Group 5 Final Project AETA Earthquake Prediction

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Why earthquake ?

Why earthquake ?

Catastrophic natural disaster

Have claimed millions of lives in the last 100 years

Improvements in technology have only slightly reduced the death toll.

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Related Work

1

Focus on LSTMs based techniques

Long short - term memory (LSTM)

LightGBM

2

Some people see this as a classification problem

Convolutional Neural Network (CNN)

4

For automatic earthquake detection using raw seismic data

LSTM + CNN

3

Capture both spatial and temporal features in the seismic data

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3 Part Three

Data processing

1455
Samples

48
Features

Imbalanced Class

https://aeta.io/
https://reurl.cc/xlML3b

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Part Three

Data processing

Balance class

94 , 94

Label the data

0 No earthquake

1 Has earthquake

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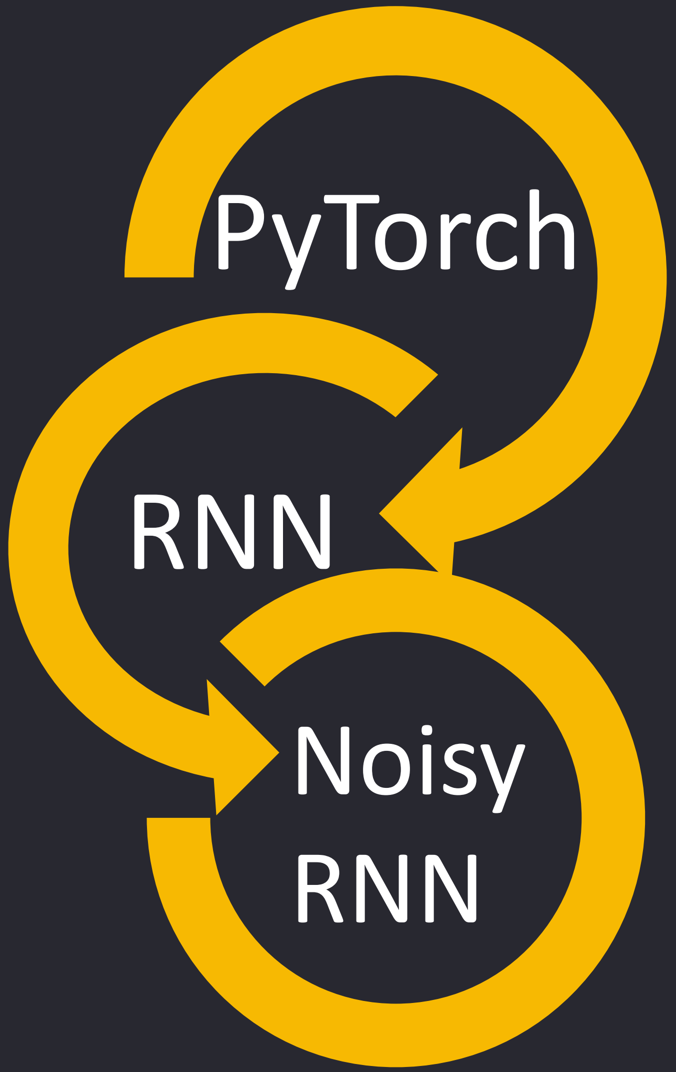
4 Part Four

Model

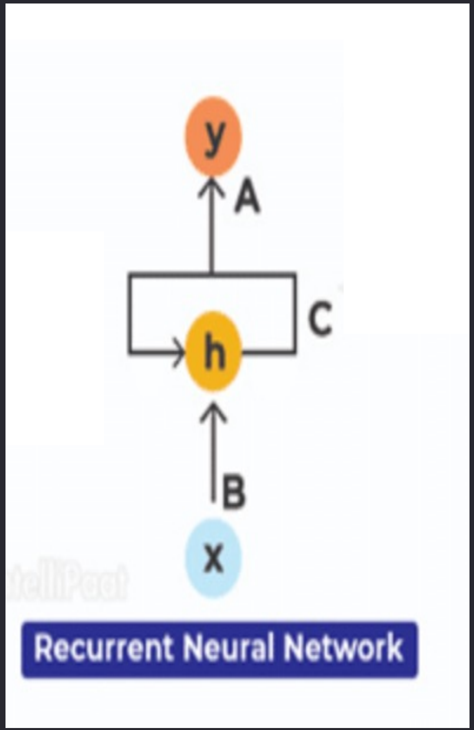


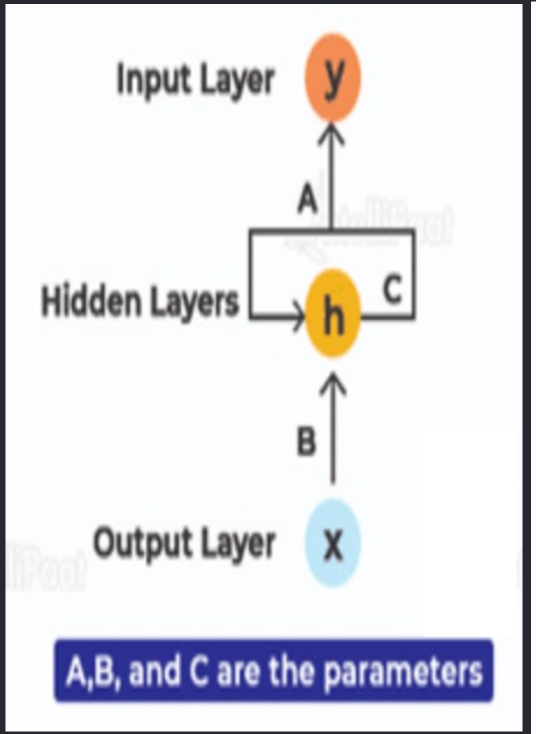
We use PyTorch as our library

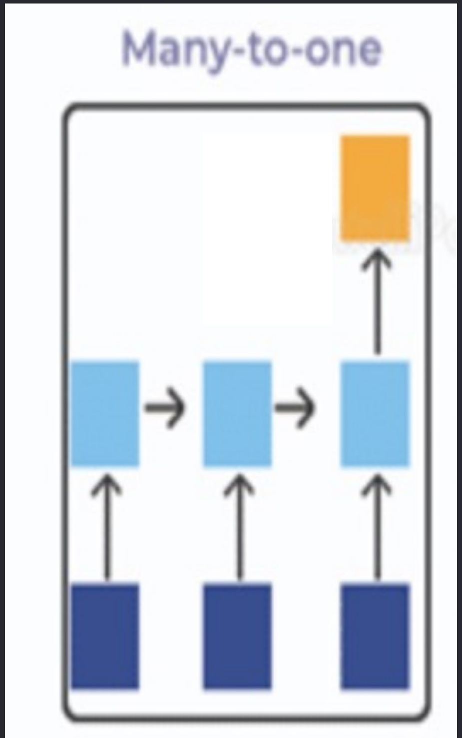
https://arxiv.org/pdf/2102.04877.pdf

4 Part Four

Model - RNN







- Input layer input size is 48 features
  self.rnn = nn.RNN(48,k,num_layers)
- Linear layer classify class 0 or 1
  self.linear = nn.Linear(k,2)
- Output layer's activation function is leaky ReLU
  outputs = F.leaky_relu(self.linear(output))

RNN is designed to process sequential data, such as time-series data.

https://reurl.cc/qkAvDR

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Part Four

Model – Noisy Recurrent Neural Networks (NRNNs)

```
if self.add_noise > 0:
    add_noise = self.add_noise * torch.randn(h.shape[0],
h.shape[1]).float().to(self.device)

if self.mult_noise > 0:
    mult_noise = self.mult_noise * torch.rand(h.shape[0],
h.shape[1]).float().to(self.device) + (1-self.mult_noise)
```

1. Earthquake data is often noisy
2. The noise acts as a form of regularization, which helps to prevent overfitting
3. Better capture the underlying dynamics of the data

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Model Evaluation – training data

0.0655

F1 Score

0.7661

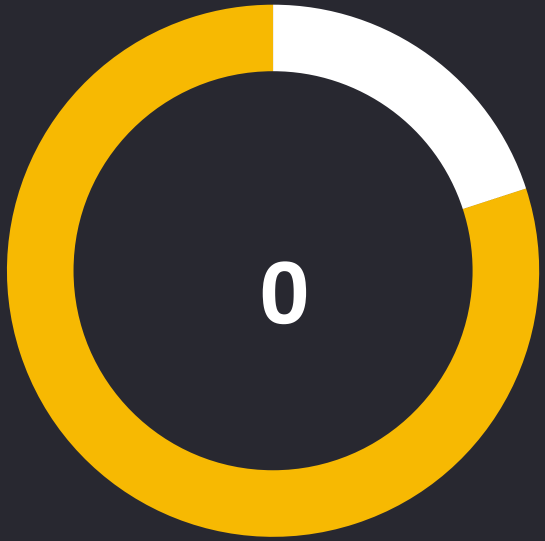
Accuracy

[188 34]
[24 2]

Confusion Matrix

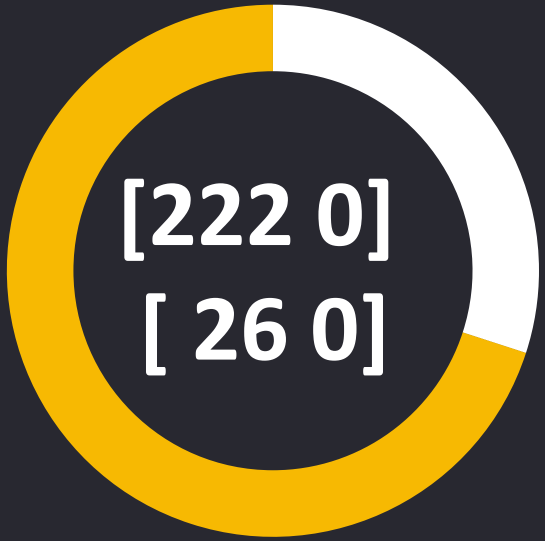
5 Part Five

Model Evaluation – test data



F1 Score

Accuracy



Confusion Matrix

Technically, Noisy RNN should have better result
F1 score 0 it failed in predicting has earthquake

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Discussion

Real-world data quality

Seismic data is often noisy and can be difficult to interpret

Traditional modeling techniques may not be well-suited

New approaches may need to be developed in order to improve accuracy.

Limited understanding

Seismic activity is influenced by a wide range of factors

Thank you for watching

References

[1] Wang, C.; Li, C.; Yong, S.; Wang, X.; Yang, C. Time Series and Non-Time Series Models of Earthquake Prediction Based on AETA Data: 16-Week Real Case Study. Appl. Sci. 2022, 12, 8536.

[2] LI, L., SHI, Y., & CHENG, S. (2022). Exploration of long short-term memory neural network in intermediate earthquake forecast: a case study in Sichuan-Yunnan region. Chinese Journal of Geophysics, 65(1), 12-25. DOI: https://doi.org/10.6038/cjg2022P0086

[3]Sak, H., Senior, A. W., & Beaufays, F. (2014). Long short-term memory recurrent neural network architectures for large scale acoustic modeling. In Proceedings of the Annual Conference of the International Speech Communication Association (INTERSPEECH), 2014

[4] Zhang, J., Li, H., Li, C., & Zhao, W. (2021). An adaptive deep learning model for earthquake prediction. Natural Hazards, 105(2), 1299-1318.

[5] Schaff, D. P., & Richards, M. A. (2014). Earthquake location, directivity, and magnitude estimation using sparse data from a single array. Journal of Geophysical Research: Solid Earth, 119(3), 2073-2088.

[6] https://arxiv.org/pdf/2102.04877.pdf

[7] https://www.mdpi.com/2076-3417/12/17/8536

[8] https://intellipaat.com/blog/tutorial/artificial-intelligence-tutorial/recurrent-neural-network/

[9]https://account.alibabacloud.com/register/intl_register.htm?spm=a2c45.11132017.2.2.561179f4eJLtOd&oauth_callback=https%3A%2F%2Ftianchi.aliyun.com%2Fhome%2Fauth%2Faliyun%2Fcallback%3Ftctrace%3Da3f8f92a150d4bedd8bf2b049 082c1