Brain Signal Prediction

Project Proposal – Group 69 – DD2424 Spring 2021

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We want to attempt to model/predict brain signals. We want to explore, given either the "raw" signal or a spectrogram of the signal, dependent on the length of input data, how far into the future we can give an accurate estimation of the continuation of that signal. For example;

- Given 2 seconds of raw activity, can we predict the following 1 second of activity?
- Given a 2 second spectrogram sample (for some appropriate sampling rate, Fourier transform window size), can we predict the next 1 second of that same spectrogram?

Two papers we found (with some overlapping authors) which explore this idea are *Kim et al*[1] and *Rangamani et al*[2].

We are not sure whether we will be focusing on LFP or EEG signals. If we have time, we might experiment with both. We intent to use LSTM-based networks mainly, but may explore alternative approaches; we may for example use CNNs on spectrogram data. We intend to use the cited papers as a baseline approach for architecture of our network, and explore possible variations and improvements from thereon.

There is plenty of publicly available data for our intents[3], and we have not yet decided on a specific data set to work with. We may want to investigate transferability of our results from one data set to another, but this is not a priority, in part due to the effects of various recording conditions for different data sets.

One novelty we are keeping in mind is preprocessing of data. For example, given spectrogram data, it may turn out that e.g. PCA is effective in reducing dimensionality and thus reducing computational load, which is of course desirable.

We will be using Tensorflow/Keras, as well as various common libraries (NumPy, matplotlib, Scikit Learn, pandas, etc.). We will write the full software implementation.

Our initial planned experiment will be to construct a LSTM-based network for prediction of the "raw" brain signal from a relatively long-time input, and try to predict a very short-time output, to investigate the initial viability of our model (and also in order to get software in place for extensions). We will shortly thereafter experiment similarly with spectrogram data.

Project success will be measured mainly by the performance of our best model(s), taking into account reconstruction error of that model, the breadth of input necessary for that model, and its' output range. We will compare our work with cited work as a measure of relative success.

Simon mainly want to learn working with the Tensorflow software package, and architectures for robust prediction, as well as getting some "hands on" experience with brain signals. Gustav is mainly interested in developing skills using LSTM and CNN networks, as well as better experience with time series analysis in general. Our initial target grade is C.

References

[1] "Predicting Local Field Potentials with Recurrent Neural Networks"
https://scholar.harvard.edu/files/awidge/files/07590824.pdf
[210412]
[2] "Modeling Local Field Potentials with Recurrent Neural Networks"
https://www.researchgate.net/profile/Amit_Sinha20/publication/292606043_Modeling_Local_Field_Potentials_with_Recurrent_Neural_Networks/links/56af888d08ae9f0ff7b262e6/Modeling-Local-Field-Potentials-with-Recurrent-Neural-Networks.pdf
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