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The SMACkers99 RoboCup Team

SMACkers99

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Abstract. *This paper describes the* SMACkers99 *RoboCup team, developped at the Institut de Recherche en Informatique de Toulouse. Our research team has defined an adaptation process for artificial systems founded on self-organization between its parts (the agents), where cooperation is the criteria for organization evaluation and transformation. The decision process is local to each agent and led by suppression of un-cooperative situations. The combination of these individual decisions leads to a efficient collective behavior.*

1 The theory of self-organization by cooperation

Our team Systèmes Multi-Agents et Coopératifs (SMAC) has developped a theory of self-organization for complex systems immerged in a dynamic environment. We have shown that for any functionnaly adequate system (that is, a system that realizes the global function it has been designed for), there is a cooperative system which realizes an equivalent function.

The main charateristic of such systems is that self-organization decisions are always taken autonomously by the agents from local interactions. If the agents are well defined, our theory guarantees the emergence of an effective global phenomenom. This result seems surprising but is in coherence with most of the studies in the field of multi-agent systems.

Th systems we are dealing with have the following properties:

- the parts of the system (the agents) are unaware of the global function to be obtained.
- each agent realizes its partial function autonomously: there is no central control nor pre-planned decisions.
- an agent has only a limited ability to perceive an act in the world.
- an agent is able to interact directly (via messages exchanges) or indirectly (via the environment) with other agents of the system.

From the local viewpoint of an agent, its behavior in the world is fully cooperative if it believes that there is at least another agent interested by the resulting state of the world and that it does not disturb the activity of any other agent. Thus the goal of each autonomous agent is to find the right place inside the organization in order to interact cooperatively with others.

This theory leads to a new design methodology because only individual agents conception is necessary to obtain an adaptative and efficient multi-agent system. Designing such a system consists only in defining for each agent the possible un-cooperative states and the actions to suppress them, without having to make a presuppose about the finality of the system.

2 The SMACkers99 RoboCup team

In order to test our theory, a number of experimentations in various fields have to be undertaken. Among them is our participation to RoboCup simulation league. The field of simulated soccer is a perfect example of our domains of interest: it's quite complex, highly dynamic, and the global function of the system is very difficult to pre-define. Playing against several teams is an excellent way to compare our design methodology to other ones. Good performance in RoboCup would somewhat prove that our theory is an efficient method for designing multi-agent systems.

2.1 Team architecture

Given the fact that all field players have the same skills, we have decided not to give pre-defined roles to our agents. If the agent design is correct, specializations (i.e. defender, midfield,) should appear by emergence. Since the goalkeeper has a special skill (catching the ball), a specific development has been made for him. Thus, the SMACkers99 team is made of 10 identical agents and a goalkeeper.

2.2 Application of the theory

A cooperative agent works as follows:

- if it perceives a cooperative situation, it acts to achieve its individual goal.
- on the contrary, if it perceives an un-cooperative situation it applies a action to suppress this situation.

The individual objective of a player is to score a goal. So the cooperative situations are the situations where the agent can shoot to the goal or dribble towards it. If it can't, the situation is un-cooperative and the agent must act to turn the world state into a cooperative situation. The available actions are:

- find the exact location of the ball,
- pass the ball to an open teammate,

- get open to receive a pass,
- move to a useful offensive position,
- intercept the ball,
- mark an opponent,
- move to a useful defensive position,
- catch the ball (goalkeeper only).

2.3 The decision process

For each of the precedings actions, a corresponding *behavior* has been designed. Here's the behavior choosing process:

1. the agent examines if its current behavior is still appropriated to the situation. If yes, the new behavior will be the current one.
2. if no, the correct behaviors for the situation are selected.
3. the agent chooses its new behavior among them, using success probabilities.

Once the new behavior has been chosen, the agent sends to the server a corresponding atomic action (—textitdash, *turn*...).

2.4 Low-level implementation

Concerning the low-level implementation, we would like to thank CMUnited-98 and ATH-98 teams designers. Since it's our first participation to RoboCup and only one person has been responsible for coding, a lot of time has been saved by adapting their work to our team.

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