Prediction of Earthquake Using Seismic Information

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Abstract : Earthquake is one of the devastating events in natural hazards that causes great casualties and property damage every day in the world since that it is hard to predict. With the increasing amount of earthquake datasets collected, many researchers try to solve the task of predicting the earthquakein the future time. Earthquake prediction is to estimate the time, location and magnitude of the future earthquake. In this project we will use precursory pattern based feature extraction method for earthquake prediction, which can predict both the magnitude range of future earth- quakes and obtain the effective time range of prediction results. Earthquake precursor refers to a part of seismic records before the main shock, which is represented as the precursory pattern of earthquake

***IndexTerms* - Earthquake, seismic activity, Precursory pattern, CART, Timeseries.**

I. INTRODUCTION

Earthquake prediction is a branch of the science of seismology concerned with the specification of the time, location, and magnitude of future earthquakes within stated limits, and particularly "the determination of parameters for the next strong earthquake to occur in a region. Earthquake prediction is sometimes distinguished from earthquake forecasting, which can be described as the probabilistic assessment of general earthquake risk, including the frequency and magnitude of damaging earthquakes over the years or decades in a given area. Predictions can also be distinguished from earthquake warning systems that detect an earthquake and provide a real-time warning of seconds to neighboring regions that might be affected**.**

When they can be shown to be accurate beyond random chance, predictions are considered significant.Therefore, statistical hypothesis testing methods are used to determine the likelihood that an expected earthquake will occur anyway (the null hypothesis). The projections are then tested by checking whether they match better than the null hypothesis with real earthquakes.

In numerous occasions, notwithstanding, the measurable idea of quake event isn't just homogeneous. Grouping happens in both existence. In southern California about 6% of $M \geq 3.0$ seismic tremors are "trailed by a quake of bigger extent inside 5 days and 10 km." In focal Italy 9.5% of $M \geq 3.0$ quakes are trailed by a bigger occasion inside 48 hours and 30 km. While such measurements are not agreeable for motivations behind forecast (offering ten to twenty false cautions for each effective expectation) they will slant the consequences of any investigation that accept that seismic tremors happen haphazardly in time, for instance, as acknowledged from a Poisson procedure. It has been indicated that an "innocent" technique dependent on grouping can effectively foresee about 5% of seismic tremors; "much better than 'possibility'".

Seismic tremor forecast is a juvenile science—it has not yet prompted an effective expectation of a quake from first physical standards. Examination into strategies for expectation in this manner center around observational investigation, with two general approaches: either recognizing unmistakable forerunners to quakes, or distinguishing some sort of geophysical pattern or example in seismicity that may go before an enormous earthquake.Precursor techniques are sought after to a great extent on account of their potential utility for momentary tremor forecast or anticipating, while 'pattern' techniques are commonly thought to be helpful for guaging, long haul expectation (10 to 100 years time scale) or middle of the road term forecast (1 to 10 years time scale).

II. OBJECTIVES

1.Feature Extraction(precursory pattern based) to better capture the characteristics of earthquake, thus can be used to enhance earthquake prediction.
2. Applying machine learning algorithm - CART (Classification And Regression Trees) algorithm on the extracted features to predict the magnitude of Earthquake on the Richter Scale.

III. LITERATURE SURVEY

Gutenberg designed seismic indicators based on mathematical statistical methods, e.g. earthquake magnitude, earthquake energy, earthquake acceleration, *b*-value and so on, a lot of researchers have proposed different feature extraction methods to obtain indicators for earthquake prediction.

Nuannin applied the sliding time and space windows containing a fixed number of seismic events to obtain earthquake indicators. In order to detect the precursors for large earthquakes, Nuannin et al. used the sliding time-windows containing a constant number of events to examine the spatial distribution of *b*-value. Particularly, observed variations in *b* reveals a precursory potential which could be used in medium-term (months, years) earthquake prediction. However, this method is designed for large earthquakes (magnitude greater than 7) and does not provide the specific precursory pattern for earthquakes.

Florido considered a fixed number of seismic events before main earthquake as the precursory pattern to extract features, which is useful for analyzing the trend of earthquakes and also proposed to enhance earthquake prediction by detecting the precursory patterns, which is an improvement on the basis of. Specifically, the data are first grouped into the set of five chronologically ordered earthquakes according to [8], and then the sighed variation on the *b*-values in the time interval for the five earthquakes is used to discover the precursory patterns of earthquakes with magnitude larger than a constant. The results showed that the precursory patterns are useful for earthquakes with magnitude larger than. Unfortunately, these precursor signals extracted from the earthquakes with magnitude exceeding a fixed threshold cannot obtain the specific magnitude range of earthquakes.

Narayanakumar extracted seismic features of a fixed number of events before main shock to make earthquake prediction with BP neural network technique. The historical earthquake catalog with Richter magnitudes between 3.0 and 8.6 is divided into fifteen groups where each group is comprised of earthquakes of magnitude in a 0.4 Richter range, and the category tag is considered as predicted target. The results show that this method can provide better accuracy for medium-large earthquakes, but still cannot achieve satisfactory prediction results for large earthquake. Besides, this feature extraction method cannot estimate the effective time range of the predicted earthquakes.

To address the problem of magnitude range prediction and the effective time range of prediction results, **Adeli** proposed a novel feature extraction method. To be specific, the historical records for a given region are divided into fixed day time periods such as 15 days or one month, and the earthquake with the largest magnitude in each time period is labeled as main shock. And then the author predicted the magnitude range of the largest earthquake in the following predefined day time periods. Thus, the problem of the effective time range of prediction results is well handled. Moreover, the author claimed that this feature extraction method with selected probabilistic neural network (PNN) can provide good prediction results for earthquakes.

Mirrashid contributed the prediction of earthquakes with magnitude 5.5 or more based on the adaptive neuro-fuzzy inference system (ANFIS), and the experimental results validated that ANFIS can obtain the best results in terms of precision comparing to the baseline algorithms.

Asencio proposed to use a clustering method for seismogenic zones partitioning, and then use different machine learning techniques to make earthquake prediction, including KNN, ANN, NB, C4.5 decision trees and SVM, which can build reliable and general earthquake prediction systems.

In order to improve the precision of earthquake prediction, many researchers used feature selection techniques to eliminate redundant features, **Mart** adopted the information gain of each seismic indicator for feature selection.

Asim designed a hybrid embedded feature selection method, which can be used to make accurate earthquake prediction.

Hamze-Ziabari recently proposed an efficient bagging ensemble model of M5' and CART algorithms to predict ground motion parameters such as Peak Ground Acceleration, Peak Ground Velocity, and Peak Ground Displacement. These parameters are well known to characterize an earthquake, which are very helpful for seismic analysis of structures and risk assessment.

IV. METHODOLOGY

In order to obtain the representative learning samples, the raw seismic data is firstly divided into a set of fixed day time periods and the magnitude of the largest earthquake of each time period called main shock is as the label of the fixed period according to. Then the sequence composed of the last events in the last time period before the current time and the events before the main shock in current time period is treated as earthquake precursory pattern. And the seismic indicators based on the obtained precursory patterns with a selected classification and regression tree algorithm named CART can lead to satisfactory earthquake prediction results. In order to predict both the magnitude range of future earthquakes as well as obtain the effective time range of prediction results, we will be using a precursory pattern based features extraction method. The sequence of historical seismic records is firstly divided into N -day time period. The magnitude range of the largest earthquake in the corresponding time period is the prediction target which will serve as an effective seismic indicator. In general, a decision tree contains a root node, several internal nodes and leaf nodes. The leaf node is the decision result. Therefore, the key of the decision tree algorithm is to select the partitioning attribute based on data purity, and there are many methods to measure the purity of data, such as information gain. After applying the CART algorithm, we will be able to predict the earthquakemagnitude.

V. CONCLUTION

In this paper, we proposed a precursory pattern based feature extraction method with the selected CART approach for accurate earthquake prediction. To verify the effectiveness of the proposed method, many state-of-the-art baselines were compared on the two datasets, i.e. Changding-Garzˆe and Wudu-Mabian seismic zones of China. Noting that the prediction accuracy of the proposed method can reach 93.26% and 92.07% on the two datasets respectively,

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