Advanced Approach For Crime Rate Prediction Using Neural Network

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***Abstract*— Crime Prediction plays a crucial role in addressing crime, violence, conflict and insecurity in cities to promote good governance, appropriate urban planning and management. Plenty effort shave been made on developing crime prediction models by leveraging demographic data, Linear model or K-means but they failed to capture the dynamic nature of crimes in urban. However, for a city it is hard to build a uniform framework for all boroughs due to the uneven distribution of data. This project is about the study of Crimes and provides the approach of security along with the detection of those crimes. The Megalopolis protection is main aspect of this project. This project proposed the approach for predicting crimes using Python packages and is based on ANN model. This project further exploits the spatio-temporal patterns in urban data in one borough in a city, and then leverages transfer learning techniques to reinforce the crime prediction of other boroughs. Specifically, we first validate the existence of spatio-temporal patterns in urban crime. Then we extract the Crime related features from cross-domain datasets. Finally, we propose a novel transfer learning framework to integrate these features and model spatio-temporal patterns of Crime prediction. [1].**

***Keywords*— Artificial Neural Network, STCN, Keras, Dense Layer, Tensorflow, Spatio-temporal.**

I. INTRODUCTION

In the ongoing past, wrongdoing examinations are required to uncover the complexities in the crime dataset. This procedure will help the gatherings that include in law authorization in capturing guilty parties and coordinating the crime aversion methodologies. The capacity to foresee the future crimes are dependent on the area, example and time can fill in as a significant wellspring of learning for them either from vital or strategic points of view. By the by, to anticipate future wrongdoing precisely with a superior execution, it is a testing undertaking on account of the expanding quantities of crime in present days. Hence, crime expectation technique is essential to distinguish the future crime and lessens the quantities of wrongdoing. As of now, a few scientists have been directed an examination to anticipate wrongdoing dependent on specific sources of info. The execution of expectation models can be assessed utilizing a wide range of forecast techniques, for example, bolster vector machine, multivariate time arrangement and artificial neural system. Be that as it may, there are still a few constraints and limitations on their discoveries to give an exact forecast to the area of violations. Our goal is to distinguish current usage of crime forecast strategy and the likelihood to improve it for future needs [2].

All through human development, violations have been available from that point onward. This has been a testing problem in the public eye that must be managed in like manner with arrangements and systems which would empower law authorization to work with most extreme productivity. wrongdoings have influenced the quality of life and the economic development of the society. Obviously, something should be done with the end goal to anticipate, and in the long run, destroy all types of violations in a general public [3]. This paper proposes a novel spatio-temporal crime network (STCN), trying to apply deep neural networks(dnns) for consequently wrongdoing referenced component extraction. This model can estimate the crime danger of every district in the urban territory for the following timeline from the review data. Finally, the anticipated outcomes will be pictured to enable individuals to comprehend its connection with the ground truth [4].

Section II describes the literature survey which contains comparisons of various previous research papers. Section III describes the data preprocessing. Section IV talks about model training and testing. Section V represents the analysis and finally Section VI presents contains the conclusion.

II. LITERATURE SURVEY

Artificial Neural Network (ANN)

Artificial neural network (ANN), is a neural network model proposed in the 80's which is same as that of a standard multilayer perceptron, which has a distinction that we allow connections among hidden units that are associated with delay in time. Through these connections the model can retain information about the past, enabling it to discover temporal correlations between events that are far away from each other in the data [5].

Artificial neural network (ANN) is a part of artificial neural network where connections between nodes form a directed graph along a sequence. This allows it to exhibit temporal dynamic behaviour. Unlike feedforward neural networks, ANNs to process sequences of inputs can use their internal state (memory) [6].

Artificial neural networks are very efficient because of the following two properties:

- Use of hidden states which helps them as using them as a storage block of the memory for storing past information.

- Non-linearity which allows them to modify values of hidden states in complicate ways.

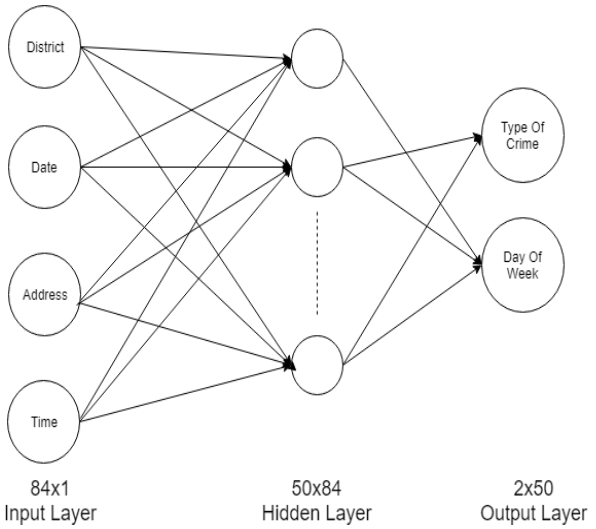

Fig. 1. Unfolding of Artificial neural network in time domain. Where S_t represents hidden layer present at time t [*7*].

In Research Papers Survey this field is studied and researched widely, we found research papers with crime prediction as their base. Following papers are referred for our project :-

I. Forecasting Crime with Deep learning ,2018 [8] :

The objective of this work was to take advantage of deep neural networks in order to make next day crime count in a de-grain city partition, Chicago and Portland crime data, which was augmented with additional datasets covering weather, census data, and public transportation. The rate of crime counts were disintegrated into 10 buckets and the most likely bucket is predicted at a daily level for the spatial region. This model uses complex neural network structures, that suites to the spatial and temporal aspects of the crime prediction problem. This model was able to predict 75.6 percent and 65.3 percent accuracy crime rate for Chicago and Portland, respectively.

II. Deep Learning for Real Time Crime Forecasting, 2017 [9] :

This proposed methodology work was adapted referring state-of-the-art deep learning spatio-temporal predictor,ST-4 ResNet, to collectively predict crime distribution over the Los Angeles area. The models are two staged. First, the crime data is pre-processed which includes both space and time to enhance predictable signals through regularization. Second, they used hierarchical structures of residual convolutional units to train multifactor crime prediction models. Previous Experiments conducted in Los Angeles reveal highly accurate predictive power of their models. In this work, crime types are not classified. In reality, different types of crime may lead to different consequences. Intervention strategies should not be based on the crime intensity alone; crime type should also be addressed. Due to the super resolution regularization in space, the computational cost increases dramatically.

III. Once Upon a Crime (Towards Crime Prediction from Demographics and Mobile Data),2014 [10]:

In this paper, they presented a novel approach to predict crime in a geographic space from multiple data sources, in particular mobile phone and demographic data. The main focus of the proposed approach lies in using cumulative and obscure human behavioural data that is derived from mobile network activity to tackle the crime prediction problem. While in previous research work have used either background of their historical knowledge or any links to offender profiles, their findings support the hypothesis that collected human behavioural data captured from the mobile network infrastructure, in combination with basic demographic information, can be used to predict crime. In this model, these results with real crime data from London give out a prediction accuracy rate of 70 percent when predicting whether a specificc area in the city will be a crime hotspot or not. Moreover, discussions of the implications of their findings for data-driven crime analysis were provided.

The Table I compares various existing models with our model :

- The first paper predicts crime using a feedforward network. Date, time and location were used as attributes The model achieved a 65.3% accuracy rate which was a bit low.
- The second model used CNN with time, weather and holidays as attributes. It predicted crime with 84% accuracy but training the CNN model is computationally expensive.
- The third model was a prediction of crime using decision tree classifier. It predicted crime with 69.5% accuracy and attributes considered were mobile network activity. The drawback of this model is it's difficult to collect this data.
- The fourth model used KNN with date and location as an attribute. It had 53.9% accuracy. This model needed a large dataset for greater achieving greater accuracy.
- The proposed model used ANN for crime prediction with Date, time, location, PdDistrict as parameters for prediction. It has achieved an accuracy rate of 89.37% and this model has covered flaws of existing models.

TABLE I. ANALYSIS AND COMPARISON OF VARIOUS ALGORITHMS

Sr. no.	Name of the Paper	Algorithm used	Time Complexity	Accuracy	Loss	Attributes considered	Advantages	Research Gaps
1.	Forecasting Crime with Deep learning,2018	Feedforward network is used	O(i*j*k) Nodes in i- input layer j-hidden layer k-Output layer	65.3%	-	Date, Time, District, Latitude , longitude	This model is able to predict the correct bin for overall crime count with 65.3% accuracy for Chicago.	Vast amount of additional datasets needed for accurate predictions.
2.	Deep Learning for Real Time Crime Forecasting, 2017	Used CNN for crime prediction	$O(n^4)$	84.78	-	Time, weather, holidays	they adapt hierarchical structures of residual convolutional units to train multifactor crime prediction models. Experiments over a half year period in Los Angeles reveal highly accurate predictive power of their models.	No classification of crime types : • Since CNN is being used, it is computationally expensive • Used ad hoc grid partitioning
3.	Once Upon a Crime (Towards Crime Prediction from Demographics and Mobile Data),2014	Used decision tree classifier for prediction	O(NklogN)	69.54	5.88%	Mobile network activity, demography , weather, population	experimental results with real crime data from London are obtained as an accuracy mark of almost 70% when predicting whether a specific area in the city will be a crime hotspot or not	The dataset is only available for certain number of years • The dataset is aggregated monthly basis which would be a little invalid and would result in unclear approach in terms of finer granularity. Since a daily, hourly aggregated dataset would give more clarity.
4.	Crime Prediction using K-means Algorithm	Used KNN model for prediction	O(t*k*n) n-instances t- iterations k- clusters	53.97	2.61%	Date, District, Latitude , longitude	Works great when data is noisy.	Needs large dataset for greater accuracy levels.
5.	Crime Rate Prediction Using Neural Network	Used neural network model for predicting crime based on location, date and time.	O(i*j*k) Nodes in i- input layer j-hidden layer k-Output layer	89.37%	1.23%	Date, Time, District ,Latitude , longitude	Predicts whether a particular type of crime takes place and on which day of week.	Covered previous faults of detection of multiple class of crime

III. PROPOSED WORK

The proposed work is summarized as follows:
A Crime Rate Prediction Using:

1. Data pre-processing and refining.
2. Feature extraction using 5 feature types.
3. Classifying the type of crime based on the classifier.

The following are steps involved in training and prediction process: -

- Data preprocessing
- Creating a Artificial Neural Network
- Training the Neural Network
- Making predictions
- Graphical representation of the predictions and actual outputs

The data needs to be processed before feeding it into the neural network. The data is present in csv format which is processed using Pandas library of python. It is easy to import csv files using Pandas. The rows and columns of the csv are processed for creating training and testing dataset. The rows containing wrong or null data are discarded.

- For creating model, Keras library along with tensorflow is used for creating the layers. Sequential layers can be built using simple. add() function of the Keras Library. The following is the syntax for same: -

"crime_pred.add(Dense(look_back,input_dim=look_back, activation="relu"))"

- Dense layers are used to connect neurons on one layer to other layer's neurons. The input_dim argument is used to provide support to the dimensions of its input shape and the activation function is used to convert the input signal to output signal.The layers are then compiled so as to convert the signals into machine readable format.

"crime_pred.compile(loss="mean_squared_error",optimizer="adam", metrics= ["accuracy"])"

- Optimizers are used to reduce loss during training the model. Adam stands for Adaptive Moment Estimation. It helps in maintaining dynamic learning rates for the training process. After compilation we begin training of the model, model.fit() is the built-in function of the Keras API which is used to feed data to the neural network compiled earlier.

"crime_pred.fit(trainX,trainY,epochs=200,batch_size=2,verbose=1,validation_data=(testX,testY))"

- Where trainX and trainY are the arrays of training dataset and testX and testY are the arrays of testing dataset created using numpy library of python. Batch_size is used for memory management of the system and verbose is used to show progress bar during each epoch.
- For prediction crime_pred.predict() function of the Keras Library is used. Both training and testing dataset are taken place during prediction.

"trainPredict=crime_pred.predict(trainX) testPredict = model.predict(testX)"

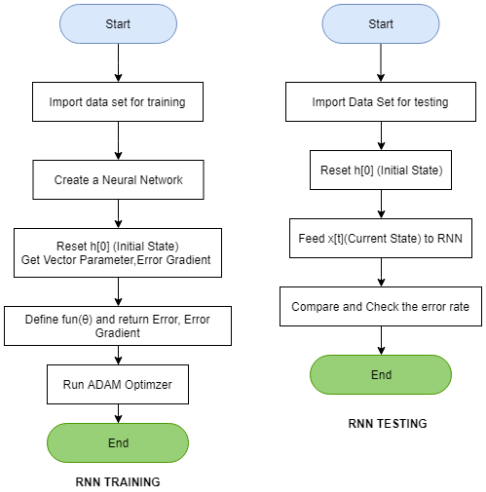

Fig. 2. Training and Testing in Artificial Neural Network

The outputs are then compared in graphical form using matplotlib library of python.

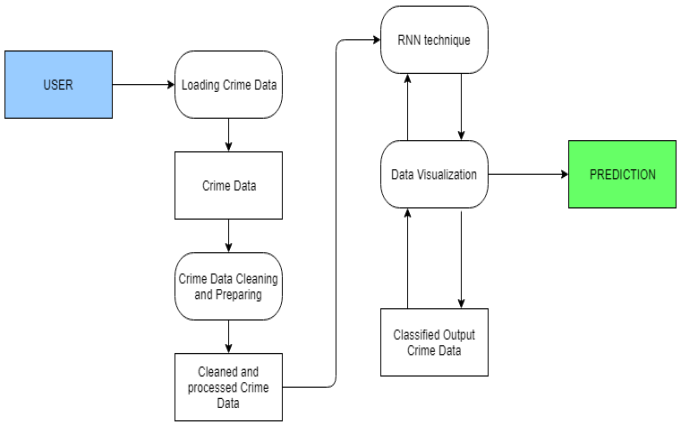

Fig. 3. Architecture of Neural Network

IV. RESULTS AND ANALYSIS

The proposed system is explored, researched, analyzed, trained and tested for outcomes.System was tested on environment with python 3.6 and jupyter notebook.

- The model with higher accuracy having the advantages of both Neural Network models and the K-Means was created.
- The designed system uses supervised learning approach to successfully predict crime rate, with the help of a defined dataset.
- Two parameters were considered, accuracy and loss function to measure the effectiveness of the model created.

- The model predicted the outcome with 89.37% accuracy which is almost 30% more than previous K-Means model.

- The system learns from its correct predictions and uses them for its learning process and for further outputs and predictions.

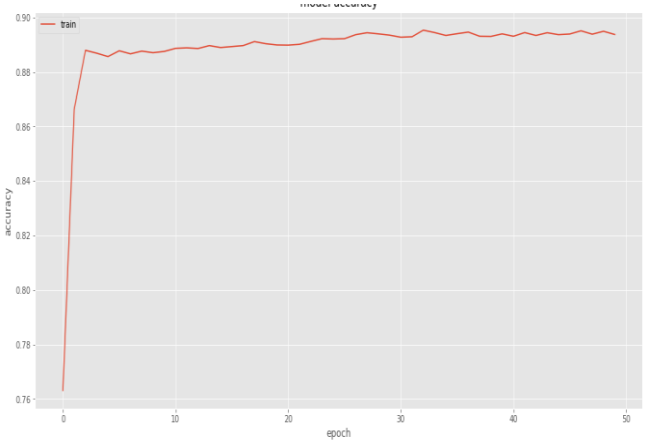

Fig 4. Model Accuracy

- The loss function was reduced from 1.44% to 1.23%

- Both of the graphs above clearly depict the gradual increase and decrease in the accuracy and the loss function of the model respectively.

- The rate of increase of the accuracy is very high during the first 10 epochs and they stabilize itself progressively.

- The rate of decrease of the loss is high during the first 10 epoch and later it remains almost constant for further epochs.

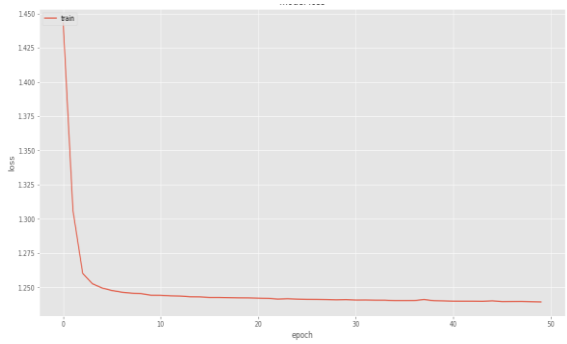

Fig. 5. Model loss

- The following graphs depict the comparison between the actual values and the prediction

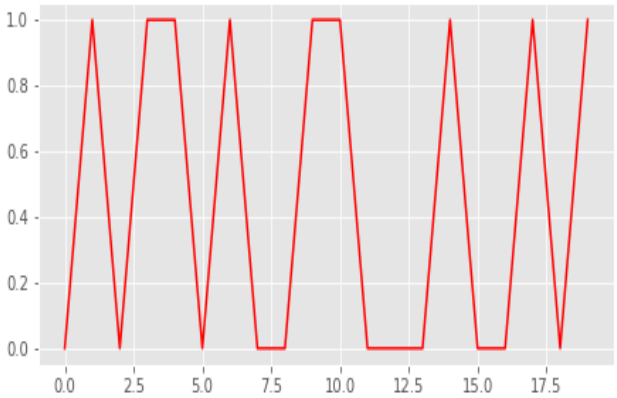

Fig. 6. Predicted Output

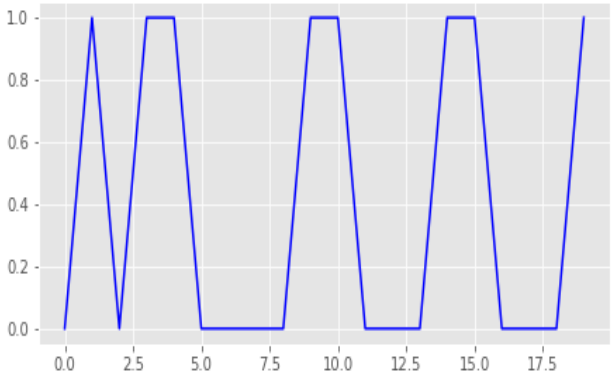

Fig. 7. Actual Output

- The model predicted whether a particular type of crime will occur at a particular location and at what day, while concentrating on Location, PDistrict and Date as the input attributes.

V. Conclusion

Crime, a serious offence punishable by law which implies as a transgression of law. The proposed system reflects an overview of various modules required for crime rate prediction. With the various techniques compared for each of these modules and each technique has its own advantages or disadvantages over the others which further offers the opportunity to define and classify the proposed system. The working of various layers of Artificial neural network are analysed. Because it takes into the account the history of the crime and makes the prediction accordingly. These features are used to predict the crime based on the location and also tell us the chances of crime taking place and at what day of the week. The proposed system provides greater accuracy rates over existing models. Accuracy rates and loss functions were considered as the parameters for evaluation of this model. This system has achieved its efficiency of 89.7% which has reflected to be better then the other compared modules efficiency rates. Finally, the proposed model has more accuracy over the other algorithm-based models. As future enhancement, the proposed methodology can go through a possible extension which will

foresee which zones of the city might be a Crime Hotspots on certain dates. This way the officers of the law could be warned and pertain a much upgraded way of providing security through extra surveillance and can be deployed in as Cellular applications with mapping features on google maps.

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