COMPS Computer-Mediated Problem Solving Dialogues

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Abstract: COMPS is a web-delivered platform for collaborative problem-solving conversations. When deployed in classroom exercises the teacher joins the dialogues as needed. The two goals for COMPS are a) environment and protocol that promotes group cognition, and b) machine-generated real time status display showing the teacher which groups need assistance. This poster shows an example dialogue containing group cognition at work and reports the first results of computer classification of student utterances.

Introduction

The COMPS project has students solve problems through monitored, computer-mediated group discussion. We are working in two problem domains: quantitative literacy word problems and computer programming skills and concepts. COMPS dialogues are typed computer chat on web pages. COMPS also contains specialized problem-specific software for exploratory learning. Problem-solving discussions are monitored by the instructor, who can intervene in the discussion (Desjarlais, Kim, & Glass, 2012). Research goals for the COMPS project are broadly: facilitating group cognition in problem-solving dialogues and developing computer monitoring technology to assess the progress of the conversations in real time. COMPS is still under development. We have deployed problem solving exercises in two different classes (Java programming and mathematics education) for testing purposes. We have the first experiments with computer language classifiers.

Example of Group Cognition in Programming Problem Dialogue

Our initial deployment dialogues show many examples of what Stahl (2009) calls *group cognition*. Figure 1 is an extract of students solving a problem in class inheritance in the Java programming language. The students have the problem on paper with multiple-choice answers, the prompt specifies they must all agree on an answer. In this protocol the instructor checks whether the agreed-on answer was correct. Turns in Figure 1 are marked with I (initiate) or R (respond) according to exchange structure analysis. In this dialogue group cognition is achieved by the students taking different roles in the problem-solving process. Our analysis is like this:

- Student A is in control of the dialogue. All but one of the Initiate dialogue moves came from A. And A is the person who evinces the least understanding. However we observe that it is A who suggested a problem solving strategy (turn 4), invoked a reasonableness check on a proposed answer (turn 8), and caused the answer to be summarized in a single argument (turn 18). Student A provided the metacognitive regulation in this process.
- Student B provided most of the reasoning and the summary (turns 5, 7, 11, 13, 19).
- Student C, who participated the least, was the *first* to moot the correct answer into the discussion (turn 16) after only one contribution late in the game (turn 14). Clearly C had been mentally engaged in following the problem-solving activity taking place between A and B.

With A directing and checking the problem-solving activity, B doing most of the figuring out, and C providing the last step, it is clear that these students are indeed reasoning as a group.

Example of Computer Classification of Dialogue Turns

The COMPS project has been using both Latent Semantic Analysis (LSA) and Nonnegative Matrix Factorization to build classifiers that recognize problem-specific features in the dialogues. The technique is to compare dialogue turns to bundles of exemplar sentences (Dion, Jank, & Rutt, 2011). For these results we have been using a quantitative literacy problem: determining whether there is a winning strategy in a Nim-like game called Poison. COMPS contains a facility for the students to practice playing Poison while chatting at the same time. In the Poison dialogues here are three key behaviors that the computer will monitor, with our best achievable LSA recognition accuracy for each:

- Dialogue turns where students express the idea that you want to leave your opponent with 1, 4, 7, . . . tiles. This is a key realization in the solution path. All successful groups come to this conclusion. We can recognize it with 63% accuracy.
- Dialogue directly concerned with playing the game (e.g. who goes next, what move to make). We can recognize these turns with 86% accuracy.
- Dialogue where the students are clarifying the rules of the game to each other. Recognized with 96% accuracy.

As of this writing the classifier has been trained on exemplar sentences taken from verbal dialogues. We will re-train it using typed-chat dialogue collected from students using the online COMPS system before deploying real-time monitoring.

Conclusion

COMPS has been used with four problems (two each in quantitative literacy and programming), on seven different occasions, collecting 48 discussion groups. Hand coding and analysis of the transcripts reveals that most dialogues show evidence of either a) collaboration in problem-solving or b) achieving a common level of understanding. Initial training of LSA classifiers for future real time computer monitoring shows that some categories of utterance are highly recognizable.

Figure 1: Solving a Programming Puzzle in Class Inheritance

1	A	do you guys understand this second problem	I	A Most initiate-response pairs in this group are initiated by A.
2	B	this one is confusing.	R	
3	C	yeah this one got me thinking	R	
4	A	lets try and take it like one output at a time...how are we gong to get this to print Foo_3 first? [*ellipsis dots in the original*]	I	A sets the problem-solving agenda
5	B	we need to first make foo_2 extend foo_2	R	B moots first important idea
6	A	why	I	A prompts for explanation
7	B	because foo_2 starts the main method but it isnt the first thing that prints	R	B explains
8	A	wait hold on..that cant be right its not a choice bro	I	A notices the multiple-choice answers do not include the proposed answer.
		so it has to start with foo 3 or 4		
		or object		
11	B	oh that's what i meant . we have to make foo_2 extend to foo_3 my bad	R	B corrects first idea
12	A	so when you do foo 2 extends foo 3 , the program goes down to foo 3 and prints out "From Foo_3"?	I	A articulates B's idea more fully
13	B	yes and then it goes back to foo_2 to print "From foo_2" .	R	B finishes
14	C	so what is the main calling when it says Object foo_2 = new Foo_1? and for the other	I	C shifts focus to next part
15	A	idk it kinda looks like a swap without the "temp" thing/example Dr. <Instructor> showed us	R	A provides not-relevant analogy
16	C	I got answer c	I	C is first to provide correct answer
17	B	i do too.	R	B concurs
18	A	can you explain it to me because i am confused	I	A prompts for explanation
19	B:	ok , i got it now. (*types first part of explanation, 42 words. Subsequent dialogue elicits rest.)*	R	B explains all

References

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