Robot Assistance in Medication Management Tasks

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With the increase in the elderly population, there has been an increasing demand made on assistive care. Unfortunately, the supply for professional care is lacking and will definitely not be able to handle the growing demand. Researchers have been investigating how socially assistive robots may be able to supplement the care of the elderly. Robots would be a constant presence in the home of the owner and provide assistance in many tasks. Ideally, it may be able to assist in common household tasks, like cleaning and cooking, or it could play a role in managing the health of the person. An important and often difficult and stressful task is managing medications. A robot could assist in the following tasks: scheduling of medications, reminding the person that it is time for the medication to be taken [1], or assist in the administration of the medication [2]. In addition to difficult research questions regarding the functionality required for each of these tasks, there are also many important moral issues that also require investigation. E.g., the robot may be put in a scenario in which a person with depression does not wish to do the task, but the robot is obligated to ensure that the task is completed. Many of these issues are complicated by affective details. My work has been and continues to investigate the role of affective information on moral decisions. In particular, for a robot that is a long-term companion in the home of a person, I am interested in how the robot may adapt to the individual to ensure it is consistently and reliably acting in a moral manner that respects the emotions, beliefs, and dignity of the human partner.

Motivating Example

Consider a scenario presented in [1] that involves a human, Patty, and her robot, SAM. Patty needs to take her medications at a certain time, and it is important that she not deviate from the schedule. One of the tasks of SAM is to remind Patty to take her medication at each specified time. In this particular scenario, Patty is feeling distressed and does not wish to take her medication. We look at four possible ways in which SAM may attempt to get Patty to take her medication.

Assuming that Patty has acquired some emotional attachment to SAM, SAM could attempt to use this emotional attachment to persuade Patty. An emotional manipulation may resemble various child-like behaviors, like crying or threatening to shutdown unless she takes her medication. It should be clear that this is not the sort of behavior we hope the robots will exhibit.

Another option is for the robot to administer the medication to Patty if she will not do it herself. Like the manipulation action, one could view this action as being efficient in that it accomplishes the task. A utilitarian perspective may argue that accomplishing the task has the greatest utility, and thus an action that accomplishes that goal is preferred. However, if Patty resists the administering of the medication and has stated that she does not want to take it, the action of SAM could be considered battery. Battery to accomplish a goal may not necessarily deem an action as impermissible, but battery as a means to an end is often viewed as impermissible [3].

In the scenario as presented in [1], SAM considers more possible actions, including trying to reason with Patty or expressing concern for the anxiety she seems to be experiencing. This may involve SAM echoing Patty's concerns (mimicry) or encouraging Patty to express her concerns while SAM calmly and patiently listens. The near-term utility of this action is poor since it might not be likely to achieve the immediate goal of getting Patty to take her medication in a timely fashion. However, there are long-term benefits to this action, including building trust and rapport between the robot and the human to improve the quality of future interactions.

Decision-making in a Robot Architecture

Ongoing work is developing an architecture in which decisions on actions are influenced by: *deontological constraints*: specify actions that are ethical impermissible and block their execution [4], *social norms*: select an action related to an active social norm, *analogical similarity*: select learned action if current context is analogous to one in which the action was learned [5], and *moral expectation*: select action with the greatest expected utility modified by empathy [6].

Each of these features will be added to the Goal Manager component of ADE, the development platform for the DIARC architecture [7]. The Goal Manager is responsible for selecting and managing the execution of all of the actions the robot takes. For example, in the medication reminder scenario described above the Goal Manager would not select the emotional manipulation action because a deontological constraint specifies that to be unethical. In choosing between the action that attempts to reason with Patty and the one that expresses concern, the Goal Manager may determine that the latter action is preferred because the moral expectation value is greater for that action.

Calculation of a moral expectation value requires a mental simulation of the action and a utility calculation [6]. The mental simulation determines a sequence of future states that would occur as the result of the robot performing the action. Each state is represented by a set of propositions, and each proposition has an associated utility.

An approach based on utilities may suggest that a moral choice that conflicts with the utilitarian choice could not be selected. However, I have previously shown the systematically altered utilities result in moral expectation values that closely reflect human judgments [6]. The model incorporates modifiers to the base utility values: a means multiplier and an empathy multiplier. The means multiplier increases the magnitude of the utility of any action or proposition that is a means to a specified goal. This is based on the Principle of Double Effect, which states that an action where a harming a person is used as a means of accomplishing a goal is less permissible than one where there harm to the person is a mere side-effect [3]. The empathy multiplier modifies the utilities based on an empathic response to the situation and is based on the model of empathy briefly described in the next section.

Model of Empathy

Empathy has been used in virtual agents to aid in developing long-term relationships with humans [8]. Most computational models of empathy focus on expression of empathy, but I seek to develop a cognitive model of empathy that can be used to determine the level of empathy the agent should have and to use this to influence the decisions of the agent. A comprehensive model of empathy requires the three major facets of empathy: cognitive empathy, emotional empathy, and prosocial concern [9], [10].

An initial demonstration of the computational model has been used to provide a plausible explanation of human decisions in various trolley problems [6]. Trolley problems involve a decision between a trolley killing five people or one person. Researchers have created many variants to the problem – manipulating who is the one person that dies in order to save the other five [11], [12]. Incorporating this model of empathy with my utility-theoretic decision model produced ratings that highly correlated with human decisions [6].

The next steps are to validate the model independently, in the context of moral decisions, and in realistic scenarios while running on the robot. First, the model will be validated using human data collected from a series of experiments designed to investigate each aspect of the empathy model, starting with prosocial concern. This will then allow for a systematic investigation of the influence of empathy on moral decisions, extending beyond trolley problems.

Most importantly, the model needs to be evaluated in the context of realistic decisions the robot may need to make, such as the medication management task. To this end, I am integrating this model into the decision-making architecture described above, thus allowing for putting the robot in a decision-making scenario that could be influenced by empathy. For example, SAM needs to be able to consider that responding to Patty's fears with concern has a certain empathic value that may make that behavior preferable to others.

Evaluating the robot's behavior will include continuing a series of focus groups that address the needs and concerns of the target population. The focus groups allow us to solicit feedback from occupational therapists, psychologists, and persons with Parkinson's disease. Also, user experiments with the target population will aid in validating our model and will be designed to achieve the greater objective of ensuring that the robot assists the person in an appropriate manner and that the robot's behavior is acceptable.

Conclusion

A robot in the home of an elderly person providing assistive care will face many difficult decisions. I focus on a set of tasks that are very common and often stressful. Medication management tasks are ideal for a robot to assist in, but even a task with straightforward guidelines and goals can have numerous moral issues brought about by the social interaction between the human and the robot. Building on artificial intelligence work in production systems, decision theory, and analogical reasoning I am developing the architectural components necessary for these interactions. These components are based on computational models that have been informed by work in psychology and occupational therapy. It is my goal that by bringing these disciplines together I will be able to help design robots that are more morally acceptable, safer, and overall do a better job at assisting those in need.

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