Model-Free Control Based on Reinforcement Learning

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When controlling physical systems, the aim of the control mechanism is to influence the behavior of the process plant to achieve the desired design goals. An objective can be, for instance, to keep the output of the system near a reference signal. The performance metrics of a control can be measured in terms of the settling time and the error signal. Traditional control algorithm designs are based not on the physical plant, but on its mathematical model. However, the incorrectness or complexity of the model can make it hard to design an appropriate controller.

In several problem domains the model of the process is either not known or hard to handle. Applying a model-free controller in these domains can ease the design of the control structure. Several model-free control strategies have previously been introduced [1, 2, 3]. Here we discuss a method based on reinforcement learning. Reinforcement learning is a computational approach to learning how to map states of the environment to actions, in order to maximize a numerical reward signal. In the reinforcement learning scenario, the agent is in a continuous interaction with its discrete time environment, performing actions on it, and receiving state and reward signals of the environment. Any algorithm is considered to be a reinforcement learning algorithm if it is able to provide a mapping from states to actions, while maximizing the discounted reward (weighted sum of future rewards) in the long run.

Thus, reinforcement learning techniques can be applied in any environment, where the goal of the learning process can be represented with a numerical reward signal, and the environment can be modeled with a Markov Decision Process.

The main requirement of applying reinforcement learning in process control is to find an appropriate mapping from the closed loop system to a Markov Decision Process. In this paper, we examine several mapping techniques and reinforcement learning controller implementation. Moreover, we evaluate their appropriateness for process control by comparing them to a traditional PID controller.

Keywords: *reinforcement learning, process control*

References

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