

Decoding Neural Activity Representing Continuous-State Processes

Prerequisites:

- 044202 – Random signals (solid background in random signals is essential).
- 046326 – Introduction to biological signals and systems.
- Experience with MATLAB programming.

Introduction

Neurons in the brain constantly communicate and transmit information between each other in order to represent information about the world. It is widely accepted that information is transmitted by sequences of action potentials (rapid impulses) called 'spike trains'. The mathematical model for representing spike trains is that of 'point processes' (e.g. Poisson processes). The study of neural decoding focuses on how to read the information represented by neural activity. Recent efforts in neural computation aim at establishing the link between neural decoding and the well established mathematical framework of point process filtering. Most of the results to date assume either that the world is static, or can change between a finite number of states. As the world is not finite (or even discrete) by nature, we would like to investigate how neural systems can handle information on continuous-state processes.

Project Description

The mathematical tools for decoding continuous-state information from neural data are well developed. The main goal of this project will be to examine the decoding capabilities of this theoretical framework. The first stage of the project will be to study these tools, and establish a simulation environment implementing them in a neural context. Once this is done, the biological setting introduces possible extensions, and the students will examine a few of them (and are welcome to come up with their own ideas). Examples for such extensions are - tracking two or more states simultaneously, multisensory integration (e.g. combining visual and auditory information), noise reduction, and more. The heart of the project will be designing and writing MATLAB simulations, and investigating the results from the biological point of view. However, there is also plenty of room for new ideas for both the mathematical aspects and the biological ones.

Project Requirements

- Becoming familiar with the mathematical field of point process filtering.
- Establishing a simulation environment for the continuous-state neural decoding scheme.
- Designing simulation setups and analyzing their results.
- Examining possible extensions of the existing framework.

Project Duration

One semester

Contact

Omer Bobrowski, 04-8294697, bober@tx.technion.ac.il