ATTRACTORS IN SONG

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This paper summarizes our recent attempts to integrate action and perception within a single optimization framework. We start with a statistical formulation of Helmholtz's ideas about neural energy to furnish a model of perceptual inference and learning that can explain a remarkable range of neurobiological facts. Using constructs from statistical physics it can be shown that the problems of inferring the causes of our sensory inputs and learning regularities in the sensorium 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 information is generated. 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 the brain's organization and responses. We will demonstrate the brain-like dynamics that this scheme entails by using models of birdsongs that are based on chaotic attractors with autonomous dynamics. This provides a nice example of how non-linear dynamics can be exploited by the brain to represent and predict dynamics in the environment.

Keywords: Generative models; predictive coding; hierarchical; dynamic; non-linear; variational; birdsong