PREDICTING EARTHQUAKES USING LONG-TERM EARLY EARTHQUAKE WARNING SYSTEMS

ANALYZING THE NECESSARY CONFIGURATIONS OF A LONG-TERM EARTHQUAKE EARLY WARNING SYSTEM

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SOCIOTECHNICAL SYNTHESIS

Predicting earthquakes is a significantly challenging problem with a long history of largely unsuccessful attempts. The technical project explores the ability of long short-term memory networks to predict earthquakes. The goal of prediction is to mitigate earthquake-induced damage by preparing in advance. Based on such models, earthquake early warning systems to alert the public will eventually be created in certain regions. While potentially a powerful tool in any field, early warning systems must be carefully configured due to the uncertainty in any prediction. The STS research compares and contrasts early warning systems from other domains to propose necessary configurations for future earthquake early warning systems.

While there are known, physical equations that govern when and where an earthquake will happen, humans are unable to obtain the measurements necessary to perform such a calculation. There is also a large flux of data about when and where earthquakes have happened, but no significant patterns have emerged based on human analysis. The technical project uses machine learning based methods to predict earthquakes. Specifically, we used long-short term memory networks trained on earthquake data from the United States Geological Survey.

The model was able to make predictions months in advance that aligned with the historic earthquakes in certain regions. Although the results were inconsistent from region to region, they suggested that long-term patterns do exist for earthquake events. Additionally, certain machine learning models such as long short-term memory networks have the potential to capture these patterns. Presumably, the outcomes can improve through more thorough datasets and more sophisticated models.

The STS research is comparing and contrasting early warning (EW) systems from other application domains in order to suggest necessary technological and policy configurations for such a novel earthquake EW system. The case studies analyzed were on geographical landslide EW systems, patient monitoring EW systems in hospitals, flood detection EW systems, and current short-term earthquake EW systems. Questions derived from the Social Construction Theory of Technology were used to guide the analysis. The questions were specifically answered for each study, and the results were combined to create a set of best practices that future long-term earthquake EW systems should follow.

Based on the findings of each of the case studies, we hypothesize that an effective long-term EEW system should equitably describe the public, either by using the model itself, a separate susceptibility model, or another holistic approach. The public's preferences should be gauged on topics such as false positive tolerance level and methods for alerting. Alerts should concisely contain a trusted source, the type of event, the reason for belief in a threat, and actionable advice, and should be delivered through multiple mediums such as warning speakers, phone alerts, and website alerts. General education programs should be implemented so that engineers, project administrators, and local government officials are all knowledgeable on how the long-term EEW system works. The implementation of long-term EEW systems should be standardized from the start in terms of thorough datasets, the exact model, and model and threshold validation procedures. They would best support the overall goal of reducing earthquake-induced damage by assisting rather than replacing current short-term models.

The technical research is an effort to accurately predict earthquakes months in advance. The STS research is an effort to understand how to effectively take action given such a prediction. With high-quality execution of both, our communities can persist.

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