An Episodic Memory Implementation for a Virtual Creature (extended abstract)

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I. Introduction

The research agenda on intelligent virtual creatures [1,2,3,4] is a very intense one, both in terms of philosophy and in computer science. In a general sense, a virtual creature is an intelligent agent [5] which is embodied in a virtual world, capturing data through its sensors and autonomously acting on its environment, in order to meet some internal purpose or goal. In the literature, there are multiple reports on many different strategies for building up artificial minds to control such virtual creatures. Among more traditional artificial intelligence techniques [4], some proposals of cognitive architectures were presented as possible implementations for such artificial minds. Cognitive architectures [6,7] are mainly inspired by human neuro-cognitive and psychological abilities, where typical human cognitive tasks as perception, learning, memory, emotions, reasoning, decision-making, behavior, language, consciousness, etc. are in some way modeled and used as a source of inspiration in order to enhance the capabilities of artificial creatures. Many of such cognitive abilities were successfully reported as very useful in making smarter creatures. Among others, abilities as emotions, learning, language evolution, action selection and either consciousness brought the performance of such virtual creatures to an amazing level. Nevertheless, there seems to be at least one of such cognitive abilities which was not so widely explored since so far. This ability is what we may refer from now on as episodic memory [8]. Earlier virtual creatures used to live only on the present, sensoring its surroundings and choosing its action based only on the current situation. Later creatures enhanced that by living not only on the present, but also with an eye on the future, being able to making plans and expectations, which clearly sophisticated its behavior. But few of them were able to refer to its past, just like we do as humans. We are able to remember what we did by this morning, some issues we lived last week, 2 months ago or even years ago. And more than this, we are able to build up a chronological time line, and order such events and locate them in this time line. We use this memory in order to learn things and to help us in performing our daily behavior. This is currently a missing gap in cognitive systems research. It will be an important improvement if our creatures were able to remember that they already were in such and such location, where they met such and such objects and creatures, and where such and such episodes were testified by them. This is the next step we are waiting for in cognitive systems research. Even though there are already some tiny initiatives [7,9,10,11,12,13] in such a path, we are still very far from this being a well known technology to be widely embedded in our intelligent agents. In this work we report on our ongoing efforts to bring up such technology by building up a cognitive architecture where episodic memory is a central capability.

II. Episodic Memory

Episodic Memory is a neurocognitive mechanism for accessing timing contextualized information that naturally makes part of the human process of decision making, which usually enhances the chances of a successful behavior. This assertion is supported by several human psychological researches which indicate that the knowledge of his/her personal history enhances one's person ability to accomplish several cognitive capabilities in the context of sensing, reasoning and learning. Therefore, within artificial systems the purpose of episodic memory is to assist the process of learning and ultimately provide a mechanism for better performance of intelligent autonomous agents in dynamic and possibly complex environments.

An Episodic Memory framework is formed from three major phases:

- Encoding: the way the episodes are captured and stored;
- Storage: how the episodes are maintained;
- Retrieval: the way the episodes are retrieved.

An episode is a record defined within a period of time and formed from information regarding the agent's task or other specific data observed in the environment. It also contains a measurement of "how successful" or relevant that information was for accomplishing a task in a past situation. In other words, the episode links particular data to a particular time and place in the environment and provides an indication of how to use that information to successfully perform a task. Therefore, along the time, it builds a repository of previous gathered experiences. Then whenever the creature faces certain situations and has to decide how to proceed next, it makes use of its repository of episodes to evaluate the best decision to make.

III. Current Development and motivation

Our project consists of a computer game where robots (virtual creatures) use episodic memory in order to enhance their performance of accomplishing the task received. The task is a "leaflet" containing a sequence of specific objects that must be collected in the environment and delivered in a specific place. The performance is basically measured in how fast the robots correctly accomplish their tasks along the game time. Figure 1 presents a screen shot of the scenario of the game.

The environment is essentially dynamic, since the robots can change the position of the objects by hiding them under the ground or simply moving them to other positions in the game space. In the current version of the game, competition among the robots is encouraged and they never help each other of form teams. Consequently, simply moving an object that does not belong to its private *leaflet*, but that may belong to others, may be an interesting move to interfere in the other robots' performance. In addition, homeostatic internal states must be observed: the robots spend energy along the time, which has to be reestablished by food consuming. However, the food may be perishable or not. Consequently, along the time, it is expected that the robots develop a strategy where perishable food is consumed preferably and within their validity period and the best place to store the non-perishable food for future consumption and precaution.

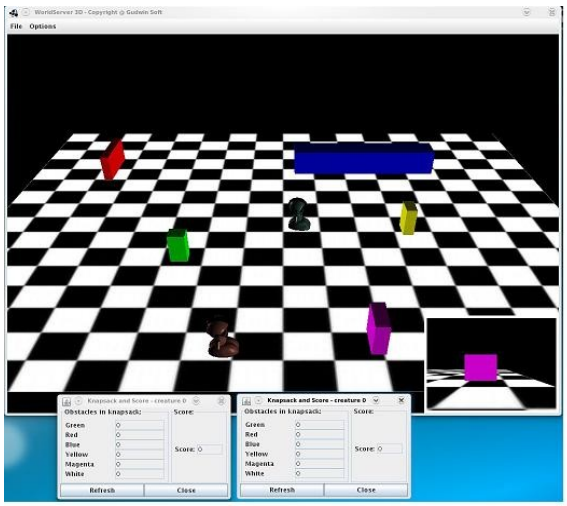

Figure 1: Screenshot of the game

By and large, our main purpose is the development of an "episodic memory" module, mainly consisted in storing and using the agents' previous actions and other specific data, while exploring the game environment. This module could be interpreted as a metaphor of a simplified "declarative memory" of each agent. The agent could access this information whenever a similar situation emerges and then decide how to proceed. Ultimately, the project aims in verifying if the use of the "episodic memories" actually enhances the agents' performance in the game.

IV. References

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