Modeling Dynamic Tasks: Implications for ACT-R/PM

Frank J. Lee
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213-3890
+1 412 268 8117
fjl+@cmu.edu

Michael D. Byrne
Department of Psychology
Rice University
Houston, TX 77251-1892
+1 713 527 8101
byrne@acm.org

ABSTRACT

ACT-R/PM (Byrne & Anderson, 1998) is an extension to the ACT-R (Anderson & Lebiere, 1998) architecture that allows ACT-R to precisely model perceptual and motor processes. While modeling of these processes may not be important in many tasks, it becomes critical in modeling dynamic problem solving tasks. In our presentation, we highlight some important limitations in the current ACT-R/PM that we have encountered while modeling a dynamic problem-solving task.

Keywords

ACT-R/PM

INTRODUCTION

We have enthusiastically jumped into modeling dynamic problem solving tasks. This enthusiasm was engendered by the convergence of several factors: (a) our desire to scale up ACT-R models to complex task environments, (b) the availability of eye-movement data, and (c) the development of ACT-R/PM and its potential to account for high-resolution data provided by the eye-tracker.

The strength of ACT-R/PM lies with its ability to model parallelism across cognitive, perceptual, and motor processes and the finer grained control over perceptual and motor processes that it provides. Additionally, ACT-R/PM provides the necessary restrictions on representing visual information that researchers have thus far lustily indulged in as a free parameter.

While our faith in ACT-R/PM as the right architecture for modeling dynamic tasks has not diminished, our initial attempts have highlighted some important limitations in the current ACT-R/PM architecture. These include: (1) difficulties with recognizing, representing, and targeting empty regions on the screen (2) management of memory for what has and has not been attended (3) insensitivity to visual onsets and offsets (4) the vagueness of the relationship between eye movements and attention

In our presentation, we will first examine how these issues arose in the context of modeling the Kanfer-Ackerman ATC task and discuss why they naturally arise in modeling dynamic tasks in general. Then we will discuss these issues in a broader context of the ACT-R/PM architecture and what changes might be made at the architecture level of ACT-R/PM to overcome these limitations.

In this extended abstract, we briefly review each of these limitations.

(1) Difficulties with recognizing, representing, and targeting empty regions on screen

This problem arises when a location of an empty space in your task screen is an integral part of your task. Consider for example, a simple visual task where one must identify the location of a missing circle in a set of five circles. This task is rather trivial for people to do, but it cannot be done - at least with any degree of fidelity to latencies – within the current ACT-R/PM.

(2) Management of memory for what has and has not been attended

This problem arises when one desires to enumerate a set of stimuli more than once. Enumeration in ACT-R/PM is accomplished by using the `attended` flag in the `visual-location` chunk. However, once the `attended` flag has been set, it does not expire. Hence, one cannot reuse them for this purpose.

(3) Insensitivity to visual onsets and offsets.

This problem arises because `attended` flag is also used to note the visual onsets of new visual items. However, if we allow for the expiration of `attended` flags, they can no longer be used to mark visual onsets. Additionally, there is currently no mechanism for visual offsets to draw ACT-R/PM's attention.

(4) The vagueness of relationship between eye movements and attention

This problem arises because there is a mismatch between the eye movement data that we collect and the modeling assumption behind ACT-R/PM. ACT-R/PM assumes that one is modeling attention shifts, not eye movements. An attention shift in ACT-R/PM takes fixed time regardless of visual distance, but latencies for eye movements is a function of distance moved.

REFERENCES

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