Adaptive Signal Processing by Biological Neural Networks

Prerequisites:

- 044202 – Random signals
- 046326 – Introduction to biological signals and systems
- Programming experience in Matlab software

Introduction:

The nervous system can accurately estimate the state of the environment based on sensory signals (e.g., visual, auditory, somatosensory), despite the fact that external stimuli are noisy and partial. External events are transformed into stochastic neural processes (spike trains) that are subject to physiological constraints. One of the intriguing features of early sensory processing is neural adaptation, whereby the system changes its attributes in response to environmental input. An intriguing question is whether such adaptation is a 'bug or a feature'.

Project Description:

The goal of the project is to characterize the effect of neural adaptation on the quality of state estimation, to search for optimal neural adaptation mechanisms and find their relationship to the statistical nature of the environment. The underlying theoretical framework is that of optimal real-time point process filtering (based on a recently developed mathematical framework). The analyses will be carried out by means of computer simulations, which may be extended by mathematical analysis.

Project Requirements:

- Getting acquainted with the basics of point process filtering
- Designing a setup for the computer simulations
- Analyzing the effects of adaptation and its dependence on environmental parameters

Project Duration:

One semester

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