Robot skill learning

Creating autonomous robots that can learn to assist humans in daily life situations is a fascinating challenge for machine learning. We focus on the first step of creating robots that can learn to accomplish many different tasks triggered by an environmental context or a higher-level instruction and plan to obtain a general approach to motor skill learning. We focus on (1) domain-appropriate machine learning approaches that allow for better control, imitation of behavior and self-improvement, as well as (2) new robotics approaches to create more appropriate systems for high-speed skill learning.

Starting from theoretically sound robotic control structures for task representation and execution, we replace analytic modules with more flexible learned ones [468]. To this end, we tackle problems such as accurate but compliant execution in joint-space [583] or task-space [150], learning of elementary behaviors using combination of imitation and reinforcement learning [178, 238], hierarchical composition of behaviors, and parsing complex demonstrations into elementary behaviors.

Mimicking how children learn new motor tasks, we have used imitation to initialize to learn libraries of elementary primitives, and subsequently reinforcement learning to improve the performance. We have learned elementary tasks such as Ball-in-a-Cup or bouncing a ball [178, 238] and gradually moved to more complex ones. As the benchmark of complex behavior, we chose the task of returning table tennis balls over the net. We created a parser that segments movements of a human teacher into elementary movements [594, 596]. These then train the single elementary movements [178, 238]. Novel behaviors, modulated by the opponent’s incoming ball, are composed by mixing motor primitives [465, 581]. With the help of this method, the robot table tennis player learnt with this method successfully returns of 97% of the balls played against a ball gun. Current approaches are likely to achieve even better results [347] and use accurate prediction of the human opponent’s behavior before the opponent even touched the ball [459].

More information: https://ei.is.tuebingen.mpg.de/project/robot-skill-learning