Module Code
COM00037H

BEng, BSc Degree Examinations 2021–22

DEPARTMENT OF COMPUTER SCIENCE

Evolutionary & Adaptive Computing

EVAC-2

Open Individual Assessment

Issued: 12 noon on 16 March 2022 (Spr/10/Wed)
Submission due: 12 noon on 20 April 2022 (Sum/1/Wed)
Feedback and marks due: 25 May 2022 (Sum/6/Wed)

All students should submit their answers through the electronic submission system: http://www.cs.york.ac.uk/student/assessment/submit/ by 12 noon on 20 April 2022 (Sum/1/Wed). An assessment that has been submitted after this deadline will be marked initially as if it had been handed in on time, but the Board of Examiners will normally apply a lateness penalty.

Your attention is drawn to the section about Academic Misconduct in your Departmental Handbook: https://www.cs.york.ac.uk/student/handbook/.

Any queries on this assessment should be addressed by email to Dimitar Kazakov at dlk2@york.ac.uk. Answers that apply to all students will be posted on the VLE.

Your submission should identify you through your exam number only.

Rubric

Your submission should be a single zip file named after your exam number, `Yxxxxxxx.zip`. You may choose to use Python in the form of a Colab notebook or NetLogo.

A submission using Python should contain a Colab notebook `evac2.ipynb` combining code and explanations, and a PDF `evac2.pdf` of the state of the same notebook after all of its code has been executed. In case of any discrepancies between the contents and output of the Google Colab notebook and the PDF, the former will be used for marking. Your code should assume any auxiliary files that you provide or generate are in the same folder as the notebook from which they are accessed. All Python code should be in Python3. Your Python code must run correctly on Google Colab. Your notebook should contain a text note about the time it took to execute the main part of your code and whether you used any hardware accelerator. Your code does not require the user to have administrative rights.

A submission using NetLogo should consist of a single *.zip archive containing the NetLogo file `evac2.nlogo` with your solution. All text should be included in the 'Info' part of the corresponding NetLogo file, which may contain links to local images supplied separately in the submitted archive. Use as much as possible the standard headings of the 'Info' part of the NetLogo file to introduce your model, explain how it works and how to use it. Report the results and their evaluation under the heading 'Things to Notice'. Use the rest of the headings as appropriate.

Make sure you do not use archive formats other than zip. **If your submission is not a single zip archive, you will be penalised**. Unless otherwise indicated there are no word limits on your answers, but a large amount of irrelevant comments can affect negatively your mark.

Society-based Cooperation

1 Setup

A population of agents exists in an environment in which the location of an agent is unknown and irrelevant; the only possible event in this environment is for a pair of agents chosen at random to play a game. The game is very simple: each agent carries out one of two possible actions, 'cooperate' or 'be selfish'. The game payoffs to both agents are described by the following table:

	Agent 2	
Agent 1	Cooperate	Be selfish
Cooperate	(4,4)	(0,6)
Be selfish	(6,0)	(1,1)

Table 1: Payoffs: (Agent1, Agent2)

Every agent is a member of exactly one society, and there are four societies with different rules of conduct to choose from. Each agent's action is fully determined by the rules of the society it belongs to, and whether the other agent belongs to the same society or not. However, after the payoff from each encounter is received (and added to the total payoff from all previous encounters), each agent may decide to leave its current society and join another in an attempt to maximise its future payoff.

The four societies and their rules of conduct are as follows. Members of the "Saints" society cooperate with everyone. Members of the "Buddies" Society always cooperate with each other, but never with anyone else. Members of the "Fight Club" never cooperate with each other, but always cooperate with everyone else. Members of the "Vandals" Society never cooperate with anyone.

When an agent is selected to play a game, it must follow the strategy prescribed by the society it is a member of. Once both players have determined their move, the appropriate payoffs are handed out as listed in Table 1. After each game played, each player is shown the total wealth of the other player, the current society that other player belongs to, and it is allowed to leave its current society and join another one. (An agent must always remain a member of exactly one of the four societies.) Each agent's personal objective is to maximise its total payoff over the course of the whole simulation, which consists of repeating the above game N times, where the agents do not know that number in advance, and for each round of the game, the pair of participating agents is chosen afresh. The population size should be appropriately chosen, with the available computational power in mind, among other factors.

2 To Do

Your main objective is to use evolutionary algorithms, possibly in combination with machine learning, in order to develop a strategy that will allow an agent to maximise its total payoff by changing its society membership over time as appropriate.

1. For 10 marks, choose a simple and efficient representation of your agents' behaviour that would also allow for adaptation (and learning, if needed). Describe the chosen representation in your submission and explain the reasons behind it.

2. For 20 marks, provide the necessary, working code, describe how running the simulation is going to provide the basis for estimating the fitness of your agents' adaptive behaviour, and show how training examples for the learning component of your algorithm will be generated, if needed.

3. Describe the design of (20 marks), and implement (20 marks) a procedure that uses adaptation, and possibly learning, to produce a viable behaviour for your agents.

4. For 20 marks, design and describe an evaluation procedure that allows you to compare the behaviour obtained through adaptation (and possibly learning) to a non-adaptive behaviour preserving the initial assignment to societies, and draw conclusions that are supported by results that are statistically significant, and based on the most appropriate statistical tests (where applicable). Assume all agents are capable of changing (learning/adaptation) their behaviours at the same time.

5. For 10 marks, collect experimental evidence, carry out, and show the results of the evaluation procedure described above.

3 Marking Criteria

All of the above assumes there is working code implementing the individual objectives. Partial marks may be allocated for design alone. No results will be accepted, if the corresponding parts of the code involved in their generation cannot be executed.

The criteria to be used in the marking also include clarity, simplicity, generality and rigour of the methods chosen, as well as the ability to describe, analyse and visualise experimental results in an effective way.

End of examination paper