Master in Artificial Intelligence (UPC-URV-UB)

Master's Thesis Proposal

General Information

Master's Thesis Title:	**Intelligent Tutoring System for Geometric Problems in High School using Case-Based Reasoning**
Publication Date:	
Expiry Date:	
Modality:	☐ technological project ☒ research work
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Observations:	The master thesis is involved with the Departament de la Didàctica de les Matemàtiques UAB. Coordinator Dr. Josep Maria Fortuny.
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M.Sc. Thesis Description

Main issues / Brief Description:

Intelligent Tutoring Systems (ITS) is a software system that provides direct customized instruction or feedback to students, without the intervention of any human tutor, whilst the student is performing a task. Usually an ITS consists of four different subsystems or modules:
The *interface module*, the *expert module*, the *student module* and the *tutor module*. The *interface module* provides the means for the student to interact with the ITS, usually through a GUI. The *expert module* references an expert or domain model containing a description of the knowledge or behaviors that represent expertise in the subject-matter domain the ITS is teaching, often an expert system or cognitive model. The *student module* uses a student model containing descriptions of student knowledge or behaviors, including his misconceptions and knowledge gaps.
A mismatch between a student's behavior or knowledge and the expert's presumed behavior or knowledge is signaled to the *tutor module*, which subsequently takes corrective action, such as providing feedback or remedial instruction. To be able to do this, it needs information about what a human tutor in such situations would do: the *tutor model*.

In the area of educational studies in mathematics, the idea of an ITS for such areas as Geometry and Algebra is very appealing. Many students have serious difficulties for solving mathematical problems. A tutoring system can help them providing hints and messages that make the pupils rethink the problem. Furthermore with the incursion of dynamic geometry environments in the classrooms, the students are now very used to manipulate geometric forms with the help of the computer. Geogebra, for example, is one of these successful tools, used nowadays in almost all High Schools in Catalunya.

Detailed Description:

Recently, we had developed jointly with Educational studies in mathematics department in Autonomous University of Barcelona an ITS called AgentGeom [Cobo et al, 2007].
Using Geogebra as main GUI, we had developed the entire e-learning web platform for its use in the classrooms. A human teacher sets the *expert module*. For each problem proposed, the teacher solves the problem, as many ways he wants, using the same Geogebra GUI. This produces a guide of what is expected the student have to do. The *tutor module* has the main task of tracking the student along the resolution of the problem. If in any time the tutor noticed that the student is losing the way to a right solution, it has to provide a hint or message to try to redirect the student.

In this work, we start from a database of expert resolutions for several geometrical problems used in high school mathematical courses. These resolutions have been done using Geogebra primitives. The main idea is to use such resolutions as cases in a Case-Based Reasoning system. Therefore the t*utor module* can use this information for track the student along his way of solving a problem. This way of solving a problem can be seen as a planning task, which, eventually ends with the right solution of the problem. If the resolution that the student is doing differs too much from the plan issued by the human tutor, then the t*utor module* has to take an action that, by now, is to provide a message. This message is associated with the current state in the human tutor plan.

Considering the status of the project, the thesis work will involve the following tasks:

First task in this work is to adapt a CBR system for planning in our framework. Concretely in the *tutor module*, we take the geometrical resolutions of a concrete problem provided by the expert model as a plan. For this purpose, first of all, we have to automatically translate the geogebra format based on primitives of construction (saved of xml files) to a graph model that represents the CBR plan. Then it is necessary to check the performance of different similarity measures applied to the plan the student is doing and the ones from the expert module.

The second task is to develop the *student model*, which does not exist at the moment. The idea is to use CBR also, for designing a student profile. This profile is associated to the problems he/she had performed and the feedback messages that have been proved useful for the final resolution. This information can be used as feedback when the human tutor has to choose or create messages for other problems.

Finally, it should be desirable a tool for the *expert module*, that assesses a human tutor which problems, messages and resolutions have to choose for a concrete pupil, based on his interactive history.

References:

[Cobo et al., 2007] P. Cobo, J. Fortuny, E. Puertas and P. Richard, AgentGeom: a multiagent system for pedagogical support in geometric proof problems, *International Journal of Computers for Mathematical Learning* **12** (2007), pp. 57–79.

Other comments:

This master thesis may require some experimentation be done in situ at High Schools, with real students. These experimental sessions may be recorded for further analysis for experts in educational studies in mathematics. For this purpose, we count with the collaboration of several High Schools in Catalunya, like IES Pius Font i Quer located in Manresa.

Location and Date: 18 October 2010 Barcelona,

To the Academic Commission of the Master in Artificial Intelligence (CAIMIA)