Title: Communication Theoretic Analysis of Brain Cortical Circuits

Aims/Objectives

The project aims to develop an efficient and robust Machine Learning model. Robust in terms of functionality, for example to capture the topology of the cortex of a certain individual. This can be achieved by having a limited number of electrodes in a brain machine interface.

Why? Well the next generation of brain machine interfaces or even brain simulation devices require a feedback loop. Why Machine Learning? Machine Learning would be important to infer the state of the tissue or what is the topology of the tissue. To achieve this, we need a general model – a Machine Learning model to predict as much information as possible.

Part of the problem is designing a training set for the machine learning model. NEURON simulator plays an important role in designing this training set. There exist many adjustable variables in a system. However, in machine learning the size and order of the training set are key pieces in getting the correct outcome.

Summary of Project Aims

- Create a training set using NEURON simulator. The variables can be adjusted to observe the difference when applying different criteria.
- Test and validate this training set using RapidMiner, a Machine Learning tool. The outcome will be a misclassification error – whether RapidMiner could correctly infer some properties such as the network topology and the condition of the tissue.

Methodology

The proposed methodology involves using two tools: NEURON simulator and RapidMiner. Details about the functionality of these tools are described below:

NEURON simulator

NEURON simulator provides the label set. The label set consists of simulated neurons and their generated outputs. A neuron sends a lot of spikes and a spike train is created. The location of the spikes would be known as they would be the interface to the device. Other variables include:

- Morphology of the neuron.
- Number of terminals.
- The size and volume of the terminals.

The generated data through the simulated neuron gives us the label set which is then fed to RapidMiner.

RapidMiner

The label set is obtained from the NEURON simulator. To estimate the statistical performance of a learning model and to estimate how accurately a model will perform in practice, a Cross Validation technique will be used. RapidMiner divides this into two sub-processes:

- Training: Create a synthetic set of neurons model where the topology is known. Parameters include: Hidden Layers, Training Cycles, Learning rate, Momentum and Decay. These parameters are not fixed and their values can be adjusted.
- Testing: Random models could be created to generate real measures. These generated measures can be used to check whether the training model can correctly infer them.

Expected Results

The performance of the Machine Learning model can be analysed. Misclassification rates, accuracy and precision can be measured.