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 has currently been submitted 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 withholds 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. For the first half of my project, we have already extracted key features that give us indications about how a child may react to or engage with the robot tutoring system. These features mostly revolve around a couple most important features. The first of these features is the pretest score, which is a good indicator of how well the child will perform throughout the entire
interaction. Students with higher pretest scores will commit fewer help seeking errors such as getting hints denied or hints automatically prompted, will receive less hints per question before getting the question correct, and will get more questions correct on the first attempt and overall. This indicates to us that students who score highly on the pretest score may not need specific help, so we can reduce the number of automatic hints prompted and hints denied. Keeping these students happy, then, will be our main concern. Because research has shown that students may not learn more with the on-demand model but vastly prefer it, then these high performing students should perhaps just be given the on-demand model.

We have also found a correlation with student motivation. Aditi’s project had every student take the Self Regulation Questionnaire that measures student motivation, and we found that students who were more intrinsically motivated were less likely to give up on problems (we defined giving up on a problem as two attempts in rapid succession) and took less time on a problem (a measure mostly of higher engagement). Using this, we are also going to factor these features into the system that we will now construct, giving more automatically prompted hints to students who ‘give up’ on a problem and students who are taking too long on a problem.

Finally, the last factor that I will consider before building a new and final model is using facial recognition using the Affdex software. Affdex can detect anything from baseline facial responses such as eyebrow furrowing and blinking to high level emotions such as confusion, sadness, or joy. We can take these emotions and features, and have the system adapt to them on the fly, maybe having a live feed from the software to the system. Using this feed with the extracted features should be pretty simple - if a student
looks confused, a hint should be prompted, and if a student looks engaged, then a hint perhaps should not be denied to such a hard working student.

Overall, the project this semester 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 continue working on the project!