A Scene-Based Episodic Memory System for a Simulated Autonomous Creature

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ABSTRACT

In this paper the authors present the development of a scene-based episodic memory module for the cognitive architecture controlling an autonomous virtual creature, in a simulated 3D environment. The scene-based episodic memory has the role of improving the creature’s navigation system, by evoking the objects to be considered in planning, according to episodic remembrance of earlier scenes testified by the creature where these objects were present in the past. They introduce the main background on human memory systems and episodic memory study, and provide the main ideas behind the experiment.

Keywords: Autonomous Agent, Cognitive Architecture, Episodic Memory, Navigation, Virtual Creature

1. INTRODUCTION

Tasks such as navigation and planning (LaValle, 2006) have attracted the attention of many researchers in the field of autonomous mobile robots (Siegwart & Nourbakhsh, 2004; Ge & Lewis, 2006; Kolski, 2007), since a long time. Nevertheless, it seems that these issues still have a lot of open questions demanding original solutions under specific constraints. Research in the field of autonomous mobile robots is usually split into two main sub-fields. The first, called here hard robotics, deals with real robots, and is concerned mainly with real world problems, like e.g. noise interference, sensors and actuators and real world robotics tasks. The other subfield deals with simulated robots in simulated environments, and is more concerned with strategies, general algorithms, complexity issues and new techniques applied to the robotics domain. This second sub-field, called here soft robotics is more multi-disciplinary, sometimes running into other fields of research, like e.g. artificial life and cognitive science. In both the hard robotics and soft robotics sub-domains, an approach, which is usually called Cognitive Robotics (Clark & Grush, 1999; Christaller, 1999) tries to associate cognition to robot control. In some cases, this inspiration in cognition is more biological (Webb & Consi, 2006).
In other cases, this inspiration is really toward the construction of humanoid robots (Asada et al., 2001). Sometimes, the robotics issue is abstracted, and the robot is treated simply like an agent (Worgotter et al., 2009). A general field of research, Cognitive Systems (Christensen et al., 2009) was created to deal exclusively with these ideas.

An important concept related to cognitive systems research is the concept of a Cognitive Architecture (Langley & Laird, 2009; Franklin et al., 1998). A cognitive architecture is usually a control system for a robot, which comprises a set of modules responsible for the implementation of cognitive capabilities in such control system. Cognitive architectures 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 autonomous mobile robots. In many situations, robots controlled by a cognitive architecture are called artificial creatures (Balkenius, 1995). Many of such cognitive abilities were reported as very useful in making smarter creatures. Abilities such as emotions, learning, language evolution, action selection and even consciousness, among others, have brought the performance of such creatures to an amazing level.

Nevertheless, there seems to be at least one of such cognitive abilities which has not been so widely explored so far. This ability is what we may refer from now on as episodic memory (Tulving, 2002). Making a historical evaluation on how new cognitive architectures for artificial creatures started to appear in the literature (Franklin et al., 1998; Dodd, 2005; Dodd & Gutierrez, 2005; Kawamura et al., 2005; Nuxoll et al., 2007; Nuxoll & Laird, 2004; Nuxoll & Laird, 2007; Brom et al., 2007; Deutsch et al., 2008; Kuppuswami et al., 2006; Tecuci, 2005; Tecuci, 2007; Tecuci & Porter, 2006; Tecuci & Porter, 2007; Ho et al., 2005), including also some earlier work in case-based reasoning (Kolodner, 1992; Kolodner, 1993), we are still very far from having this as a well known technology to be widely used in 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.

In this paper, we will be adopting the following strategy to argument in favour of the usefulness of episodic memory in cognitive systems. We will be relying on empirical findings and empirical models in the realm of neuro-sciences as well as psychology at one hand, in order to build a theoretical model of technical systems which shall exploit some of these empirical findings, in order to consider possible implementations of these theoretical models in artificial systems. From a meta-theoretical point of view, the empirical domain...
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