6COM1035 Coursework 2: Constructing Autonomous Systems

Academic Year 2017/2018

Important information about this piece of coursework

This piece of coursework can be done either individually or in pairs, up to you. Please see the information below and also the information provided at the end of this document regarding how marks will be awarded in the case of individual submissions and in the case of submissions done in pairs.

- **Students working in pairs** will need to make their own arrangements to find a suitable colleague who would like to work with them. Students working in pairs will need to work on and submit the code and the report as a pair, but each student will need to give a demo of the joint work individually. In addition, the report should include a statement explaining what was the contribution of each student to the joint work. Both students will obtain the same mark for the joint parts of the coursework (code and report) but will be assessed individually for the demo, as specified in the Marking Scheme at the end of this document.

- **Students working individually**, will need to carry out all the elements of the coursework individually, and will be assessed individually for all of them, as specified in the Marking Scheme at the end of this document.

Description

In this piece of coursework, you need to apply the notions, principles, methods and algorithms seen in the Constructive AI lectures and practicals to design, program and test the autonomous systems described below, and write a short report describing your work and justifying your design choices. You will also be asked to give a short demo (between 4 and 5 minutes) on the week of 8th January 2018).

You should implement the autonomous systems using the e-puck robot model of the Webots robot simulator available in the student labs.

The work must be done individually by each student, and submitted on StudyNet in two documents: (1) a .zip archive containing your commented code and (2) a report in PDF format.

This coursework is worth 65% of the marks for this module.

a) Implementation of Autonomous Systems

Using the e-puck robot model of the Webots robot simulator, implement the following autonomous robots. To implement them, you are welcome to build on the sample robot controllers provided in the practical sessions (i.e., you can use them as an initial model that you can modify and adapt to create your robots), or to design a new controller from scratch. Please state clearly in your report which option you have chosen, and add appropriate comments to your code which allow to identify which code is borrowed and which code is your own.

1) Implement a wall following robot using a subsumption architecture. Your environment should be surrounded by a wall.

2) Implement a garbage collection robot. For this, you can use the robot architecture (controller) of your choice; you will need to justify your choice in the report. Your environment should be surrounded by a wall and also contain obstacles and other objects to be used as “garbage”. The robot must move the “garbage” scattered around the environment to a specific place, e.g., by the wall, inside a spotlight, inside a small area of the arena, etc.

3) Implement a robot that can solve a “two resource problem” in the environment of your choice. For this robot, you need to use a motivated architecture that uses a simulated physiology of homeostatically controlled variables, as well as appropriate motivations and behaviors.

b) Testing your autonomous robots in the original environment and in more complex multi-agent environments

You need to test the behavior of each of the three robots above in more complex environments that include several (e.g. 2 or 3) identical robots. In addition to the additional robots, you can make the environments more complex for example by adding other elements such as rocks, movable objects, etc.

You need to test each of the three robots in the original environment for at least 2 “runs” and in the new complex environment for at least three “runs” of no more than 6 minutes and no less than 3 minutes per run. All the runs should be of the same duration.

You need to evaluate the runs for robots 1 and 2 qualitatively, and the runs for robot 3 both qualitatively and quantitatively:

- **Qualitative evaluation (robots 1, 2 and 3):**

For each of the three robots and run, make a note of the differences you might observe in the behavior of the robots. For example, do they get stuck in corners and if so, in which cases? Do they lose track of the walls if an object is placed next to them? How much of the environment do they explore? Are there observable differences in behavior between the single-robot and the multi-robot environments? Try to identify as many interesting behaviors as possible. ***Tip***: making movies of the runs would be helpful for you to be able watch each run several times and take more complete / precise notes.

- **Quantitative evaluation (robot 3 only):**

For the 3rd robot, you also need to assess its performance using two of the quantitative metrics seen in class: *survival* for each run and “*wellbeing*” (the latter taking into account the evolution of the internal physiological parameters over the course of the run). In the multi-robot environment, you only need to track one of the robots. ***Note***: *Please note that you will need to log the relevant data in order to carry out this quantitative evaluation.*

c) Report

Write a short report of no more than 10 pages describing:

For each of the three robots:

- the design of the architecture using (a) a detailed diagram (cf. the architecture diagrams seen in class), (b) an explanation of the type of architecture you are using and (c) how your design implements that type of architecture (e.g., for a Subsumption architecture, you would need to (a) draw a diagram of your specific architecture using as a model Subsumption-like diagram, (b) provide a brief explanation of how Subsumption architectures work, and (c) explain why you think your specific architecture is an example of Subsumption architecture);

- a brief explanation of how it works;

- a brief explanation of how the architecture matches the task and the environment; and

- a brief justification of your design choices.

For the tests of each of the three robots in the modified environments:

- a brief description of the environments (original and modified), justifying your choices;

- a brief description of the experimental conditions of the runs (e.g. duration and number of runs carried out for each robot, starting position of the robot in each run, and other elements that you might consider important to mention);

- a description and discussion of the observed behaviors, and a comparison of the robot behavior in the simple (initial) and modified environments.

- For the third robot, tables showing your quantitative analysis, and discussion of the results shown in the tables.

For students working in pairs only:

- In addition, include statement clearly explaining what has been the contribution of each student to the joint work (design, coding, testing, analysis of results, writing of the report).

d) Demo

Regardless of whether you are doing this coursework individually or in pairs, you will need to give a short demo (typically 4 or 5 minutes) individually, on the week of 8th January 2018. Slots will be allocated for this, normally using the regular slots timetabled for the module (lecture and/or practical session) whenever possible. You will be able to sign up for one of the slots closer to the hand-in date; slots will be allocated on a first-come, first-serve basis.

<u>Marking Scheme:</u>

IF THE COURSE WORK IS DONE INDIVIDUALLY, Marks awarded for:

Out of a maximum of 65% (65 marks) of the overall assessment of this module, marks for this course work will be awarded as follows:

- Design and implementation (well commented code) of each autonomous system. Assessment of the design includes the architecture of each robot, the design of environment, the matching between architecture, environment, and the task that the robot has to perform, and the justification of your choices – up to 11 marks for each of the three autonomous systems.

- Quality and thoroughness of the testing of the autonomous robots in the original and in the more complex environments, of the explanation of the tests, and justification of your choices – up to 5 marks for the qualitative analysis of each of the three robots, and up to 10 marks for the quantitative testing of robot 3.

- Quality and clarity of the demo – up to 7 marks.

IF THE COURSE WORK IS DONE IN PAIRS, Marks awarded for:

Out of a maximum of 65% (65 marks) of the overall assessment of this module, marks for this course work will be awarded as follows:

- Design and implementation (well commented code) of each autonomous system. Assessment of the design includes the architecture of each robot, the design of environment, the matching between architecture, environment, and the task that the robot has to perform, and the justification of your choices – up to 10 marks for each of the three autonomous systems. ***This part of coursework will be assessed for the pair, and both students will be awarded the same mark***.

- Quality and thoroughness of the testing of the autonomous robots in the original and in the more complex environments, of the explanation of the tests, and justification of your choices – up to 4 marks for the qualitative analysis of each of the three robots, and up to 9 marks for the quantitative testing of robot 3. ***This part of coursework will be assessed for the pair, and both students will be awarded the same mark***

- Quality and clarity of the demo – up to 14 marks. ***This part of coursework will be assessed INDIVIDUALLY: each student will have to give an individual demo, and will be assessed individually for this.***