# CS 4080-5080: Reinforcement Learniing

## Home Work Assignment 3
Out: 10-15-2021, Due 12-1-2021

This assignment requires you to implement a reinforcement learning agent using artificial neural networks. You can use a library that lets you build a neural network, but you must build the networks yourself.

Once again, consider simplified the parking lot agent(s) from homework assignment 2. It has 8 parking spots marked $P$, and one marked entrance. It is described in terms of a $6 \times 7$ grid, as in Figure 1. There is barrier to movement between the two rows of parking.

A car agent can move only forward, backward, or sideways. For a simple car, we make the assumption that there is no angular steering. A car cannot drive over parking spots on its way to a goal parking spot.

The agent needs to learn a policy or a number of policies that will take it from the entrance to any of the parking spots. Assume all grid cells are of equal size and a car fits well inside any of the cells. We assume that the car is a square and the grid cells are squares as well.

1. How would you represent the various components that are required to program the car to learn to park in any of the parking spots? Discuss each component. Keep in mind that you are going to implement a neural network, and it will be beneficial to describe the states in terms of some features or attributes.

2. You are asked to a neural network that can implement the Q-learning algorithm .

   What are the inputs and the outputs of the neural network? What is the neural network going to learn?

   What is the architecture of the neural network you are going to build? Why did you choose this architecture?

   Create at least two different architectures and compare performance.

   Are you going to use a replay memory? What is the structure of the replay memory? Why have you chosen this structure? How big is the replay memory? How are you going to fill the replay memory? You can play with sizes of the replay memory and make observations regarding effects.

3. Implement the neural network using any programming language and libraries of choice. Show one or more of the policies learned. Change any relevant parameters and comment on how changes in parameter values change learning. It is a good idea to include graphs or tables for such analysis.
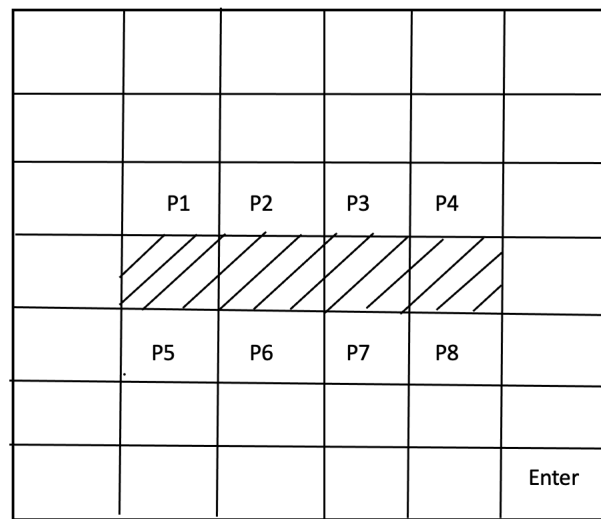
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Figure 1: A Simplified Parking Lot

4. Perform one or more enhancements. The problem as given is trivial. You can make it more complex in terms of size of the environment or other details, and adapt your solution. Discuss how you make the problem a little more complex, and what kinds of adaptations you have to perform.

5. Write a short paper giving details of what you have done, the results you have obtained, the problems you have faced, and how you have overcome the problems. Use the format you use for your semester project papers. The maximum number of pages is 4 for content, followed by an extra page for references, if necessary.

You do not need to hand in soft copies of your programs for this assignment. Written answers in the paper to questions given or issues raised above are sufficient. You will have to demo your program the week it is due or before. Please upload copy of your paper on Canvas on the due date.