Towards an Affective Cognitive Architecture

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Motivation
- Affective state influences users’ cognitive processing capabilities and productivity (Picard, 1997).
- We will develop methods to timely and efficiently recognize negative user affective states, model their influence on cognition and behavior, and provide the most appropriate intervention in a timely manner to return the user to his/her productive state.
- We will develop an integrated architecture of affect and cognition.
- We face multiple challenges:
  1. Affect develops over time
  2. Expression of affect varies with individual and context.
  3. Sensory measures of affect are ambiguous, uncertain, incomplete.
  4. Influence of cognition on affect and vice versa is not well understood.
  5. Interventions to improve performance must be timely and effective.

Bootstrapping CASS

We will develop Emotionally Normative Cognitive Models (ENoCoMos) of individuals. The ENoCoMos will be models of skilled performance. In deriving the models, detailed analyses of each participant’s strategies and microstrategies will be conducted (Gray & Boehm-Davis, 2000).

We increase and decrease the tempo of the dual-tasks. This second step will yield significant mismatches between the behavior of the ENoCoMos and the behavior of human participants. Our working hypothesis is that the mismatches represent the effect of affect on cognitive performance.

The results of the second step will be used by both strands of our research in the third step. For R-BARS, mismatches between the model and participant are taken as evidence that increases the prior probability that these periods include non-normative affective states. For RAAC, we will determine a set of low-level cognitive factors that, when varied, enable the model to match the user’s behavior. This means that we will develop Emotional Cognitive Models (ECMoS).

In the fourth step, we will discover, for each participant, how to scale the output of R-BARS to provide an input to an ACT-R parameter so that the ACT-R model produces the same outcomes and processes (strategies and microstrategies) as its human.

The CASS Architecture

CASS is the Cognitive Affective State System.

R-BARS (Rensselaer Bayesian Affect Recognition System) collects noninvasive perceptual measures of facial expression and sensory data in order to assess the user’s affective state in real-time.

RAAC (Rensselaer Affective Architecture for Cognition) simulates changes in affective state with changes in low-level parameters in a unified architecture of cognition. RAAC produces changes in high-level outcomes and the processes (strategies and microstrategies) that produce these outcomes from low-level alterations in the parameters that govern memory decay, memory activation, movement of visual attention, conflict resolution, etc.

AUA (Active User Assistance): With R-BARS identifying the affective state, dynamic model tracing allows RAAC to pinpoint differences in low-level cognitive parameters between an emotionally normative model and an emotional model. These differences are input to the AUA, which assists the user in performing the task, e.g., by modifying the interface or giving feedback.

Current Task

The first task for the CASS project is a dual task, i.e., participants have to perform two tasks simultaneously. The first task is to determine whether simple addition/subtraction problems are correct or not. The second task is to classify a letter with respect to whether it occurs before or after the previously presented one in the alphabet.

The tasks are varied in the speed in which the problems are presented. In conditions with high workload participants show confusion/frustration to a varying degree.

References
