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Effective Learner Modeling for Computer-Based Tutoring of Cognitive and Affective Tasks

ARL

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Heather Holden, Robert Sottilare, Benjamin Goldberg, and Keith Brawner
Army Research Laboratory (ARL)

ARL LITELab

Presentation Agenda

- Introduction and Background
- Components to Consider for Comprehensive Learner Models
- Initial Ontology and Functionality Vision of a Comprehensive Learner Model within the Generalized Framework for Tutoring (GIFT)
- Conclusions

Introduction and Background

Research Motivation

- **Equipping Computer-Based Tutoring Systems (CBTSs) with the ability to emulate the same benefits of one-to-one human tutoring is extremely complex.**

- **A Warfighter's tutor must:** *(MG Nick Justice, I/ITSEC 2011)*
  - Have knowledge of the operational context being trained
  - Have mechanisms to monitor and adapt to learner fatigue and cognitive load
  - Allow Warfighter's to "train as they fight"
  - Prepare the Warfighter to become their individual best
  - Motivate Social Learning

Learner Models

- The core module of CBTSs
- **Used to represent the learner's current state of knowledge at any given time.** (Kassim, Kazi, & Ranganath, 2004)
- Ideally can contain information about the learner's individual difference characteristics, his/her past and current competency, performance, cognition, affect, behaviors, etc.
- Commonly referred to as a student model
- Can be constructed/generated in multiple ways with various levels of abstraction

Research Problem and Scope

- No standardization on the structure of learner models or the most appropriate learner modeling techniques that can be reusable across different populations and learning objectives.

- ***What aspects of the learner should be modeled and how can we achieve the best possible levels of state and performance classification and predictive accuracy?***

- ***How can we address the need for reusability, modularity, and generalizability?***

Components to Consider for Comprehensive Learner Models

Learner Model Content

Domain-Specific Information	Domain-Independent Information
Represents a reflection of the learner's state and level of knowledge or ability within a specific domain.	Consists of all relevant characteristics of an individual learner.
Data Includes: • Historical Competency (i.e., domain knowledge and skills measured over time) • Misconceptions • Problem-Solving Strategies • …	***Data Includes:*** • Learning Goals • Cognitive Aptitudes • Measures of Motivational State • Learning Preferences (including styles and personality) • Interest • Demographics • Past Performance and Competency (domain-independent) • Behavioral/Psychological Measures • Cognitive and Affective Dimensions • Personal Control Beliefs • ….

Influence of Individual Differences

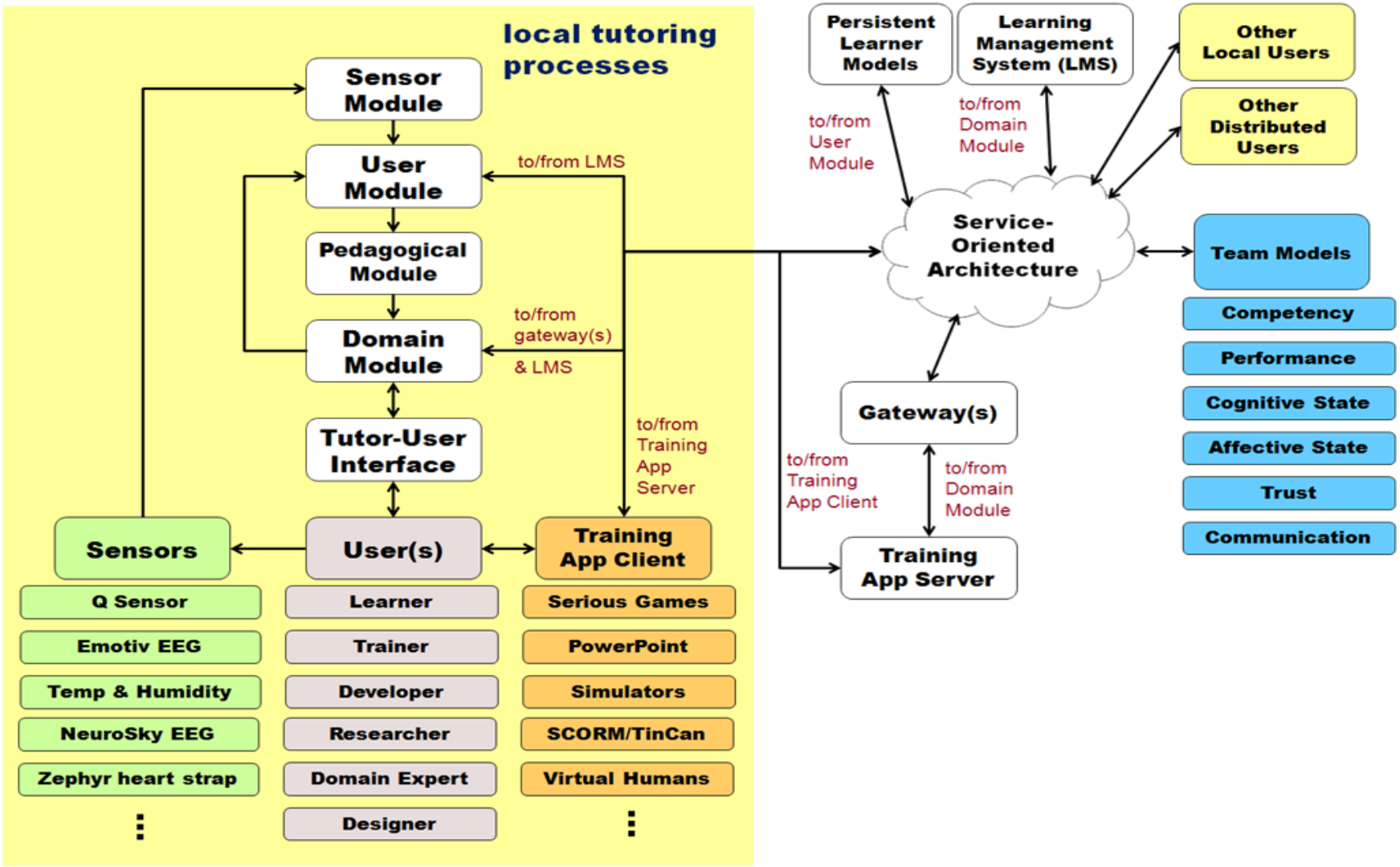
- **Individual difference can have a great impact on learning performance:**
  - **Information- Processing Allocation**
  - **Attention Focus and Metacognitive Processes**
  - **Motivation and Effort Allocation**
  - **Emotional Regulation and Control**
  - **State Determinations (Cognitive, Affective, Motivational, Social, Behavioral, etc.)**
- **Sensor Data vs. Self-Reported Data**

Other Learner Model Elements

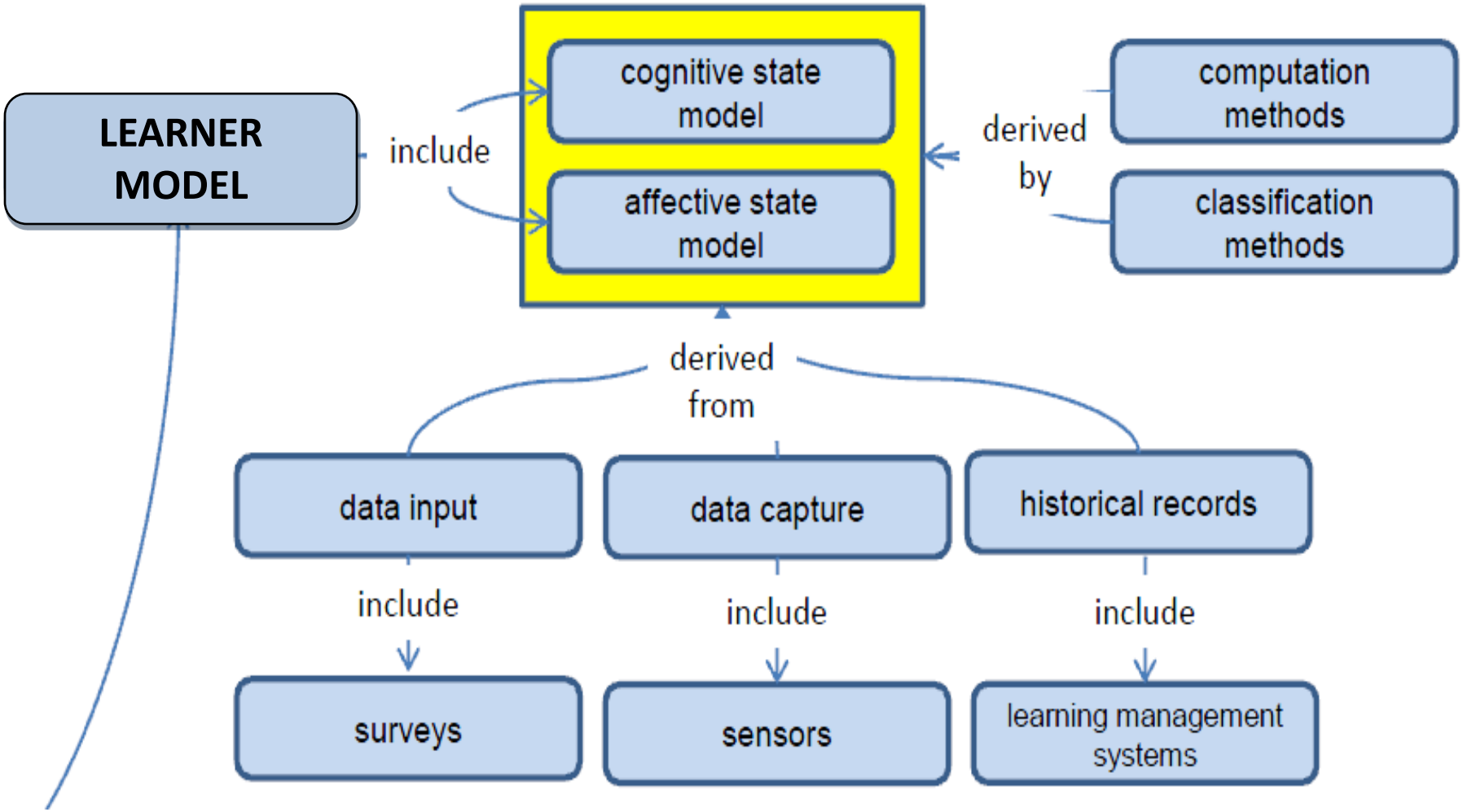
- Learner acceptance and system interactions may be indicative of current and future system usage behaviors.
  - Includes the evaluation of learner's expertise, skills, attitudes, perceptions, and self-efficacy towards both computers in general and the specified system.
  - Combined with the evaluation of the same perceptions towards learning, learner models could potentially increase explanations of states, performance, and system behavior.

Initial Ontology and Functionality Vision of a Comprehensive Learner Model

GIFT Functional Diagram



Initial Learner Model Ontology



Functionality Vision of GIFT Learner Module

- ***Inputs:***
  - **Weighted model/algorithm containing relevant learner characteristics. (Learning Management Systems (LMS))**
  - **Processed sensor Information (Sensor Module)**
  - **Current performance and other assessment variables (Domain module)**
  - **Survey response data (Survey Authoring Tool)**
- ***Functions:***
  - **Pre-training and Mid-training Assessment**
  - **Readiness Monitoring (interpretation cognition and affect)**
  - **Performance/Progress Monitoring**
  - **Interaction/Psychomotor behaviors of trainee within the training simulation**
- ***Outputs:***
  - **Changes of monitoring results (including potential elements contributing to change) (Pedagogical Module)**
  - **Necessary updates relevant learner characteristics (LMS)**

Conclusions

- **Learner models with higher-level functionality and a more comprehensive understanding of the learner can produce the following benefits:**
  - **Provide great strides towards developing/generating learner models that are reusable, modular, and standardized**
  - **Increase the adaptability of the overall CBTS**
- **Many challenges ahead towards achieving this level of functionality.**
- **More research is needed to identify and validate interaction effects and causal relationships between learner model elements and state determinations.**

Thank You!

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Questions?

Backup Slides

Individual Differences/Historical Data

Demographics

Personality

Experiences

Cognitive Ability

General Motivation and Goal-orientation

Learning Styles and Preferences

Learner

Acceptance toward <u>learning</u>, <u>general technology</u>, and <u>computer-based learning environments</u>

How should a learner's individual differences be used by tutors to influence learning and retention?

Which individual differences have the most significant impact on learning?

<u>Pre-Instruction Readiness</u>

-Mood
-Previous night's sleep
-Caffeine intake
-Current cognition and affect baseline

Domain-Specific Information
•Initial competency/knowledge
•Self-Efficacy
•….

Past Performance and Previous Behavioral Patterns