ML-BASED CLASSIFICATION ON EARTHQUAKE EVENTS

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Introduction

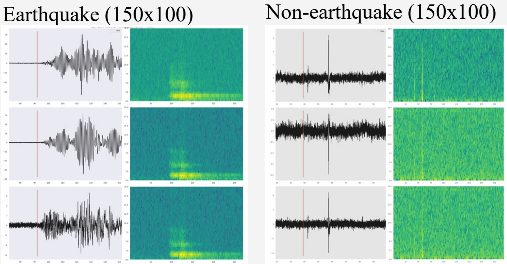
Quake Structure Integrity Sensor (QSIS) seismic network (QSN), which is aimed to establish real-time seismic events analysis and structural health monitoring system through deploying low-cost MEMS Accelerometers in different building arrays. The QSN project has developed data acquisition system for retrieving onsite triggered waveform data and provides real-time notifications to subscribers. To enhance the data acquisition system, we plan to utilize machine learning methods for classifying seismic signals from artificial ones. This classification model will be deployed on both the QSN client and server sides.

Methods

Input

Spectrogram of each trace

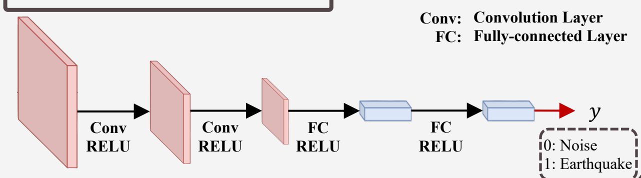
Earthquake (150x100) Non-earthquake (150x100)



* 80 seconds window

Convolution Neural Network

Conv: Convolution Layer
FC: Fully-connected Layer



Output

Use our model to classify each trace in a signal

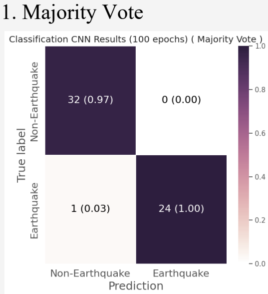
Use
1. Majority Vote
2. Mean of probability
to further validate

Results and Discussion

Testing on our training dataset

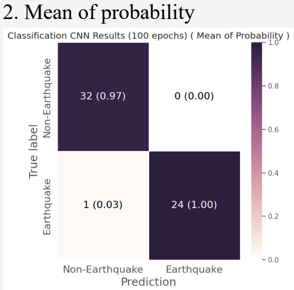
Training dataset: 227
Testing dataset: 57

1. Majority Vote



Accuracy: 98.246%
Precision 100%
Recall: 96%

2. Mean of probability



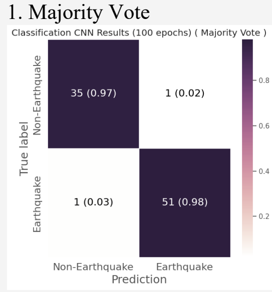
Accuracy: 98.246%
Precision 100%
Recall: 96%

Results and Discussion

Testing on Additional Dataset

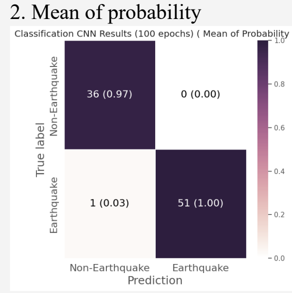
Testing dataset: 88

1. Majority Vote



Accuracy: 97.727%
Precision 98.077%
Recall: 98.077%

2. Mean of probability



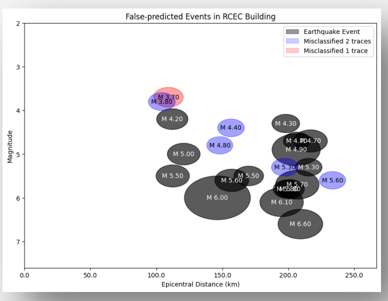
Accuracy: 98.864 %
Precision 100%
Recall: 98.077%

- The scheme that uses the concept of "ensemble" is good for Earthquake classification.
- Our model can be generalized to different dataset.

Analysis on False-predicted Events

*** Only events with PGA >1.5 gal be selected**

- The only misclassified earthquake events has the smallest magnitude.
- Earthquake that has lower PGA values are also prone to be misclassified as noise.
- Earthquake data from higher floor is more susceptible to being mistaken for noise.



Conclusion and Future Works

Conclusion

- Earthquake classification using spectrogram is suitable for our task and can further implement on server side of QSIS system.
- Notification on triggered events, including classification reports would be sent automatically to user.

Future Works

- Augment the dataset and refine the research workflow.
- Enhance the reliability of classification results.
- Dockerize our package to implement on computers with different specifications.

References

- Clements, T. (2023). Earthquake Detection with tinyML. Seismological Research Letters. https://doi.org/10.1785/0220220322
- Kaelynn Rose. (2022). Earthquake Classification using CNNs [Jupyter Notebook]. https://github.com/kaelynn-rose/EarthquakeClassification (Original work published 2021)
- QSIS. (2022). Retrieved August 27, 2023, from https://140.109.80.226/