1. **Motivation**

Strides have been made in the production of powerful industrial robotic systems for the completion of tasks that are tedious and/or pose risk for humans, such as the autonomous robotics for transmission lines-inspection (Limall et al., 2018), or the scope of commercial robotics for construction applications (Bogue, 2018). In such situations, robotics have been known to serve in the completion of precise, repetitive tasks.

However, there is significant motivation to improve systems that interact with humans in the completion of a task. In fact, recent years have seen research improvements that would allow robotic systems to play a significant role in far less isolated environments in the near future (for example, research in the areas of crash injury evaluations and shock tolerance (Pratt et al., 2002), versatile gripping (Tegin & Wikander, 2005) and perception systems (Lindner et al., 2016), to cite just a few examples).

This project seeks to study scenarios in which robots contribute to the completion of a task alongside and as the teammate of a human, thus contributing to the sub-field of human-robot interaction (HRI) known as human-robot collaboration (HRC). My project is part of an ongoing project in the Social Robotics Laboratory that aims at predicting supportive behaviors based on user preferences to individual users. This work focuses both on modeling the task, and modeling user preferences.

Since user-provided labels in an HRC scenario are expensive to obtain, it is assumed for this project that a set of general user preferences for supportive behaviors that map to task features are given, as a baseline. It is also assumed that a model of the task in the form of a hierarchical task model (HTM). We then aim to leverage the interaction with a new user and learn their individual preferences for delivered supportive behaviors. Using active learning paradigms, the goal of this project is to explore how to best learn user preferences with a minimal number of queries made to the user by the robot.

2. **Proposed Study**

The proposed study would involve three main components. First, through a more in-depth literature review and background study, a more specific problem space with constraints for simplicity would be defined, that might later be generalized. Within that problem space an appropriate active learning paradigm would be applied, with an initial demonstration of learnings to be delivered as the first project checkpoint. Resources I have found and propose to follow include Settles’ 2012 Active Learning textbook and Brigham and Moore’s work, 2005. This may or may not include an evaluation of multiple algorithms for implementation over the proposed dataset.

The second component would be a method of querying the user for supportive behavior-labels at various points to the task. Focus may be spent building a user-friendly proxy system.
tablet application, rather than command-line input) if other components of the project are completed.

The third but primary component would be to implement a system using the Baxter Robot that queries the user for appropriate action. Data should be collected through a few user trials to demonstrate proof-of-concept as well as to evaluate. Further work to improve the user preference modelling system can be proposed if time permits.

3. Preliminary Project Timeline and Deliverables

<table>
<thead>
<tr>
<th>Date</th>
<th>Deliverable</th>
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<tbody>
<tr>
<td>February 12</td>
<td>Completion of literature review and background preparation</td>
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<tr>
<td>February 23</td>
<td>Checkpoint 1: Demonstration of learnings</td>
</tr>
<tr>
<td>March 09</td>
<td>Checkpoint 2: Prototype</td>
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<tr>
<td>March 30</td>
<td>Checkpoint 3: Prototype</td>
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<tr>
<td>April 13</td>
<td>Checkpoint 4: Final demo</td>
</tr>
<tr>
<td>TBD</td>
<td>Final Presentation (at Lab Lunch)</td>
</tr>
<tr>
<td>April 20</td>
<td>User data collection/analysis</td>
</tr>
<tr>
<td>May 02</td>
<td>Final Report</td>
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4. References


Tegin, Johan, and Jan Wikander. “Tactile sensing in intelligent robotic manipulation – a