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EARTHQUAKE PREDICTION BASED ON SPATIO-TEMPORAL DATAMINING: AN LSTM NETWORK APPROACH

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Abstract- The importance of seismological research around the globe is very clear. Therefore, new tools and algorithms are needed in order to predict magnitude, time, and geographic location, as well as to discover relationships that allow us to better understand this phenomenon and thus be able to save countless human lives. However, given the highly random nature of earthquakes and the complexity in obtaining an efficient mathematical model, efforts until now have been insufficient and new methods that can contribute to solving this challenge are needed. In this work, a novel earthquake magnitude prediction method is proposed, which is based on the composition of a known system whose behavior is governed according to the measurements of more than two decades of seismic events and is modeled as a time series using machine learning, specifically a network architecture based on LSTM (long short-term memory) cells.

1.INTRODUCTION:

A variety of physical systems exhibit regular behavior in different time or space scales, such as the burst of the earthquakes on faults and crackling noise of paper crumpling . The behaviors are likely independent events, but there is universality for real systems which can be explained by simple models. If there is a slow driving force, the system crackles accompanied with various sizes of discrete events, such as the earthquakes burst at a critical state as the tectonic plates interacting with each other under a driving plate . We have explored the plastic deformation mechanism during compressive deformation for disordered Avariety of physical systems exhibit regular behavior in different time or space scales, such as the burst of the earthquakes on faults and crackling noise of paper crumpling. The behaviors are likely independent events, but there is universality for real systems which can be explained by simple models.

2.METHEDOLOGY

Natural disasters are without any doubt a latent danger and become very devastating and threaten the entire ecosystem of one region. That is why the prediction of earthquakes plays such an important role since its goal is to specify the magnitude and geographical and temporary location of future earthquakes with enough precision and anticipation to issue a warning.

Despite the efforts made to produce mechanical or computational models of the earthquake process, these still do not achieve real predictive power. Given the highly random nature of earthquakes with relatively high magnitude, their occurrence can only be analyzed using a statistical approach, but any synthetic model must show the same characteristics with respect to its distribution in size, time, and space, which is very hard to achieve.

3.DATA FLOW DIAGRAM:

3.1 LEVEL 0:

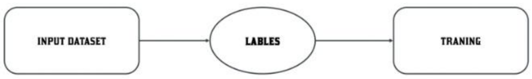

Fig3.1 data flow diagram

3.2 LEVEL 1:

Fig3.2 data flow diagram

3.3 OVERALL DIAGRAM:

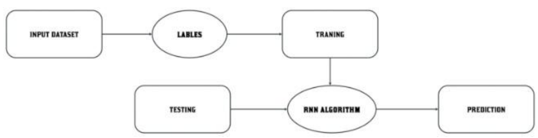

Fig3.3 data flow diagram

4.PROPOSED SYSTEM:

Natural disasters are without any doubt a latent danger and become very devastating and threaten the entire ecosystem of one region. That is why the prediction of earthquakes plays such an important role since its goal is to specify the magnitude and geographical and temporary location of future earthquakes with enough precision and anticipation to issue a warning. Despite the efforts made to produce mechanical or computational models of the earthquake process, these still do not achieve real predictive power. Given the highly random nature of earthquakes with relatively high magnitude, their occurrence can only be analyzed using a statistical approach, but any synthetic model must show the same characteristics with respect to its distribution in size, time, and space, which is very hard to achieve.

In this research we will create a LSTM (long short-term memory) cells. which will take the parameters as features and from that we will try to classify the damage made by the earthquake in a particular region .At initial we will have six nodes and they will be Remote Sensing data ,Seismic Data ,Geo-Physical data ,Geological data, Petrological data and Historical data. We will have hidden nodes and hidden layers as study is still on the process to find the exact value of k and h. We will have three nodes as output Low damage, Moderate damage and High damage

There are two general approaches to predict earthquakes, precursors based and trend based. Precursors are anomalous phenomena that might signal an impending earthquake such as radon gas emissions, unusual animal behavior, electromagnetic anomalies etc. Trend based methods involve identifying patterns of seismicity that precede an earthquake. In this paper, a trends-based approach is adopted and the LSTM neural network is used to capture the trend involving statistical techniques

ADVANTAGES:

Predicting earthquakes well in advance can alert the public in saving lives as well as resources at the right time.

In this research project we will be studying the impact of earthquakes which have

happened in the past through the historical data.
The traditional processes like preprocessing of data, training the neural network, weight adjustments, testing on test data are done.

DISADVANGES:
The problem is challenging because large earthquakes cannot be reliably predicted for specific regions over time scales that span less than decades.
Still successfully applied to many problems but still cannot capture long term dependencies.
Exploding gradients problem in which gradients are either squashed to zero or increase without bound during back propagation through a large number of time steps
Primarily to overcome the problem of vanishing gradients.

4.1 H/W SYSTEM CONFIGURATION:

Processor	i3, i5, i7
RAM	8 Gb
Hard Disk	500 GB

Table4.1 h\w system configuration

4.2 S/W SYSTEM CONFIGURATION:

Operating System	Windows 7/8/10
Front End	Html, Css
Scripts	Python language
Tool	Python Idle

Table4.2 s\w system configuration

5.MODULES DISCRIPTION

5.1 DATA COLLECTION:

Data collection is defined as the procedure of collecting, measuring and analyzing accurate insights for research using standard validated techniques. A researcher can evaluate their hypothesis on the basis of collected data. In most cases, data collection is the primary and most important step for research, irrespective of the field of research. The approach of data collection is different for different fields of study, depending on the required information. The most critical objective of data collection is ensuring that information-rich and reliable data is collected for statistical analysis so that data-driven decisions can be made for research. Earthquakes have over the course of time, evolved into an effective alternative to expensive mail or telephone surveys. There are a few conditions which need to be met to online surveys however that you must be aware of. If you are trying to survey a sample which represents the target population, please keep in mind that not everyone is online.

5.2 DATA CLEANING:

Data cleaning is the process of preparing data for analysis by removing or modifying data that is incorrect, incomplete, irrelevant, duplicated, or improperly formatted. This data is usually not necessary or helpful when it comes to analyzing data because it may hinder the process or provide inaccurate results. There are several methods for cleaning data depending on how it is stored along with the answers being sought. Data cleaning is not simply about erasing information to make space for new data, but rather finding a way to maximize a data set's accuracy without necessarily deleting information. Most importantly, the goal of data cleaning is to create data sets that are standardized and uniform to allow business intelligence and data analytics tools to easily access and find the right data for each query.

5.3 EXPLORATORY DATA ANALYSIS (EDA):

Finally, I am ready to start building my bridge between my experience with seismic earthquakes data set and my new skills in EDA. For making it I will use some clues as the building blocks. The first block is related to what the seismic earthquakes data set tell us about the subsurface. When a seismic earthquakes is observed it brings to the observer a perception of the subsurface as a collage of diverse visual patterns, called seismic earthquakes reflections in the Population, arranged in such way that after an appropriate interpretation of it a meaningful geological model appears as formed by layers defining structures. How do we get geological sense from seismic earthquakes data set. Because the seismic earthquakes data is usually recorded in time, what we are seen on a seismic earthquakes is just a record of the arriving times to the ground of all the reflected seismic earthquakes waves travelling across the subsurface. As explained previously, each seismic reflected amplitude is a response to a particular elastic contrast in depth. Then, each recorded arriving time is only a transformed representation of the seismic response in depth. For this reason, the coherent distribution of all those reflected amplitudes, arranged as a function of their associated travel times, is what give us the geological perception of it. But this fact also introduces, as we will see later, a bias in the DL training stage which must be removed or mitigated before EDA.

5.4 IMPLEMENTATION OF LSTM:

The idea of this post is to teach you how to build your first Recurrent Neural Network (RNN) for series prediction. In particular, we are going to use the Long Short Term Memory (LSTM) RNN, which has gained a lot of attention in the last years. LSTM solve the problem of vanishing / exploding gradient in typical RNN. Basically, LSTM have an internal state which is able to remember data over big periods of time, allowing it to outperform typical RNN. There is a lot of material on the web regarding the theory of this network, but there are a lot of misleading articles regarding how to apply this algorithm. In this article we will get straight to the point, building an LSTM network, training it and showing how it is able to make predictions based on the historic data it has seen.

5.5 TIME-SERIES MODELING:

Time series data often arise when monitoring industrial processes or tracking corporate business metrics. The essential difference between modeling data via time series methods or using the process monitoring methods discussed earlier in this chapter is the following:Time series analysis accounts for the fact that data points taken over time may have an internal structure (such as autocorrelation, trend or seasonal variation) that should be accounted for.This section will give a brief overview of some of the more widely used techniques in the rich and rapidly growing field of time series modeling and analysis.

6. BLOCK DIAGRAM:

A block diagram for an Earthquake Prediction System typically outlines the components involved in detecting, analyzing, and forecasting earthquake events

These are physical sensors like seismometers, accelerometers, and geophones, which are placed in various locations to measure ground motion, vibrations, and other seismic activities.

The data from these sensors is gathered and transmitted to a central system. This is often done in real-time for immediate processing. The data can include ground motion data, pressure variations, and more.

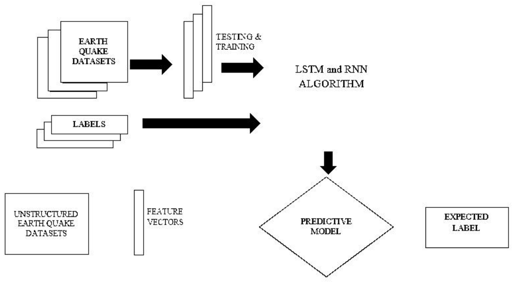

Fig6.1 block diagram

7.EXPERIMENTAL RESULTS:

This result discuss about the implementation of earthquake prediction based on spatio-temporal data mining this below fig 7.1 show the implementation of earthquake forecaster.

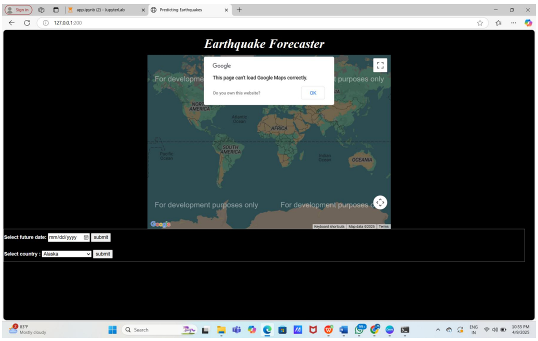

Fig7.1 earthquake forecaster

8. CONCLUSION& FUTURE WORK:

In this paper, we have proposed a new earthquake prediction system from the Spatio-temporal perspective. Specifically, we have designed an LSTM network with two-dimensional input, which can discover the Spatio-temporal correlations among earthquake occurrences and take advantage of the correlations to make accurate earthquake predictions. The proposed decomposition method for improving the effectiveness and efficiency of our LSTM network has been shown to be able to significantly improve the system performance. Simulation results also demonstrate that our system can make accurate predictions with different temporal and spatial prediction granularities.

we describe in detail our proposed earthquake prediction algorithm using an LSTM network with twodimensional input. The main idea of our algorithm is to develop an LSTM network with two-dimensional input to predict the next system status based on a number of the most recent system statuses

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