LEARNING IN MACHINES & BRAINS

Aims to contribute to the understanding of the computational and mathematical principles that enable intelligence through learning, be it in brains or in machines.

The program in Learning in Machines & Brains (formerly Neural Computation & Adaptive Perception) advanced one of its core research directions, deep learning, by making it the central theme of its annual program meeting in December 2016. This choice reflected a strong surge of interest within the program and the machine learning community at large, driven by a rapid series of outstanding successes in recent years that have seen deep learning embraced by global information companies like Google and Facebook, and the placement of CIFAR fellows at their research helms.

The program meeting took place in Montreal during the two days preceding the annual Neural Information Processing Systems (NIPS) conference, the premier venue for the presentation of research in machine learning and neural networks. As in most years, the program used this strategic timing to leverage the attendance of many of the world's leading researchers at both events. Program Co-Directors **Yoshua Bengio** and **Yann LeCun** subsequently drew a record audience of about 2,000 at a NIPS tutorial on deep learning.

The program meeting was supported in partnership with the Brain Canada Foundation and Inria, through multi-year agreements.

From its early days, the program has convened an annual summer school for its fellows' graduate and postdoctoral trainees. Student organizers invite CIFAR fellows and other distinguished researchers to lecture on cutting-edge topics not yet covered in the regular university curricula. In 2015/2016, the program opened its doors to host the largest-ever summer school in deep learning, attracting participants from around the world, coming from both academia and industry.

Research

- Senior Fellow **Nando de Freitas** (University of Oxford) collaborated with Google DeepMind intern Scott Reed to propose the 'neural programmer-interpreter': a recurrent and compositional neural network that learns to represent and execute programs. Inspired by CIFAR Advisor **Geoffrey Hinton**'s (University of Toronto & Google) work on programmable neural networks, they investigated a way to build agents that learn with fewer data, learn new programs incrementally and can transfer knowledge to new domains. This research earned the Best Paper Award at the 2016 International Conference on Learning Representations.
  > Reed S, **de Freitas N**. 2016. Neural Programmer-Interpreters. ICLR 2016.

- Fellows **Hugo Larochelle** (Université de Sherbrooke) and **Aaron Courville** (Université de Montréal) developed a new approach that uses significantly fewer computations to train neural networks to recognize objects in images, while maintaining a state-of-the-art performance level. This work provides a step toward making the training of large, high-performance neural networks achievable in research labs and industry that lack extensive computational resources. The team credits its inspiration to research in attention mechanisms in neural networks, developed in the program.
  > Almahairi A, Ballas N, Cooijmans T, Zheng Y, **Larochelle H**, **Courville A**. 2016. Dynamic Capacity Networks. ICML 2016.

- Statistical inference and learning are increasingly used to render automated decisions, ranging from targeted advertising to the issuing of bank loans. Fellows **Richard Zemel** (University of Toronto) and **Max Welling** (University of Amsterdam) developed computational methods aimed at producing fair decisions that are not unduly biased for or against specific subgroups in the population. They developed formulations of fairness as an optimization problem with two competing goals: to encode data as well as possible, while obfuscating any information about membership in a specific group.
  > Louizos C, Li Y, Swersky K, **Welling M**, **Zemel RS**. 2016. The variational fair autoencoder. ICLR 2016.

IdeasExchange

- In May 2016, CIFAR partnered with RBC to present a moderated panel discussion in Toronto featuring Senior Fellow **Brendan Frey** (University of Toronto) and other participants from the investment and technology sectors to explore how artificial intelligence may disrupt the financial industry in future years. Over 500 individuals attended, in addition to a global audience reached by WebEx broadcast.

Global Academy

- The program held the largest deep learning summer school ever organized. Conducted over ten days in August 2015 at the Université de Montréal, it attracted more than 150 graduate students and postdoctoral fellows from universities and research institutes in 16 countries and from 18 global companies, including Samsung, Google and Amazon.com. The event was co-organized by program fellows **Yoshua Bengio** and **Roland Memisevic** (both Université de Montréal) and included numerous other fellows as lecturers.

To learn more: **https://www.cifar.ca/research/ learning-in-machine-and-brains/**

Senior Fellow Joëlle Pineau presents at the December 2015 meeting of CIFAR's program in Learning in Machines & Brains.