Understanding how AI is applied in training: Case Studies

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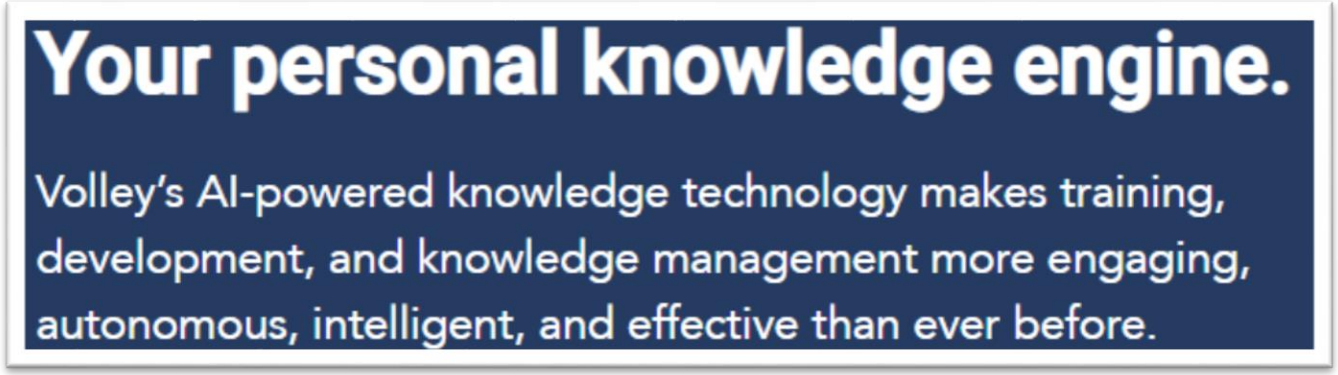
Outline

- Motivation
- Types of AI (Rules versus Machine Learning)
- Uses of AI (Decide versus Classify)
- Input Data
- Proposed Analysis Framework
- Use Cases
  - Learning Navigator
  - GIFT & PSTAAT
  - Human Instruction
  - ALEKS
  - ElectronixTutor
- Summary

Motivation



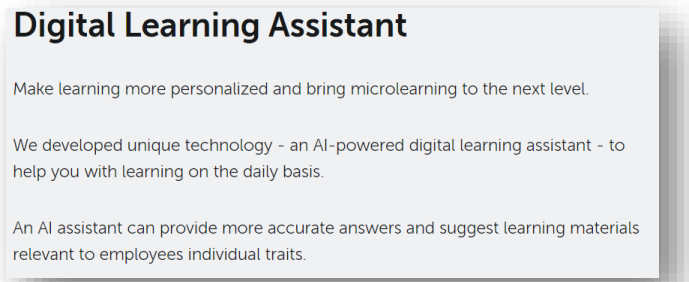

SOFTWARE

AI in Education Will Grow Exponentially by 2021

Teachers will get a boost in efficiency thanks to machine-learning tools.

by Meghan Bogardus Cortez

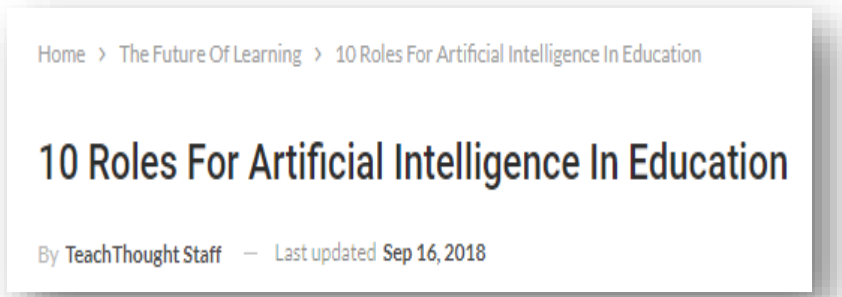
Meghan is an associate editor with *EdTech*. She enjoys coffee, cats and science fiction TV.


Digital Learning Assistant

Make learning more personalized and bring microlearning to the next level.

We developed unique technology - an AI-powered digital learning assistant - to help you with learning on the daily basis.

An AI assistant can provide more accurate answers and suggest learning materials relevant to employees individual traits.


Home › The Future Of Learning › 10 Roles For Artificial Intelligence In Education

10 Roles For Artificial Intelligence In Education

By TeachThought Staff — Last updated Sep 16, 2018

US Department of Education "What Works Clearinghouse" Report on Carnegie Learning's Cognitive Tutor

Mixed effects
No discernable effects
Potentially negative effects

The Cognitive Tutor™: Successful Application of Cognitive Science
Dr. Stephen Blessing, Cognitive Scientist
Carnegie Learning

What Works Clearinghouse™ U.S. DEPARTMENT OF EDUCATION

WWC Intervention Report

A summary of findings from a systematic review of the evidence

ies INSTITUTE OF EDUCATION SCIENCES

Secondary Mathematics **June 2016***

Cognitive Tutor®

Report Contents

Table 1. Summary of findings[8]

Course and outcome domain	Rating of effectiveness	Improvement index (percentile points) Average	Improvement index (percentile points) Range	Number of studies	Number of students	Extent of evidence
Cognitive Tutor® Algebra I						
Algebra	Mixed effects	+4	–7 to +19	5	12,182	Medium to large
General mathematics achievement	No discernible effects	+2	na	1	658	Small

Proven effective: In the early 1980s, Anderson and his colleagues began developing the Cognitive Tutor technology to test the ACT theory. Since then, a wide variety of rigorous research studies have confirmed the effectiveness of the Cognitive Tutor curricula. Typical results show that students who use these tutors perform one grade-letter better than students taught using more conventional methods.

Three of the most effective features of Cognitive Tutor programs are its constant student monitoring, just-in-time help and individualized skills tracking.

Consequences

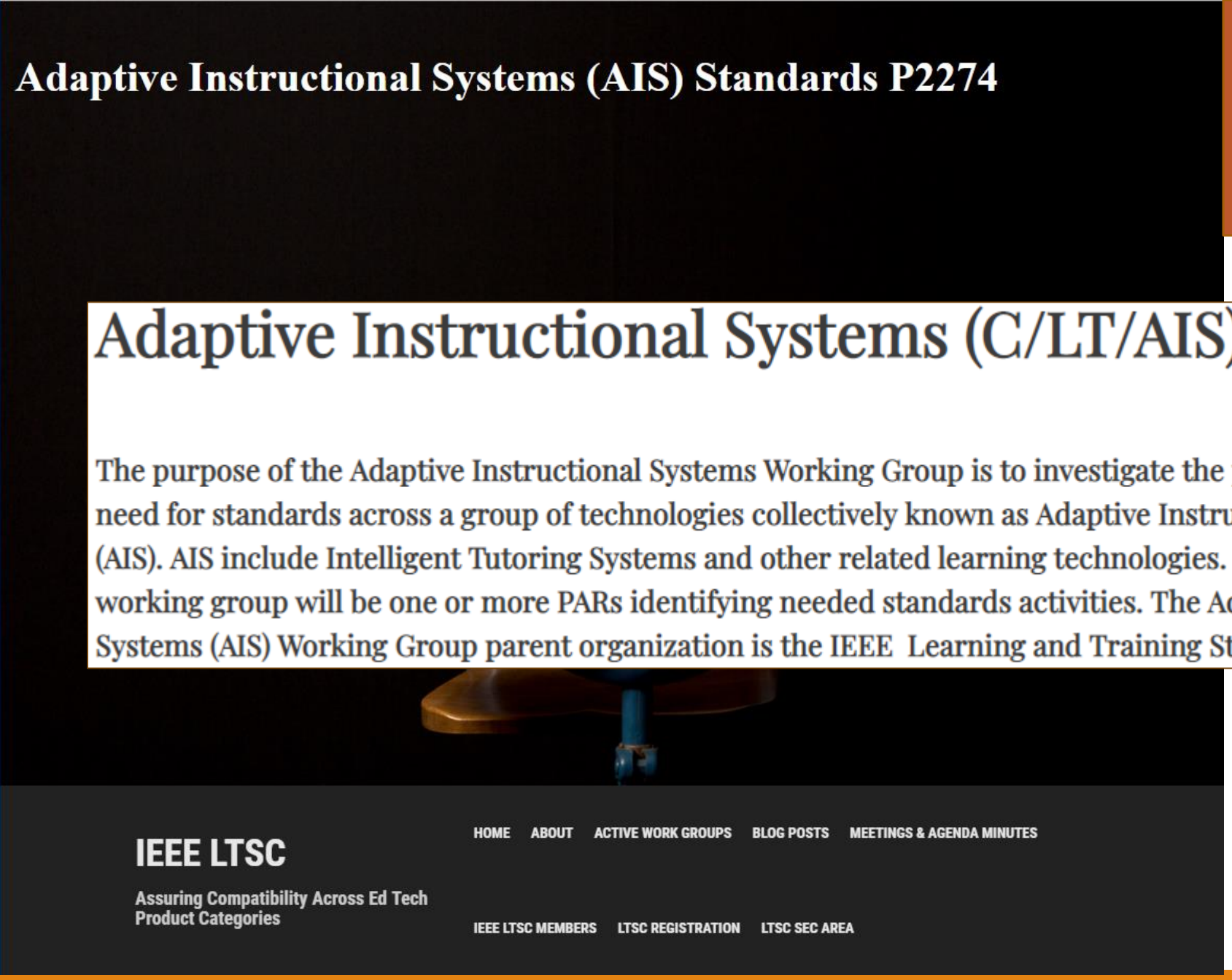
- **Producers don’t engage in studies**
- **Researchers are isolated from producers**
- **Consumers don’t know what to believe**
- **Purchasers don’t know what to buy**
- **Beneficial technology stays on the shelf**

IEEE STANDARDS ACTIVITY

Adaptive Instructional Systems (AIS) Standards P2274

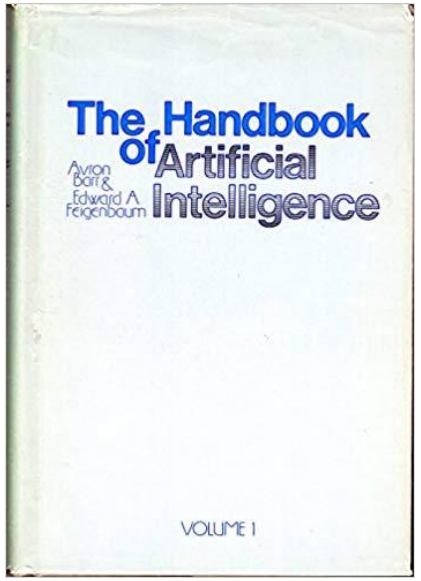
Adaptive Instructional Systems (C/LT/AIS) P2247.1

The purpose of the Adaptive Instructional Systems Working Group is to investigate the possible market need for standards across a group of technologies collectively known as Adaptive Instructional Systems (AIS). AIS include Intelligent Tutoring Systems and other related learning technologies. The output of the working group will be one or more PARs identifying needed standards activities. The Adaptive Instructional Systems (AIS) Working Group parent organization is the IEEE Learning and Training Standards Committee



- *What does AI mean in adaptive instructional systems (AIS)?*
- *How can we clarify the use of AI to improve adoption?*

Definition of AI



Definitions of Artificial Intelligence (AI)

Oxford: The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages

Barr: The part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics we associate with intelligence in human behavior – understanding language, learning, reasoning, solving problems, and so on.

IBM: Anything that makes machines act more intelligently, including basic and applied research in machine learning, deep question answering, search and planning, knowledge representation, and cognitive architectures.

Types of AI

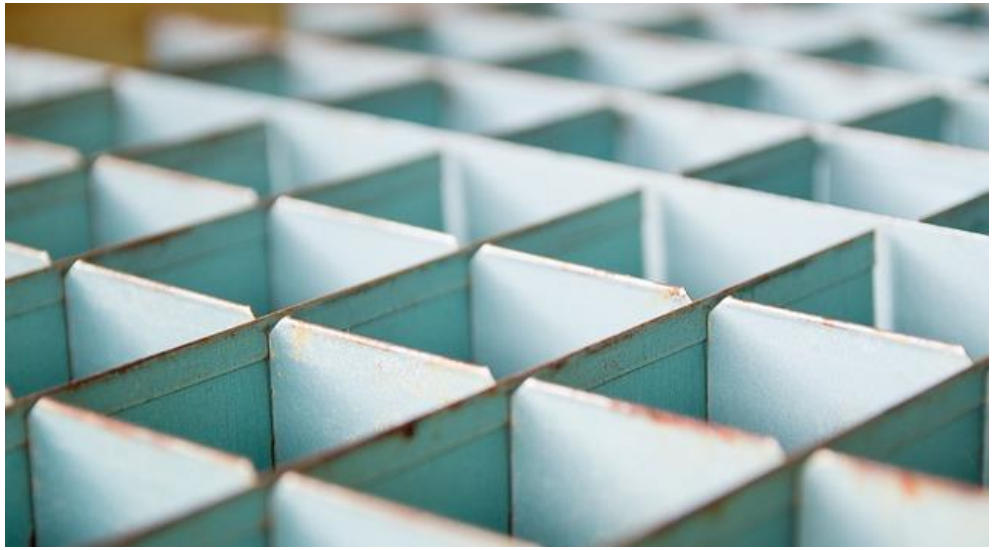
- **Rules and Formulas**
  - Expert Systems
  - Event-Condition-Action tables
  - Hard-coded branching decisions
- **Machine Learning**
  - Naïve Bayes
  - Neural Networks
  - Genetic Algorithms
  - Clustering Algorithms
  - Ensemble Learning (Stacking)
  - Supervised and Unsupervised

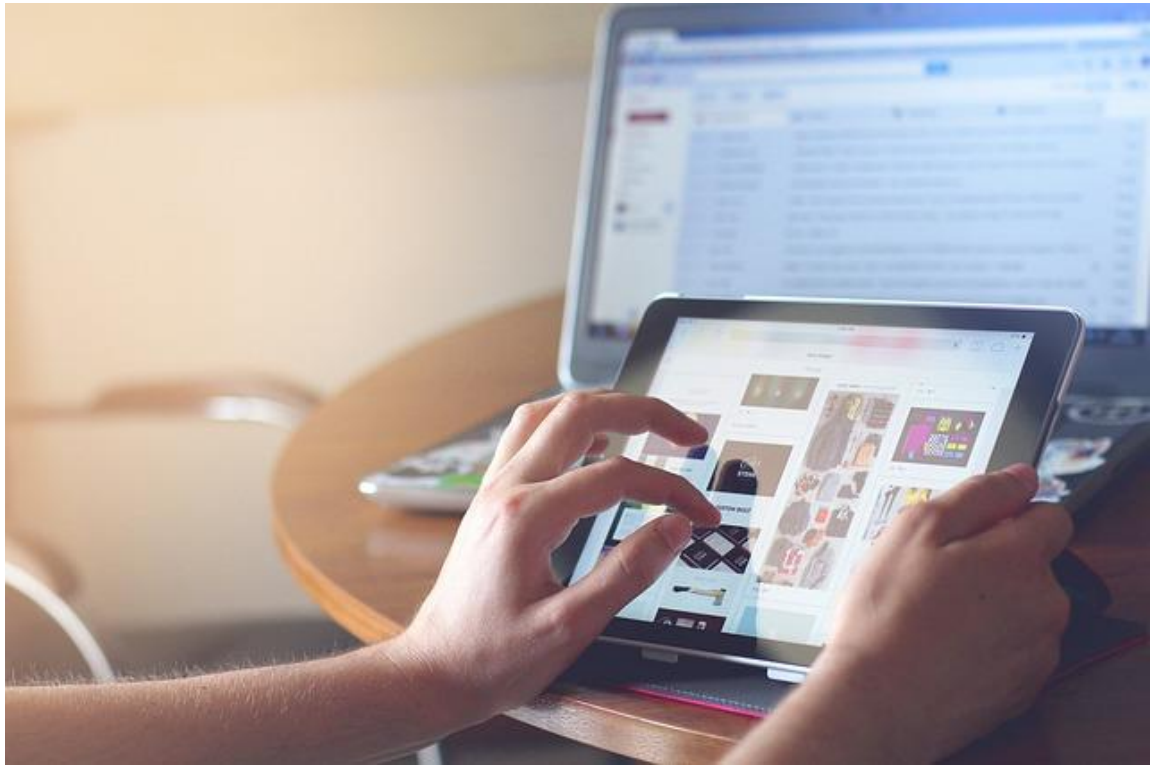
Any sufficiently advanced machine behaviour is indistinguishable from AI.
(apologies to Arthur C. Clarke)

- **Natural Language Processing**
  - Computational linguistics
  - Dialog agents
  - Text analysis
  - Machine translation
  - Speech recognition
  - Ontological methods

Uses of AI

- **Decisions**
  - What action to take?
  - What topic is next?
  - What content to display?
- **Classifications**
  - What does the learner know?
  - What topic does this content address?
  - How difficult is this task?
  - How engaged is the learner?



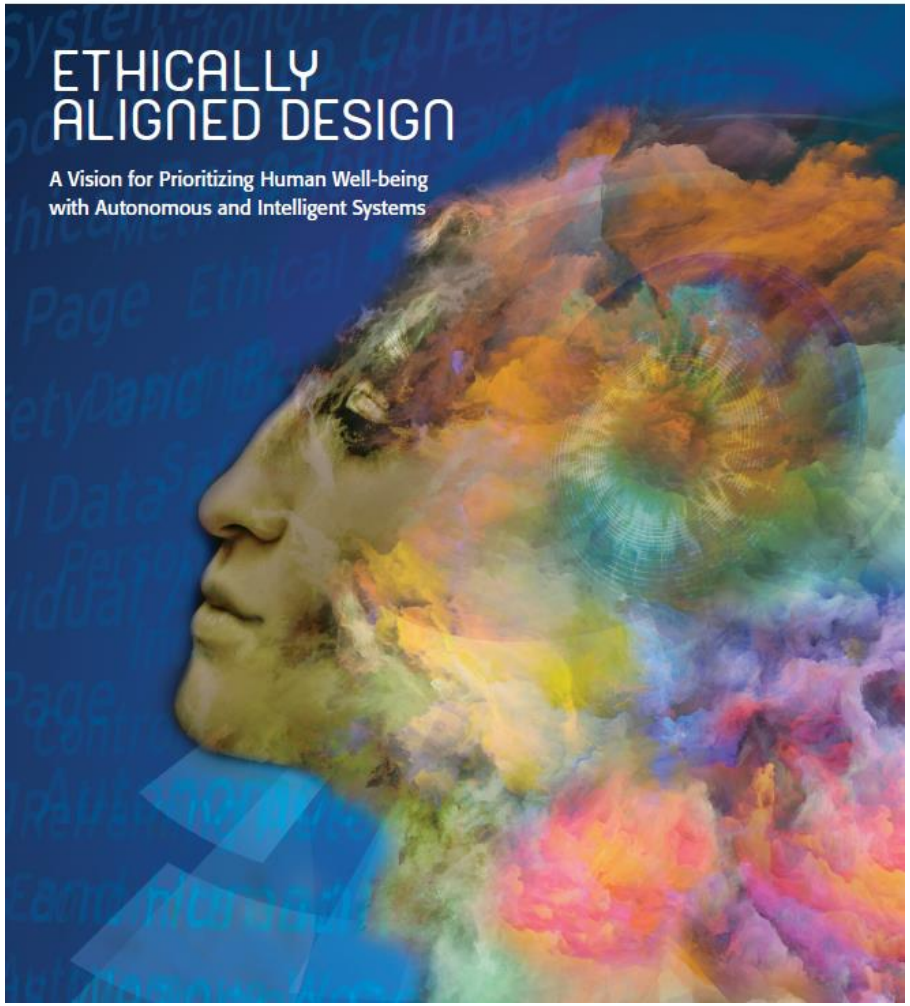


Input Data

- Activity Steams and Test Results
- Sensor Data and Biometrics
- Competency Frameworks, Topic Maps, Knowledge Spaces
- Models and Data from Simulations
- Learner Input (text, voice, other)

Issues to Consider

- Transparency
- Bias
- Regulations



The Framework

Identify major components used for adaptivity and personalization

Identify where AI is used or might be used

For each such component identify:

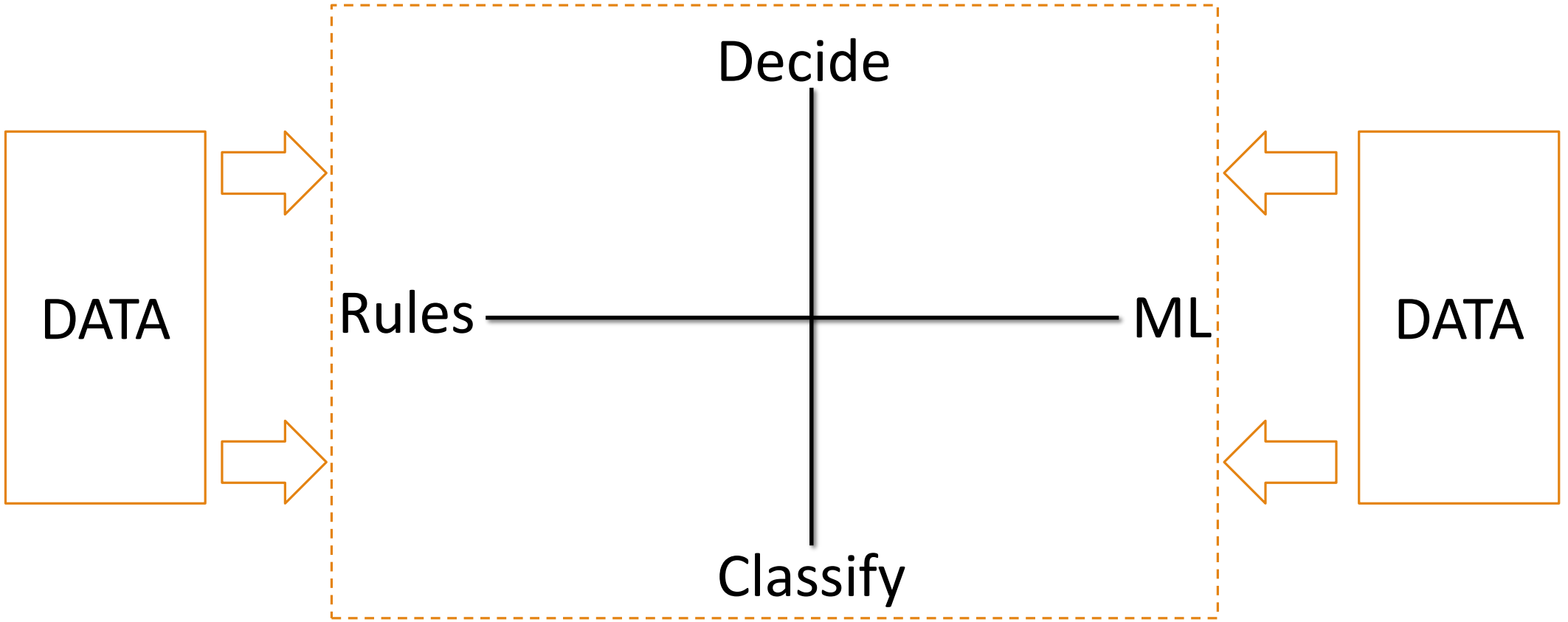
- the input data used;
- whether the component uses rules or ML (and any known techniques or algorithms used);
- whether the component decides or classifies; and
- how data are fed forward among the components.

Map this out visually

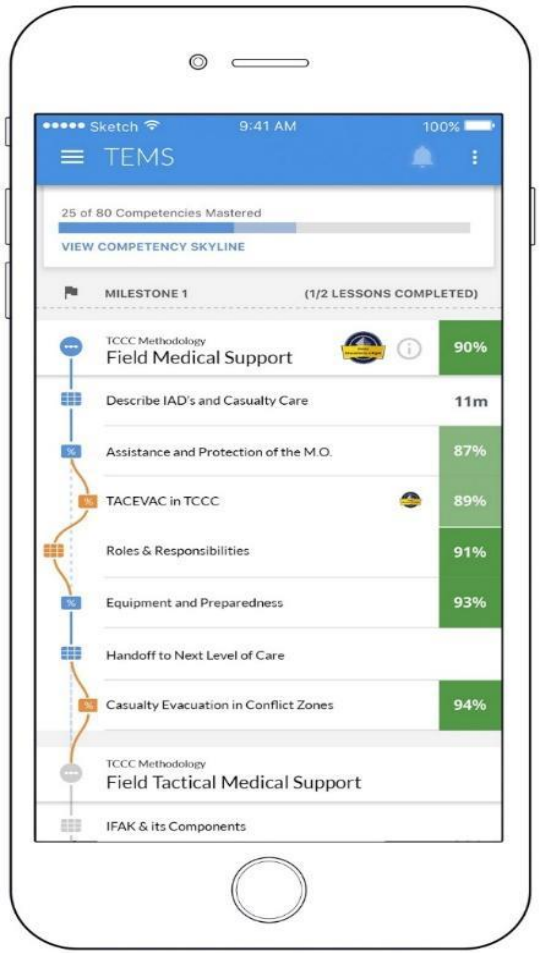
Add text description and analysis, ideally:

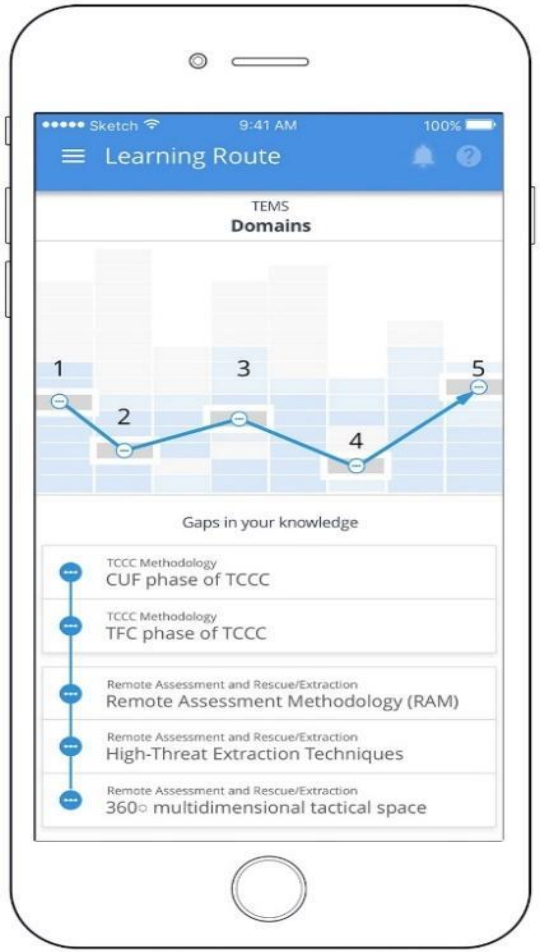
- High level description of system
- High level description of classifiers and decision making
- Transparency and potential biases

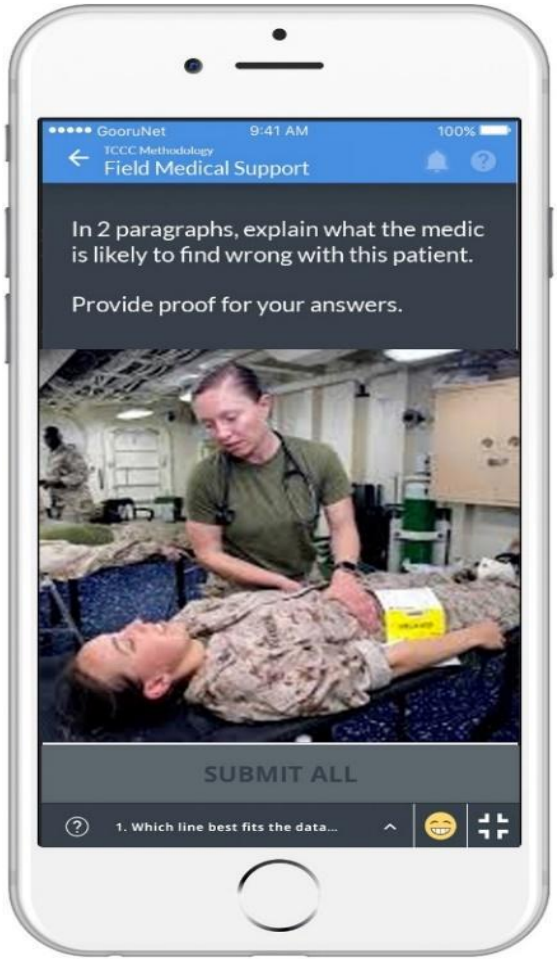
Visual Representation



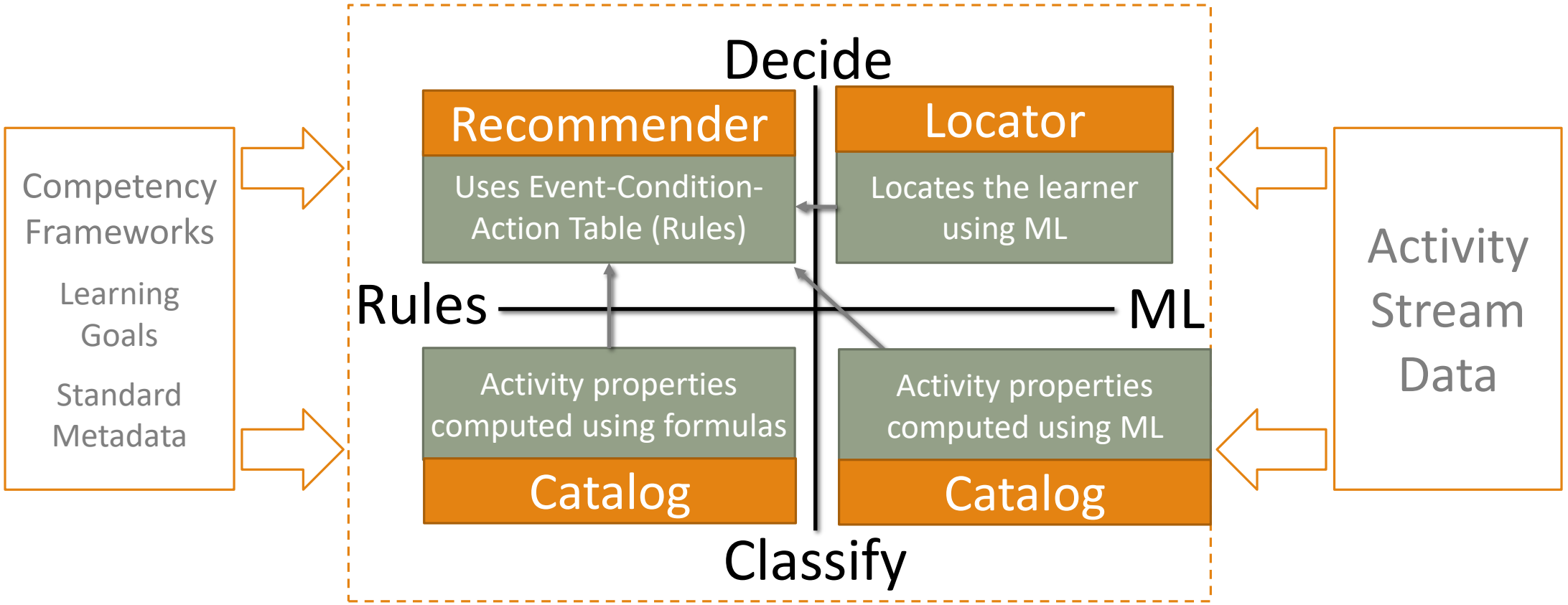
Gooru Navigator



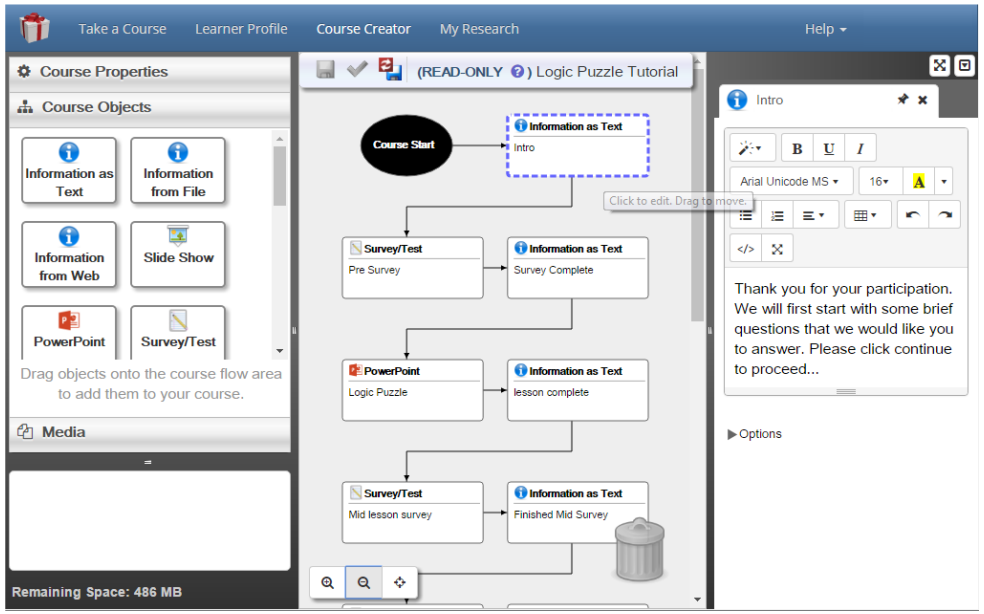




Gooru Navigator



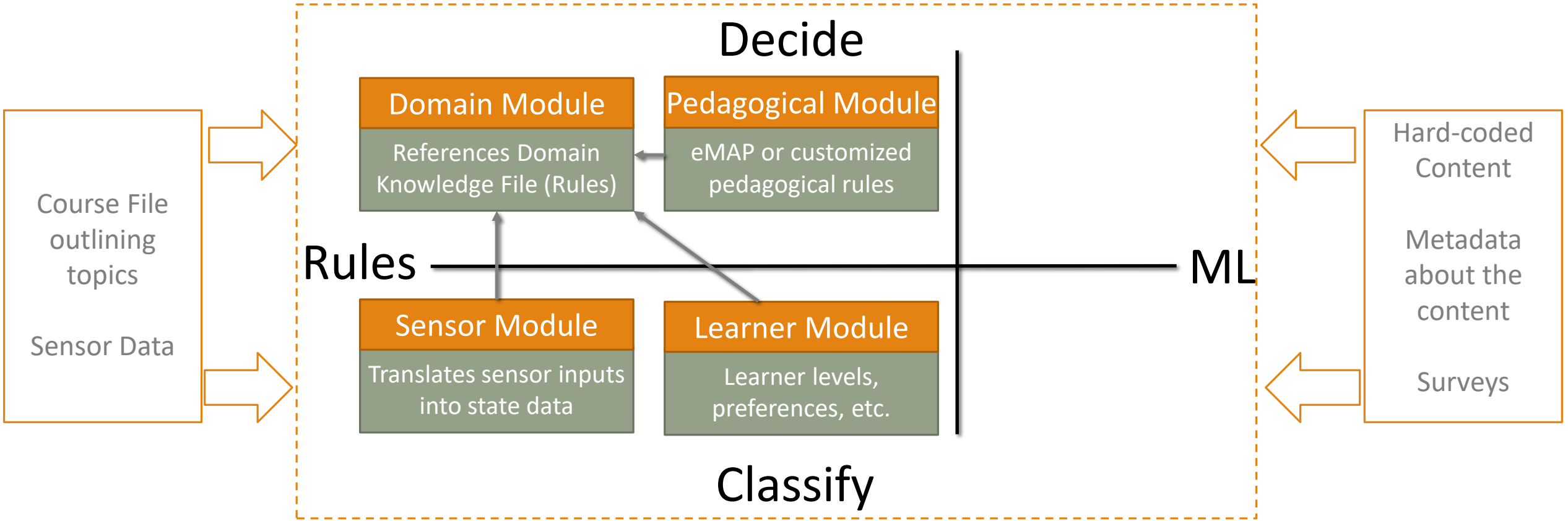
Generalized Intelligent Framework for Tutoring (GIFT)



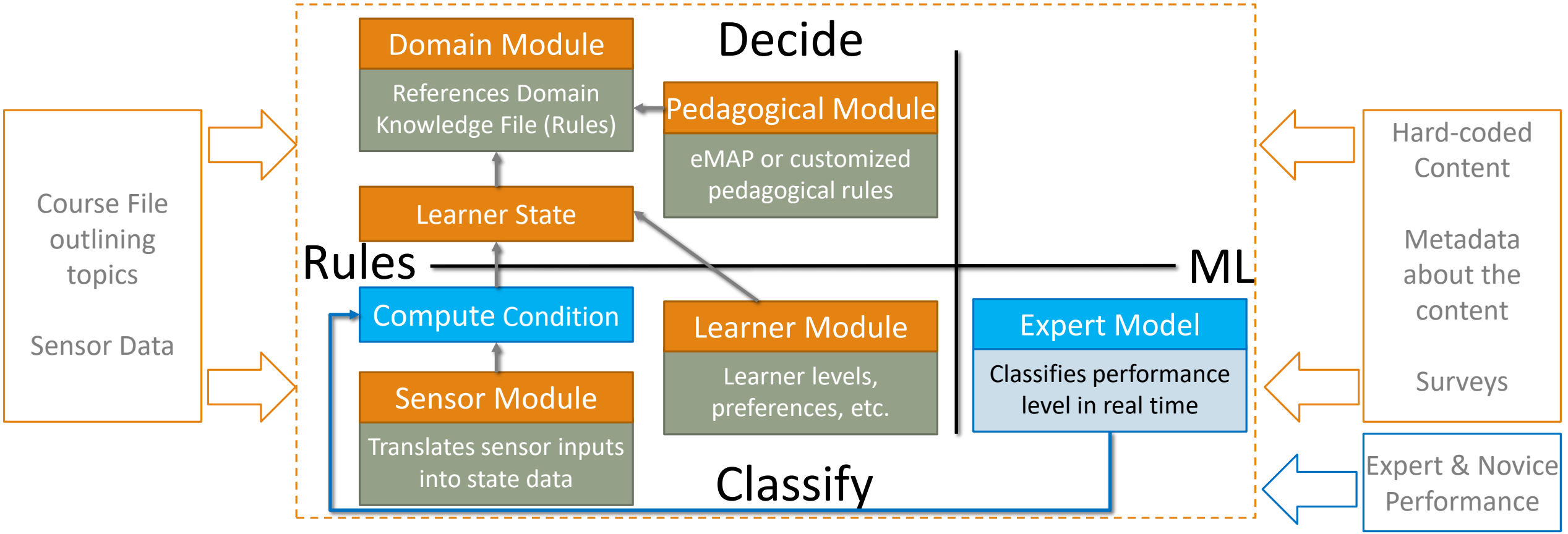
Instructional management has taken a leap forward with the development of the engine for managing adaptive pedagogy (EMAP) which examines learner domain competency, motivation, goal-orientation, and grit to aid in recommending courses and course paths for the learner, based upon research evidence (Goldberg et al., 2012). Domain modelling remains a complicated and challenging area for standardisation, but progress is being made in branching tutors from simple desktop tools for cognitive domains to more complex and dynamic tutors for psychomotor tasks.

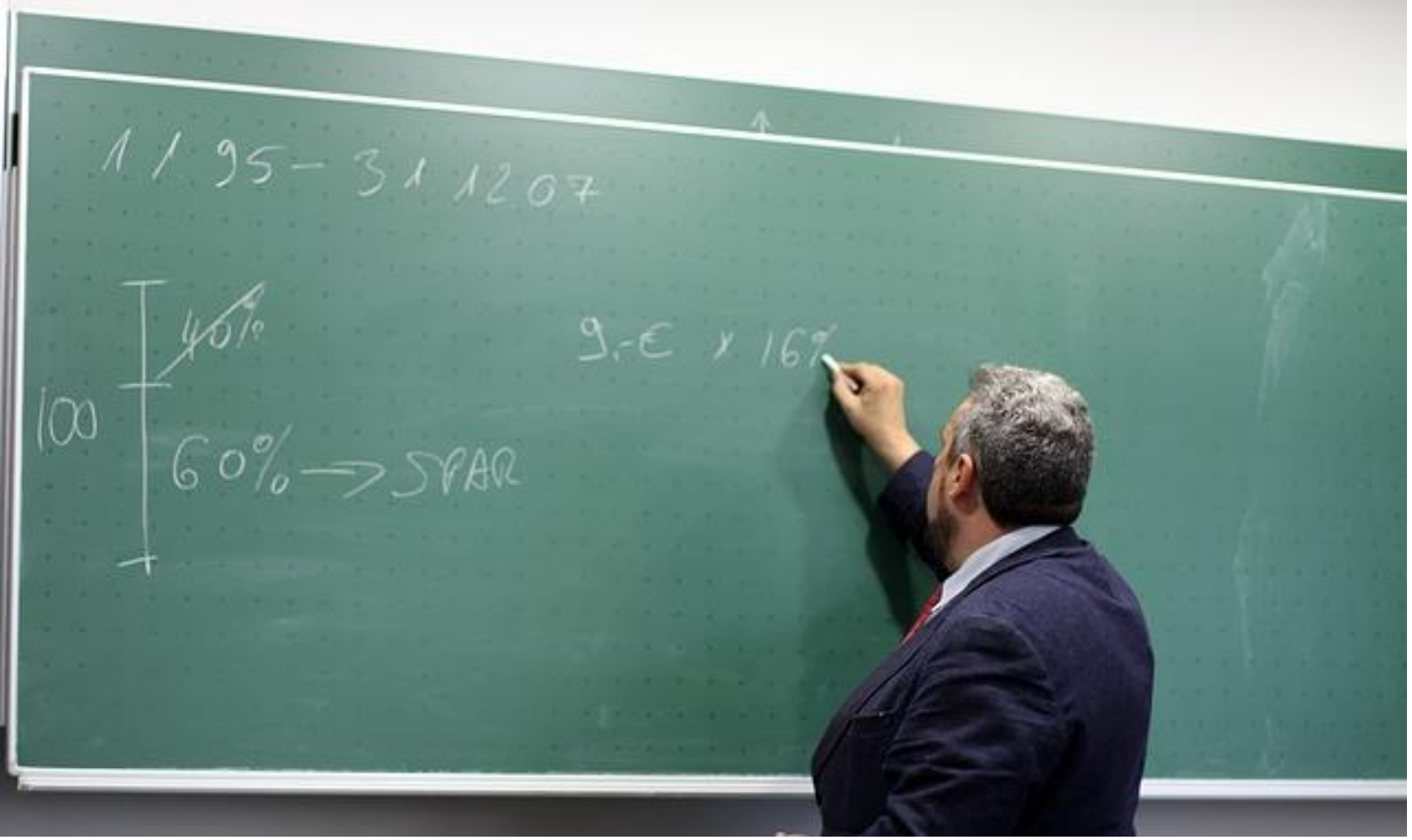
Brawner, Keith W., Anne M. Sinatra, and Robert A. Sottilare. "Motivation and research in architectural intelligent tutoring." *IJSPM* 12, no. 3/4 (2017): 300-312.

Generalized Intelligent Framework for Tutoring (GIFT)



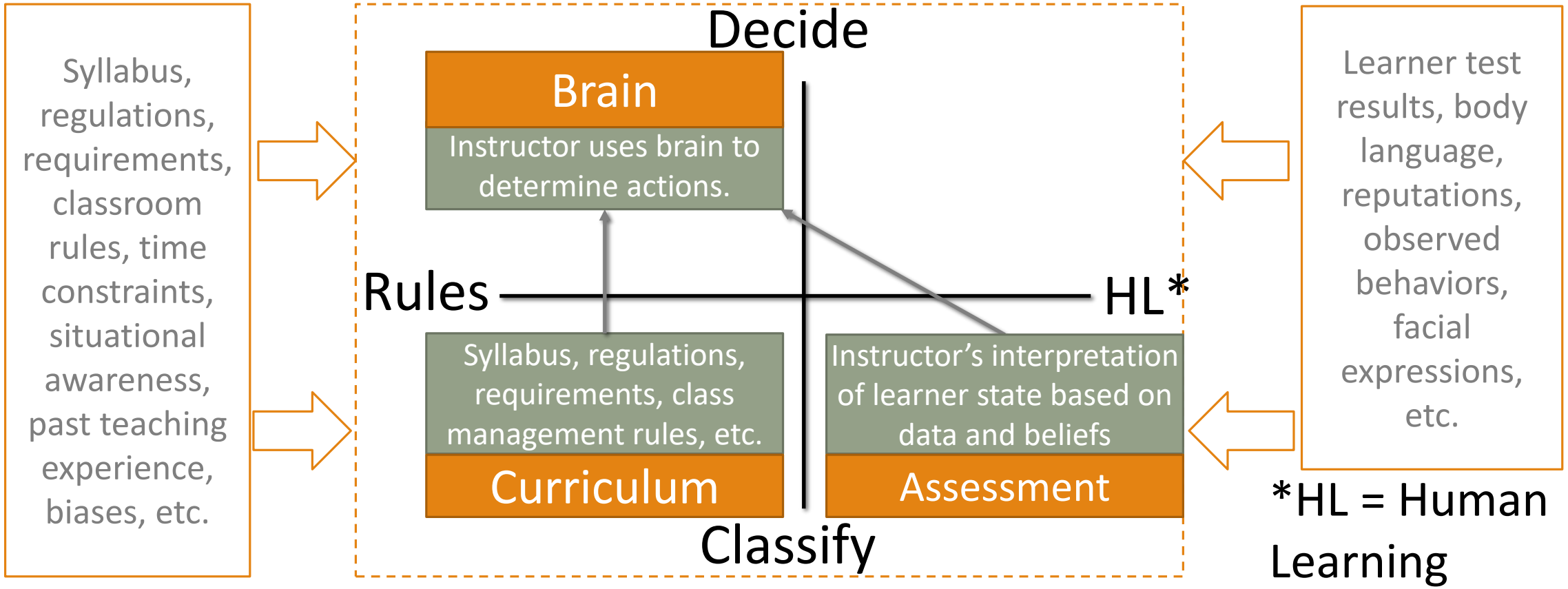
Generalized Intelligent Framework for Tutoring (GIFT)
(As used in Psychomotor Skills Training Agent-based Authoring Tool)

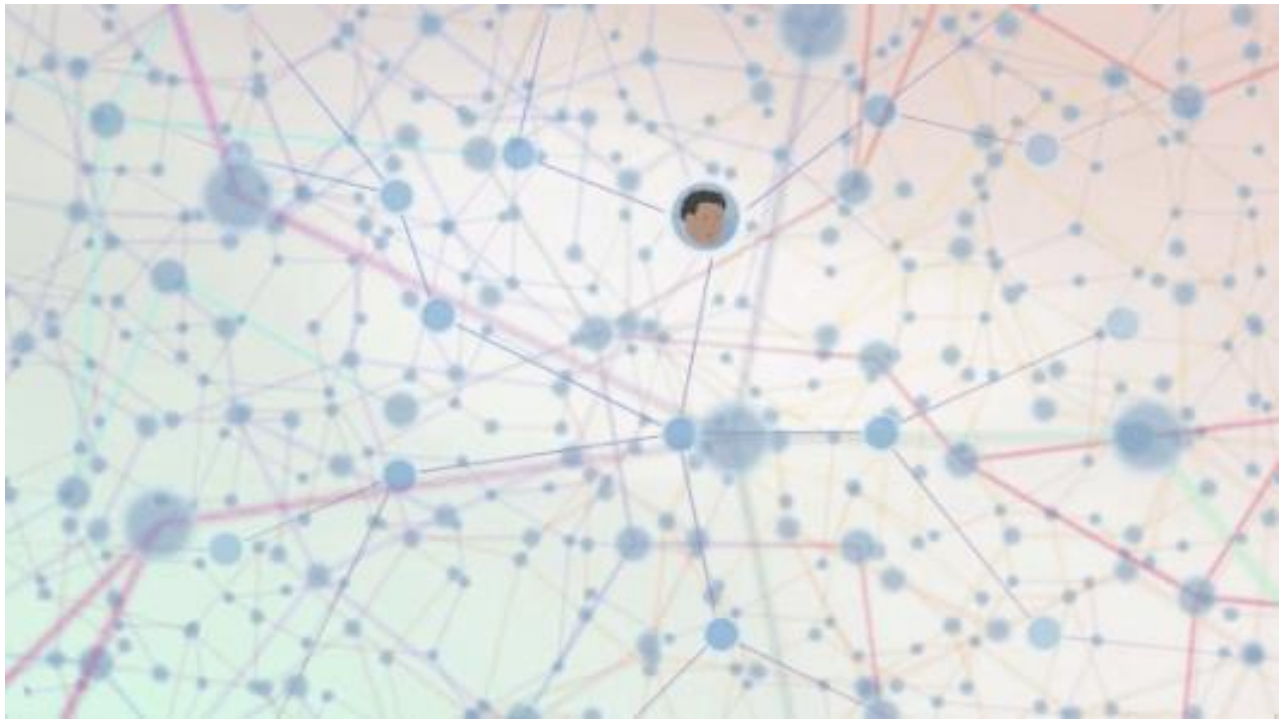




Human Instruction

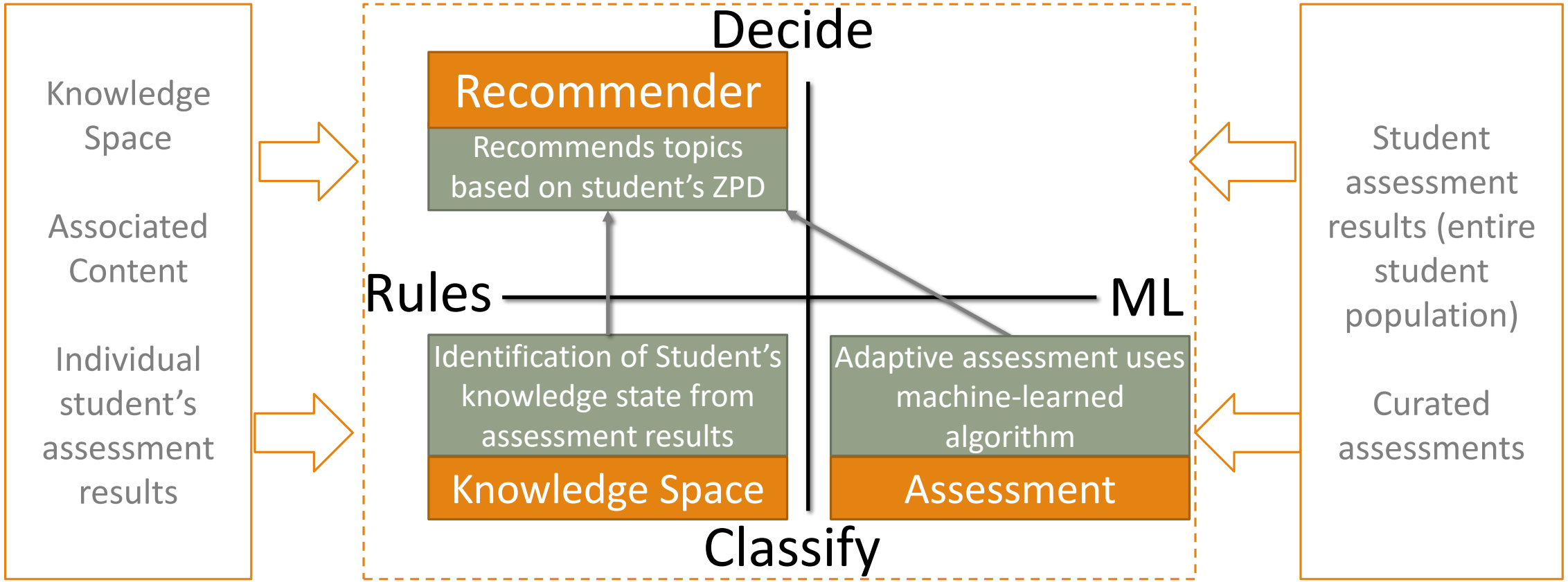
Human Instruction



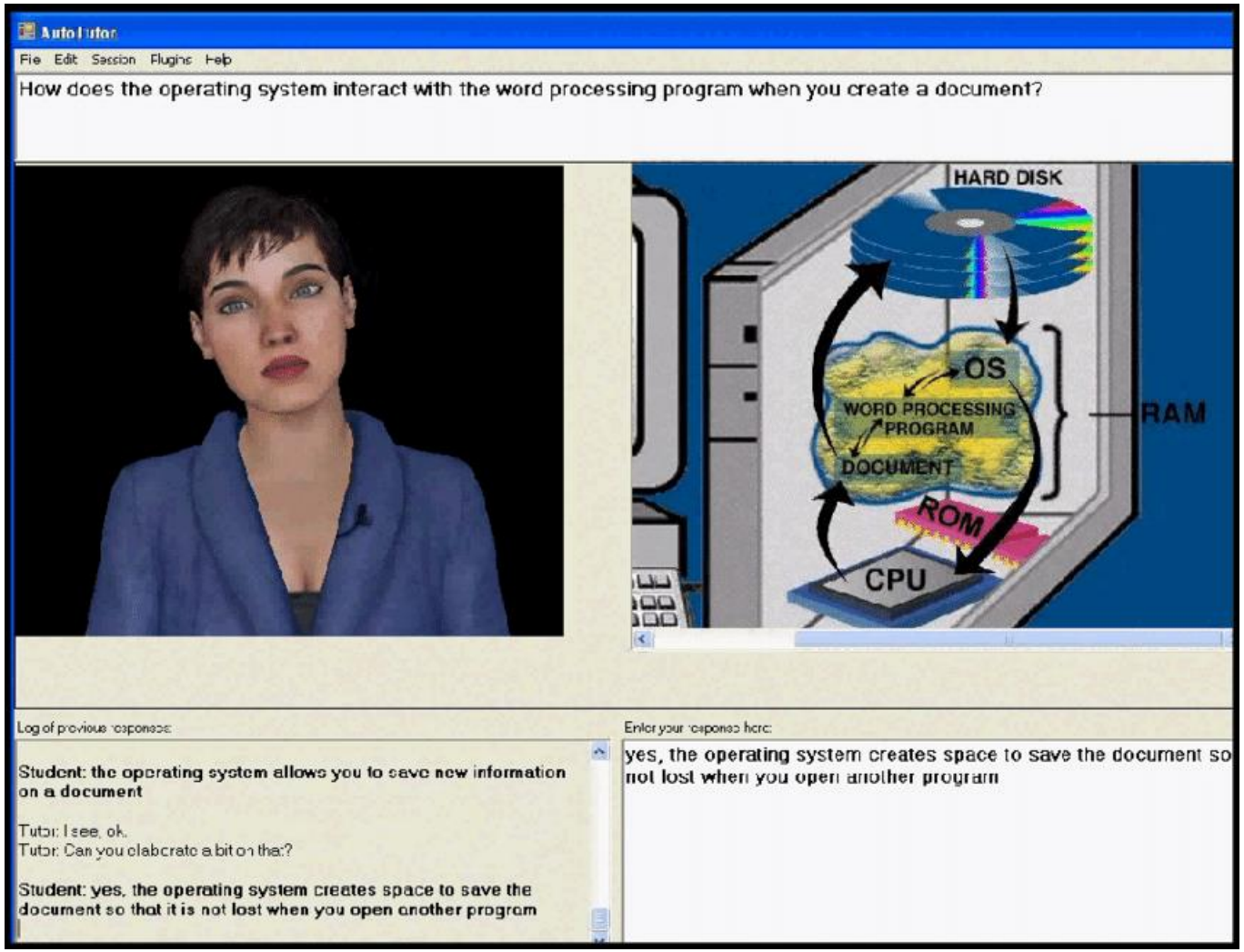


In ALEKS, the basic element of the graph is not an individual concept or topic, but a “knowledge state”, that is, the combination of topics that might constitute an actual state of student knowledge in a subject. We use “big data” to build knowledge spaces, which map the relations among the knowledge states, or feasible states of student knowledge. These knowledge spaces enable ALEKS to accurately determine which individual topics the student has already mastered, and which ones she is ready to learn. - **Smart ALEKS** INTERVIEW | by Victor Rivero, Ed Tech Digest, April 10, 2013

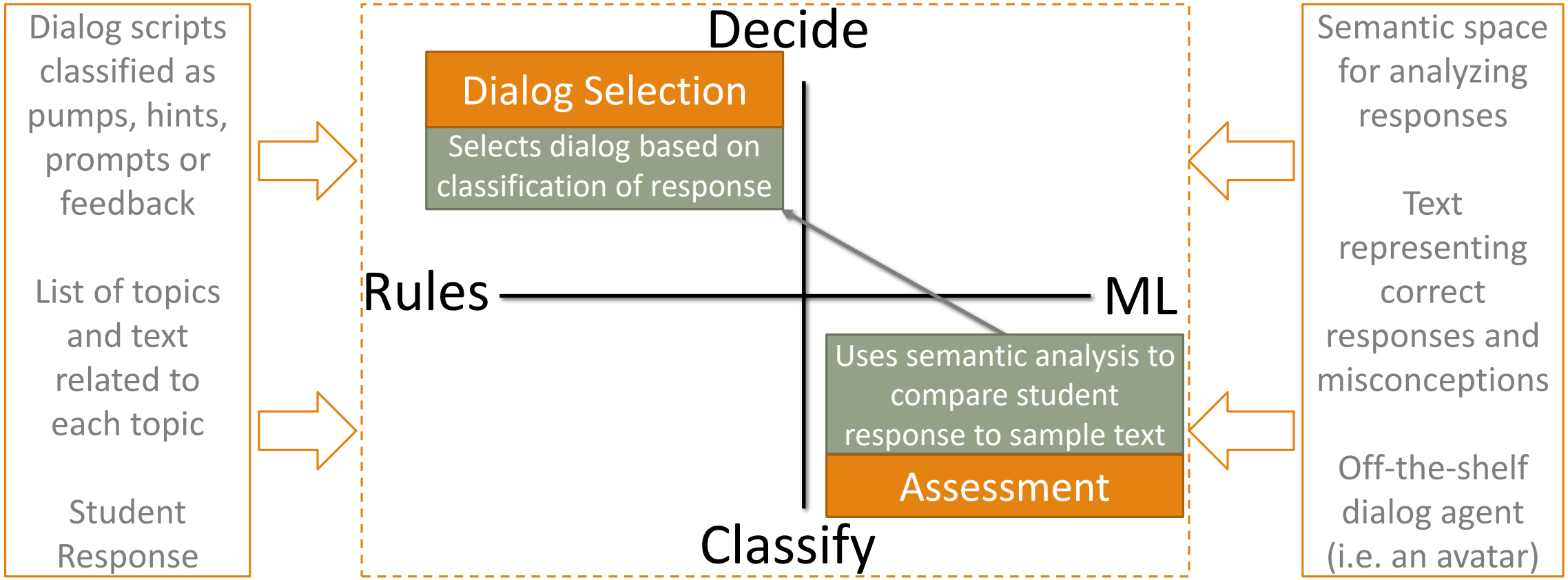
ALEKS


Knowledge Space
Associated Content
Individual student's assessment results
Decide
Recommender
Recommends topics based on student's ZPD
Rules
ML
Identification of Student's knowledge state from assessment results
Knowledge Space
Adaptive assessment uses machine-learned algorithm
Assessment
Classify
Student assessment results (entire student population)
Curated assessments

AutoTutor (Expectations / Misconceptions Version)



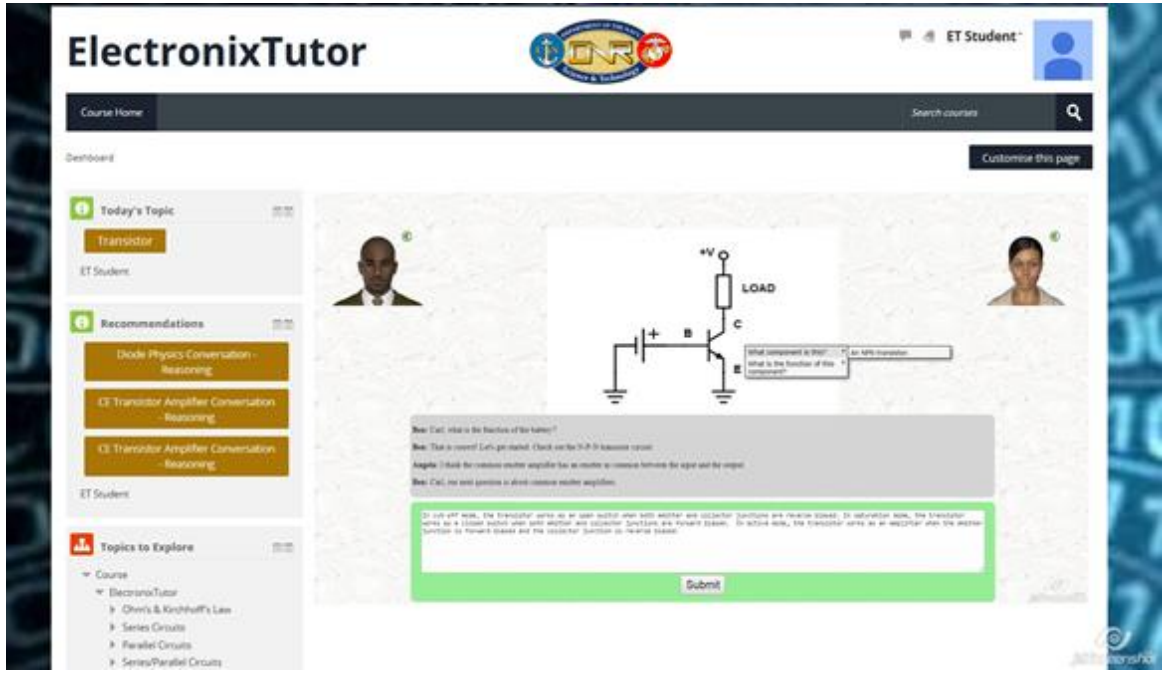
AutoTutor (Expectations / Misconceptions Version)



ElectronixTutor Recommender System

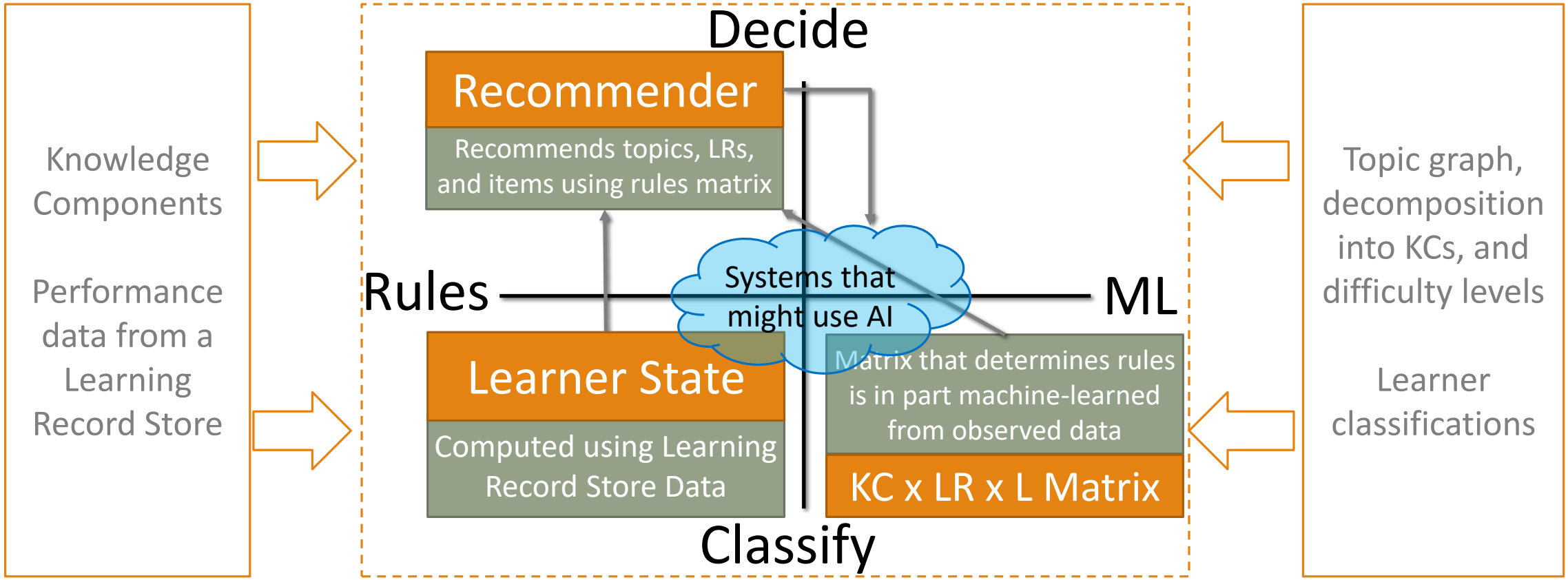
Art Graesser, 12/10/17

Older version



The purpose of this document is to specify the Recommender System for ElectronixTutor on the Moodle learning management system. The Moodle version is similar to the ASSISTment version, which is specified in Graesser et al. (2018, *International Journal of STEM Education*). That document should be read to understand the architecture of ElectronixTutor, the previous Recommender System, the Student Model (and the Learner Record Store), definitions of topics and their associated Knowledge Components, and the various Learning Resources: AutoTutor, Dragoon, BBN Multiple Choice questions, Skill Builders, BEETLE, succinct summaries to read about topics, NEETS documents, and topic bundles.

ElectronixTutor



Recap

Contact:
robby.robson@eduworks.com

Classifying the use of AI and Adaptivity is important for consumers, users, and producers

Part of an IEEE Standardization Effort (Standards for Adaptive Instructional Systems or AIS)

The most common uses of ML are for classification rather than decision making

Sophisticated rules engines are used for decision making (and seem very intelligent!)

This work is evolving

Try it yourself!