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Assisting students with argumentation plans when solving problems in CSCL

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ABSTRACT

In CSCL systems, students who are solving problems in group have to negotiate with each other by exchanging proposals and arguments in order to resolve the conflicts and generate a shared solution. In this context, argument construction assistance is necessary to facilitate reaching to a consensus. This assistance is usually provided with isolated arguments by demand, but this does not offer students a real and integral view of the conflicts. In this work, we study the utilisation of argumentation plans to assist a student during the argumentation. The actions of an argumentation plan represent the arguments that a student might use during the argumentation process. Moreover, these plans can be integrated with the tasks needed to reach a shared solution. These plans give the student an integral and intuitive view of the problem resolution and the conflict that must be resolved. We evaluated our proposal with students of an Artificial Intelligence course. This evaluation was carried out by comparing three different assistance scenarios in which students had to solve exercises: no assistance, assistance with isolated arguments, and assistance with argumentation plans. The results obtained show that reaching consensus was easier for the students when the assistance was provided using argumentations plans.

1. Introduction

In a computer-supported collaborative learning (CSCL) context, when students solve problems in groups, they need to interact with one another. In such scenarios, negotiation is a fundamental tool to reach agreements among students with conflictive goals, mainly, because learning is particularly effective when students encounter conflicts and resolve through negotiation generating a shared solution (Baker, 1999; Petraglia, 1997; Piaget, 1977; Veerman, Andriessen, & Kanselaar, 2000). Therefore, students must negotiate with each other, exchanging proposals and arguments to persuade their group-mates. Particularly, in CSCL systems, argument construction is more difficult than in face-to-face argumentations, since there are factors that make argument construction difficult (Veerman et al., 2000). Hence, it is necessary to assist students in such a task. Most of this assistance is provided with isolated arguments. That is, when the student is solving a problem in a CSCL system, arguments construction assistance is provided by demand, when a conflict arises. However, we claim that the student can be assisted in an integral way.

When we negotiate, the arguments uttered are not the result of an isolated analysis, but of an integral view of the problem that we want to agree about. Given a situation where it is needed to negotiate, the ability to plan the course of action that it will be executed to solve the conflict allows the negotiator to anticipate the problems that he/she could find during the interaction, and also, to analyse anticipated solutions to the conflict in order to avoid or minimise its problematic effects. This anticipation is also useful to evaluate several plans in advance in order to choose the most profitable one. We claim that this fact can be taken into account to provide assistance to students and make reaching consensus easy.

In this work, we present a study that shows the advantage of assisting the students by suggesting *argumentation plans*. We define an argumentation plan as a partial order sequence of arguments that allows a student to reach an expected agreement when it is uttered in a specified conflictive situation. These plans could be integrated into a general one, which determines the task needed to solve the problem. In contrast with the assistance provided using isolated arguments, these plans give the students an integral view of the problem resolution, and allow them to detect relations among the different conflicts, decide which task could be agreed, and in which conflict and what they should concede.

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To build the argumentation plans, we take into account the concepts and techniques used in the field of negotiation among agents. Agents are computational entities with autonomous, social, reactive and pro-active behaviour. These agents can execute actions autonomously or assist a user (such as a student in a CSCL environment) in his/her task. In this field, negotiation has been widely studied. The essence of a negotiation process is the exchange of proposals. Agents make proposals and respond to proposals made to them in order to converge to a mutually acceptable agreement that finds a solution to a conflict. However, not all approaches are restricted to that exchange. Several approaches to automated negotiation have been developed. One of them is the argumentation-based approach (Kraus, Sycara, & Evenchik, 1998; Rahwan et al., 2003; Ramchurn, Jennings, & Sierra, 2003; Sierra, Jennings, Noriega, & Parsons, 1998). In argumentation-based approaches, negotiators are allowed to exchange some additional information as arguments, besides the information uttered on the proposal (Rahwan et al., 2003). Thus, in the context of negotiation, an argument is seen like a piece of information that supports a proposal and allows a negotiator to justify its position in the negotiation, or to influence the position of the counterpart (Jennings, Parsons, Sierra, & Noriega, 1998). In other words, we can say that the argumentation process that the negotiator carries out during the negotiation, starts in an initial state of conflict and finishes in a final state of agreement, and we can see the arguments as actions or movements to go from this initial state to the final one.

In view of this idea, we propose to model the argumentation process as a planning problem. This modelling allows us to build argumentation plans using a planning algorithm. Planning algorithms provide a course of action that, when it is executed on the specified initial state, it allows us to achieve an expected final state (Fikes & Nilsson, 1971). In particular, we use a planning algorithm based on preferences in which student preferences impact on the action selection process and, as a result, on the argument selection mechanism, which decides what argument must be uttered in a given situation when there are several alternatives to choose. Finally, we can use an argumentative user model (Monteserin & Amandi, 2008) to personalise the argumentation plan construction. This model is composed of the action that a user (in this study, the student) uses to generate arguments and it is built from the arguments that he/she uttered in previous argumentations.

In summary, a tutor agent assisting a student in a CSCL scenario observes him/her, builds a tentative argumentation plan, and guides him/her during the conflict resolution. We claim that this kind of assistance is better that the assistance provided with isolated arguments. Although we choose a tutor agent to implement the assistance, it is worth noticing that the same assistance can be provided in different ways. Also notice that the focus of this study is the assistance that the students receive, not the development of a software assistant or intelligent tutor.

We have evaluated our proposal within an e-learning platform named SAVER[1] where tutor agents assist students that solve exercises using a collaborative application available in this platform. Students of an Artificial Intelligence course participated in the experiments. This evaluation was carried out by comparing three different assistance scenarios in which students had to solve exercises: no assistance, assistance with isolated arguments, and assistance with argumentation plans. The results obtained are promising. We found that when the students were assisted with argumentation plans they perceived that reaching consensus was easier than in the other two scenarios, whereas they perceived that the problem complexity increased.

The paper is organized as follows. Section 2 describes some works related to argumentation in CSCL. Section 3 shows how the argumentation process can be modelled as planning problem. Section 4 shows how the argumentation problem is represented in the planner, as an initial state, a final state and the actions. Section 5 shows how the planning algorithm works to generate argumentation plans for students. Then, Section 6 shows a case study to illustrate our proposal. Section 7 presents the methodology used and the experimental results obtained when evaluating this work. Finally, Section 8 presents a discussion and our conclusions.

2. Argumentation in CSCL

The negotiated construction of knowledge through argumentation is one of the main principles of constructivist learning theory. As we have introduced, learning is particularly effective when students encounter conflicts and resolve them through negotiation to generate a shared solution. In the last years, the increase of accessibility to the Internet has fomented the rise of e-learning. In this context, computer-mediated communication (CMC) has shown to increase learning-to-learning interaction and facilitate critical thinking in online group discussions. As a consequence, CMC has been used to support collaborative argumentation (CA), originating, computer-supported collaborative argumentation (CSCA). CSCA allows students to practice argumentation and debate to resolve conflicts and communicate online with other students using text-based communication tools (Baker, 1999).

Several systems have been developed for supporting collaborative argumentation: CATO, (Aleven, 1997), Beldevere (Suthers, 2003), ArgueTrack (Bouwer, 1999), LARGO (Pinkwart, Aleven, Ashley, & Lynch, 2006), Digalo (Kochan, 2006) and the works of Yuan, Moore, and Grierson (2008), Loll, Pinkwart, Scheuer, and McLaren (2009), among others. There are some differences among these CSCL systems and face-to-face argumentation (Wen & Duh, 2000). Specially, the systems can overcome temporal and geographical barriers, and they can eliminate social differences, such as age, sex, and hierarchies. For that reason, it is important that the students receive some kind of assistance during the argumentation. Some of the works on CSCA focus on the assistance that can be provided to students. There are several kinds of assistance in CSCA: (a) to facilitate argument construction, (b) to assist argument understanding and (c) to promote the participation of the students in the discussions. Our work concentrates on the first type of assistance.

As regards agents that assist users in CSCA, Huang, Chen, and Chen (2009) propose an agent that makes suggestions to students when it detects devious argument or abnormal behaviour that is unfitted to the learners' learning style. Wen and Duh (2000) propose an Automatic Facilitator that facilitates clear presentation of argumentation and better interface environment for students to articulate his/her arguments. An intelligent agent that provides students with suitable online argumentation strategies and rhetorical methods in a computer-supported collaborative argumentation environment is described by Yu and Chee (1999). This agent suggests isolated arguments patterns when a student is taking part in a discussion. Also, in Verheij (2003), the author presents an argument assistant tool to guide the user's production of arguments.

[1] http://www.e-unicen.edu.ar.