Artificial Life as a Virtual Lab for Cognitive Science Experiments

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Artificial Life

This tutorial presents some concepts and principles of Artificial Life, and then focuses on how to develop applications that can assist researchers, considering mainly their work on cognitive sciences. These include virtual experiments of social behavior, live beings evolution, adaptive live systems, learning, decision taking, and communication abilities.

Artificial Life (Adami, 1998) is a research area related to cognitive sciences (Thagart, 1998) on many aspects. Both study live beings, propose models to simulate some of their characteristics and to evaluate their behavior. Even though different in other aspects, their strong relationship allows a linkage between both, as for instance in the conduction of virtual experiments. Some artificial life models and correspondent simulation platforms can be used to analyze different topics related to live and cognitive beings.

The tutorial presents a short historical overview of this area, with the eminent scientists that started the discussion of "What is Life", life fundamental concepts, and consequently the possibility to simulate it on computers. Following this presentation we discuss life under different approaches (metabolic, genetic, entropic), levels of detail (from micro to macro-organisms, considering them in accordance with the objectives of the experiment to be conducted), substrates (including the virtual ones), and organization (as organs and their purposes). Based on these concepts we propose a model for artificial live beings structured in accordance with their phylogeny (species evolution), ontogeny (self evolution – learning), and epistemology (knowledge and reasoning). Then we present mathematical methods and models that can be used to implement appropriate simulation platforms, able to handle some of those aspects of interest in an artificial life experiments (computational simulations). And finally we discuss some case studies (Netto, 2005) illustrating how to make effective usage of these tools to study interesting natural mechanisms and phenomena in live beings, considered as individuals and as social groups.

Some Projects

Some project under conduction or already concluded of the Cognitive Sciences Research Group from USP are shortly described as examples.

Evolution of Adaptive Sensing and Neuro-evolutive Systems, focusing on the morphological aspects of sensors, that makes them better suited for certain purposes. For instance, a vision-creature co-evolution and how it does lead to better living conditions. In a more general sense, this work studies artificial neuronal networks and how they can evolve to adjust themselves to certain implicitly expressed purposes, as providing better survival chances.

Adaptive Cognitive Virtual Characters, considering how virtual students can follow real ones and reproduce their way of thinking, providing us with a better understanding of some cognitive actions, as reasoning on problem solving.

Narrative and Propositional Languages, evaluating the importance of narrative to communicate ideas and thoughts, where artificial languages are extended to support not just propositional models, but to include narrative assistance.

Behavior on Artificial Life Societies, focusing on decision taking based on persuasion, using Bayesian rules to predict actions that should be taken by people in small communities. Characters should be able to recognize the role performed by the other society beings, and then to use this knowledge to take the most suitable actions in different situations. Cultural heritage can be also evaluated considering characters migration among independent groups. Herewith it allows the study of the social evolution.

ALGA, an environment inhabited by artificial beings that acquire their basic knowledge through communication with their peers. The purpose here is to evaluate the learning abilities, using language as a support for communication and reasoning. Markov chains are used for reflexive analysis of their decisions and consequences of their actions.

WOXBOT, a virtual experiment to evaluate the evolution of virtual beings through generations, considering just their survival abilities. Neural networks are used to sense the environment, and to provide information about what is seen to a cognitive engine that takes decisions. This engine is a state machine, genetically coded, that may evolve through generations. The evolution is conducted by genetic algorithms. Although conceptually simple, this framework provides good results, showing the possibility to achieve desired goals without any explicitly programmed code.

References

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