An Intelligent Debater for Teaching Argumentation

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Abstract. Despite the growing number of ITSs for teaching argumentation, few tutors actually debate the student. An *intelligent debater* allows the student to practice argumentation and provides the motivation to analyze evidence. Here I describe an *intelligent debater* used in Policy World to argue with students about policy recommendations. The *intelligent debater* forces the student to recommend a policy intervention, to describe how the intervention affects the desired policy outcomes, and to provide evidence. The debater then attacks infeasible recommendations, implausible mechanisms, and weak evidence. Key aspects of the intelligent debater algorithm are presented for those interested in using intelligent debaters in science, law, and history.

Keywords: Argumentation, Debate, Pedagogical agents, Causal reasoning.

Deliberative argument [1], e.g., "*We should limit junk food advertising on children's television to decrease childhood obesity*" forces students to analyze evidence (the focus of many argument ITSs [2]) and is a goal in its own right. However, the majority of causal reasoning tutors for science and history [3-7] do not ask students to make such arguments, perhaps because of the difficulty of designing tutors for ill-defined tasks. Here, I present an *intelligent debater* that can argue with students.

The challenge is to create a microworld that allows the student to make deliberative arguments that the system can evaluate, rebut, (and eventually tutor). In the educational game Policy World, students make recommendations about policy problems. Students begin the game by searching for information such as causal claims in expert testimony or summaries of scientific reports about observational studies and experiments as might be seen on the science page of the New York Times. As the student analyzes this information, Policy World monitors the subset of causal claims found by the student, the student's evaluation of the type and strength of those claims, and the student's overall beliefs about which causal claims are best supported by the evidence. Once the student has finished searching for and analyzing evidence, he must then convince a judge to adopt his policy position by defeating a computer opponent in a debate. This debate tests three sets of deliberative argument skills: making a recommendation, explaining the mechanism by which the recommended intervention affects the desired outcome, and providing evidence for that mechanism.

Making a recommendation. In the beginning of the debate, the judge, played by the senator, asks the student to make a recommendation such as: "What should we do about childhood obesity?" The student then picks his intervention from a list that

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includes increasing or decreasing the level of each variable in the domain model, e.g., "decreasing the number of junk food advertisements on children's television," or doing nothing. Once the student selects an intervention, the student's avatar states the intervention, and the *debater, (*played by Mr. Harding) will oppose the recommendation. If the student selects a recommendation that cannot be intervened upon, e.g., "decrease genetic propensity for obesity," then he receives a "strike" and will have to pick another recommendation before proceeding. After 3 strikes, the student receives tutoring.

Table 1. Debate dialogue showing a recommendation, explanation and evidence

Role	Dialogue
Judge	What do you recommend we do about childhood obesity?
Student	I think we should decrease the amount of junk food commercials seen!
Debater	That will never work!
Judge	How will decreasing junk food advertising seen affect obesity?
Student	Decreasing the number of junk food commercials seen will decrease the amount of junk food eaten, which will decrease obesity.
Debater	You must be joking. *Should the Government Regulate Junk Food Advertising?* shows that junk food commercials don't affect the amount of junk food eaten!
Judge	What evidence do you have that the amount of junk food commercials seen increases the amount of junk food eaten?
Student	*Fighting Obesity: An Uphill Battle* shows that the increasing the amount junk food commercials seen increases the amount of junk food eaten!
Judge	Hmmm, your experimental data is stronger than Harding's case study. You've proven your case. It looks like we should decrease junk food advertising.

Explaining mechanism. In the next stage of the debate, the judge asks the student to explain how his recommendation affects the outcome. The student uses drop down menus to construct a causal explanation using terms for the expert model. For example, the explanation begins with the student's recommendation, e.g., "Decreasing junk food advertising…". The student then selects an effect, e.g. "will increase..." or "will decrease…" and a second variable from the list of variables in the expert model, e.g. "the amount of junk food eaten." The student continues to construct a chain of effects from his recommendation to the desired outcome. Once the student has constructed the main causal path of his explanation, e.g., "Decreasing junk food advertising will decrease the amount of junk food eaten which will decrease obesity," he can then submit his explanation, or add additional mechanisms and outcomes. To add an additional mechanism, the student selects another starting variable, which may or may not already be included in his existing explanation, and continues to construct a causal path in the same way. After the student has submitted his explanation, the debater may attack the explanation on essentially syntactic grounds, e.g., if the student's explanation does not include the outcome, or if the outcome is not the terminal variable on the causal path. In this case, the student receives a "strike" and must submit another explanation of his mechanism. If the mechanism is plausible, then the debate enters the evidence phase.

Providing evidence. At this point the debater attacks different parts of the student's explanation. The debater will select one causal link in the student's explanation, e.g., that "junk food advertising increases the amount of junk food eaten" then cite a report

contradicting the student's claim. The debater selects a link to attack in the following manner: it will first select a causal claim for which the majority of evidence opposes the student's position, it will next select causal claims for which the evidence is stronger than the amount of evidence the student actually collected, and finally, it will select causal claims randomly in the hope that the student will make a mistake defending the claim. Once the debater has attacked a claim, the judge will ask the student to defend it. The student then selects one or more reports from the list of reports that he collected before the debate. If he presents weak evidence and fails to defend a causal claim, he receives a strike. The student can then attempt to present evidence again, or modify his explanation or recommendation. If he successfully defends several attacks, he wins the debate.

Conclusion. This work contributes to the literature on ITS systems for argumentation by describing how to design an *intelligent debater* that can argue with the student, both to practice argumentation and to motivate the search and analysis of evidence supported by most argumentation tutors. Future work is empirically testing the educational and motivational impact of *intelligent debaters.*

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