Name(s)

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Project Number

J1403

Project Title

Obstacle Avoiding Robot: A Reinforcement Learning Approach

Abstract

Objectives

Artificial intelligence is the wave of our future. We wanted to undertake a science project involving AI with real life applicability. Our goal was to program a robot that could detect and avoid obstacles using a Q learning algorithm. This capability could be applied in many helpful ways, such as in delivery systems or self-driving wheelchairs. We hypothesized that when the Q learning algorithm records more states, it learns an obstacle free path that covers a larger area of the enclosed space.

Methods

For this project, we obtained a LEGO Mindstorms Ev3 robot and attached an ultrasonic sensor to detect obstacles and a gyro sensor to make precise turns. We programmed the robot with a Q learning algorithm to avoid obstacles in an enclosed area by selectively moving forward or rotating to the right. In Q learning there are states, actions possible with each state, and a reward associated with an action. When the reward is high, the robot knows it performed the best action. The robot learns to choose moves that maximize the value of the reward. We first simulated the experiment on a computer using a virtual 11x11 coordinate plane.

Results

We performed over 300 trials with different parameters to make the Q learning algorithm run successfully. We tested the influence of various parameters on our algorithm and determined that a discount factor less than 0.75 makes the robot learn in fewer than thirty moves and the probability of random moves must be less than 0.1 for the algorithm to learn in a consistent manner. The effectiveness of the algorithm is influenced by how the states are encoded. Our state function remembers the last n moves made by the robot. We demonstrated that the area of the enclosed space covered by the robot increased as n was increased from 2 to 10.

Conclusions

Our experiments confirmed the hypothesis, that increasing the number of states recorded by the robot enabled it to cover a larger area. Once we programmed the Ev3 robot with our Q learning algorithm, it was remarkable to see it adapt to new obstacles and surroundings as the algorithm learned and taught itself.

Summary Statement

We devised a Q learning algorithm that enabled a robot to learn a repetitive path within an enclosed space which avoided all obstacles.

Help Received

We received help from our parents to write and debug the Q learning based simulator program in python. We modified the simulator program for each experiment on our own. Further, we also modified the program for moving the robot by including functions for actuating the motors and reading the sensors.