

Chapter 2

On Abstract Intelligence: Toward a Unifying Theory of Natural, Artificial, Machinable, and Computational Intelligence

Yingxu Wang
University of Calgary, Canada

ABSTRACT

Abstract intelligence is a human enquiry of both natural and artificial intelligence at the reductive embodying levels of neural, cognitive, functional, and logical from the bottom up. This paper describes the taxonomy and nature of intelligence. It analyzes roles of information in the evolution of human intelligence, and the needs for logical abstraction in modeling the brain and natural intelligence. A formal model of intelligence is developed known as the Generic Abstract Intelligence Mode (GAIM), which provides a foundation to explain the mechanisms of advanced natural intelligence such as thinking, learning, and inferences. A measurement framework of intelligent capability of humans and systems is comparatively studied in the forms of intelligent quotient, intelligent equivalence, and intelligent metrics. On the basis of the GAIM model and the abstract intelligence theories, the compatibility of natural and machine intelligence is revealed in order to investigate into a wide range of paradigms of abstract intelligence such as natural, artificial, machinable intelligence, and their engineering applications.

INTRODUCTION

Intelligence is a driving force or an ability to acquire and use knowledge and skills, or to inference in problem solving. It is a profound human wonder on how conscious intelligence is generated as a highly complex cognitive state in human mind on the basis of biological and physiological structures. How natural intelligence functions

logically and physiologically? How natural and artificial intelligence are converged on the basis of brain, software, and intelligence science? It was conventionally deemed that only mankind and advanced species possess intelligence. However, the development of computers, robots, software agents, and autonomous systems indicates that intelligence may also be created or embodied by machines and man-made systems. Therefore, it is

DOI: 10.4018/978-1-4666-0261-8.ch002

one of the key objectives in cognitive informatics and intelligence science to seek a coherent theory for explaining the nature and mechanisms of both natural and artificial intelligence.

The history of investigation into the brain and natural intelligence is as long as the history of mankind, which can be traced back to the Aristotle's era and earlier. Early studies on intelligence are represented by works of Vygotsky, Spearman, and Thurstone (Bender, 1996; Matlin, 1998; Payne and Wenger, 1998; Parker and McK-inney, 1999; Wilson and Keil, 2001; Lefton et al., 2005). Lev Vygotsky's (1896 - 1934) presents a communication view that perceives intelligence as inter- and intra-personal communication in a social context. Charles E. Spearman (1863 - 1945) and Lois L. Thurstone (1887 - 1955) proposed the *factor theory* (Lefton et al., 2005), in which seven factors of intelligence are identified such as the *verbal comprehension, word fluency, number facility, spatial visualization, associative memory, perceptual speed, and reasoning*.

David Wechsler's *intelligent measurement theory* (Lefton et al., 2005) models intelligence from the aspects of *verbal, quantitative, abstract visual, and short-term working memory reasoning*. He proposed the Wechsler Adult Intelligence Scale (WAIS) in 1932. Arthur Jensen's *two-level theory* (Jensen, 1969, 1970, 1987) classifies intelligence into two levels known as the *associative* ability level and the *cognitive* ability level. The former is the ability to process external stimuli and events; while the latter is the ability to carry out reasoning and problem solving.

Howard Gardner's *multiple intelligences theory* (Gardner, 1983, 1995) identifies eight forms of intelligence, which are those of *linguistic, logical-mathematical, musical, spatial, bodily-kinesthetic, naturalist, interpersonal, and intrapersonal*. He perceives that intelligence is an ability to solve a problem or create a product within a specific cultural setting. Robert J. Sternberg's *triarchic theory* (Sternberg, 1997, 2000, 2003)

models intelligence in three dimensions known as the *analytic, practical, and creative* intelligence. He perceives intelligence as the ability to adapt to, shape, and select environments to accomplish one's goals and those of society. Lester A. Lefton and his colleagues (Lefton et al., 2005) defined intelligence as the overall capacity of the individual to act purposefully, to think rationally, and to deal effectively with the social and cultural environment. They perceive that intelligence is not a thing but a process that is affected by a person's experiences in the environment.

J. McCarthy, M.L. Minsky, N. Rochester, and C.E. Shannon proposed the term *Artificial Intelligence* (AI) in 1955 (McCarthy et al., 1955; McCulloch, 1965). S.C. Kleene analyzed the relations of automata and nerve nets (Kleene, 1956), and Bernard Widrow initiated the technology of *Artificial Neural Networks* (ANNs) in the 1950s (Widrow and Lehr, 1990) based on multilevel, distributed, dynamic, interactive, and self-organizing nonlinear networks (Albus, 1991; Ellis and Fred, 1962; Haykin, 1998). The concepts of robotics (Brooks, 1970) and expert systems (Giarrantans and Riley, 1989) were developed in the 1970s and 1980s, respectively. Then, intelligent systems (Meystel and Albus, 2002) and software agents (Hewitt, 1977; Jennings, 2000) emerged in the 1990s.

Yingxu Wang's *real-time intelligent theory* (Wang, 2007a, 2007b; Wang and Wang, 2006; Wang et al., 2006) reveals that natural intelligence is the driving force that transforms cognitive information in the forms of data, knowledge, skill, and behavior. Intelligence can be modeled into two categories known as the *subconscious* (inherent) intelligence and *conscious* (acquired) intelligence. A *Layered Reference Model of the Brain* (LRMB) has been developed (Wang et al., 2006), which encompasses 39 cognitive processes at seven layers known as the *sensation, memory, perception, action, meta-cognitive, meta-inference, and higher-cognitive layers* from the bottom up.

16 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/chapter/abstract-intelligence-toward-unifying-theory/65120

Related Content

Graph Based Segmentation of Digital Images

B.K. Tripathy and P.V.S.S.R. Chandra Mouli (2013). *Handbook of Research on Computational Intelligence for Engineering, Science, and Business* (pp. 182-199).

www.irma-international.org/chapter/graph-based-segmentation-digital-images/72493

A Review of Computational Intelligence Models for Brain Tumour Classification and Prediction

Justice Kwame Appati, Godfred Akwetey Brown, Michael Agbo Tettey Soli and Ismail Wafaa Denwar (2021). *International Journal of Software Science and Computational Intelligence* (pp. 18-39).

www.irma-international.org/article/a-review-of-computational-intelligence-models-for-brain-tumour-classification-and-prediction/287394

Enhancing User Experience in Public Spaces by Measuring Passengers' Flow and Perception Through ICT: The Case of the Municipal Market of Chania

Anna Karagianni, Vasiliki Geropanta, Panagiotis Parthenios, Riccardo Porreca, Sofia Mavroudi, Antonios Vogiatzis, Lais-Ioanna Margiori, Christos Mpaknis, Eleutheria Papadosifou and Asimina Ioanna Sampani (2021). *Research Advancements in Smart Technology, Optimization, and Renewable Energy* (pp. 16-36).

www.irma-international.org/chapter/enhancing-user-experience-in-public-spaces-by-measuring-passengers-flow-and-perception-through-ict/260041

Artificial-Intelligence-Based Service-Oriented Architectures (SOAs) for Crisis Management

Konstantinos Domdouzis (2018). *Handbook of Research on Investigations in Artificial Life Research and Development* (pp. 79-95).

www.irma-international.org/chapter/artificial-intelligence-based-service-oriented-architectures-soas-for-crisis-management/207200

Problem Solving in the Brain and by the Machine

Juan A. Barceló (2009). *Computational Intelligence in Archaeology* (pp. 32-71).

www.irma-international.org/chapter/problem-solving-brain-machine/6820