CASE STUDY

NIMBioS Working Group: Multi-Scale Analysis of Cortical Networks

Overview

IBM Research and the Mt. Sinai School of Medicine partnered with NIMBioS to create a Working Group on Multi-scale Analysis of Cortical Networks in order to better understand the brain from a network function perspective. A. Ravishankar Rao (Biometaphorical Computing, IBM Research) and Ehud Kaplan (Mt. Sinai School of Medicine) along with 11 other individuals from a wide range of backgrounds, including mathematical physics, computer science and neuroscience, gathered for two three-day onsite meetings at NIMBioS in 2010 and 2011.

"We would not have been able to create the output or impact if it weren't for the ideas generated during our Working Group. Though our work was spread over two years, the intensity and focus during these sessions ensured that we would create an immediate and tangible output."
-A. Ravishanakar Rao, IBM

Problem

How can statistical network theory be used as a unifying mathematical model to enable the analysis of neuroscientific data across multiple levels of abstraction, from single neuron to whole brain? Can functional network features be used as bio-markers to assess brain state? Answers may prove useful in distinguishing diseased brains from normal ones, such as in the case of Alzheimer's. The experimentalists provided detailed reports of recording techniques and neural behavior across multiple brain areas at different levels of abstraction. Mechanisms for coding and generation of stimulus responses were examined. The theoreticians and computational modelers presented models of cortical function where the interactions between neural units were determined by properties of the networks connecting these units. Techniques for the computation of causal relationships from multivariate neural data were discussed, as were dynamics of a network of interconnected neurons.

Outcomes

- A novel aspect that emerged from the presentations of the experimentalists is that the representation of the external world in the brain may not be as highly compartmentalized into specific functional areas as is widely thought. Rather, representations are distributed widely across the brain.
- The main finding from theoreticians in the Group is that the structure and evolution of the network determine its function.

For more information, see Special Topics Issue of Frontiers in Neural Circuits: "Towards an Integrated Approach to Measurement, Analysis and Modeling of Cortical Networks." 20 October 2015. doi: 10.3389/fncir.2015.00061
www.nimbios.org/cortical

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