Traci Fairchild
CS7637 KBAI Assignment 4
October 5, 2015

Robots Learn New Skills by Observing Humans

The Problem & Why it is difficult

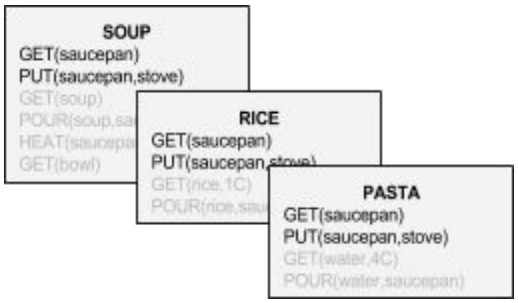
Teaching robots to learn from humans simply by observing is a challenge facing robotics and AI communities today. Although imitation learning is naturally developed in humans at an early age, social robot learning introduces problems. The robot must have a certain degree of background knowledge and basic representations that similarly matches what the human is demonstrating. This paper tries to address the problem of matching previously stored events using case-based reasoning. There are also other challenges such as perception of what the robot is observing and matching its own actions to mimic this observation. If these challenges, and many more can be overcome then a robot could learn quickly simply by observing a human demonstrator.

A Case-Based Reasoning Design

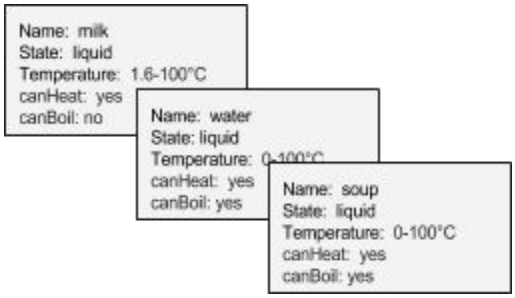
As we start, the robot will observe the demonstrator and it can begin to imitate its actions. But imitating alone will not give the robot a basic understanding, or record, of what it is actually doing. If the robot can synthesize what it is observing with a case that it has already encountered, then it can adapt what it knows to fit the observation. Case based reasoning has been presented as a route to allowing robots to learn from observing. Case based reasoning involves retrieving previous case demonstrations so that it may adapt it for the current learning observation.

For example, let us consider that a robot is observing a human demonstrator making tea, fill the pot with water, turn on the heat, wait for boil, pour into cup, add tea leaves. Now let us suppose the robot has in its case based memory the process of making soup - open soup, pour into pot, turn on the heat, wait for near boil, pour into bowl. These two tasks are very similar. Can the robot adapt what it knows of heating soup to what it is observing with making tea?

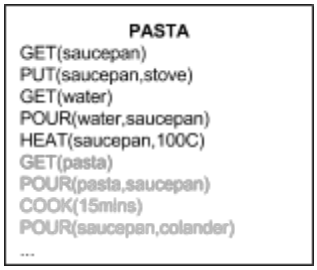
A robotic system based on this idea would begin by observing the human demonstrator in its first sub-tasks of the overall demonstration. The system, or robot, would quickly search it's stored cases for actions that also perform those first few subtasks. For example, the human reaches for a pot and puts it on the stove. Immediately the robot searches for cases which use a pot and a stove.



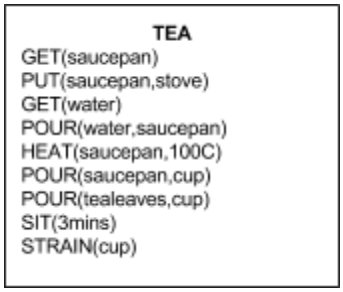
At the same time, the robot selects from its own data representations food items that are typically boiled.



Using case-based reasoning, the robot may retrieve what it knows of making pasta



As it observes the human demonstrator it may find the same process in memory, as the robot has already experienced it, but if not, then the robot could select a case that is closely related to the demonstrators actions, as above. It will likely reach a point where the two methods diverge and the robot is forced to adapt what it knows to what it is observing, creating a new case.



And now that the robot has an actual case that is defined, it can store it in memory for future retrieval. The ability to store and retrieve a task from memory could suggest that learning has actually taken place. If the robot simply imitates without further actions then it is not really learning at all.

The ability for the robot to adapt in this way could be used for many other tasks such as pouring cereal into a bowl, making rice by boiling water and rice together, pouring laundry detergent into a washing machine, etc.

Conclusion

In this design, Case-Based Reasoning should not stand on it's own. It should be accompanied by the observation of tasks which the robot can successfully mimic and actuate on it's own. The two together can be a very useful tool in teaching a robot how to learn by imitation. Advancements in learning by imitation could bring about swift changes in the development of robots and how they are able to learn and perform the way humans do.