Artificial Life Simulation

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MOTIVATION

This poster presents overview to a research of agents and robots encompassing designs inspired by principles of biological systems. The interaction with the environment and another biological systems sets up agents' free parameters and creates resulting behaviour. Resulting systems are able to act in a very complex and dynamic environment and can incorporate various levels of intelligence. Used deliberative, reactive and homeostatic pattern is the base for a biosystem and we have tested it in several applications, from physical mobile robots, through artificial life simulations. A major goal of Artificial Life research is to gain insight into both *„life as it is"* and *„life as it might have been"*. Inner agents' behaviour is hard to understand. We have developed a couple of visualisation approaches that allow the transparent analysis of agents' social behavior together with the Computer Graphics Group at CTU. This proves merits of the presented CZAR architecture.

FEATURES OF THE CZAR ARCHITECTURE

CZAR (Czech Animal-Like Robot) is a hybrid autonomous agent architecture which combines knowledge-based and behaviour-based approaches. Basic building blocks include perception, actuation, internal state model, cognition, action selection and a special importance is put onto attention selection. Particular focus is also placed on learning and adaptivity. A simplified ecosystem was created to test features of CZAR architecture. The idea of decentralization can be understood as a variant of *bottom-up* approach. The behavioral approach consists of *expanding* the simple capabilities of well-understood agents instead of the *top-down* effort of the classical artificial intelligence to *reduce* complicated and only poorly understood agents (intelligent animal beings e.g.) to a form manageable by computer architecture at hand.

MAIN COMPONENTS

Functional features : *Emergent, Autonomous, Adaptive* - apply to all levels of complexity (from genes and cells to societies)*, Social* - applies to group species*, and Deliberative* - applies to sub-human animals or the man itself only.
Structural features: *Hybrid, Extensible, both bottom-up and top-down* - Apply to all levels of complexity.
Specialized behavioral components: *Perception, Actuation, Self-preservation* – homeostasis, *Automatic behavior* - reflexes and instincts, *willed behavior* - cognitive functions, *Focus of attention* – selective reduction of an information overload.
Learning and adaptation: influence successfulness of a particular individual: *Species adaptation* – intergeneration improvement (genetically), *Individual adaptation* – learning from experience (typically unsupervised) and physical changes, *Social adaptation* – changes related to integration into a community.

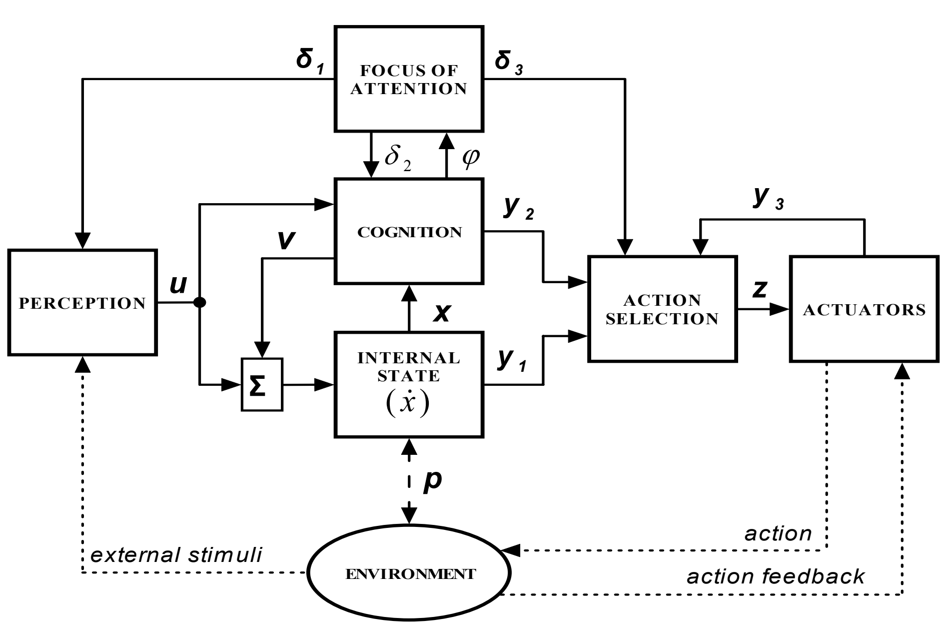

Figure 1: General structure architecture

INTERNAL STATE: Each biological system embodies its own internal model (vegetative system) that has to preserve in stabile state.
COGNITION: Cover more "specific and intelligent" behaviours and facilitates such as memory, sequence planning, reasoning, imagination and other types of willed or deliberative behaviour.
ACTION SELECTION: The problem of action selection mechanism (ASM) is that of choosing at each moment in time the most appropriate action out of a repertoire of possible actions. ASM represents automatic behaviour – represents reflexes and instincts found in biological systems.
FOCUS OF ATTENTION: In dynamic and complex environments, there is an information overload such that the amount of information to be processed is greater than the computational capability of the agent. By focusing its attention, the perceptual and cognitive load is dramatically decreased.

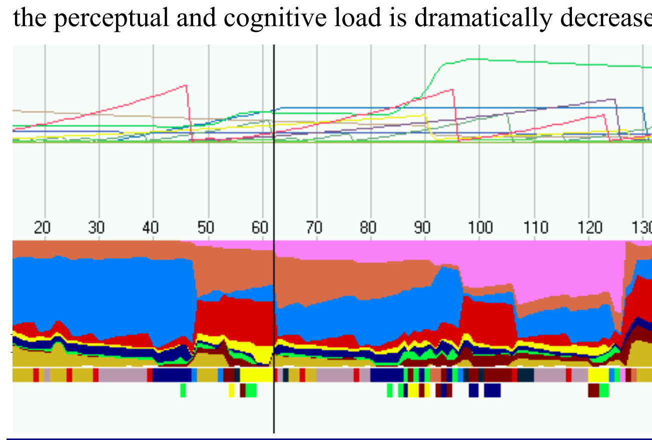

Figure 2: Window from our visualization application. Upper part shows progress of agent's internal parameters in time. Lower part shows how the color map method is used for visualization of the agent's ASM.

EXPERIMENTS

The Experiment "Survival and Adaptation" - agents behave "cleverly" in order to survive in different environments, satisfy needs and adapt in several ways
The Experiment "Population Dynamics of the Predator-Prey System" - tests population dynamics in systems with high number of agents
The Experiment „Postman" - social hierarchies and cooperative solving of more complex tasks in a multi-agent system

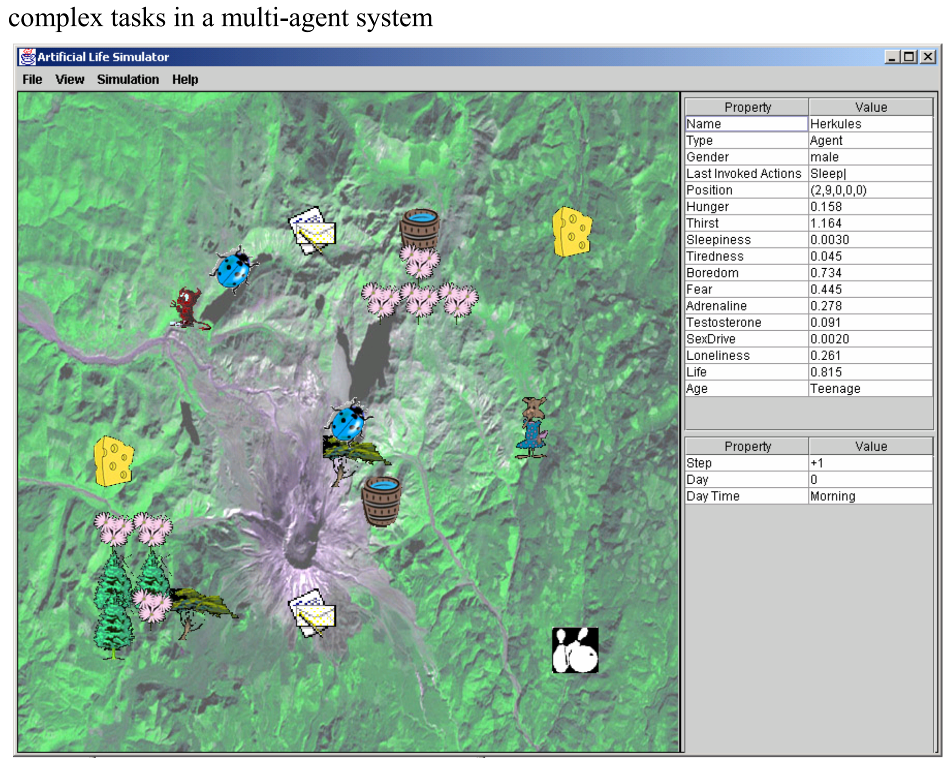

Figure 3: Example of simulation

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