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[Graded] Value Functions and Bellman Equations

Graded Quiz • 45 min • 11 total points

Due Feb 14, 2:59 AM -05

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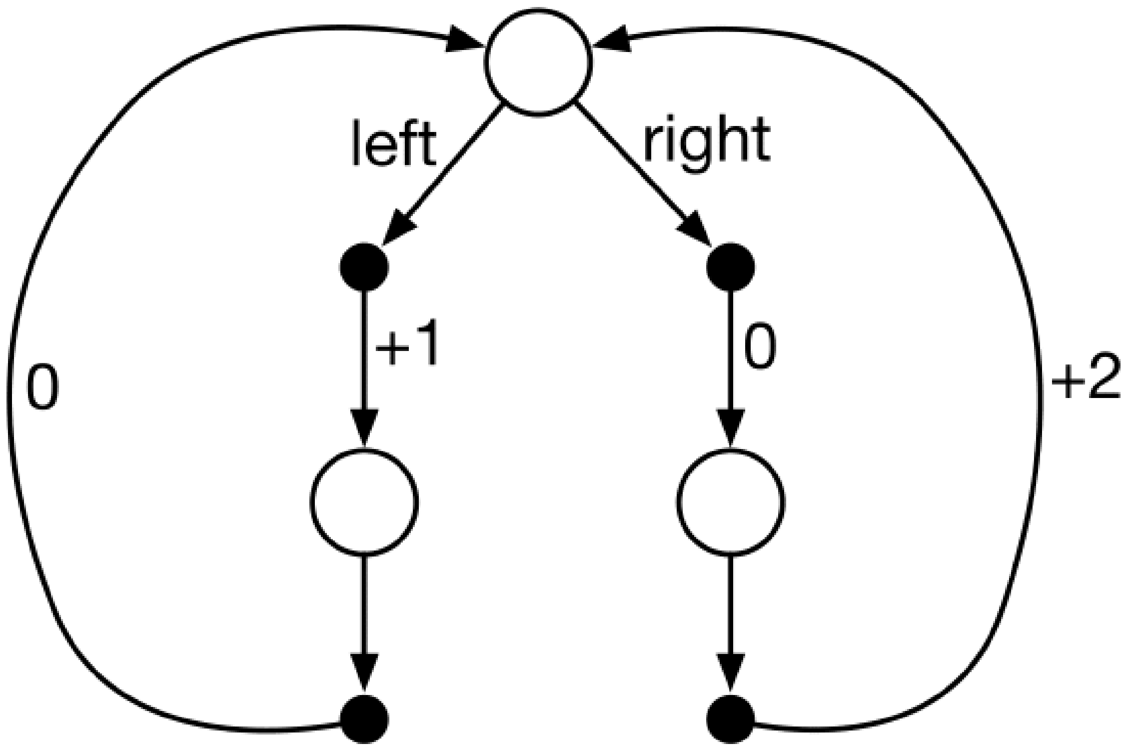
1. A function which maps ___ to ___ is a value function. [Select all that apply] **1 point**

- [ ] State-action pairs to expected returns.
- [ ] Values to states.
- [ ] Values to actions.
- [ ] States to expected returns.

2. Consider the continuing Markov decision process shown below. The only decision to be made is in the top state, where two actions are available, left and right. The numbers show the rewards that are received deterministically after each action. There are exactly two deterministic policies, π_{left} and π_{right}. Indicate the optimal policies if $\gamma = 0$? If $\gamma = 0.9$? If $\gamma = 0.5$? [Select all that apply]

1 point



- [ ] For $\gamma = 0.9$, π_{left}
- [ ] For $\gamma = 0.9$, π_{right}
- [ ] For $\gamma = 0.5$, π_{left}
- [ ] For $\gamma = 0$, π_{left}
- [ ] For $\gamma = 0.5$, π_{right}
- [ ] For $\gamma = 0$, π_{right}

3. Every finite Markov decision process has __. [Select all that apply]

1 point

- [ ] A unique optimal value function
- [ ] A unique optimal policy
- [ ] A deterministic optimal policy

- [ ] A stochastic optimal policy

4. The ___ of the reward for each state-action pair, the dynamics function p, and the policy π is _____ to characterize the value function v_π. (Remember that the value of a policy π at state s is $v_\pi(s) = \sum_a \pi(a|s) \sum_{s',r} p(s', r|s, a)[r + \gamma v_\pi(s')]$.) **1 point**

   - ○ Distribution; necessary
   - ○ Mean; sufficient

5. The Bellman equation for a given a policy π: [Select all that apply] **1 point**

   - [ ] Expresses state values $v(s)$ in terms of state values of successor states.
   - [ ] Expresses the improved policy in terms of the existing policy.
   - [ ] Holds only when the policy is greedy with respect to the value function.

6. An optimal policy: **1 point**

   - ○ Is unique in every finite Markov decision process.
   - ○ Is unique in every Markov decision process.
   - ○ Is not guaranteed to be unique, even in finite Markov decision processes.

7. The Bellman optimality equation for v_*: [Select all that apply] **1 point**

   - [ ] Expresses state values $v_*(s)$ in terms of state values of successor states.
   - [ ] Expresses the improved policy in terms of the existing policy.
   - [ ] Holds for v_π, the value function of an arbitrary policy π.
   - [ ] Holds when the policy is greedy with respect to the value function.
   - [ ] Holds for the optimal state value function.

8. Give an equation for v_π in terms of q_π and π. **1 point**

- $v_\pi(s) = \sum_a \pi(a|s) q_\pi(s, a)$
- $v_\pi(s) = \max_a \gamma\pi(a|s) q_\pi(s, a)$
- $v_\pi(s) = \sum_a \gamma\pi(a|s) q_\pi(s, a)$
- $v_\pi(s) = \max_a \pi(a|s) q_\pi(s, a)$

9. Give an equation for q_π in terms of v_π and the four-argument p. **1 point**

- $q_\pi(s, a) = \sum_{s'} \sum_r p(s', r|s, a)[r + v_\pi(s')]$
- $q_\pi(s, a) = \max_{s',r} p(s', r|s, a)[r + \gamma v_\pi(s')]$
- $q_\pi(s, a) = \max_{s',r} p(s', r|s, a)\gamma[r + v_\pi(s')]$
- $q_\pi(s, a) = \sum_{s'} \sum_r p(s', r|s, a)\gamma[r + v_\pi(s')]$
- $q_\pi(s, a) = \max_{s',r} p(s', r|s, a)[r + v_\pi(s')]$
- $q_\pi(s, a) = \sum_{s'} \sum_r p(s', r|s, a)[r + \gamma v_\pi(s')]$

10. Let $r(s, a)$ be the expected reward for taking action a in state s, as defined in equation 3.5 of the textbook. Which of the following are valid ways to re-express the Bellman equations, using this expected reward function? [**Select all that apply**] **1 point**

- $q_\pi(s, a) = r(s, a) + \gamma \sum_{s'} \sum_{a'} p(s'|s, a)\pi(a'|s') q_\pi(s', a')$
- $v_*(s) = \max_a [r(s, a) + \gamma \sum_{s'} p(s'|s, a) v_*(s')]$
- $v_\pi(s) = \sum_a \pi(a|s)[r(s, a) + \gamma \sum_{s'} p(s'|s, a) v_\pi(s')]$
- $q_*(s, a) = r(s, a) + \gamma \sum_{s'} p(s'|s, a) \max_{a'} q_*(s', a')$

11. Consider an episodic MDP with one state and two actions (left and right). The left action has stochastic reward 1 with probability p and 3 with probability $1 - p$. The right action has stochastic reward 0 with probability q and 10 with probability $1 - q$. What relationship between p and q makes the actions equally optimal? **1 point**

- $13 + 2p = -10q$
- $7 + 3p = 10q$

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