PROJECT DSCI 510   
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**Earthquake and moment magnitude dependency on its distance to closest recording station**

# A picture containing sunset, outdoor, nature Description automatically generated

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# Background/Introduction

Earthquake is one of the most studied natural hazards in California in hazard engineering. Civil Engineers and researchers are responsible for protecting our community from hazards and prevent communal losses. The new type of civil engineers rely much on availability of data and use informatics technique to advance his engineering skills. Since the advancement of technology, there has been a tremendous amount of data been collected through the updated network stations. Data are stored multiple services naming IRIS Database, USGS Database, PEER Database. This report chooses USGS Database, flat file from NGAWest2\_finite\_fault.csv, and a IRIS station database.

In engineering strong motion, a NEHRP site class (NEHRP stands for National Engineering Hazard Reduction Program) is demanded in foundation design and structural design. NEHRP is also a parameter in seismic design. Therefore, the importance of having accurate NEHRP code is essential to our building and infrastructure design. The motivation of this report provide a data tool to validate the current NEHRP classification.

An example of data query from IRIS

Text

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# Data Description

In this example, data is extracted from IRIS Database which consists of

The author is particularly interested finding the determination of earthquake magnitude to the geometry and distances of the location of the earthquake.

* File get\_iris\_stations.py retrieve the number of stations and its location to an excel file named “stations\_info.txt”
* File get\_earthquakes.py have 3 running mode which are –static, --scrape, --default modes. They retrieve earthquakes from USGS database and store them into an excel file named “earthquakes.csv”
* File analysis.py provide a histogram distribution of moment magnitudes and a plot of moment magnitude versus the closest distance from an earthquake to a station. Shortest distance were calculated based on the combination of 2 dataset mentioned 2 bullets above
* File nn\_test.py runs a machine learning neural network linear regression to predict the geometry of a fault to a corresponding moment magnitude

# Methodology

The classifying methods are plot visualization and ‘Neural Network’. Both methods are part of the learning system where they generate auto decisions relying on prior experience, in this case we have trained data and tested data. Trained data is a set of data used to determine patterns. They store the results in computer and produce a path through the solved cases in order to predict the testing data. The requirement is that they both need the same inputs or sometimes referred as predictor variables.

## Procedure

Visualization is examined by the reviewer who has background in civil engineering and make decision

# Results and Discussion

First, a plot of moment magnitude and closest distance from an earthquake to a station is plotted. We can visually inspect the distribution of smaller earthquakes where moment magnitude do not exceed magnitude of 5 are heavily record. It implies that closest distance has a strong correlation with the moment magnitude of an earthquake. Three distances are plotted: diagonal distance is the hypothenuse of the square triangle including the hypocenter depth and the distance as the sides in the square triangle. The distribution of moment at longer distances also show a strong trend in moment magnitude and how far it is to the closest recording station.

A picture containing chart

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Figure : Moment magnitude and closest distance to a recording station

A distribution of moment magnitude is plotted in histogram

Chart, histogram

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Figure : Moment magnitude distribution from usgs earthquake database

## Neural NETWORK RESULTS

Figure 3 and 4 shows the results of neural networks utilized by the package scikit-learn MLPRegressor in predicting moment magnitude based on ['Hypocenter Depth (km)', 'Total Fault Length (km)', 'Total Fault Width (km)','Strike (deg)', 'Dip  (deg)']. These are the geometry information of an earthquake when the fault slips.

Chart, bar chart

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Figure : Neural network prediction of moment magnitude

Chart, scatter chart

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Figure : Residuals and actual moment magnitude

# Conclusion

We can observe a strong trend of moment magnitude dependent on geometry and distance of an earthquake attributes such as hypocenter depth, fault geometry, the mechanism of a slip.

# References

Boore, D., Joyner, T., & Fumal, T. (1993). *Estimation of response spectra and peak accelerations from western North American earthquakes: An interim report.* U.S. Geological Survey Open-File.

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