Anticipatory Behaving Creatures in the Artificial Life Domain – Preliminary Research

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Keywords: ALife, Simulated environment, Anticipation, Animate, Agent

Since the beginning of this decade there has been an increasing interest in the field of research of algorithms realizing anticipation. This topic is in focus of our group for several years already. First experiments and propositions of architectures were presented in 2004. Several advances have been made on the field of anticipation research since then. It is due to say that there are still more opened questions that answers in this topic. These are still being addressed by the top researchers. The ground for this topic has been proposed in 1985 by Robert Rosen [1]. Even though it has served as a base for further research the term of anticipation itself is understood and interpreted differently by various researchers. The whole topic of Artificial Life has been inspired by nature hence the nature should be considered for anticipation as well. During the study of various articles and books regarding this topic we noticed that the term anticipation has been treated differently. Also this was noted by researches and they begin to define types of anticipation. The two main of them were Martin Butz [2] and Daniel Dubois [3]. In the first mentioned work four basic types of anticipation are identified and described. Implicit anticipation does not perform any prediction about its future states, reward anticipation for action that is going to execute, anticipation of sensory data, one of the most interesting types of anticipation is future state prediction. The second mentioned work used different point of view. Weak anticipation systems are those, which creates the model of the object they are interacting with. Strong anticipation systems do not create the model it is part of their structure. Anticipation seems to be is suitable for key role in design and realization of anticipatory behavior. A lot of questions are still unanswered or answered just partially. Even the very basic ones such as: “Is anticipation worth the effort?”, “Will it measurably improve the current architectures and algorithms?” Obviously the answer is yes, otherwise there would not be such interest in this field. But was this proven enough in the results of simulations? It is a purpose and the goal of our work to prove it, together with identification of possible applications outside the field of Artificial Life. These applications matters because they make our life easier at the end of day.

Our research is focused on design and simulation of artificial creatures – animate with anticipatory behavior. Designed animates were greatly inspired by sciences such as ethology, biology and psychology. After several successful hybrid architectures which combined the
top-down and bottom-up approach we have realized, that anticipation would bring another
dimension into the decision process. In last years it has become a challenge to incorporate
anticipation into animate design. Several preliminary architectures were proposed. The real
problem we are facing and trying to solve now is to design, as we call it, fully anticipatory
agent architecture. This means to find optimal tradeoff between top-down and bottom-up
anticipatory approaches in order to employ the anticipatory mechanism on more than one
aspect of the architecture. In terms of four basic types of anticipation defined by Martin Butz
we want to incorporate all these four types in single anticipatory architecture of animate. We
split anticipation into two new categories – conscious and unconscious anticipation. As a first
rough approximation we can understand unconscious anticipation as implicit and sensory
anticipation in sense of Butz definitions and payoff and state anticipation as conscious
anticipation. One of the challenges we are facing here is to combine all these anticipatory
principles in single architecture in such manner to advance it capabilities. Design of specific
technical realization (algorithm) is also important. In our opinion there are several basic
instruments which each animate need in order to survive in natural sense: ability so perceive
the environment (sensors), ability to influence the environment (actuators), the internal state
(self-reflection), possibility of genetic evolution (survival of the species) and learning
capabilities (survival of individual). Anticipation can be integrated in all of them. This work
can be understood as anticipatory redesign of so far agent structures. Up today there have
been architectures focused on specific area or type of anticipation. What we want to achieve is
to integrate all this knowledge into one fully anticipation capable animate at all levels of
decision making process. Starting from the bottom-up approach in sense of Arkin, first step is
design of reactive anticipatory agent. This agent can be then further modified with sensory
anticipation. Once this architecture is tested and proper algorithms selected we can start with
further advancements building the learning functions, generalization, planning, reasoning up
to social interaction, cooperation and collaboration. This structure is quite complex so it needs
to be built up slowly and carefully with stress on experiments as confirmation of the
functionality of designed architecture and assurance of reusability. This is still the subject of
our ongoing research none the less we want to share our preliminary results and approaches.

References