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Earthquake Prediction using Deep Learning

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Abstract: *Earthquakes are one of the most expensive natural disasters to which humans are subject and occur without prior notice, earthquake prediction becomes a very important and difficult task for humanity. Although many existing approaches make an attempt to deal with this problem, the majority of them characterize an earthquake for earthquake prediction using either feature vectors (implicit features) extracted by deep learning techniques or seismic indicators (explicit features) created by geologists. Combining these two types of features to enhance the performance of final earthquake prediction is still a challenge. To achieve this, we suggest DLEP, a deep learning model that successfully fuses explicit and implicit features for earthquake prediction. In DLEP, we use a convolutional neural network (CNN) to extract implicit features and eight precursory pattern-based indicators as the explicit features. After that, an attention-based approach is recommended to effectively combine these two categories of features. A dynamic loss function is additionally created to address the category imbalance in seismic data. Finally, experimental outcomes on eight datasets from various regions show that the proposed DLEP for earthquake prediction is more effective than several state-of-the-art methods.*

Keywords: CNN, DLEP, Explicit features, Implicit features

I. INTRODUCTION

One of the most destructive natural disasters in the world, earthquakes can result in serious injuries or the death of people and often strike without prior notice. Earthquake prediction, which seeks to use the available earthquake data to specify three elements, namely when, where, and the magnitude of the future earthquake, is one of the most efficient ways to lessen earthquake loss. Because effective earthquake prediction can significantly lessen earthquake damage, which is important for the nation and society, there has been an increase in academic research and interest in predicting seismic events.Many academics have tried to use physical methods to explain and analyse earthquakes, as well as investigated earthquake precursors through the study of geology, in an effort to predict earthquakes such as their magnitude, duration, and location. In these works, scientists developed a number of earthquake indicators as explicit features of seismic events, including earthquake magnitude and intensity energy. The values of these indicators are calculated using site investigation data, and various feature extraction techniques based on precursory patterns were also proposed.We suggest a brand-new deep learning model called DLEP for predicting earthquakes. In DLEP, a suggested attention-based strategy effectively combines the explicit features and implicit features. Additionally, a dynamic loss function is created to address the seismic data category imbalance issue. The experimental results on eight datasets with various characteristics show the promising performance of the proposed DLEP, indicating that the idea of fusing both explicit features and implicit features is an effective solution for precise earthquake prediction. • We evaluate the effectiveness of our model DLEP comparing to state-of-the-art baselines.

II. LITERATURE SURVEY

To categorize and identify the various earth quake techniques, many researchers have proposed a model that combines image processing and machine learning algorithms and techniques.

By Laura Laurenti and Elisa Tinti, "Deep learning for laboratory earthquake prediction and autoregressive forecasting of fault zone stress" Using seismic signals coming from lab faults, deep neural networks can forecast and predict laboratory earthquakes and measure the shear stress in the fault zone. Previous research demonstrated that fault shear stress and time to failure could be predicted using the variance of lab seismic signals (from fault zone acoustic emissions). We thoroughly evaluated a variety of DL models using various lab flaws, and we discovered that our models significantly outperformed the state-of-the-art. In addition, we demonstrated that it is feasible..

By M. A. Mubarak, Muhammad Shahid Riaz, Muhammad Awais, and Zeeshan Jilani. "Earthquake prediction" This piece evaluatesGravitational changes, radon emissions, anomalous electric fields, and variations in meteorological variables like temperature and relative humidity are examples of natural pre-earthquake phenomena. It is explained what an earthquake preparation zone is and how it can be recognized. This theory holds that this zone is where all ground-based pre-earthquake signals are generated. This zone may have a radius of more than 300 km for an earthquake of magnitude 6, depending on the size of the earthquake being prepared. Additionally, it has been suggested to use specialized satellites to track earthquake precursors from space.

Vanita Buradkar and Dinky Tulsi Nandwani: "Prediction of Earthquake Damage using Machine Learning" by Project Building damage during an earthquake may be predicted, allowing for the classification of building grades. The structure's grade is categorised into the following five groups: minor, medium, large, partial, and total collapse. In the event of an earthquake, a building with a low gradient will sustain more damage. When an earthquake strikes, a building with a high gradient will sustain less damage. Therefore, required preparations can be performed before an earthquake by understanding the grade of the buildings.

Dr. S. Anbu Kumar, Abhay Kumar, Aditya Dhanraj, and Ashish Thakur's paper, "Earthquake Prediction Using Machine Learning," is available online. A prediction of earthquakes was made during this study,by using seismic and acoustic data gathered from a lab micro-earthquake simulation to train various Machine Learning models. The "single-feature" acoustic data, which was essentially in the form of a time series, was used to extract 40 statistical features, such as the number of peaks, time to failure, etc. to make predictions. In this study, accuracy in the training and testing datasets were compared between six machine learning techniques, including Linear Regression, Support Vector Machine, Random Forest Regression, Case Based Reasoning, XGBoost, and Light Gradient Boosting Mechanism, to determine which model performed the best.

III. ARCHITECTURE

The system architecture is comparable to an object's blueprint. It provides a theoretical framework for the methodical blending of mechanical systems and business logic.It offers instances of thethe design, perspective, actions, traits, and capabilities of the system. a strategy to increase the Earthquake Prediction System's algorithmic accuracy. The proposed uses NN-based algorithms and implementations. Yandex's CatBoost is a group machine learning approach. Classification and boosting are the roots of the name "CatBoost.In comparison to Random Forest and other Gradient Boosting Methods, this technique performs significantly better.The system architecturesuccessfully process.

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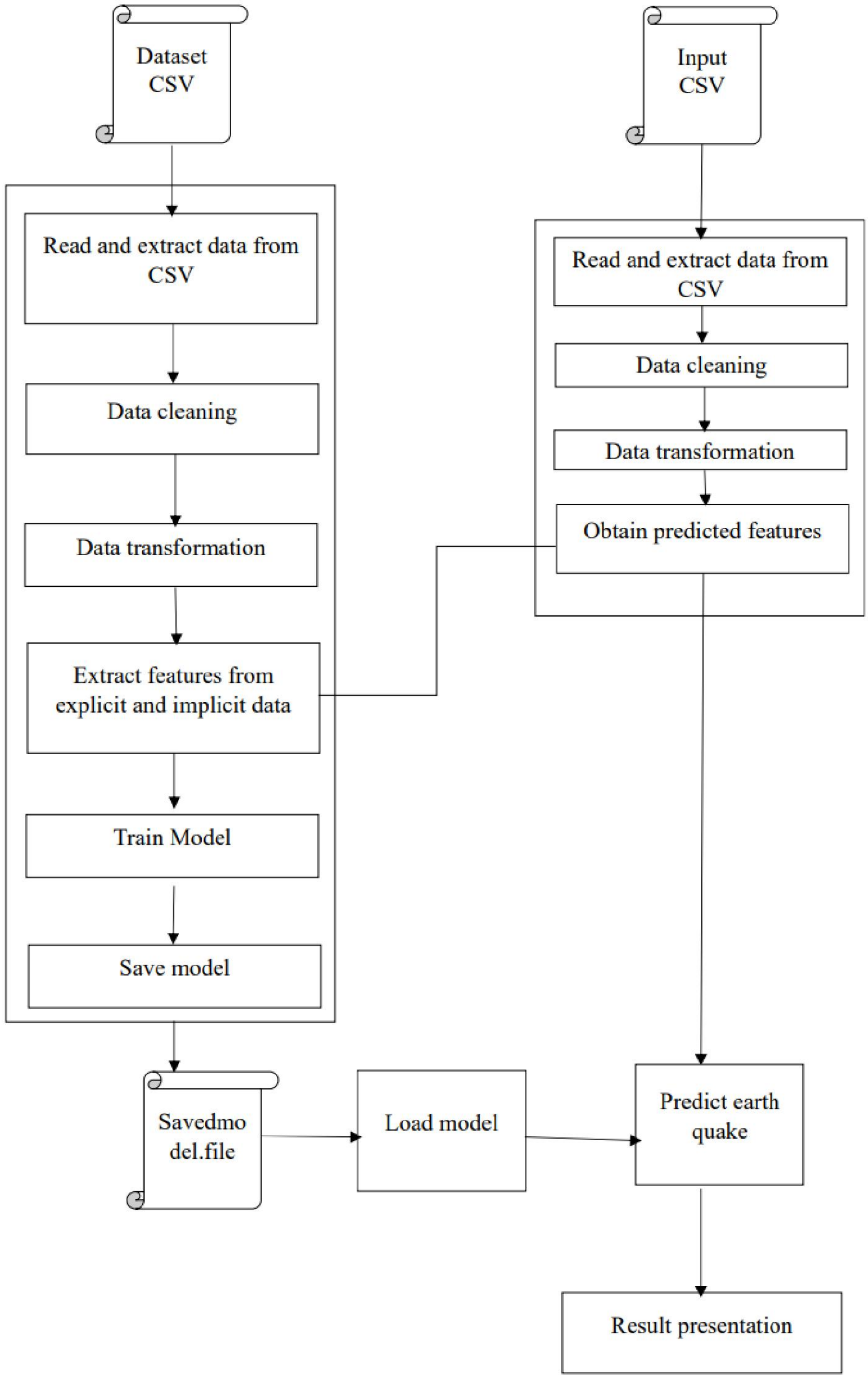

IV. METHODOLOGY

a. *mechanism used in proposed system*
b. Algorithm implemented in the system
c. Architecture of the proposed system

The proposed model, which can predict earthquake magnitude with high accuracy, is based on a feed-forward neural network model with multiple hidden layers. We go over the elements of the suggested neural network

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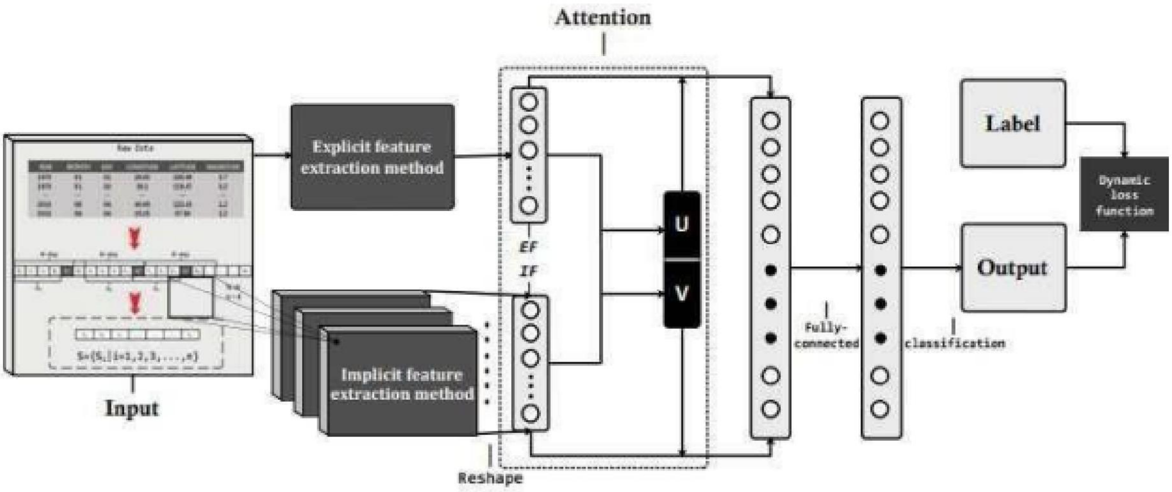
model in this section. Now, we'll concentrate on the model's design. An artificial intelligence technique called a neural network instructs computers to process data in a manner modeled after the human brain. Deep learning is a type of machine learning that employs interconnected neurons or nodes in a layered structure to mimic the human brain. It develops an adaptive system that computers use to continuously learn from their errors and improve.
To predict earthquakes, we propose a novel deep learning model called DLEP. A suggested attention-based strategy in DLEP effectively combines the explicit features and implicit features.
Additionally, a dynamic loss function is created to address the seismic data category imbalance issue. The experimental results on eight datasets with various characteristics show the promising performance of the proposed DLEP, which suggests that the idea of fusing both explicit features and implicit features is an effective solution for accurate earthquake prediction. We compare the effectiveness of our model DLEP to state-of-the-art baselines.



Architecture of the DLEP

V. CONCLUSION AND FUTURE SCOPE

Previous research's feature extraction techniques only extract explicit features created by geologists or implicit features extracted by deep learning techniques, and they lack a general model that can combine the benefits of features that are both explicit and implicit. In order to achieve this, the DLEP deep learning model is suggested to combine explicit and implicit features for precise earthquake prediction. Eight indicators based on precursory patterns were used in our model as explicit features, and a convolutional It's important to note that the proposed DLEP only includes explicit features and implicit features.In order to further enhance the performance of earthquake prediction using existing work, we would like to design or extract more efficient explicit features and implicit features in the future.

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