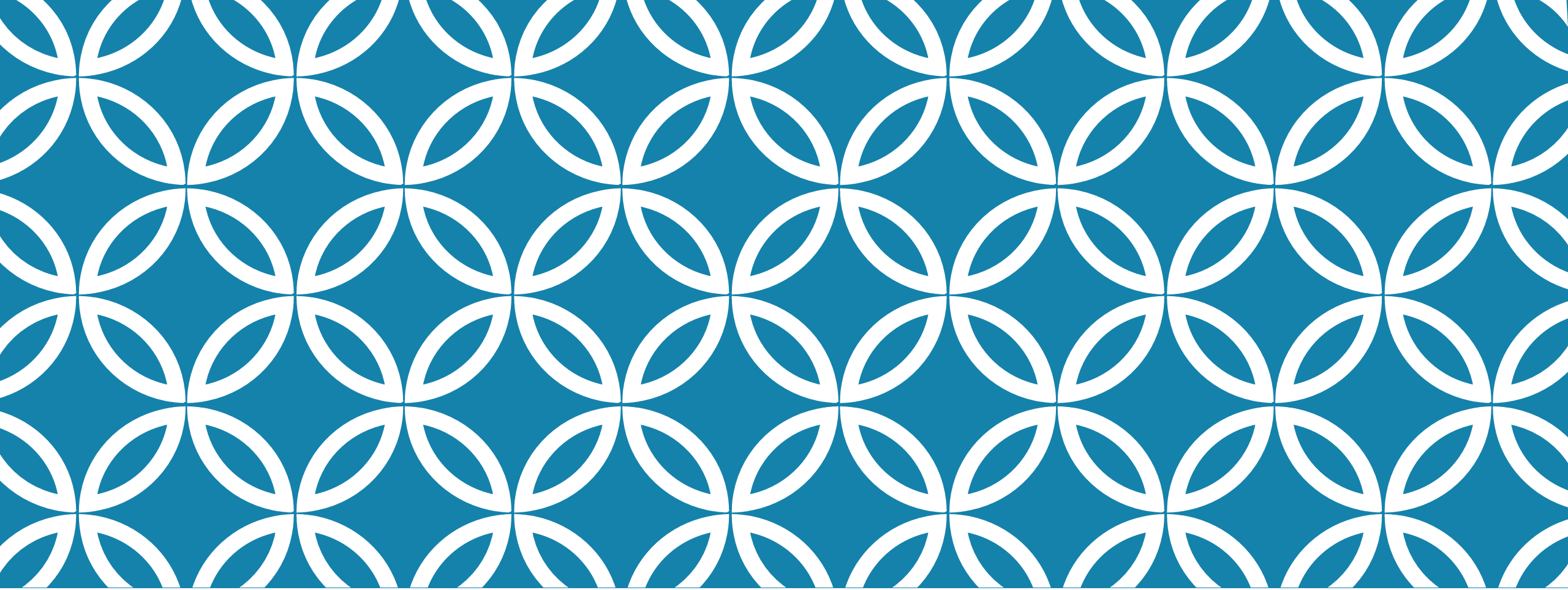

ANT COLONY OPTIMIZATION

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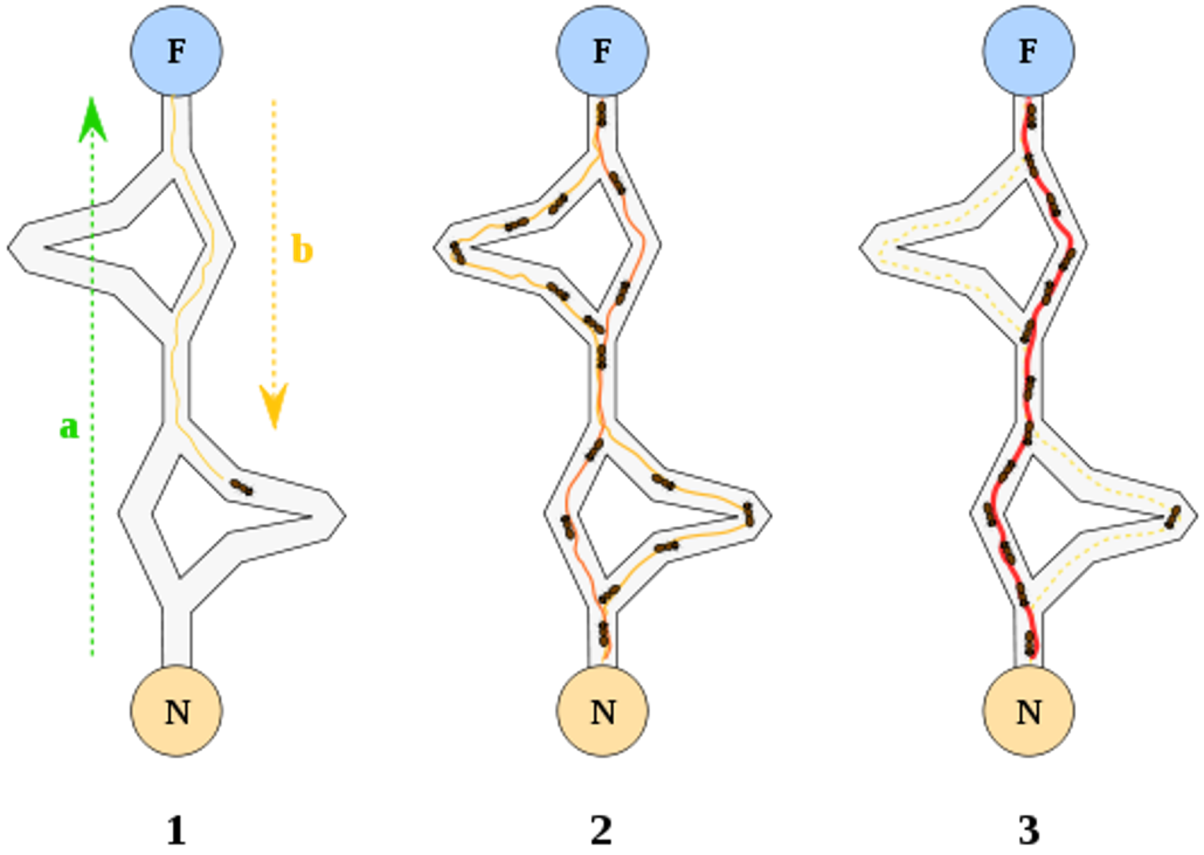
SWARM INTELLIGENCE

Optimization method, where the collective behaviour of agents that interact locally with their environment cause coherent functional global patterns to emerge

- Applied to real-world problems:
  - Protein folding, routing problems, stochastic problems, urban transportation systems, image detection, …
- Is dynamic → adapt to changes in real time
- *Import to know how the models works!*

ANT COLONY OPTIMIZATION



PHEROMONES

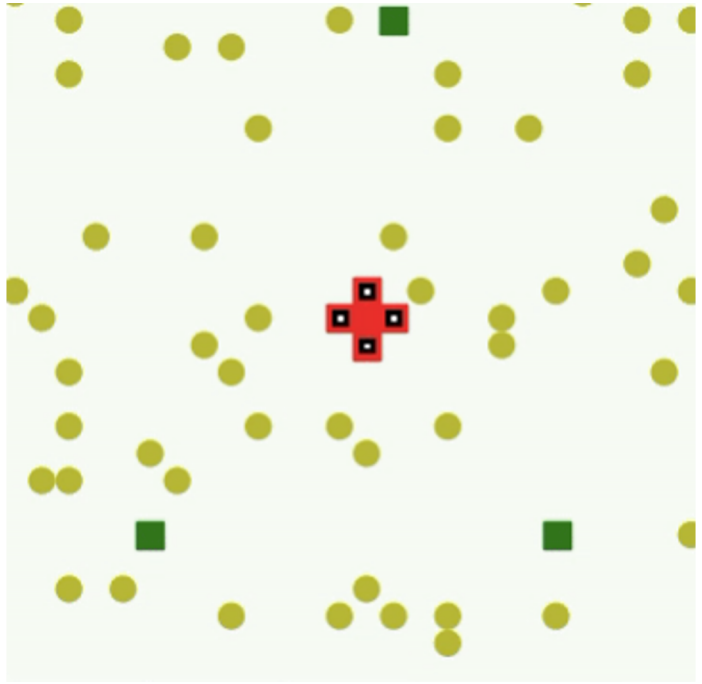
Parameters → strength, decay, spread

Long path → less pheromone density

Short path → higher pheromone density

Finding a path vs. exploration

Important in artificial systems



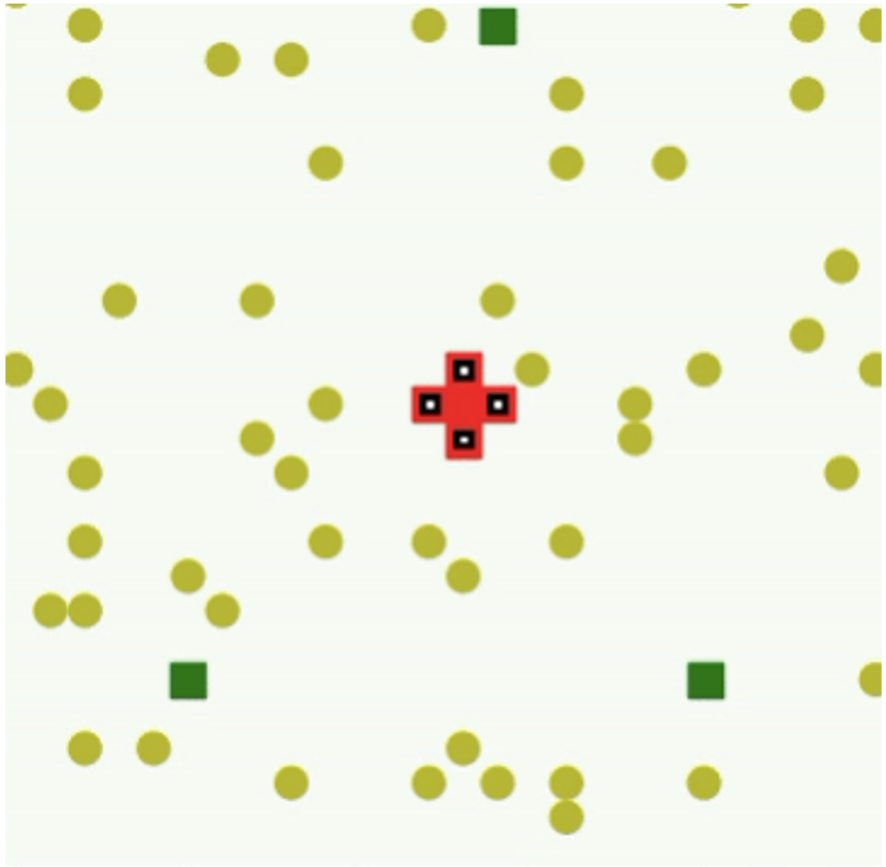
RESEARCH QUESTION

- Influence of **pheromones** on the collective **behavior** of ants
  - **Trade off** between pheromone spread, decay and strength
  - The influence of colony and grid size on finding a continuous path between food and nest (**percolation**)

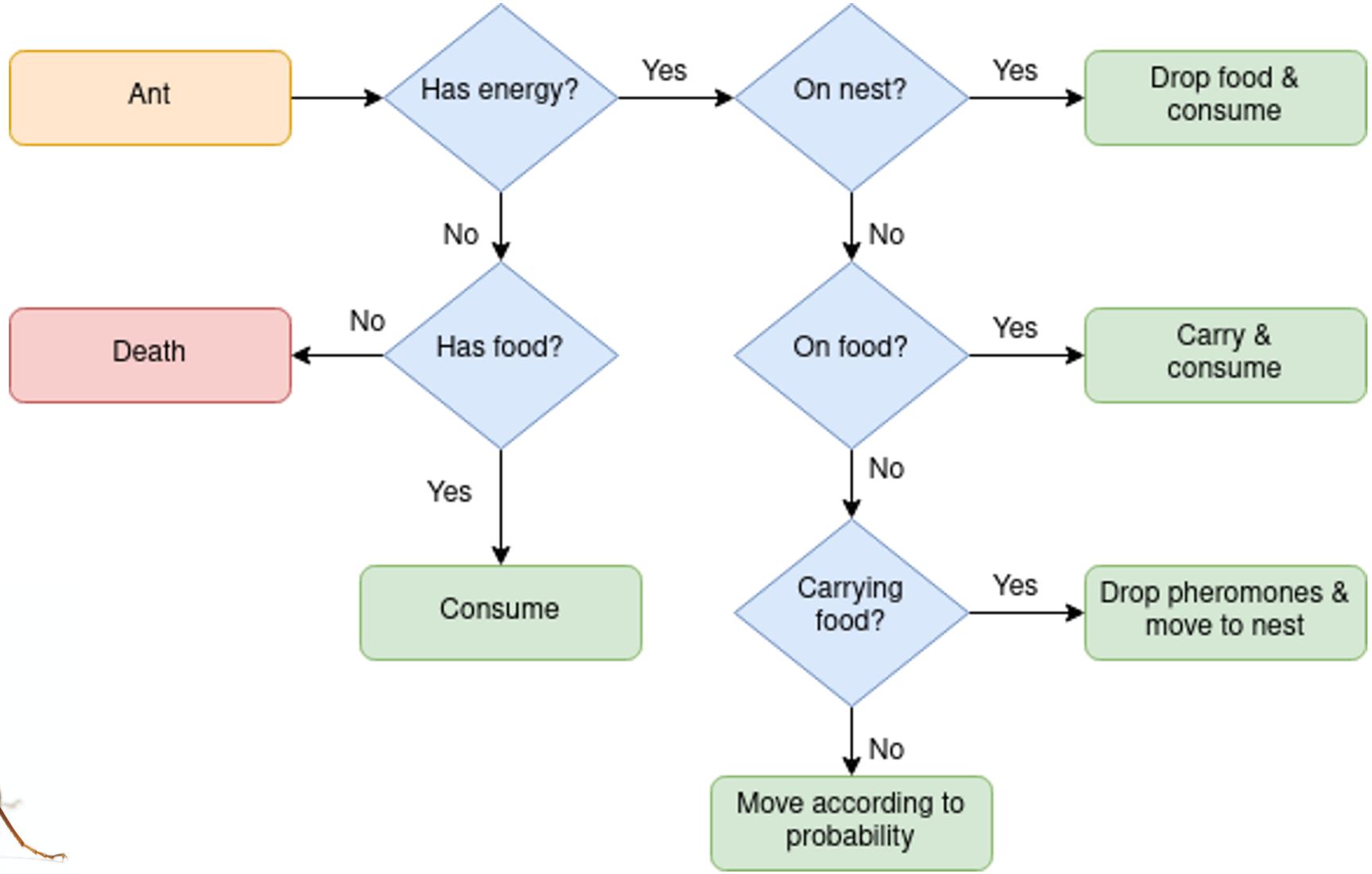
- HYPOTHESIS:
  - A trade off between exploration behaviour and persistence of a path
  - Colony size and grid size have to increase linearly to reach percolation

MODEL

- Agents:
  - Ants
  - Nest
- Environment:
  - *NxN* grid
  - von Neumann neighbourhood
  - Obstacles
- Resources
  - Food

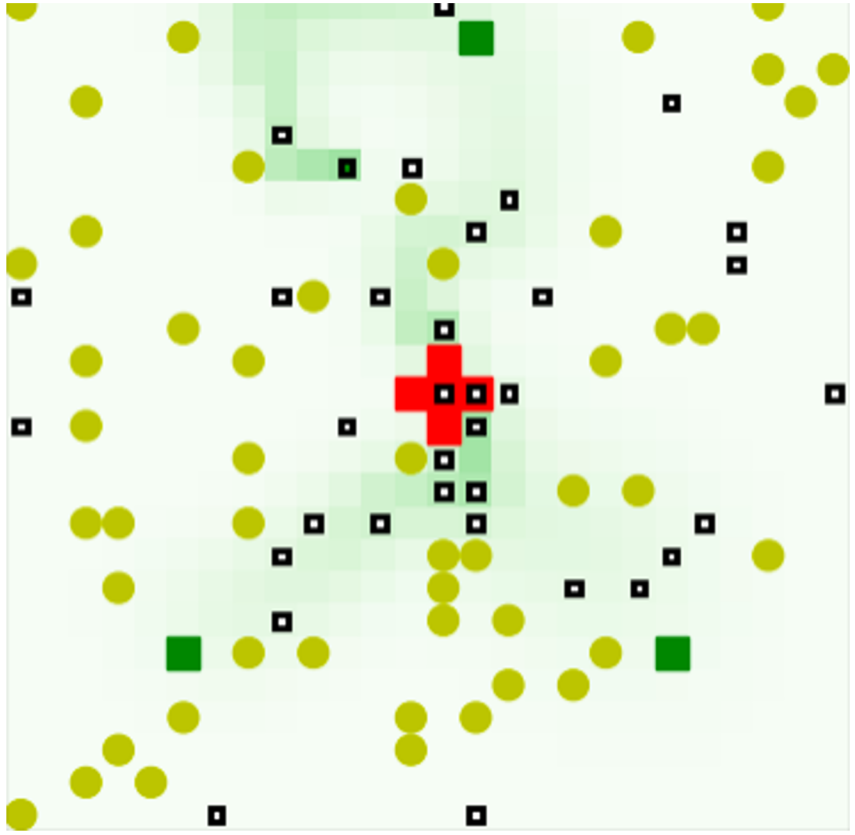


ANT

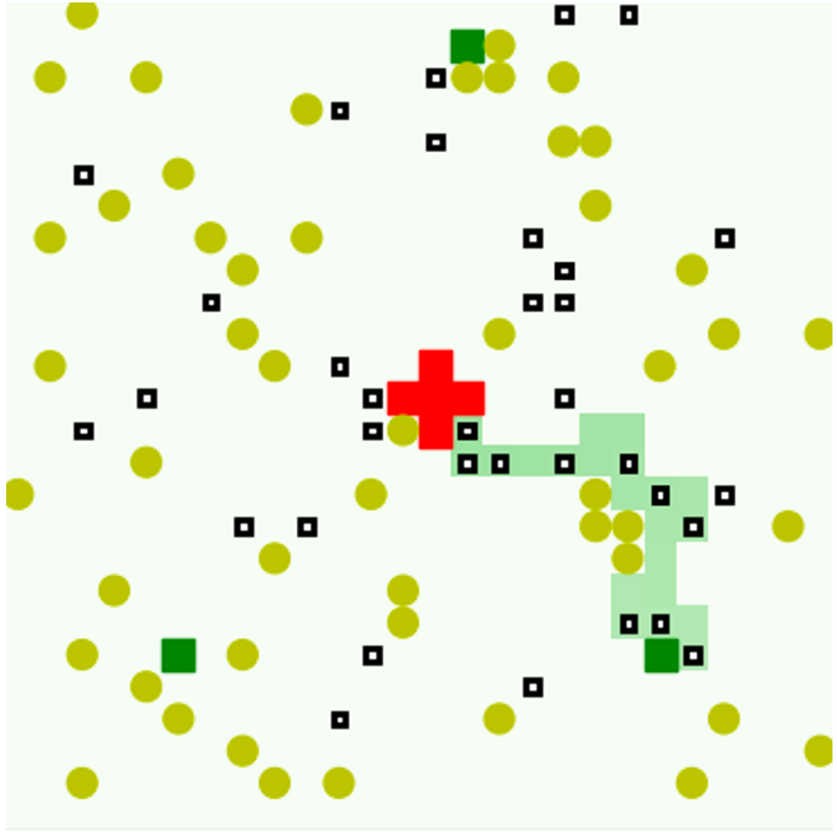

Ant
Has energy?
Yes
On nest?
Yes
Drop food & consume
No
No
Death
No
Has food?
On food?
Yes
Carry & consume
Yes
No
Consume
Carrying food?
Yes
Drop pheromones & move to nest
No
Move according to probability

SIMULATION

HIGH PHEROMONE SPREAD

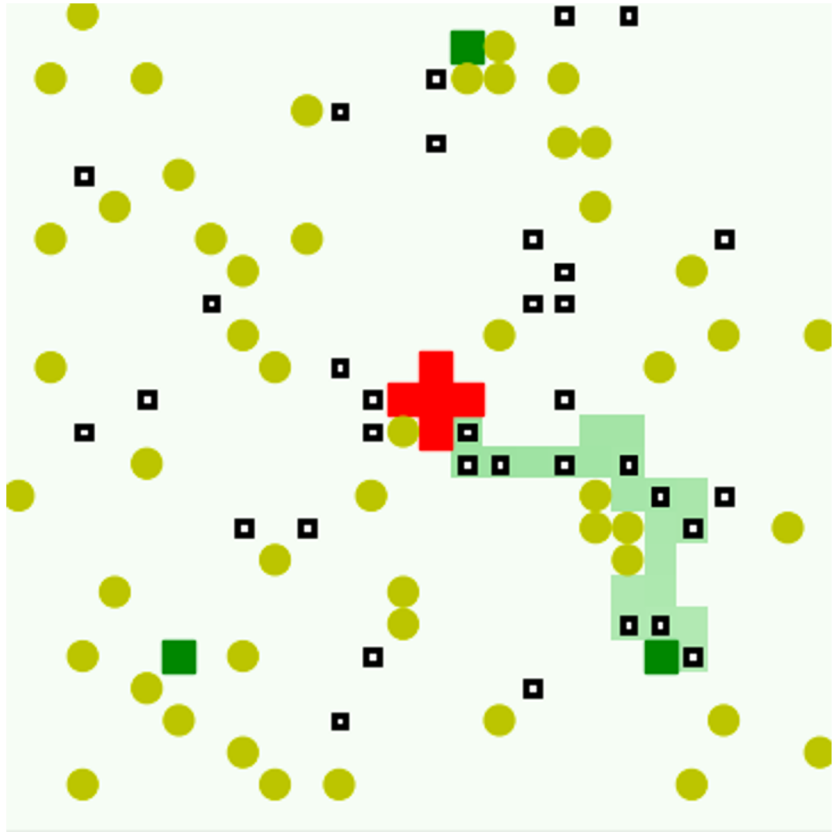


LOW PHEROMONE SPREAD

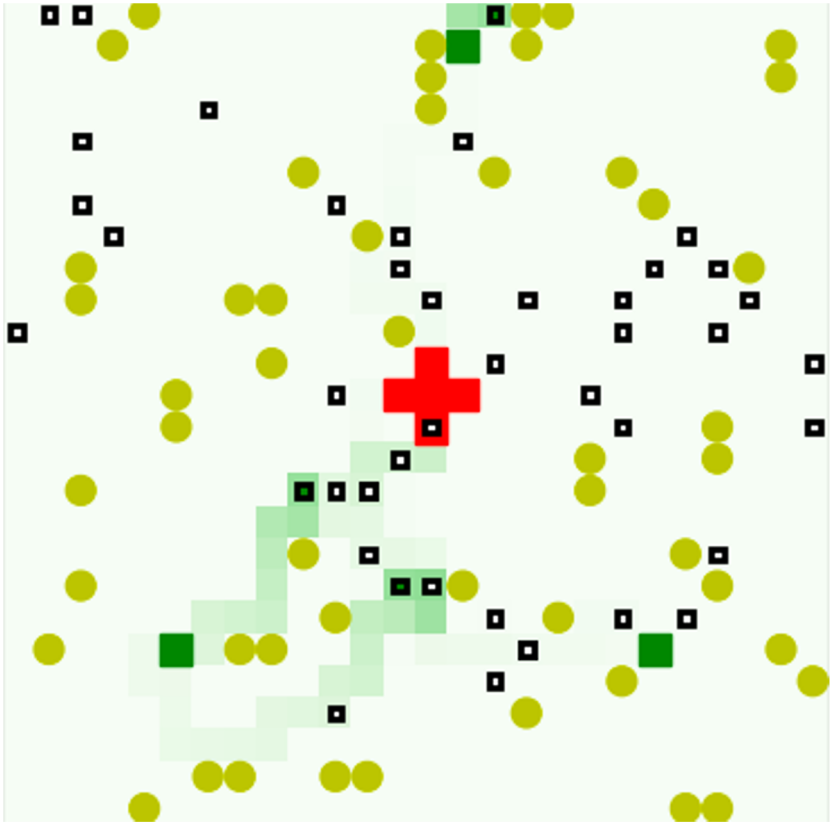


SIMULATION

LONG PHEROMONE DURATION
DURATION



SHORT PHEROMONE

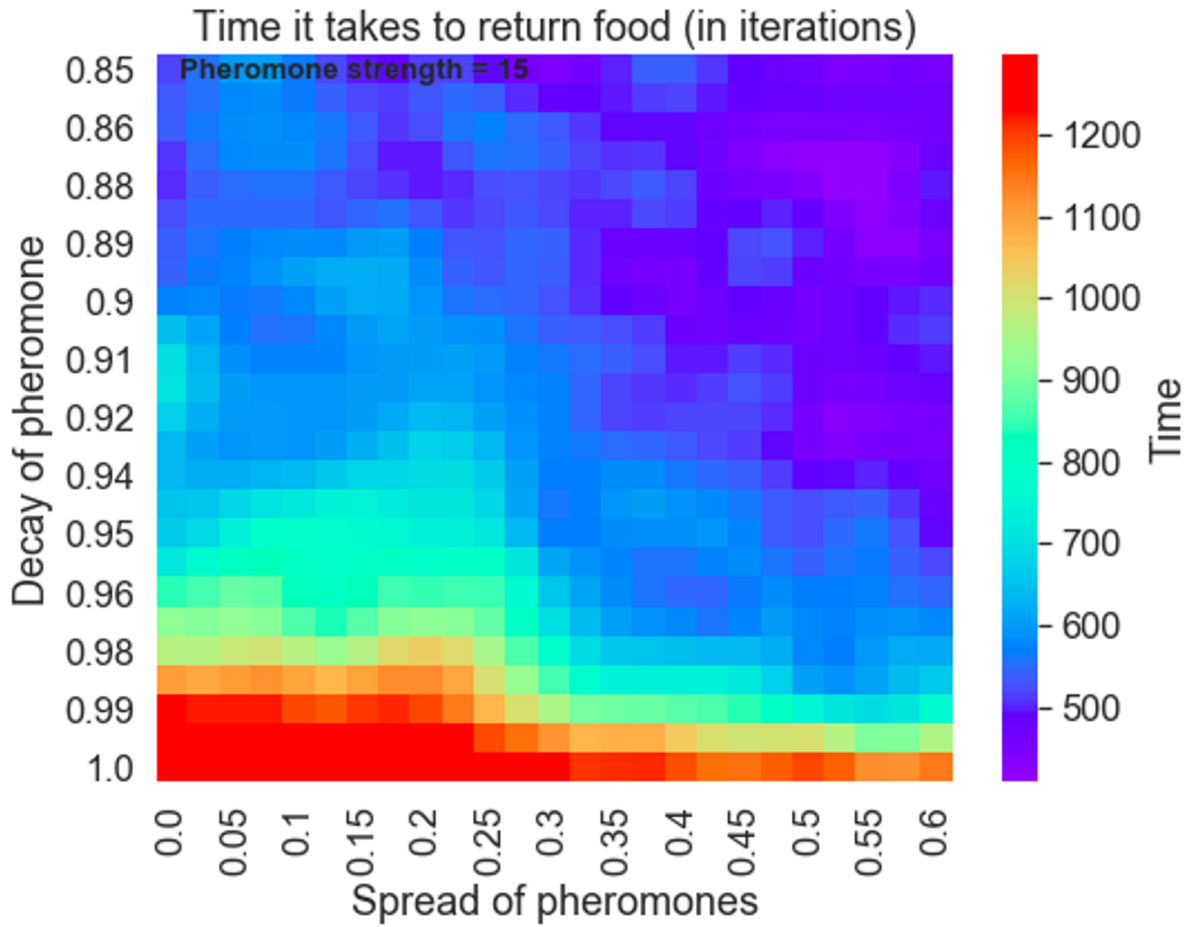


ANALYSIS

- **Trade-off** between pheromone strength evaporation

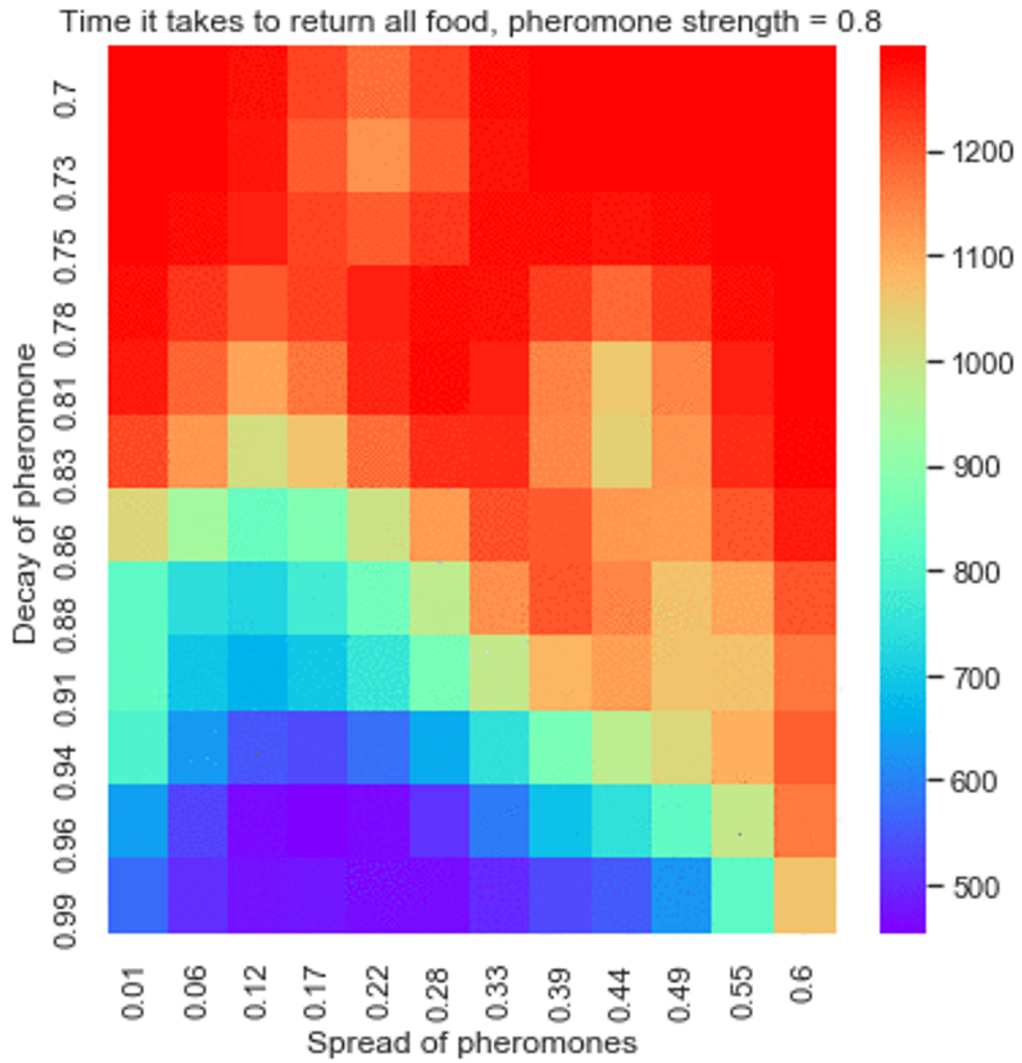
- **Percolation** → a continuous pheromone path between food and nest
  - The average number of times a continuous path between food and nest is formed
    - Varying number of ants
    - Varying grid sizes

Pheromone spread and evaporation



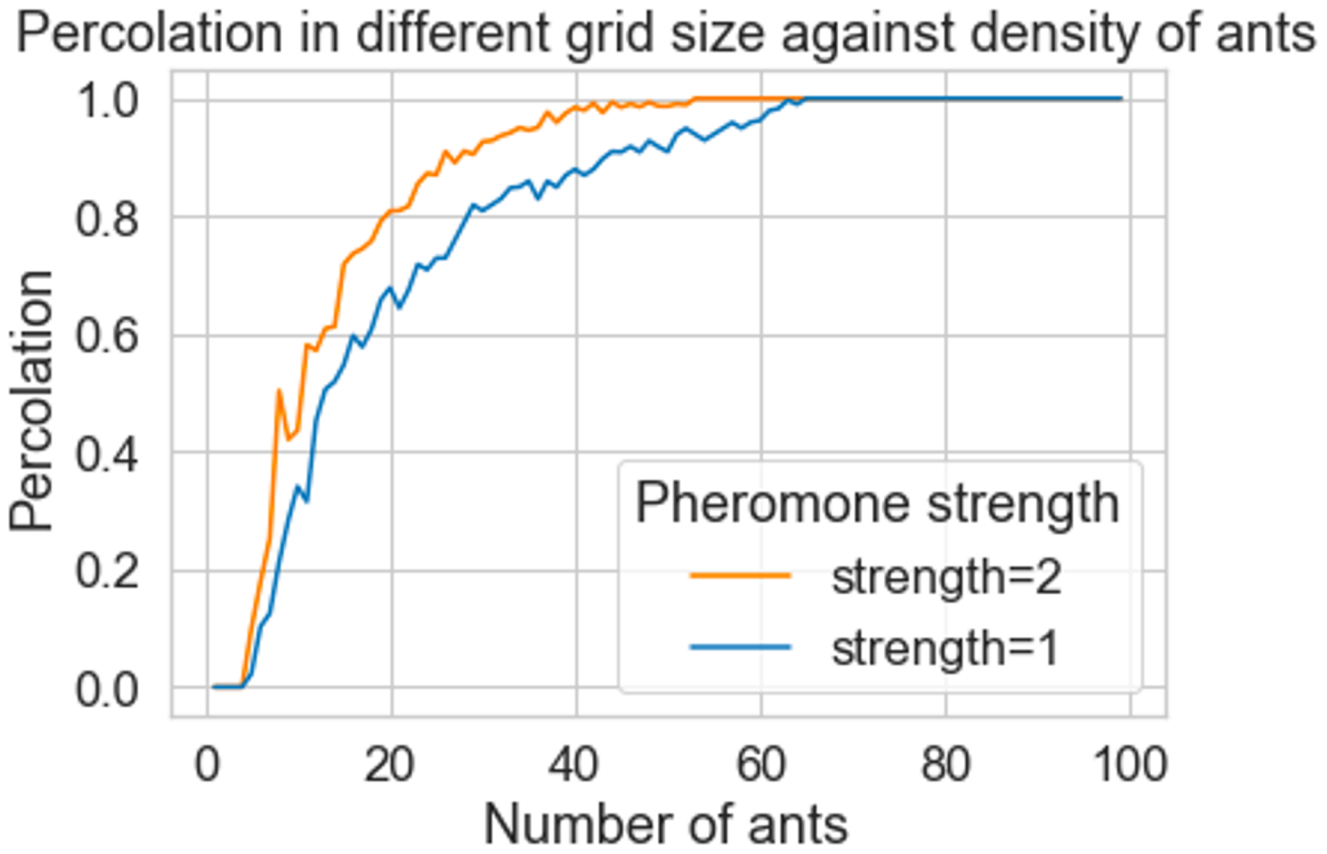
TRADE OFF:
Pheromone strength vs. decay

- Optimal values for:
  - Pheromone strength
  - Evaporation
  - Decay



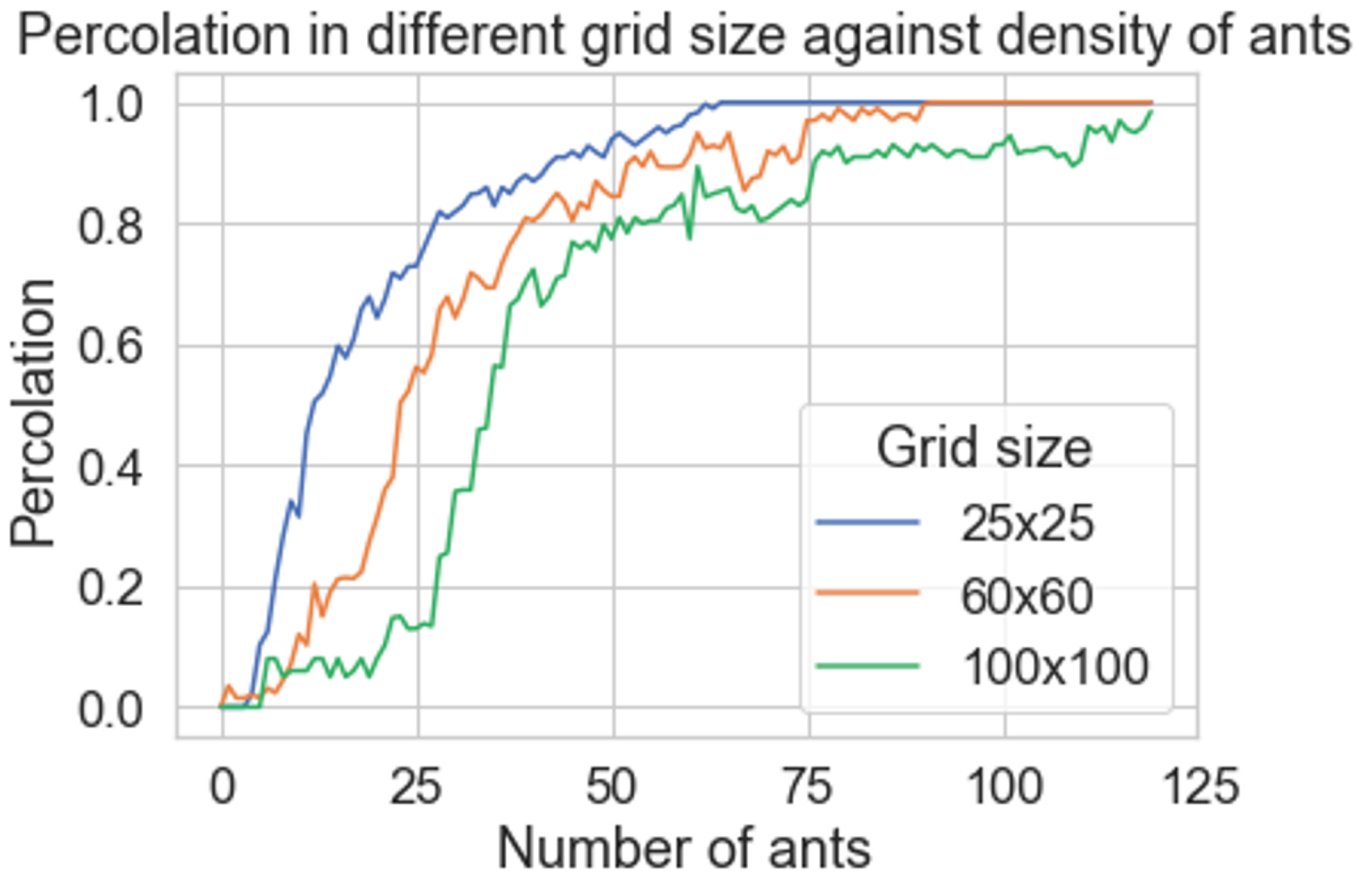
PERCOLATION → a continuous pheromone path between food and nest

- There exists percolation when number of ants is greater than 50
- On average:
  - L**ess percolation** for **lower pheromone** strength
- Increasing grid size → increase nr of ants in order to reach percolation again



PERCOLATION → a continuous pheromone path between food and nest

- There exists percolation when number of ants is greater than 50
- On average:
  - **Less percolation** for **lower pheromone** strength
- **Increasing grid** size → **increase number of ants** in order to reach percolation again



CONCLUSION

There is a trade off between different values of pheromone strength, decay and spread: the larger the pheromone spread, the lower the values of the decay and strength have to be for similar results.

Less percolation for lower pheromone strengths:

- Percolation for number of ants > 50
- Increase ant density in bigger grid size

Corresponds to the hypothesis

LIMITATIONS AND BIASES

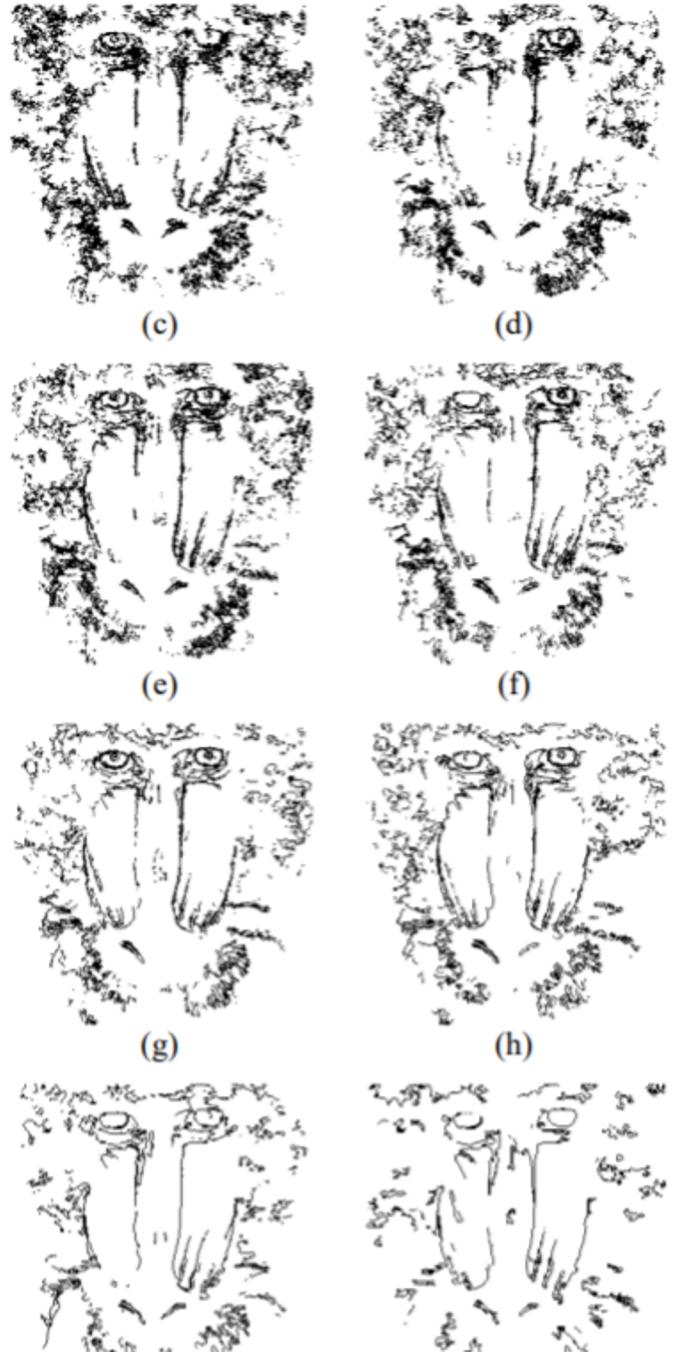
- Each set of parameters must be tested many times.

To measure percolation:

- Ants must not be capable to produce a continuous path by themselves.

DISCUSSION

- Further research into percolation and colony size
- These results are used for image detection



EXTRA SLIDES

INITIALIZATION

Empty *N*x*N* grid.

N Ants spawn from colony

N Obstacles at random location

N Food on random locations

Decay	[0.7, 0.99]
Evaporation	[0.05, 0.6]
Pheromone strength	[0.8, 2.5]