Dynamical internal and external organization in MAS by swapping agent internal components

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ABSTRACT

Adaptability of the individual agents and the subsequent evolution of the agent society seems to be necessary for agents to operate with true autonomy in every time more complex and unpredictable environments. This adaptation process is original and successfully achieved by means of the new agent dynamical components, and the application of evolutionary computation principles to the previous dynamical structure of the system.

Keywords

Agent dynamical components; Energy; Multi-agent system; Evolutionary computation.

1. MULTI-AGENT SYSTEM STRUCTURE AND EVOLUTION PROCESS

Multi-agent systems (MAS) have a normal process of adaptation to the environment and to the conditions of the issue they have to deal with. It begins with a process of individual agent adaptation by means of the new *agent dynamical components (ADC)*, which are the *agent dynamical internal structure (ADIS)* for the agents, and the *agent dynamical external structure (ADES)* for the MAS. The ADIS' dynamical components are the *agent slot (AS)* and the *agent extension (AE)*. An AS is a general-purpose agent interface that is common to all sloter software agents. An AE is an independent and exchangeable agent component, that assembling in an AS implements a unique functionality. The ADES' structure is organized in *planes* and *cubes*. The agents are organized in planes, which deal with a particular issue to be solved. A cube is formed by sets of planes and it constitutes the agents' sub-world. On the other hand, the evolutionary perspective of the model introduces the concept of energy as cornerstone. Three are the energies associated with the system. The *Agent Adaptation Energy* (fit_i) is a general level of suitability (or fitness) of the agents. The *Energy from the AE* (eae_{tot}) depends on the AEs assembled by the agent. And the *AE Energy* (ke_x) is constant and associated to each AE.

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A MAS consists in a set of n agents, $\{a_i\}_{1..n}$. An agent has got m AS, $\{s_i\}_{1..m}$, where it can be inserted the same number of AE, $\{e_i\}_{1..m}$. There is a series of p problems to be managed by the MAS, and it is done by means of the AEs existing in the system. Each AE implements its own functionality fnc in order to solve a problem p_j, that is $e_{(fnc)(pj)}$. The ADIS properties allow two individuals of the agent society to have AEs with the same functionality. However it is not possible to have a sloter software agent with two AEs managing the same problem, although they implement different functionalities. That is, $\exists s_i = e_{(fnc)(pj)} \wedge \sim((\exists s_{i'} = e_{(fnc)(pj)}) \vee (\exists s_{i''} = e_{(fnc')(pj)}))$. Initially, to manage a collection of p problems there is a stochastic distribution of p AEs among the agent society, and an adjustment of the energy levels. As the system evolves, the agents incorporate new AEs to satisfy the requirements of the problems. This AE swapping implies that the energy parameters eae_{tot} and fit_i of the agents are modified with the new energy from the AEs, ke_x. Following this evolution process, next time it was necessary to solve a problem p_j, the most ideal individuals to do it will be those including the appropriate AE, $e_{(fnc)(pj)}$, and have got highest levels of energies eae_{tot} and fit_i. Those agents of the MAS that are not working on this problem constitute the ideal targets to be applied the same described process, but attending to other kind of problem p_k, on which they are a most favorable alternative to be elected, presenting appropriate AEs and the most adequate levels of internal energies. Therefore, by means of swapping internal ADC, the agent community really evolves towards some more specialized aggregations of agents that have learnt and have become specialists managing certain kind of problems.

The model has the feature of obtaining new individuals when needed in the MAS, in order to accomplish the requirements of the system. To generate these new agents it has been followed the three main phases of the EC. The evaluation of the fitness inherent to the individuals is done attending to the energy levels associated to an agent. The selection of individuals considers as candidates to be crossed those agents with appropriate agent energy levels. And finally, for the reproduction phase the selection is carried out employing a *2-member tournament* method. Therefore, the selection chooses for the new agent one or more AEs, and the energies associated to the new individual is calculated from the parent by means of an equation. Hence, there is an adaptation and evolution process emerged in the agent society, and consequently it is produced a process of agent learning in the MAS.