Measures of Context-Awareness for Self-Organizing Systems

Andrei Olaru, Cristian Gratie, Adina Magda Florea

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17.12.2009

- Introduction
- Emergence
- Context-awareness
- System description
- Pressure
- Interest
- Results
- Conclusion
- References

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overview

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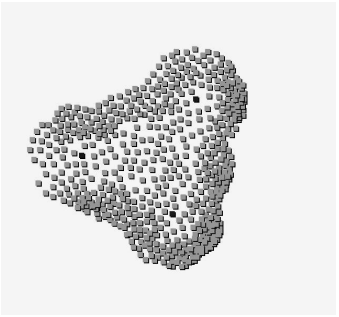
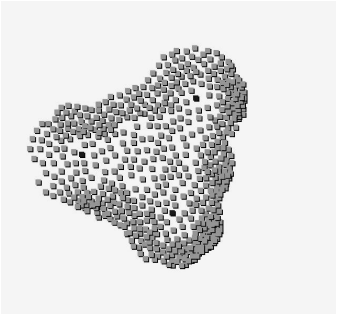
Self-organising agent systems



- Self-organising agent systems



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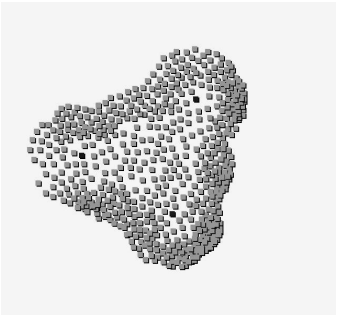
  human-machine interface – information exchange – network layer

- Self-organising agent systems



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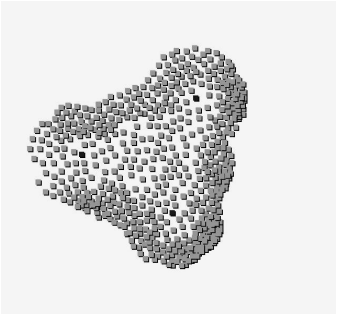

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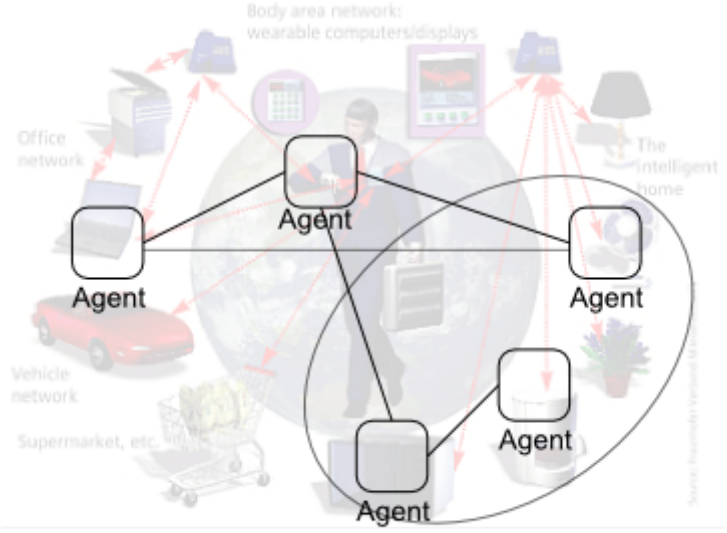

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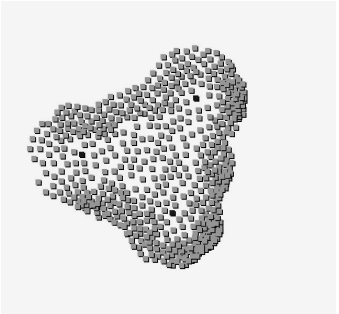

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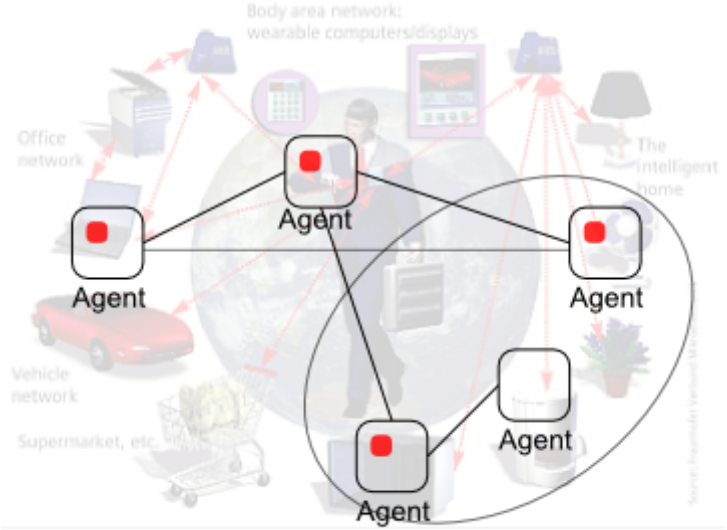

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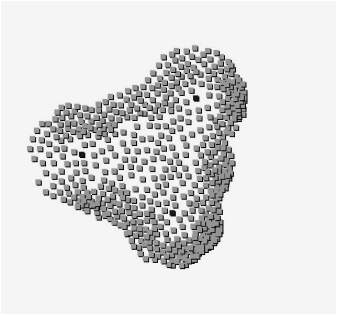

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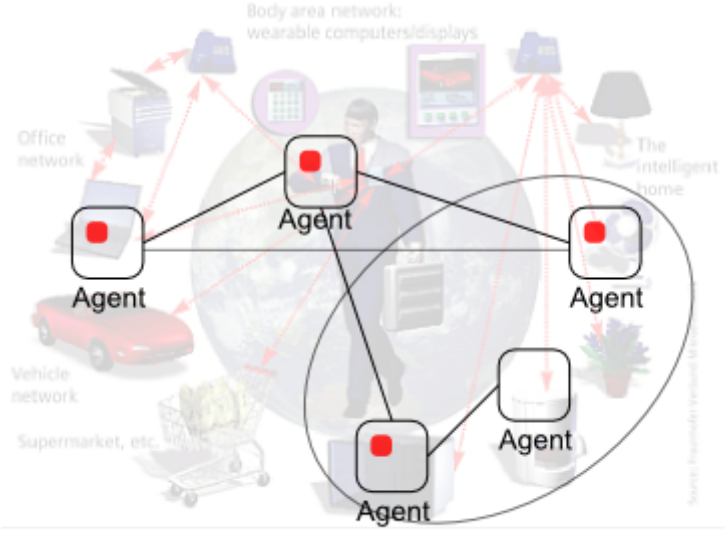

Constraints:
·limited storage
·limited performance
·large numbers
·much information

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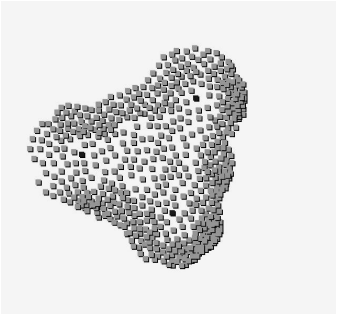

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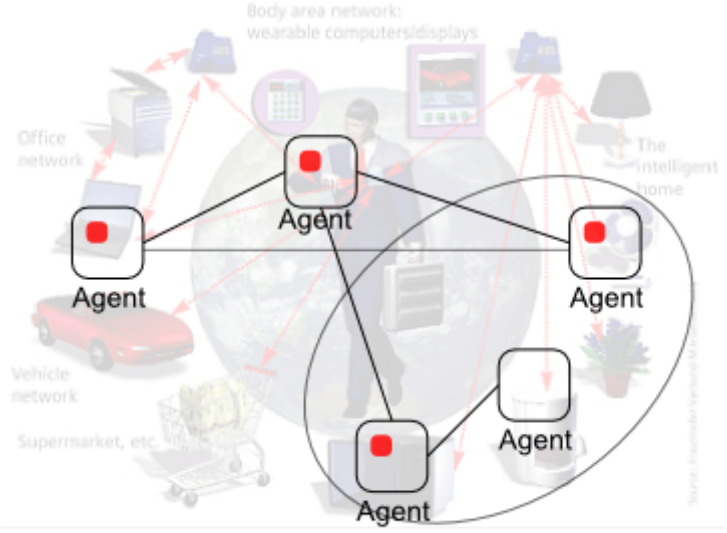

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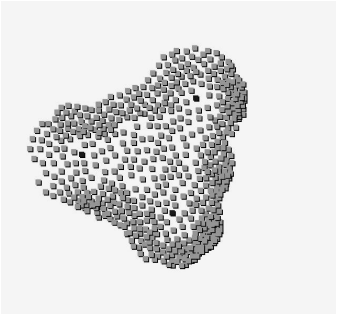

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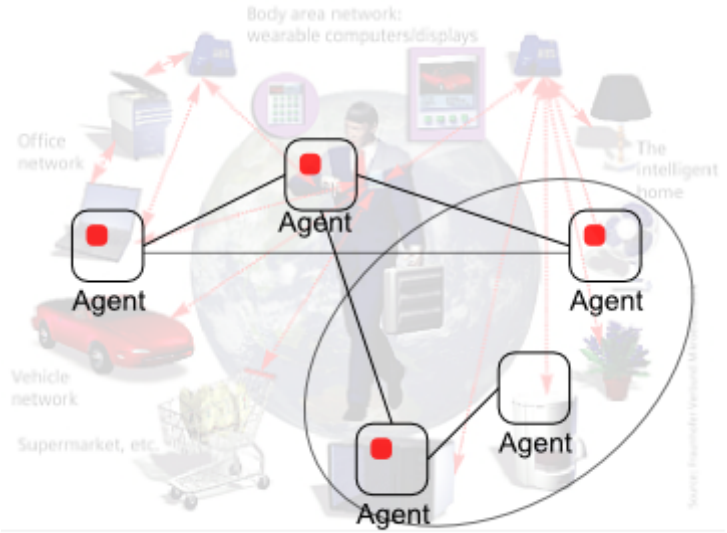

Constraints:
·limited storage
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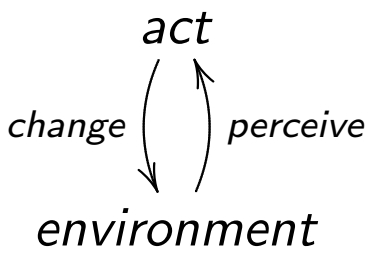
- Create a multi-agent system that exchanges information

·coherent emergents at the macro-level that dynamically arise from the interactions between the parts at the micro-level. Such emergents are novel with respect to the individual parts of the system. [De Wolf and Holvoet, 2005]

·reactive agents:



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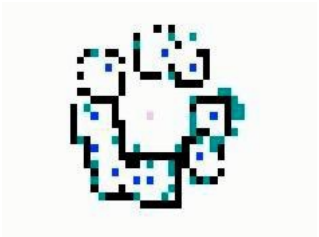

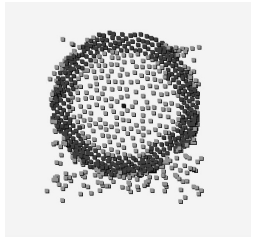

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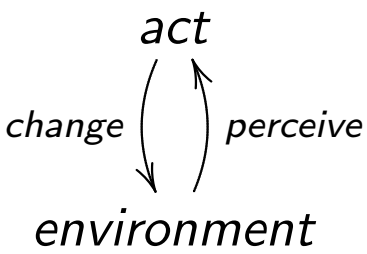
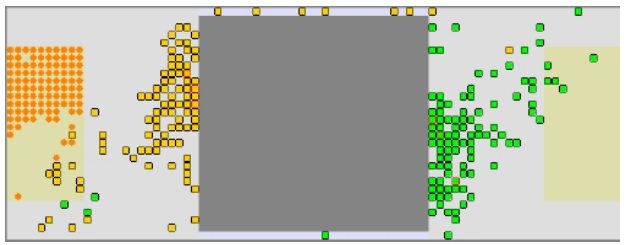


[Beurier et al., 2002] [Zambonelli et al., 2004]



[Picard and Toulouse, 2005]

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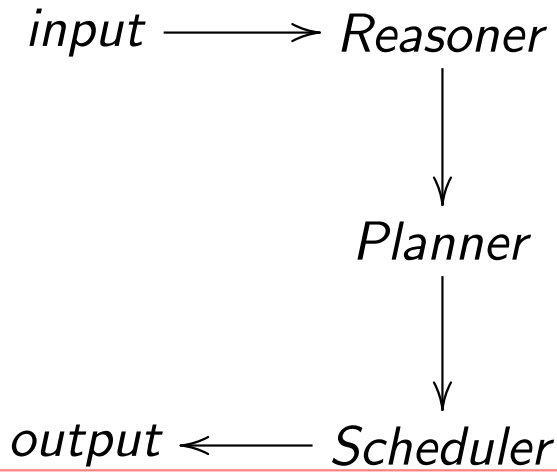

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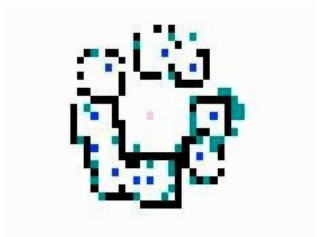

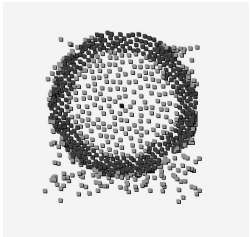

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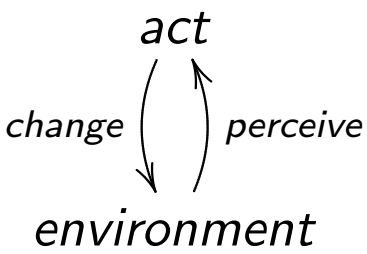

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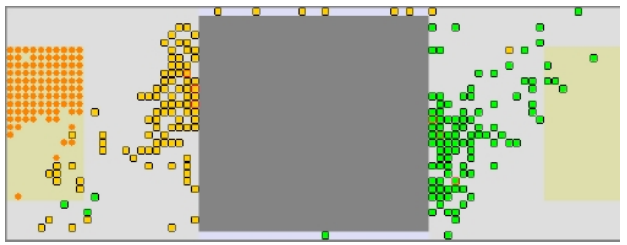

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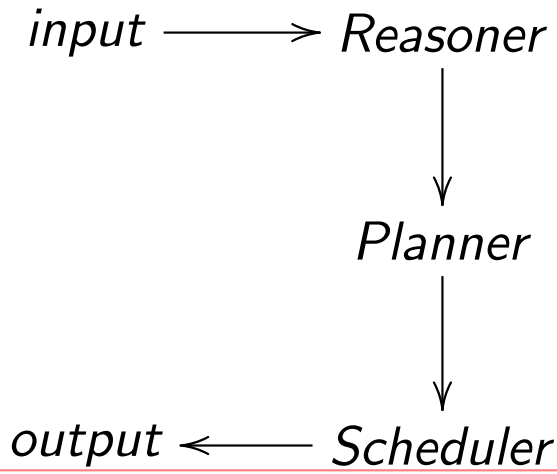

knows:

- what it wants to do
- what it is able to do
- how it can do it

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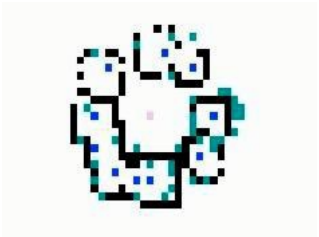

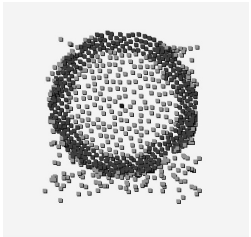

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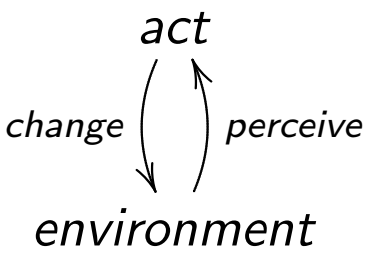

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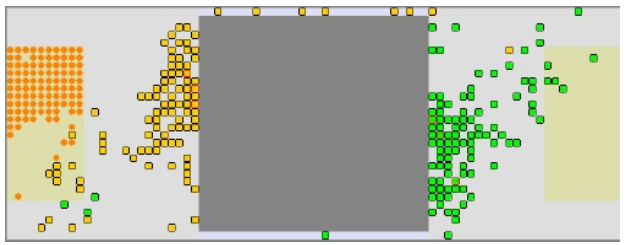

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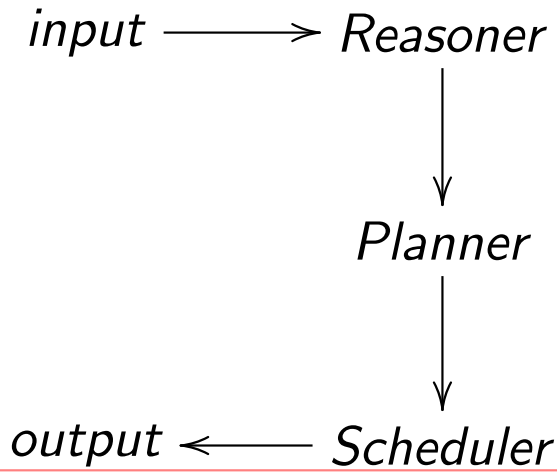

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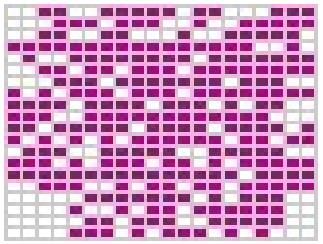

- obtain global goal
- by local selfish goals

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·allows for adequate action, according to the conditions

·context should influence not only the choice of actions, but the internal metabolism of agents

·for a self-organising AmI system for information exchange, context measures should be simple, and generic enough.

·two measures of context-awareness for pieces of information were developed:

·allows for adequate action, according to the conditions

·context should influence not only the choice of actions, but the internal metabolism of agents

·for a self-organising AmI system for information exchange, context measures should be simple, and generic enough.

·two measures of context-awareness for pieces of information were developed:

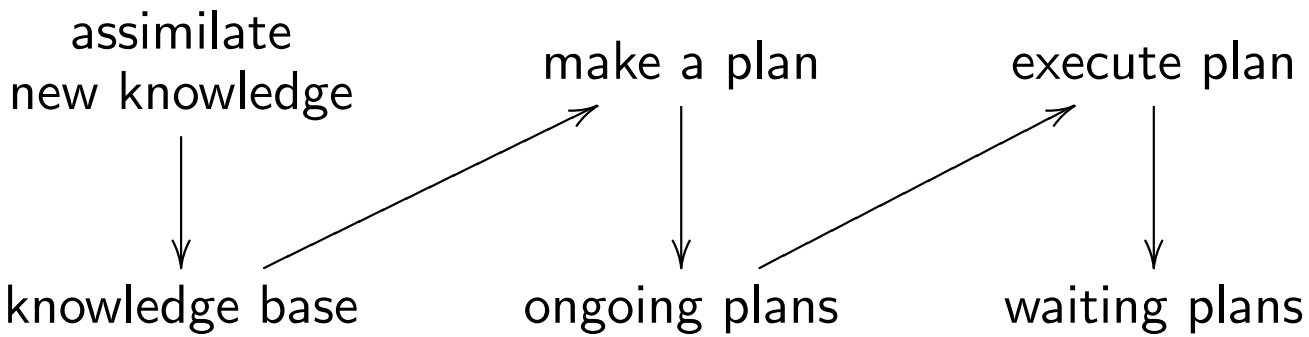
source-centred	destination-centred
pressure	interest

- Cognitive agents placed in a rectangular grid.
- Agents communicate directly only with their 8 neighbours.
- Agents have a limited storage of information.
- All information (knowledge) held by the agent is held in Facts

$$
\begin{aligned}
Fact \quad ::= \quad & \langle Agent, Data, pressure, interest \rangle && (1)\\
| \quad & \langle Agent, Goal, pressure, interest \rangle && (2)\\
| \quad & \langle Agent, Fact, pressure, interest \rangle && (3)
\end{aligned}
$$

agent behaviour

$$Reasoner \longrightarrow Planner \longrightarrow Scheduler$$



The measure of pressure, considered in the interval [0, 1] represents the urgency of a piece of information (a Fact), i.e.

·how important it is that other agents get know this fact and

·how quick the fact should be spreading

·pressure is set by the source of the fact

·pressure diminishes in time

Agent-pressure:

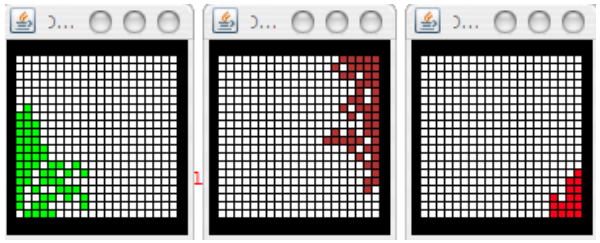
·mean of the pressures of the facts in the knowledge base

·influences the "metabolism" of agents, i.e. the balance between the time dedicated to belief revision and the time dedicated to planning and action

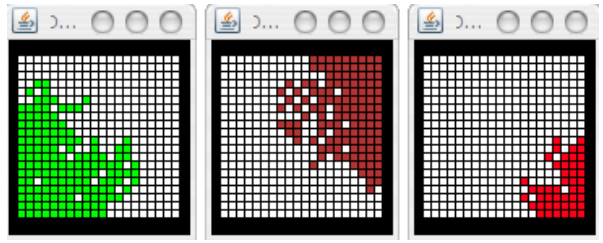
The measure of interest is used with three different meanings:

- data-interest – tells how related one piece of data is to different domains of interest. It is an n-dimensional vector, with n the number of domains, and is set by the source of the data.
- agent-interest – indicates the domains that the agent is interested in. It is an n-dimensional vector, each component showing how interested an agent is in the corresponding domain. It is calculated as a mean of the data held by the agent.
- fact-interest – assigned by each agent to a fact in its database, it show how interesting the fact is for the agent. It is calculated based on the agent-interest and on the data-interest of the data is related to.

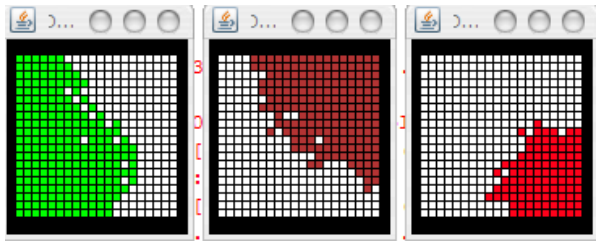
·scenario – part 1: insertion of 3 new pieces of data in 3 different corners of the grid.



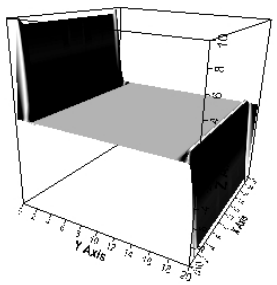
step 5



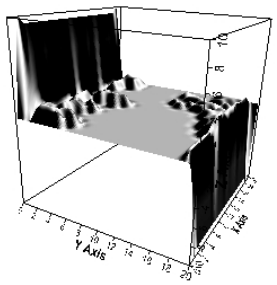
step 10



step 20



step 0



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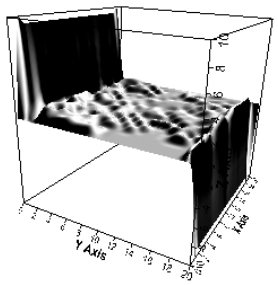

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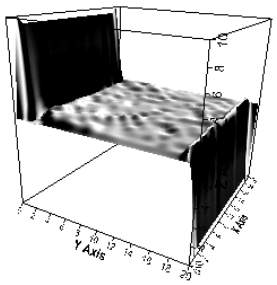
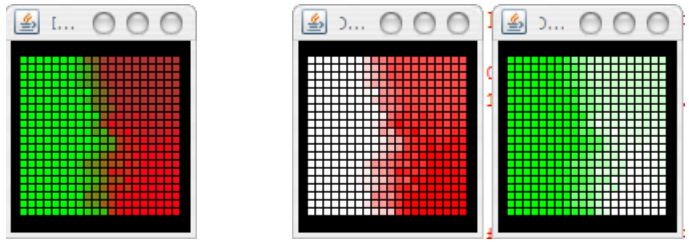


step 20

- higher pressure makes facts spread more, and faster
- "busy" agents are more reluctant to new facts

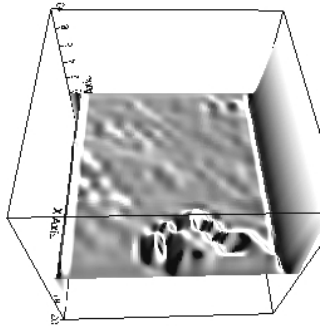
·scenario – part 2: after the stabilisation of the system, insert two more new facts, in the same initial area

·current interest (step 39):

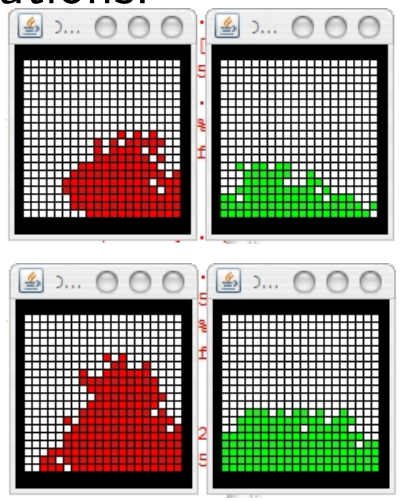


combined individual domains

·evolution of fact distributions:



pressure at step 35



step 47

step 54

- facts spread according to the indication of interest
- high pressure makes facts spread more

- decentralisation – an essential element for the viable implementation of Ambient Intelligence
- information must be exchanged in a self-organising manner, considering notions of context awareness
- two measures of context-awareness have been developed, that influence the direction and speed of the spread of information
- the implementation showed promising experimental results

Beurier, G., Simonin, O., and Ferber, J. (2002).

Model and simulation of multi-level emergence.
Proceedings of IEEE ISSPIT, pages 231–236.

De Wolf, T. and Holvoet, T. (2005).

Emergence versus self-organisation: Different concepts but promising when combined.
Engineering Self Organising Systems: Methodologies and Applications, 3464:1–15.

Picard, G. and Toulouse, F. (2005).

Cooperative agent model instantiation to collective robotics.
In *Engineering Societies in the Agents World V: 5th International Workshop, ESAW 2004, Toulouse, France, October 20-22, 2004: Revised Selected and Invited Papers*. Springer.

Zambonelli, F., Gleizes, M., Mamei, M., and Tolksdorf, R. (2004).

Spray computers: Frontiers of self-organization for pervasive computing.
Proceedings of the 13th IEEE Int'l Workshops on Enabling Technologies, WETICE, pages 403–408.

Thank you!

Any Questions?