A Pragmatic Characterization of Concept Algebra:
A Few Formal Remarks on Wang’s Denotational Mathematics

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ABSTRACT

Taking into account the framework of denotational mathematics as seen by Yingxu Wang, in this paper the author wishes to implement a possible further pragmatic (context-depend) dimension into the algebraic structure of concept algebra. One of the main problems of software science is that regarding context-depend question of a programming language. Indeed, attention has been paid above all to syntactic and semantic dimensions of a programming language, neglecting the pragmatic one concerning context. The author has tried to face this question providing a first denotational mathematics structure taking into account a possible pragmatic dimension.

KEYWORDS

Abstract Concept, Category, Concept Algebra, Pragmatics, Semantics, Semiotics, Syntax

1. INTRODUCTION

The history of science and technology clearly shows that often the rising of new problems require new forms of mathematics. In the last years, informatics and software sciences have been characterized by a great enlargement of their own technical and formal frameworks with the institution of some new disciplines, among which are cognitive informatics, cognitive computing, natural informatics, natural and computational intelligence, artificial and abstract intelligence, denotational mathematics, cognitive machine learning, cognitive linguistics and systems, cognitive robots and agents, neuroinformatics, neural and brain informatics. These disciplines are the cutting-edge research fields of the International Institute of Cognitive Informatics and Cognitive Computing (ICIC), which is leader in the international panorama. Herein, we shall briefly report the main lines of some of these disciplines.

Cognitive Informatics (in short, CI) is a discipline which operates in the cross-zone of computer science, information science, cognitive and brain science, intelligence science, knowledge science and cognitive linguistics, investigating general human cognitive mechanisms and processes in the framework of abstract intelligence theory and denotational mathematics. It is a new discipline (Wang 2003), and the problems posed by it require new mathematical tools which should be descriptive, rigorous and precise in expressing and denoting human and system actions and behaviors. Conventional mathematics is unable to solve the fundamental problems coming from cognitive informatics and related disciplines such as neuroscience, psychology, philosophy, computing, software engineering, and knowledge theory.
In this regard, the new structures and notions provided by denotational mathematical enable to face these problems in the right formal setting. Although there exist various fashions to express facts, objects, notions, relations, actions, and behaviors in natural languages, CI allows human and system behaviors to be classified into three main basic categories known as ‘to be’, ‘to have’, and ‘to do’. All traditional mathematical tools and forms, in general, are an abstract and formal description of these three main categories of expressibility and their rules. Taking into account this standpoint, we may say roughly that mathematical logic may be considered as the abstract means for describing ‘to be’ category, set theory for describing ‘to have’ category, and algebras, particularly process algebra, for describing ‘to do’ category.

One of the main aims of mathematics is to provide means and rules for expressing thought rigorously and generically at a higher level of abstraction. The investigation of cognitive models of information and knowledge representation in the brain is a fundamental research area that, in turn, may help to understand mechanisms of the brain. The human brain and its information processing mechanisms are central in cognitive informatics. A valuable cognitive informatics model of the brain, as the one proposed by Yingxu Wang, tries to explain the natural intelligence via interactions between the inborn (unconscious) and acquired (conscious) life functions.

This model mainly proves that memory is the unavoidable foundation for any other possible form of natural intelligence. Formalisms in terms of mathematics and logic provide a rigorous treatment for the study of cognitive and neural psychology and natural informatics. Fundamental cognitive mechanisms of the brain, such as the architecture of the thinking engine, internal knowledge representation, long-term memory establishment, and roles of sleep in long-term memory development have been investigated.

Informatics, loosely meant as the science of information, can be classified into three main trends. The first one is that of classic informatics which, after the pioneering works of Claude E. Shannon, David A. Bell and Stanford Goldman of the 1950s, was oriented towards communication properties of information and signal theory. The second trend is that of computational informatics which, after Alan Turing pioneering work of the 1950s, is instead data oriented and studies information as properties of the natural world which can be distinctly elicited, generally abstracted, binary represented, and reducibly operational.

These first two trends of informatics put emphases on external information processing, which are yet to be extended to observing the fundamental fact that human brain is however both the original source and final destination of information. Any information must be cognized by human being before it is understood, comprehended, and consumed. The contemporary theory of information reveals that information is the third essence of the natural world supplementing to matter and energy. Finally, we have the third trend of cognitive informatics, mainly due to Yingxu Wang, which is mainly knowledge and intelligence oriented, and studies the properties of cognitive information and the mechanisms of abstract intelligence making use of denotational mathematics formalism.

Natural Intelligence (in short, NI) is a domain of cognitive informatics. Briefly speaking, software and computer systems are recognized as a subset of intelligent behaviors of humans described by programmed instructive information. Abstract Intelligence (in short, AbI) is the general mathematical form of intelligence conceived as a complex natural mechanism that transfers information into behaviors and knowledge at the embodied neural, cognitive, functional and logical levels from the bottom up point of view. AbI, in a narrow sense, is a human or a system ability that transforms information into behaviors, while, in a broad sense, AbI is any human or system ability that autonomously transfers the forms of abstract information between data, information, knowledge, and behaviors in the brain or cognitive systems. The field of AbI studies the foundations of intelligence science stressing the core properties of intelligence as a natural mechanism that transfers information into behaviors and knowledge.

The paradigms of AbI deal with natural, artificial, machinable and computational intelligence. Studies and researches of CI and AbI allow to have theoretical foundations for identifying and revealing
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