SimBorgs

Towards the Building of Simulated Human Users for Interactive System Design

Wayne D. Gray

Michael J. Schoelles

CogWorks Lab

Rensselaer | Cognitive Science

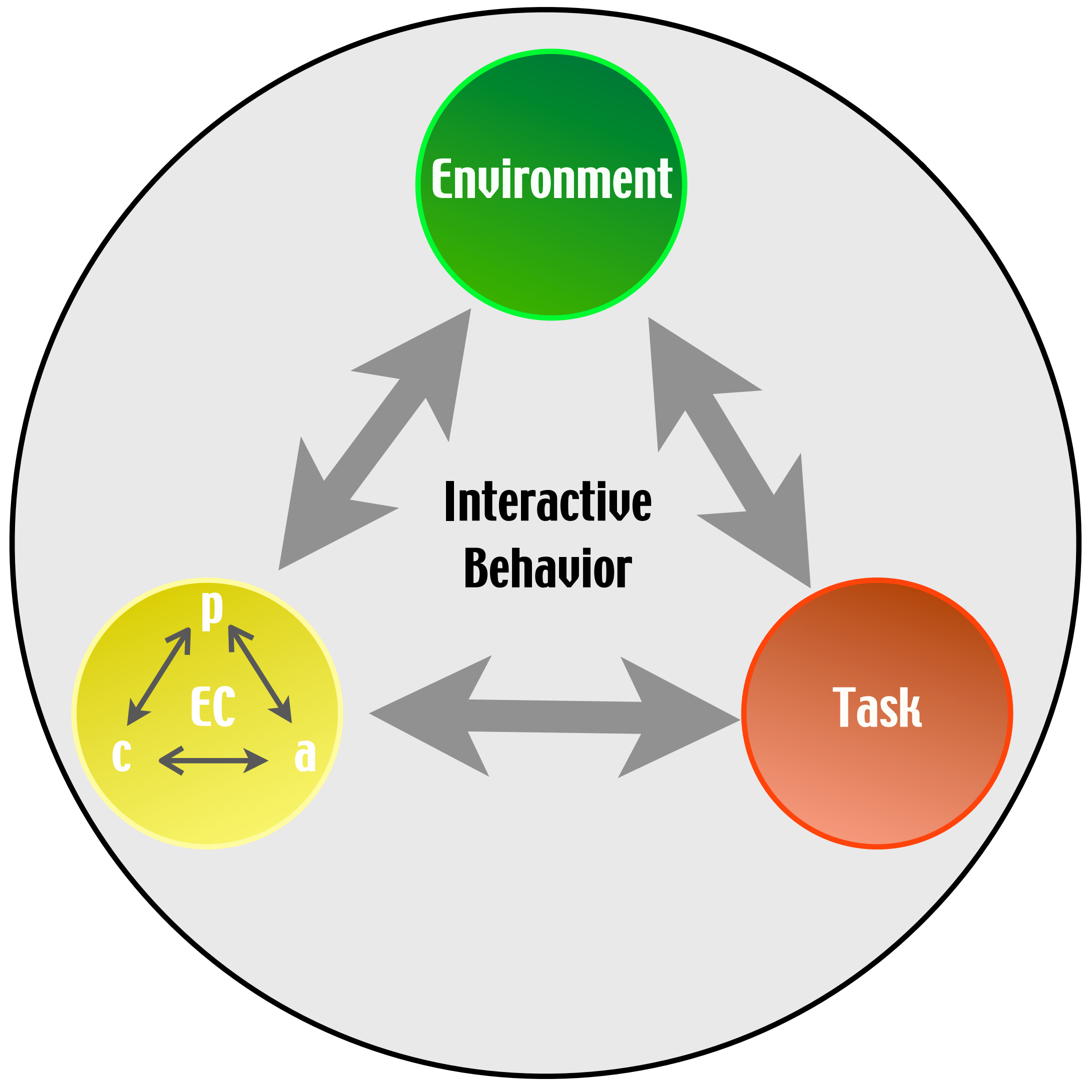
SimBorgs

- SimBorg = Simulated Cyborgs
- Cyborgs = part human & part machine
- For SimBorgs
  - The machine part is real
  - The human part is simulated in ACT-R (hence the name)

Issues & Motivations

- Seeking to interact with task environments built by other people, running on other machines (see Schoelles' presentation at this afternoon's symposium)
- Looking to transition our basic research into engineering applications
- How to apply cognitive theory to interactive system design?
- Why is so little of this sort of thing done now?

The Interactive Behavior Triad



Goal

- To separate the low-level acquisition and interactive processes specific to the design of the task environment from higher-level, task-specific expertise

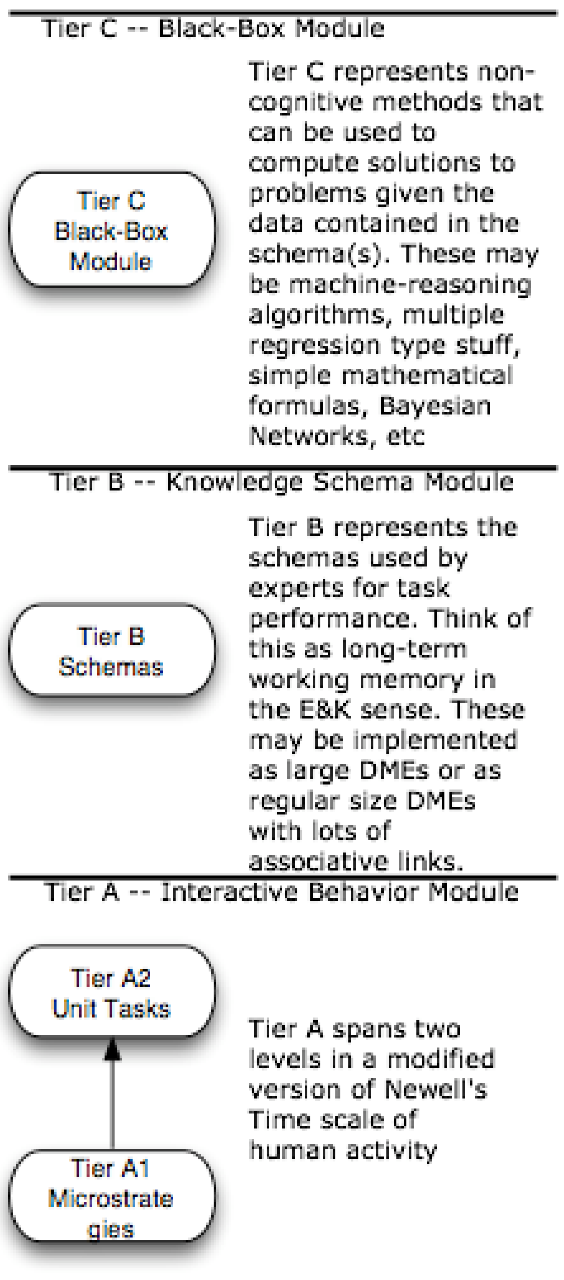
What is the problem we are trying to solve?

- For a simulated human user to be useful in testing interface designs how much of human behavior must be simulated in a cognitively plausible manner?
- The Problem
  - Task knowledge and even cognitive processes are very task-specific (as per Ericsson & Kintsch, 1995)
  - How much of human expertise do we need to model in order to develop computational cognitive models capable of being used as tools for design and usability testing?

A Way Out?

- Many instances where we can match (or exceed) human expert performance by very non-human means
  - Deep Blue
  - Statistical techniques such as multiple regression
  - Math modeling
  - etc
- Possible to finesse the expertise issue by turning the reasoning component over to a black-box module
  - No claims made about the cognitive fidelity of the processing of the module

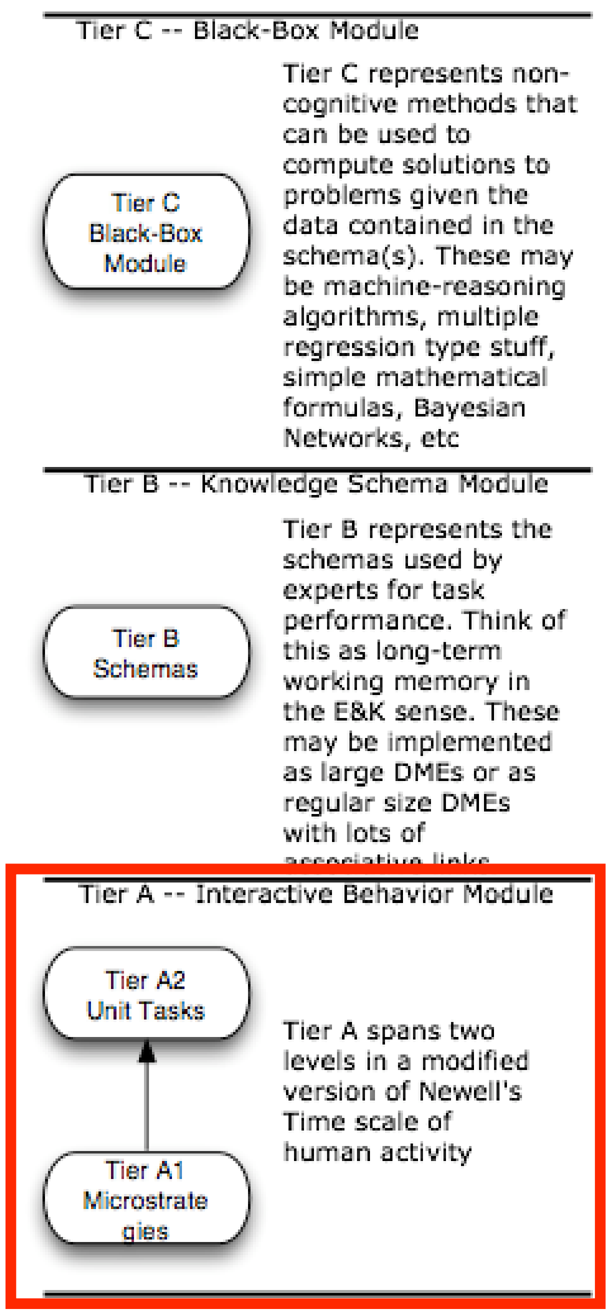
A 3-Tier Architecture for Interactive System Design



A three tier architecture for building simBorgs

- Tier C -- Black-Box Module
- Tier B -- Knowledge Schema Module
- Tier A -- Interactive Behavior Module

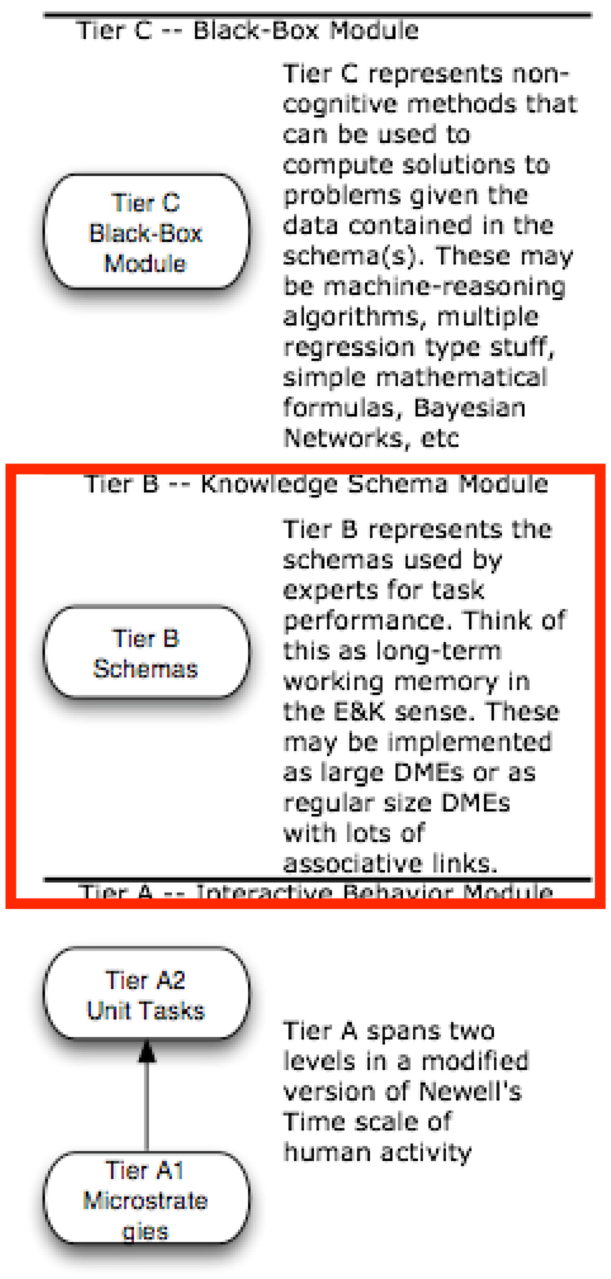
A 3-Tier Architecture for Interactive System Design



A three tier architecture for building simBorgs

- Tier A -- Interactive Behavior Module
  - Level of highest cognitive fidelity
  - Interacts directly with the task environment the way that people interact with it
- A1 -- Microstrategy level
  - Hard Constraints
  - Greatest reusability of productions
- A2 -- Unit task level
  - Soft Constraints
  - Driven by least-effort considerations

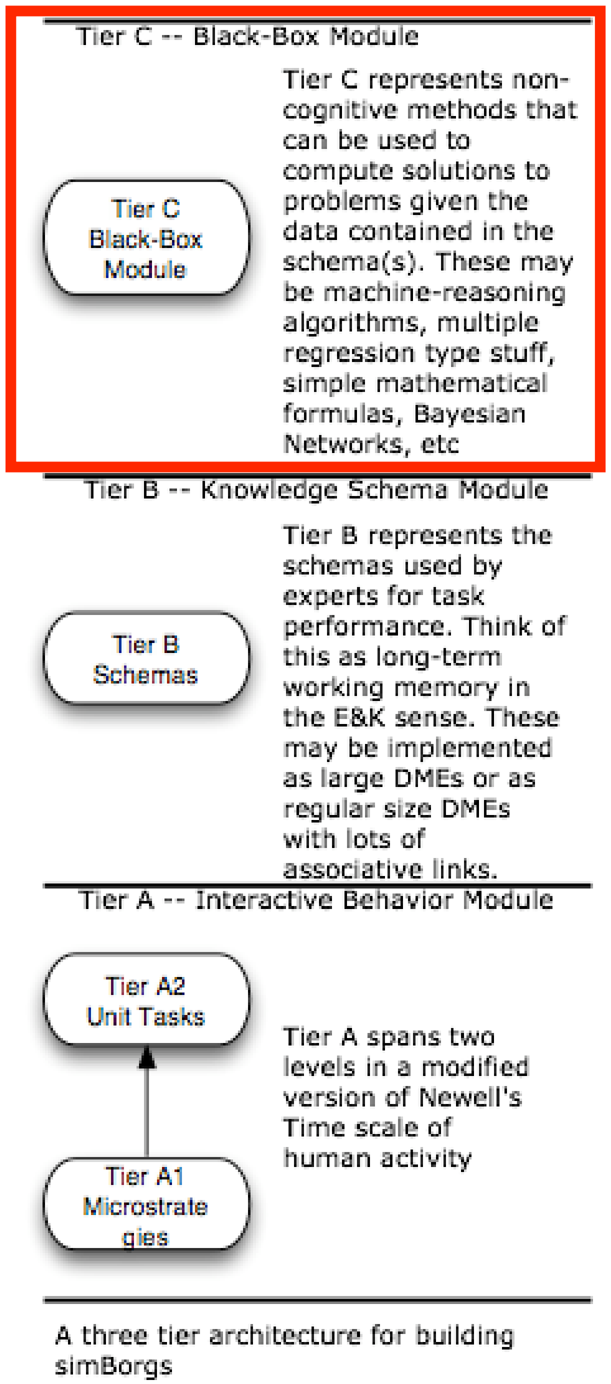
A 3-Tier Architecture for Interactive System Design



A three tier architecture for building simBorgs

- Tier B -- Knowledge Schema Module
  - Sets of scenario-specific schemas
  - Derived by knowledge engineering techniques from human experts as they solve a given scenario
  - This level is based on modeling work with Project Nemo (Gray, 2003; in progress)
  - Schemas as E&K's long-term working memory knowledge structures

A 3-Tier Architecture for Interactive System Design



- Tier C -- Black-Box Module
  - May contain a variety of methods for problem solving or reasoning
  - Machine-reasoning algorithms, Bayesian networks, multiple regression models, or algebra equations that simply compute an answer
  - The method provides an answer the human might give, but the process bears no resemblance to human information processing

SimBorgs

- GIGO
  - Black-box module will work perfectly -- to the limits of the information provided it by the other two modules
  - Old information, wrong information, incomplete information will cause degradations in performance
- Holds the reasoning *process* constant
  - Provides a general way of exploring how differences in interface design lead people to trade off effectiveness for efficiency
- Goal: To be able to separate
  - the low-level information acquisition and interactive processes specific to the design of a task environment, from
  - the higher-level, problem-specific expertise required to do a particular job

Changes to ACT-R

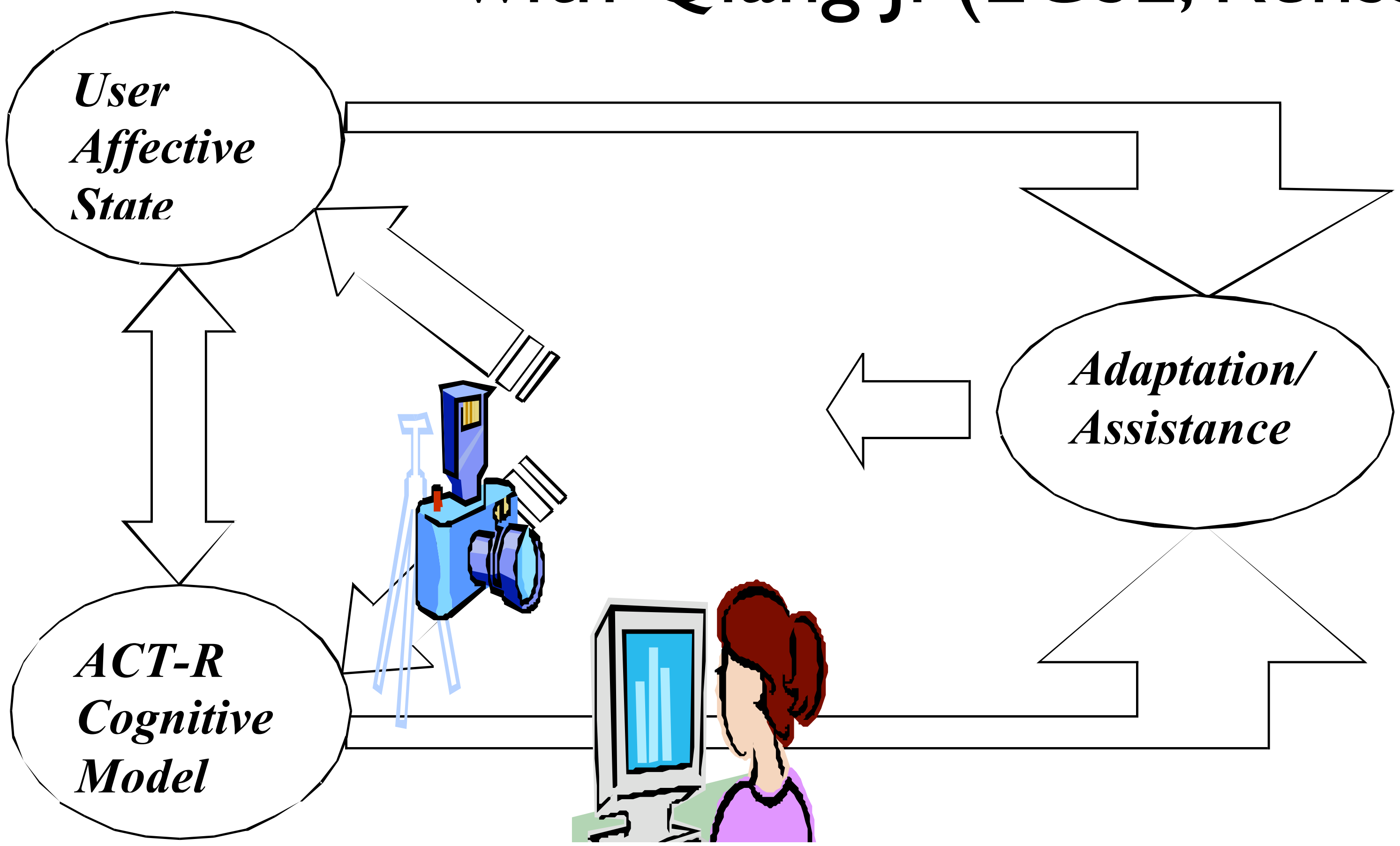
- Addition of a Black-Box buffer
- To the extent that the other ACT-R buffers are grounded in neurocognitive data (Anderson, et al., 2002), then the black-box buffer may be regarded as a simulated brain implant

Other New Work

- ***ASAP -- Affective State Argus Prime***
- ***Combining Powerful Technologies!***
  - **What can happen when you combine a system that can parse emotions in real-time with . . .**

Affect-Sensitive Cognitive Modeling for User Assistance

with Qiang Ji (ECSE, Rensselaer)



DARPA AUGCOG

- S & T Areas
  - User affective state inference
  - Emotional ACT-R
  - User assistance for performance enhancement

- Technical Challenges:
  - Represent and integrate uncertain and dynamic sensory data of different modalities over time to infer user state efficiently and timely
  - Incorporate affect state into ACT-R in a principled way
  - Dynamically characterize the utility of an assistance and determine the best application timing