

Self-organizing MAS

Sistemi Intelligenti Distribuiti LS

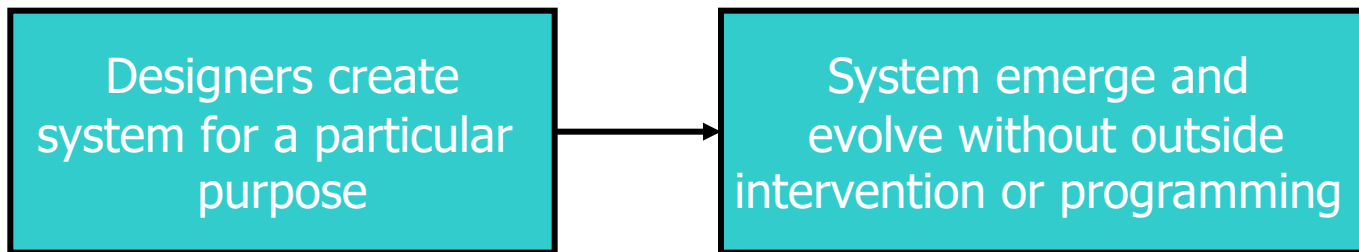
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Explain of Self-organizing System

Self-organizing system is a process in which the internal organization (as structure with function) of a system increases in complexity without begin guided or managed by an outside source.

Self-organization then means that a functional structure appears and maintains spontaneously.



Features of Self-organizing system

- **Control this must distributed** over all participating components. If it was centralized in a subsystem or module, then this module could in principle be removed and the system would lose its organization;
- They are **intrinsically robust**: they can withstand a variety of errors, perturbations, or even partial destruction;
- They will **repair or correct** most damage **themselves**, getting back to their initial state;
- They will **adapt their organization** to any changes in the environment.

Mechanisms of self-organization

Changes initially are local: components only interact with their immediate "neighbors" (they are virtually independent of components farther away).

But self-organization is often defined as **global order** emerging from **local interactions**. Two interacting components pass through a variety of configurations until they find one that is mutually "satisfactory".

We might say that they have adapted to each other, and now **fit** together. To achieve global order, this fit must **propagate** to the other components.

For example, two people who discovered a common interest may start talking about this to others, and end up founding a club, political movement, or company.

Propriety of **Fit**

- **Self-reinforcing:** additional components join ever more quickly, this positive feedback produces an explosive growth or reproduction of the assembly. When the assembly has now stabilized then feedback becomes mostly negative (this means that it will counteract any loss of organization);
- **Self-maintenance:** has become its implicit purpose, and each component will perform its function toward this goal;
- **Self-organized:** assemblies formed from individual components start acting like higher level components, these can in turn self-organize into even higher level components.

Towards Self-organizing MAS

Is possible define self-organizing MAS with the following set of definitions:

- A system can be defined as a group of **interacting agents** that is functioning as a whole and distinguishable from its surroundings by its behavior;
- An **organization** is an arrangement of selected parts so as to promote a specific function (task/goal);
- Self-organization is the evolution of a system into an organized form **in the absence of an external supervisor.**

Research in self-organizing multi-agents systems can make it possible to:

- Design and build systems that are **fault-tolerant**, i.e. systems that maintain their functional integrity despite partial (unit) failures;
- Simplifying system maintenance by extending them with some degree of "plug and play functionality", i.e. allow self-installing and **self-configuring** components;
- Enable **high level control** of systems, i.e. instead of controlling the behavior of each individual system part we will rather control the system at subsystem or system level;
- Extend the system functional scope by enabling some degree of **adaptation**, i.e. have a system autonomously optimize it's functionality given its beliefs of the current (or even expected) situation;
- Enable large collections of independent hardware/software components to coordinate their behaviors and strive for an implicit defined collective goal.

Agent organization aspect (1)

- **Common Goal:** agents in a multi-agent system can collaborate or operate solo (collaboration can take the form of work-sharing: lifting heavy loads, exploring large areas; or task division: some agents facilitate the specialists in the team);
- **Agents diversity:** absolute knowledge about the behavior of its teammates is not possible as long as the communication lines are not perfect, because two 'similar' agents on a different location will not have the same situation awareness;
- **Team Formation:** the number of team members can decrease or increase therefore important are the capabilities of the team members that leave or join into the organization.

Agent organization aspect (2)

- **Coordination:** all members of an organization are operating towards a common goal, it is possible that the world model of each agent is too limited; in that case it can happen that opportunities are missed which a central coordination unit could have found (i.e. of central coordination unit is a Tuple Center) ;
- **Communication:** different agents must use the same concepts or categories. To achieve effective coordination, agents must reach a shared understanding of a concept, so that they agree about which situations and actions belong to that category, and which do not. A group of agents negotiating such a consensus may self-organize, so that a globally shared categorization emerges out of local interactions between agents.

Achieving Self-organization

We can divide the problem of self-organizing integration into three sub-problems:

- Devices should **learn to communicate** with each other, even when they have no a priori shared understanding of what a particular message or function means;
- Devices should **learn** which other devices they can trust to **cooperate**, avoiding the others;
- Devices should develop an efficient division of labour and workflow, so that each performs that part of the overall task that it is most competent at, at the right moment, while delegating the remaining functions to the others.

Learning to Communicate

To **communicate** effectively, different agents must use the same concepts or **categories**. To achieve effective coordination, agents must **reach a shared understanding of a concept**, so that they agree about which situations and actions belong to that category, and which do not. A group of agents negotiating such a consensus may self-organize, so that a globally shared categorization emerges out of local interactions between.

Therefore they interpret the same expressions, symbols, or “words” in the same way.

Learning to Cooperate

The main idea is that agents are identified by “**tags**”, and that they cooperate with those agents whose tags are similar to their own. The rationale is that agents with the same type of tag belong to the same group, “family” or “culture”, following the same rules, so that they can be trusted to reciprocate.

For **artifacts**, a tag may include such markers as brand, model, and protocols understood. This would show that a device is capable and willing to lend particular services to another one, thus obviating the need for a repeated, “tit-for-tat-like” interaction probing the willingness to reciprocate.

The **tags** and their association thus develop the function of a **mediator** that increases the probability of positive interactions by creating a division between “friends” (in-group) and “strangers” or “foes” (out-group).

Learning to Coordinate

Each agent can either **execute a task itself**, or **delegate** it to another agent.

We will assume that the agent who delegated a task will increase its trust in the competence of the agent that performed that task, and thus increase its probability to delegate a similar task to the same agent in the future. Otherwise, it will reduce its trust.

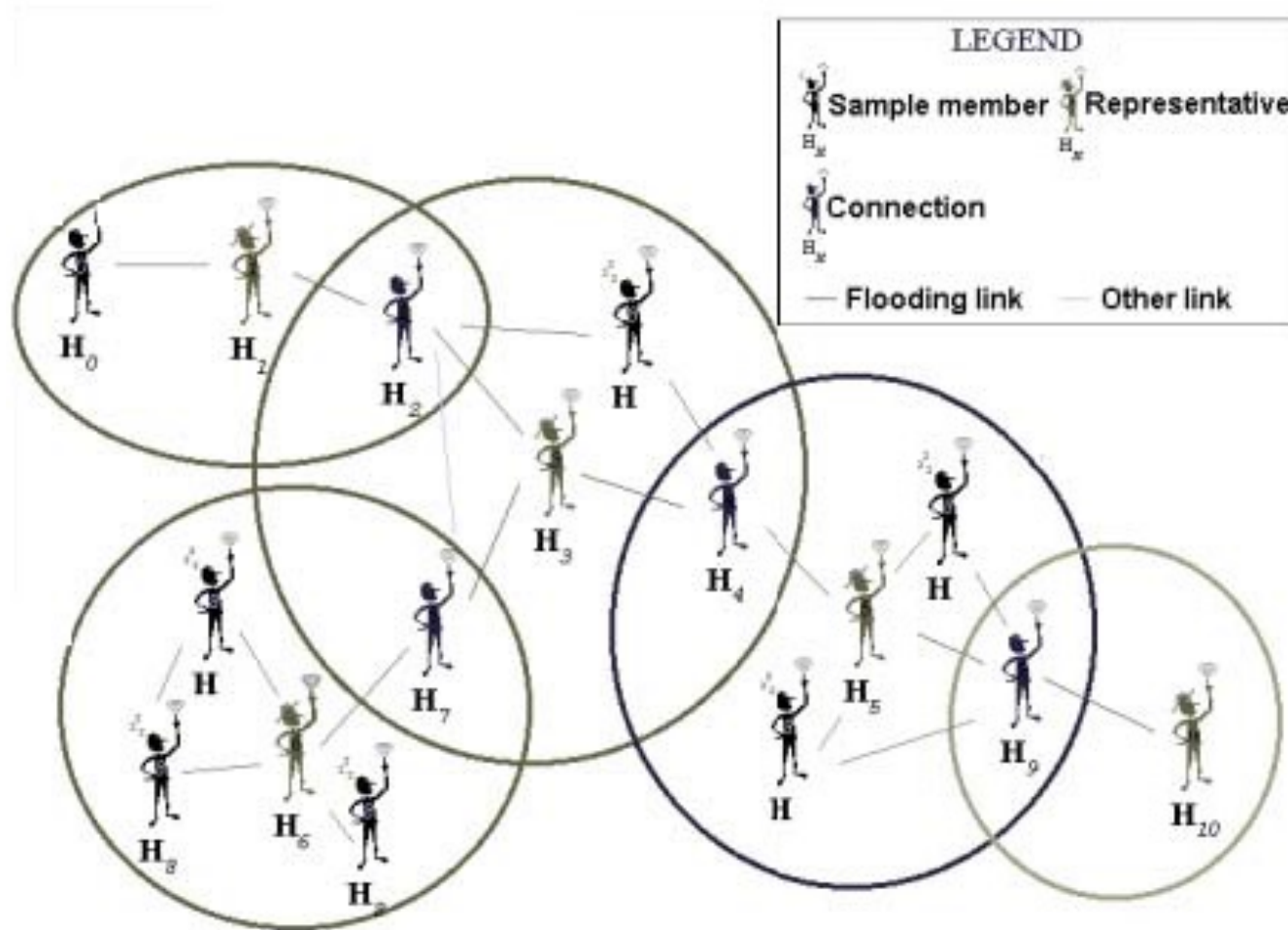
When new **devices are added** to the system, system and device should mutually adapt, producing a new organization. While no single agent knows how to tackle the entire problem, the **knowledge has been “distributed”** across the system. The **“tags” that identify agents**, and the learned associations between a tag and the competence for a particular task, play the role of a mediator, delegating tasks to the right agents and coordinating their interactions so that the problem is tackled as efficiently as possible.

Practical example of S-o.s.

This intelligence in **communication networks** usually comes from distributed artificial intelligence (DAI). We can use intelligent components in configuration management, security management, fault management, performance management and accounting management. The distributed and open nature of **sensor networks** means that the multi-agent system approach is an adapted answer. Another advantage of this approach is the **external representation of the interactions and of the organization**. External representations offer multiple possibilities such as the monitoring by an external observer.

Follow is possible to see an example of infrastructure Multi Agent self-organized.

A Multi-agent Infrastructure for Self-organized



Multi-agent Approach for Communication in WSN (1)

- **The Environment Axis.:** The environment will be made of information measurable by every agent. Agents are situated but don't know their position. This environment is deterministic, non episodic, dynamic and continuous.
- **The Organization Axis.:** The main property of this organization is that it will be dynamic. In this type of application no one can control the organization a priori. Relations between agents are going to emerge from the evolution of the agents' states and from their interactions. We are going to be content with fixing the organization parameters, i.e. agents' tasks, agents' roles.
- **The Interaction Axis.:** The agents will interact only with the agents in acquaintance (an agent is in acquaintance with another if it is aware of its existence). Agents interact by exchange of messages. We can distinguish two methods: a synchronous and an asynchronous version.

Multi-agent Approach for Communication in WSN (2)

- **The Agent Axis.:** In multi-agent system, sensors are modeled by agents. The agents have then to achieve several functions:
 - ***A measuring function*** : It is the main work of a sensor, it consists in interacting with the environment to acquire information about one of the environment parameters. –
 - A communication task*** : giving (if necessary) the information to other devices or relaying neighbor's messages. All the agents have the same communication capabilities but the communicated data depend of their roles.

The organizational Structures

The organizational basic structures (see figure-slide#15) are composed of :

- one *group representative agent* managing the communication in his group;
- some *connection agents*: they know different representative agents and they can belong to several groups;
- some *ordinary members* : active in the communication process only for their own tasks (They don't ensure information relay).

Why S-o.s. in WSN?

We may be viewed WSN as a runtime system for executing agents and migrating agents from node to node over a network. This because Agent may be viewed as **Mobile Agent**. Therefore the network at such instant time must update itself assuring that agents can coordinate, cooperate and communicate to each others.

In the end the problem is not to understand how function the entire system, but to reach an agreement how standardize the entire system.

Conclusion

Self Organized system are even more immerse in the daily life, because the life is an incessant mutation. Therefore, also, systems changes everyday, develops itself to improve the human daily life, and then what is the better system that can fit itself at the human rhythm?

The solution is Self Organizing System based on Agent.

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