F20/F21RO – **Intelligent Robotics**

Coursework 2 (CW2) – Robotics Project

Dr Patricia A. Vargas

a) Overview :

For this assessment you are being formed into groups of two people. Each group will develop a controller for a robot to perform a given ***task*** by week 12.

You must choose one CW partner, no collaboration beyond that is allowed. You should communicate your partner name to Dr Patricia A. Vargas at most by the 29/02/2016 (Monday) via email, with the subject: "F20/F21RO 2016 – CW PARTNER" including both names and surnames and student ID. No changes will be allowed after that date.

Each group will develop its own robot controller (in C language) for a ***task*** using the Webots simulator software installed in the Windows Lab Room EM2.45.

The demos will take place at the Windows Lab Room EM2.45 during the Thursday Lab slot of week 12 (31/03) starting promptly at 11am.

The final group allocation will be circulated by Thursday (03/03) @ VISION.

Each group will be asked to hand in to Dr Patricia A Vargas, on the 31st of March, just before the their demo session:

- a hard copy of a **2000** words essay on their controller development rationale.
- a memory USB stick/pen drive with the controller code and an electronic copy of the essay in PDF format (memory USB stick/pen drive will be returned after the demos).

PLEASE CONTACT PATRICIA IF THERE ARE PROBLEMS IN YOUR GROUP.

b) The task and what you must do:

1. You should **evolve** a robot controller using **evolutionary robotics** techniques. The controller should be modeled as an **Artificial Neural Network** (ANN) to control a single robot on an elevated plus-maze (EPM) arena depicted on Figure 1. For the ***task***, the robot should move in the elevated plus-maze and mimic as close as possible the behaviour of the rat that is shown on the Video1 (@VISION). Basically, the robot should avoid obstacles while moving around in the maze and explore it as quickly as possible. **You should have in mind that the behavior of the rat in the EPM is a result of the approach-avoidance conflict. Therefore your robot will have to deal with 2 conflicting behaviours: exploratory behavior *versus* fear.** Marks are awarded for creativity and performance as well.

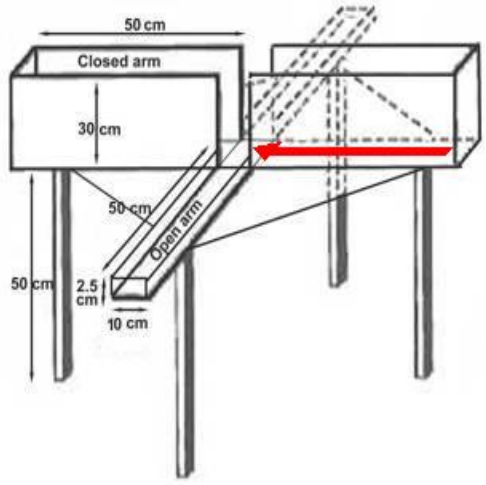

Figure 1. Diagram of the elevated plus-maze (EPM) model. Adapted from Wahlsten et. al. (2007).

NOTE 1: PLEASE REFER TO THE TASK DESCRIPTION DOCUMENT AND VIDEO @ VISION, FOR MORE DETAILS ON THE PROBLEM TASK. You are also expected to search and find relevant papers that describe the task into more details. And use those as references for your report and to back up your designing decisions.

2. Extra marks will be given the quickest robot, i.e. the robot that could explore the maze in less time while dealing with the conflicting behaviours. Therefore you should record the time spent on the average of three runs for your best evolved controller.

3. Hand in **the 2000** words report about your robot controller development rationale. We expect your written submission to do more than merely summarise your controller code but to explain in details the technique or framework you have employed or used as an inspiration to create your controller. Of course we also expect some evidence you have READ about your topic (reference real papers and books please and not only websites).

4. Print, sign in the Group Signing Sheet that can be found @ VISION under <Assessment> and hand it in before your demo.

5. Read carefully the basic marking scheme at the end of this document.

(*) FOR MASTER STUDENTS ONLY:

Master students should do all tasks described in this document plus handing in their report on 6 page conference style paper format following an IEEE conference template that can be found @ VISION under <Assessment>.

In this paper, a brief literature review, design, implementation as well as the evaluation have to be presented. Furthermore, it needs to include a "discussion" section, which highlights the difference between a Behaviour Based Robotics approach and an Evolutionary Robotics approach for this EPM task.

c) The basic rules for developing the controller are the following:

1. You should use the e-puck robot in the Webots simulator.
2. You should build your own arena that must be similar to the rat's arena on Figure 1.
3. As a designer you will decide the dimensions of the arena and how it should be built in the simulator.
4. You should design your own Artificial Neural Network (ANN) topology. But it should be a recurrent artificial network model, which could receive inputs for the sensors readings (infrared (IR) sensors, floor sensors and/or camera) and have 2 output neurons that will provide speed values for the left wheel and right wheel, respectively
5. You should choose the ANN parameters to be evolved. They could be only the weights, or the weights and the activation function.
6. You should use Genetic Algorithms to evolve your ANN and thus you should design your genotype and fitness function.
7. You should also choose the Genetic Algorithm evolutionary parameters:
   - crossover rate,
   - mutation rate,
   - initial population size,
   - selection criteria,
   - max number of generations, etc.
8. After evolving the best controller, the maximum time to perform the task is 5 min. After that the simulation should be stopped and 5 min should be added to that specific run as the time spent, irrespective if the robot has completed the task or not.

9. You should fill in the following table accordingly, and this table should be included as an **Appendix** in your report.

Table 1: Statistics.

	Time			
	First run	**Second run**	**Third run**	**Total Time (Average)**
Task				

<u>NOTE 2:</u> All your designing decisions should be backed up in your report by relevant material (e.g, journal and conference papers, books, scientific reports, master and PhD thesis, etc.)

If you are having difficulty in finding any references please let me know and I can point you out to some.

Marking scheme: This assessment scores **20%** of the overall course assessment.

REPORT MARKS	A (100%)	B(<80%)	C(<60%)	D(<40%)	Final
Content					
40	Very clear; make use of relevant material. Strong evidence of use of the techniques learned during the course.	Clear; make use of some relevant material. Some evidence of use of the techniques learned during the course.	Not so clear; some relevant material is missing. No evidence of use of the techniques learned during the course.	Unclear; no relevant material. No evidence of use of the techniques learned during the course;	
Discussion					
35	Strong evidence of reading and thought	Evidence of reading and thought	Some evidence of reading and thought	No evidence of reading and thought	
App/Style					
20	Report very well structured and divided into sections; consistent use of font Arial, size 12	Report well structured and divided into sections; use of font Arial, size 12	Report structured and but not divided into sections; use of different fonts and sizes.	No structure and no division into sections; use of different fonts and sizes.	
References					
5	Perfect use of the Harvard Referencing Style	Use of the Harvard Referencing Style	Mix use of referencing styles.	No referencing style.	
Total = 100					

DEMO					
Presentation					
25	Demo well prepared and organised; it is very ease to identify the main and strong points of the controller development	Some evidence of preparation and organisation; it is ease to identify the main and strong points of the controller development	Lack evidence of preparation and organisation; it is not so ease to identify the main and strong points of the controller development	No preparation and organisation; it is quite difficult to identify the main and strong points of the controller development	
Development					
50	Very good implementation and use of the techniques learned during the course; creativity	Good implementation and use of the techniques learned during the course; some creativity	Fair implementation and use of the techniques learned during the course; some creativity	No implementation or evidence of use of the techniques learned during the course; no creativity	
Performance					
25	Controller runs with no bugs; task is very well performed by the robot	Controller runs with no bugs; task is performed by the robot	Controller runs with no bugs; task is partially performed by the robot	Controller runs with no bugs; robot could not perform the task.	
Total = 100					
FINAL MARK	**(Report + Demo)/2**				