

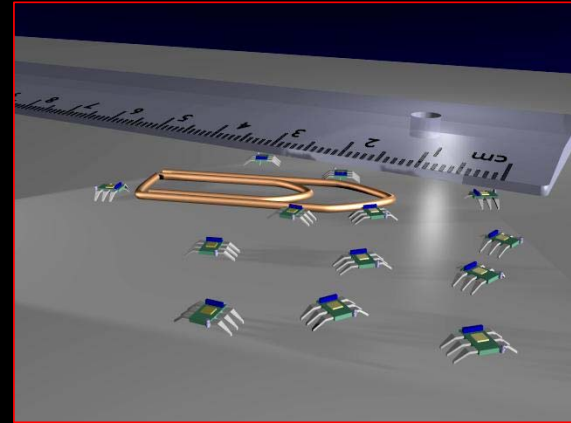
A navigation algorithm for swarm robotics inspired by slime mold aggregation

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SAB'06**

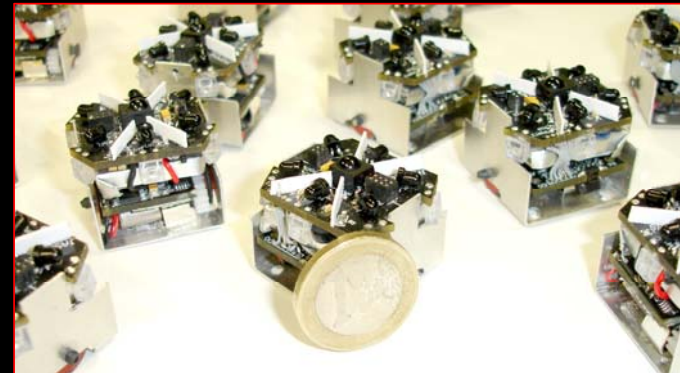


Background

- I-SWARM Project
 - Swarm of 1000 robots (2mm x 2mm x 2mm)
 - Very limited capabilities

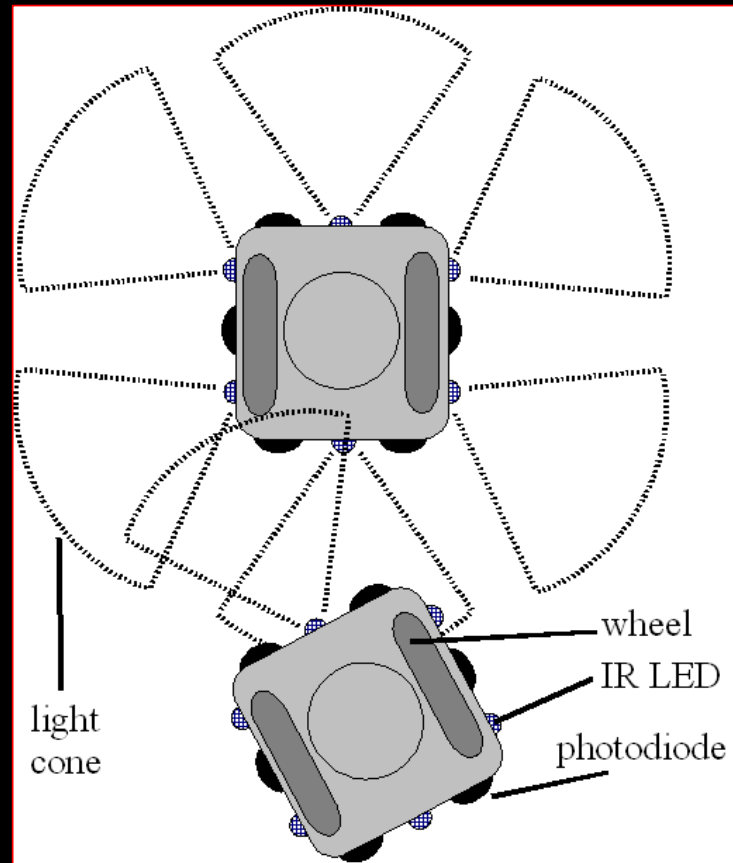


- “Training-Swarm”
 - JASMINE robots (3cm x 3cm x 3cm)
 - Same communication principals



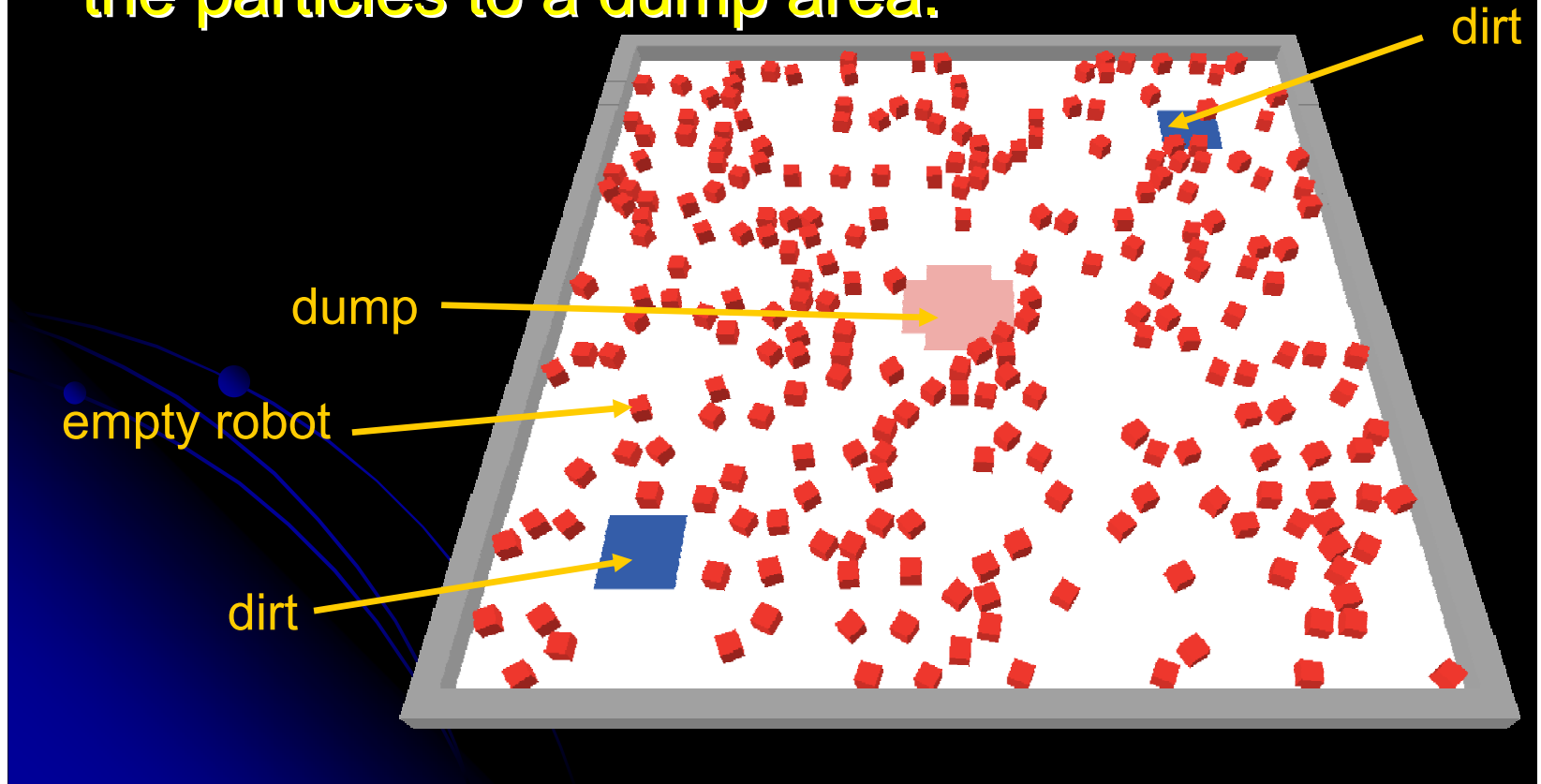
Technics

- Communication with horizontal LED light-cones and photodiodes
- Also obstacle avoidance is made this way
- Motion: two wheels → difference to I-SWARM

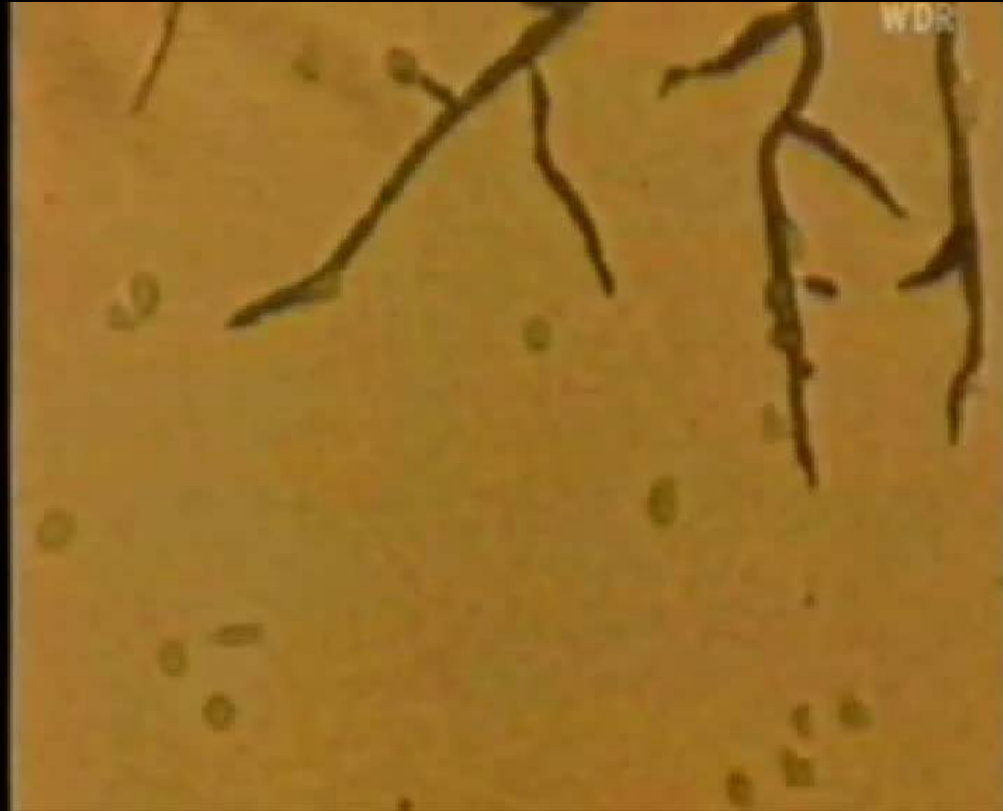


The task to be performed

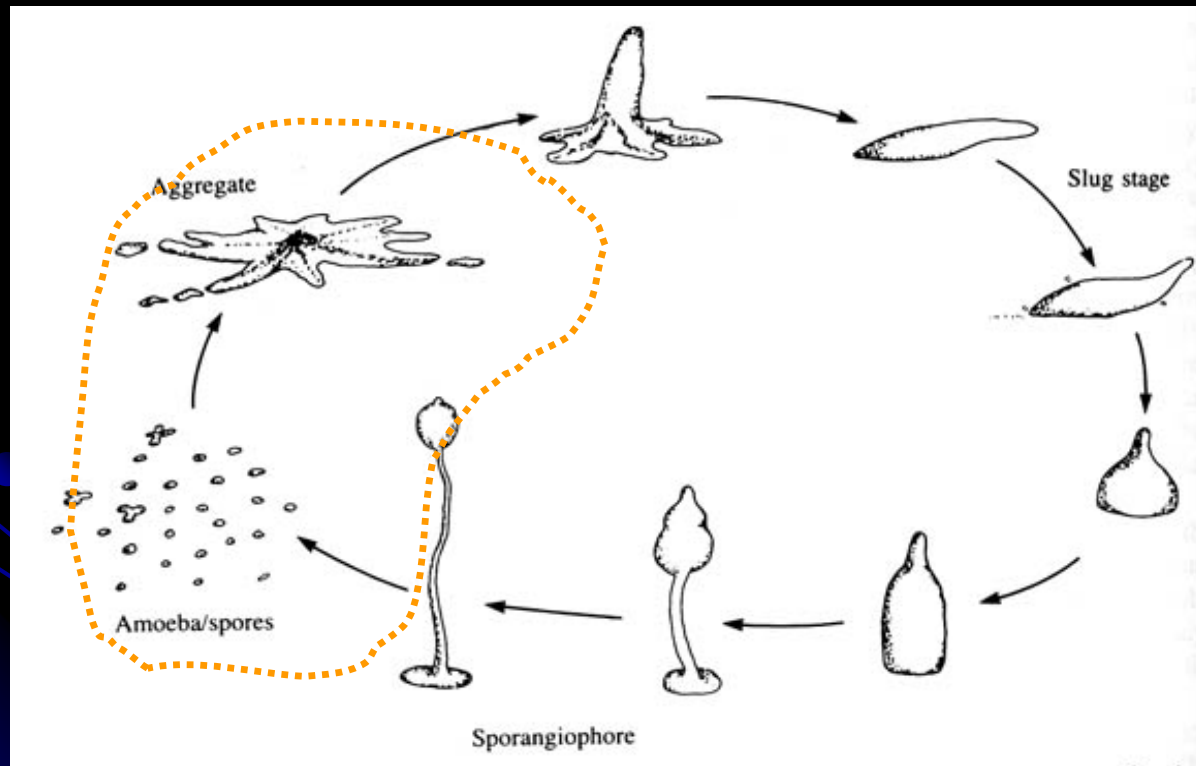
- Cleaning dirt from an arena and to transfer the particles to a dump area.



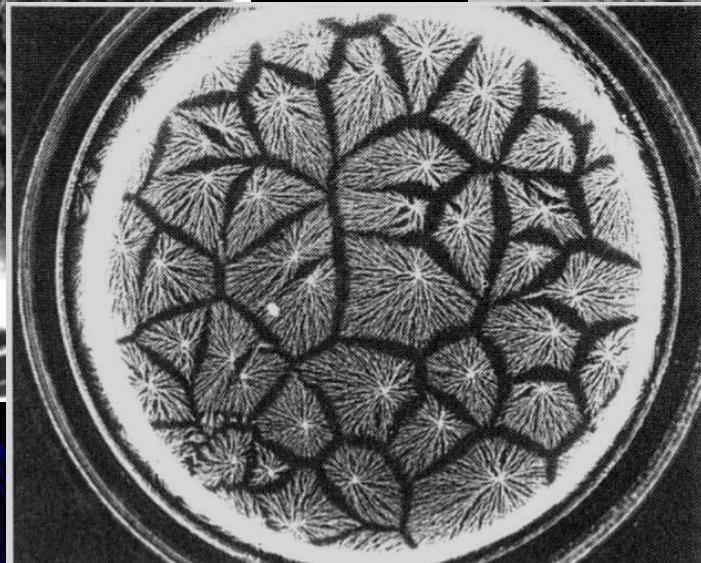
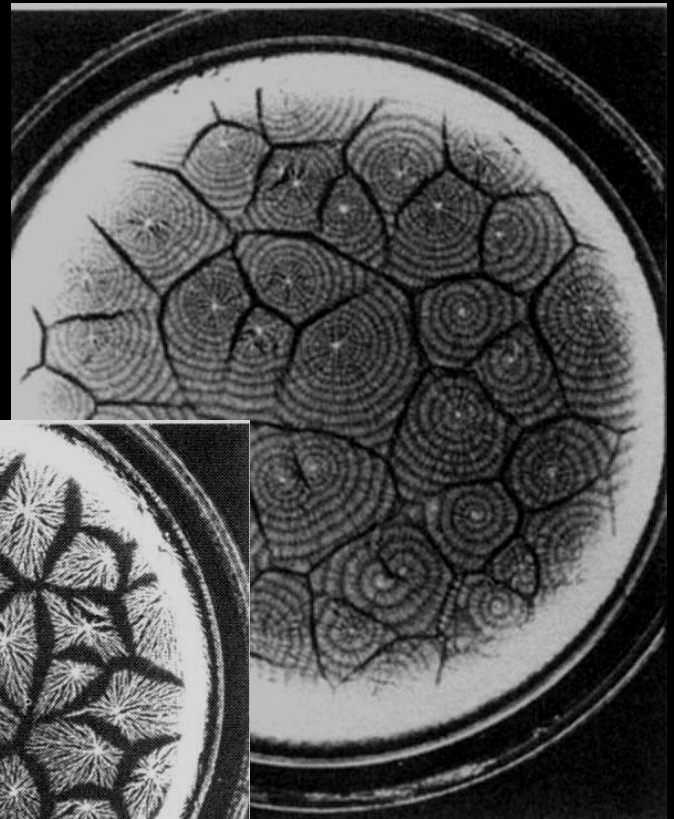
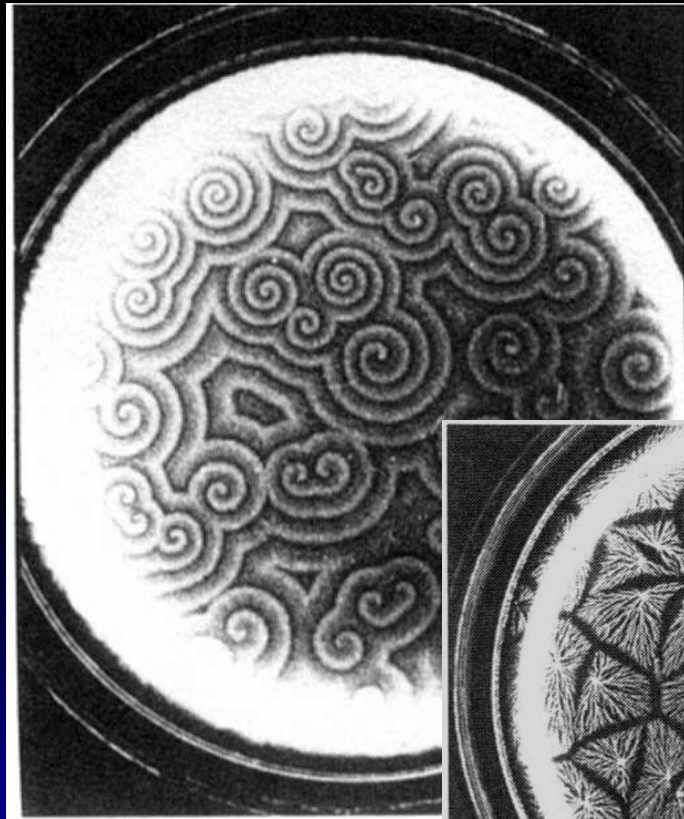
The source of inspiration



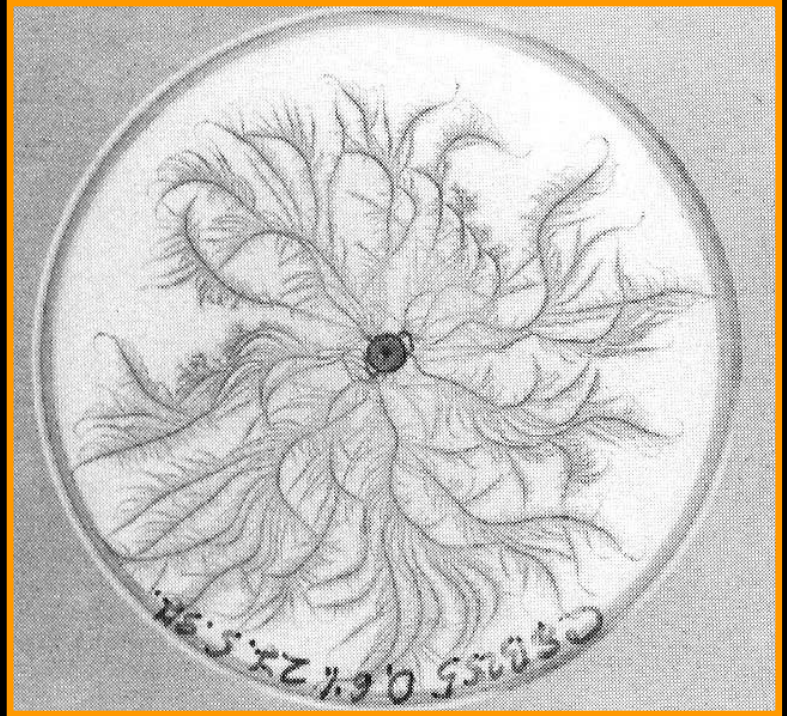
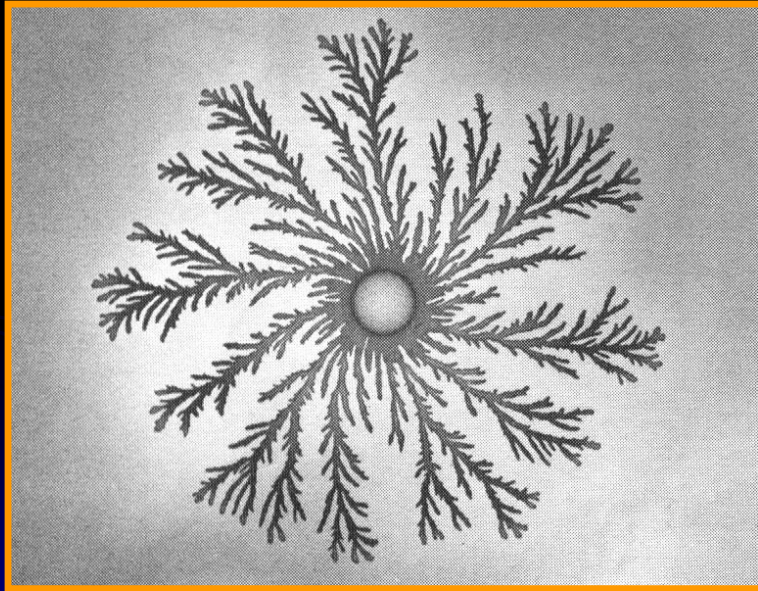
The lifecycle of this slime mold



How does it work: waves

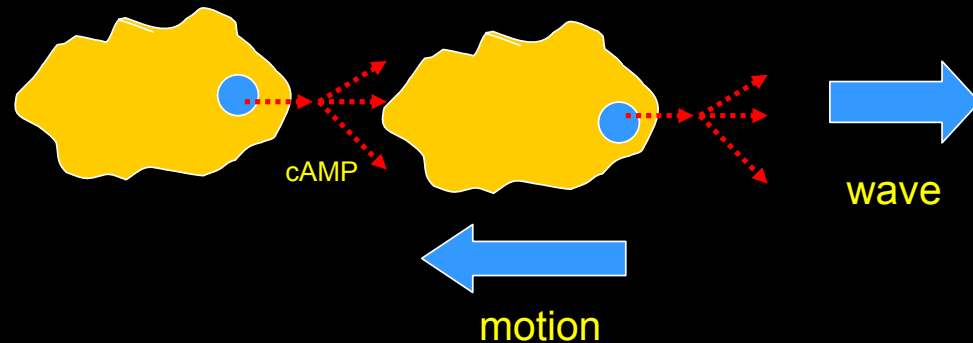


Other examples of aggregation patterns



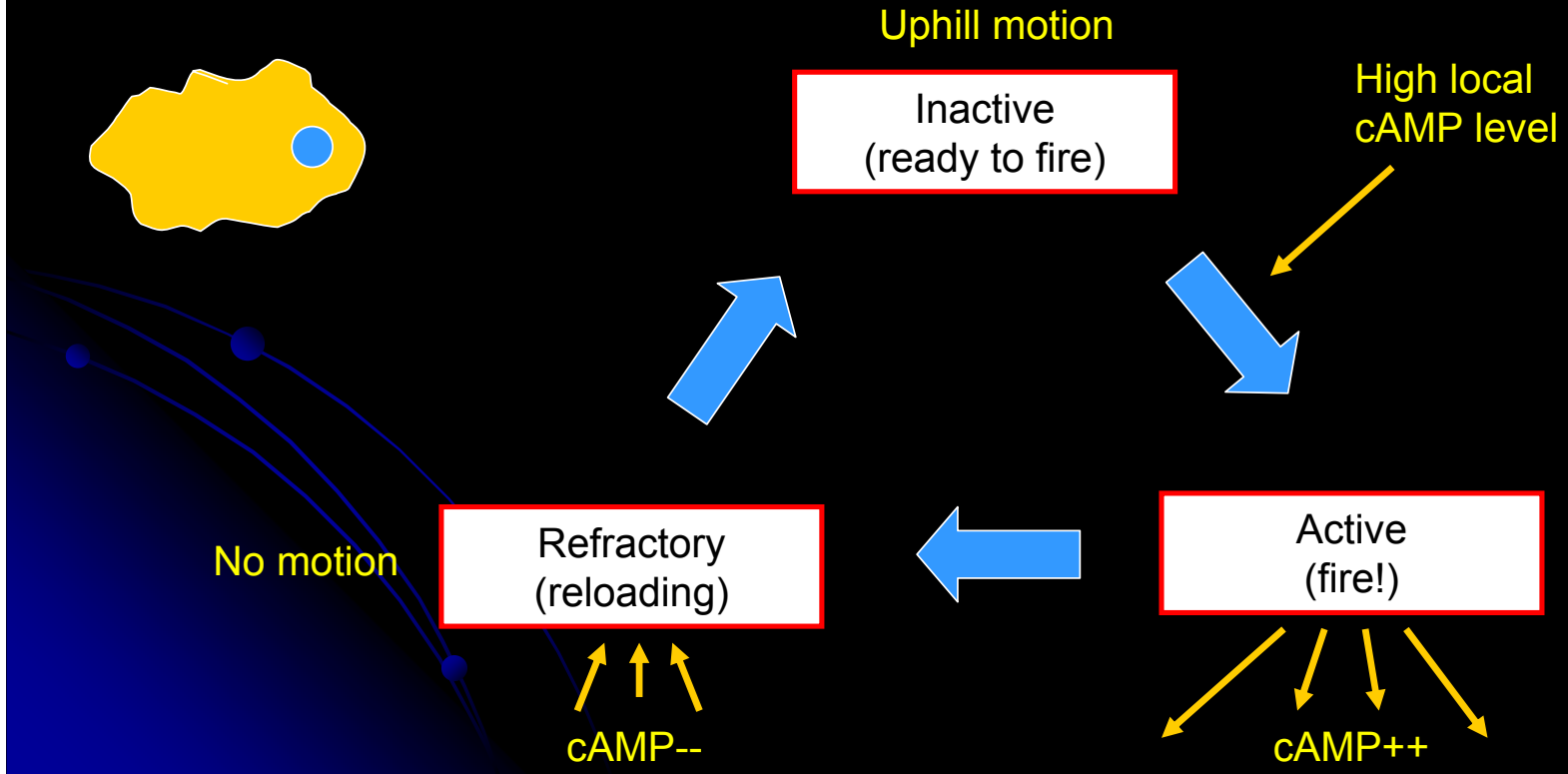
Movement principles

- Basic movement: Random motion
- Directed movement:



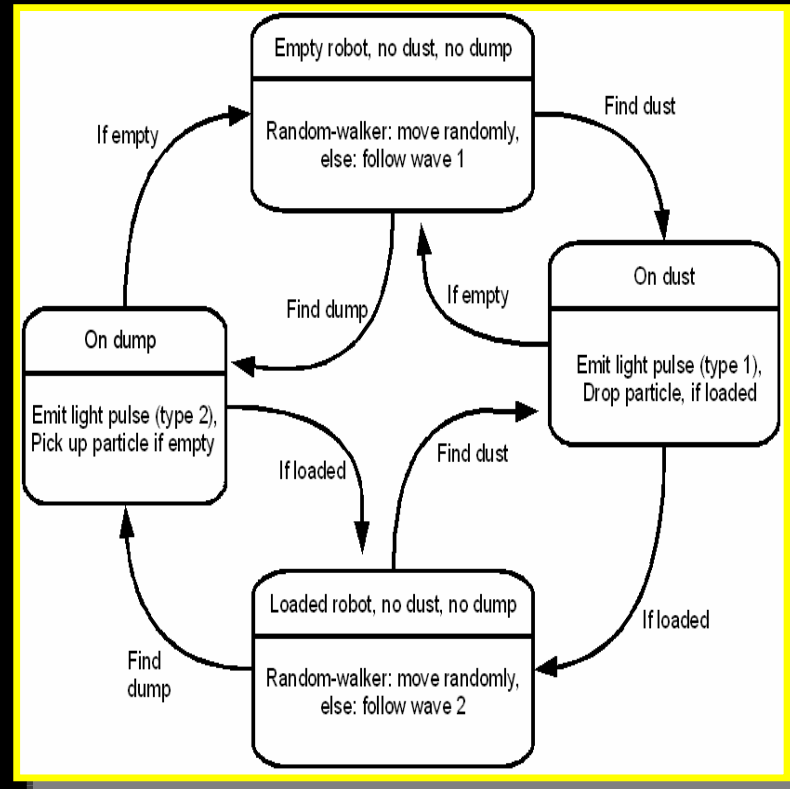
This can be described

- by a finite state automaton:

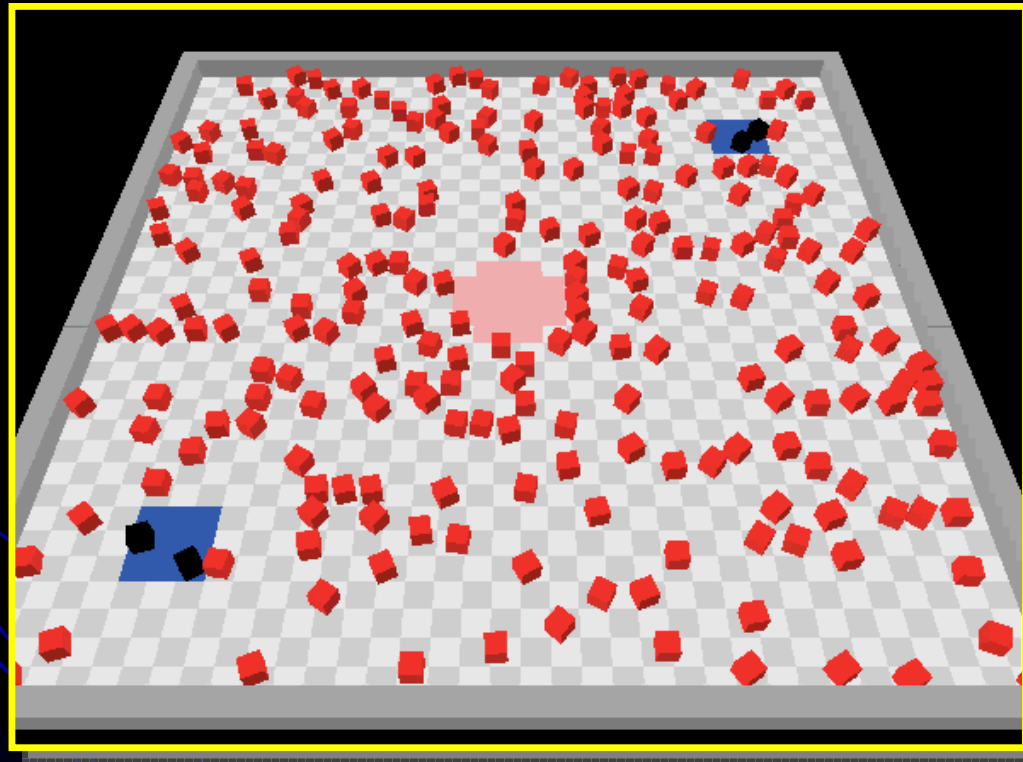


And the same for the robots

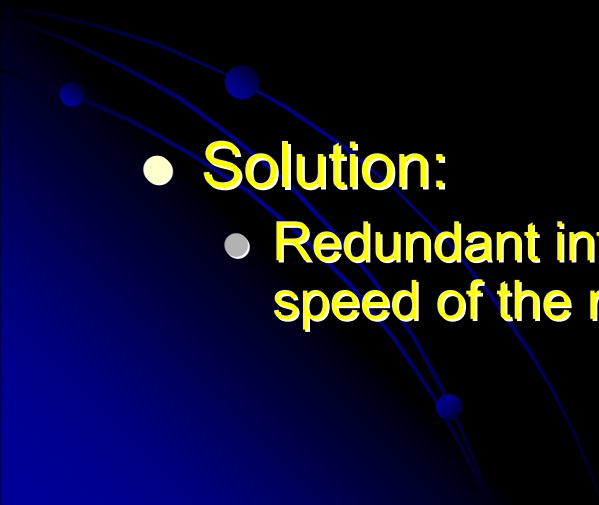
- The emitting of the chemical substance is represented by a **light pulse!**



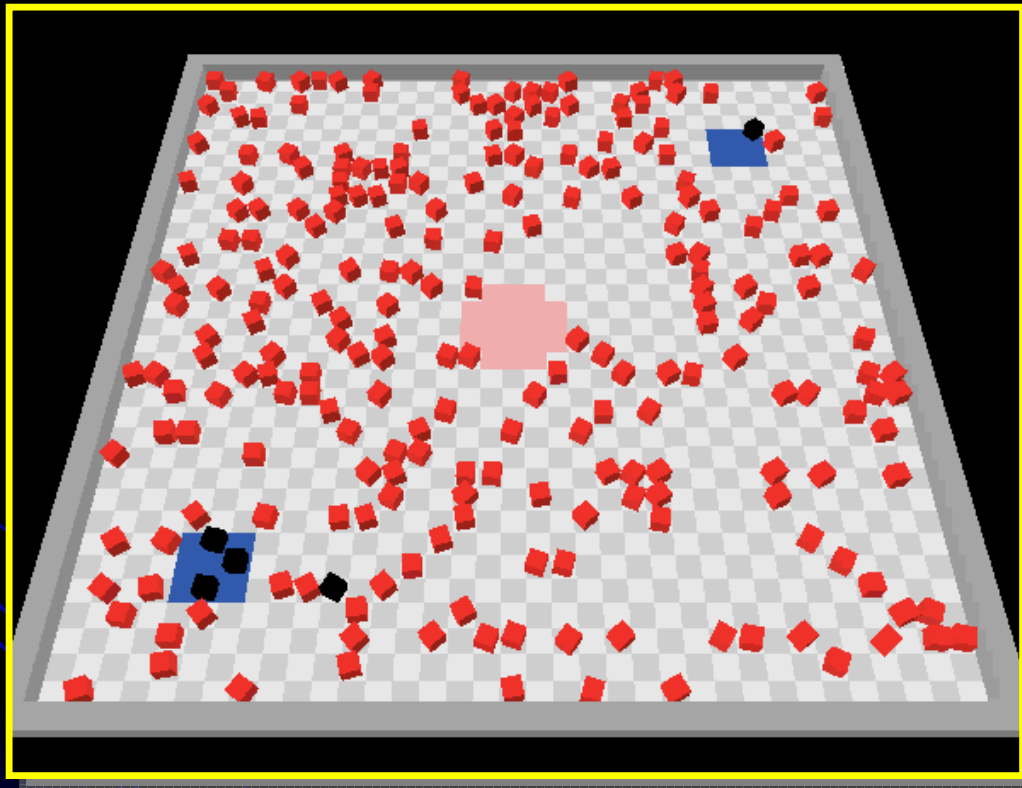
The algorithm at work



Summary 1

- The loaded robots reach the dump area
 - But the path is very „noisy“
 - Problem:
 - Information is noisy and has little “content”
 - Solution:
 - Redundant information by reducing the movement speed of the robots
- 

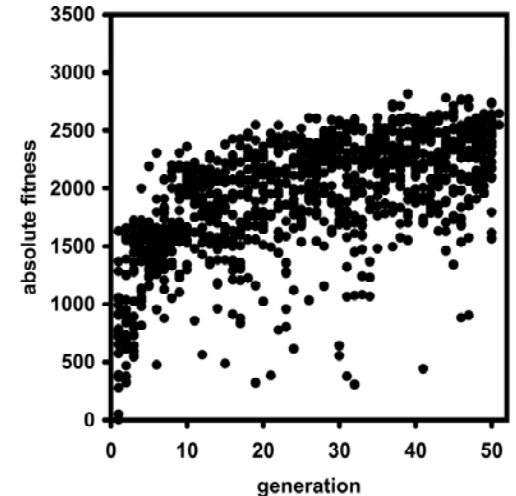
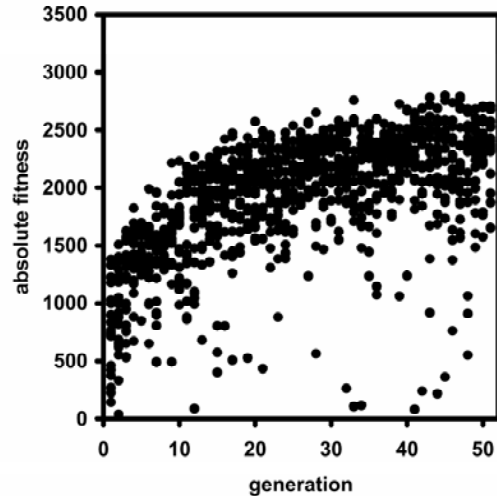
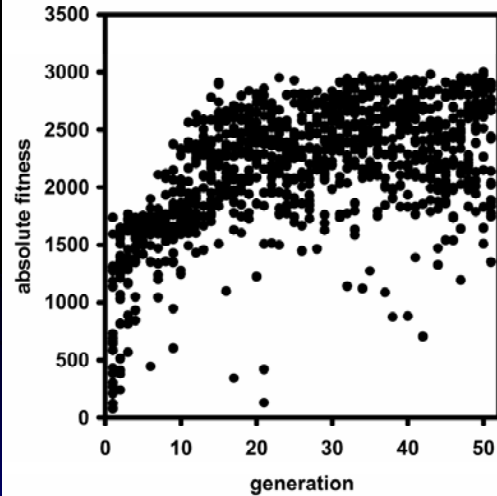
With reduced movement speed



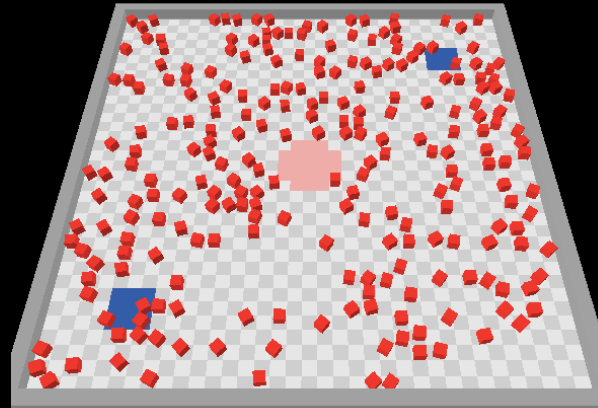
Before: 0.35 patches/sec
(~1.1cm/sec)

Now: 0.1 patch/sec
(~0.3cm/sec)

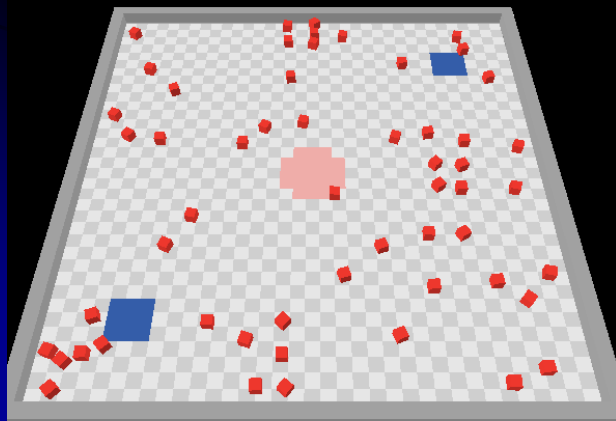
Evolving good parameters



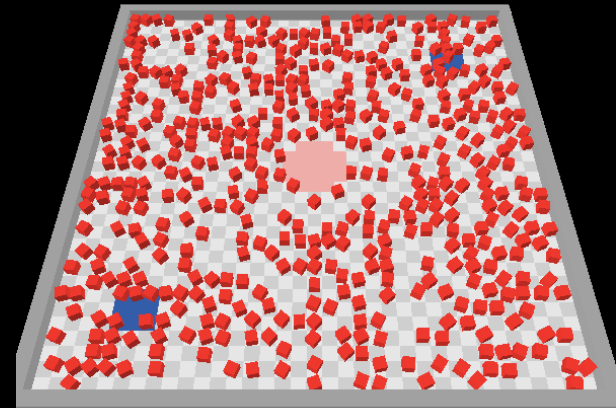
The importance of the swarm's density



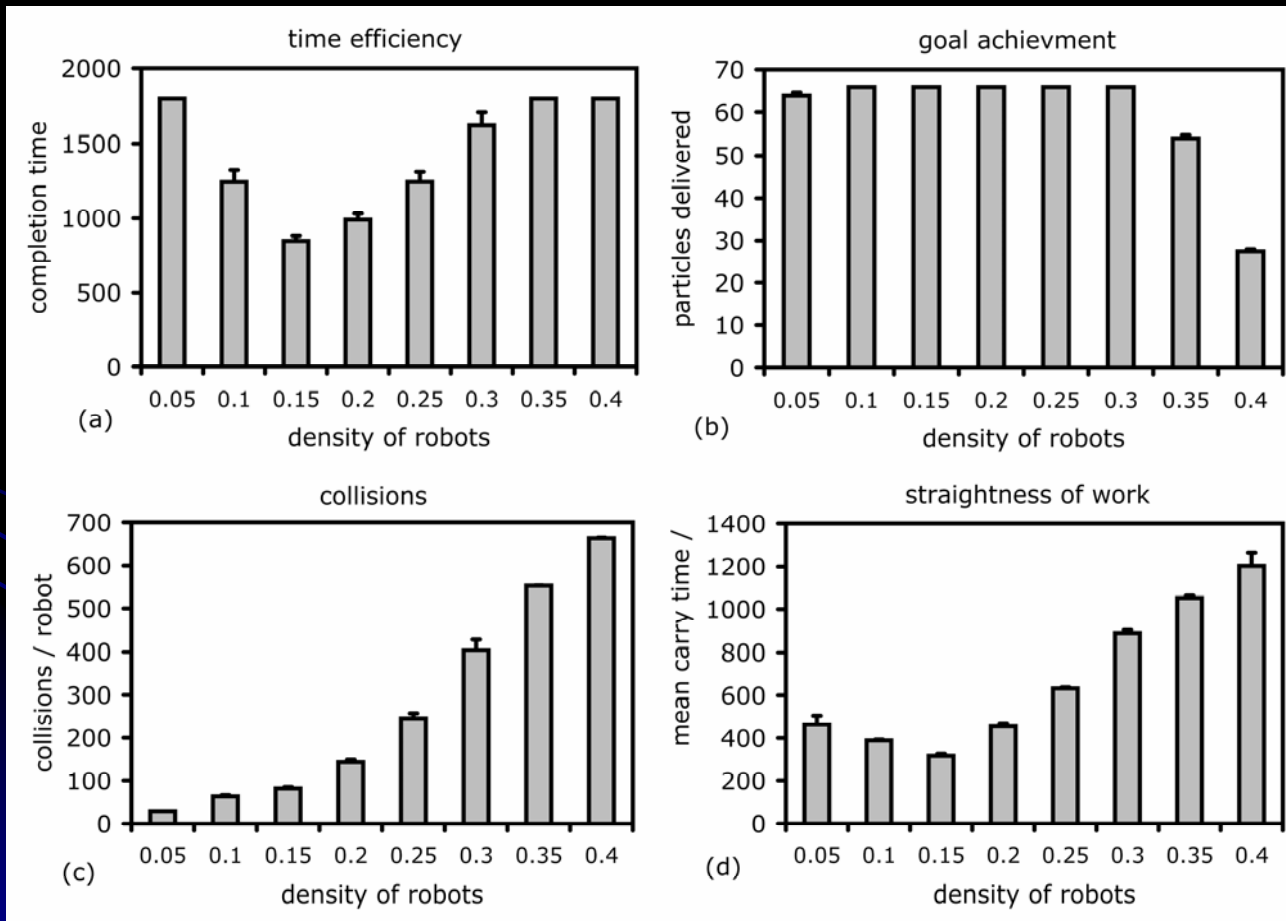
No „bridging“ of information



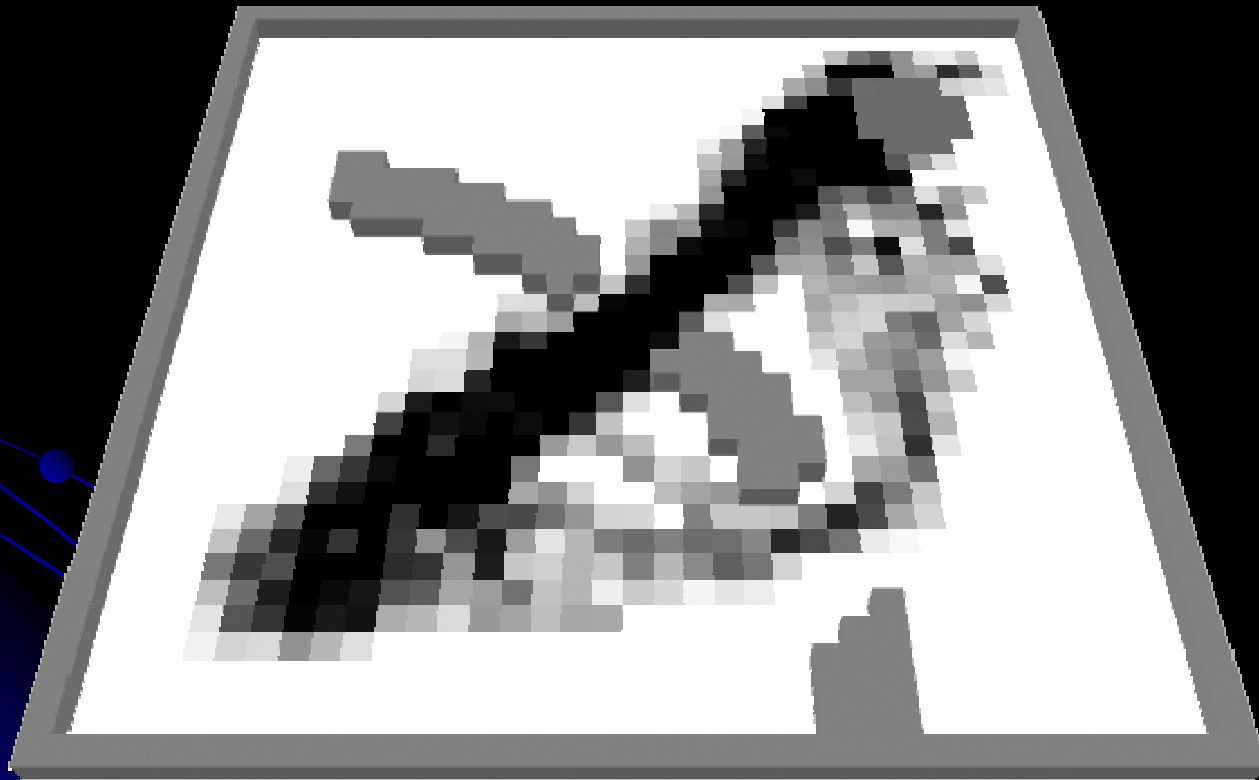
Traffic jam



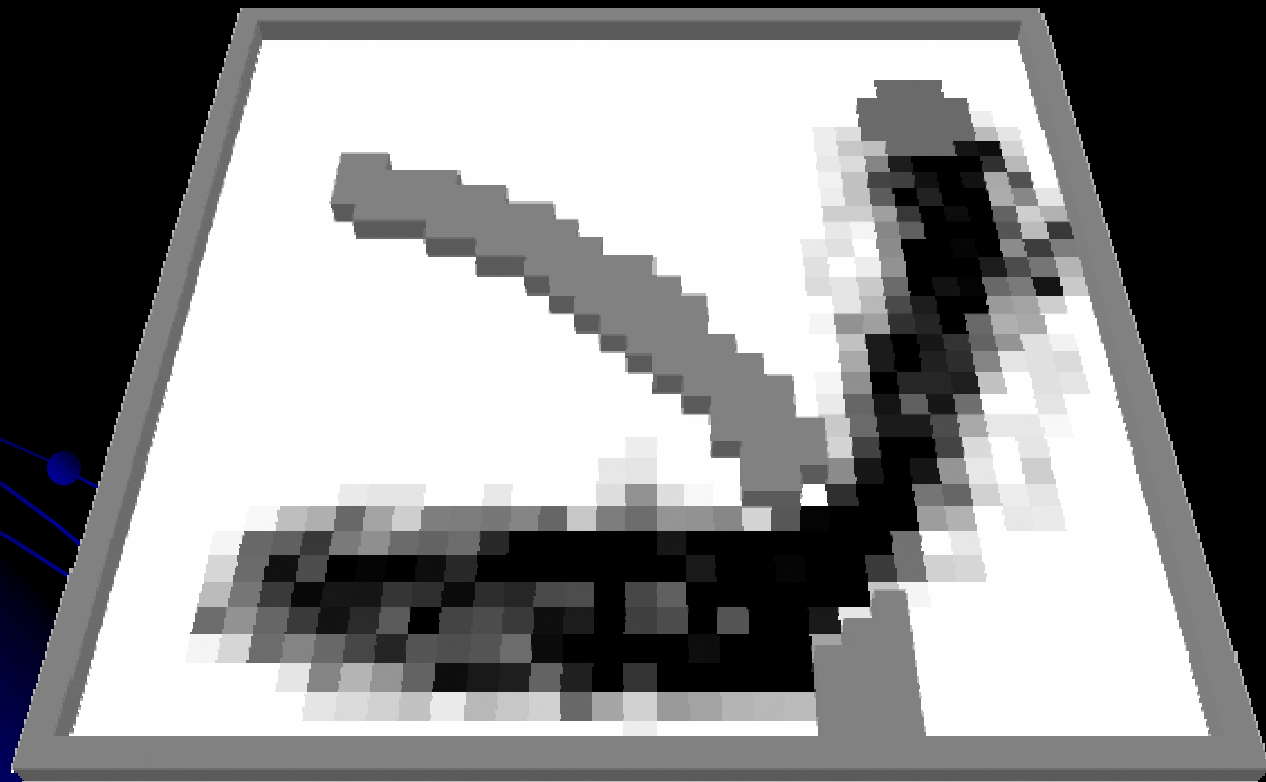
Analysing the importance of the swarms density



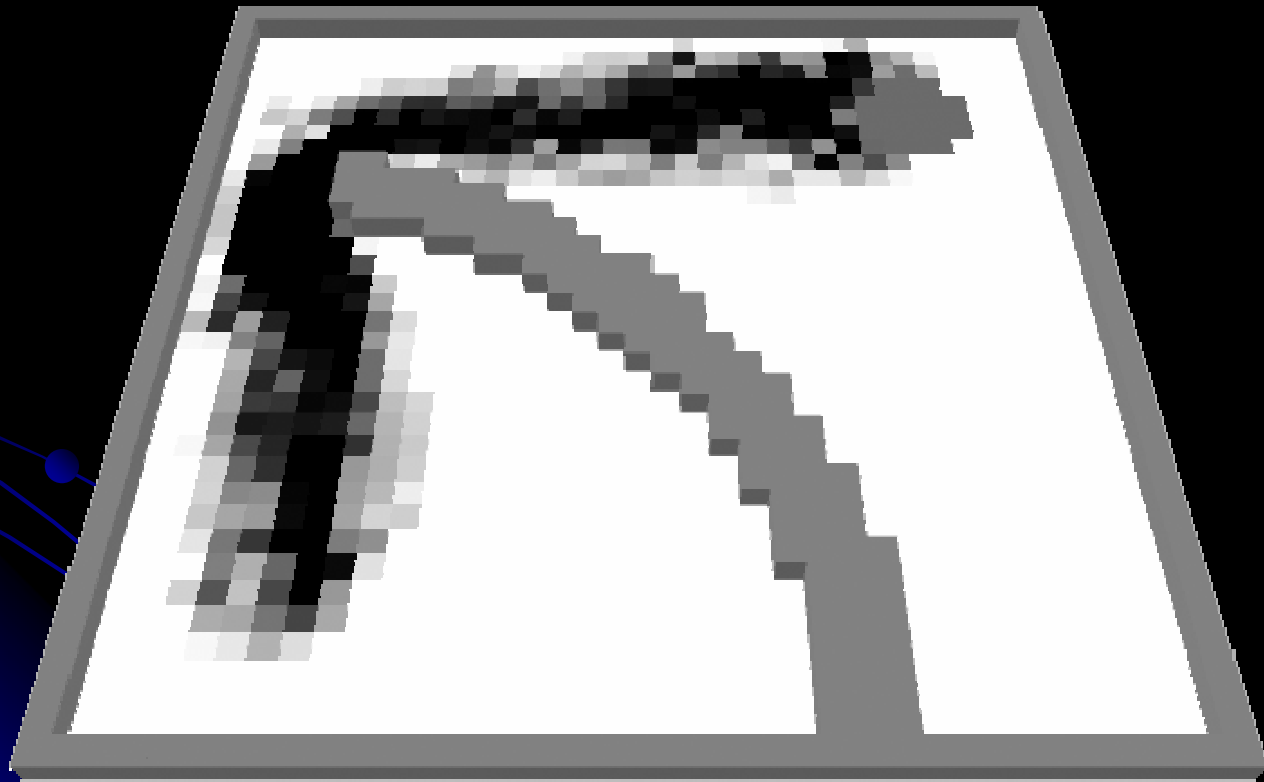
Path finding



Path finding

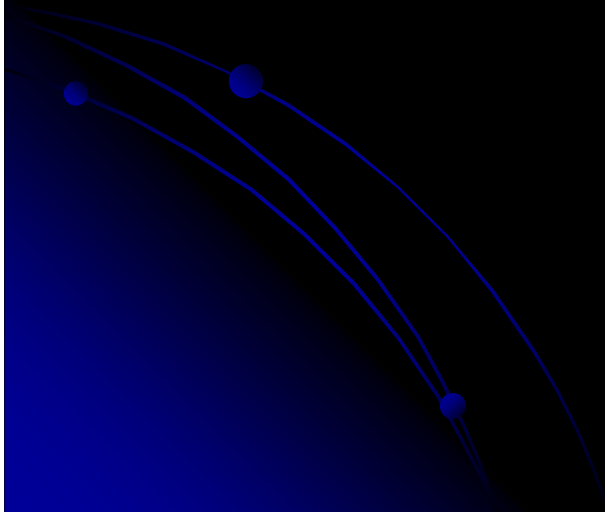


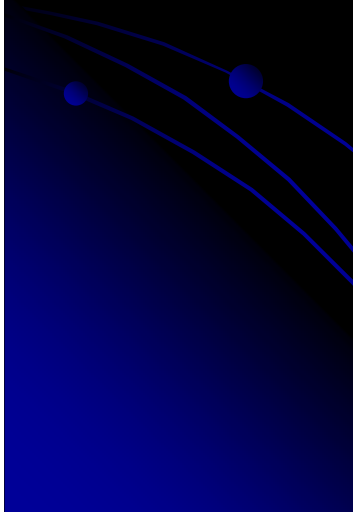
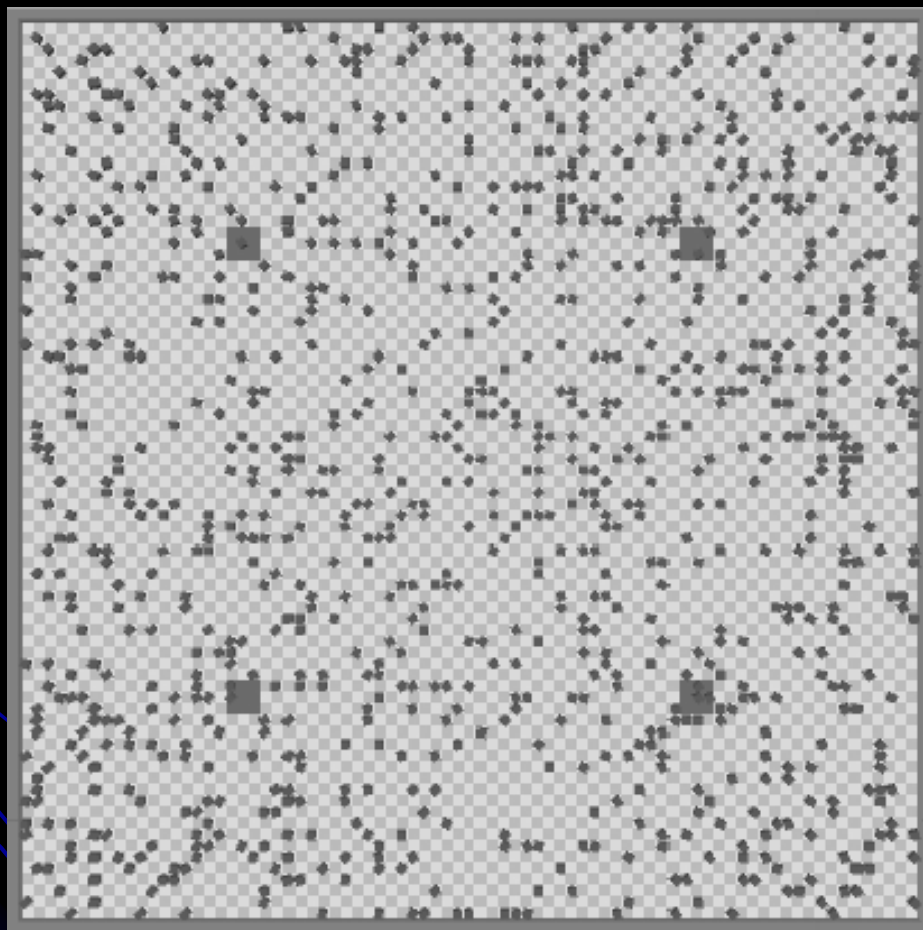
Path finding

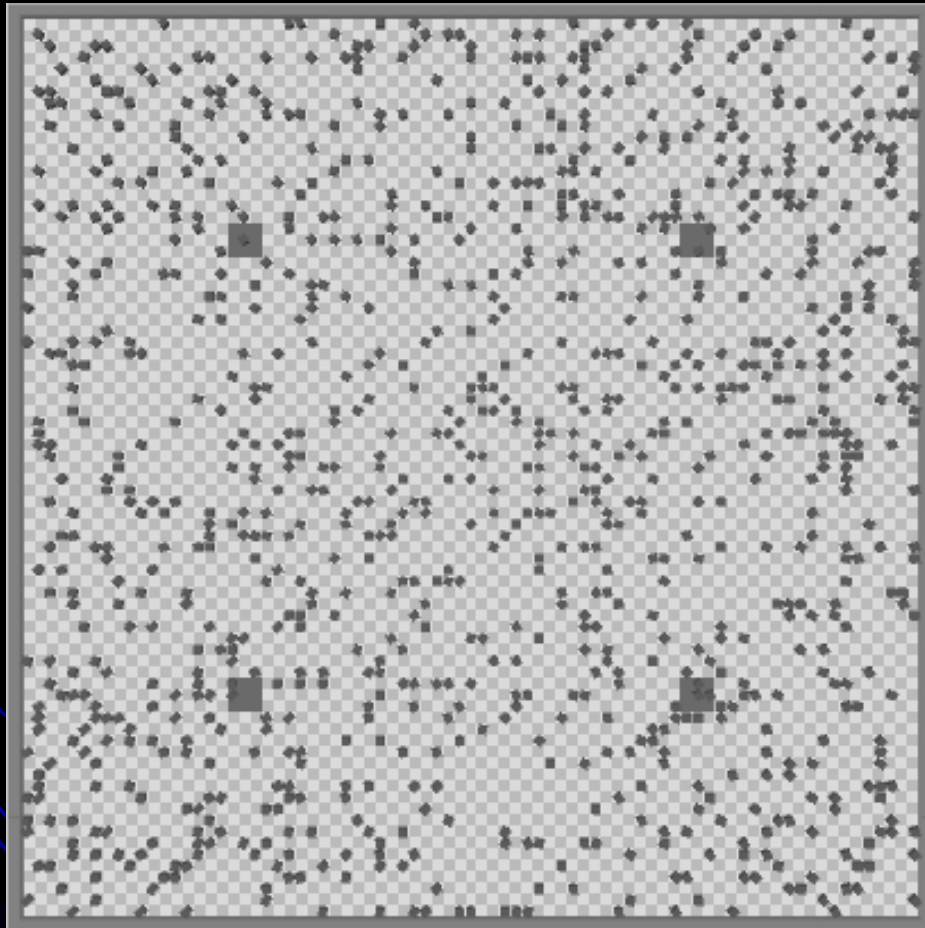


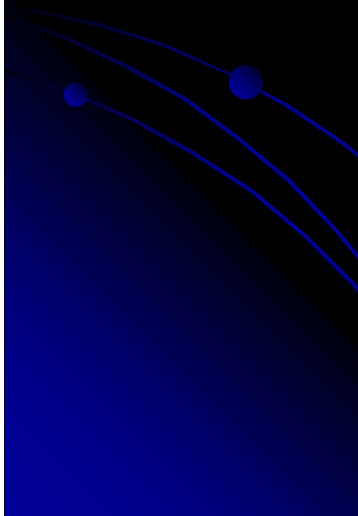
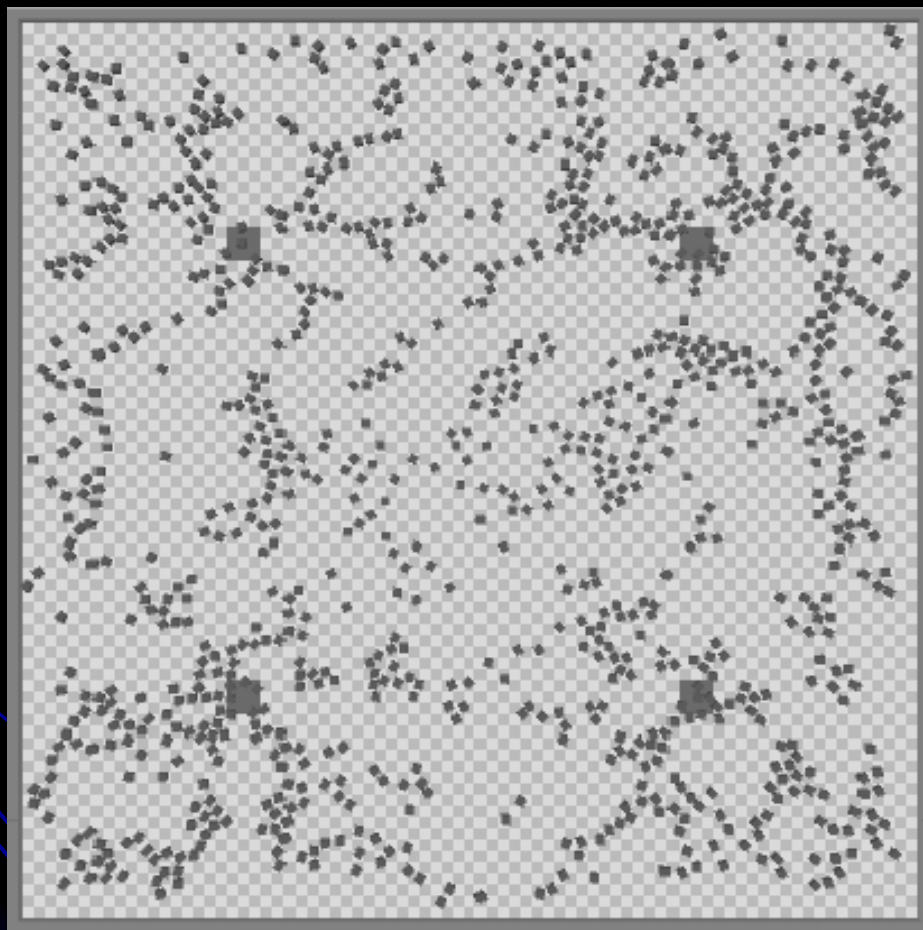
Biomimicry

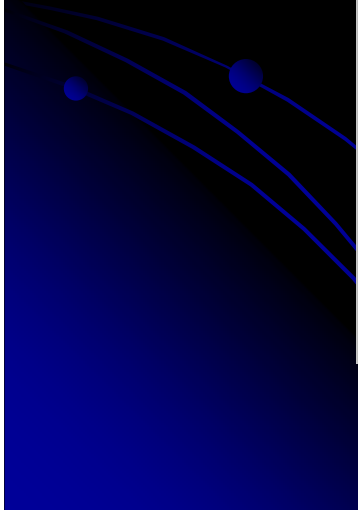
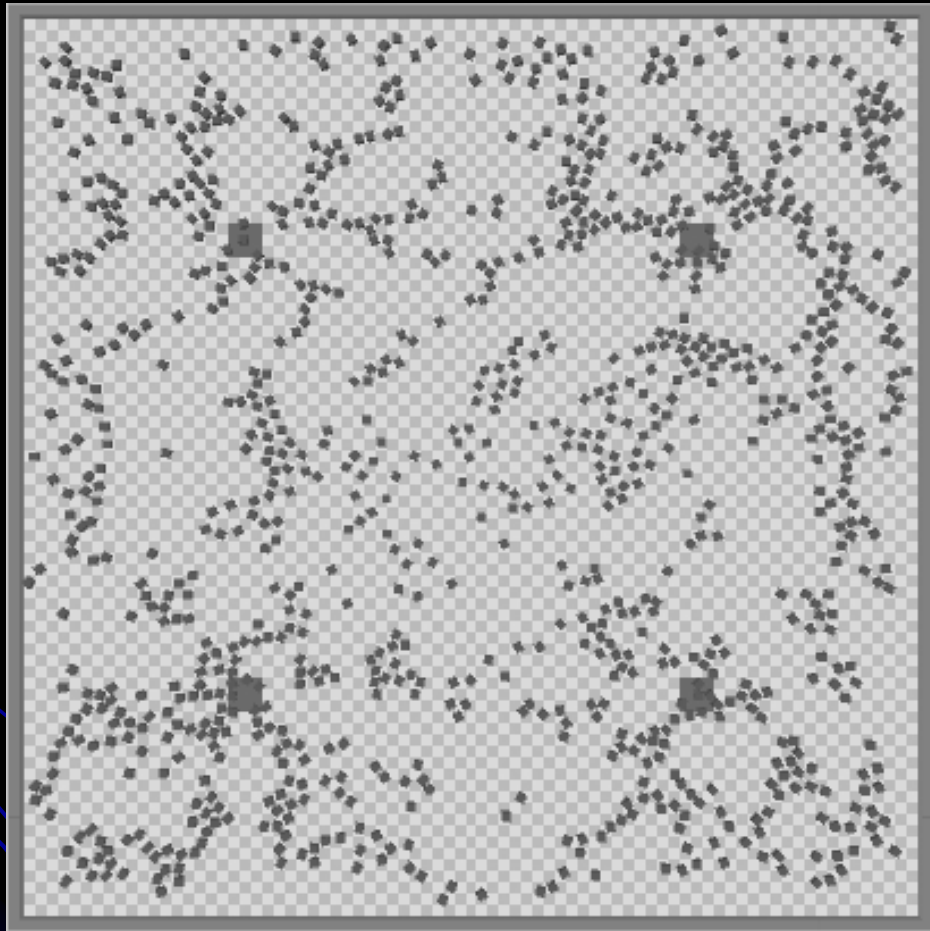
- Finally, we replaced the binary (on/off) signal by a floating-point wave:

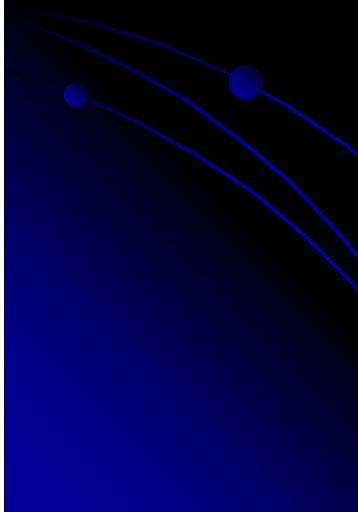
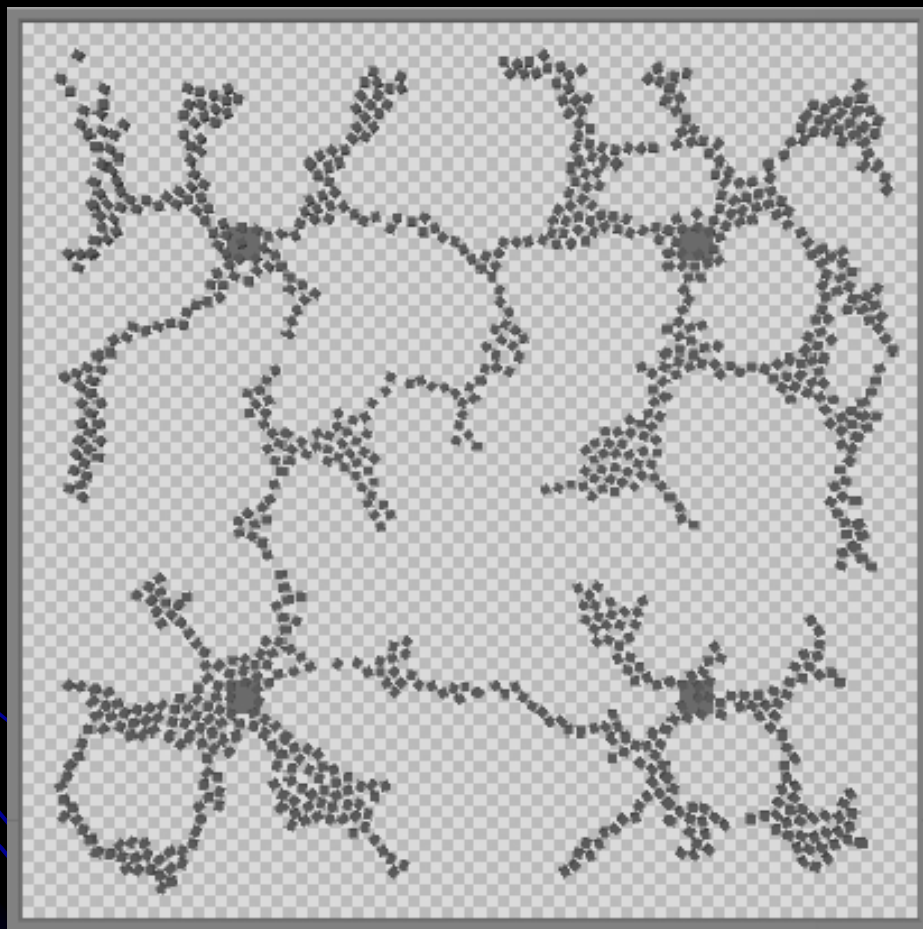


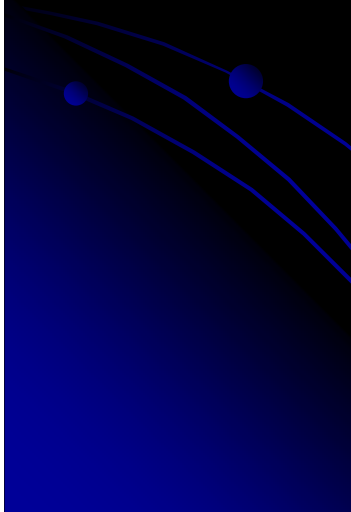
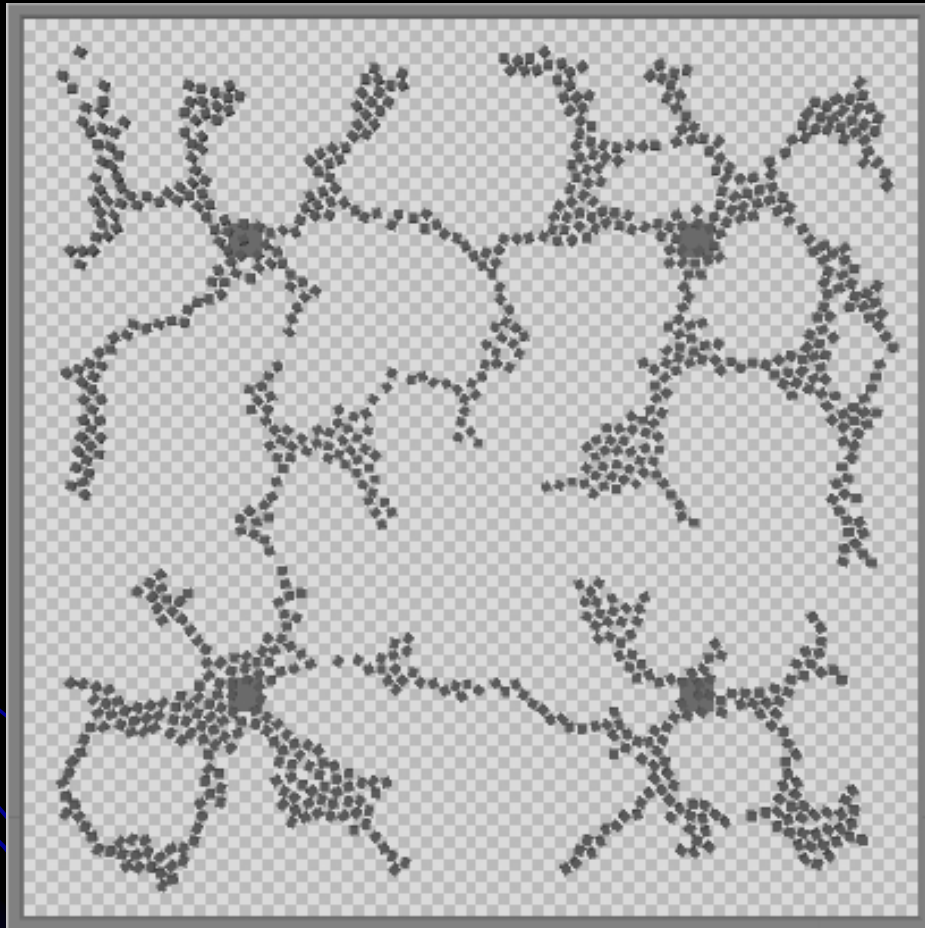


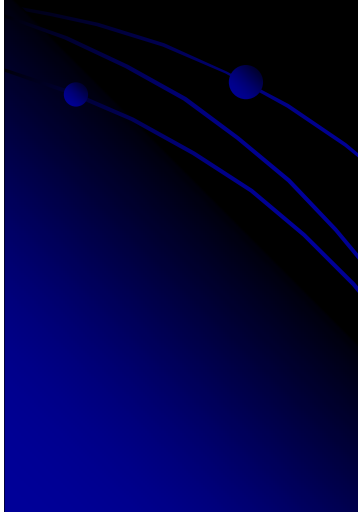
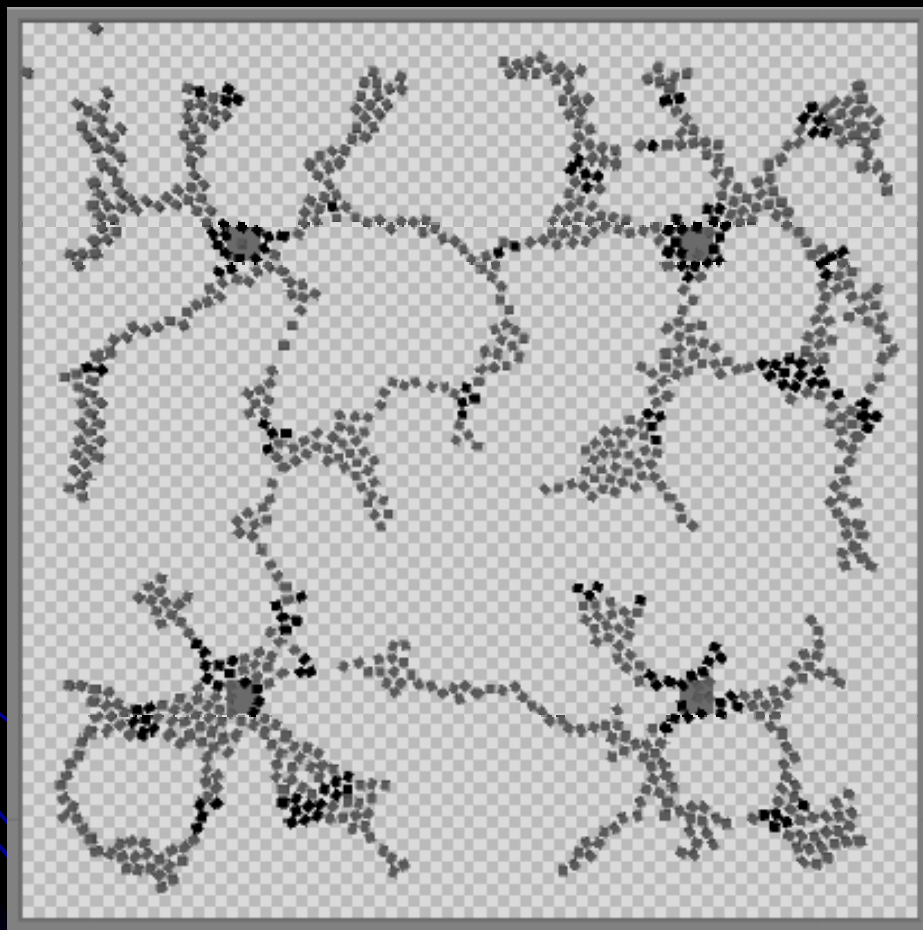


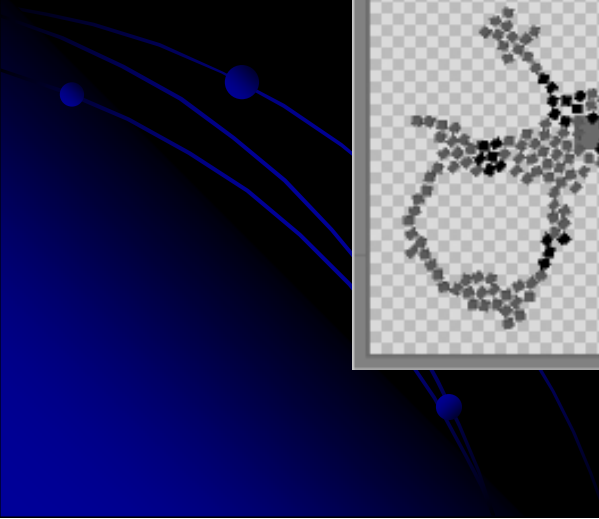
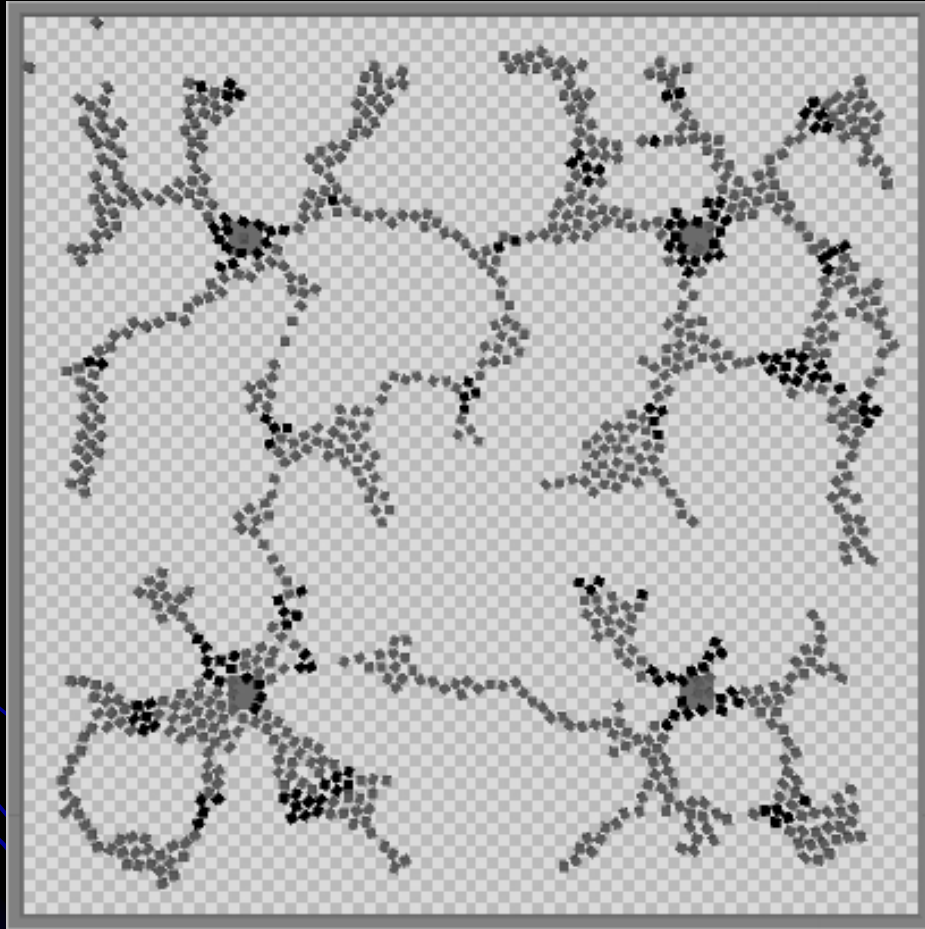












Conclusuion

- We sucessfully implemented the
 - „**Slime-mold**„-inspired startegy
 - Into a „**foraging**“-scenario
 - Of a **robot swarm**.
- It works with a very **narrow** communication bandwidth
- It shows „**self-organisation**“ and „**swarm-intelligence**“

Thank you

