Modeling Individual Difference Factors in a Complex Task Environment

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Abstract

Cognitive models are often used to predict the average performance of a population. For many purposes, however, generating predictions of individual performance is crucial. We propose a methodology in which the ACT-R architecture is extended, through the setting of architectural parameters that represent individual differences, into a model of individual behavior. This approach can provide a vast range of predictive and diagnostic capabilities from a modest initial investment of resources.

Introduction

Cognitive models often produce results that model those of a typical individual, or the average of a population of individuals. For many purposes, however, it is desirable or even necessary to model individuals.

We describe here a methodology in which data from subjects performing simple tasks are used to parameterize a cognitive-level model so as to model each individual. These models can then be used to predict individual performance in more complex tasks. Those models can inform pure scientific investigations or serve as a low-cost diagnostic procedure in applications such as low-cost evaluation of personnel, in task analysis, or interface design.

Lovett, Reder & Lebiere (1997) showed that ACT-R's *W* parameter that describes working memory capacity can be set to values that describe individual ability, yielding models that predict individual performance. The work described here extends that foundation by testing a two-parameter model of individual differences utilizing both *W* and a parameter describing psychomotor ability. Individual values for these parameters can be determined via easily administered tests. We have begun comparison of individual and model performance in the moderately complex AMBR air-traffic control (ATC) simulation (Gluck & Pew, 2002).

The AMBR Task

AMBR is loosely based upon air traffic control. It calls for the subject to process aircraft (AC) as they enter and leave a central airspace zone, for which the subject is responsible. As an AC moves to or from the central airspace zone to any of the four neighboring zones, the subject must issue commands, via a graphical interface, that transfer responsibility for the

is scored as an error. AC can never crash, nor do they take off or land.

It should be noted that AMBR is not highly faithful to the task that professional air traffic controllers face. (Notably, real ATC involves voice communication with aircrews and changing aircrafts' routes and altitudes.) Our goal is not to study expert behavior, but rather the behavior of novices who thoroughly understand the AMBR task, the rules of which subjects come to understand in a matter of minutes.

Parameters and Individual Differences

The ACT-R architecture provides a well-developed core around which to build specific cognitive models (Anderson & Lebiere, 1998). Certain work in the ACT-R community has pursued values for some architectural parameters, based on the assumption that those values are roughly universal across subjects and situations (ibid, p. 217). In contrast, Lovett, Reder & Lebiere (1997) posited that the *W* parameter, governing working memory capacity, may be thought of as an individual difference variable, and that varying *W* can tune an ACT-R model to the abilities of an individual. This has been empirically u450 -1 4o Twng -1Tc 02 TD -0.by383 .01 Tc4.1579 Tw al y hmaan ibaspirce AM