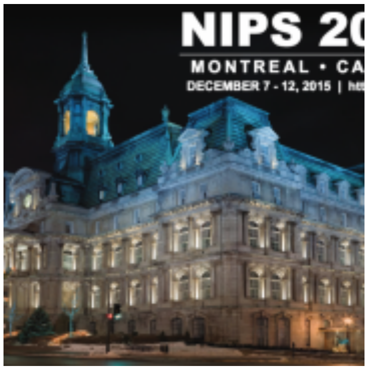
Neural Information Processing Systems (NIPS) 2015 Review

By Gabriel Kreiman January 19, 2016



The charming city of Montreal hosted more than 4000 researchers from all over the globe during the Neural Information Processing Systems (NIPS) conference. In addition to the notable exponential growth in the number of attendees, a novel highlight this year was the addition of a Symposium format. The Brain, Minds and Machines Symposium aimed to discuss the relationship between biological hardware and how to understand the fundamental computations that give rise to intelligence.

In a room packed with circa 600 researchers, Prof. Poggio energetically started the conversation: “By developing the science of intelligence today”, his motto emphatically claimed, “we will lead the engineering efforts of tomorrow and the development of true AI systems”. One of the fathers of the field, Poggio navigated through the history of AI research, the challenges and stumbling blocks along the way, and lucidly articulated the path and opportunities ahead. In a bottom-up fashion, Koch and Kreiman continued by describing recent progress in Neuroscience and the marvelous set of new tools that provide unprecedented resolution to investigate how neural circuits compute. Koch described the efforts to map the anatomical connections in the mouse visual system and also to interrogate the activity of large ensembles of neurons. Up until now, we only had detailed circuit information for small nervous systems such as the one of the *C. elegans* worm. Novel technologies are beginning to describe the connections in cortex in a large way. This provides a tremendous opportunity to attempt to derive computational models from this biological knowledge. At the same time, novel tools developed by people like Ed Boyden at MIT enable turning on and off specific neuronal types within those circuits and thus open the doors to causally test the predictions from those models.

Bridging across multiple scales, Kreiman provided a series of examples illustrating how it is possible to write algorithms and translate biological codes into computational codes in the context of understanding the computations afforded by recurrent and feedback connections during visual recognition.

While ad-hoc tricks and maneuvers can push performance in restricted domains and under circumscribed computational experiments, ultimately, we need a solid theoretical foundation to build upon. The emphasis on science and a solid theoretical framework described by Poggio, was nicely illustrated by the work of Saxe and Ganguli. For example, in the context of deep linear networks, they showed how analytical solutions to the learning problem can both significantly deepen our understanding of how convolutional networks operate and also can aid develop a principal approach to create adequate practical algorithms. They were even kind enough to show that their analysis holds under simulations when relaxing some of the linearity requirements.

Hassabis gave a fascinating presentation that embodied the spirit of the symposium. A man of many hats, his work takes inspiration from neurophysiological experiments, using those biological insights to teach computers how to solve a number of natural tasks such as playing video games. This work provides a concrete link to how AI systems can tackle real-world behavioral problems. The importance of respecting behavioral constraints is nowhere better illustrated than in the animated presentation by Tenenbaum. He emphasized how building generative models can provide sophisticated descriptions and solutions to problems that are at the heart of common sense and quite challenging for computational approaches. His models teach computers how to learn novel shapes from a few examples or even how to begin to elucidate basic physical principles from observation.

The completely full room joined in for the panel discussion, with the addition of two talented scholars in the field, Marcus and Sejnowski. The broad set of questions highlighted the enthusiasm, challenges, opportunities and range of approaches and ideas in the field. How can understanding biology lead to better AI? Is every problem that computers can solve successfully automatically labeled as not requiring intelligence? Are enormous computational power and massive supervised data sets an essential ingredient of AI for the foreseeable future? How can we better use behavioral constraints to speed up the development of AI?

Advances in AI have been cyclical, with enthusiasm waxing and waning multiple times throughout the twentieth century. But now AI is here to stay. The conjunction of tremendous growth in Neuroscience, tools to rapidly collect behavioral data in Cognitive Science, rigorous advancement in Mathematics, accessibility to large computational resources to rapidly evaluate new ideas and synergistic enthusiasm in Industry, Government and Academia, make this an idyllic moment in time to join forces to solve AI. The intersection of Brains, Minds and Machines advocated in the Symposium may pave the way to one of the greatest if not the greatest revolution in Science.