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Assessing Science Inquiry using MDP Goal Detectors

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Abstract: Complex cognitive tasks, such as science inquiry, often involve a sequence of goals, each of which is pursued through a sequence of actions. Effective assessment of inquiry performance requires identification of these student goals. Markov decision processes (MDPs) have been used to infer goals and beliefs over a single directed sequence of actions (Baker et al., 2009), but multi-goal complex systems are computationally prohibitive to model. This research investigates the use of targeted MDPs as goal detectors, embedded within a larger hidden Markov model (HMM) that accounts for the transition between goals. This multi-layer approach allows the MDP state spaces to remain small while modeling complex cognition. Because canonical HMM estimation is complicated by the dynamic nature of MDPs, in which action probabilities depend on context, we explore several different estimation methods. The approach is applied to log-file data of test-taker interactions with a simulation-based science inquiry assessment.