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Network of Intelligent Agents

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INTRODUCTION

Any problem-solving can be modelled by actions or methods by which from resources or data, one agent makes an action to obtain a result or arrive at a task. A network of actions can be used as a model of the behaviour of the agents. Any sink in the network is a final goal or task. The other tasks are only intermediate tasks. Any source in the network is a primitive resource from which we can begin to obtain results or tasks. Cycles in the network are self-generated resources from the tasks. Now we denote "agent" as the first order that any agent can make one action or can run a method. Now we argue that there also exist agents at the second and at the more high order. Agents that copy the agents of the first order are agents of the second order. To copy one agent of the first order means to copy all the properties of one agent or part of the properties. This is similar to the offspring for animals. The network of resources, action, and tasks in the new agent, has the same properties or part of the properties of the original network. In the copy process, it is possible that the new agent has new properties that are not present in the prototype agent. This is similar to the genetic process of the cross over. The agent of the second order uses the prototype agent as a reference to create new a agent in which all the properties or part of the properties of the original agent are present. When all properties of the prototype network of agents are copied in the new network of agents, we have a symmetry between the prototype network of agents in the new network. When agents are permuted in the same network, agents can change their type of activities without losing the global properties of the network. The properties are invariant for the copy operation as permutation. We remember that also, if two networks of agents have the same properties, they are not equal. When in the copy process, only part of the properties do not change, and new properties appear; in this case we say that we have a break of symmetry. For example, in the animals in the clone process, one cellule is generated from another. The new cell has the same properties of the old cell. In this case, we have symmetry among cells. In fact, because any cell is considered as a network of internal agents (enzymes), two cells are in a symmetric position when the internal network of both the cells have the same properties. With the sexual copy process, it is possible that we lose properties or we generate new properties. In this case, the cellular population assume or lose properties. We break the symmetry in the cellular population. The adaptation process can be considered as a copy process triggered by the environment. For example, to play chess is a network of possible actions with resources and tasks. Any player is an agent of the second order that can change the network of the possible actions. The player can copy the schemes or network of actions located in the external environment in his mind. A physician that makes a model of the nature is a second order agent that makes a copy of the agent's network of actions in a physical nature into the symbolic domain of the mathematical expressions. Agents as ants can share resources from one field generated by other agents or ants. This field is a global memory that is used by the agents. For example, an ant pheromone field, generated by any ant, is used by all ants. In this way, ants are guided to obtain their task (minimum path). In this case, the pheromone field is an example of global memory resource. The network of connection among ants and its field is shown in the article.

Agents that take care to copy one network of agents in another network of agents are agents of the second order. Because we can also copy the network of agents of the second order by agents, these agents are at the third order. In this way, agents of any order can control and adapt a network of agents at a lesser order.

AGENTS AND SYMMETRY (COHERENCE)

Any agent (Ferber, 1999; Deen, 2003; Resconi & Jain, 2004) at the first order can be considered as an entity that in the domain of the resources, uses an action to obtain a wanted range of tasks. Resources can be any type of information or entities as physical resources, functions, table of data or any type of information that is necessary to make the action and obtain the wanted task. An action is a method or a set of methods or in general, any activity, by which we solve our problem and we obtain our task. In a symbolic way, we can represent any simple agent at the first by the Figure 1.

Now agents of the first order use the resources, generate actions and obtain the tasks. Agents of the first order cannot generate other resources, cannot change the actions or have new tasks. Only agents of the second order can change the resources and the tasks and implement the suitable actions. To introduce agents of the second order, we must extend the traditional paradigm of input-output structure shown in Figure 1. To build the second order of agents, we use the theory described in Penna, Eliano, and Resconi (1996), Resconi and Tzvetkova (1991), Germano and Hill (1996), Rattray, Resconi, and Hill (1997), Kazakov and Resconi (1994), Lane (1971), Mesarovich and Takahara (1989), and Resconi and Jessel (1986). In the general system logical theory, we begin with a graph (see Figure 2).

On graph 2, we locate the resources and the task represented symbolically in this way: Resources S_k , tasks T_h . The network of agents of the first order, one for any arrow is shown in Figure 3.

Figure 1. Resource, action, task of the agents or first order

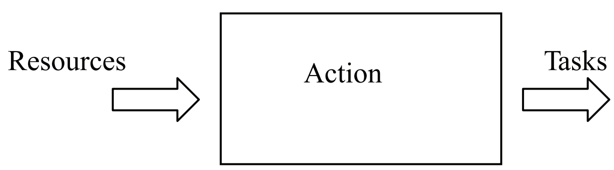


Figure 2. Graph support of the agent coordinate (coherent) actions.

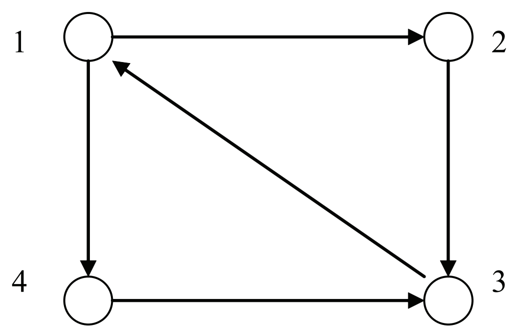
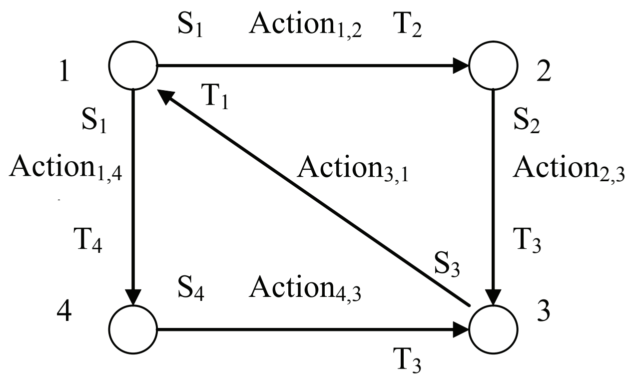


Figure 3. Resources, actions and tasks for a network of five collaborative agents of the first order, one for any arrow



In Figure 3, the agent, which action is $Action_{1,2}$, and the agent which action is $Action_{1,4,}$ share the same resources S_1. In this cas, agents are dependent by the same resource.

Again, in Figure 3, agents which actions are $Action_{2,3}$ and $Action_{4,3}$ collaborate to obtain the same task $T_{3.}$ One agent is also subordinate to another agent when it must wait the for the action of the other agent. For example, the agent which action is $Action_{2,3}$ is subordinate to the agent which action is $Action_{1,2}$. The graph in Figure 3 with the agents of the first order is an holonic system (Deen, 2003) and shows all possible connections among agents to obtain global tasks obtained by the fixed interconnection of resources and tasks. We remark that tasks for one agent can become resources to other agents. Cycles inside the network of agents are homeostatic systems that regenerate the initial resources after an interval of time. When the graph has no cycle, the network of agents at the first order stop its process when they obtain all the tasks without regeneration of the resources.

Symmetry principle:

In a point of the intelligent network, the entity is a resource and in the same time can be also a task. So we have a fundamental symmetry principle.

"The task in one node is the same entity of the resource in the same node."

The agent of the second order is responsible for the allocation of the source, task and actions. Only the agent of the second order can change the tasks and resources inside the network of agents.

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