Developing Adaptive Social Robot Tutors for Children
Project Proposal for Eric Ho
Mentor: Aditi Ramachandran
Faculty Advisor: Brian Scassellati

For my senior year, I will be working on a year-long senior project with the guidance of Aditi Ramachandran under the supervision of Brian Scassellati. My project will build off of Aditi’s project that is currently pending submission to the Human-Robot Interaction conference.

Aditi’s project involves running an experiment that determines whether an adaptive robot tutor is an effective teacher for children. To understand this, let us first discuss a bit of the existing research in the field. There has been substantial research regarding help-seeking behavior and tailoring a tutor’s guidance to the individual in intelligent tutoring systems that do not involve a robot. Studies show that on-demand help in which a tutor provides a hint whenever the child requests it, is effective. These studies are mostly conducted with an ILE, or an Interactive Learning Environment. Effective on-demand help, however, begs the question of whether or not an adaptive model could be even more useful in facilitating learning gains. A paper by Aleven et. al estimates that 72% of help requests are unproductive in on demand tutoring, which means that if help requests come at a better time, people can be coached more effectively.

Convincing people to make more timely help requests, however, is no easy task. There are two main bodies of research surrounding this - one is when a program coaches a person to learn to ask for hints more effectively in general, then allows the person to solve the problem, and another is when the program withholding or preemptively gives information pertaining to the specific problem at hand to the person it is tutoring.
For Aditi’s project, help requests come in the form of a hint button. Each problem that she administers to the children has three possible hints, going from a first, general hint, a second, more specific hint, and a third, very targeted hint (the bottom-out hint). Generally, there are two main groups of children that we seek to improve their help seeking requests. These groups have also been identified in research pertaining to ILEs. The first is when a child asks for help too much. They repeatedly click through the hints to get to the bottom-out hint, which basically solves the problem for them. They are essentially cheating the system, and one can easily see why that could be harmful to that child’s education. The other camp is the opposite - they are help averse. They refuse to ask for help even when they need it, and repeatedly guess at the answer while getting nowhere.

These two groups are helped by either withholding hints for a while - letting the child take a guess before giving them the bottom-out hint, or by offering a hint even when the child did not explicitly ask for one, so that the child would be better suited to solve the problem. More specifically, in Aditi’s experiment, hints would only be withheld if a child requests three hints in a row, and hints would be offered if they would make two wrong guesses in a row. These heuristics were the only thing that differentiated Aditi’s adaptive model.

For my project, I will improve upon this adaptive model. Aditi has already collected data from children that suggests that her model works, and with even better heuristics to follow, this adaptive tutoring method could be even more effective and children can see even greater learning gains. With the data, I can implement pattern-mining techniques to see if children ask for hints in a non-optimal way. Once these
patterns are identified and realized as ineffective, hints can either be pushed or withdrawn accordingly. I can also implement algorithms that will find at what point a hint would be most helpful. Additionally, going back to the idea that there are two main camps of children - help averse and help greedy, I can select and sort children into these two camps. Once these two camps are known and identified, it would be much easier to provide hints in a helpful manner. This does require that their mannerisms be identified, but the experiment is already structured as such. A pretest precedes the four tutoring sessions, which is followed by a posttest. The first tutoring sessions can be used as an identifying stage, while the later ones could be used as a more tailored version of the tutor.

Identifying camps which the children are in is very important. For example, a child could have solved the problem 90% correctly, but just made a simple arithmetic error. Let’s say the child is not help averse and has not asked for a hint - would we really want to offer a hint in this situation? Perhaps in this situation as well, the child really does not want a hint because he/she wants to solve the problem on his/her own. That would be a failure of the tutoring system.

Overall, the project will involve a lot of data analysis, a lot of psychology work, and a lot of coding to implement these new algorithms for finding a more optimal adaptive model for robot tutoring. I’m very excited to get started working on the project!