AGENTS: INVESTIGATING ENVIRONMENT PERCEPTION

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ABSTRACT

We are surrounded by cases in which very limited agents put together can give rise to very sophisticated overall behaviour. Social insects have been incredibly successful in solving complex problems. This project proposes an agent oriented computational model that simulates aspects of social insects. A brief introduction is given on emergence and the relevant aspects of distributed complex systems to this project, as well as some background information on social insects and their communication techniques.

Three experiments are proposed and run. Firstly an experiment to investigate the best parameters to be used in the other simulations is carried. After a study on the velocity of reaction against predator warning stimulus is done. The last experiment investigates the affect of changing the radius of action of the chemical stimulus in the forage task.

Possible future improvements are also presented. Lastly a more technical description of the model implementation is given.

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LISTINGS

ACRONYMS

API Application Public Interface

UML Unified Modelling Language

BDI Beliefs Desires Intentions

Part I

SETTING THE CONTEXT

In this first part a introduction to the project is given, also some background information and an overview of the proposed computational model are presented. More details of the computational model are left to be shown later on with the experiments descriptions.

1 INTRODUCTION

1.1 EMERGENCE

1.2 DISTRIBUTED SYSTEMS

1.3 AGENT-BASED OBJECT MODELS

Chapter 6 of complex adaptive systems.

2 BACKGROUND INFORMATION

2.1 SOCIAL INSECTS

2.2 COMMUNICATION

2.3 CURRENT RESEARCH

3 MODEL OVERVIEW

3.1 ENVIRONMENT

Explain how the environment is represented.

3.1.1 *Nodes*

Describe the Node interface and the BasicNode implementation. This implementation is a four-way connected grid.

3.1.1.1 *Pheromone Nodes*

Pheromone nodes are a specialisation of the BasicNode implementation that containing a list of chemical communication stimuli.

3.1.2 *Communication Stimuli*

Talk about CommunicationStimulus and CommunicationStimulusType interface. Explain why they are required (different types of communication can be designed and implemented). Relating to what is seen in nature.

3.1.2.1 *Chemical Communication Stimulus*

Define the new communication stimulus type and its properties as radius and decay factor. Relating to what is seen in nature.

3.1.2.2 *Forage Communication Stimulus*

Describe the type, its parameters and when it is used.

3.1.2.3 *Warning Communication Stimulus*

Describe the type, its parameters and when it is used.

3.2 AGENTS

A small introduction to agents in general, touch BDI agents, relate the feature of the agents of this model with the features of agents discussed in the introduction.

3.2.1 *Task Agents*

Explain that a specialisation of the Agent interface is proposed to create agents that are capable of executing tasks.

3.2.2 *Agent Types*

Explain what are agents types and why they are necessary. relate with cases in nature.

3.3 TASKS

Tasks are a unit of specialised work. Agents types have a list of tasks that a particular type is able to execute. Explain how agents can switch between tasks depending on the context.

Part II

EXPERIMENTS AND OBSERVATIONS

In this part of the report three experiments are proposed and executed. The results observed are discussed. At the end some possible improvements to the model and possible experiments are proposed.

4 EXPERIMENTS AND OBSERVATIONS

4.1 INITIAL PHEROMONE CONCENTRATION SENSIBILITY

Explain that the agents are sensitive to initial pheromone concentration due to the model of node selection.

This experiment is proposed to investigate what parameters are the best to be used in the other experiments.

Explain that there are two variables important here, the initial concentration of pheromone throughout the environment and the amount of pheromone deposited by the agents each time they visit a node.

Explain the how the agents choose to move from one node to another, and why the environment pheromone concentration cannot be initialised with 0.

Tell that the initial concentrations values tried were: 0.001, 0.005, 0.01, 0.02, 0.04. And that each agent could deposit 0.01 of chemical communication pheromone when visiting a node.

Each simulation was run for 10 seconds, each agent resting a minimum of 5 milliseconds in each node.

[add a compiled image with pheromone trail for each variation]

0.001 - the agents get trapped in the pheromone trail that they have deposited and end up not being able to explore the environment.

0.005 - Much better result, the agents are able to explore the environment in a way they could not before. But it is quite unlikely for agents to 'break' from the pheromone trail and explore new areas.

0.01 - Most of the agents are able to follow the main pheromone trail, which with time get reinforced by the agent's themselves. But at the same time the agents are able to 'break' from the main pheromone trail and explore new parts of the space available form them.

0.02 - Agents still have a main pheromone trail but they tend to disperse quite a lot over time.

0.04 - No main pheromone trail present at all. The agents get too much dispersed, impossible to communicate properly, for instance when foraging food.

Explain that for the reasons above all the other experiments are run using 0.01 as the initial pheromone concentration. In fact it was observed that what is important is that the initial concentration has to match the agent's capacity of pheromone deposition. So other initial pheromone concentrations could be used, as long as the amount of pheromone deposited by each agent would have been changed to match the initial concentration.

4.2 WARNING PHEROMONE RESPONSE

In this experiment the response of the agents to a warning communication stimulus is tested.

Describe the experiment setup.

Explain that the experiment is done in two phases, the first one the agents react only to amount of warning pheromone and the second one the agents react also to the number of other agents they meet that are traveling in the opposite direction and are not caring food.

Add block diagrams that explain the algorithms the agents use to decide on task selection.

Discuss the results. [experiment not done yet] Results should vary with the use of different parameters, such as the number of agents traveling in the opposite direction before the agent abort the current task and change to findNestAndHide task.

4.3 FORAGE RADIUS INVESTIGATION

In this experiment the radius of action of the forage pheromone is varied in order to check the effects in the amount of food the colony is capable of forage.

Explain how the variation of the radius actually impact the pheromone deposition. Add images to explain how the pheromone is actually deposited depending on the radius. Explain that the deposition follow $1/x$.

Describe the experiment setup

Radius values used in the experiment were 0, 1 and 2.

Add simulation images.

Add the simulation data results

Discussion: Agents depend on the pheromone trail that they create to forage food, when the radius is 0 the agents are able to forage well, because the trail is well defined, but this indirectly limit the amount of agents recruited as the width of the main pheromone trail is very narrow.

Using radius equals to one the main pheromone trail gets wider allowing more agents to be pointed to the right direction.

Now when using radius equals to two, the pheromone trail gets too wide, this gets on the way of the agents as they do not have a clear direction to follow when they are within the trail.

Add image of an agent history, showing how much steps it spend inside the trail going up and down, going nowhere.

5 FUTURE WORK

5.1 Model improvements

5.2 Implementation issues

5.2.1 *Four way connected grid*

5.2.2 *Simulation handler*

Part III

APPENDIX

A EXTRA EXPERIMENTAL RESULTS

Add extra images from the experiments described in the report.

B MODEL AND SIMULATION SOURCE CODE

B.1 MODEL IMPLEMENTATION DETAILS

A more technical talk on the implementation of the model, with general UML diagrams.

B.2 SOURCE CODE

Add source code.

BIBLIOGRAPHY