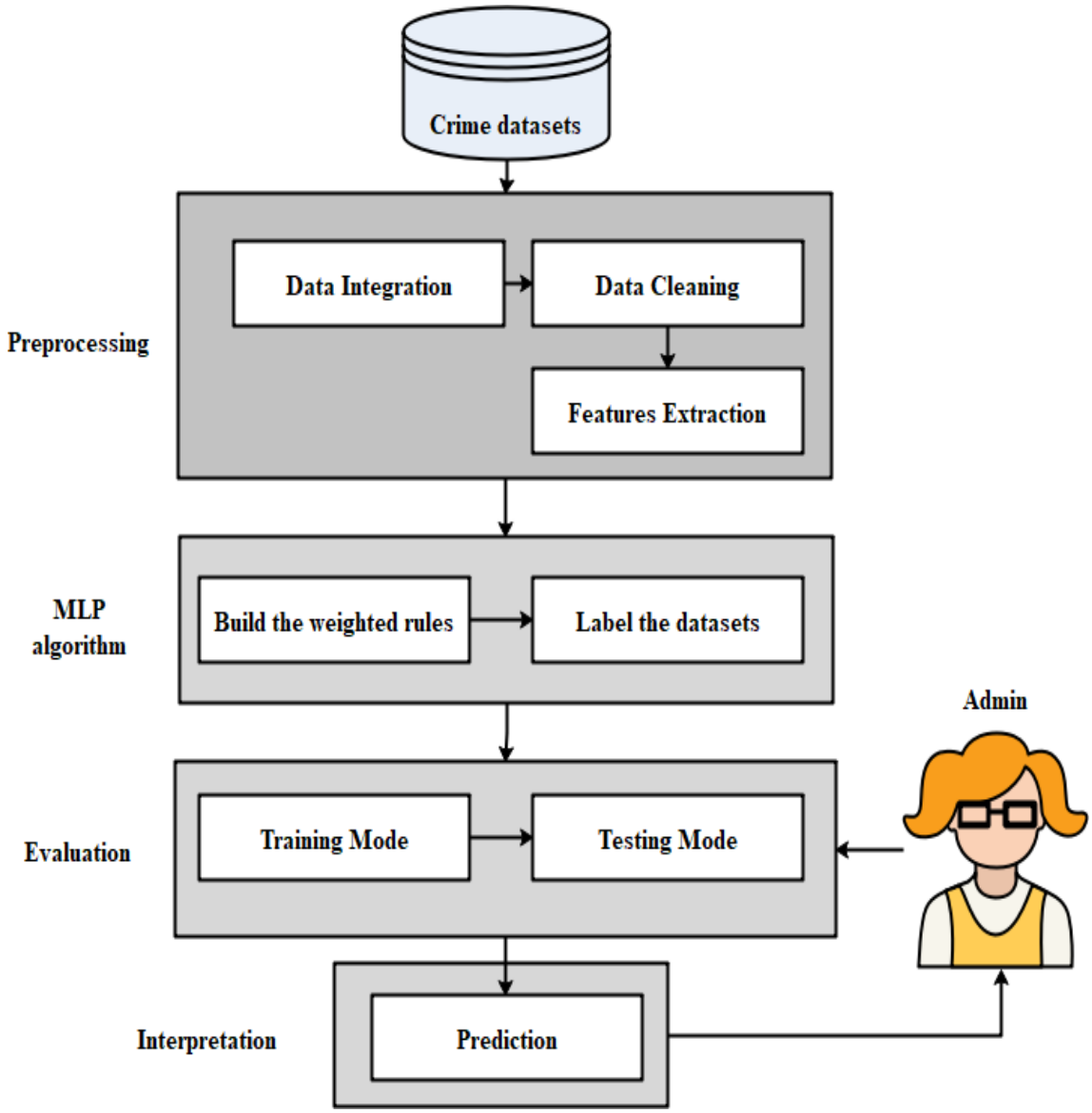

Fig 1: Architecture diagram

V. PERFORMANCE EVALUATION

We can upload the datasets for 1000 records and collect the samples from Kaggle Website. And using attributes such as year, month, day, hour, minute, latitude, longitude and type of crimes. These attributes can perform classification using tool named as PYTHON as front end and MYSQL as back end for WINDOWS OS with any configuration. We can evaluate the performance of each algorithm and compare the performance based on MSE, RMSE, RAE, RRSE and shown in table and performance graph.

MSE:

Mean Squared Error (MSE) is by far the most common measure of numerical model performance. It is simply the average of the squares

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of the differences between the predicted and actual values. It is a reasonably good measure of performance, though it could be argued that it overemphasizes the importance of larger errors. Many modeling procedures directly minimize the MSE.

RMSE:

The RMSE serves to aggregate the magnitudes of the errors in predictions into a single measure of predictive power. RMSE is a good measure of accuracy, but only to compare forecasting errors of different models for a particular variable and not between variables, as it is scale-dependent

RAE:

The relative absolute error in some data is the discrepancy between an exact value and some approximation to it. An approximation error can occur because:

- The measurement of the data is not precise due to the instruments.
- Approximations are used instead of the real data (e.g., 3.14 instead of π).

In the mathematical field of numerical analysis, the numerical stability ofan algorithm indicates how the error is propagated by the algorithm.

RRSE:

The root relative squared error is relative to what it would have been if a simple predictor had been used. More specifically, this simple predictor is just the average of the actual values. Thus, the relative squared error takes the total squared error and normalizes it by dividing by the total squared error of the simple predictor. By taking the square root of the relative squared error one reduces the error to the same dimensions as the quantity being predicted.

Algorithms	MSE	RMSE	RAE	RRSE
Random Forest	0.46	0.49	93.37	98.36
Naives Bayes algorithm	0.44	0.47	88.48	95.35
Support Vector Machine	0.43	0.65	86.91	131.83
Multi-Layer perceptron	0.42	0.52	85.74	103.19

TABLE 1 PERFORMANCE METRICS

The overall performance of the results is shown as graph

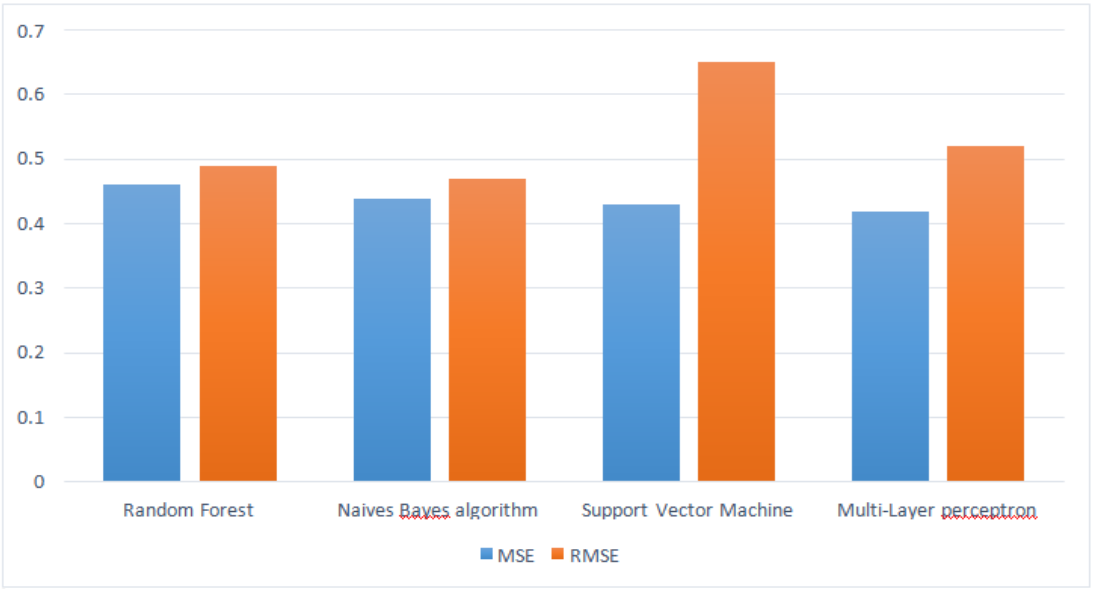

FIG 2 MSE AND RMSE GRAPH

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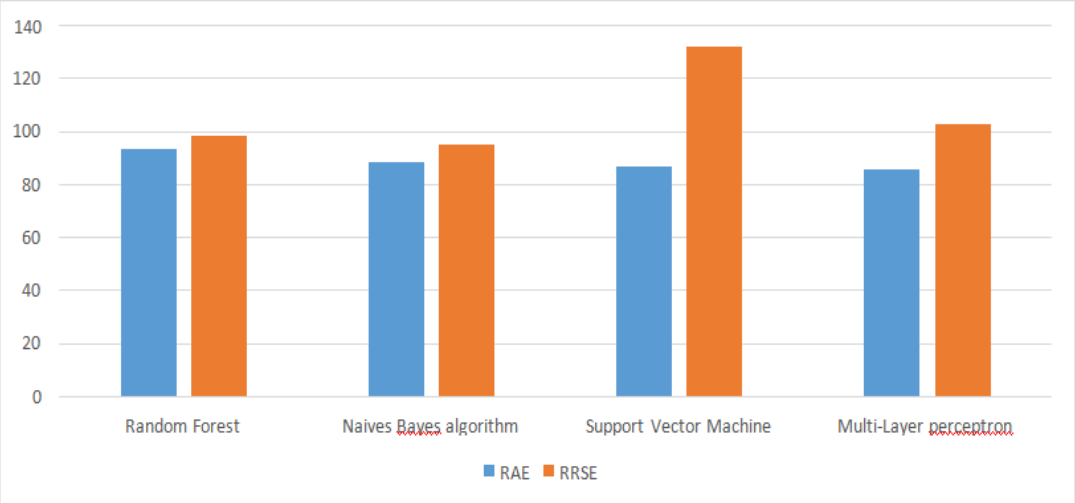

FIG 3 RAE AND RRSE GRAPH

From the above comparison in fig 2 and 3, MLP can be outperforms than the existing algorithms and provides reduce number of error rate values. In this paper, a novel approach based on MLP Back Propagation Neural Network is proposed to predict the crimes. The Proposed system used nearly 7 significant attributes for crime predictions. Multi-Layer Perceptron neural network architecture is used to train the neural network for classification. The experiment displays good performance of the proposed algorithm and was compared to similar approaches over the same dataset. By analyzing the experimental results, it is observed that the MLP algorithm turned out to be best classifier for crime occurence prediction because it contains more accuracy and least error rate.

VI. CONCLUSION

In this paper the problem of constraining and summarizing different algorithms of data mining used in the field of crime prediction are discussed. The focus is on using different algorithms and combinations of several target attributes for intelligent and effective crime prediction using data mining. Data mining technology provides an important means for extracting valuable rules hidden in crime data and acts as an important role in prediction and law enforcements. There is an increasing interest in using classification to identify crime which is present or not. In the current study, have demonstrated, using a large sample of crime records with classification. Classification algorithm is very sensitive to noisy data. If any noisy data is present then it causes very serious problems regarding to the processing power of classification. It not only slows down the task of classification algorithm but also degrades its performance. Hence, before applying classification algorithm it must be necessary to remove all those attributes from datasets who later on acts as noisy attributes. In this research work, we can implement preprocessing steps and implemented the classification rule algorithms namely Multi-layer perceptron are used for classifying datasets which are uploaded by user. By analyzing the experimental results it is observed that the Multi-layer perceptron technique has yields better result than other techniques.

VII. FUTURE WORK

In future we tend to improve efficiency of performance by applying other data mining techniques and algorithms.

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