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Conférence Statistique

16h30 – 17h15

Learning and Inference in the Brain

By formulating the original ideas of Helmholtz on perception, in terms of modern-day theories, one arrives at a model of perceptual inference and learning that can explain a remarkable range of neurobiological facts.
Using constructs from statistical physics, machine learning and probability theory the problems of inferring the causes of sensory input and learning the causal structure of their generation can be resolved using exactly the same principles. Furthermore, inference and learning can proceed in a biologically plausible fashion. The ensuing scheme rests on Empirical Bayes and hierarchical models of how sensory input is caused. The use of hierarchical models enables the brain to construct prior expectations in a dynamic and context-sensitive fashion. This scheme provides a principled way to understand many aspects of cortical organisation and responses.

In terms of cortical architectures, it predicts that sensory cortices should be arranged hierarchically, that connections should be reciprocal, and that forward and backward connections should show a functional asymmetry (backward connections are both modulatory and driving, whereas forward connections need only be driving). In terms of synaptic physiology it predicts associative plasticity and, for dynamic models, spike-timing-dependent plasticity. In terms of electrophysiology it accounts for classical and extra-classical receptive field effects and long-latency or endogenous components of evoked cortical responses. It predicts the attenuation of responses encoding prediction error with perceptual learning and explains many phenomena like repetition suppression, mismatch negativity (MMN) and the P300 in electroencephalography. In psychophysical terms, it accounts for the behavioural correlates of these physiological phenomena, e.g. priming, and global precedence. The final focus of this presentation is on perceptual learning as measured with the MMN and the implications for empirical studies of coupling among cortical areas.

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