Cogn Comput (2009) 1:1–3
DOI 10.1007/s12559-009-9013-z

Cognitive Computation: An Introduction

Amir Hussain

Published online: 20 February 2009

A very warm welcome to the first quarterly Issue of *Cognitive Computation*—a vibrant addition to Springer's Neuroscience journals portfolio for 2009.

The launch of *Cognitive Computation* by Springer, heralds an exciting new era in a strongly interdisciplinary area. As reflected in its name, *Cognitive Computation* identifies a distinctive, timely and productive niche at this growing interface between neuroscience, cognitive psychology and artificial intelligence. *Cognitive Computation* is hence unique both in its scope and target, and its broad remit is also evidenced in the breadth of its Editorial and Advisory Boards.

Cognitive Computation specifically aims to publish cutting-edge articles describing original basic and applied work involving biologically inspired theoretical, computational, experimental and integrative accounts of all aspects of natural and artificial cognitive systems. By establishing a forum to bring together different scientific communities, *Cognitive Computation* will promote a more comprehensive and unified understanding of diverse topics, including those related to perception, action, attention, learning and memory, decision making, language processing, communication, reasoning, problem solving and consciousness aspects of cognition.

The Editorial Board is truly international and includes leading experts from Finland, Switzerland, Germany, Turkey, Japan, and the USA as well as the United Kingdom. Dr. Igor Aleksander from Imperial College, London, is the Honorary Editor-in-Chief and Dr. John Taylor from King's College, London, is Chair of the strategic Advisory Board.

A. Hussain (✉)
University of Stirling, Stirling, Scotland, UK
e-mail: ahu@cs.stir.ac.uk

Cognitive Computation is published in both electronic and quarterly print formats. All articles are initially published online via Online First™, a feature that allows authors to bring their work to the attention of their peers at a very early stage of the publication process. All authors, via the Springer Open Choice™ program, also have the option of publishing their articles using the open access publishing model.

This first Issue of *Cognitive Computation* is composed of 10 invited contributions from leading researchers in their subject areas, all of whom are also members of the journal's Editorial Board. The selection of these papers has been no less a daunting task as several equally outstanding invited contributions from other experts have had to be moved to the second Issue due to space constraints. The selected papers for this Issue are predominantly state-of-the-art reviews of some of the key journal areas with the first three contributions by Taylor, McClelland and Aleksander making up the keynote papers for this Issue.

The first keynote contribution is by Taylor, who describes a pioneering multi-modular approach to "Cognitive Computation". Taylor raises a number of very interesting points in his ongoing attempts to construct an artificial being empowered with its own cognitive powers. Initially, he lists a range of key questions relevant to the creation of such a machine and step-by-step attempts to answer these by providing convincing evidence from national and international research projects he has led over the years. Taylor's theory is one of very few attempts to construct a global brain theory of cognition and consciousness and is based on a unique multi-modular approach including vision and attention, motor action, language and emotion. Conventional studies in cognition and consciousness on the other hand, have primarily focussed on single modalities such as vision (such as the

visual awareness models of Koch and Crick) or more abstract formulations (such as those of Aleksander).

In the second keynote paper, McClelland shows how, even after more than half a century of research on machine intelligence, humans remain far better than the strongest computing machines available today at a wide range of natural cognitive tasks, such as object recognition, language comprehension, and planning and acting in contextually appropriate ways. After briefly reviewing the progress that is being made in many of these areas, he succinctly examines how and why computers still lack the fluidity, adaptability, open-endedness, creativity, purposefulness and insightfulness that are normally associated with the supreme achievements of human cognitive ability. Finally, he presents some exciting prospects for overcoming these limitations.

Aleksander, in the third keynote paper, provides a comprehensive review of computational work that is currently developing under the heading of 'Machine Consciousness' and sets out to provide a guide for those who wish to contribute to this field. Initially, he raises and discusses questions of philosophical concern relating to the appropriateness of this activity and then describes a number of interesting classical designs and computational attitudes. This is followed by a convincing argument that shows that fine-grain neural approaches are needed to provide truly phenomenal representations that stand in relation to the behaviour of a computational organism, just as subjective mental states stand in relation to the existence of a conscious organism. He concludes the paper with an evaluation of the validity and benefits of designing conscious systems.

In the next invited paper, Gurney makes an exciting and timely case for quantitative computational modelling as the only route to understanding cognition. Within this general strategy he argues that a programme of reverse engineering the brain, by building biologically constrained models using methods in computational neuroscience, holds most promise. In his ongoing attempts to address this grand challenge, the author outlines a four-level framework (computation, algorithm, mechanism and biological substrate) which provides a novel principled approach to model building. The author demonstrates the utility of the framework which can encompass working at multiple structural levels of description in the brain (from membranes to systems). Finally, the author describes a novel method involving the use of core-surround embedding for working at multiple levels simultaneously.

Haikonen first reviews why the two traditional approaches towards artificial cognition, of symbolic artificial intelligence (AI) and sub-symbolic neural networks have not been very successful. He next shows how recent hybrid approaches that combine symbolic AI and sub-symbolic neural networks have also fallen short of the ultimate goal. The author argues that traditional AI programs do not operate with meanings and consequently do not understand anything. As a potential remedy, the author introduces and critically reviews the role of associative information processing principles for cognitive computing that may enable the utilization of meaning and the combined sub-symbolic/symbolic operation of neural networks.

Seth presents an excellent review of consciousness as a key feature of mammalian cognition. He reviews how computational and theoretical approaches can facilitate a transition from correlation to explanation in consciousness science. He succinctly describes progress towards identifying 'explanatory correlates' underlying a number of fundamental properties that characterize conscious experiences. He also discusses how synthetic approaches can shed additional light on possible functions of consciousness, the role of embodiment in consciousness and the plausibility of constructing a conscious artefact.

Underwood presents a very interesting and timely review of models of attentional guidance in human image processing, with a focus on the visual saliency map hypothesis. His paper gives a 'big picture' perspective of how this work cumulates by evaluating the saliency map hypothesis of scene perception using evidence of eye movements made when images are first inspected. He concludes that visual saliency can be used by viewers, but that its use is both task-dependent and knowledge-dependent.

Gros addresses an important question in cognitive systems research, specifically of understanding the functional role of self-sustained neural activity in the brain and its interplay with the sensory data input stream. He reviews the present state of theoretical modelling and introduces an emerging approach to cognitive computation based on autonomously active neural networks. In contrast to the classical stimulus–response type neural networks, the author presents two novel neural architectures exhibiting continuous ongoing transient state dynamics in the context of a general critical discussion of the autonomous, self sustained activity of the brain.

Sun presents a generic computational cognitive architecture emphasizing the role of motivational variables. The author convincingly argues that motivational representations can help make cognitive architectural models more comprehensive and provide deeper explanations of psychological processes. His pioneering work represents a step forward in making computational cognitive architectures better reflections of the human mind and its motivational complexity and intricacy.

In the final paper of this Inaugural Issue, Ziemke and Lowe review the key role of emotion in embodied cognitive architectures. The authors succinctly argue that

contrary to the traditional view in cognitive science, cognition and emotion are in fact closely interrelated, and accordingly, their view of emotion is one of embodied cognition and emotion as grounded in multiple levels of affective and homeostatic bodily regulation. The authors conclude that while a better understanding of these mechanisms and their contributions to cognition is clearly desirable, specifically from the perspective of scientific modelling, further research is required to establish the degree to which such a multi-level view of homeostasis and emotion could be meaningfully and usefully transferred to cognitive systems engineering and robotics.

In summary, the papers in this first Issue represent an exciting mix of topics covering virtually the entire breadth of the Journal's remit. I would also like to take this opportunity to invite the readers to contribute to future Issues of *Cognitive Computation*. In particular, the Editorial Board members would welcome proposals for future Special Issues which could either be based on invited and/or open Calls for Papers, or based on follow-on papers of relevant international Conferences and Workshops. Other submission categories of interest include: regular or short papers, in-depth reviews of important new developments, Book reviews, comments/discussions on papers, opinions and controversies, letters to the Editor and announcements for upcoming related Events/Conferences and Books.

Finally, on behalf of the Editorial Board, I would like to thank all the authors, Editors and reviewers who helped ensure the quality of all articles included in this Inaugural Issue, which have also effectively set the scene for this journal and its future profile. Last and not least, I would like to personally thank Springer's Publishing Editor: Ann Avouris, without whose persistent support and enthusiasm, the launch of *Cognitive Computation* would not have become a reality.

Looking forward to an exciting and productive future for *Cognitive Computation* and for all its aspiring contributors and readers!