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Alert System of Earthquake Detection

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Abstract: ***Global warning shows unpredictablenature that changes in subsurface geologicfeatures. Due to the complex nature ofseismic events, it is challengeable task to efficiently identify the prominent features that leads to seismic events. Taking the advantage of availability of Seismic dataset, AI using machine learning is a powerful statistical tools to mitigate these practical challenges for earthquake prediction. The paper focuses on the alert and prediction model of an earthquake using machine learning algorithm. The alert time is a function of distance from epicenter and most alert time is for high magnitude earthquake, because high magnitude earthquake rupture over much larger area and take time to propagate, thus delayed for warning. The main aim of the project is to build precise earthquake prediction model using XGboost regression in machine learning technique. The XGboost regression model implemented on the dataset of 14700 data records. The data is gathered from the Kaggle platform that contains data on events of the earthquake in Indian Subcontinent of 18 years and the last updated is of the year 2018. Tableau 2019 is explored for data visualization of the predicted outcome. The proposed technique is able to give precise prediction of earthquake with sufficient time that will reduce the maximum damages and many lives will be saved.***

Keywords: Seismic signals, XGboost, Tableau, Prediction.

I. INTRODUCTION

Earthquake is floor shaking caused by a sudden motion of rock in the earth's crust. Such moves occur alongside faults, which can be skinny zones of overwhelmed rock setting apart blocks of crust. Earthquake prediction research has been conducted for more than 100 years withoutapparent success. Allegations of the breaches failed to withstand scrutiny. Extensive searches failed to find reliable precursors. The theoreticalwork suggests that error is a non-linear process that is highly sensitive to minute details that cannot be measured for the state of the Earth in large volume, and not just in the immediate vicinity of the hypocenter. Thus any small earthquake has some probability of graduating into a large event. It appears that reliable warnings of impending large earthquakes arevirtually impossible.

Algorithms have been proposed for earthquake prediction using expert system. The main objective of the proposed framework is to identify and evaluate methods, models, parameter and equipment used to forecast earthquakes using different features present in the dataset. The aim is to explore different tools to improve the accuracy / precision of forecast model. It is quite difficult to build a precisemodel because many factors are related for the occurrence of earthquake, like depth, temperature, magnitude etc. The main focus isto provide accurate prediction of earthquake event using machine learning approach. The proposed prediction model can give precise prediction of earthquake event with sufficient time that will help the government to take the necessary measures to prevent maximum damages and save maximum lives. XGboost is a powerful machine learning method which can research extraordinarily complex features.

II. LITERATURE SURVEY

Frequency filtering is extensively used in the habitual processing of seismic records to enhance the signal-to-noise ratio (SNR) of the recorded indicators and as a consequence to enhance subsequent analyzes, primarily based on a deep neural network.[1]The performance ofthe Deep Denoiser was impressive even after it did not result in perfect signal-to-noiseseparation. [2]Subsequent results showed when using wireless sensor network (WSN) , smart phones could be used not only as a recording tool, but also as a highly accurate seismic detection tool. Early warning of 5 seconds was achieved. [3]Internet of things (IOT) is a network of computed physical objects that enables the connection, collection and exchange of data in the conditions of the physical environment. Early warning system implementation via lab view software, Alert signal is sent to smart phones and is carried out by IOT. The hardware part helps to detect the signal , the software part is used to deliver the warning signal to the human. [4] The developed early warning system can trigger a local protection coverage (alarms, disconnectionof hazardous gadget) to reduce the effect of a seismic episode. [5]Another implementationwas tested in the WSN high-speed rail earlywarning system. The problem in the WSN is thelack of technology to provide information on surface movement characteristics, spectrum or time series, and to trigger an alarm to minimize casualties. [6]

Machine learning is an artificial intelligence (AI) utility that permits systems to analyze robotically and improve on the basis of experience without express programming Implementing the svm classifier model for prediction, although the XGboost will give the best result among all classifiers as it is a team technique. Thus, an average detection time of less than 1.3 seconds is achieved. It can be further enhanced with the XGboost algorithm techniques.

III. DATASET DESCRIPTION

The dataset considered is from Kaggle platform,which comprises of 23 features. There are 14700 data records. The data gathered contains data on events of the earthquake in Indian Subcontinent of 18 years and the last updated is of the year 2018.Link of the dataset is https://www.kaggle.com/nksingh673/earthquake-indian-subcontinent.

A. Proposed Framework

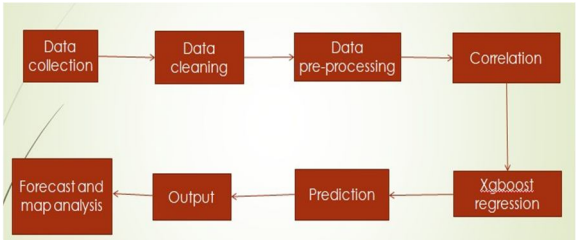

Figure 1 Proposed Framework

The first part constitutes of exploratory data analysis, ultimately model implementation is done and forecasting is performed for the overall analysis. All the steps are followed as shown in the Figure 1.

IV. METHODOLOGY

The mathematical expression of XGboost is-X= Regularization parameter
Y= For auto tree pruning
eta= How much model will converge.
Similarity Score (S.S)=(S.R^2)/(N+X)
Here, S.R is the sum of residuals, N is number of residuals.
The main focus is to predict the latitude and longitude for the upcoming years. The last updated data is for 2018, so XGboost regression is used to check the trends which are resulting for the event of occurrence, initially all the data cleaning, data preprocessing, feature engineering, handling the missing values and feature selection process is followed before finding the correlation which help in selecting the relevant good correlated features compared to the target variable. Model comprises of features having good correlated values with respect to magnitude, and magnitude is taken as output variable to predict the trend. Thirty percent of the dataset is taken as test data, and fitted into the rest train dataset, giving the final result. Further the result is taken into csv file and analysis, forecasting is done in tableau.

V. RESULT AND DISCUSSION

Figure 2 represent a correlation graph where darker the feature, represent more highly correlated with the target variable. Here nearest seismic signal is having the highest correlation with the value 0.644013 followed by gap, magnitude type, magnitude source, year, latitude, longitude, root mean square, depth and place. This helps in selecting the relevant features.

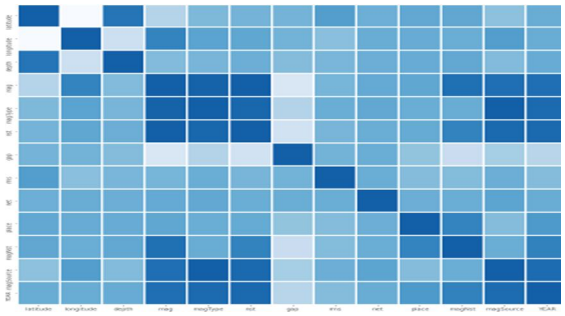

Figure 2 Correlation of extracted features.

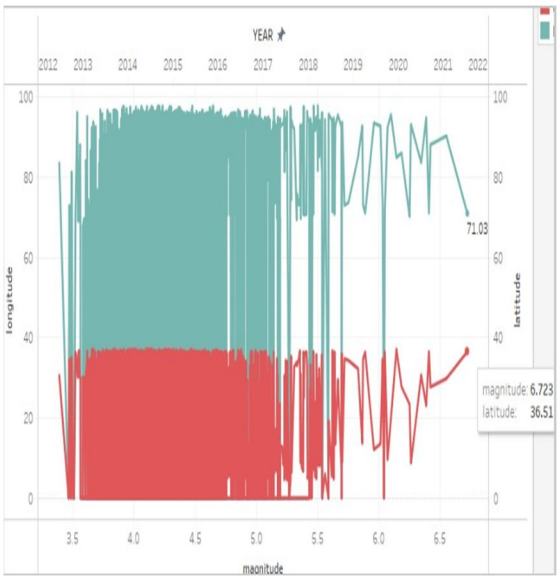

Figure 3 Predictive Analysis of Model

The predictive analysis of the event can be seen in Figure3 which is done by forecasting the magnitude of the data which is obtained by data cleaning and feature selection. This visualization is performed in tableau. Figure 3 represent the longitude and latitude where the earthquake might happen with particular magnitude. Red color in the graph indicates latitude and the blue color indicates longitude. From the graph it can be seen that for 2021, 71.03longitude and 36.51latitude the possibility of event to occur is 70 percent with 6.7 magnitude, further the result is validated where recently 6.3 magnitude of earthquake happened around this geographic area.

Figure4 shows the map of earthquake event happened which is highlighted the dark blue spot. It represent the prone area where the eventhave high probability of the occurrence.

Figure 4 Map of Earthquake event happened

XGboost is an effective implementation of gradient boosting for classification and regression situation .It is fast and efficient as itis a **decision tree ensemble(**Figure 5**)** techniqueand Ensemble learning consists of a group of predictors that are more than one models to provide better prediction accuracy. In boosting approach the errors made with the aid of preceding fashions are attempted to be correctedvia succeeding models via including a few weights to the models. Not like other boosting algorithms wherein the weights of the misclassified branches are improved, the loss feature of the gradient boosting algorithms is progressed. XGboost is a complicated scaling boosting app with some law factors technique that uses gradient boosting. Since this is a structured data and generally for structured or tabular data , this algorithm is best preferred, but if there is an unstructured data which is not in this case, neural network is opted forprediction.

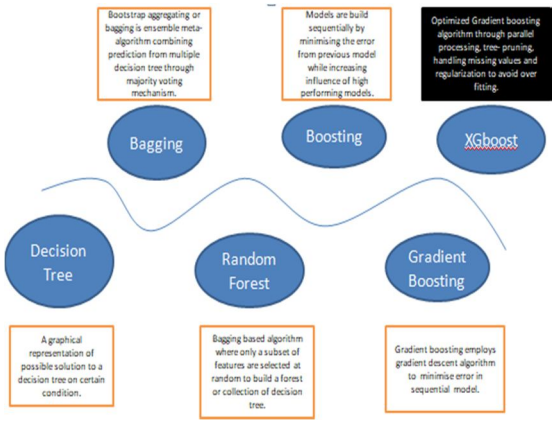

Figure 5 XGboost chart

Figure.5 is XGboost chart that highlight exclusive feature of XGboost model that enhancethe performance of prediction model, how the performance of a XGboost model increases as compared to other algorithms.

Prediction research	Method Used	Result
Earthquake early warning	IOT	Predicion time less than 5second.(52%)
Earthquake detection	WSN	Predtion time 30-40seconds.(48%)
Proposed Earthquake early warning	Machine learning XGboost	Prediction with 2018 data, 70% accuracy. ⇦

Table 1Accuracy performance of Earthquake prediction System

Table 1 shows that accuracy performance of comparison of proposed technique with previous technique**.** According to Table 1 proposed technique enhanced the performance accuracy by 20%.

VI. CONCLUSION

The paper focuses on the experiment tests of 14700 records and 23 features on XGboost regression model. Records are segregate in 70 %training and 30% in testing. The experimentation results shows the accuracy of proposed prediction model is 70% which shows 20% is improvement in performance accuracy as compared to all the previous model.

XGboost regression model is able to extract prominent features that are highly responsible for occurrence such as nearest seismic station, gap etc. Although some features like ‘depth’also play a vital role for occurrence but the correlated value was not that good, which affected the accuracy to some point. Prediction was analyzed in tableau software, which also helped in map analysis.

VII. ACKNOWLEDGEMENT

One of the parameter 'Depth' is also a prominent feature playing important role in occurrence of earthquake.Correlation of extracted feature unable to show depth as a prominent feature. Structure dataset and regularly updated dataset will help to predict precisely the future earthquake event**.**

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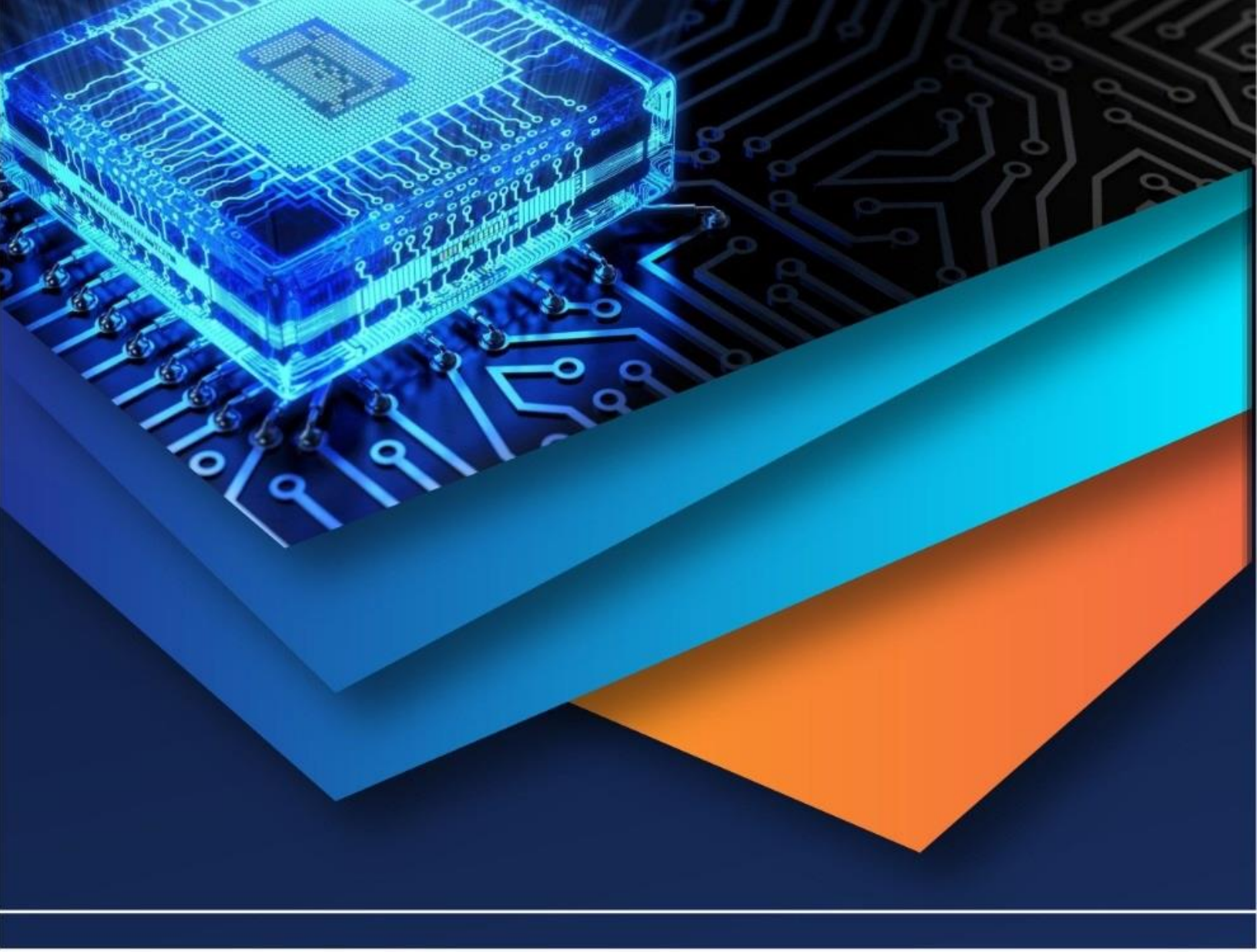

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