CS-370-X6161 Current/Emerging Trends in CS 23EW6

Resources: Q-Learning Algorithms

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There are a variety of different algorithms that can be used for reinforcement learning. In this course, you will primarily study variants of Q-learning algorithms. “Q-learning is an off policy reinforcement learning algorithm that seeks to find the best action to take given the current state...More specifically, Q-learning seeks to learn a policy that maximizes the total reward. *The ‘Q’ in Q-learning stands for quality*. Quality in this case represents how useful a given action is in gaining some future reward.” (Emphasis added.)

Reference:

Violante, A. (2019 March 18). *Simple reinforcement learning: Q-learning*. Medium: Towards Data Science. Retrieved from https://towardsdatascience.com/simple-reinforcement-learning-q-learning-fcddc4b6fe56

Required Resources

Textbook: *Deep Learning with Keras (http://ezproxy.snhu.edu/login?url=https://ebookcentral.proquest.com/lib/snhu-ebooks/detail.action?docID=4850536)*, Chapter 8

In this reading from the Shapiro Library textbook, you will review the concepts of reinforcement learning, and learn more about Q-learning algorithms and the Keras deep Q-network. This reading does overlap slightly with the chapter in *Applied Reinforcement Learning with Python*, but it is important to read both chapters to have a solid understanding of the different components of Q-learning. The chapter also provides a step-by-step walkthrough and explanation of the code for a “catch” game that applies these algorithms. As you read, consider the following:

- What is Q-learning and how can it be used? How does the Q-learning algorithm work?
- What is the difference between exploration and exploitation? How does the Epsilon greedy exploration method help to balance exploration with exploitation?

Textbook: *Applied Reinforcement Learning With Python (http://ezproxy.snhu.edu/login?url=https://ebookcentral.proquest.com/lib/snhu-ebooks/detail.action?docID=5880718)*, Chapter 3

This chapter from the Shapiro Library textbook will build on the work you did in the previous module with reinforcement learning. You will explore different algorithms used in reinforcement module with reinforcement learning. You will explore different algorithms used in reinforcement learning, including the Q-learning and deep Q-learning algorithms and their variants. You will also see examples of how these algorithms can be applied to programming problems. As you read, consider the following:

- What is the difference between a Q-matrix and an R-matrix? How are they related?
- What are the advantages of Q-learning? What are the disadvantages?
- How does deep Q-learning improve upon Q-learning? What are its limitations?

Note: There are some complicated math equations referenced in this chapter. Understanding the details of the equations is *not* essential for your work in this course. Be sure to pay special attention to the code sections that are included.

Reading: An Introduction to Q-Learning: Reinforcement Learning (https://medium.com/free-code-camp/an-introduction-to-q-learning-reinforcement-learning-14ac0b4493cc)
In this reading, you will see another example of how Q-learning can be applied to a pathfinding problem similar to the one you will explore in Project Two. This reading will help you see a more step-by-step breakdown of what the Q-learning algorithm is doing at each step, and how it is updating the Q-table. As you read, consider the following:

- What are the inputs of the Q-function? What are its returns?
- What are the steps the Q-algorithm is taking? How does the reward mechanism affect this process?

Reading: Finding Shortest Path Using Q-Learning Algorithm (https://towardsdatascience.com/finding-shortest-path-using-q-learning-algorithm-1c1f39e89505)
In this reading, you will explore the application of Q-learning to a “shortest path problem”. This scenario differs from the pathfinding problems in the other readings and in Project Two, as the “world” the agent is navigating is not a simple grid. However, the same basic concepts of reward, state, and action apply. As you read, consider the following:

- How is the reward matrix set up? Why are the reward values set the way they are?
- How does the set of steps for the shortest path between 0 and 10 relate to the Q-matrix values?

Reading: Cartpole - Introduction to Reinforcement Learning (DQN - Deep Q-Learning) (https://towardsdatascience.com/cartpole-introduction-to-reinforcement-learning-ed0eb5b58288)
This reading explains a solution to a “cartpole problem” using reinforcement learning, specifically deep Q-learning. Though the problem is different than the one you are exploring in Project Two, the type of algorithm (deep Q-learning) is the same. As you read, consider the following:

- What does each line of code do in the cartpole.py file?
- What are the purposes of the “remember” and “experience replay” steps in the algorithm?

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Additional Support (Optional)

Reading: Math Symbols List
(https://www.rapidtables.com/math/symbols/Basic_Math_Symbols.html)
This optional reading contains a list of symbols used in a variety of math fields, including algebra, geometry, probability, calculus, and set theory. Though you are not required to understand all of the formulas in the textbook readings, if you would like a deeper understanding of the formulas, this resource will help you understand some of the symbols.

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Explore these resources, which will help you learn how to apply Q-learning algorithms to programming problems.

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