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Modeling Search Behaviors during the Acquisition of Expertise in a Sequential Decision-Making Task

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Our daily interaction with the world is plagued of situations in which we develop expertise through self-motivated repetition of the same task. In many of these interactions, and especially when dealing with computer and machine interfaces, we must deal with sequences of decisions and actions. For instance, when drawing cash from an ATM machine, choices are presented in a step-by-step fashion and a specific sequence of choices must be performed in order to produce the expected outcome. But, as we become experts in the use of such interfaces, is it possible to identify specific search and learning strategies? And if so, can we use this information to predict future actions? In addition to better understanding the cognitive processes underlying sequential decision making, this could allow building adaptive interfaces that can facilitate interaction at different moments of the learning curve. Here we tackle the question of modeling sequential decision-making behavior in a simple human-computer interface that instantiates a 4-level binary decision tree (BDT) task. We record behavioral data from voluntary participants while they attempt to solve the task. Using a Hidden Markov Model-based approach that capitalizes on the hierarchical structure of behavior, we then model their performance during the interaction. Our results show that partitioning the problem space into a small set of hierarchically related stereotyped strategies can potentially capture a host of individual decision making policies. This allows us to follow how participants learn and develop expertise in the use of the interface. Moreover, using a Mixture of Experts based on these stereotyped strategies, the model is able to predict the behavior of participants that master the task.

Keywords: sequential decision-making, Hidden Markov Models, expertise acquisition, behavioral modeling, search strategies

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1. INTRODUCTION

Whether you are preparing breakfast or choosing a web link to click on, decision making processes in daily life usually involve sequences of actions that are highly dependent on prior experience. Consider what happens when you interact with an ATM machine: you have to go through a series of specific button presses (i.e., actions) that depend on whether you are interested in, for instance, drawing money or consulting your account balance (i.e., the outcome). Despite some