Simulation and visualization of anticipatory ALife agents

Karel Kohout, Pavel Nahodil

Dept. of Cybernetics, FEE, Czech Technical University in Prague, Prague, Czech Republic

E-mail: kohoutk@fel.cvut.cz

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This paper presents our approach to design, simulation and visualization of selected ALife agents. This topic has been addressed in our research group for almost six years. In last two years there is a growing interest in the field of anticipatory behavior. We consider this topic as highly perspective and hence it has been the focus of our attention it in past two years. There is an existing simulation environment called WAL (World of Artificial Life). It was designed for the purpose of simulation of various ALife phenomena in our research group [1], [2]. It is currently being modified to be able to aid us in the research, simulation and testing of anticipatory agent architecture. Anticipation occurs in all spheres of life. It complements the physics of reaction with the pro-active quality of the living. Nature evolves in a continuous anticipatory fashion targeted at survival. The dynamics of stem cells demonstrate this mechanism. Sometimes we humans are aware of anticipation, as when we plan. Often, we are not aware of it, as when processes embedded in our body and mind take place before we realize their finality. In tennis, for example, the return of a professional serve can be successful only through anticipatory mechanisms. A conscious reaction takes too long to process. Motivation mechanisms in learning, the arts, and all types of research are dominated by the underlying principle that a expected future state controls present action. The entire subject of prevention entails anticipatory mechanisms. We try to show and demonstrate that under anticipation we understand much more that prediction or estimation of the future states. Anticipation takes the information from prediction and/or estimation as an input and performs reasoning, learning and planning tasks based on these inputs. Because proving of functionality of designed architecture could be time and money consuming I decided to evaluate the architecture in computer simulation. Several anticipatory architectures have been proposed, implemented and tested in the modified WAL environment already by members of our research group in their diploma theses [4], [5]. They utilized the anticipatory approach from different points of view, using different techniques from artificial intelligence field. The first mentioned work [4] utilizes decision trees (TDIDT) to build a knowledge base from which one can reason and anticipate with. The proposed and designed architecture of the agent was called Lemming. It uses algorithms known from Artificial Intelligence for agent's learning and offers an alternative to genetic programming and artificial neural networks commonly used in ALife domain. This model is powerful enough to ensure agent's survival in unknown dynamically changing environment. Generalization using least general algorithm

was incorporated into architecture Lemming and practically used for agents. Architecture is based on behaviors' competition for resources. During the process of reasoning, each agent/object in the surrounding environment is assigned some attraction based on the agent's knowledge, his current needs and long-term goals. The second successful work in the field of anticipation was focused on “learning problem in artificial life domain [5]”. The Anticipatory Learning Classifier System (ACS) is presented as a promising approach that combines reinforcement learning, evolutionary computing and other heuristics to produce adaptive learning system. The core of ACS system is the fact that the behavior and decisions are based on knowledge about their effect. This means that it is crucial what effect the reaction has to the given situation. Thus each action is executed with expectation of the effect. This relationship is either reinforced of suppressed based on the difference between expected and the actual effect. The anticipation of effect of one executed action is an easy task. The anticipation of the future states of whole environment based on the executed action is the main problem. The reason is well known problem of local and global extreme. Sometime the bad step or decision can lead to the overall advantage of success. This work uses Markov decision process to deal with this problem. The current research of myself and the research group is to utilize the former works and to design a hybrid anticipatory architecture, implement it and test it in the above mentioned simulation environment. The visualization part of the simulation has two parts. One of them is the visualization of the simulation world itself and the agents living in it. This can serve for presentation purposes and for debugging because it provides an overview of the simulated “world”. The second part is the analytical tools for parameter and properties analysis in time. There were efforts in past to use techniques known to computer graphics experts and utilize these to design and implement powerful analytical tools capable of visualization and analysis of multidimensional data. There was developed a tool named VAT [2] which was successfully used for agent properties analysis. However this tool is no longer worked on and it has become obsolete. The main aim of my research nowadays is to propose anticipatory architecture of an agent as well as modify the WAL simulation environment, together with design or update of current analytical tools.

References

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