Good Noise in Neural Computation

Thursday, Jun 21: 8:00 AM - 9:15 AM
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Symposium
Thursday - Symposia AM

New theories on power consumption and energy efficiency in the human brain suggest that noise is an essential part of neural computation. By filtering out noise from our data, we may be missing essential information related to both the healthy brain and in disease (e.g., epileptic seizures). Stochastic facilitation theory has played an important role in improving understanding of signal transmission in other domains, but has yet to be fully appreciated by the neuroimaging community. Here we will discuss the importance of understanding and modeling noise in our data across conventional data analysis techniques as well as in decoding models.

Objective

1.) Understand the importance of noise in healthy neural computation and disease.
2.) Learn the core principles of stochastic facilitation.
3.) Appreciate reasons why modeling noise is beneficial in encoding and decoding studies.

Target Audience

Our target audience are researchers in neuroimaging who have an interest in improving both encoding and decoding studies by modeling noise and inter-indvidual variations thereof in our data analyses. We feel that this workshop is important for the community as it is time to bridge key theories of neural computation with what we have learned from cognitive neuroscience.

Co Organizer(s)

Andrew Doyle, Montreal Neurological Institute
Biswa Sengupta, University of Cambridge

Organizer

Pamela Douglas, UCF/UCLA

Presentations

Good Noise in the Human Brain (index.cfm?do=ev.viewEv&ev=1700)

Contrary to the old theorem that “noise never helps,” additive noise can provide a mechanism for inferring the presence of otherwise sub-threshold signals. Noise can provide a frequency landscape with which weak periodic signals can resonate. This ‘stochastic resonance’ phenomenon has been studied for decades in the statistical physics community, and the facilitative properties of ‘good’ noise in neural systems have now been observed empirically across many levels of abstraction throughout the brain. This talk will review recent evidence for stochastic facilitation across a variety of neuroimaging modalities (e.g., EEG, fMRI).

Presenter

Pamela Douglas, UCF/UCLA

Power Consumption in Neural Computation During Seizures (index.cfm?do=ev.viewEv&ev=1701)

Maintaining the ability of the nervous system to perceive, remember, process, and react to the outside world requires a continuous energy supply. Yet the overall power consumption of the human brain is remarkably low, which has

inspired engineers to mimic nervous systems in designing artificial cochlea, retinal implants, and brain–computer interfaces (BCIs) to improve the quality of life in patients. We examine the energy constraints of neuronal signaling within biology, and how these are altered during inter-ictal EEG measurements in patients with epilepsy.

Presenter

Biswa Sengupta, University of Cambridge

The Importance of Noise in Decoding Models (index.cfm?do=ev.viewEv&ev=1702)

Noise features are typically considered to be deleterious in decoding studies, as they corrupt our ability to interpret the importance of feature weights that give rise to predictive accuracies. However, including noise features (e.g., voxel time series in the CSF) often improve classification accuracies – even in studies where the features are themselves independent (e.g., ICA features). Here, we will examine why noise features are beneficial both in conventional linear decoding models (e.g., MVPA), as well as in nonlinear decoding approaches including artificial neural networks.

Presenter

Andrew Doyle, Montreal Neurological Institute

Modeling Noise and Individual Variation (index.cfm?do=ev.viewEv&ev=1703)

Brain imaging datasets are now reaching sizes where using deep learning approaches become useful. While the practical reality of DNNs is that larger data sizes help, the fundamental concepts are still about capturing variation, whether in individuals, scanners, or imaging protocols. This talk will highlight how variation is individual brains and software processing can be leveraged to create robust networks for research and clinical use. Specific examples will focus on improving brain and tumor segmentation.

Presenter

Satrajit Ghosh, Massachusetts Institute of Technology