Maze Solver with Reinforcement Learning

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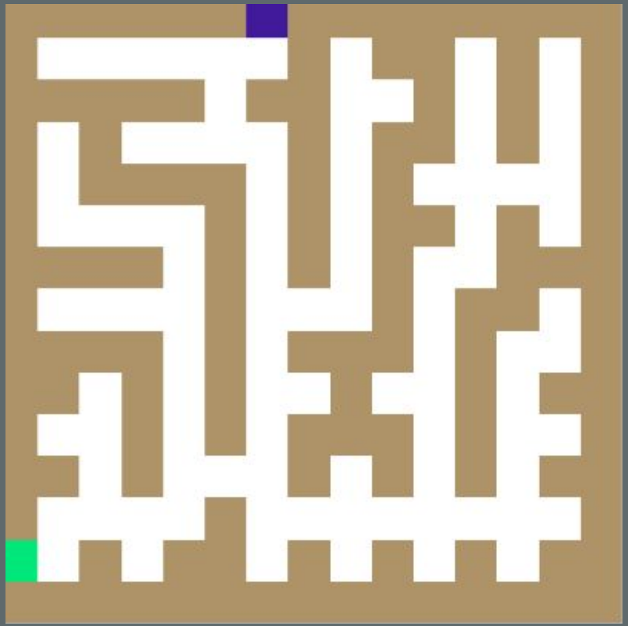
What is the project about?

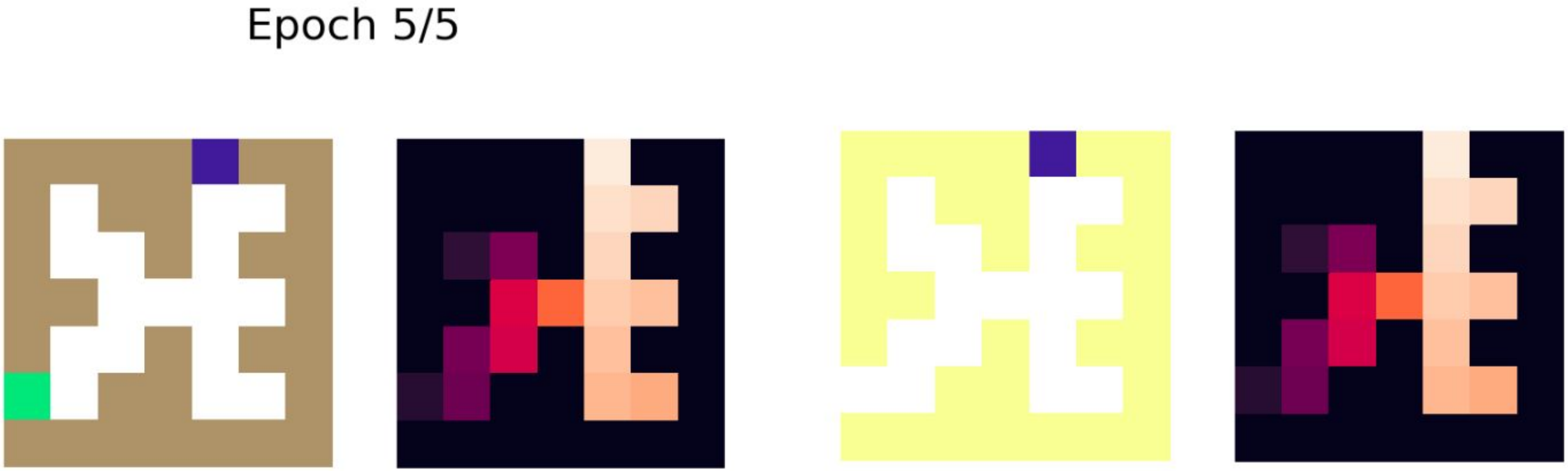


Steps

Background information

1. Creating the Environment
2. Learning Process
3. Developing the Optimal Policy
4. Solve Theeeeeeee Maaaaaze!

Creating the Environment



Learning Process

- Markov Property

$$p(\mathbf{s}_{t+1}|\mathbf{s}_0, \mathbf{s}_1, \ldots, \mathbf{s}_t, \mathbf{a}_t) = p(\mathbf{s}_{t+1}|\mathbf{s}_t, \mathbf{a}_t)$$

- Reinforcement Learning

$$\mathbb{E}_{\tau_\pi}\left[\sum_{t=0}^{T} r(\mathbf{s}_t, \mathbf{a}_t)\right] \to \max_\pi$$

$$\mathbb{E}_{\tau_\pi}\left[\sum_{t=0}^{T} \gamma^t r(\mathbf{s}_t, \mathbf{a}_t)\right] \to \max_\pi, \quad 0 \leq \gamma \leq 1$$

discount factor

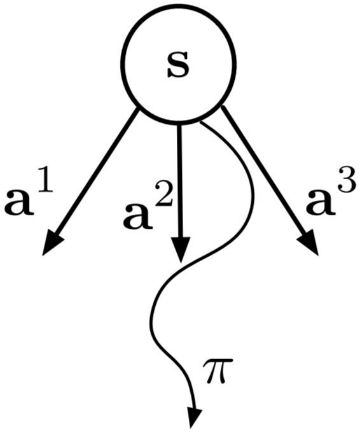
Value Function

- Value function shows how good it is to act in accordance to policy π starting from some state $\mathbf{s}_t$

$$V^\pi(\mathbf{s}_t) = \mathbb{E}_{\mathbf{a}_t, \mathbf{s}_{t+1}, \mathbf{a}_{t+1}, \ldots}\left[r(\mathbf{s}_t, \mathbf{a}_t) + \gamma r(\mathbf{s}_{t+1}, \mathbf{a}_{t+1}) + \ldots\right]$$

- Optimal value function shows the maximum amount of reward we can get starting from some state $\mathbf{s}_t$

$$V^*(\mathbf{s}_t) = \max_\pi V^\pi(\mathbf{s}_t), \quad \forall \mathbf{s}_t \in \mathcal{S}$$

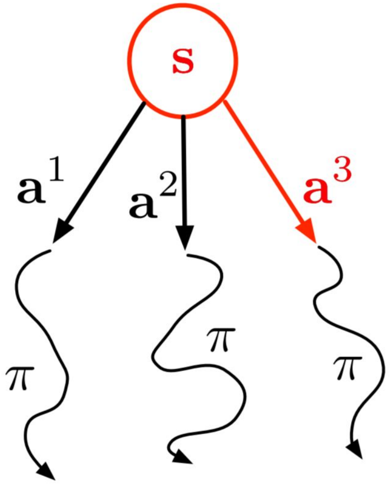


Q-function

- Q-function shows how good it is to act in accordance to policy π starting from some state $\mathbf{s}_t$ after taking action $\mathbf{a}_t$

$$Q^{\pi}(\mathbf{s}_t, \mathbf{a}_t) = \mathbb{E}_{\mathbf{s}_{t+1}, \mathbf{a}_{t+1}, \ldots}\left[r(\mathbf{s}_t, \mathbf{a}_t) + \gamma r(\mathbf{s}_{t+1}, \mathbf{a}_{t+1}) + \ldots\right]$$

- Optimal Q-function shows the maximum amount of reward we can get starting from some state $\mathbf{s}_t$ after taking action $\mathbf{a}_t$



$$Q^{*}(\mathbf{s}_t, \mathbf{a}_t) = \max_{\pi} Q^{\pi}(\mathbf{s}_t, \mathbf{a}_t), \quad \forall(\mathbf{s}_t, \mathbf{a}_t)$$

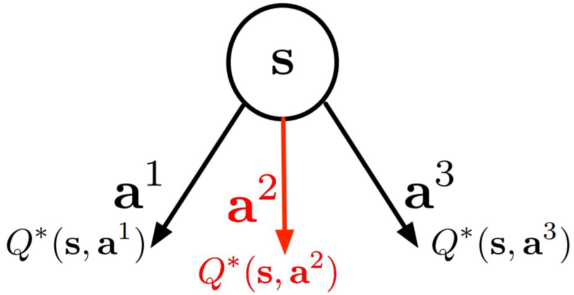
Optimal Policy

Suppose we know the optimal Q-function.

$$Q^*(\mathbf{s}_t, \mathbf{a}_t) = \max_{\pi} Q^{\pi}(\mathbf{s}_t, \mathbf{a}_t), \quad \forall (\mathbf{s}_t, \mathbf{a}_t)$$

What will be the optimal policy?

$$\pi^*(\mathbf{a}_t | \mathbf{s}_t) = \begin{cases} 1, & \mathbf{a}_t = \arg\max_{\mathbf{a}_t \in \mathcal{A}} Q^*(\mathbf{s}_t, \mathbf{a}_t) \\ 0, & \text{otherwise} \end{cases}$$



Thank You