UNIVERSITAT DE VALÈNCIA

NOTES

Reinforcement Learning

Author:
Pablo CARRERA

"People worry that computers will get too smart and take over the world, but the real problem is that they're too stupid and they've already taken over the world."

Pedro Domingos

Contents

Chapter 1

Introduction

1.1 What is Reinforcement Learning?

The idea that we learn by interacting with our environment is probably the first to occur to us when we think about the nature of learning. We explore designs for machines that are effective in solving learning problems of scientific or economic interest, evaluating the designs through mathematical analysis or computational experiments. The approach we explore, called reinforcement learning, is much more focused on goal-directed learning from interaction than are other approaches to machine learning.

Reinforcement learning is learning what to do, how to map situations to actions, so as to maximize a numerical reward signal. The learner is not told which actions to take, but instead must discover which actions yield the most reward by trying them. In the most interesting and challenging cases, actions may affect not only the immediate reward but also the next situation and, through that, all subsequent rewards. These two characteristics, trial-and-error search and delayed reward, are the two most important distinguishing features of reinforcement learning:

- Reinforcement learning is different from supervised learning. In supervised learning the system learn from a training set of labeled examples provided by a knowledgeable external supervisor. Each example is a description of a situation together with a specification, the label, of the correct action the system should take to that situation, which is often to identify a category to which the situation belongs. The object of this kind of learning is make the system able to extrapolate, or generalize, its responses so that it acts correctly in situations not present in the training set. This is an important kind of learning, but alone it is not adequate for learning from interaction. In interactive problems it is often impractical to obtain examples of desired behavior that are both correct and representative of all the situations in which the agent has to act. In uncharted territory, where one would expect learning to be most beneficial, an agent must be able to learn from its own experience.
- Reinforcement learning is also different from unsupervised learning. In unsupervised learning the system find the structure hidden in collections of unlabeled data. Although one might be tempted to think of reinforcement learning as a kind of unsupervised learning because it does not rely on examples of correct behavior, reinforcement learning is trying to maximize a reward signal instead of trying to find hidden structure. Uncovering structure in an agent's experience can certainly be useful in reinforcement learning, but by itself does

not address the reinforcement learning problem of maximizing a reward signal.

Then, we consider reinforcement learning to be a third machine learning paradigm, alongside supervised learning and unsupervised learning.

1.2 Key points of Reinforcement Learning

We formalize the problem of reinforcement learning using ideas from dynamical systems theory, specifically, as the optimal control of incompletely-known Markov decision processes. The basic idea is simply to capture the most important aspects of the real problem facing a learning agent interacting over time with its environment to achieve a goal. A learning agent must be able to sense the state of its environment to some extent and must be able to take actions that affect the state. The agent also must have a goal or goals relating to the state of the environment. Markov decision processes are intended to include just these three aspects-sensation, action, and goal-in their simplest possible forms without trivializing any of them. Any method that is well suited to solving such problems we consider to be a reinforcement learning method.

Bibliography

[1] Richard S. Sutton and Andrew G. Barto. *Reinforcement Learning: An Introduction*. 2nd. Adaptive Computation and Machine Learning. MIT Press, 2018. ISBN: 9780262039246.