TYPE - KEYNOTE • JULY 18 • SATURDAY

K Keynote

JULY 18 • SATURDAY

3:00pm – 4:00pm K **K1: Deep reinforcement learning and its neuroscientific implications** Crowdcast (link TBA)

Speakers: Matthew Botvinick

Matthew Botvinick

The last few years have seen some dramatic developments in artificial intelligence research. What implications might these have for neuroscience? Investigations of this question have, to date, focused largely on deep neural networks trained using supervised learning, in tasks such as image classification. However, there is another area of recent AI work which has so far received less attention from neuroscientists, but which may have more profound neuroscientific implications: Deep reinforcement learning. Deep RL offers a rich framework for studying the interplay among learning, representation and decision-making, offering to the brain sciences a new set of research tools and a wide range of novel hypotheses. I'll provide a high level introduction to deep RL, discuss some recent neuroscience-oriented investigations from my group at DeepMind, and survey some wider implications for research on brain and behavior.

JULY 19 • SUNDAY

3:00pm – 4:00pm K **K2: A new computational framework for understanding vision in our brain** Crowdcast (link TBA)

Speakers: Zhaoping Li

Zhaoping Li

Visual attention selects only a tiny fraction of visual input information for further processing. Selection starts in the primary visual cortex (V1), which creates a bottom-up saliency map to guide the fovea to selected visual locations via gaze shifts. This motivates a new framework that views vision as consisting of encoding, selection, and decoding stages, placing selection on center stage. It suggests a massive loss of non-selected information from V1 downstream along the visual pathway. Hence, feedback from downstream visual cortical areas to V1 for better decoding (recognition), through analysis-by- synthesis, should query for additional information and be mainly directed at the foveal region. Accordingly, non-foveal vision is not only poorer in spatial resolution, but also more susceptible to many illusions.

JULY 20 • MONDAY

3:00pm – 4:00pm K **K3: Information and Decision-Making** Crowdcast (link TBA)

Speakers: Daniel Polani

Daniel Polani

In recent years it has become increasingly clear that (Shannon) information is a central resource for organisms, akin in importance to energy. Any decision that an organism or a subsystem of an organism takes involves the acquisition, selection, and processing of information and ultimately its concentration and enaction. It is the consequences of this balance that will occupy us in this talk. This perception-action loop picture of an agent's life cycle is well established and expounded especially in the context of Fuster's sensorimotor hierarchies. Nevertheless, the information-theoretic perspective drastically expands the potential and predictive power of the perception-action loop perspective. On the one hand information can be treated - to a significant extent - as a resource that is being sought and utilized by an organism. On the other hand, unlike energy, information is not additive. The intrinsic structure and dynamics of information can be exceedingly complex and subtle; in the last two decades one has discovered that Shannon information possesses a rich and nontrivial intrinsic structure that must be taken into account when informational contributions, information flow or causal interactions of processes are investigated, whether in the brain or in other complex processes. In addition, strong parallels between information and control theory have emerged. This parallelism between the theories allows one to obtain unexpected insights into the nature and properties of the perception-action loop. Through the lens of information theory, one can not only come up with novel hypotheses about necessary conditions for the organization of information processing in a brain, but also with constructive conjectures and predictions about what behaviours, brain structure and dynamics and even evolutionary pressures one can expect to operate on biological organisms, induced purely by informational considerations.

JULY 21 • TUESDAY

7:00am – 8:00am

K **K4: Computational models of neural development**

Crowdcast (link TBA)

Speakers: Geoffrey J. Goodhill

Geoffrey J. Goodhill

Unlike even the most sophisticated current forms of artificial intelligence, developing biological organisms must build their neural hardware from scratch. Furthermore they must start to evade predators and find food before this construction process is complete. I will discuss an interdisciplinary program of mathematical and experimental work which addresses some of the computational principles underlying neural development. This includes (i) how growing axons navigate to their targets by detecting and responding to molecular cues in their environment, (ii) the formation of maps in the visual cortex and how these are influenced by visual experience, and (iii) how patterns of neural activity in the zebrafish brain develop to facilitate precisely targeted hunting behaviour. Together this work contributes to our understanding of both normal neural development and the etiology of neurodevelopmental disorders.