Using Markov Decision Processes to Model Planning in Novel Environments

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Presentation Abstract Summary Goal-directed behavior rests on being able to rapidly evaluate the potential consequences of future actions, even in situations we have never previously encountered. For example, consider the neuronal processing required for planning a new route home when a road you normally take is closed. We introduce a formulation of this type of planning using Markov decision processes (MDPs). We offer both normative and process theories for planning and navigating in novel environments – using simulations of participants performing a maze task. Our objective is not to find an optimal solution, but to develop a model of how the problem could be solved in a neurobiologically plausible and efficient fashion. We compare different models in terms of their ability to explain empirical responses; i.e., reaction times, saccadic eye movements, and neurophysiological responses. To accomplish this, we focus on a minimal model of nontrivial planning that involves visual navigating a maze from a start location to a goal location. Crucially, we consider this problem under uncertainty about the maze – thereby requiring the subject to visually explore the maze and then use this information to navigate to a goal. We also illustrate model predictions, using simulated behavioral and electrophysiological responses.

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