Deep Reinforcement Learning for deep learning experts

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Prerequisites for knowing Reinforcement Learning

1. Linear algebra
2. Probability
3. Python

Prerequisites for knowing Deep Reinforcement Learning

1. Deep Learning

BF Skinner's Reinforcement Learning for Pigeons

Video

[1]

[1] Image source:bfskinner.org

DRL for DL experts

BF Skinner's Reinforcement Learning for Pigeons

BF Skinner's Reinforcement Learning for Pigeons

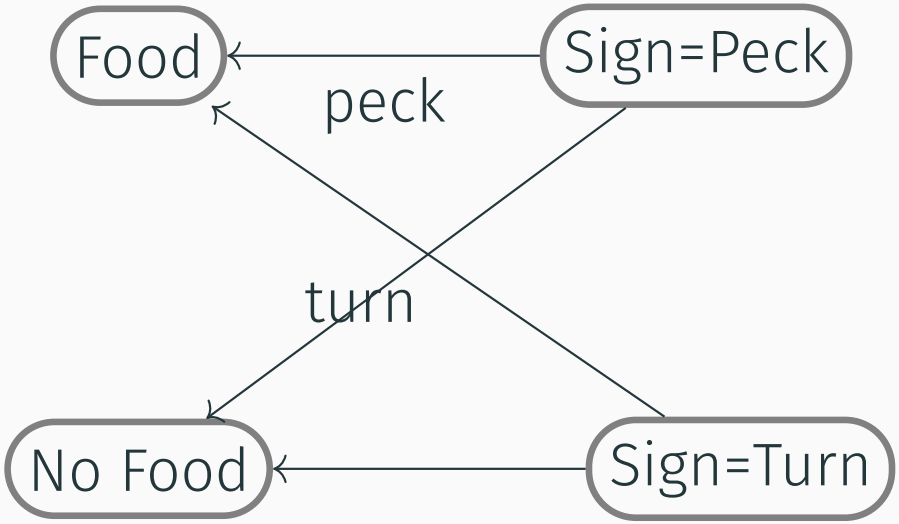
Video

[1]

[1] Image source:bfskinner.org

1. BF Skinner demonstrated that pigeons could learn to repeat an action that lead them to a particular reward. [1, p15]

RL terminology



State ($\mathbf{s}_t \in \mathcal{S}$) Example: Sign is peck or turn. Food is dispensed or not.

Reward function ($r_t(\mathbf{s}_t) \to \mathbb{R}$) Example: Food is high reward ($r_t = 100$). food is zero-reward ($r_t = 0$).

Actions ($\mathbf{a}_t \in \mathcal{A}$) Example: To peck or to turn or no action.

Transition probabilities ($T(\mathbf{s}_{t+1}|\mathbf{s}_t, \mathbf{a}_t) \to [0, 1]$) Example: Probability of food dispensing if you peck when Sign-peck is shown.

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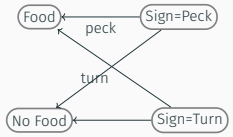

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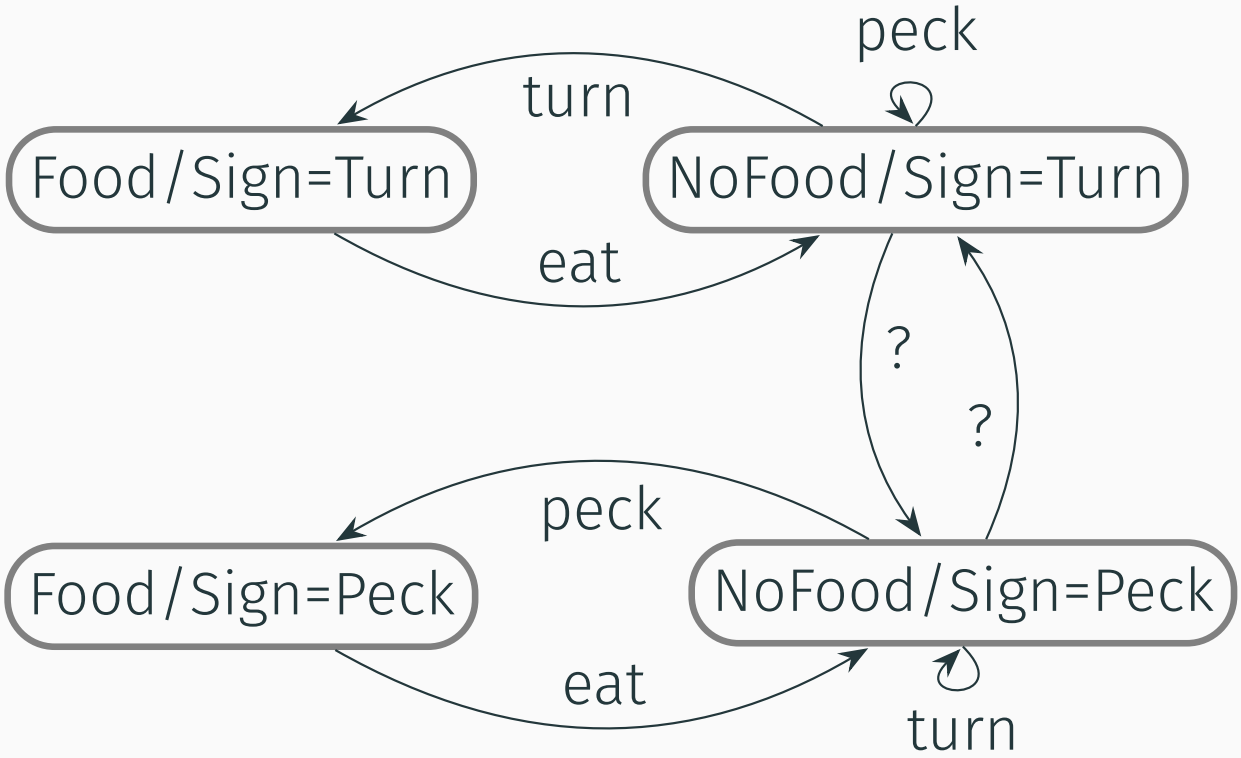
State is the full description of the world at time t that captures the entire history. Example: in this example the state can be captured with two bits $\mathbf{s}_t = [f_t; p_t]$, where $f_t \in \{0, 1\}$ describes a food or no food state and $p_t \in \{0, 1\}$ describes the sign showing peck or turn.

Better state diagram



RL problem

Policy function $\pi(\mathbf{s}_t) \rightarrow \mathbf{a}_t$

Discount factor $\gamma \in (0, 1)$.

$$\pi^*(.) = \arg \max_{\pi} \mathbb{E}_T \left[\sum_{t=0}^{\infty} \gamma^t r(\mathbf{s}_t) \right]$$

$$\text{such that } \mathbf{s}_{t+1} \sim T(.|\mathbf{s}_t, \pi(\mathbf{s}_t)) \forall t \in [k, \infty)$$

$$\text{and } \mathbf{s}_0 \sim p_0(.)$$

Value Function

$$\pi^*(.) = \arg \max_{\pi} \mathbb{E}_T \left[\sum_{t=0}^{\infty} \gamma^t r(\mathbf{s}_t) \right]$$

$$\text{such that } \mathbf{s}_{t+1} \sim T(.|\mathbf{s}_t, \pi(\mathbf{s}_t)) \forall t \in [k, \infty)$$

$$\text{and } \mathbf{s}_0 \sim p_0(.)$$

$$V_\pi(\mathbf{s}_k) = \mathbb{E}_T \left[\sum_{t=k}^{\infty} \gamma^t r(\mathbf{s}_t) \right]$$

$$\text{such that } \mathbf{s}_{t+1} \sim T(.|\mathbf{s}_t, \pi(\mathbf{s}_t)) \forall t \in [k, \infty)$$

Action Value Function

$$Q_\pi(\mathbf{s}_k, \mathbf{a}_k) = \mathbb{E}_T \left[\sum_{t=k+1}^{\infty} \gamma^t r(\mathbf{s}_t) \right]$$

such that $\mathbf{s}_{t+1} \sim T(.|\mathbf{s}_t, \pi(\mathbf{s}_t)) \forall t \in [k, \infty)$

References


Richard S Sutton and Andrew G Barto.
Reinforcement learning: An introduction.
MIT press, 2020.