Mestrado em
Engenharia Informática e de Computadores
MSc in
Information and Computer Engineering

INTRODUÇÃO À ROBÓTICA / INTRODUCTION TO ROBOTICS

2019/2020

Mini-Project 3

Hand-out: 23 September 2019 **Due:** 30 December 2019

Objective

The objective of this homework is to provide the course students with the opportunity to get familiarized with the practical aspects of decision-making in autonomous mobile robots. As in past mini-projects, students must also get used to saving all the relevant data to be reported using `rosbags`.

Procedure

The work will be implemented in a TurtleBot3 Waffle Pi[1] mobile robot, already equipped with the algorithms developed in past mini-projects that enable it to navigate in the previously mapped environment. The algorithms implemented in the mini-project will run on an external computer that communicates with the onboard ROS master using WiFi.

The main steps to be followed to achieve the objectives of the project are (using the real robot):

1. Discretize the map obtained in mini-project 1. by using a gridmap with squared cells with size equal to the length of the robot.
2. Suppose you want your robot to run several times a policy (with actions having uncertain outcomes) determined to reach sequentially two cells representing desired locations of its environment, while making sure a third cell/location will not be visited (e.g., the robot should go to the kitchen, then to the dining room, but never passing near the stairs to the 2nd floor). Formulate this as a Markov Decision Process (MDP), by defining its states, actions, transition and reward functions. Solve the MDP to obtain the policy. **Hint:** *you may need to solve two MDPs and switch between them at some point in a run*.
3. Execute the policy determined in 2. by running it on the mobile robot, using the algorithms developed in mini-projects 1. and 2. to move the robot and know its cell/location in the map at each time step.

1 http://www.robotis.us/turtlebot-3-waffle-pi/

Expected results

The following list represents the minimal set of results to be reported:

- MDP model;
- MDP solution (policy);
- results of several runs of the robot, starting from different cells/locations in the map, by showing the traversed path – in RVIZ.

The groups are strongly encouraged to explore and modify relevant parameters of the methods used, so as to be able to present a diverse set of results and justify the differences among them as a function of the parameters used.

The key locations in 2. should be such that the solution of the problem is not trivial. This choice will be subject to evaluation.

Bonus points will be given for those attempting to use Reinforcement Learning to learn the MDP solution.

Reporting

The mini-project will be evaluated taking into account the quality of reporting on the work done, the results presented in class and in the written report, and the ability to explain them formally. The written report should be no longer than 10 pages A4, one column, 12pt, 1.5pt spacing. All reports shall be structured in Sections as follows:

1. Introduction – *summarizing the work done*
2. Background – *brief introduction of main equations and algorithms involved in the used methods, to establish notation, citing references used*
3. Implementation – *core section, where the implementation of the applied methods is described with some detail*
4. Results – *addressing mainly the questions raised in the homework text*
5. Conclusions – *what went well; what went less well, explaining why*
6. References