AINT509 – Reinforcement learning

Coursework assignment 1b

Objective

In this assignment you will program reinforcement learning on a Lego Mindstorm robot. The robot will need to learn line following. This coursework will count towards 25% of your mark for AINT509.

Note : you must choose between coursework 1a (Monte Carlo localisation) or coursework 1b (reinforcement learning). Do not do both coursework assignments.

Assignment details

For this assignment you will again need to build a small wheeled robot (a differential drive robot would be a good choice), which needs to learn how to follow a line.

Note that you will have to solve the following problems

- Build a robot with an appropriate setup of sensors to solve the line following problem.
- Come up with an appropriate number of states and actions for this problem. States will relate to the sensor values of the robot and actions will be different moves of the robot (forward, back, turn left, turn right).
- Define an appropriate reward function which rewards the robot for driving on the line, and negatively rewards the robot for driving off the line or not driving at all.
- Let the robot learn using a mixed exploration and exploitation method.

Practical issues

The Q learning can run on or off-board the robot. When programming on-board the robot, NXC would be recommended. The best environment to program, compile and download NXC is Brix Command Centre: this is an Integrated Development Environment (IDE) for programming the Lego Mindstorm.

When controlling the robot from a PC, then the RWTH Mindstorms NXT Toolbox is useful: this is a library for Matlab which allows you to control the robot and read sensorsusing Matlab. This is useful for just running the robot to read sensor values and execute motor command and do the processing on the PC.

Demonstration and submission deadline

Your coursework will be assessed during a demonstration. In addition you will need to upload your code and any additional material to the AINT509 website (ROCO502 if you are a MEng student).

- **You will need to demonstrate your work on Tuesday 17 March 2015. We meet in SMB204 starting at 9am. Please prepare a fully working demo: there will be <u>no time</u> for code tweaking or modifications to your setup. The demo should show the robot starting from a random place on the sheet and should show how the robot cycles through prediction and update steps and maintain various estimates of where it is and eventually localises itself. Each demo should take under 10 minutes!**
- By **Wednesday 18 March 2015 (23h55)** you will need submit (1) the code you wrote and (2) any additional material which you would like to have considered, for example a video of the robot learning. All files should be zipped into one file and submitted on the module website (although uploading the video to a streaming service, such as Youtube, might be easier than zipping it and loading it onto the DLE).

Marks will be available approximately 4 weeks after the deadline.

This is an individual coursework. Helping each other and communication is positively encouraged, but each student should submit a report and code which is <u>their own</u>.

Notes

- You do not have to use the Lego Mindstorms, you can use a simulation of a robot instead. You are also free to choose another challenge to learn. However, discuss this with Tony before you start your coursework.

Rules and advice on coursework submissions

- You must submit your coursework online via the module website.
- Please zip your code and any additional material into a single zip file. You will have to submit this zip file.
- You can submit any time you like before the deadline. You can resubmit as many times as you like before the deadline: each submission overwrites the previous submission.
- Please note that the University caps coursework which is submitted within 24 hours after the deadline at 50%. You receive zero percent for work submitted after this deadline without valid extenuating circumstances.

Notes on Mindstorms firmware

You might want to check the firmware on your robot. Use the buttons on the robot to go to settings (the "tool" system, and go the "version"). Your firmware (FW) version should be 1.29. If it isn't, you can download new firmware from http://mindstorms.lego.com/en-us/support/files/default.aspx#Firmware. Just unzip and use the Tools > Download Firmware function to download it to your robot. If things fail (robot is stuck and makes a clicking sound), try again. If it still fails, remove batteries, wait 10s, and redo from start.