Learning Robot Tasks with Loops from Experiences to Enhance Robot Adaptability

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This paper contributes towards the development of robot capabilities to acquire high-level task planning models, by conceptualizing past experiences, for solving any particular instances of the same tasks. The motivation for tackling this problem centers on the belief that it is impossible to preprogram all the necessary knowledge into a robot operating in a diverse, dynamic and unstructured environment. We propose and integrate the notion of Experience-Based Planning Domain (EBPD) – a framework that provides important concepts for long-term learning and planning) – into robotics. This framework includes three main components (see Figure 1): experience extraction, conceptualization and planning. Experience extraction provides a human-robot interaction for teaching tasks and an approach to recording experiences of past robot's observations and activities. Experiences are used to learn activity schemata, i.e., methods of guiding a searchbased planner for finding solutions to other related problems.

Conceptualization combines several techniques, including deductive generalization, different forms of abstraction, feature extraction and loop detection to generateactivity schemata from experiences. Planning is a hierarchical problem solver consisting of an abstract and a concrete planner which applies learned activity schemata for problem solving [1, 3, 2].

We demonstrated the utility of this system in different domains, and effectively tackled complex, real world tasks. Figure 2 shows the integration of this system into a real robotic arm JACO) – a lightweight assistive robotic device delivered by Kinova Robotics. In this demonstration, the JACO arm is taught to clear a table by removing objects from the table. By conceptualizing and learning this task, the robot is able to instantiate the learned concept and generate solutions to other instances of this problem with varying sets of objects without requiring an exhaustive search.

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FIGURE 1
The learning and planning system in EBPDs.

FIGURE 2
From left to right, JACO arm moves to the cup, picks up the cup from the table, carries the cup, and place it on the tray.
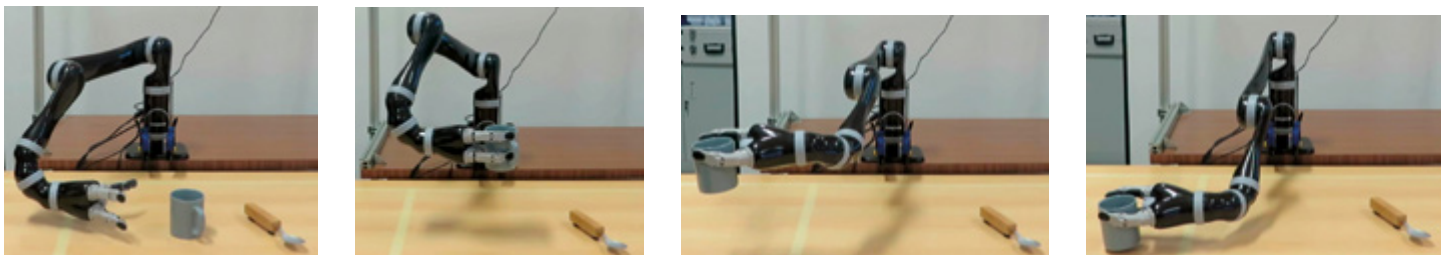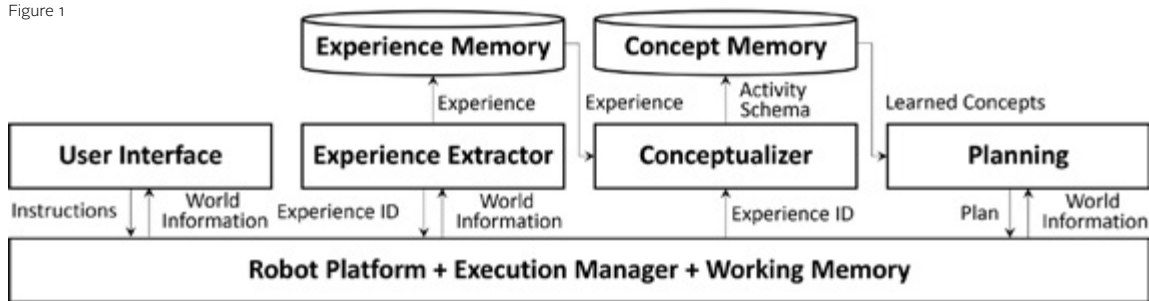
Figure 1

Figure 2