IGI PUBLISHING ITJ 5518
701 E. Chocolate Avenue, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.igi-global.com

This paper appears in the publication, International Journal of Artificial Life Research, Volume 1, Issue 1
edited by **E. Stanley Lee and Ping-Teng Chang © 2010, IGI Global**

A "Society of Mind" Cognitive Architecture Based on the Principles of Artificial Economics

Darryl N. Davis, University of Hull, UK

Vijayakumar Maragal Venkatamuni, New Horizon College of Engineering, India

ABSTRACT

This research investigates the concept of mind as a control system using the "Society of Agents" metaphor, whereby the whole is described as the collective behaviour of simple and intelligent agents. This powerful concept for mind research benefits from the use of metacognition, and eases the development of a self configurable computational model. A six tiered SMCA (Society of Mind Cognitive Architecture) control model is designed that relies on a society of agents operating using metrics associated with the principles of artificial economics in animal cognition. Qualities such as level of decision making, its cost function and utility behaviour (the microeconomic level), physiological and goal oriented behaviour are investigated. The research builds on current work, and shows the use of affect norms as metacontrol heuristics enables the computational model to adapt and learn in order to optimise its behaviour.

Keywords: *Affect, Artificial Economics, Cognitive Architectures, Learning, Metacognition, Norms, Society of Mind*

INTRODUCTION

A cognitive architecture can be viewed as an embodiment of a scientific hypothesis of (human and nonhuman, both animal and artificial) cognition. Cognitive architectures are designed to be capable of performing certain behaviours and functions based on our understanding of minds (Newell & Simon, 1972; Franklin, 1995; Davis, 2002). Cognitive science has developed in a number of directions including intelligent systems, reasoning, knowledge representation, and robotics. The evaluation of cognitive architectures has always been challenging. Several common concepts and different methodologies have been applied to developing new architectures.

There are many examples of cognitive architectures developed for different purposes through using different concepts available in different disciplines; for example, SOAR (Newell, 1990), ACT-R (Anderson, 1993), CRIBB

DOI: 10.4018/jalr.2010102104

Copyright © 2010, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

(Bartsch & Wellman, 1989; Wahl & Spada, 2000), CHREST (Gobet et al., 2001), EM-ONE (Singh, 2005), CogAff (Sloman, 2002) and CAMAL (Davis, 2002, 2008). Different cognitive architectures and paradigms can be said to be modelling different aspects of cognition, with different aims, using different metaphors, and from different contexts. To develop a better and more sophisticated cognitive architecture, researchers need to understand: (1) the sufficient description of theoretical, design and implementation levels of different architectures and; (2) the missing, common and generalised factors of relevant cognitive architectures.

The developing Society of Mind Cognitive Architecture (SMCA) (Venkatamuni, 2008) extends the Davis (2002, 2008) CAMAL cognitive architecture with extra processing layers using society of mind and metacognition concepts. Intelligent behaviour can be viewed as a combination of more simple behaviours. Imagine a simple reactive agent that can only move towards and collect a resource in an environment. Building an optimal or metacognition agent cannot be done with just a community of such simple agents, as they need to interact or take help from other agents. Hence from the perspective of Minsky (1985), developing a cognitive architecture requires the development of many different types of agents, with different behaviours and capabilities.

More importantly, such a community of agents requires agents that perform at more abstract levels. In order to provide a truly adaptable framework a "Society of Mind" needs a top layer catalyst like metacognition. Metacognition is a relatively new buzz word in cognitive theory (Adkins, 2004). Metacognition is defined as thinking about thinking and can be viewed in two ways:

- Monitoring a group of agents in an intelligent or cognitive or robotic architecture (i.e. self reflection)
- Making changes by adapting effective strategies in that group of agents (i.e. metacontrol).

Agent behaviours can be analyzed using many different metrics; for example, affect valencing, (pseudo-)metabolic activity, competition and social interaction with respect to environment and microeconomics. The application of economics to artificial life to analyse adaptive behaviors provides a coherent framework from a cognitive architecture across many levels and types of processing.

ARTIFICIAL MINDS

Minsky (1985) defines mind as the functioning of the brain. Franklin (1995) defines mind as a mechanism of the brain. Minsky says "minds are just what brains do". Franklin (1995) argues that the foundation for exploring the mechanisms of mind can be done through the possibilities offered by artificial minds. This gives rise to artificial minds defined as man made systems that exhibit behavioral characteristics of natural minds. However, artificial minds need not be limited to being analogues of natural ones. The possibilities offered by computational techniques, and synthetic designs, are equally valid in defining what constitutes an artificial mind.

Reasons for Studying Artificial Minds

Why do we need to study artificial minds? What is the need for studying nonhuman minds such as agents or robots? In "Artificial Minds", Franklin (1995) gave three important reasons for studying artificial minds.

- Questions related to the nature of intelligence in human and nonhuman natural minds are inherently fascinating. The research on artificial minds may well throw a light on these questions.
- To better understand upcoming man machine mechanisms.
- To build better robots or intelligent machines and to work with them more effectively.

Copyright © 2010, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

19 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/society-mind-cognitive-architecture-based/38933

Related Content

Automatic Tuning of PSSs and PODs Using a Parallel Differential Evolution Algorithm

Marcelo Favoretto Castoldi, Sérgio Carlos Mazucato Júnior, Danilo Sipoli Sanches, Carolina Ribeiro Rodriguesand Rodrigo Andrade Ramos (2014). *International Journal of Natural Computing Research (pp. 1-16).*

www.irma-international.org/article/automatic-tuning-of-psss-and-pods-using-a-parallel-differential-evolution-algorithm/104690

Phylogenetic Differential Evolution

Vinícius Veloso de Melo, Danilo Vasconcellos Vargasand Marcio Kassouf Crocomo (2014). *Natural Computing for Simulation and Knowledge Discovery (pp. 22-40).*

www.irma-international.org/chapter/phylogenetic-differential-evolution/80055

Corticofugal Modulation of Tactile Responses of Neurons in the Spinal Trigeminal Nucleus: A Wavelet Coherence Study

Eduardo Malmierca, Nazareth P. Castellanos, Valeri A. Makarovand Angel Nuñez (2009). *Advancing Artificial Intelligence through Biological Process Applications (pp. 1-19).*

www.irma-international.org/chapter/corticofugal-modulation-tactile-responses-neurons/4969

Modification of Happiness Expression in Face Images

Dao Nam Anhand Trinh Minh Duc (2017). *International Journal of Natural Computing Research (pp. 58-69).*

www.irma-international.org/article/modification-of-happiness-expression-in-face-images/198501

Orbit of an Image Under Iterated System II

S. L. Singh, S. N. Mishraand Sarika Jain (2011). *International Journal of Artificial Life Research (pp. 57-74).*

www.irma-international.org/article/orbit-image-under-iterated-system/62073