Computational Science: Movement of Ants

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Overview

- Ants are social insects of the family Formicidae.
- Big ants' average speed is 300 meters per hour. (Human 18 m/h).
- Foraging ants travel distances of up to 200 meters from their nest.
- Ants communicate with each other using pheromones, sounds, and touch.

Approach to the problem

- Grid 2D space, 500×500!
- Nest, Food, points in 2D space.
- Ants independent agents
- Random ant movement
- Two kinds of pheromone
- Home, food pheromone
- ϵ-greedy approach
- Diffusion, evaporation

How the simulation works:

- Initially all ants located at their nest
- Their hunger level is $h = 1.0,\ h \in [0.0, 1.0]$
- $h = 1.0$, means they are starving
- They start a random walk
- They are dropping home pheromone as they are located in their nest:

$$ph\_home_t^{i,j} = max\_ph\_home, if\ \ i, j = nest \tag{1}$$

- When they move they take with them the pheromone:

$$ph\_home_t^{i,j} = \max_{-1 \le x, y \le 1} [ph\_home_{t-1}^{i+x, j+y}] - \beta,\ \ x, y \in \mathbb{R} \tag{2}$$

- instead:

$$ph\_home_t^{i,j} = ph\_home_{t-1}^{i,j} - \beta \tag{3}$$

- When food is located in the same cell as an ant is:

$$ph\_food_t^{i,j} = max\_ph\_food, if \ i,j = food \tag{4}$$

- Ants leave trails as they move out from the food source, with the same way they do for home. But now they are dropping food pheromone.
- When the ants have $h < hunger\_threshold$, 0.3 is used. They want to go back at their nest.
- When the ants have $h \geq hunger\_threshold$. They want to go find food again.

Epsilon-greedy action selection:

- The best action is selected for a proportion $1 - \epsilon$ of the trials, and another action is randomly selected for a proportion ϵ.
- A typical parameter that is used is: $\epsilon = 0.2$, but this can vary.
- Depending where they want to go, they follow with ϵ-greedy the pheromone.

Diffusion:

$$ph_t^{i,j} = max[ph_{t-1}^{i,j}, r_d * \max_{-1 \leq x,y \leq 1}[ph_{t-1}^{i+x,j+y}], x, y \in \mathbb{R} \qquad (5)$$

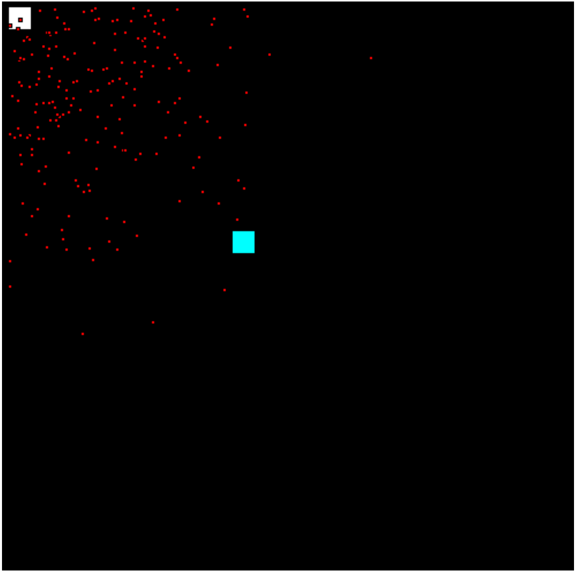
$r_d \in [0.0, 1.0]$, diffusion rate.

Evaporation:

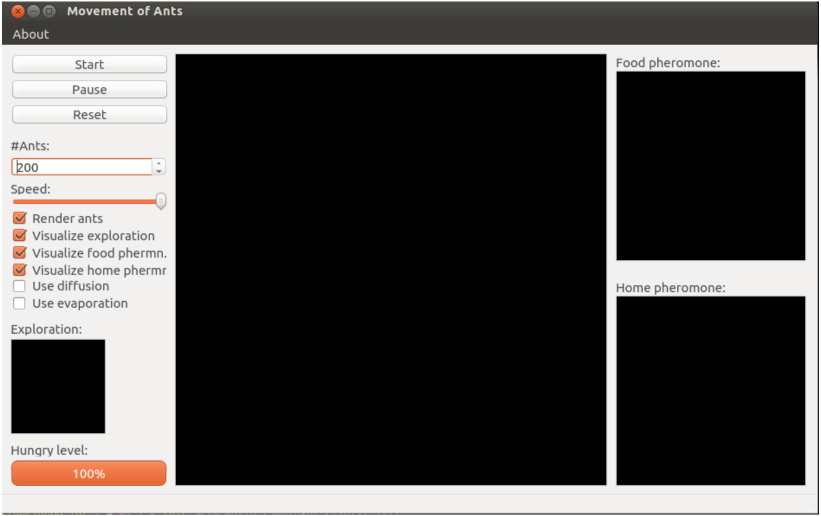
$$ph_t^{i,j} = r_e * ph_{t-1}^{i,j} \qquad (6)$$

$r_e \in [0.0, 1.0]$, evaporation rate.

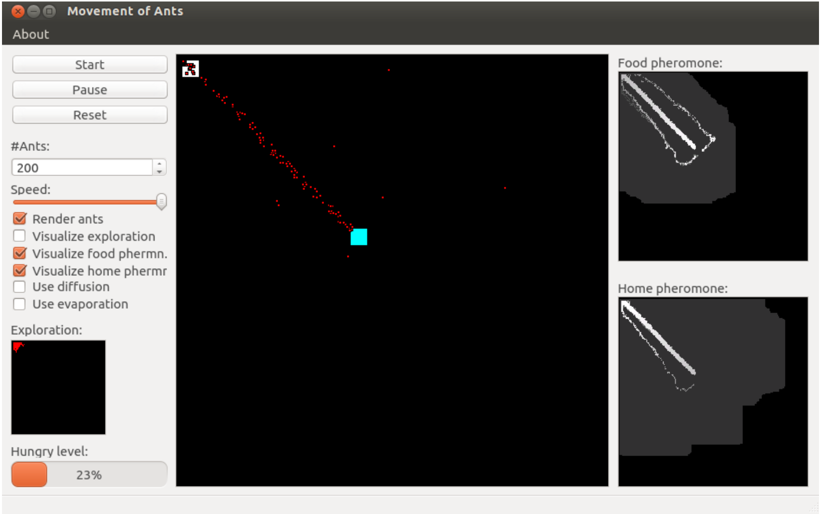
Map:



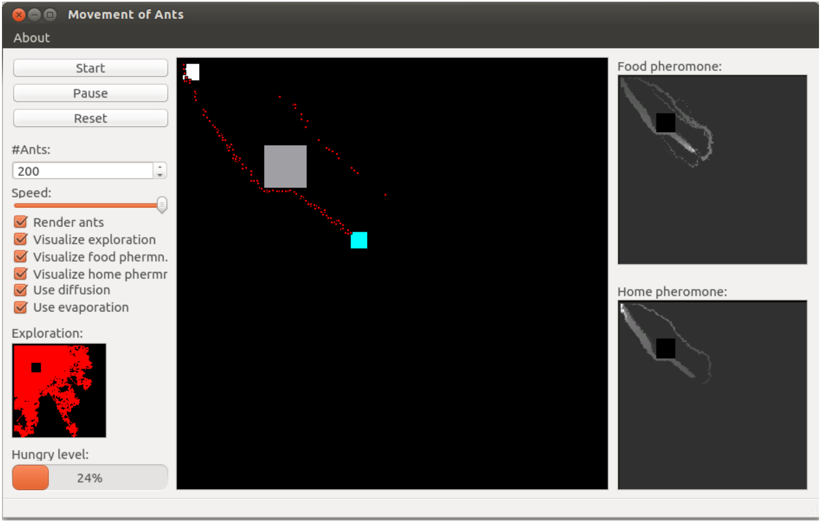
Gui:


Movement of Ants
About
Start
Pause
Reset
#Ants:
200
Speed:
Render ants
Visualize exploration
Visualize food phermn.
Visualize home phermr
Use diffusion
Use evaporation
Exploration:
Hungry level:
100%
Food pheromone:
Home pheromone:

Experiment(No obstacle)



Experiment(With obstacle)



Demo

Future Work:

- Include also death, born rates.
- Make the simulation more realistic, constants, distances, etc..

References

- Paulo E. Merloti
  Simulation of Artificial Ants Behavior in a Digital Environment.
  Department of Computer Science Graduate Seminar in Artificial Intelligence Evolutionary and Adaptive Computation

- Liviu A. Panait and Sean Luke
  Ant Foraging Revisited
  George Mason University, Fairfax, VA 22030 lpanait@cs.gmu.edu, sean@cs.gmu.edu

- How Fast Can an Ant Run?

- Wiki: Ant

- Ant colony optimization algorithms

The End