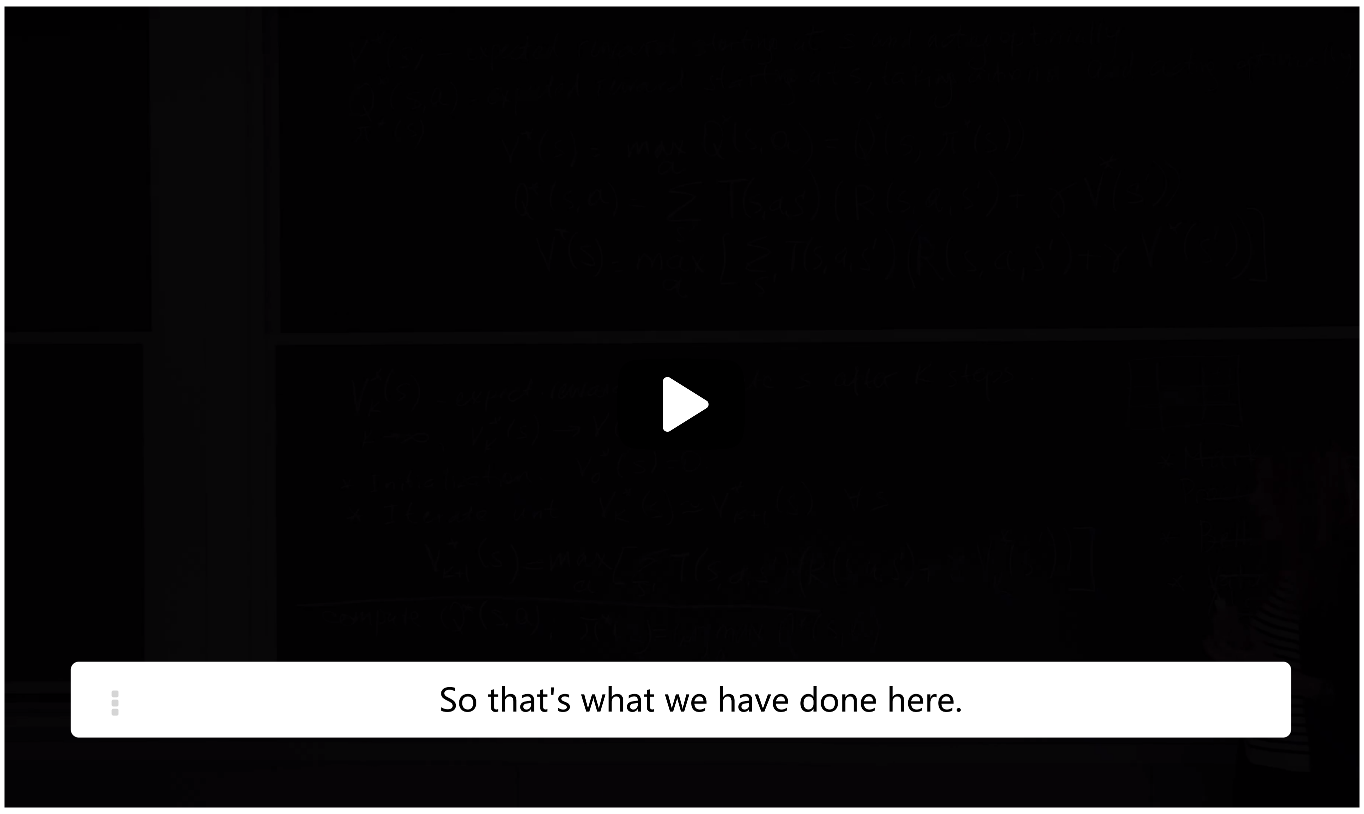
7. Value Iteration

Value Iteration



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a Q star S A. What it says for a given state

is go select, check all the Q star S a's and select

the action which maximizes it.

So what eventually I go to after this algorithm?

After this algorithm, when it converged,

I computed the Q values, and then I computed the policy.

And now I know how to act in my MDP.

So that's what we have done here.

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Recall from lecture the **value iteration update rule** :

$$V_{k+1}^{*}\left(s\right) = \max_{a}\left[\sum_{s'} T\left(s,a,s'\right)\left(R\left(s,a,s'\right) + \gamma V_{k}^{*}\left(s'\right)\right)\right],$$

where $V_k^*\left(s\right)$ is the expected reward from state s after acting optimally for k steps.

Recall the example discussed in the lecture.

Agent's starting state				$+1$

An agent is trying to navigate a one-dimensional grid consisting of 5 cells. At each step, the agent has only one action to choose from, i.e. it moves to the cell on the immediate right. When it reaches the rightmost cell, it receives a reward of $+1$ and comes to a halt.

Let $V^*\left(i\right)$ denote the value function of state i, the i^{th} cell starting from left.

Let $V_k^*\left(i\right)$ denote the value function estimate at state i at the k^{th} step of the value iteration algorithm. Let $V_0^*\left(i\right)$ denote the initialization of this estimate.

Use the discount factor $\gamma = 0.5$.

We will write the functions V_k^* as arrays below, i.e. as $\begin{bmatrix} V_k^*(1) & V_k^*(2) & V_k^*(3) & V_k^*(4) & V_k^*(5) \end{bmatrix}$.

Initialize by setting $V_0^*(i) = 0$ for all i:

$$V_0^* = [0 \quad 0 \quad 0 \quad 0 \quad 0].$$

Then, using the value iteration update rule, we get

$$\begin{aligned} V_1^* &= [0 \quad 0 \quad 0 \quad 0 \quad 1], \\ V_2^* &= [0 \quad 0 \quad 0 \quad 0.5 \quad 1] \end{aligned}$$

Note (Aug 22): Note that as soon as the agent takes the first action to reach cell 5, it halts and does not take any more action, so we set $V_{k+1}^*(5) = V_k^*(5)$ for all $k \geq 1$.

Value Function Update

1/1 point (graded)
Run the 3^{rd} iteration of the value iteration algorithm to get V_3^* and answer the following questions:

Enter the value of V_3^* as an array $\begin{bmatrix} V_3^*(0) & V_3^*(1) & V_3^*(2) & V_3^*(3) & V_3^*(4) \end{bmatrix}$.

(For example, type `[0,2,0,3,4]` for the array $\begin{bmatrix} 0 & 2 & 0 & 3 & 4 \end{bmatrix}$.)

[0,0,1/4,1/2,1] ✔ **Answer:** [0, 0, 0.25, 0.5, 1]

Solution:

Note that a non-zero reward is obtained only in state s_4 when transitioning to s_5.

The 3^{rd} step of the value iteration could be worked out as follows:

$$\begin{aligned} V_3^*(1) &= 0 + \gamma * V_2^*(2) \\ V_3^*(1) &= 0 + 0.5 * 0 = 0 \end{aligned}$$

$$\begin{aligned} V_3^*(2) &= 0 + \gamma * V_2^*(3) \\ V_3^*(2) &= 0 + 0.5 * 0 = 0 \end{aligned}$$

$$\begin{aligned} V_3^*(3) &= 0 + \gamma * V_2^*(4) \\ V_3^*(3) &= 0 + 0.5 * 0.5 = 0.25 \end{aligned}$$

$$\begin{aligned} V_3^*(4) &= 0 + \gamma * V_2^*(5) \\ V_3^*(4) &= 0 + 0.5 * 1 = 0.5 \end{aligned}$$

and $V_3^*(5) = V_2^*(5) = 1$.

The same computation for the rest of the states.

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You have used 1 of 3 attempts

Answers are displayed within the problem

Number of steps till convergence

1/1 point (graded)
Enter below the number of steps it takes starting from V_0^* for the value function updates to converge to the optimal value function V^*:

5

Answer: 5

Solution:

Note that after the 5^{th} step, the reward from the rightmost cell in the grid gets propagated to the leftmost state after which the value function estimate V_k^* stops updating. Hence, for this example it takes 5 steps for the value function estimate to converge to the optimal value function.

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You have used 1 of 2 attempts

Answers are displayed within the problem

Discussion

Topic: Unit 5 Reinforcement Learning (2 weeks) :Lecture 17. Reinforcement Learning 1 / 7. Value Iteration

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