Article

Classify earthquakes using Machine Learning algorithms

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Abstract

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 Law of Seismic Entropy Production proposed by S. Ts. Akopian has demonstrated high levels of predictive accuracy. 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 been explored in this context, with its application emerging in 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, which will be categorized and classified, with the aim of employing Machine Learning 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 apply Machine Learning techniques for estimating earthquake magnitudes, using various (ML) algorithms.

Keywords: Earthquakes; Machine learning; Neural networks

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1. How to Use this Template

2. Introduction

3. Materials and Methods

4. Results

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All figures and tables should be cited in the main text as Figure 1, Table 1, Table 2, etc.

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Table 1. This is a table caption. Tables should be placed in the main text near to the first time they are cited.

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Entry 1	Data	Data
Entry 2	Data	Data[1]

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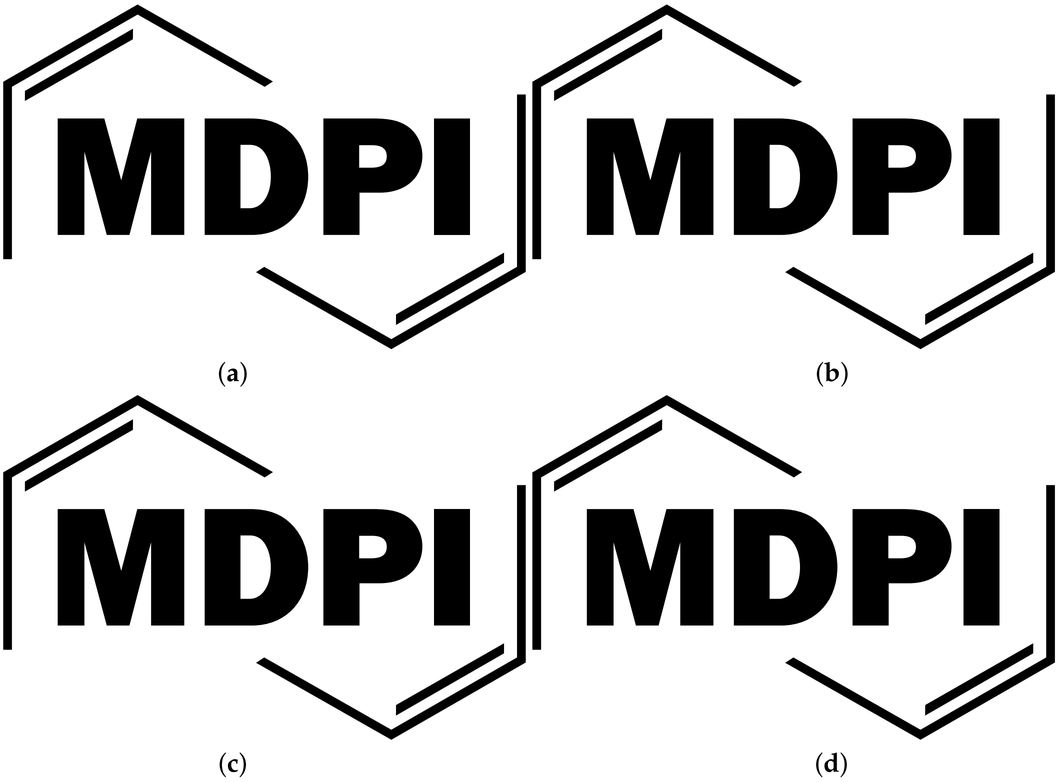

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Entry 2	Data Data Data	Data Data Data	Data Data Data

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Text.

Text.

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$$a = 1, \tag{1}$$

the text following an equation need not be a new paragraph. Please punctuate equations as regular text.

This is the example 2 of equation:

$$a = b + c + d + e + f + g + h + i + j + k + l + m + n + o + p + q + r + s + t + u + v + w + x + y + z \tag{2}$$

Please punctuate equations as regular text. Theorem-type environments (including propositions, lemmas, corollaries etc.) can be formatted as follows:

Theorem 1. *Example text of a theorem.*

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Proof of Theorem 1. Text of the proof. Note that the phrase "of Theorem 1" is optional if it is clear which theorem is being referred to. □

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Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

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Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	Linear dichroism

Appendix A

Appendix A.1

The appendix is an optional section that can contain details and data supplemental to the main text—for example, explanations of experimental details that would disrupt the flow of the main text but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data are shown in the main text can be added here if brief, or as Supplementary Data. Mathematical proofs of results not central to the paper can be added as an appendix.

Table A1. This is a table caption.

Title 1	Title 2	Title 3
Entry 1	Data	Data
Entry 2	Data	Data

Appendix B

All appendix sections must be cited in the main text. In the appendices, Figures, Tables, etc. should be labeled, starting with "A"—e.g., Figure A1, Figure A2, etc.

References

1. Author 1, T. The title of the cited article. *Journal Abbreviation* **2008**, *10*, 142–149.
2. Author 2, L. The title of the cited contribution. In *The Book Title*; Editor1, F., Editor2, A., Eds.; Publishing House: City, Country, 2007; pp. 32–58.
3. Author 1, A.; Author 2, B. *Book Title*, 3rd ed.; Publisher: Publisher Location, Country, 2008; pp. 154–196.
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