Assignment 1
AI and Robotics (AIR) - 236609

November 21, 2022

This is the first out of the three assignments of this course. Each assignment will be divided into two distinct and complimentary parts: theoretical and practical.

1 Theoretical Assignment

For the theoretical part you are required to submit one document, a pdf file generated using the latex template "Theoretical Assignment.tex" provided at `https://www.overleaf.com/read/mkphtcyjbjpc`. The maximal length of the submitted document is 3 pages.

1.1 State Space Search

1.1.1

In the graph shown in Figure 1, A is the start node and D is the goal state. In addition, $h(A) = 8$, $h(B) = 3$, $h(C) = 7$ and $h(D) = 0$,

(a) Is h an admissible heuristic? Is it consistent ?

(b) Trace the execution of A*, showing the successive configurations of the frontier where the elements on the frontier are paths. That is, the path n1 $\rightarrow$ n2 $\rightarrow$ n3 would be written [n1,

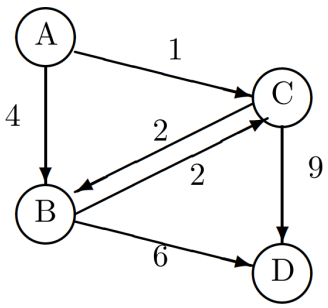

Figure 1

n2, n3]. Under each element of the frontier, indicate the f, g and h values of the final node in the path (e.g., if $g(m) = 5$ and $h(m) = 7$ write "$12 = 5 + 7$" underneath m), Remember to get the order right, $g(m)$ followed by $h(m)$. **For this part, you don't need to generate the answer using latex, but can instead include an image you generated manually or with a drawing software**.

(c) What is the path to the goal found by A* ?

(d) Indicate how the search would change if cycle checking is used, and how it would change if path checking is used (detecting permutations of the same sequence of nodes)?

1.1.2

While running A* with heuristic h, a node that was in the closed-list was put in the open-list. This means that h is:

(i) consistent

(ii) admissible

(iii) not admissible

(iv) not consistent

(v) it is impossible to know

Explain your answer (up to 2 lines)

1.1.3

While running A* with some heuristic h, a goal node was expanded and put into the closed-list with value f. Is it possible that the value of the node will be updated at future steps?

(i) yes, if h is consistent

(ii) yes, if h is admissible

(iii) yes, if h is admissible or consistent

(iv) no

Explain your answer (up to 2 lines)

1.2 Modeling

1.2.1

Consider a robot with a gripper that needs to create a tower of several blocks (for example: a tower with a red block on top of a green block) from blocks that are scattered on the table (as depicted in Figure 2).

Figure 2

1. For each of the models below, suggest an appropriate definition of each of its elements.

   (a) Classical planning

   (b) Markov-Decision Process (MDP)

   (c) Partially Observable Markov Decision Process (POMDP)

2. For the classical planning and MDP models, describe briefly a limitation the model (i.e., what it cannot capture) that is addressed by the following model. For the POMDP model, mention one aspect of the problem that is not captured.

2 Practical Assignment

2.1 Logistics

For the practical part, you are required to submit 1 documents: A single python module containing your code named assignment1.py.

You will be working with the turtlebots 3. To complete the practical part of the assignment you must run your solution both in simulation and on the real robots during reception hours.

2.2 Technical details

- We will be using Ubuntu18 with ROS melodic.
- The repo for the exercise can be downloaded from `https://github.com/sarah-keren/MRS_236609`
- You need to install the Turtlebot3 (see separate guide on how to do this).

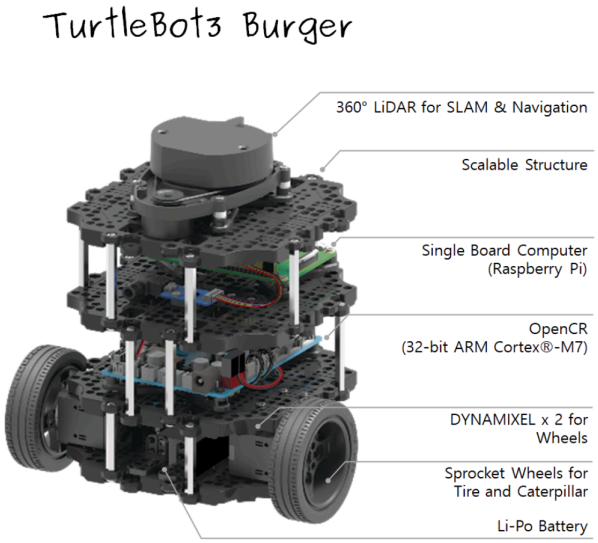

Figure 3

- Our code should be installed under the src folder of the ROS project you created (see separate guide on how to do this).
- You will need to complete assignment1.py.

2.3 Tasks

- Task 1: drawing a circle with a diameter of 0.5-1.0 meters. For this, you will complete the method **move_circle** in the file assignment1.py that is provided as part of this assignment.
- Task 2: drawing a square with an edge of length 0.5-1.0 meters by completing the method **move_square**
- Task 3: drawing the letter M with width and length both of length 0.5-1.0 meters by completing the method **move_MShape**

2.4 How to check you solution

To run the simulation, open a terminal, and run the following commands (press enter to run each command):

- cd ~/my_ws/
- source devel/setup.bash
- export TURTLEBOT3_MODEL=burger
- roslaunch turtlebot3_gazebo turtlebot3_house.launch

Note: if you want to run the simulation in an empty world, you can replace the launch file in the last command with turtlebot3_empty_world.launch

And to run your code, open a new terminal and run the following commands:

- cd ~/my_ws/
- source devel/setup.bash
- export TURTLEBOT3_MODEL=burger
- rosrun MRS_236609 assignment1.py

2.5 Pay attention

- **Do not !** include ANY package that is not already installed by default. If you want a package that is not installed - you need our approval.
- You need to make sure your code is python2 compatible.
- The lab report must not exceed 4 pages.
- Even if you don't how to run the turtlebot yet, you can start working on the assignment using the Turtlesim package.
- This may not be the final description of the assignment. As you start working on it, you will have questions, and we may need to slightly update the description accordingly.

Good luck and don't forget to enjoy the process!