I will be doing a senior project in Professor Scassellati’s Social Robotics Lab with Aditi Ramachandran and Sarah Sebo. We will be developing and testing an adaptive social robot tutor for children.

1 Motivation

We know that students learn better if they receive one-on-one tutoring. [1, 2]. However, at school, most children learn in large group settings that do not allow for personalization of lessons and it is impossible for every student to receive enough personalized one-on-one attention from a human teacher. Adaptive tutors can help fill this gap.

Much work has been done to investigate online teaching and tutoring systems, and recent studies have dealt with adaptive models for tutoring systems and their behaviors. Techniques such as Bayesian Knowledge Tracing (BKT), a hidden markov model used to infer student’s knowledge of various topics given their answers to questions, have been honed to parametrize the likelihood of mistakes or correct guesses to individual pieces of knowledge or to take into account recent tutoring interventions. [3, 4, 5] These inferences about what a particular student does or does not know are often used to suggest future learning tasks to maximize usefulness and continued learning.

Other studies have focused on providing the correct type and degree of help. Tutors often give examples to students who are stuck in the middle of a solution. Adaptive systems have experimented with generating examples from final answers or incomplete solutions from other learners that are relevant to the challenge being faced by a particular student. [6] Recent work has also investigated automatic hint generation, especially in situations where open ended problems have multiple approaches. These have used solutions from other students or searched for the shortest edit path to a final solution to provide small, useful and relevant suggestions to students. [7, 8]

These studies have been mainly focused on disembodied tutoring systems in the form of a computer program or website. Research has also shown that the physical presence of a robot tutor can increase effectiveness of a tutoring system.[9] Aditi Ramachandran in the Social Robotics Lab has been studying the use of such adaptive robot tutor systems.
Her previous work has included developing adaptive strategies to improve help-seeking strategies, finding that students who interacted with a robot tutor using adapting hint giving strategies performed better than those who could ask for and receive help on demand [10]. She has also investigated adaptive strategies in timing breaks for students with different attention spans. [11] Work in progress includes a study in which a robot encourages students by asking them to “think out loud”.

Adaptive tutoring systems must not only be able to generate hints and choose helpful exercises, but also do these things at the right time in order to facilitate learning. Human tutors are able to evaluate how their students respond to each of their actions or behaviors to choose the most appropriate action to help their pupil. The current project will develop and test an adaptive robot tutoring system that personalizes the selection of various tutoring behaviors (questions, hints, breaks, examples, encouragement to think aloud etc.) to individual students.

2 Project Plan

This project will involve developing an adaptive robot tutoring system that selects what tutoring behavior to exhibit at any given time, and then testing it with participant students. My work will be as follows.

2.1 Tablet Application

During the study, participants will be using a tablet to complete math problems with tutoring aid from the robot. This tablet application must show participants questions, examples, hints, give breaks in the form of a tic-tac-toe game, and otherwise respond to the model’s decisions of actions. It will also, through a TCP connection to the computer code controlling the robot, interface with the robot throughout the tutoring session.

The application will show math problems for the students to solve and allow them to input answers through a keypad. It will inform them if the answers are correct or incorrect, as well as transmit this information to the computer to allow the robot to respond to their attempt. When an answer is correct, the buttons will allow the student to move on to the next question.

When the model determines that the student should receive a break, the application will receive a message instructing it to begin a tic-tac-toe game with the student. Similarly, when the model determines that the student should receive a hint or be shown an example of the math concept, the application will respond to a TCP message by displaying the relevant activity or information. To ensure that students cannot ignore the robot and continue working while the robot is speaking, buttons on the application will be disabled at that time.

My first task in this project will be to design and build this application.
2.2 The Tutoring Model

Aditi and Sarah will develop a model to choose which tutoring action the robot should perform at any given time. When they have completed this model, I will work on integrating it with the app, so that the selected actions are smoothly performed by the robot and shown on the tablet.

This will involve sending and receiving the correct TCP messages from the computer program and the tablet as well as programming the robot’s speech and actions to match the activities on the tablet and the selected behaviors of the model. The robot must act in a way that gives the impression that it is watching and responding to the student’s work. It will, for example, read each question and respond to correct or incorrect solutions, as well as give praise or encouragement.

2.3 The Study

When the system is ready, it will be used in tutoring sessions with participants from local elementary schools. During each session, the participant will use the tablet to answer math questions while interacting with the tutoring robot, which will be seated next to the participant and will act as if it is observing and reacting to the student’s progress.

Each participant will complete a series of tutoring sessions with the robot, which will either employ the adaptive model or an unadaptive control. After a yet to be determined number of sessions, each participant’s progress in learning the material will be measured.

I will then help analyze this data to determine the effectiveness of the adaptive model.

This research, when completed, will provide meaningful insights into how adaptive robot tutoring systems can be used to best used to facilitate the most learning improvement.

3 Timeline

- Week 1 Literature review
- Weeks 2 - 4 Create tablet application
- Weeks 5 - 7 Integrate behavior model with tablet application
- Weeks 8 - 9 Integrate robot behavior
- Week 10 - 13 Run study and do analysis

References


