RLChina Reinforcement Learning Summer School

RLChina 2022

实践课三：经典强化学习算法实践

Prof. 田政

上海科技大学
ShanghaiTech University

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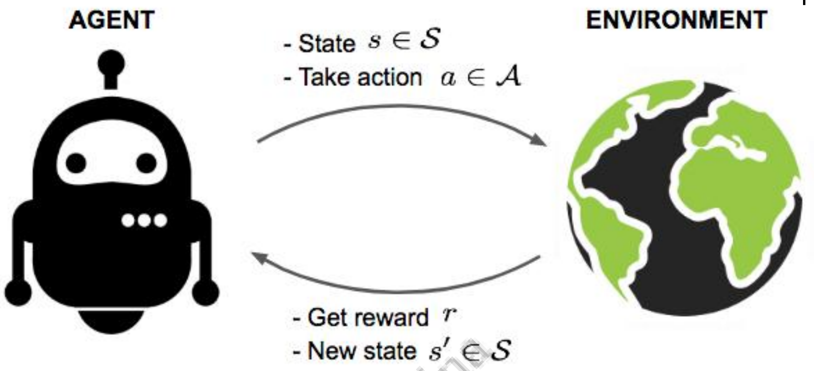
Markov Decision Process(MDP)


AGENT
ENVIRONMENT
- State $s \in \mathcal{S}$
- Take action $a \in \mathcal{A}$
- Get reward r
- New state $s' \in \mathcal{S}$

[1]

A MDP can be defined as a tuple $(\mathcal{S}, \mathcal{A}, \mathcal{P}, \gamma, \mathcal{R})$, which consists of:

- $\mathcal{S}$: a set of states called the state space;
- $\mathcal{A}$: a set of actions called the action space ;
- $P(s'|s,a)$: states transition function, describing the probability that action *a* and state *s* at time step *t* will lead to state *s'* at time step *t+1*;
- $\mathcal{R}(s,a)$: reward function, describing the immediate reward received after taking action *a* at state *s*.
- $\gamma \in [0,1]$: discount factor, which will discount the future rewards.

[1] *https://blog.paperspace.com/reinforcement-learning-for-machine-learning-folks/*

Goal: Maximizing Cumulated Return

- $$G_t = R_t + \gamma R_{t+1} + \gamma^2 R_{t+2} + \cdots = \sum_{k=0}^{\infty} \gamma^k R_{t+k}$$

Tools:

- Policy: $\pi(a \mid s) = P\left(A_t = a \mid S_t = s\right)$, describing the probability of taking action *a* at state *s*. Policy can be stochastic or deterministic. Policy depending on current state is sufficient to be optimal in MDP.
- State-value function: $V^\pi(s) = \mathbb{E}_\pi\left[G_t \mid S_t = s\right]$
- Action-value function: $Q^\pi(s,a) = \mathbb{E}_\pi\left[G_t \mid S_t = s, A_t = a\right]$
- Bellman expectation function:

$$\begin{aligned} V^\pi(s) &= \mathbb{E}_\pi[R_t + \gamma V^\pi(S_{t+1}) | S_t = s] \\ &= \sum_{a \in A} \pi(a|s) \left(r(s,a) + \gamma \sum_{s' \in S} p(s'|s,a) V^\pi(s') \right) \end{aligned}$$

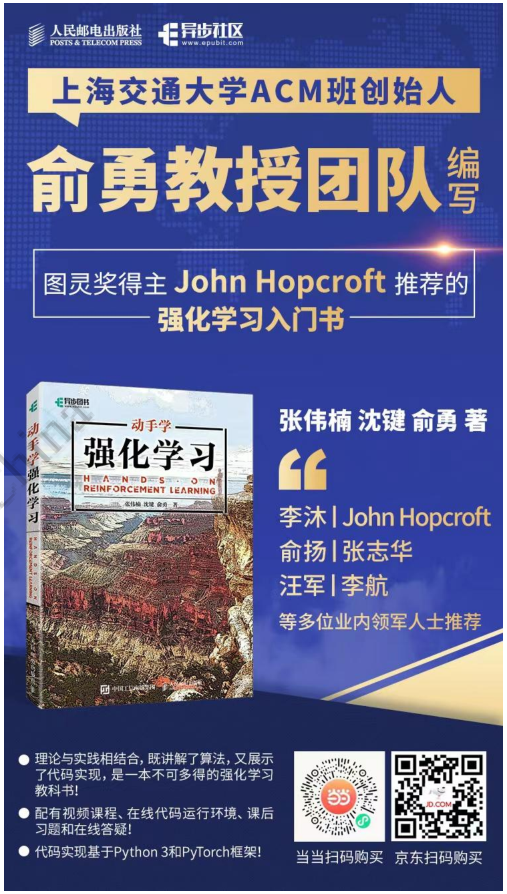
$$\begin{aligned} Q^\pi(s,a) &= \mathbb{E}_\pi[R_t + \gamma Q^\pi(S_{t+1}, A_{t+1}) | S_t = s, A_t = a] \\ &= r(s,a) + \gamma \sum_{s' \in S} p(s'|s,a) \sum_{a' \in A} \pi(a'|s') Q^\pi(s',a') \end{aligned}$$

- Bellman optimal function:

$$V^*(s) = \max_{a \in \mathcal{A}} \{ r(s,a) + \gamma \sum_{s' \in \mathcal{S}} p(s'|s,a) V^*(s') \}$$

$$Q^*(s,a) = r(s,a) + \gamma \sum_{s' \in \mathcal{S}} p(s'|s,a) \max_{a' \in \mathcal{A}} Q^*(s',a')$$

Main Resources



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等多位业内领军人士推荐

- 理论与实践相结合，既讲解了算法，又展示了代码实现，是一本不可多得的强化学习教科书！
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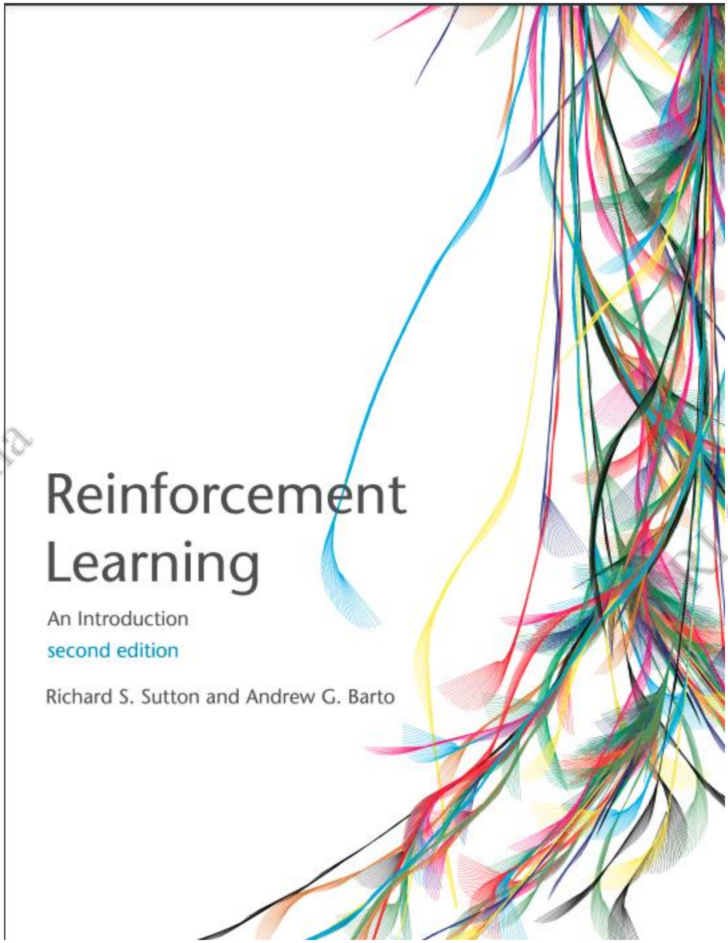

Reinforcement Learning

An Introduction

second edition

Richard S. Sutton and Andrew G. Barto

https://hrl.boyuai.com/

http://incompleteideas.net/book/the-book-2nd.html

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HR邮箱：jing.liu@digitalbrain.cn
联系电话：13024157621（微信）
联系人：刘小姐

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