ALGAE

Programmierpraktikum II SS 2000

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Chapter 1

Introduction

Evolution, learning and communication (elc) is an implementation of a multi agent system (MAS) conceptualized and implemented by Roland Schwaiger and Konrad Lang. They investigate the evolution of wandering behavior of simple (reactive) agents in a highly dynamic environment. Those simple agents wander based on the outcomes of feed forward ANNs (multi layer perceptrons). The inputs to the network are calculated from positions of other agents within a sensor range of each single agent. As an outcome the ANN determines the steering direction (Forward, Back, Left, Right). The ANNs of the agents are evolved according to some given criteria, e.g. maximize the number of places visited or maximize the number of distinct partners within sensor range. Surprising results evolve over time s.a. simple steering rules and complex group behaviors.

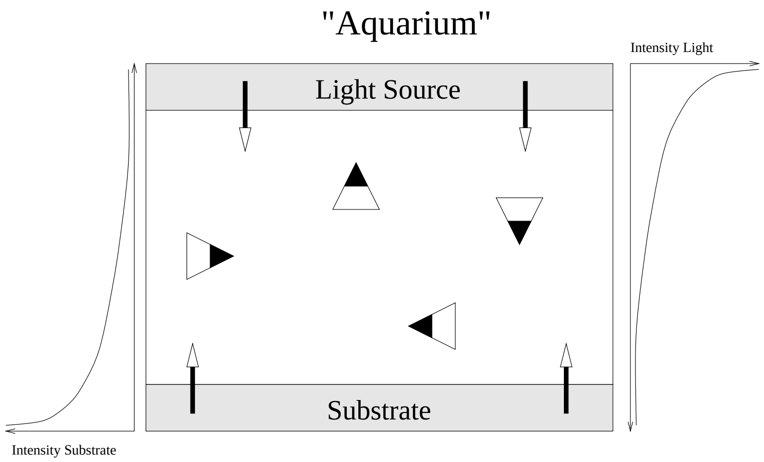

Figure 1.1: The world where the various agents live.

Based on the first findings in elc a followup system will be implemented based on the algae LOGOPODIUM. Imagine an aquarium where on top a uniform light source resides. At the bottom you may find some substrate. Algae (agents) live in the world between – for now we may view the aquarim as a two dimensional object. From time to time the light is switched on and off. As you might imagine, light has a higher intensity at the top of the aquarium than at the bottom. We might model the intensity by the function $1/x$ but any other function with similar shape will do, for now. The same holds for the substrate which diffuses into the water. The agents may consume the substrate, which after some time will be renewed.

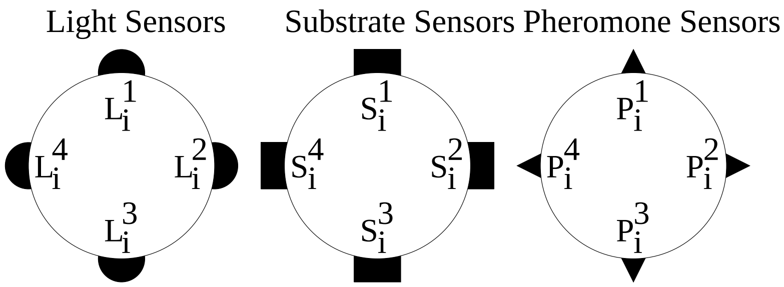

Figure 1.2: The various sensors of agents a_i.

All actions of one agent result from influences of its neighborhood. The agents (a_i) have sensors (receptors) for light ($L_i^j, j = 1, 2, 3, 4$), substrate ($S_i^j, j = 1, 2, 3, 4$) and pheromone ($P_i^j, j = 1, 2, 3, 4$) which is released by other agents. According to the density of the various sources (light, substrate, pheromone) the sensors will show different values[1]. Through differnt values in the sensors an agent may "learn" to steer towards a target.

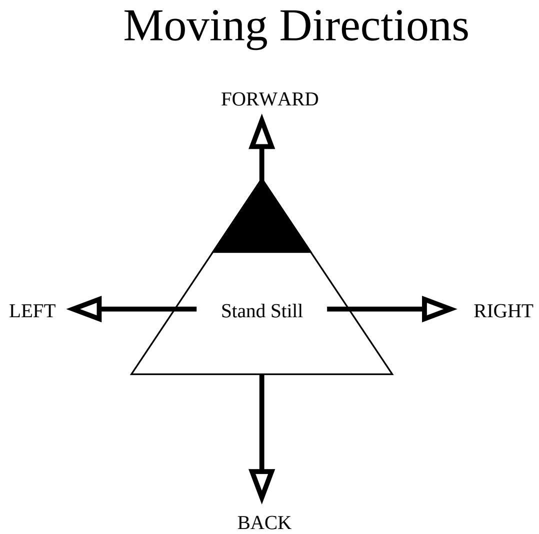

Figure 1.3: The possible moving directions of agent a_i.

The agents perform some actions acording to their internal model. They may move in the world (aquarium). According to their local coordinate system they may move FORWARD, LEFT, RIGHT and BACK. The agents may stand still and do nothing. Obviously other agents or the borders of the aquarium hinter the agent to move according to the ANN output. Each action as described before requires a certain amount of energy. Agents consume substrate and light and collect and increase their energy level E. Agents may reproduce by mitosis (asexual) or meiosis (sexual).
The various actions of an agent are partially determined by its mapping from input of the environment to output, i.e. reactions. This type of agent may be calles reactive agent or stimulus/response agent. In our multi agent system we model this stimulus/response relationship by means of an artificial neural network – multi layer perceptron – (ANN). The input to the ANN consists of the sensor inputs and the energy level of the agent. Various hidden layers are used to perform transformations of the signals. Finally at the

[1]In order to model this situation a world object will set the sensor values

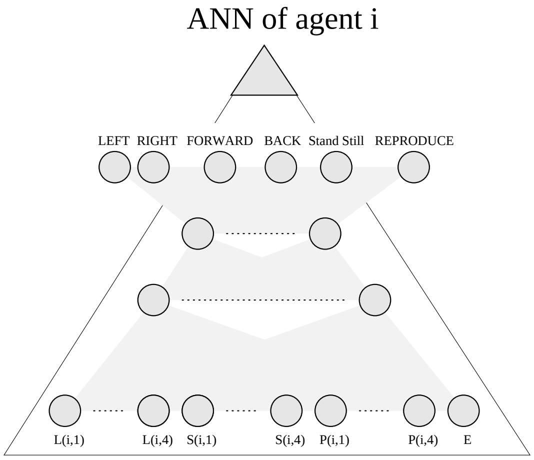

Figure 1.4: The ANN of agent a_i (first proposal).

output level the calculated moving directions are shown. At the moment of writing the shown ANN is our first proposal, it will change during course of discussion.

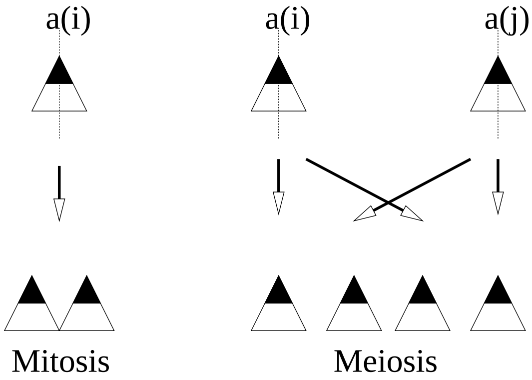

Figure 1.5: Reproduction of the agents a_i and a_j .

As has been pointed out, the algae live their lifes in a steady state population. That means that agents may life and prosper as long as their energy level does not reach 0. Once it has reached 0 the algae is damned to die. On the other hand if the energy level reaches a certain amount E_r, the algae may reproduce either sexually (meiosis) or asexually (mitosis). In order to find a partner the algae may produce pheromones. These pheromones may be detected by other agents throught their pheromone sensors. Possibly some algae learn to navigate to reproduction partners.

Appendix A

Session logs

A.1 March 15, 1999

Time: 17:00 - 17:30
Place: Room 202.2, Institute for Computer Sciences, University of Salzburg
Present persons: R. Schwaiger, C. Bauer, P. Eisenmann, T. Frommwald, M. Liedlgruber and D. Kadir

Treated points:

- Formalities
- General introduction to the problem

Tasks to perform until March 22,2000

- Get photos for the project-homepage
- Have a careful look at the document
- Have a look on JAVA

A.2 March 22, 2000

Time: 17:00 - 17:30
Place: Room 202.2, Institute for Computer Science, University of Salzburg
Present persons: R. Schwaiger, C. Bauer, P. Eisenmann, T. Frommwald, M. Liedlgruber and D. Kadir

Treated points:

- We have a concrete matrix where the simulation should take place
- Substrate

  Distribution of substrate is based on a mathematical function

  There is a specific amount of the substrate at every point in our matrix

The regeneration of the substrate depends on the distribution function and a basic time period (determined by some parameters)

- Sensors

  The sensors of our agents have a specific range and an angel of 'sight'. These things are variabel.

  We got a new sensor that can detect contact (with the wall or other agents)

- Pheromons disintegrate after a while

- Possible agent actions: Power consumption, movement, pheromon output, reproduction

  All actions consume different amounts of energy

- Energy consumption through photosynthesis or substrat accomondation

- Movement

  Speed ?

  Agents may move one unit in one time unit

- Reproduction

  Meiose / Mitose

  If the agent wants to reproduce through meiose he has to have a certain amount of energy. The agent follows the pheromon tracks of other agents and puts out pheromons himself.

- Pheromon output

  During movement

  The agent should not follow his own pheromon track

- Simulation steps

  The current status of the sim is displayed after each simulation step

  During one step the agents may perform an arbitrary amount of actions (exception: movement !)

Tasks to fullfill until March 29, 2000

- Prepare further questions

A.3 March 29, 2000

Time: 17:00 - 17:30
Place: Room 202.2, Institute for Computer Science, University of Salzburg
Present persons: R. Schwaiger, C. Bauer, P. Eisenmann, T. Frommwald and D. Kadir

Treated points:

- Agent input

  We need another input for our neural network: the current energy level of the agent

  It is probably necessary that agents know whether the detected pheromon is their own or not

- The neural network

  There are units in the ANN which are connected through weighted lines

  The more important the connection of two unit becomes, the thicker the connecting line.

  Output consists of the movement direction and everything concerning reproduction

- The light

  Probably there will be some sort of 'fight' for the positions that are near the light

  Agents that are not on top level will get less light (shadows)

  For this reason they may try to consume more of the substrate - the according connecting line of the ANN gets thicker

- How could the agent learn that sexual reproduction is better than the mitose ?

Tasks to fullfill until April 12, 2000:

- Revise the paper:

  Exact problem definition

  Session logs

  Discussions