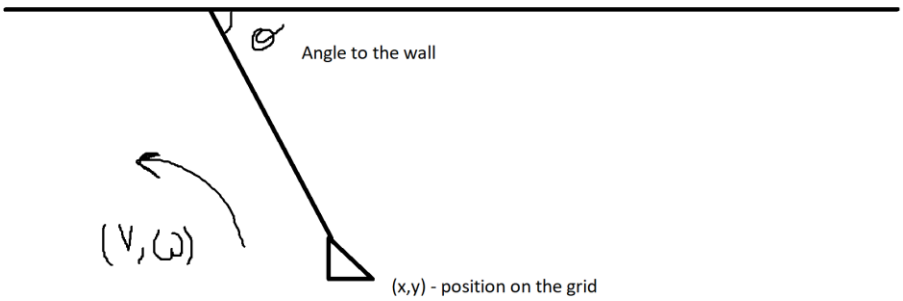
Advanced Robotics – CSE 668

Homework 1

Answer 1.1

The state space of a robot is the list of all possible states a robot can be present in. Let us assume that our robot is present in a space which is grid-like, with equal number of grids on the x and y axes, say 50 and 50 cells in each direction. We must also consider the angle the robot makes to the wall, which will range from 0 degrees to 180 degrees. We assume that the wall is present at y = 0 (the top). Then our state space will look like -
x – {0….50}, y – {0….50} and theta – {0…..180}



Answer 1.2

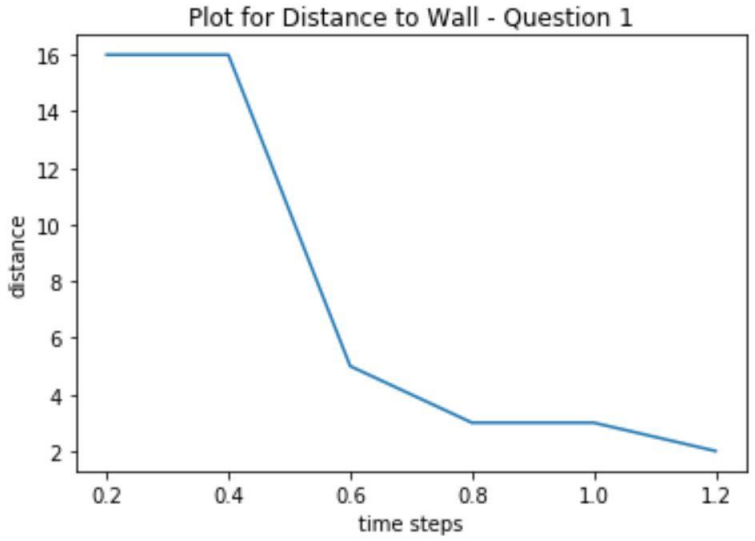
Looking at the ranges1.dat file, we can see that the ranges vary from 2 to 17 approximately. Hence, a reasonable assumption for our state space would be x – {0…25}, y – {0…25} and theta – {0...180}. But, we need to discretize out theta, as steps of 1 are too small. Therefore, I picked 20 values for theta in the range of 0-180 degrees with steps of 9 degrees each time. So the state space for theta would look something like – {0,9,18,……,171,180} in degrees.

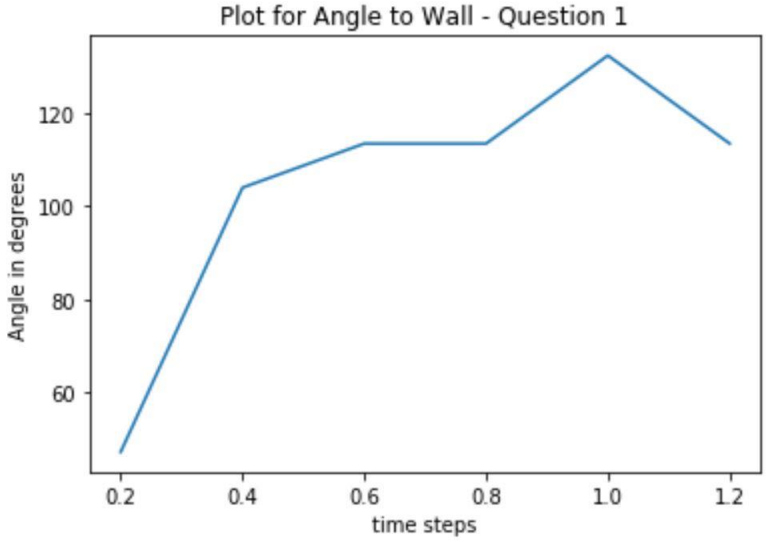
Answers 1.3 – Answers 1.6 are present in the code “main.py”

Answer 1.7

At each time step, we estimate the angle to the wall and the distance. The plots for that are shown below –

The distance to the wall is taken from the y coordinate.





The x, y, theta values at each time step are shown below –

24	16	47.26902
23	16	103.9918
23	5	113.4456
23	3	113.4456
22	3	132.3533
23	2	113.4456

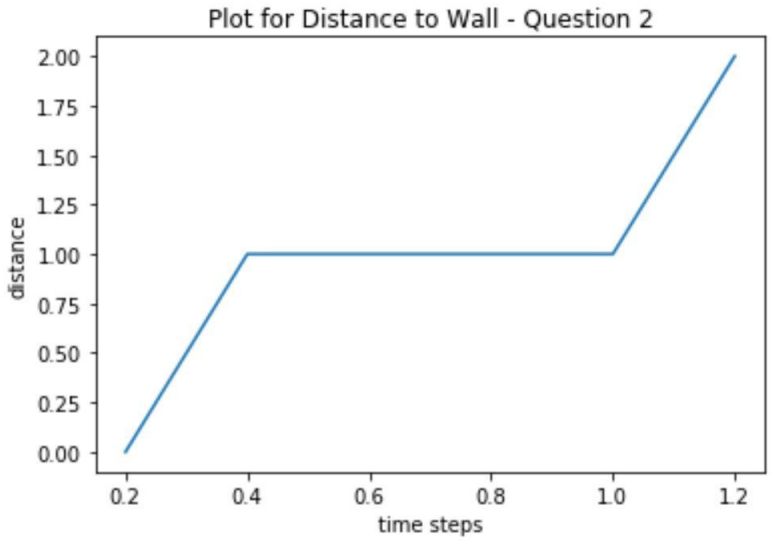
Answer 1.8

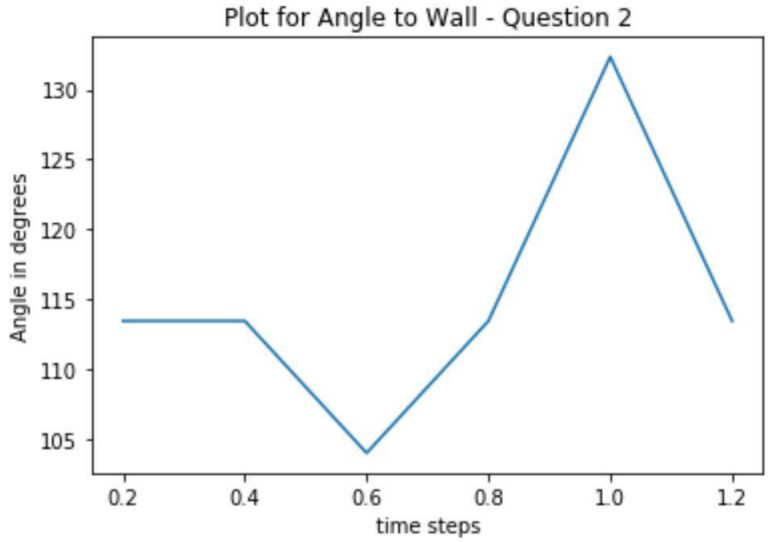
At time t=1, this refers to 0.2s*5, which is the 5th time step, so the robot it at (22,3) x and y coordinate, making an angle of 113 degrees with the wall.

Answer 2

Below are the two graphs for the ranges2.dat file for the distance to the wall and the angle made by the robot with the wall. We only change the data file in this case and the observe function to consider that the sensor is noisy and will return a shorter range 20% of the time.

The distance to the wall is taken from the y coordinate.





Find below the x,y, theta values at each time step.

21	0	113.4456
23	1	113.4456
23	1	103.9918
23	1	113.4456
22	1	132.3533
23	2	113.4456

6. Project – Goals and Outcomes

Project Title : **Automatic Design of robots**

Project Partner : Aditya Singh Rathore

This project would be to determine if a robot can be built given a set of parts. There are three things to consider in this design problem – A functionality space (what a particular part can do- for a motor it will be torque, speed), an implementation space (all parts that are available – for a motor it would be all possible motors present in the store) and a resource space (what resources are needed for that part – for a motor it will be the cost, voltage, current, etc.) We also need to consider the two maps that relate an implementation to functionality provided and resources required.

This is an optimization problem, where we need to minimize the resources used and maximize the performance. The reference paper uses “order theory” in order to solve this problem. This is in a way, similar to set theory and has it’s own set of rules and definitions.

The first step would be to scrape the internet (specifically robot parts websites) and create a library where we can get all the robot parts that are available for sale, and their configurations, specifications and price.

The long term goal would be to input a set of parts with some specifications into the system, and the output should be all possible and viable configurations of these parts that could build a working robot.

Reference : https://arxiv.org/pdf/1512.08055.pdf - A Mathematical Theory of Co-Design - Andrea Censi