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

Authors : Cristóbal Moënne-Loccoz, Rodrigo C. Vergara, Vladimir López, Domingo Mery, Diego Cosmelli

Abstract : Our daily interaction with computational interfaces is plagued of situations in which we go from inexperienced users to experts through self-motivated exploration of the same task. In many of these interactions, we must learn to find our way through a sequence of decisions and actions before obtaining the desired result. For instance, when drawing cash from an ATM machine, choices are presented in a step-by-step fashion so that a specific sequence of actions must be performed in order to produce the expected outcome. But, as they become experts in the use of such interfaces, do users adopt specific search and learning strategies? Moreover, if so, can we use this information to follow the process of expertise development and, eventually, predict future actions? This would be a critical step towards building truly adaptive interfaces that can facilitate interaction at different moments of the learning curve. Furthermore, it could provide a window into potential mechanisms underlying decision-making behavior in real world scenarios. Here we tackle this question using a simple game interface that instantiates a 4-level binary decision tree (BDT) sequential decision-making task. Participants have to explore the interface and discover an underlying concept-icon mapping in order to complete the game. We develop a Hidden Markov Model (HMM)-based approach whereby a set of stereotyped, hierarchically related search behaviors act as hidden states. Using this model, we are able to track the decision-making process as participants explore, learn and develop expertise in the use of the interface. Our results show that partitioning the problem space into such stereotyped strategies is sufficient to capture a host of exploratory and learning behaviors. Moreover, using the modular architecture of stereotyped strategies as a Mixture of Experts, we are able to simultaneously ask the experts about the user's most probable future actions. We show that for those participants that learn the task, it becomes possible to predict their next decision, above chance, approximately halfway through the game. Our long-term goal is, on the basis of a better understanding of real-world decision-making processes, to inform the construction of interfaces that can establish dynamic conversations with their users in order to facilitate the development of expertise.

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