Guided Tours in ALeA

Assembling Tailored Educational Dialogues from Semantically Annotated Learning Objects

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Al4Al Workshop @ ECAl23 2023 - 09 - 30





Motivation

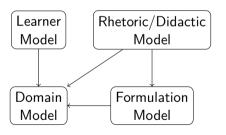
Education is becoming more diverse in terms of neurotypes, cultural and educational backgrounds as well as educational goals and more.

This is a good thing!

However, due to staffing and budget constraints, not all institutions can compensate. The shift to online delivery of course materials often does not address this.

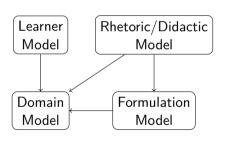


In ALEA, our learning-platform-shaped answer to these problems¹, we contend that any good educator (human or not) relies on four different models for teaching:



¹For details, please see: https://url.mathhub.info/CICM23ALEA/

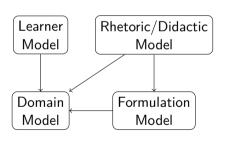
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 Domain Model Information about concepts and their relations

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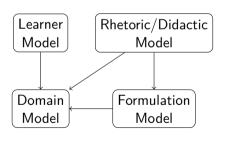
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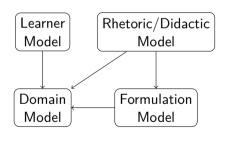
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- Rhetoric Model
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- Domain Model Information about concepts and their relations
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- Rhetoric Model
 Didactic classification of learning objects
- Learner Model
 Estimation of educatee competency distribution

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How we do it: Semantic annotation on the *concept level* in course materials.

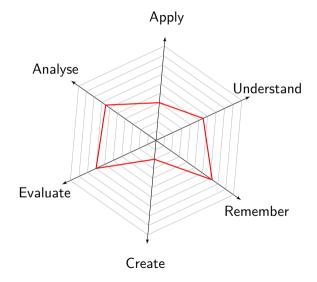
```
1 \begin{sassertion} [name=Pythagorean Theorem]
2 \importmodule [geometry] {right-triangle}
3 In a \symname{right triangle}, the \symname{square} of the
4 \symname{hypotenuse} is \symname{equal} to the \symref{plus}{sum}
5 of the \symnames{square} of the other two \symnames{side}.
6 Often, this is expressed as the formula
7 $\definiens{\equal{\plus{\square \a, \square \b}, \square \c}}.
8
9 \includegraphics{right_triangle.png}
10 \end{sassertion}
```

An Example STEX Fragment

The Learner Model

Our learner model uses a revised version of Bloom's taxonomy of educational objectives. It tracks six cognitive dimensions for every student for every concept they have encountered.

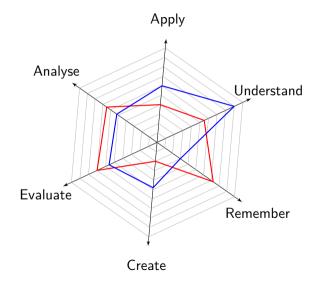
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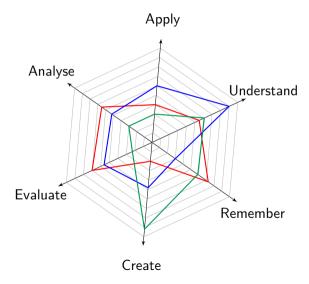
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This granular and precise learner model allows us to offer *tailored* educational services that take into account the knowledge state of the individual.

One such service are *guided tours*, minicourses assembled on the fly, that students can request for any topic. They begin at precisely their current knowledge level and step-by-step work up to the concept they wanted to understand. This is presented in dialogue form to mimic one-on-one tutoring.

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This topic concerns right-angled triangles. Do you already feel comfortable with that topic?

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In a right-angled triangle, one of the angles at the longest side is 60°. What would that make the other angle on the longest side?

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That is correct! Okay, let's talk about the Pythagorean Theorem.

Determine cutoff points. Learner L requests Pick a sink node in Guided Tour Granh remove dangling Guided Tour on dependency graph Empty? complete (any seed concept dependencies. Fetch Learner Model Find Learning Objects related to sink concept for dependency hull Fetch L's Communicate Learner Model for Backend computes progress and sink concents Consult logs which requested concept. source's dependency hull. next steps available? LOs are new to L topologically sorted Introduce that node's Reduce cooldown on used LOs concept to Learner (Familiar Definition). Is L's competency LOs out sufficient? L's comp. of cooldown sufficient? available? Ask learner to Evaluate via self-evaluate problem Undate Learner Model competency or adapt sufficiency threshold Pick ("most helpful") Set "cooldown" LO appropriate to for LOs used so far concept and current I M state Undate Undate Learner Model Dependency Set cooldown for (local & remote) Graph LO used, reduce other cooldowns Learner Learner skips LO fails LO Present chosen Learner LO to learner clears LO

Overview

The complete algorithm for guided tours in ALeA.

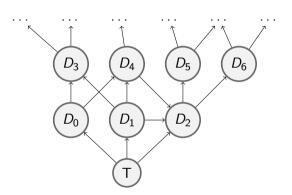
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Initialisation

Important points:

- Assemble the dependency graph of domain concepts
- No trivial guided tours allowed

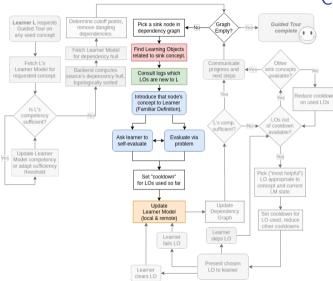
Aside: cut-off points



When we talk about *cut-off points*, we mean any concept in the dependency closure of our target that the educatee already understands "sufficiently".

We do not present them *or any of only their dependencies* to the learner, even if their dependencies are not yet "sufficiently" understood.

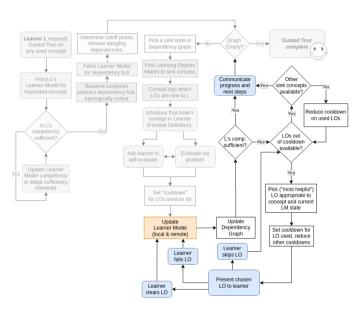
Concept Introduction



Important points:

- Always present familiar definition
- Cooldown to avoid LO doubling

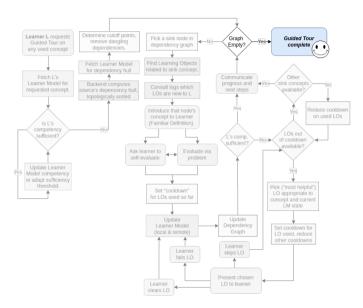
Learning



Important points:

- "Most Helpful" LO varies by context
- Updates to learner model can change graph.

Finish



When all relevant concepts in the dependency hull have been mastered, the guided tour concludes.

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Recap

Diverse educational backgrounds demand solutions tailored to the individual.

Semantic annotations of course materials using STEX allow for granular learner models.

Guided tours in ${\rm ALEA}$ are educational dialogues that are assembled for where the student is and where they want to go.