

Classify earthquakes using Machine Learning algorithms

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Abstract

The predictability of earthquakes remains a central challenge in seismological research. Are earthquakes inherently unpredictable phenomena, or can they be forecasted through advances in technology? Contemporary seismological research continues to pursue this scientific milestone, often referred to as the ‘Holy Grail’ of earthquake prediction. In the direction of earthquake prediction based on historical data, the Grammatical Evolution technique demonstrated high predictive accuracy for earthquake magnitude. Similarly, our research team follows this line of reasoning, operating under the belief that nature provides a pattern that, with the appropriate tools, can be decoded. What is certain is that, over the past 30 years, scientists and researchers have made significant strides in the field of seismology, largely aided by the development and application of artificial intelligence techniques. Artificial Neural Networks (ANNs) were first applied in the domain of seismology in 1994. The introduction of Deep Neural Networks (DNNs), characterized by architectures incorporating two hidden layers, followed in 2002. Subsequently, Recurrent Neural Networks (RNNs) were implemented within seismological studies as early as 2007. Most recently, Grammatical Evolution (GE) has recently been introduced in seismological studies (2025). Despite ongoing advancements, the so-called "triple prediction" accurately forecasting the time, location, and magnitude of a seismic event, remains unachieved. Beyond that, Machine learning and soft computing techniques have maintained a longstanding presence in the field of seismology. Concerning these approaches, significant advancements have been achieved, both in mapping seismic patterns and in predicting seismic characteristics on a smaller geographical scale. In such a way, our research will analyze historical seismic events from 1970 to 2025, for the Latitude 33 - 44 & Longitude 17 - 44. The data will be categorized and classified, with the aim of employing Grammatical Evolution techniques to achieve more accurate and timely predictions of earthquake magnitudes. Furthermore, in constructing our seismic dataset, we identified and categorized the lithospheric–tectonic plate associated with each seismic event. In addition, we incorporated the Kp index, which reflects geomagnetic storms occurring within the closest temporal window to each seismic event. This paper presents a systematic effort to enhance magnitude prediction accuracy using GE, contributing to the broader goal of reliable earthquake forecasting. During the course of our experiments, the application of the SMOTE technique may be considered in cases where class imbalance arises and cannot be effectively addressed through alternative methods.

Keywords: Earthquakes; Machine learning; Neural networks

Received:

Revised:

Accepted:

Published:

Citation: Kopitsa, C.; Tsoulos, I.G.; Charilogis, V.; Stylios, C.. Predicting the magnitude of earthquakes using Grammatical Evolution. *Journal Not Specified* **2025**, *1*, 0. <https://doi.org/>

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