Machine Learning Nanodegree Capstone Project Proposal

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Domain Background

This project is based on Artificial Intelligence Path Planning. Robot navigation is a generalization of the route-finding problem This project takes inspiration from Micromouse competitions, wherein a robot mouse is tasked with plotting a path from a corner of the maze to its center. The robot mouse may make multiple runs in a given maze. In the first run, the robot mouse tries to map out the maze to not only find the center, but also figure out the best paths to the center. In subsequent runs, the robot mouse attempts to reach the center in the fastest time possible, using what it has previously learned.
The approach may also be applicable to path planning for self driving cars that need to plan the optimum route to the desired destination and other planning challenges.

Problem Statement

To search and determine the best path towards a desired location. This project will utilize a Reinforcement Leaning based algorithm than can help a robot navigate the fastest way through a maze. This may be useful solving path planning problems such as in self driving cars and other real world robots that need to navigate the real world to accomplish a goal.
The robot will first explore the maze tho collect data that may be used to compute the optimum path. Once the optimum path is determined by the algorithm the robot must be able achieve the goal within the required time limit.

Datasets and Inputs

- The inputs to this project will be the provided scripts for the robot, maze and other helper scripts that will be modified as required to solve the stated problem.
- The input the agent will utilize will be inputs from the three obstacle sensors, mounted on the front of the robot, its right side, starting orientation, and its left side and the demotions of the maze.

Solution Statement

- An a Reinforcement Learning algorithm will be utilized to identify and plot the most efficient path towards the desired goal.
- The task of reinforcement learning is to use observed rewards to learn an optimal (or nearly optimal) policy for the environment[1].
- The approach that will be utilized is Q-learning which is a model-free reinforcement learning technique.
    - It works by learning an action-value function that ultimately gives the expected utility of taking a given action in a given state and following the optimal policy thereafter. A policy is a rule that the agent follows in selecting actions, given the state it is in. When such an action-value function is learned, the optimal policy can be constructed by simply selecting the action with the highest value in each state. One of the strengths of Q-learning is that it is able to compare the expected utility of the available actions without requiring a model of the environment[2].
- The agent will constructs a Q-table that will represents the learned action-value function as traverses the the maze in the first run. Then during the second run the agent will utilize the optimal policy by simply selecting the action with the highest value in each state to navigate through the maze to the goal state.

Benchmark

This will be based on an estimate the agent will take to navigate each maze. On the first run the agent will need to try to explore the entire maze at least once hence it will be estimated to be N^2, where N is dimension of one side. Then for the second run the optimum steps required to get to the goal will be manually assessed. Then then total estimate to complete each maze will computed by adding 1/30th of the steps determine for run one (10 and optimum steps counted for each maze for run two (2).

Evaluation Metrics

The number of time steps required to execute the second run, plus one thirtieth the number of time steps required to execute the first run.

Project Design

1. First the baseline estimates of what is expected to complete each maze will be computed.
2. Then a Q Learning reinforcement learning algorithms will be developed and implemented to help the agent successfully complete the task of learning and navigating its way to the goal.

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[1] Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. Pearson, 2016.

[2] “Q-Learning.” Wikipedia, Wikimedia Foundation, 20 Oct. 2017, en.wikipedia.org/wiki/Q-learning.