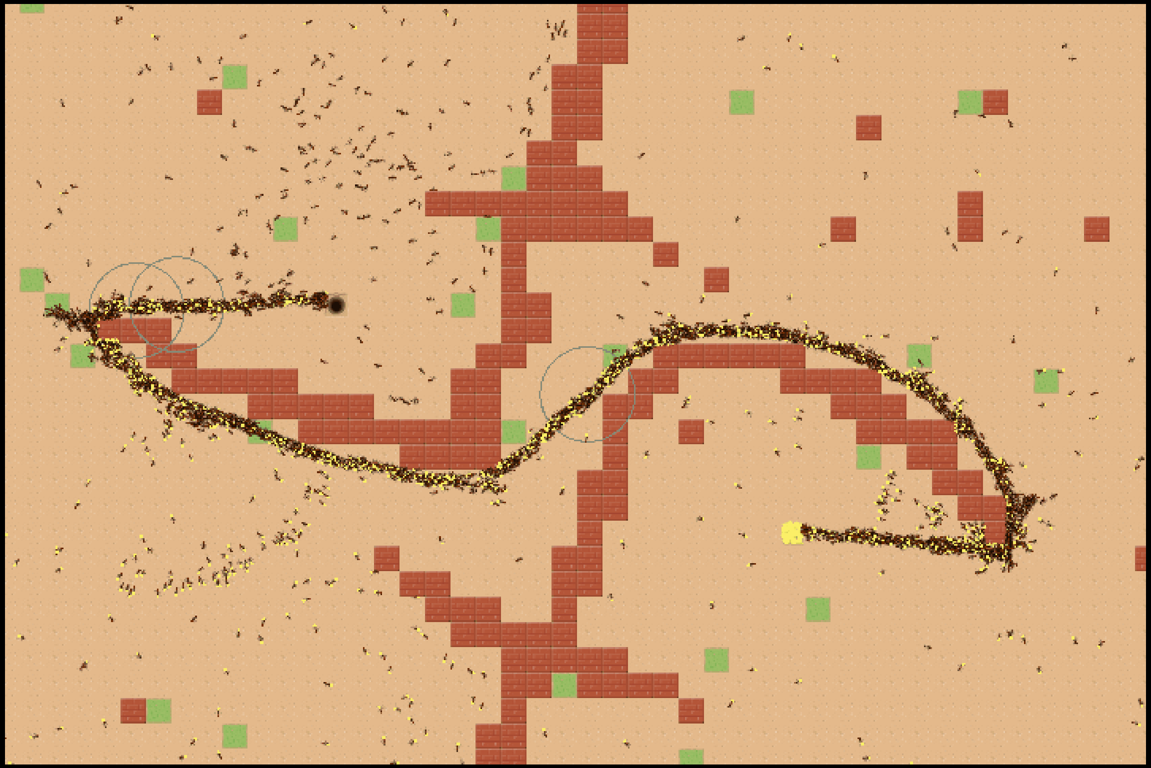
Computer modeling of physical phenomena

Lab IX: Ants

Ant trail formation model



Types of cells:

- nest
- food source
- open field
- obstacle

https://github.com/piXelicidio/locas-ants

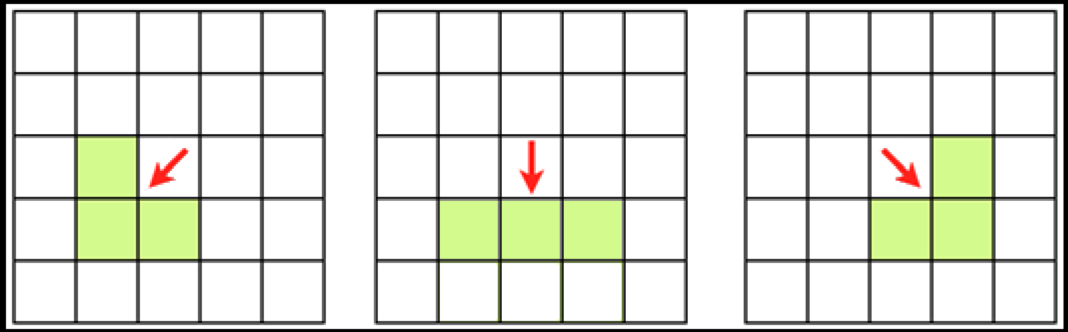
Leaving pheromones

Types of pheromones:

- foraging pheromone (left when looking for food)
- home pheromone (left when going home with food)

http://www.perna.fr/exploratorypatterns.html

Moving around



- eight orientations (0, 45, 90, 135... degrees)
- we allow for a change of orientation by 45 degrees during a single step

If you moved forward (to a cell corresponding to your orientation), keep your orientation. If you turned (moved to a cell rotated with respect to your orientation), change your orientation to a corresponding one.

https://practicingruby.com/articles/ant-colony-simulation

Rules of the movement

When searching for food:

1) Check the three cells in front. If they contain food, move there, pick up a unit of food and turn 180 degrees.
2) If not, move to one of the three cells in front, choosing them with a probability proportional to their home pheromone level.
3) Leave one unit of foraging pheromone on a cell that you just left.

Rules of the movement (2)

When searching for the nest:

1) Check the three cells in front. If they are part of the nest, move there, drop food and turn 180 degrees.
2) If not, move to one of the three cells in front, choosing them with a probability proportional to their foraging pheromone level.
3) Leave one unit of home pheromone on a cell that you just left.

Rules of the movement (3)

You can also try to make probability a nonlinear function of the pheromone levels, e.g.

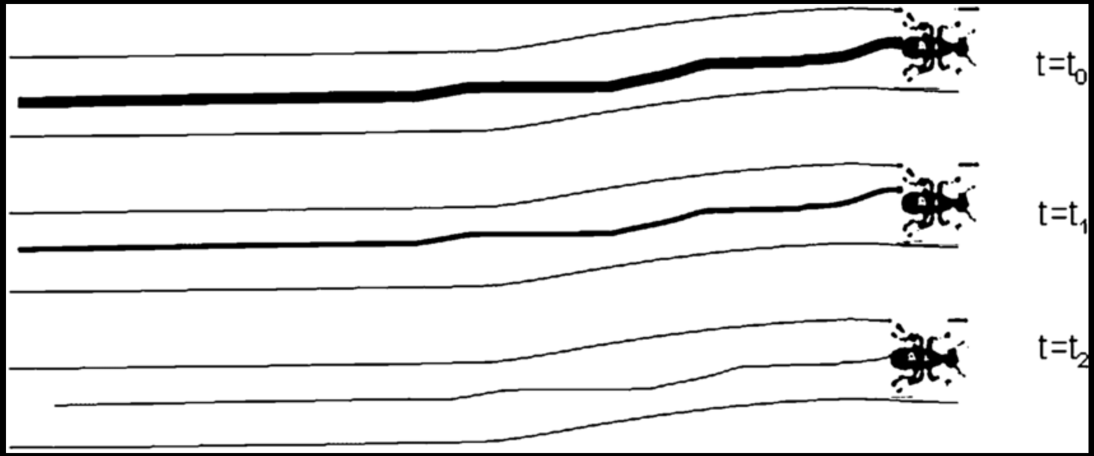
$$p(I) \sim (h + I)^{\alpha}$$

e.g. $\alpha \approx 2 - 7,\ h \approx 2 - 20$

which agrees with experiments where ants face a branching point in their trail.

(Deneubourg et al., 1989)

Pheromone evaporation

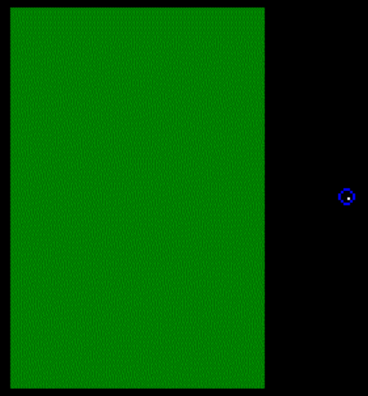


- Pheromones evaporate – in each iteration we reduce their amounts on cells (multiplying by e.g. $\beta = 0.99$).
- A `lost` ant releases less pheromones (to prevent others from getting lost too) – amount of released pheromone can decrease in time (and be restored to full value once ant found food/home) or it can just drop to zero after a certain number of iterations away from food/home.

Details of the simulation

- number of ants: 40-100 (or more if you can)
- size of the system: 80x80 (or larger)
- periodic boundary conditions

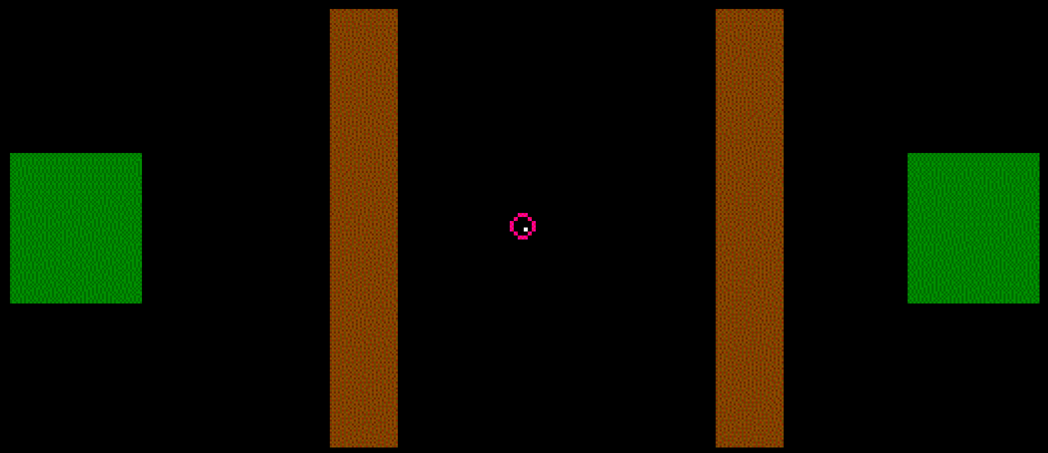
Place the food in big chunks and observe the trail formation:



https://softologyblog.wordpress.com/2020/03/21/ant-colony-simulations/

Extra task

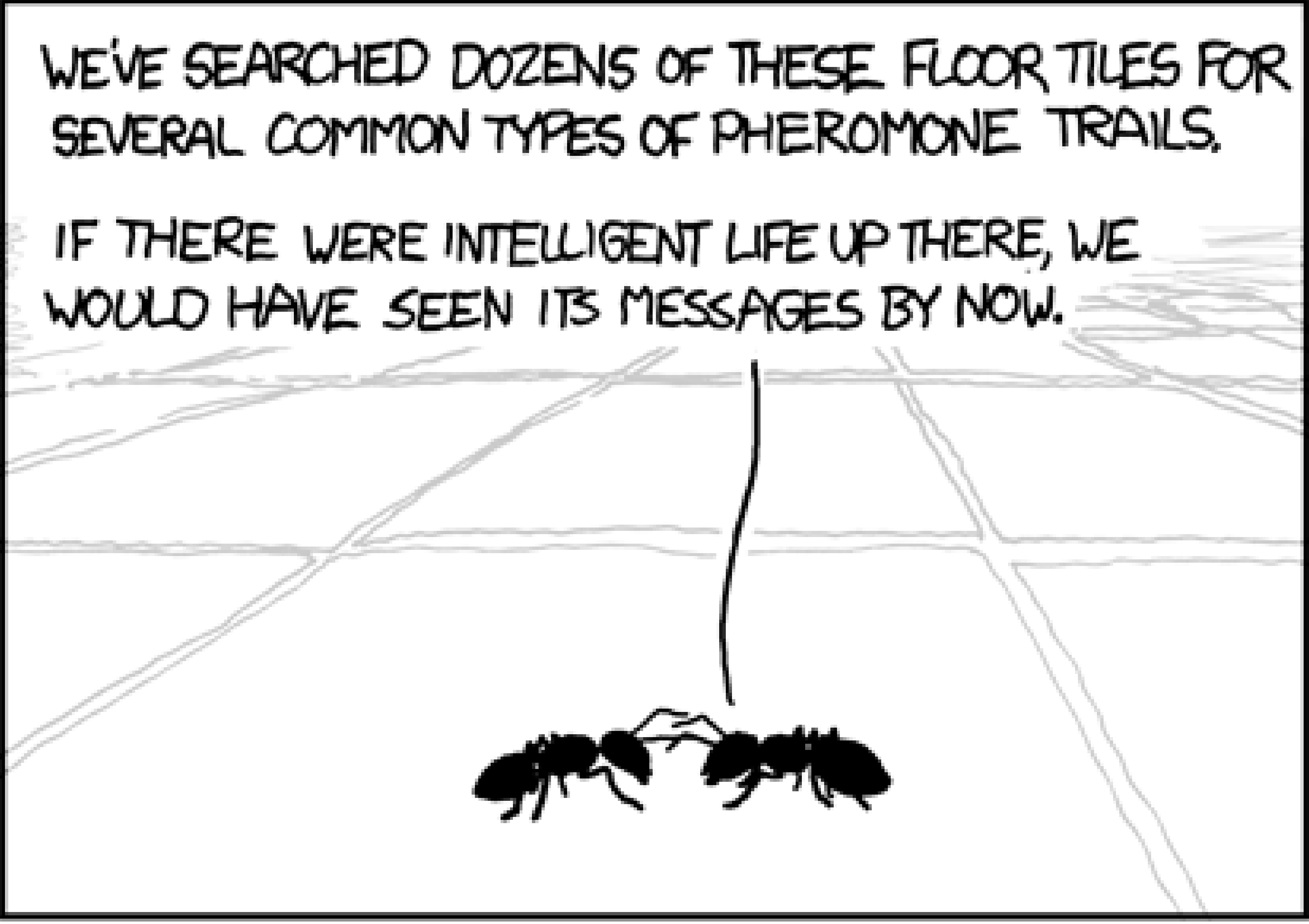
Place some obstacles, try to optimize the parameters of the system for efficient path finding.



https://softologyblog.wordpress.com/2020/03/21/ant-colony-simulations/

Tips

- Use classes, especially for ants!
- Define the directions in a convenient way to make turning easy.
- Initialize ants by sending one in each step (until you reach the desired numer of ants). The ant should start from the nest and go in a random direction.
- It is useful to track the amount of food brought to the nest (to see if your ants are any good at collecting it).
- The easiest way to visualize is to plot the sum of pheromones. If you want something more fancy, you can add ant positions or seperate colors for the pheromones.
- Play with the model! Use your imagination to improve it (e.g. ants turning randomly at times or leaving pheromone on more than one cell, limit on the number of ants on a given cell). Anything is fine, as long as your ants find their path!



THE WORLD'S FIRST ANT COLONY TO ACHIEVE SENTIENCE CALLS OFF THE SEARCH FOR US.