HOMEOSTATIC MODELS IN ARTIFICIAL INTELLIGENCE*

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A Network Paradigm took its final shape in the field of Artificial Intelligence. It awoke a special interest to network-type structures and collective behavior of agents. The most essential for this paradigm is the idea of stable states in the system "organism-environment" despite of a possible divergence among the interests of various parts of the "organism". These ideas are very close to that of homeostasis from Cybernetics. Our survey of Distributed AI and Collective Automata Behavior proves the point. In order to control the homeostatic properties it is proposed to introduce the Homeostatic-Level Knowledge in DAI supplementing recently recognized Cooperative-Level Knowledge.

Introduction. By the end of 80th the so-called Network Paradigm, involving Multi-Agent, Connections and Neural Nets, took its final shape in the field of Artificial Intelligence (AI). This new understanding of the intellectual behavior awoke a new wave of interest to network-type structures and to the ideas of collective behavior of automata.

The most essential for this paradigm is the idea of a stable state in the system "organism-environment" (or sets of such stable states) despite of a possible contradiction among the interests of various parts of the "organism" and a possible divergence between the interests of the "organism" and "environment". These ideas receiving an increasing attention in AI have many points of correspondence with homeostasis and homeostatic control [1-2].

A retrospective survey of AI and Collective Automata Behavior models based on these homeostatic ideas lead us to the proposal to introduce yet another knowledge level in DAI, namely Homeostatic-Level Knowledge, supplementing the Cooperative-Level Knowledge that was recently recognized in DAI by many researches. The Homeostatic-Level Knowledge provides for the system stability, reactivity, reliability, survivability, etc.

Distributed AI and Multi-Agent Systems. Researchers in DAI have attempted to address the problem of interacting agents. [3]

It was noted [4] that in multi-agent systems a cooperative-level knowledge should be introduced concerned with those aspects of problem solving specifically related to interacting with others (cooperation, conflicts, competition , etc.)

The understanding of the importance of separate consideration of cooperation level solutions may be seen within the context of speech communication, in conflict resolution, in persuasion/negotiation, separating out the domain independent principles from the domain dependent knowledge which they make use of. The generic component, embodying the cooperation level, can be applied to new problems merely by providing appropriate domain knowledge.

Activity in DAI and multi-agent often requires agreement by the agents as to how they will act, and the reaching of consensus is a major concern of DAI. Thus, in paper [5] the basic architecture consists of a set of communicating agents, each with their own beliefs, and able to revise their beliefs in the face of inconsistent information.

Collective Automata Behavior. The science of Automata Collective Behavior was born in 60th in the School of Professor Michail Tsetlin, Moscow University, who offered a new class of mathematical models for individual and social behavior [6]. Initially, the models presented purely distributed systems with very little mutual information exchange among its agents [7]. Performing an action the automaton receives a penalty or a reward depending on actions of all members of the collective. As the automaton does not know the law governing the reaction, it gets some understanding what is going on through a simple learning scheme that was implemented in the construction of automata.

A great deal of attention was devoted to the question of construction of a single automata and organization of interaction in a collective that provides homeostatic properties. A number of constructions of automata was proposed, including

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Tsetlin's linear automaton, Krinskii's automaton, Ponomarev's automaton, ε-automaton and others [8]. Some of the models were of strictly deterministic nature, resembling atraditional dynamic systems.

Many of the constructions and results were successfully re-discovered and re-studied in AI community especially in the area of Multi-Agent Systems and Neural Nets. For example, the concept of Asymptotic Optimality, that is similar to a fuzzy notion of "Artificial Annealing", received a strict mathematical study in the field of Collective Behavior.

Homeostatic Knowledge level. Speaking about homeostatic properties, like stability, reactivity, reliability, survivability, etc., we would like to draw special attention to the notion of Elasticity described in papers[9,10]. The Elasticity Property is studied for to the systems that always have a stable attractor despite the conflicting interests of individuals. This property concerns the behavior of the equilibrium point if one varies the "degree" of interaction among agents: the system should also exhibit a graceful degradation in performance as the interaction becomes stronger.

It was proved, that the standard way to achieve stability by introducing a corresponding feedback in the individual behavior does not guarantee the elasticity. Moreover, to achieve the elasticity one has to use rather sophisticated reflexive behavior of agents [9] .

In paper [10] it is shown how the Elasticity maybe achieved in one particular example of collective of conflicting time-continuous automata. This behavior achieved due to special type of knowledge that should be acquired by each individual from the collective. It is this type of knowledge we propose to consider as the Homeostatic Knowledge.

Other authors did not mention this type of knowledge. However, this knowledge is important one and it deserves to be considered as a separate knowledge level: the personal interests of an agent that are represented at the Cooperation Level should be inferior to the collective interest of preserving the Homeostasis.

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