An Open and Inspectable Learner Modeling with a Negotiation Mechanism to Solve Cognitive Conflicts in an Intelligent Tutoring System

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Learner modeling tasks in ITS;
- High level of uncertainty;
- Probabilistic Learner Modeling in ITS;
- Opening and Viewing Learner Model;
- Presence of Cognitive Conflicts;
- Mechanisms for dealing with conflicts;
- Negotiating the open learner model.
**Research Questions**

- **Q₁**: What approach should we adopt to deal with uncertainty found in a learner model for ITS?
- **Q₂**: What is an appropriate way to define and viewing OLM?
- **Q₃**: How can we detect cognitive conflicts between the student and the system concerning problem solving activities?
- **Q₄**: How can we effectively address these conflicts?
How those Questions have been addressed?

With respect to $Q_1$ – Representation and Maintenance:

- Conati et al. [2];
How those Questions have been addressed?

With respect to $Q_2$ – OLM and Visualization:

- Zapata and Greer [5];
How those Questions have been addressed?

With respect to $Q_3$ and $Q_4$ – Conflicts detection and Negotiation:

- Bull et al. [1];
- Dimitrova [3];
- Thomson and Mitrovic [4].
Our General Approach

```
Curriculum Structure
  ↓
DBN
  ↓
Open Learner Model
  ↓
Visualization
  ↓
Cognitive Conflict
  ↓
Update Student Model
  ↓
Negotiation
```
The Open Learner Model

![Diagram of the Open Learner Model]

Learner Model

Mt

Ms

Tutoring Agent

Learner
The system put a problem to the learner: \( \frac{1}{3} + \frac{4}{3} \);

He declares his belief:
- Very unsure = 0.05;
- Unsure = 0.25;
- Almost sure = 0.5;
- Sure = 0.75;
- Very sure = 0.95.

Then, he submits a solution and the system evaluate it and returns a grade [0,1].
The Open Learner Model

(a) The $M_s$.  
(b) The $M_t$.

Figure: Task-specific part of the Learner Model.
The Open Learner Model

(a) The $M_s$.  
(b) The $M_t$.

Figure: Domain-general part of the Learner Model.
The Open Learner Model

**Figure:** The Visualization of the Learner Model.
The negotiation mechanism depends on the learner’s credibility:

**Figure:** The DBN of the learner's credibility.
### Negotiation Process

#### When the learner wants to change the tutor’s belief

<table>
<thead>
<tr>
<th>Credibility</th>
<th>L’s belief &lt; T’s belief</th>
<th>L’s Belief &gt; T’s belief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Persuasion</td>
<td>Persuasion</td>
</tr>
<tr>
<td>Medium</td>
<td>Persuasion</td>
<td>Cooperation</td>
</tr>
<tr>
<td>High</td>
<td>Persuasion</td>
<td>Cooperation</td>
</tr>
</tbody>
</table>

#### When the tutor wants to change the student’s belief

<table>
<thead>
<tr>
<th>Credibility</th>
<th>L’s belief &lt; T’s belief</th>
<th>L’s belief &gt; T’s belief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Support</td>
<td>Contestation</td>
</tr>
<tr>
<td>Medium</td>
<td>Support</td>
<td>Contestation</td>
</tr>
<tr>
<td>High</td>
<td>Support</td>
<td>Contestation</td>
</tr>
</tbody>
</table>
During the negotiation:
- The system can request that the learner proves his knowledge, or;
- The learner can request the opportunity of prove.

The proof process consists of:
- Two problems and the learner has two chances to solve each problem;
- Then, his model is updated.
Demonstration Scenario

**Dialogue about: Addition -> Different Denominator**

**System:**
- What would you like to do:
  - Request the system to explain its current belief:
  - Request that the system changes its current belief:
  - Suggest that the system changes its current belief:
  - Prove my knowledge

**System:**
- Consider the following solution:
  \[
  \frac{2}{3} + \frac{3}{5} = \frac{5}{8}
  \]
- Is this solution correct? Yes

**System:**
- The solution is correct!
- Solve the following problem:
  \[
  \frac{2}{7} + \frac{2}{5}
  \]

**Student's solution:**
- \[
  \frac{2}{7} + \frac{2}{5} = \frac{10}{35} + \frac{14}{35} = \frac{24}{35}
  \]

**System:**
- The solution is correct!
- The system belief about your knowledge on topic Addition -> Different Denominator was modified to BASIC.
- What would you like to do now:
  - Accept the opinion of the system:
  - Do not accept the opinion of the system and continue the dialogue of negotiation.

**Figure:** Example of Negotiation Dialogue Started by the Learner.
We are we going next?

- Improve the visualization, allowing the visualization of the two parts of the model;
- Put other evidences in the learner model: social characteristics, CV-curriculum of the student, collaborative information;
- Perform an experiment in a basic math classroom.
References


Thanks!!
For more information: http://tip.ic.ufal.br/site/