HEATlab 2020 Summer Research Projects

human experience & agent teamwork laboratory @ harvey mudd

The mission of the HEATlab is to create new techniques for human-robot teaming—the flexible navigation and coordination of complex, inter-related activities in shared spaces. We focus on using ideas from AI to automate the scheduling and coordination of multiple agents, including humans, computational agents, and robots (embodied agents). We are particularly motivated by the challenge of coordinating the activities of human-robot teams in environments that require explicit cooperation to be successful. Our goal is to create human-robot teams exploit the relative strengths of humans and agents to accomplish what neither can achieve alone.

Learn more by reading the recent feature in PC Magazine about the lab: https://tinyurl.com/HEATlab-PCMAG

This summer we will pursue two exciting new research directions!

Project 1 – Probably-in-Control: When robots team up with humans, we want to give human teammates autonomy in how they complete their activities. However, robustly reacting to and controlling for all the different things a human teammate could do is difficult! In this project, we will:

- Explore new and existing problem formulations (likely various forms of mixed integer linear programs) that model the variability and uncertainty that human teammates introduce in collaborative human-robot task;
- Develop new algorithms and approaches for reacting to the uncertainty that a human teammate introduces, particularly focusing on providing the human with greater choice and autonomy;
- Gain inspiration and insights from mathematical fields such as geometry, graph theory, and most notably, operations research; and
- Extend or adapt existing temporal plan quality metrics to handle scheduling situations that involved uncertainty, preferences, or choice.

Useful skills: Experience/active interest in some of the following: operations research, algorithms and algorithm design, graph theory, geometry, and mathematical modeling.

Project 2 – Creating more fluid, intuitive robot teammates: In this work we will explore what influences human's perceptions of "team" in order to design better robotic teammates. In particular, we are interested in looking at how the scheduling of a robot teammate can influence a human teammate's perception of team fluidity. We will explore how we can adapt existing temporal planning models and methods to more seamlessly interact with how humans actually execute tasks in teamwork settings. In this project, we will:

- Review existing literature in temporal reasoning for representing the preferences and tendencies of humans;
- Explore how explainable, predictable/transparent, and legible current scheduling methods are for human teammates;
- Extend last summer's exploration into fluidity metrics in scheduling human-robot teamwork to handle the novel ways that humans introduce uncertainty and contingency into scheduling scenarios;
- Develop new algorithms that are responsive to the novel sources of uncertainty for capturing the types of uncertainty that humans introduce to team activities and react in a way that humans will interpret as fluid and natural; and
- Stretch goal: Evaluate our new and existing approaches for on multi-robot / human-robot close collaborative tasks.

Useful skills/interests: Experience/active interest in the following: artificial intelligence/robotics, human-robot interaction, cognitive science, interaction design, human factors, ROS.

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