Chapter 10
Cognitive Informatics and Computational Intelligence:
From Information Revolution to Intelligence Revolution

Yingxu Wang
University of Calgary, Canada

Edmund T. Rolls
Oxford Centre for Computational Neuroscience, UK & University of Warwick, UK

Newton Howard
Massachusetts Institute of Technology, USA

Victor Raskin
Purdue University, USA

Witold Kinsner
University of Manitoba, Canada

Fionn Murtagh
University of Derby, UK, & Goldsmiths, University of London, UK

Virendrakumar C. Bhavsar
University of New Brunswick, Canada

Shushma Patel
London South Bank University, UK

Dilip Patel
London South Bank University, UK

Duane F. Shell
University of Nebraska-Lincoln, USA

ABSTRACT

*Cognitive Informatics (CI) is a contemporary multidisciplinary field spanning across computer science, information science, cognitive science, brain science, intelligence science, knowledge science, cognitive linguistics, and cognitive philosophy. Cognitive Computing (CC) is a novel paradigm of intelligent computing methodologies and systems based on CI that implements computational intelligence by autonomous inferences and perceptions mimicking the mechanisms of the brain. This paper reports a set of position statements presented in the plenary panel of IEEE ICCI*CC'14 on Cognitive Informatics and Cognitive Computing. The summary is contributed by invited panelists who are part of the world's renowned researchers and scholars in the transdisciplinary field of cognitive informatics and cognitive computing.*

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1. INTRODUCTION

Cognitive Informatics (CI) is a transdisciplinary enquiry of computer science, information science, cognitive science, and intelligence science that investigates into the internal information processing mechanisms and processes of the brain and natural intelligence, as well as their engineering applications in cognitive computing [Wang, 2002a, 2003, 2006, 2007b, 2007c, 2007d, 2009a, 2009b, 2012c, 2012d, 2012f, 2014, 2015; Wang et al., 2011c, 2013; Wang and Wang, 2006; Wang and Berwick, 2012b; Wang et al., 2009b, 2009c, 2010, 2011b].

Cognitive Computing (CC) is a novel paradigm of intelligent computing methodologies and systems based on CI that implements computational intelligence by autonomous inferences and perceptions mimicking the mechanisms of the brain [Wang, 2006, 2009b, 2009c, 2010a, 2012b, 2013, 2014, 2015; Wang et al, 2011d]. CC is emerged and developed based on the multidisciplinary research in CI, abstract intelligence, and denotational mathematics [Wang, 2009a, 2012c]. Recent paradigms of cognitive computers are such as *cognitive robots* [Wang, 2010b, 2013, 2014, 2015] and *cognitive learning engines* [Wang, 2015; Wang & Tian, 2013; Wang et al., 2011c; Tian et al., 2011].

The latest advances in CI and CC, as well as denotational mathematics, enable a systematic solution for the future generation of intelligent computers known as *cognitive computers* (CogCs) that think, perceive, inference, and learn [Wang, 2006, 2009b, 2010a, 2010b, 2012b, 2012h, 2013, 2014, 2015]. A CogC is an intelligent computer for knowledge processing as that of a conventional von Neumann computer for data processing. CogCs are designed to embody *machinable intelligence* such as computational inferences, causal analyses, knowledge manipulations, machine learning, and autonomous problem solving. Recent studies in cognitive computing reveal that the computing power in computational intelligence can be classified at four levels: *data, information, knowledge,* and *intelligence* from the bottom up. Traditional von Neumann computers are designed for imperative data and information processing by stored-program-controlled mechanisms. However, the increasing demand for advanced computing technologies for knowledge and intelligence processing in the high-tech industry and everyday lives require novel cognitive computers for providing autonomous computing power for various cognitive systems mimicking the natural intelligence of the brain.

This paper is a summary of the position statements of invited panellists presented in the *Plenary Panel on Cognitive Informatics: From Information Revolution to Intelligence Revolution* in IEEE ICCI*CC 2014 held in London, UK during Aug. 18-20, 2014. It is noteworthy that the individual statements and opinions included in this paper may not necessarily be shared by all panellists.

2. THE THEORETICAL FRAMEWORK OF COGNITIVE INFORMATICS AND COGNITIVE COMPUTING

The theoretical framework of intelligence science and brain science can be described as shown in Figure 1 where the brain is explained by a hierarchical reductive structure at the neurological, physiological, cognitive, and logical levels. The synergy of multidisciplinary studies at all levels forms the theory for explaining the brain supported by denotational mathematics. In other words, the brain may be inductively synthesized through the four levels from the bottom up and be deductively analyzed through the four levels from the top done. The fundamental theories underpinning the intelligence science framework are abstract intelligence and denotational mathematics.

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