**THÈSE de DOCTORAT de l'UNIVERSITÉ PARIS 6**
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*présentée par* ***Elpida Tzafestas***
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Sujet de la thèse :

# *VERS UNE SYSTÉMIQUE DES AGENTS AUTONOMES : DES CELLULES, DES MOTIVATIONS ET DES PERTURBATIONS*

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## Abstract

This work is situated at the intersection of artificial intelligence and multi-agent systems with autonomous robotics, artificial life and comparative cognitive science. The long term objective being to elaborate a causal theory of emergence and of evolution out of a set of principles applied to all organizational levels and a recursive emergence function, we seek an answer to the question "is there a set of organizational principles of autonomous agents, independently of organizational level ?". We propose therefore an abstract model of autonomous agents at any organizational level : an autonomous agent is a system coupled to its environment that shows properties of reactivity, motivation, sociality and adaptivity.

These principles are illustrated through the solution of a set of practical problems involving autonomous agents of two organizational levels : the "cellular animat-agent" level and the "cell-agent". We develop first a cellular organization for an animat-agent and we demonstrate its properties on two problems inspired by behavior-based robotics and production engineering. Cellularity is defined as the mode of network organization in which the component functionalities are heterogeneous but the connection syntax is homogeneous, and the cellular network is coupled with an independent physiology. We study those problems for a single or multiple cellular agents and we show, on the one hand the need to self-regulate the agent's organizational parameters and the need for a "shared needs" sociality, and on the other hand the transcription of a planning problem into an elaborate agent physiology.

Next, we descend to the cell level and we show how the same general principles may be used to ensure the network's plasticity and integrity in front of unpredictable failures. More precisely, we show how a network of cells being themselves motivated, social and adaptive agents, may show topological dynamicity and plasticity. Furthermore, we show the need for self-regulation of the cell's organizational parameters and the need for an immune cellular system complementary to the previous one.

Finally, we propose senescence as the motor of emergence of higher-order structures and of learning and we develop a senescence model that meets all the specifications set. To this end, we show that a senescence function founded on negative feedback of the agent's metabolism upon its program favors social and more cognitive agent models without prespecifying in detail their life span.

Throughout those studies, we demonstrate the importance of the dynamics of the agent-environment interactions and the need to regulate and integrate multiple interaction dynamics within a system. The perspectives of the approach lie mainly in the directions of extending the cellular models studied so far and of cellular or social learning.