Curriculum Reinforcement Learning[1]

Marius Lindauer

tnt

Leibniz Universität Hannover

[1] Based on a blog by Lilian Weng

From Easy to Hard

- We humans also learn step by step
  - E.g., in math, we learn first basic arithmetics before we later learn complex derivatives and integrals
  - E.g., in this lecture, we first talked about simple planning on MDPs, before we talked about complex meta-RL ideas
- Idea: break down complex concepts into simpler concepts s.t. we can start from the easy ones and build up the complex one
- Challenge: How can we design a curriculum starting from simple to hard tasks?
  - A poorly designed curriculum might even harm learning.
- Challenge: How do we avoid catastrophic forgetting by training on another instance?

Task-Specific Curriculum Learning [Bengio et al. 2009]

1. Cleaner Examples may yield better generalization faster.
2. Introducing gradually more difficult examples speeds up online training.
   - Results by [Zaremba and Sutskever. 2014] indicated that one should mix in easy tasks to not forget how to solve these.

How to Quantify Complexity/Difficulty of an Env?

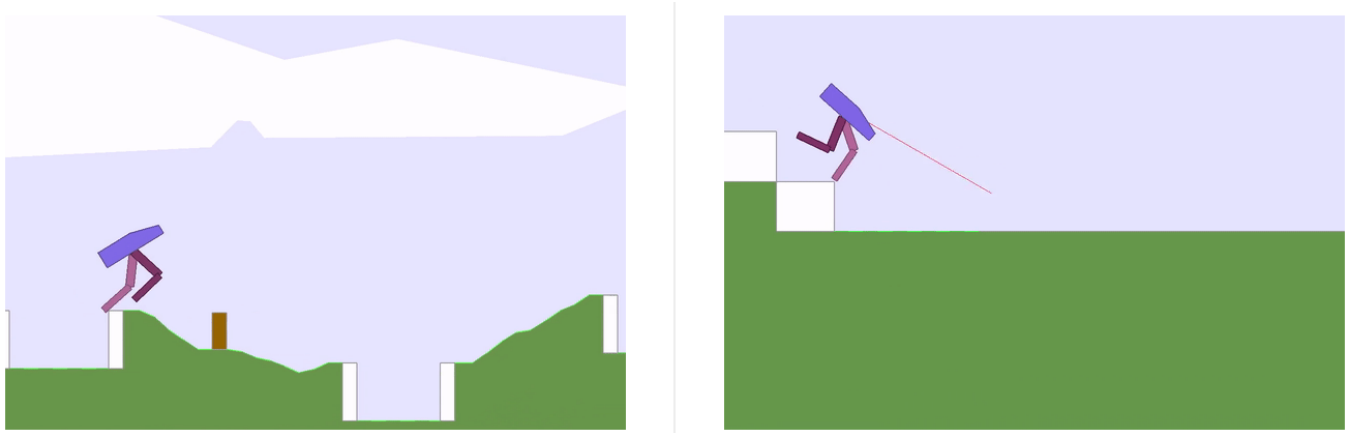
- Human specification
  - parameterized generator for environments that allow to control the complexity by hand
  - or we can measure meta-features of the different envs, e.g.
    - ★ Size of maze
    - ★ distance between start state and end state
    - ★ Fraction of floor space to walls
    - ★ ...
  - Note: We cannot quantify the complexity of the optimal policy for a given MDP, because we have to measure these before actually solving the MDP

Automatic Curriculum Generation

- In contrast to a hand-designed curriculum before training starts, the curriculum is generated on the fly for any instances in the domain
- Criteria for the ordering have to be provided or computed during runtime
- While criteria need to be computed during runtime, they do not need to be hand-designed

Example Criterion 1: Manual Difficulty Ratings

1. Idea: define a function to rate env difficulty
2. Example: POET [Wang et al. 2019][2]



[2] Image source: Uber AI

Example Criterion 2: External Model

1. Minimal loss wrt another policy being pretrained on other tasks as criterion
2. Sort the instances s.t. they go from easy to hard wrt this pretrained agent [Weinshall et al. 2018]