Earthquake Aftershocks Pattern Prediction

Mulugeta Tuji Dugda[1], Alemayehu B Kassa[2], Line Pouchard[3], Yuewei Lin[3], and Amanuel Seifu[4]

[1]Electrical and Computer Engineering, Morgan State University
[2]Computer Science, Morgan State University
[3]Computational Science Initiative, Brookhaven National Laboratory
[4]Computer Science, University of Maryland College Park

March 22, 2023

Abstract

Large earthquakes, especially those occurring in a city or population centers, create devastation and havoc, and often times kindle several deaths and injuries, and significant infrastructure damage that lead to several billions of dollars in losses. Marine earthquakes are the leading cause of large tsunamis which cause deaths, destruction, displacement of population, and a possible nuclear meltdown. Thus, prediction of earthquake or its aftershocks or earthquake early warning system has a great potential to mitigate the loss of life as well as different kinds of damage. Earthquake prediction would mean forecasting the occurrence of an earthquake by providing both its magnitude estimate and accurate location. Earthquake prediction has been an important area of seismology research for quite a while, and it looks like it will continue to be an important area of research. Recently, with the implementation of deep learning in seismology, scientists have been able to detect, predict, and model seismic waves and earthquake aftershocks.

Earthquake aftershocks are generally triggered by changes in stress formed by large earthquakes that happen within, or surrounding a given fault network system. The main goal of this study is to investigate the improvement of aftershock pattern predictions with the implementation of tuning and optimizing of deep learning parameters. To achieve these goals, we have developed an algorithm that can help first gather mainshock-aftershock sequence data. Some of the criteria used in identifying earthquakes that initiate an aftershock is to look at earthquakes that happen within a certain radius, the values we attempted are within about 0.5 degrees range, and within a certain period, from few seconds to several weeks of the occurrence of the main shock. For the sequence identification, we have been using seismic data from the United States Geological Survey (USGS)-National Earthquake Information Center (NEIC). We are also looking at different open-source data gathered by researchers for a similar study. The deep neural networks we are implementing make use of Keras python Toolkit, and Theano and Tensorflow libraries, with a plan to use PyTorch python library instead of Theano library in the future because of some maintenance issues. To this point our attempts have shown a good progress.

Earthquake Aftershocks Pattern Prediction

Abstract

Mulugeta Tuji Dugda[1], Alemayehu B Kassa[2], Line Pouchard[3], Yuewei Lin[3] and Amanuel Seifu[4], (1)Morgan State University, Electrical and Computer Engineering, Baltimore, United States, (2)Morgan State University, Computer Science, Baltimore, MD, United States, (3)Brookhaven National Laboratory, Computational Science Initiative, Upton, United States, (4)University of Maryland College Park, Computer Science, College Park, United States

Large earthquakes, especially those occurring in a city or population centers, create devastation and havoc, and often times kindle several deaths and injuries, and significant infrastructure damage that lead to several billions of dollars in losses. Marine earthquakes are the leading cause of large tsunamis which cause deaths, destruction, displacement of population, and a possible nuclear meltdown. Thus, prediction of earthquake or its aftershocks or earthquake early warning system has a great potential to mitigate the loss of life as well as different kinds of damage. Earthquake prediction would mean forecasting the occurrence of an earthquake by providing both its magnitude estimate and accurate location. Earthquake prediction has been an important area of seismology research for quite a while, and it looks like it will continue to be an important area of research. Recently, with the implementation of deep learning in seismology, scientists have been able to detect, predict, and model seismic waves and earthquake aftershocks.

Earthquake aftershocks are generally triggered by changes in stress formed by large earthquakes that happen within, or surrounding a given fault network system. The main goal of this study is to investigate the improvement of aftershock pattern predictions with the implementation of tuning and optimizing of deep learning parameters. To achieve these goals, we have developed an algorithm that can help first gather mainshock-aftershock sequence data. Some of the criteria used in identifying earthquakes that initiate an aftershock is to look at earthquakes that happen within a certain radius, the values we attempted are within about 0.5 degrees range, and within a certain period, from few seconds to several weeks of the occurrence of the main shock. For the sequence identification, we have been using seismic data from the United States Geological Survey (USGS)-National Earthquake Information Center (NEIC). We are also looking at different open-source data gathered by researchers for a similar study. The deep neural networks we are implementing make use of Keras python Toolkit, and Theano and Tensorflow libraries, with a plan to use PyTorch python library instead of Theano library in the future because of some maintenance issues. To this point our attempts have shown a good progress.