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3. Q value iteration by sampling

Q value iteration by sampling

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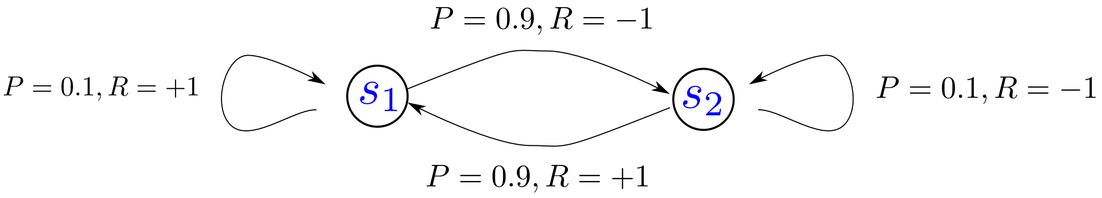
Let us consider a toy example which might not be very realistic but which neverthless can help delineate the Q-value iteration for RL using sampling approach.

For this example, assume that there are only two states, s_1, s_2 and only one action possible from each of these states. Let a_{s_1}, a_{s_2} be the actions that could be taken from s_1 and s_2 respectively.



The state transition probabilities are listed below and are also shown in the figure above.

$$T\left(s_1, a_{s_1}, s_1\right) = 0.1$$

$$T\left(s_1, a_{s_1}, s_2\right) = 0.9$$

$$T\left(s_2, a_{s_2}, s_2\right) = 0.1$$

$$T\left(s_2, a_{s_2}, s_1\right) = 0.9$$

The rewards for these actions are given by

$$R\left(s_1, a_{s_1}, s_1\right) = 1$$

$$R\left(s_1, a_{s_1}, s_2\right) = -1$$

$$R\left(s_2, a_{s_2}, s_2\right) = -1$$

$$R\left(s_2, a_{s_2}, s_1\right) = 1$$

Note that we resort to finding optimal Q^* function by sampling for tasks where we don't have access to the exact T, R functions. However, for this toy example we will assume that the Q-value iteration algorithm isn't directly provided with the above specified values of T, R and has to resort to sampling to estimate the Q function.

Let's say that the agent starts out from state s_1 and collects few samples. Each sample can be described by the following tuple $(s, a, s', R(s, a, s'))$ which indicates that the agent received a reward of $R(s, a, s')$ when it reached state s' by taking action a from the state s.

The collected samples are described as follows in the order in which they are presented to the Q-value iteration algorithm.

$$(s_1, a_{s_1}, s_1, +1)$$

$$(s_1, a_{s_1}, s_2, -1)$$

$$(s_2, a_{s_2}, s_1, +1)$$

Let $S_k^{Q(s,a)}$ be used to denote the k^{th} sample of $Q(s,a)$ ($k = i + 1$). Then recall that

$$\hat{Q}_{i+1}(s,a) = \alpha * S_k^{Q(s,a)} + (1 - \alpha) * \hat{Q}_i(s,a)$$

For all of the following problems, assume that the discount factor $\gamma = 0.5$, $\alpha = 0.75$ and that all the Q values are initialized to 0 to start with. That is,

$$\hat{Q}_0(s,a) = 0 \forall s, a$$

Numerical Example

1 point possible (graded)

Enter below the value of $Q(s_1, a_{s_1})$ after the first sample is processed by the Q-value iteration algorithm

Answer: 0.75

Solution:

Let $S_k^{Q(s,a)}$ be used to denote the k^{th} sample of $Q\left(s,a\right)$.

$$\begin{aligned} S_1^{Q(s_1,a_{s_1})} &= R\left(s_1,a_{s_1},s_1\right)+\gamma * \max_{a'} Q\left(s_1,a'\right) \\ S_1^{Q(s_1,a_{s_1})} &= +1+0.5*0=1 \\ Q_1\left(s_1,a_{s_1}\right) &= \alpha * S_1^{Q(s_1,a_{s_1})}+(1-\alpha)*Q_0\left(s_1,a_{s_1}\right) \\ Q_1\left(s_1,a_{s_1}\right) &= .75*1+(1-.75)*0=.75 \end{aligned}$$

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You have used 0 of 3 attempts

Answers are displayed within the problem

Numerical Example - 2

1 point possible (graded)

Enter below the value of $Q\left(s_1,a_{s_1}\right)$ after the second sample is seen by the Q-value iteration algorithm

Answer: -0.5625

Solution:

Let $S_k^{Q(s,a)}$ be used to denote the k^{th} sample of $Q\left(s,a\right)$. Note that from the previous example,

$$Q_1\left(s_1,a_{s_1}\right)=0.75$$

Now we find $S_2^{Q(s_1,a_{s_1})}$:

$$\begin{aligned}
S_2^{Q(s_1,a_{s_1})} &= R\left(s_1, a_{s_1}, s_2\right) + \gamma * \max_{a'} Q\left(s_2, a'\right) \\
S_2^{Q(s_1,a_{s_1})} &= -1 + 0.5 * 0 = -1 \\
Q_2\left(s_1, a_{s_1}\right) &= \alpha * S_2^{Q(s_1,a_{s_1})} + (1-\alpha) * Q_1\left(s_1, a_{s_1}\right) \\
Q_2\left(s_1, a_{s_1}\right) &= 0.75 * -1 + 0.25 * 0.75 = -0.5625
\end{aligned}$$

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You have used 0 of 3 attempts

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Can someone explain the maxQ

Community TA

28

Incorrect formula on board

The last equation on the board in the lecture is incorrect. She has left out a factor of alpha. I....

2

Do STATES increase during RL?

I have a question regarding the many things that are unknown, apart from ***T*** and ***R...

3

Hint for Q1 and Q2

Community TA

3

Heraclitus vs. Markov: Can one ever step in the same river twice?

Is anyone working on a Heraclitus Decision Process (HDP) model?

2

Reinforcement learning resources

Survey paper: https://arxiv.org/abs/cs/9605103 Free textbook: http://incompleteideas.net/bo...

1

? Expression in answers 5

Hi all, should the answers to questions in this vertical be inserted as mathematical expressio...

💬 [Staff] Hand Writing Difficult To Read 3

The hand writing in this particular video is difficult to follow, it is all squished together. Please...

💬 [Staff] Second question bugged grader 2

I introduced an incorrect answer which was graded as correct.

? [Staff] Lecture formula for Q different from exercise? 5

💬 Q value 2

in Max over a' of Q(s_1,a') is the value of Q impacted by the Q initialization to 0?

☑ [STAFF] Not clear how an exponentially weighted average formula leads to the recursive version in the lecture 2