An Agent-Based Hybrid Intelligent Tutoring System for Legal Domain

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Resumo. *In this paper we propose an agent-based hybrid Intelligent Tutoring System (ITS) for Legal domain by combining Case-based Reasoning (CBR) and Rule-based System (RBS). This system has been developed taking into consideration a Problem-based Learning as a pedagogical approach. The idea is to engage law students in interactions with the ITS based on the resolution of legal problems. The start point of these interactions occurs when ITS submits a penal situation to law students. Then, the students are expected to learn through two fundamental but different skills to solve legal problems. First, should have to know how to retrieve relevant cases and legal concepts about the cases, and second, how to use them effectively as examples for justifying positions in a legal argument.*

1. Introduction

Rule-based System and case-based reasoning are two known approaches that have been adopted in Intelligent Tutoring Systems (ITS). They are natural alternatives in knowledge representation. Rules usually represent general knowledge, whereas cases encompass knowledge accumulated from specific (specialized) situations. Each approach has advantages and disadvantages. Due to their interchangeable nature, rules and cases can be integrated and thus produce effective ITS. In this paper we propose an agent-based hybrid Intelligent Tutoring System (ITS) for Legal domain by combining artificial intelligence techniques as Case-Based Reasoning and Rule-Based System. This system has been developed taking into consideration a Problem-Based Learning as a pedagogical approach. ITS adopts tutor models that teach using CBR, checking the similarity with old cases to justify new problems.

According to [L. R. Reyes 2001], CBR used in ITS makes the system able to use references about old experience to identify strategies applied to similar situations. RBS was implemented to evaluate the rules about Normative Knowledge in the ITS. The idea is to engage law students in interactions with the ITS based on the resolution of legal problems and its consequences on other tutorial activities. The start point of these interactions occur when ITS submits a penal situation to law students. Then, they will learn two fundamental but different skills about legal problems. First, know how to identify relevant cases and legal concepts (normative knowledge, for instance) about the cases, and second, how to use them effectively as examples justifying position in a legal argument.

To find relevant cases, an arguer must first analyze the problem situation to identify the legal issues that it raises and the factual strengths and weakness of each with respect to the issues. When using an automated information retrieval system, one needs to frame a query os a set of queries that capture the issues and the intended use of the cases in a argument[Aleven and Ashley 1993]. Case-based reasoning was used to make know what kind of cases can result better solution and rule-based reasoning to find betters concepts, and consequently give skills for better explanation about the problem.

When the ITS poses problems to students, it has to provide evaluations to the solutions presented. Considering the results from diagnosis phase, in case of problems, the ITS helps the law student to perform the problems giving the adequate argumentation in the problem solving process. On the other hand, the student can submit a penal situation problem to the tutoring system. The solution returned of the tutoring system for the student is an argumentation using normative knowledge, doctrine knowledge and jurisprudence similar with the problem. In our ITS, the knowledge about the domain is decomposed into small learning units, which are connected to one another by means of semantic associations. Then, each unit is associated with a set of problems and a list of pedagogical resources.

This paper is organized as follows. In section 2, some background knowledge to our proposal is presented. In Section 3, we present the proposed system architecture and in Section 4, we discuss the dynamic of this architecture. In Section 5, some illustrative scenery is presented . Finally, the conclusions are presented in Section 6.

2. A Notion of Law and Hybrid Solution

A hybrid system combines more than one method of reasoning in order to attempt to answer a legal problem. Hybrid System typically combines the two major forms of reasoning: rule-based System (RBS) and case-based reasoning (CBR) [O'Callaghan et al. 2003].

The approach of case-based reasoning can be contrasted with that used in other knowledge-based system, such as rule-based System. In rule-based system, one have a rule base consisting of a set of production rule of the form: IF A THEN B, where A is a conditional and B is the act [Sankar K Pal 2003]. Case-Based Reasoning is an approach to the solution of the problems and to the leaning with past experience[Christiane G. von Wangenheim 2003].

A good example that combines Artificial Intelligence techniques as case-based reasoning and rule-based System in legal domain is the system GREBE. GREBE combines both the architecture blackboard architecture and distributed AI methods for creating hybrid systems.

It is impossible to represent the world with scrupulous attention to detail without approaching some concepts used in the present work. In order to represent the mechanism of hybrid solution to the legal domain, it is necessary to restrict a small number of concepts which are meaningful and sufficient to interpret the world and provide an adequate representation for a certain goal. **Norms** are the most important elements of legal systems. An adequate definition of a norm is 'a statement to the effect that something ought to, ought no to, may or can be done[van Kralingen 1997]. A central part of the

interaction in the tutoring system consists in evaluation of **process**; the way to ”make”the law act to solve problems in the society [Acquaviva 1988]. The process are the cases that will be judge After the judgment, the process will be called by jurisprudence that are the cases judge by the society or competent organs. The concepts approaches above are called **doctrine** that is the translation of a competent person of the legal world about the term.

3. System Architecture

The proposed ITS architecture is based on the Problem-based Learning approach using the rule-based System and case-based reasoning for supporting students attempting to solve legal problems. This architecture supports learning sessions organized on the basis of problem solving and its consequences by using other pedagogical resources such as examples of the generality applied to specific instances, hints etc. A range of cases and problems are provided, and the students are encouraged to work on different difficulty levels. The agent-based architecture and its components are presented in Figure 1. The interaction between the law student and the tutoring system can happen in two main ways. First, the tutoring system submiting the student to a penal situation, and second, the student submitting the tutoring system to a penal situation. We adopted an ontology, see Figure 2, that represents the base of the legal knowledge for the use of the Intelligent Tutoring System.

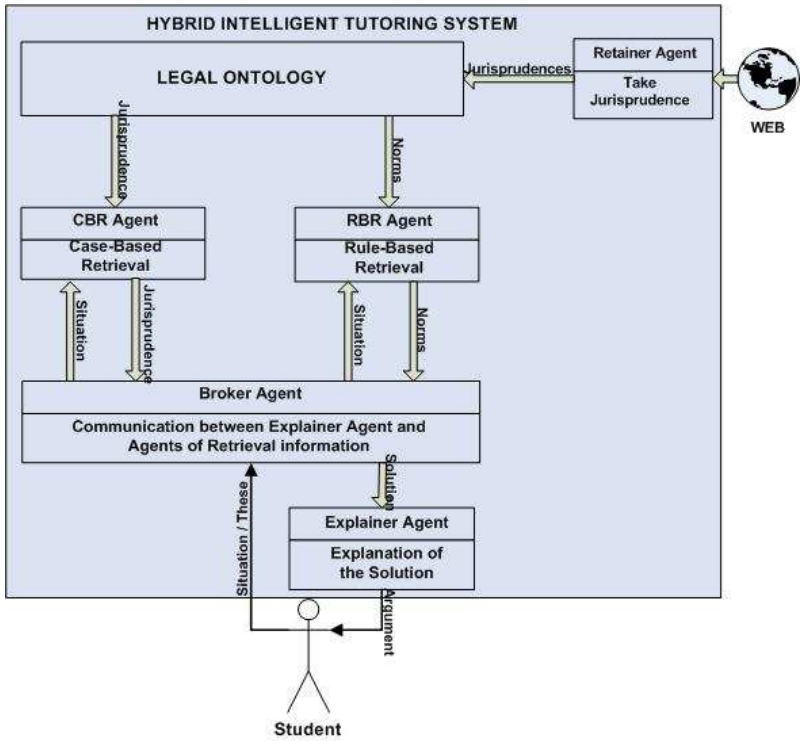

Figura 1. Intelligent Tutoring System Multiagent Architecture

3.1. Legal Ontology

Ontology make explicit to what conceptualism of terms a particular knowledge based system is committed. In constructing a knowledge base one has to make commitments anyway, so making them explicit in an ontology enables more controlled development

and also maintenance of knowledge based system [Joost Breuker 1999]. A prototype about the ontology was developed in Protegé. Legislation and jurisprudence were done to model the rules and cases, respectively. Others informations were modeled in protegé, like doctrine.

Let us consider the legal knowledge of the intelligent tutoring system used in the ontology below.

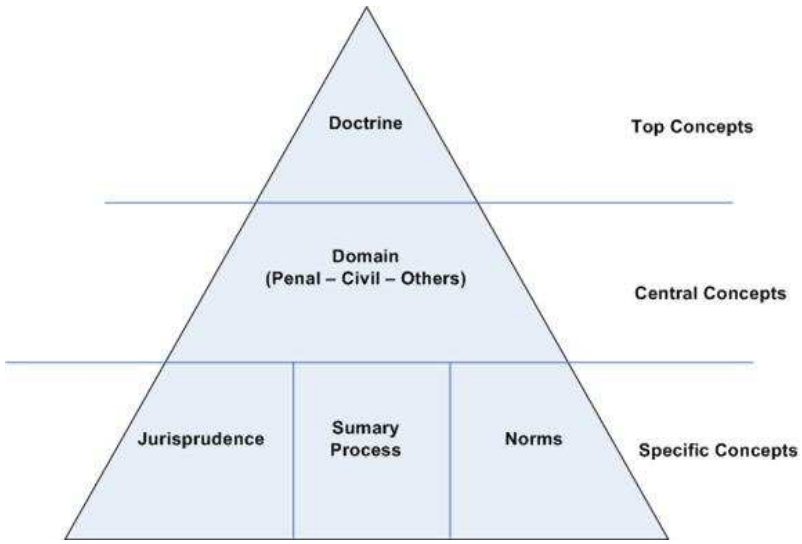

Figura 2. Legal Ontology

The legal concepts described in the figure 2 will be explained in the article according to the agent functionalities. For instance, jurisprudence will be used by Case-Based reasoning to make evaluations about similarity. For the complete view of legal ontology, see [Joost Breuker and Winkels 1997].

Besides the knowledge about the domain, the legal ontology approached above keep information about the student.

3.2. CBR (Case-Based Reasoning) Agent

The CBR Agent is responsible for the evaluation of similarity between the jurisprucences(inserted in the base cases) and the penal situation sent by law student. Below, follows the case-based reasoning model for the intelligent tutoring system.

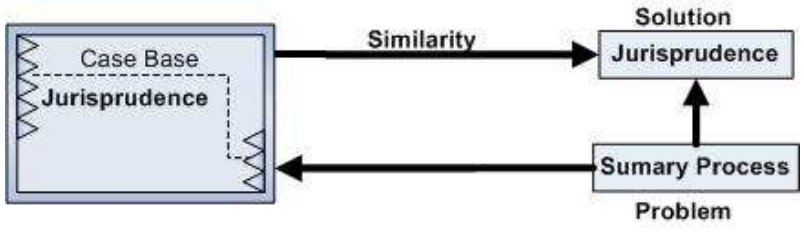

Figura 3. Basic Model of the Case-Based Reasoning to the intelligent tutoring system

As you can see, the solution returned from the CBR Agent are jurisprudences that will be send to the Broker Agent. The folowing are the techniques used in the case-based reasoning for the System.

Tabela 1. Techniques in Case-Based Reasoning

CBR Cycle	Techniques Used for ITS
Similarity	String Was used for the Global and Local Similarity
Knowledge Representation	Parts of the jurisprudence were indexed. See [Lee 1998]
Case Retrieval	Double Level-Two technique, used the first to the more important index
Case Adaptation	Without need, Because the jurisprudence can not be changed
Retention Case	Without need, because jurisprudences differ from the penal situation

3.3. RBS (Rule-Based System) Agent

RBS (Rule-based System) Agent is responsible for the rules evaluation in the legal ontology. The rules are set according to normative knowledge, which makes the whole validation of a penal situation. The uses of the rules are fundamental for the law students learn about the domain. The table below approaches any of the topics evaluated by the rule-based agent

Tabela 2. Rules Treatment

Rules	Goal
Normative knowledge about crimes	Features of a crime
Crimes	Evaluate the validation of the crime
Nullities	Evaluate if there is some nullity situation in the case
Penal Inimputability	Evaluate if there is some situation that cancel the case
Competences	Evaluate if the process is really a penal process

The following is the model about rule-based System for the intelligent tutoring system.

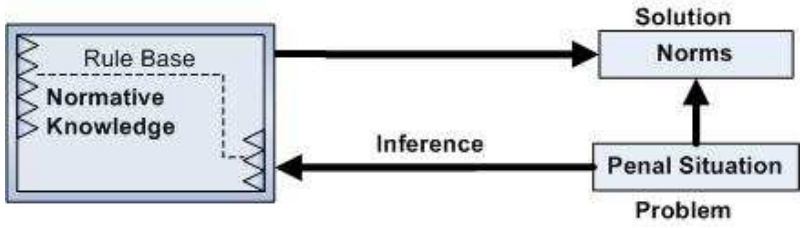

Figura 4. Basic Model of the Rule-Based System to the intelligent tutoring system

The knowledge representation of the rules is based on the normative knowledge according to *Brazilian Code*.

Case-Based Agent and Rule-Based Agent play the rule of an expert module approached in the Classical architectures of ITS.

3.4. Broker Agent

The Broker Agent is responsible for the academic informations, and delegate actions for the Rule-Based Reasoning Agent - RBR Agent - and Case-Based Reasoning Agent - CBR Agent.

To Broker Agent ”work”in two ways, described below

- **First**: The agent receives the information (penal situation) from the law student. In this case, the agent send the information to CBR Agent and RBR Agent;
- **Second**: The agent receive the information from the CBR Agent and RBR agent and send the information to the explainer agent.

3.5. Explainer Agent

The Explainer Agent is responsible for the treatment of the solutions returned from the Rule-Based System Agent - RBR Agent - and Case-Based Reasoning Agent - CBR Agent and provide a good argumentation that should be send for the law students. The functions of the Explainer Agent are:

- To Argument about the penal situation submitted from the student;
- To Argument about the penal situation submitted by the student to the system;
- To counterargument, if necessary, the thesis is sent to the system.

The Explainer Agent uses the doctrine to make the explanation about the solution in the system, working as a Tutor Module and Student Model in the architectures of ITS.

3.6. Retainer Agent

One of the biggest problems found in Case-Based Reasoning systems for the legal domain refers to the jurisprudences that update everyday. To solve this problem, we inserted a Retainer Agent in the intelligent tutoring system for evaluation of new jurisprudences in the WEB in specific web pages. The knowledge acquisition is not automatic because problems can happen in the data caused due to the inconsistent sites in the WEB. Finding a new jurisprudences, the agent acts as a knowledge engineer indexing the jurisprudence to store in the legal ontology.

4. Interactions between law students and the ITS

The interaction between the law students and the tutoring system can happens when the student submits the tutoring system to a penal situation and the system tutor submit the student to a penal situation. The Figure 5 illustrates the main interactions between law student and tutoring system.

4.1. Pedagogical Approach

As you can see in the interaction above, the pedagogical approach used to interact with the student was *problem based-learning*. Before the system return a solution to the law student, an evaluation is made to determinate the level of difficulty sent the student to the system. According to the evaluation, the system propose another penal situation more difficulty than the prior one.

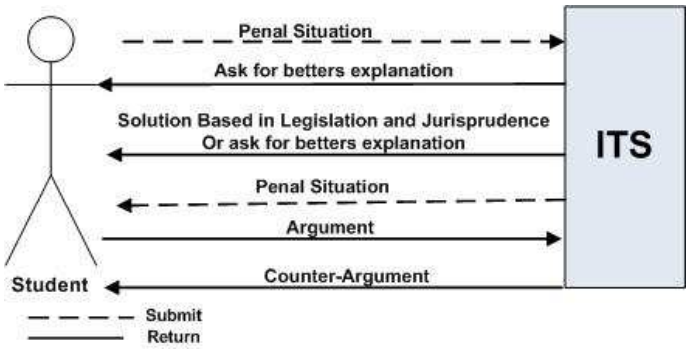

Figura 5. Complete submits interaction Model between law student and tutoring system

4.2. Student submits a penal situation to ITS

The law student can submit a problem of a penal situation to the tutoring system, and the situation can be a simple example of a crime or a summarized penal process. The solution returned from the tutoring system to the student is an argumentation of the solution with the articles and jurisprudences associated to the penal situation (figure 6) or an ask for betters explanation.

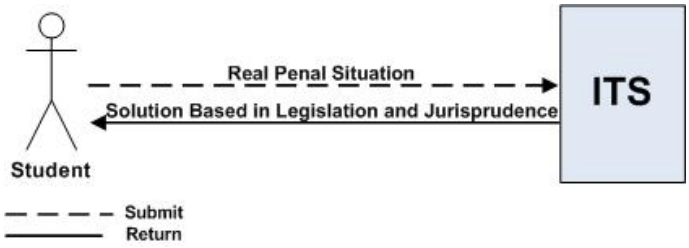

Figura 6. Law Student submits penal situation to the tutoring system

4.3. ITS submits penal situation to Student

The tutoring system can submit a problem of a penal situation to the law student, and the situation can be a simple example of a crime as well as a summarized penal process. In this situation, the student will act as a lawyer and he should return to the tutoring system a defense thesis/argumentation. After, the tutoring system should evaluate the academic's

argumentation and return a counter-argument of the evaluation, if necessary(figure 7).

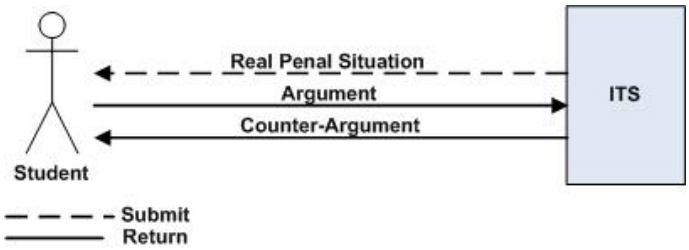

Figura 7. Tutoring System submits penal situation to the law student

5. An Illustrative Scenery

For the best understanding of the system, an illustrative scenery of a penal situation will be approached below, for which the law student could interact with the Intelligent Tutoring System, for Problem-Based Learning. In what follows we have the mentioned penal situation.

The law student can submit the following situation to the Tutoring System, as you can see in figure 5.

First Part(Law Student submits to the system a penal situation).

Student: "João got a gun to defend his cousin José who was being attacked violently. Having missed the target, he shot Mario who walking on the other side of the street and killed him."

Second Part(System ask for betters explanation).

Tutoring System: "Unfortunately, the problem described has no enough information, please, try to detail the problem as much as you can."

Third Part(Student detailed the problem).

System: "Unfortunately, the problem described has no enough information, please, try to detail as much as you can the problem."

Law Student: "João got a gun to defend his cousin José who was being attacked violently. Having missed the target, he shot Mario who walking on the other side of the street and killed him. **João percept that Mario has less than fourteen years and tried to run.**"

Comment: When the student submits the penal situation to the Tutoring System, the Broker Agent is responsible for passing the information to the Case-Based Reasoning Agent - CBR Agent - to find similar jurisprudences, and to the Rule-Based System Agent - RBR Agent - to evaluate similar rules about normative knowledge. After the evaluation of the CBR and RBR Agents, they return the solutions to the Broker Agent. The Broker Agent passes the solutions to the Retainer Agent to generate the argumentation of the solution to the student.

Fourth Part(System return the solution).

Comment: The argumentation of the Retainer agent is based on the doctrine and about the results of the inference about the RBR and CBR agents. In what follows there is an example about argumentation in the system.

"System(Normative Knowledge): Art. 121 (Simple homicide) of the Brazilian Penal Code."The Penal Code in the Title I, Of the Crimes Against the Person, Chapter I, Of the Crimes Against the Life Mentions that the Homicide is simple when somebody is adapting in the caput of Art. 121. To kill somebody: and it is it qualified Homicide, § 2nd. If the homicide is made: II - for futile reason."
Argument generated by the system:"João did not intend to kill José. He shot to scare João's aggressor. Even though he shot Mario deadly.
"*Similar Jurisprudence*: RESOURCE IN "STRICTO SENSO- SENTENCE OF PRONUNCIATION - SIMPLE HOMICIDE - ATTEMPT - PRELIMINARY OF NULLITY OF THE PRONUNCIATION - MERIT - SELF-DEFENCE - REQUEST OF SUMMARY ACQUITTAL - IMPOSSIBILITY - UNANIMOUS - being a well-based sentence, which demonstrates, clearly, the reasons of the convincing of the magistrate, there is not to speak in nullity of the pronunciation. It did not demonstrate the thesis of the legitimate defense satisfactorily, the subject should be submitted to the appreciation of the jury's tribunal, organ constitutionally competent to judge the deceitful crimes against life."
comment: As you can see, the tutoring system used three different ways to define a good argumentation about the problem.

Fifth Part(System propose other problem to the law student).

System: "The prior problem was very good. Congratulations!!! Now, try to think about this problem:

"Pedro is a famous manager and he was late to a business meeting, then he passed from the traffic signal and crashed the car in other car. There were in the other car one woman (she was pregnant) and one children. The children and Pedro survived, but the girl and the baby no. "

The scenery was just a basic illustration of one of the resources of the Intelligent Tutor System. The Scenery approached a simple penal situation where the communication was illustrated between the agents and the interactions between the legal student and the Intelligent Tutor System.

6. Final Remarks

This paper described a hybrid ITS which pose problem to the law students and giving them appropriate tutorial feedbacks, and consequently, support to human learning. Our prototype has been used with three types os domain knowledge (Jurisprudence, Normative knowledge and doctrines). At the moment, we have already developed a prototype of the multiagent ITS. We have described a Case-Based Reasoning and Rule-Based System model that integrates jurisprudence and the application of the corresponding legal concepts in the problem solving process. Also, a holistic view of each individual student is stored, allowing the tutor to be highly individualized.

We have worked to find an instructional plan that provides good hints to student in the learn process. Also, turn the system into an open architecture is other situation that will be evaluate along the development of the system. Finally, we plan evaluate the current system with legal academics to improve the system's robustness and to find an effective similarity measure to be added to Case-Based Reasoning Agent.

Protegé was used to create the knowledge representation. The tools Eclipse, Jess and JADE will be used to develop the system.

Referências

Acquaviva, M. C. (1988). *Dicionário Enciclopédico do Direito*. Brasiliense, São Paulo.

Aleven, V. and Ashley, K. D. (1993). What law students need to know to win. In Jones, R. P. and Russell, K. V., editors, *Proceedings of the Fourth International Conference on Artificial Intelligence and Law*, pages 115–129, Abingdon, UK: Carfax Publishing Co. University of Melbourne.

Christiane G. von Wangenheim, A. v. W. (2003). *Raciocínio Baseado em Casos*. Manole.

Joost Breuker, A. V. and Winkels, R. (1997). Legal ontologies: A functional view. In Visser, P. and Winkels, R., editors, *Proceedings of the 1st International Workshop on Legal Ontologies*, pages 23–36, Melbourne, Australia. University of Melbourne.

Joost Breuker, Antoniette Muntjwerff, B. B. (1999). Ontological modelling for designing educational systems. In *AI-ED 99 Workshop on Ontologies for Educational Systems, Le Mans, France. IOS Press*.

L. R. Reyes, R. S. (2001). A case-based reasoning approach to an internet agent-based tutoring system. In Redfield, C. and W.L.Johnson, editors, *Artificial Intelligence in Education: AI-ED in the Wired and Wireless Future*, pages 122–129. IOS Press, Amsterdam.

Lee, R. (1998). *Pesquisa Jurisprudencial Inteligente*. Tese de doutorado, Programa de Pós-Graduação em Engenharia de Produção, Universidade Federal de Santa Catarina.

O'Callaghan, T. A., Popple, J., and McGreath, E. (2003). Shyster-mycin: A hybrid legal expert system. In *ICAIL*, pages 103–104.

Sankar K Pal, S. C. K. S. (2003). *Foundations of Soft Case-Based Reasoning*.

van Kralingen, R. (1997). A conceptual frame-based ontology for the law. *Proceedings of the First International Workshop on Legal Ontologies*.