Sequential Data Processing with RNN

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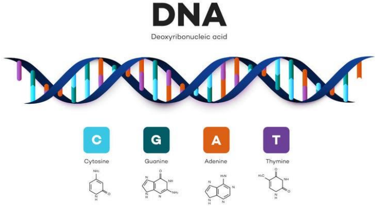
1. Introduction

- **Processing sequential data:**



- **Models on sequential data:**
    - **State Space Models:** By capturing the dynamics of neural populations over time we can explain the neural activity in ***a low-dimensional state space.***
    - **Latent Variable Models:** By inferring latent variables, we can explain ***the high-dimensional neural activity.***

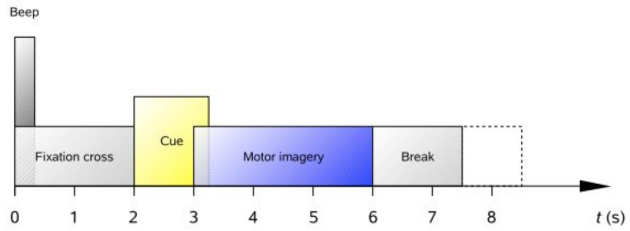
2. Research Question

- How activity in motor areas relates to the motor imagery of specific body movements and how that information is encoded in such activity?

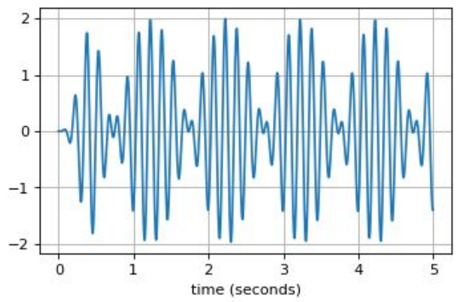
- Hypothesis: motor region’s activity for basic body movements are similar between subjects, so we could train the RNN with the data of multiple subjects and try to predict the labels of the last subject’s data.

3. Methods

- **BCI Graz data set**
  - Cued motor signal of 9 subjects
  - 25 channels (22 EEG + 3 EOG) of 250 Hz
  - Bandpass-filtered between 0.5 Hz and 100 Hz

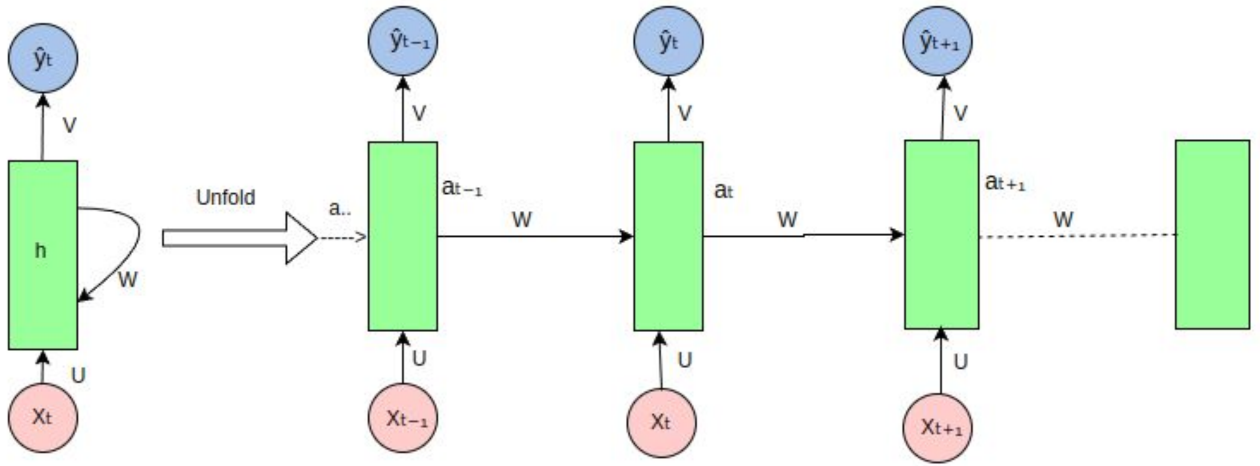


- **Preprocessing**
  - Bandpassing filters to flatten signals
    Strict to range with stable frequency response (4-40Hz)
  - 0.5 to 3.5s after cue given for L/R hand

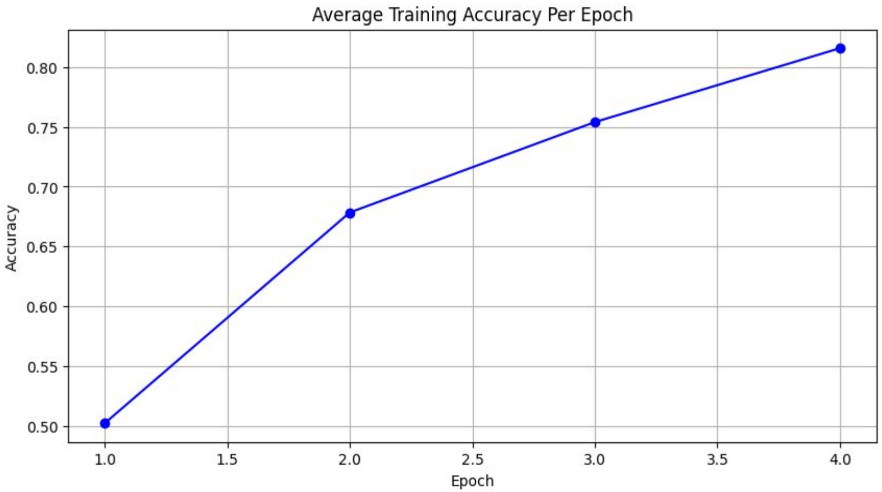


3. Methods

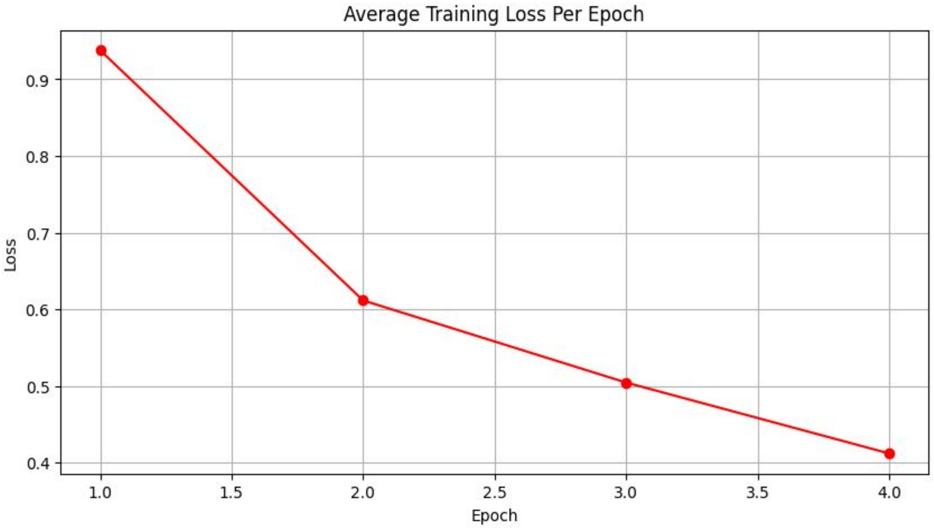
- **Model: RNN (& CNN)**
  - 80% data for training; rest for testing
  - 2 layers with 256 labels each
  - Regularization with dropout rate = 0.5
  -



4. RNN training

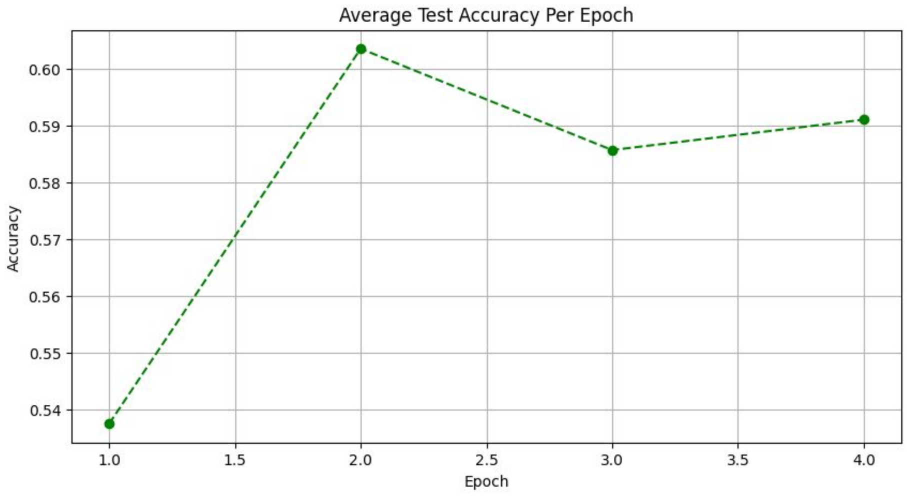


Accuracy across epochs

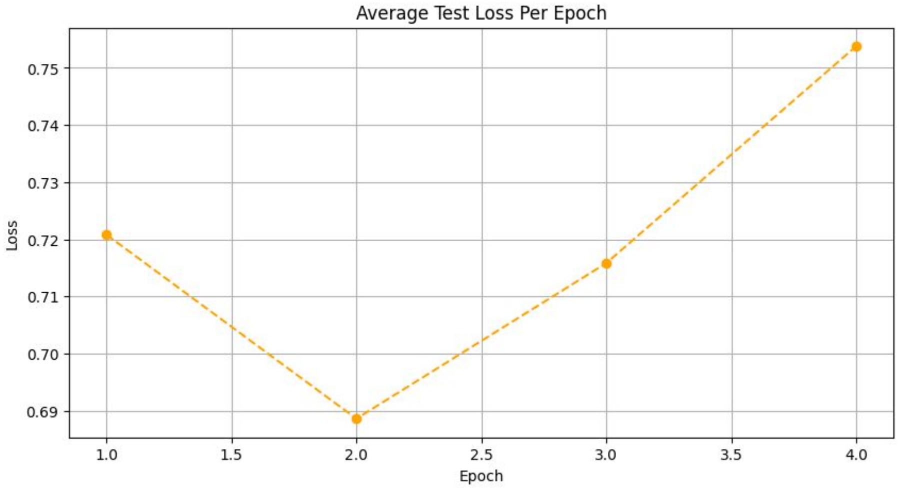


Loss across epochs

5. RNN test



Accuracy across epochs

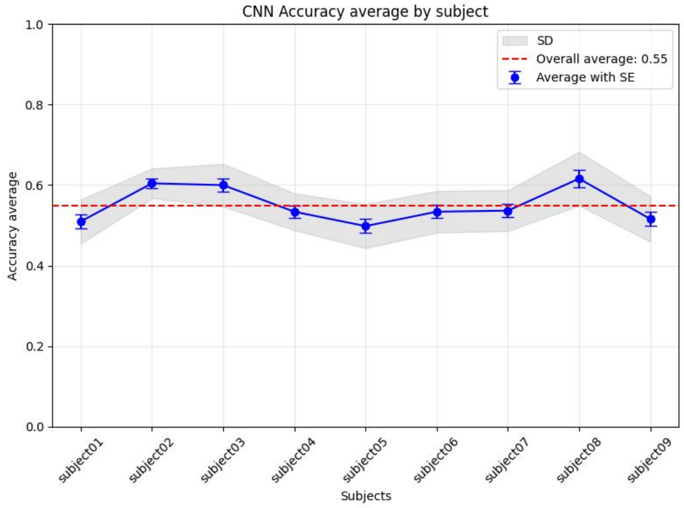


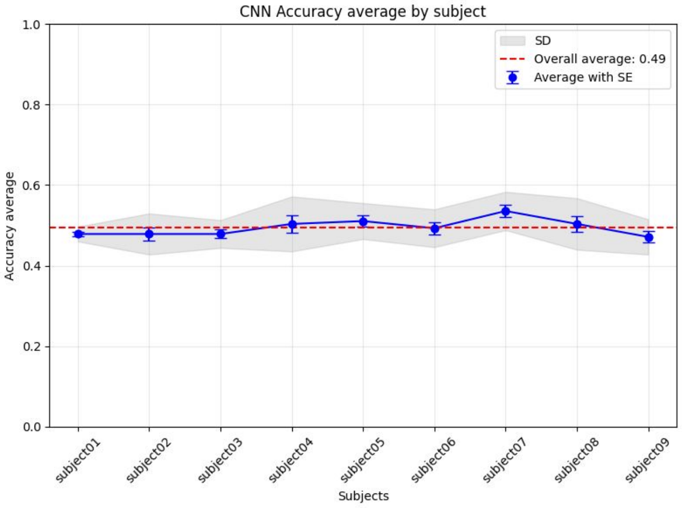
Loss across epochs

6. RNN vs CNN Performance

- The classification accuracy dropped with the grouped data
- To investigate the effects of individual differences, we plotted the accuracies across the subjects.

RNN VS. CNN





7. Generalization

- In this part, we want to know that we can use our trained model on unseen subject and compare the acc of model that trained only with that subject

Trained on 3 subjects and tested on 20% of 4th subject	Trained only on 80% data of 4th subjects and test it on rest of it
51.70% ± 2.4%	50.57% ± 2.6%

8. Generalization

- In this part we train each subject separately and getting avg of the result can compare it to the model which trained with all subjects together

Separate training and getting avg of their accuracy	All subject together
51.2% ± 1.4%	59.1% ± 6.8%

9. Conclusion

- Key results:
  - RNN can better classify the EEG data regarding different motor imagery
  - The necessity of preprocessing on EEG
  - Enhancement by hyperparameter tunings to process noisy data

- Implications of the study
  - The result can be a potential contribution in the field of BCI.

Thank you!

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- Table of Contents -

1. Introduction - Reyhane
2. Research Questions - Reyhane
3. Method - Zhiyuan
4. Result1 - Victor RNN VS CNN
5. Result2 - Victor
6. Result3 - Mohammad
7. Conclusion / Discussion - Amin