COM3001, COM6003 Assignment 1

You will carry this out in teams – mostly of three.

The principle purpose is to take an existing FLAME model and top use it as the basis for some virtual experiments and to write this up as a scientific report. You will receive the FLAME code and some brief remarks about the background of the model and the sort of research questions being investigated.

You then have to do some background research into the scientific area involved, the sort of modelling that has been done before in this area and what discoveries – if any – that have been made using previous models.

There will be systems of the following types:

1) Molecular system – e.g. Oxygen in E. Coli; NFkappa-B system

2) Cellular and tissues systems – keratinocyte colonies etc.

3) Social insects – Pharaoh’s ants

4) Economic systems – a Mall system.

Each group will be allowed to choose their preferred model.

The format of the report will be as follows:

**Name of group** – name of group’s members.

**Title of investigation/model**

*Pharaoh’s Ants Foraging Agent-Based Model*

**Background**

Animals must make decisions throughout their lives, particularly about where to live or find food, and making informed choices means making the best use of available information. For social insects, information transfer is often achieved by chemical communication; substrate-marking with pheromones. Chemical trails allow personal information to be publicly communicated in the field, away from an information centre, and this optimises foraging in a dynamic environment. Trail-following ants are some of the most abundant animals on earth.

The mechanism of pheromone trails is acknowledged as a paradigmatic self-organised process. The process is governed by feedback where positive feedback, in the form of a pheromone trail, is provided by a fed ant returning to the nest. Other ants can follow this trail to food and subsequently provide further positive feedback by reinforcing the trail. If the food source is exhausted then they provide negative feedback by refraining from reinforcing with trail pheromone. The trail decays without reinforcement, and ants abandon the food source.

Most *mathematical modelling* approaches attempted to describe aspects of ant pheromone trail formation. We believe *agent-based modeling* approach is the best approach to demonstrate the emergence of population-level behaviour.

**Ants**, **pheromones**, **food sources** and **nest** are represented as **autonomous agents**, each with a location within the environment. Ants leave the nest when their food level falls below a certain threshold and commence foraging outside the nest. They form and follow pheromone trails to find their way to food sources. Once a food source is found, they consume a small amount and look for pheromone trails to find their way back to the nest. Once they are back in the nest, they stay until they are hungry again. All agents communicate via message passing. Pheromone and food agents are created dynamically during the simulation. Ant movement is modelled through 8 directions (0, +/-45, +/-90, +/-135, 180).

**Contacts**

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**Section 1**

Introduction to the subject area, the sort of modelling done previously – a brief literature survey, the sort of research questions examined and a defensible judgment on whether this modelling led to any new insights.

**Section 2**

An explanation of the main aspects of the supplied model – e.g. the agents involved, their messages and other key factors. The key parameters, distribution of agent types and so on.

**Section 3**

A new research question that could be explored using the model or a suitable adaptation of it. This could include questions relating to what happens if some parameters are changed, if the number of agents in the simulation is changed – how does that affect things, or any other new agents that might be brought into the model. This should include a clear methods description – what has been changed and why.

**Tasks:**

1. Creating different **0.xml**s based on the following specifications for the attributes of agents:

|  |  |
| --- | --- |
| **Agent Name** | **Ant** |
| antID | ID |
| antX, antY | Based on nest coordinates |
| foodLevel | Random (i.e between 1 and 10) |
| isFed | 0 |
| isInNest | 1 |
| antDirection | Between 1 and 8 |
| state | 0 |

|  |  |
| --- | --- |
| **Agent Name** | **Generator** |
| memoryID | 1 |

|  |  |
| --- | --- |
| **Agent Name** | **FoodGenerator** |
| memoryFoodID | Initial number of food sources in 0.xml |

|  |  |
| --- | --- |
| **Agent Name** | **Nest** |
| nestX, nestY | Between (20,20) and (280, 280) |
| nestRadius | Random (i.e. 10) |

|  |  |
| --- | --- |
| **Agent Name** | **Food** |
| foodID | ID |
| size | Between 1 and 100 |
| foodX, foodY | Between (20,20) and (280, 280) |
| radius | Between 5 and 15 |

For Pheromone agent, the values of the attributes do not matter in 0.xml, as they will be created dynamically through the simulation, via the Generator agent.

1. Changing parameters in **antFunctions.c** file.



Write your own research questions for exploring the model.

**Section 4**

Results of the simulation. A number of simulations should be run for each experiment – at least 10. the length of the simulation should be suitable – if it is too short interesting behaviour might be limited.

**Section 5**

Analysis of the results. Here simple statistics should be used – for example you could measure some parameters – e.g. relating to attributes of individual agents, or characteristics/properties of a population of agents etc. Express the results as graphs with error bars or other means to display the spread of results.

**Section 6**

Conclusions. The best way to do this is to define some hypotheses and to test them – can you accept or reject them to some suitable level of significance. Again a well argued statistical analysis is needed.

**References**

**Group performance**

A list of the contributions of each member of the group – their role – e.g. group leader (if there was one), statistical boffin, programmer, project planning, scientific literature research etc.

A signed statement as to how many hours each member contributed to the project.

**Mark scheme**. Out of 50.

|  |  |
| --- | --- |
| Section | Marks |
| 1 | 3 |
| 2 | 3 |
| 3 | 10 |
| 4 | 10 |
| 5 | 10 |
| 6 | 3 |
| References | 1 |
| Group performance | 10 |
|  |  |