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Towards Including Simple Emotions in a Cognitive Architecture in Order to Better Fit Children's Behavior

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Introduction

Emotions are an important aspect of human behavior that should be included in cognitive models. Including them in a cognitive architecture is the safest way to ensure consistency, and to get reuse. We demonstrate here how interest, distress, and pleasure, three primary emotions shown by children when problem solving, can be implemented in a specific ACT-R (Anderson & Lebiere, 1998) model. These emotions can be initially implemented by modifying some of the ACT-R problem solving mechanisms and our reusable model of vision.

While emotions can be a result of information and knowledge processing, they are not purely cognitive processes. They may result in bodily changes (hormones etc.) that influence behavior, perception and decision making. Our task is to implement a simple theory of emotions into the ACT-R cognitive architecture and test it on an existing model of human behavior.

The Task and the Model

The model is a simulation of Tower of Nottingham problem (Wood & Middleton, 1975), which consists of several blocks of different shapes and sizes that have to be assembled to form a pyramid. The ACT-R model can interact with a simulation of the blocks through the Nottingham eye and hands model. The model predicts well how adults solve the puzzle. The model is accurate enough to test theories of development (Jones & Ritter, 1998) through varying parameters of the model (working memory, Expected Gain Noise, etc.). While there is good match to most of the data, there is still is room for improving the model's fit to some of the children's data (e.g., time per layer, errors per layer, strategies used). Providing this model with emotions could improve that fit, as emotions seem to play a greater role in children problem solving, particularly in this task.

The Architectural Changes

We consider three basic emotions: interest, distress, and pleasure. These emotions can be initially implemented relating interest to the goal value variable in ACT-R and by introducing two new variables representing amounts of two synthetic hormones, each produced by "positive" or "negative" emotions. The amounts will decay over time. The goal value will also decay over time and may depend on the amount of hormones. This will allow the model to abandon tasks after some time, when its interest decreases and no reinforcement by positive emotions has occurred. Successful productions will activate positive emotions, which change the amount of "positive" hormones, and associate the successful rule with that emotion as well as the knowledge facts used by the rule. A similar mechanism will support negative emotions (distress). Associations with emotions are realized through additional coefficients in expected gains of rules and base level activations of chunks. These coefficients amplify the chunks associated with a particular emotion according to the amount of the hormone corresponding to it. This will increase the possibility of retrieveing a positively associated chunk in good moods and visa versa. The coefficients in the expected gain of production rules will make the choice of actions affectively dependent. Some performance parameters, like speed of rules firing, expected gain noise, or perceptual characteristics in the model (sizes of fovea and parafovea) depend on the amount of hormones as well.

What We Expect to Find

Emotions seem to play a greater role in and sometimes take control of children's problem solving on this task. These changes will allow the existing ToN model to better match children's behavior by (a) slowing down performance in general, (b) slowing down initial performance as the child explores the puzzle driven by interest, (c) making performance sensitive to, and influenced by the success of previous actions, and (d) abandoning the task if performance is not successful. The mechanisms also can be reused to study more complex emotional behaviors using cognitive architecture where the task involves interaction.

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References

Jones, G., & Ritter, F. E. (1998). Initial explorations of simulating cognitive and perceptual development by modifying architectures. In *Proceedings of the 20th Annual Conference of the Cognitive Science Society*. 543-548. Mahwah, NJ: LEA.

Wood, D., D. Middleton (1975). A study of assisted problem-solving. *Br. J. Psychol.*, 66, 2, pp. 181-191

Anderson, J. R., & Lebiere, C. (1998). *The atomic components of thought*. Mahwah, NJ: LEA.