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The Use of Biology to Describe Bio-Inspired System: Case of Multi Agent Systems

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Abstract. Biologically inspired complex systems are increasing. As the abstractions presented by biologically inspired systems, systems architects will be required to include the abstractions in their architecture in order to communicate the design to system implementers. The paper argues that in order to correctly present the architectures of bio inspired system a need of bio inspired views will be required. The paper describes a new formalism based on biology and Model Driven Architecture (MDA) in order to find a new and easy way to design and understand (reverse engineering) a complex bio inspired system. The paper also describes then a set of bio inspired views which are used when describing bio inspired system. Finally we use the set of bio inspired views to describe Multi Agent System (MAS).

1 Introduction

Multi-agent systems, artificial neural networks, artificial immune system, swarm intelligence, genetic algorithms, cellular system, artificial ontogeny, and cognitive intelligent have one thing in common. Each of them presents a biologically inspired computing paradigm[1].

The purpose of the paper is to present a new additional manner for describing bio inspired system based on MDA and biology.

The novel contribution of the paper consists of describing the multi agent system with the biological inspired view points.

2 The Proposed Approach

Our approach is inspired from both: POE model (for more details see [2] and MDA approach, the Architectural Units (AU) are the central points of the method. Our purpose is to define several Architectural Units to describe the ontogenetic, epigenetic and phylogenetic views.

We can formulate the Architectural Unit like a function as show below:
Name_of_AU(IM1,IM2,...,IMn) → OM1,OM2,...,OMk.

This form of description will be used below to describe the ontogenetic view and the epigenetic view of multi agent systems.

There are three parts involved in all bio-inspired systems: the processes, the structures and the environment where the system is designed to operate [2]. Therefore, characterizing a system comes to characterize each part.

3 Description of MAS

To describe the organization of MAS we need to use the Class Diagram from UML 2.0, and the figure 1 show the structural form of MAS, inspired by the works of Ferber [3] upon AGR.
In the organization of the restaurant there is several roles that means several agents like customers, servers, cooks and other one, this agents can form a groups in purpose to achieve a task. These agents interact among other to achieve a service; it is possible to describe what we are waiting from an agent who play roles. The server agent for example has a capacity to bring menu, take order… every one of this service can be executed by any server agents.

Below we give the bio inspired views of restaurant’s example.

### 3.1 The Ontogenetic View

The MAS, first decompose the global goal into a set of sub-goals. For this, we use the transformation Develop with global goal like input model and we obtain sub-goals of output model, and we wrote Develop(D,M) \(\rightarrow M'\) where: D,M,M' are models

For example in the restaurant the role server can be split in sub-role: take menu, take order, bring dishes, bring the invoice.

The ontogenetic process is iterative and therefore we need the iterative AU, and we wrote Iterate(C, Develop(D,M)) \(\rightarrow M'\) where: C show the condition of end of iteration (until all sub-goals were atomic).

The Ontogenetic view describes the initialisation part of MAS and how the structure of the system can change.

### 3.2 The Epigenetic View

The second part concern the execution of the system and its view like epigenetic process, two transformations are involved to describe this, Interpret and Ajjust.

An agent interprets first what he receives from role and according to his capacity he accept or deny.

The epigenetic view is wrote Ajjust(A,AU) \(\rightarrow M'\) where:

A: describe the adjustment model and the update of agent’s capacity, the adjustment can be added, deleted of a capacity.

AU: is a composed architectural unit who characterize the transformation of interpretation, and it can be written: AU= Interpret(I,M); I is the interpretation model, it specify how agents interpret the received data, in other word a set of condition that the agent must do for playing role. For example if customer claim invoice, an agent before accepts must interpret this request according to his capacity of making calculate and give back currency.

The epigenetic process is iterative and therefore we need the iterative AU, and we wrote Iterate(C, Ajjust(A,Interpret(I,M))) \(\rightarrow M'\) where: C show the condition of end of iteration.

The epigenetic view describes how environmental feedback changes the architecture.

### 3.3 Multi-Agent Systems Criteria Set

After describing the ontogenetic view and the epigenetic view, we show below some criteria set concerning the Multi-Agent Systems.

**Role**: the agent plays the role of individual and all system is considered like a population

**Description type**: the agent can have several description type, he can be genome, neural, antibody

**Element/Set**: the MAS can be conceded like a set of package and that are agent, role and environment

**Granularity**: the granularity of agent is variable because he can represent one or several behaviours

**Alterability**: the agents are alterable

**Composition**: the MAS are a juxtaposition of two transformations that are ontogenetic and epigenetic.

### 4 Conclusion

The paper highlights the need for a new formalism to describe bio inspired systems. The paper argues that the need of biological inspired point view is the best opportunity to describe bio inspired systems. The paper shows
the contribution of Model Driven Architecture to the MAS engineering. For example the models provide an advantage for agents to have a flexible (adaptable) behaviour.

References

