Inference and prediction in neocortical circuits

organized by
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Workshop Summary

This report summarizes the proceedings and outcome of the workshop, Inference and Prediction in Neocortical Circuits, which was held at the American Institute of Mathematics (AIM), September 21-24, 2003. The conference was jointly sponsored by AIM and the Redwood Neuroscience Institute (RNI).

Goal:

Inferential processes are central to perception, and prediction is necessary to the survival of any organism, but how these things are performed by neural circuits in the brain is not at all clear. The purpose of this workshop was to bring together mathematicians, statisticians, computer scientists, neuroscientists and psychologists to discuss and develop models for how this might be done.

Organization:

There were 12 speakers invited to the workshop and approximately 28 additional participants (one of the speakers had to cancel at the last minute). Talks by the invited speakers were spread out over the first three days, with approximately 2 hours devoted to discussion on each day. The last day was devoted entirely to short, impromptu talks by the participants, recaps by the invited speakers, and general discussion. The backgrounds of the speakers and participants fell roughly into three different categories: neurophysiology, psychophysics, and theory (computational models).

Content:

Both inference and prediction are statistical problems that would benefit from building a probabilistic model of the environment, and many of the theory talks focused upon this theme (Kersten, Friston, de Sa, Ballard, Lee). Others focused on the dynamical properties of recurrent networks in the cortex and how they could facilitate processes such as filling-in (Grossberg, Li). Neurophysiologists presented data on the anatomical substrates that subserve cortical computation and could be used for top-down prediction (Angelucci, Hirsch), or neural response properties that demonstrate inferential processes at work (von der Heydt, Lee). Psychologists presented psychophysical data demonstrating the types of inferences performed by the brain in visual perception (Kersten, Nakayama). Perhaps the most successful activity of the workshop were the break-out sessions in which each group (neurophysiology, psychophysics, or theory) assembled privately to pose questions or challenges to the other groups. In the first break-out session, each group was asked to come up with a list of things the other two groups could do for them. In the second session, each group was given the chance to respond or to answer questions posed by the other groups. The ensuing dialog was extremely productive and got theorists and experimentalists seriously immersed in each others worlds and genuinely talking to each other. This has traditionally been a problem,

because each comes from different cultures/educational backgrounds with different views and priorities about how to attack the problem of understanding the brain. So the workshop succeeded at penetrating this barrier.

Outcome:

There was a high degree of interchange of ideas at this workshop, and although we are not yet aware of specific collaborations that have resulted from it, clearly the seeds were planted. For example, one participant - Bin Yu, a mathematician/statistician at UC Berkeley - has indicated an interest in re-orienting her own research towards the issues discussed at the workshop, and specifically in working with scientists at RNI on these problems. Overall, the feedback received from participants was extremely positive. We would look forward to conducting a workshop like this again with AIM in the future.