Chalmers Tekniska Högskola

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DESIGN OF AI SYSTEMS (DAT410)

Module 8: Mini-project proposal

Group 38

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We hereby declare that we have both actively participated in solving every exercise. All solutions are entirely our own work, without having taken part in other solutions.

1. Background

An earthquake is a natural phenomenon caused by the sudden movement of tectonic plates. Earthquakes are most common in areas where tectonic plates meet - such places are the Pacific Ring of Fire and the Mediterranean region. When these plates move, they create seismic waves that cause shaking and vibration of ground surface. Provided the shaking is strong enough, it can have devastating consequences. Earthquakes can cause significant damage to buildings, roads, and other infrastructure, and they can also trigger tsunamis, landslides, and other secondary disasters. Examples are Fukushima in 2011 when a tsunami was caused, and Türkiye in 2023 when buildings collapsed, both resulting in many casualties.

The recent earthquakes in the region - 6/2/23 in Türkiye and Syria (Mw 7.5), 16/2/23 in Croatia (Mw 5.3), 20/2/23 in Türkiye (Mw 6.3), 23/2/23 in Tajikistan (Mw 6.8), and 25/2/23 in Türkiye (Mw 5.3) - have prompted a heightened awareness of the potential consequences and how to mitigate their impact, i.e. casualties. Naturally, it would be preferred to be able to predict when an earthquake might occur. To this end, various instruments are used to monitor earthquakes and study their patterns to better understand their causes and effects, as well as to predict them. Machine learning is one of the tools used, and we therefore propose an implementation of a ML model for predicting earthquakes for this project.

2. Implementation

Various ML models have been tested applied to tasks related to earthquake prediction: artificial neural networks for predicting earthquake magnitudes [1], deep-learning transformers for predicting future fault friction [4] and phase picking [2] in laboratory settings, as well as decision trees for predicting the instantaneous fault shear stress, shear displacement, and gouge thickness [3], among others. Our goal would be to explore some of the methods and compare them. We would train a model on data prior to February 2023, and then test whether we can accurately predict an earthquake that happened at a later point, such as those mentioned above. Provided the complexity of the task would not be too high, and that we would have time remaining to expand our project, we would work towards predicting an earthquake's latitude, longitude, magnitude, and/or depth as well.

This project is achievable in the given time frame as 1) the various model implementations are described in detail in articles and on websites, which can be used as references, and 2) earthquake data sets exist and are freely available (for example, United States Geological Survey). This project can be related to module 3, where we talked about AI tools, their use cases and implementations, and module 5 where we implemented a classifier to predict a disease. In this project we would work towards predicting an earthquake using an AI tool.

Bibliography

[1] Abdulrahman SN Alarifi, Nassir SN Alarifi, and Saad Al-Humidan. “Earthquakes magnitude predication using artificial neural network in northern Red Sea area”. In: *Journal of King Saud University-Science* 24.4 (2012), pp. 301–313.

[2] S Mostafa Mousavi et al. “Earthquake transformer—an attentive deep-learning model for simultaneous earthquake detection and phase picking”. In: *Nature communications* 11.1 (2020), p. 3952.

[3] Paul A Johnson et al. “Laboratory earthquake forecasting: A machine learning competition”. In: *Proceedings of the national academy of sciences* 118.5 (2021), e2011362118.

[4] Kun Wang et al. “Predicting future laboratory fault friction through deep learning transformer models”. In: *Geophysical Research Letters* 49.19 (2022), e2022GL098233.