Chapter 9
A Universal Architecture for Migrating Cognitive Agents: A Case Study on Automatic Animation Generation

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ABSTRACT

In this chapter, the characteristics of a cognitive architecture that can migrate among various embodiments are discussed and the feasibility of designing such architecture is investigated. The migration refers to the ability of an agent to transfer its internal state among different embodiments without altering its underlying cognitive processes. Designing such architecture will address both weak and strong aspects of AI. The authors propose a Universal Migrating Cognitive Agent (UMCA) inspired by onboard autonomous frameworks utilized in interplanetary missions in which the embodiment can be tailored by defining a set of possible actions and perceptions associated with the new body. The proposed architecture is then evaluated within a few virtual environments to analyze the consistency between its deliberative and reactive behaviors. Finally, UMCA is tailored to automatically create computer animations using a natural language interface.

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After the term artificial intelligence (AI) was coined by John McCarthy in 1955, it was divided into two main categories: weak and strong AI. The weak AI refers to a non-sentient machine intelligence that is domain-dependent and is developed for a specific task. This type of AI is extensively applied in engineering applications and high-tech products such as robotics, search engines, voice recognition, medical expert systems, etc. and has reached a fairly good degree of success (Russell & Norvig, 2009). On the other hand, the strong AI, also known as artificial general intelligence (AGI) aims to create an intelligent machine that can successfully perform cognitive tasks that a human being can do (P. Wang & Goertzel, 2007). Intelligent behavior emerges from cognitive characteristics such as recognition, decision making, perception, situation assessment, prediction, problem solving, planning, reasoning, belief maintenance, execution, interaction and communication, reflection, and learning (Langley et al. 2009).

During the last decades, AGI was dominated by the weak AI. However, there is a new trend in community that is trying to amalgamate the advantages of both types of AI. Research on embodied agents is one of the pioneers in this field.

The embodied intelligence is a prominent topic in the multi-agent systems (MAS) and refers to a coupled mind-body loop in which high-level deliberative processes within the mind that function on a symbolic representation of the world decide the behavior of the agent by controlling a collection of physical or virtual sensors and actuators within the body (Hassani & Lee, 2015). The embodied intelligence mostly follows a dualist perspective which decomposes the agent into a mind and a body. The mind as an abstract layer provides the agent with a set of cognitive functionalities. It receives the perceptions from the body, makes decisions, and then sends the decisions as a set of abstract actions to the body. The body as an embodied layer executes the received actions within the environment and provides the mind with a set of perceptions acquired from its sensors. The continuous interaction between the mind and the body forms a closed perception-cognition-action loop. Although a few architectures such as Censys (Ribeiro et al. 2013) and embodied cognition model (Vala et al. 2012) challenge this strict separation between the mind and the body, the separation enhances the development cycle in real-world applications. The embodiment may also be considered as a situational coupling between an agent and its environment in scenarios such as situated agents (MacLennan, 1996).

The embodied agents have been extensively investigated in both physical world and the virtual environments in terms of robotic systems and intelligent virtual agents (IVA), respectively, and later on have been upgraded to social robotics (Fong et al. 2003) and embodied conversational agents (ECA) (Hassani et al. 2013b) by embedding social context and human interactions. In literature, different classifications...
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