

# Computational Science: Movement of Ants

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October 22, 2013

# Overview

- 1 Introduction
- 2 Approach
- 3 Results
- 4 Demo
- 5 Future Work



- 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,  $500 \times 500$ !
- Nest, Food, points in 2D space.
- Obstacles
- Two kinds of pheromone
- Home, food pheromone
- Ants independent agents
- Random ant movement only to neighbor cells
- $\epsilon$ -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:

$$ph\_home_t^{i,j} = max\_ph\_home, \text{ if } i, j = nest \quad (1)$$

- When they move they take with them the pheromone:

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

- instead:

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

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

$$ph\_food_t^{i,j} = max\_ph\_food, \text{ if } i,j = food \quad (4)$$

- 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.
- Value Iteration?
- 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  $\epsilon$ .
- A typical parameter that is used is:  $\epsilon = 0.2$ , but this can vary.
- Depending where they want to go, they follow with  $\epsilon$ -greedy the pheromone.
- When greedy action is chosen, ants select the cell with the maximum pheromone.

Diffusion:

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

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

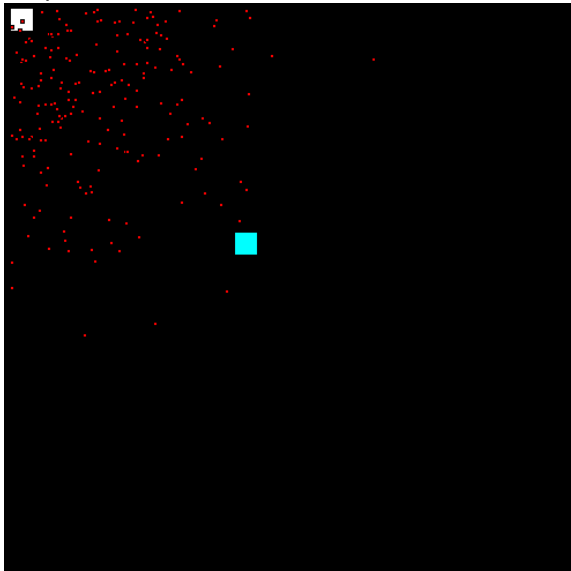
Evaporation:

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

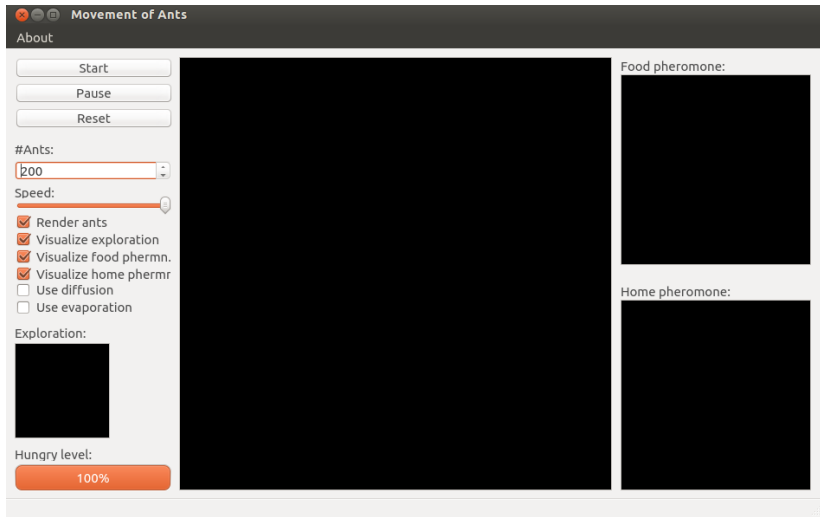
$r_e \in [0.0, 1.0]$ , evaporation rate.



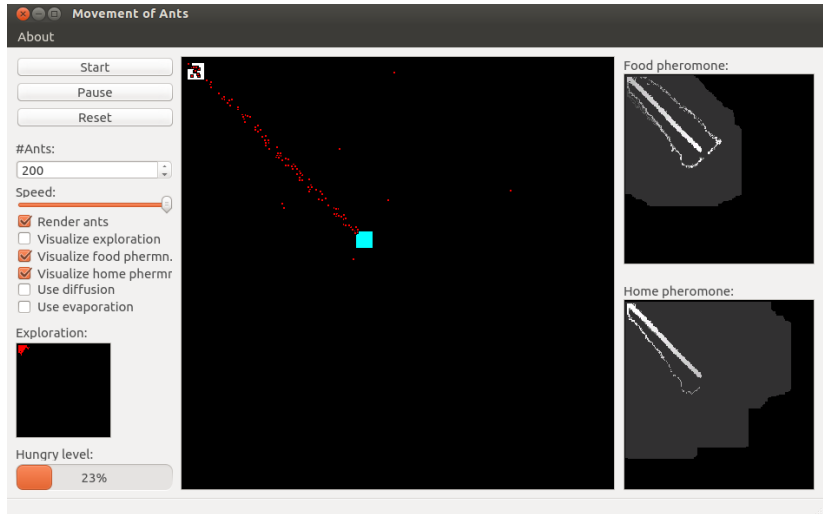
Map:



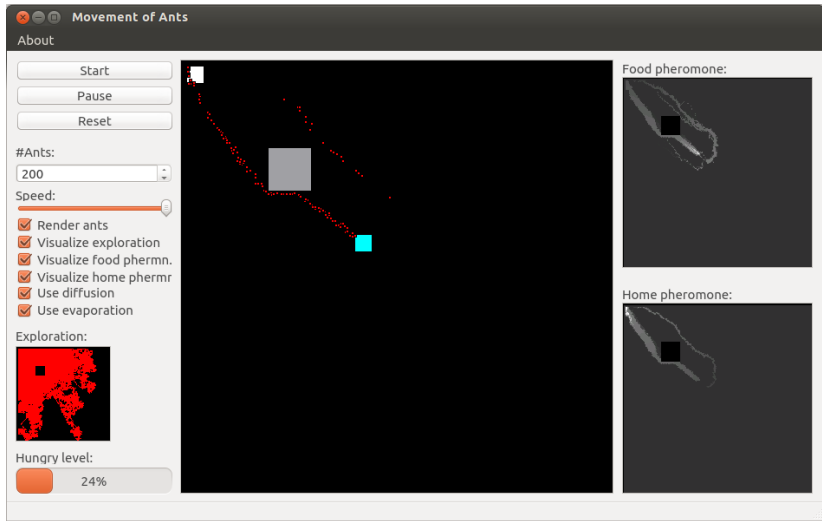
## Gui:



## Experiment(No obstacle)



## Experiment(With obstacle)



# Demo

## Future Work:

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

## Source code:

- [github.com/GiorgosMethe/AntsMovement](https://github.com/GiorgosMethe/AntsMovement)

# 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*



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Ant Foraging Revisited

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How Fast Can an Ant Run?



Wiki: Ant



Ant colony optimization algorithms

# The End