A Model of Pedagogical Negotiation

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Abstract. This paper presents a model of pedagogical negotiation developed for the AMPLIA, an Intelligent Probabilistic Multi-agent Learning Environment. Three intelligent software agents: Domain Agent, Learner Agent and Mediator Agent were developed using Bayesian Networks and Influence Diagrams. The goal of the negotiation model is to increase, as much as possible: (a) the performance of the model the students build; (b) the confidence that teachers and tutors have in the students' ability to diagnose cases; and the students' confidence on their own ability to diagnose cases; and (c) the students' confidence on their own ability to diagnose diseases.

1 Introduction

The paper discusses the pedagogical negotiation process and the model involved in the implementation of a real environment – AMPLIA [1].

Discussions about the use of negotiation mechanisms in learning environments are not recent. According to Self [2], there are two major motivations for the use of negotiation in ITS: i) they make possible to foster discussions about how to proceed, which strategy to follow, which example to look for, etc. in an attempt to decrease the control that is typical of ITS, and ii) they give room for discussions that yield different viewpoints (different beliefs), provided that the agent (tutor) is not infallible.

The approach of pedagogic negotiation can be applied to areas of knowledge that share some characteristics such as incomplete knowledge and different points of view or even domains where there is no "knowledge" – considered in its classical definition, in which knowledge is always something true – but a set of justified beliefs about what one can argue and debate. These characteristics foresee the transformation of viewpoints, both from the system and student, into beliefs instead of knowledge. This implies a special type of teaching dialogue, provided that an interactive change of justified beliefs is a simplified definition of argumentation [3]. This is a complex process because it involves the student's autonomy, the symmetry of relations among teacher and students or among agents, and the levels of flexibility, which involve the agents' level of freedom to perform their actions [4]. We do not see the presence of 'conflict' (either openly declared or acknowledged or not) as essential in the definition of negotiation. The basic requirement is that the interaction among agents

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shares a common goal so that an agreement is reached with respect to the negotiation object. Usually, different dimensions of the negotiation object will be negotiated simultaneously. The initial state for a negotiation to take place is the absence of an agreement, which can include a conflict or not. In the case of a teaching and learning process, a point of conflict is the relation of self-confidence and mutual confidence between teachers and students, besides their own beliefs about the knowledge domain. A process of teaching and learning is a way of reducing the asymmetry between the teacher's and the student's confidence on the topic studied.

AMPLIA was designed as an extra resource for the education of medical students [5][6]. It supports the development of diagnostic reasoning and modeling of diagnostic hypotheses. The learner activities comprise representing a clinical case in a Bayesian Network (BN) model; such a process is supported by software agents. BN have been widely employed in the modeling of uncertain knowledge domains [7]. Uncertainty is represented by the probability and the basic inference of the probabilistic reasoning, that is, the calculus of the probability of a variable or more, according to the evidence available. This evidence is represented by a set of variables with known values.

The main goal of a pedagogic negotiation is to provide and establish a high degree of confidence[1] among the participants of the process. We are not talking about a generic confidence, but about a very specific and objective one, associated with the abilities the student demonstrates when dealing with the learning domain. The degree of belief on an autonomous action is an important component of confidence that will take place in a given teaching and learning process, that is, how much the student's actions are guided by trials or hypotheses. This variable corresponds to the system's *credibility* on the student's actions and is inferred by the Learner Agent. *Self-confidence* (the confidence the student has on his BN model) is another variable used in the pedagogic negotiation, once the student must be confident on his hypothesis, or at least trust them more and more, as he builds his knowledge. The *quality of the BN model* is the third element considered in the negotiation process, as the student must be able to formulate a diagnosis that will probable be compliant with the case, as the diagnosis proposed by an expert would be. Quality is evaluated by the Domain Agent. The Mediator Agent uses these three elements presented above as parameters for the selection of pedagogic strategies and tactics, as well as to define the way how they will be displayed to the student.

The negotiation is characterized by: i) the negotiation object (belief on a knowledge domain), ii) the negotiation initial state (absence of an agreement, which is characterized by an unbalance between credibility, confidence, and a low BN model quality); iii) the final state (highest level of balance between credibility and confidence, and good BN model quality); and iv) the negotiation processes (from state ii to state iii). This is the base of the negotiation model developed in AMPLIA.

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[1] The notion of confidence we adopted is turned towards an expectation with the future actions of an agent, which is similar to the notion of confidence by Fischer & Ghidini [12]. They base it on a modal logic of beliefs and abilities, which intuitively is according to the idea of considering someone reliable because we know how this person is going to behave in given situations [13].