Chapter 5
Computational Intelligence–Revisited

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ABSTRACT

This chapter is a survey of CI and indicates the Simulation Mechanism-Based (SMB) classification method for Computational Intelligence through reviewing on the definitions of CI and existed classification methods. The classification method divides all CI branches into three categories: organic mechanism simulation class, inorganic mechanism simulation class and artificial mechanism simulation class. Furthermore, branches in organic mechanism simulation class are introduced in detail, by which the chapter concludes the nonlinear mapping model for each class. The work presented in this chapter will provide an efficient approach to understand essence of CI.

INTRODUCTION

IEEE academic conferences on neural networks, fuzzy systems, evolutionary computation which held the first "World Congress on Computational Intelligence (WCCI'94)" in Orlando, Florida represented the birth of CI. From then on, CI emerging as a new field of study has gained widespread concern from a growing number of scholars.

Plenty of CI branches have made considerable progress and have become hot issues in various fields of research and applications in recent years. The CI branches, although different from each other, share the property of being non-symbolic and operating in a bottom-up model, where structure emerges from an unordered begin.

We consider that CI mainly adopts the connectionism idea and actually uses the bionics ideas for reference; it is a computational method which origins from emulating intelligent phenomenon in nature and is described in abstract mathematical language. Computational intelligent systems depend on numerical data supplied by manufactured sensors and do not rely upon "knowledge", and it can establish the relationship through training and solve the complex problems.

From comprehensive discussion on definitions of CI and correct understanding the nature and com-

putational mechanism of CI branches, this chapter introduces the Simulation-Mechanism-Based (SMB) method for CI according to the collection of all CI branches and all the different classification methods. This classification method divides all CI branches into three categories: organic mechanism simulation class (OMS), inorganic mechanism simulation class (IMS) and artificial mechanism simulation class (AMS). Among them, organic mechanism simulation class is the most important part of CI, many branches in this class such as fuzzy logic, neural network and GA are the major tools in many research fields.

Organic mechanism simulation class can be also divided into group mechanism simulation class and individual mechanism simulation class. Group mechanism simulation class can be divided into group evolution mechanism simulation class and group collaboration mechanism simulation class according to the different group intelligent behaviors which they attempt to simulate. Individual mechanism simulation class attempts to simulate life phenomenon in different level of the individual. DNA computing simulates the DNA molecule structure in molecule level. Artificial Neural Network simulates the brain structure in organ structure level. Artificial immune system simulates the biology immune systems in organism function level. Fuzzy logic simulates human thinking manner in cognitive level. SVM simulates the human ability of pattern identify in perception level. Artificial life simulates the whole life character in human being level.

This chapter also introduces the nonlinear mapping models for them through elaboration on the essence and computational mechanism of each branch.

DEFINITIONS OF CI

From birth of CI in 1992, there are plenty of definitions about Computational Intelligence. But there isn't a uniform definition. In the following section, we summarize various definitions about CI. Finally, a wide-covered definition is given.

Background

The first published definition is due to Bezdek (1992) who states that computational systems depend on numerical data supplied by manufactured sensors and do not rely upon "knowledge". Bezdek (1994) notes that there are many variations on the theme of intelligent systems, and characterizes them according to the ABC's: Artificial intelligence, Biological intelligence and Computational intelligence. Artificial loosely refers to systems with a symbolic knowledge component; biological refers to physical, chemical and organic systems, while computational systems include a knowledge component and interaction with sensory information that is described in numerical models.

Bezdek (1994) offers that CI is low-level computation in the style of the mind, whereas AI is mid-level computation in the style of the mind. The envisioned difference is that mid-level systems include knowledge, while low level systems do not.

His proposal is to call a system computationally intelligent when it deals only with numerical (low-level) data, has a pattern recognition component, and does not use knowledge in the AI sense; and additionally, when it (begins to) exhibit (i) computational adaptivity; (ii) computational fault tolerance; (iii) speed approaching human-like turnaround, and (iv) error rates that approximate human performance (Bezdek, 1994).

Mark's (1993) definition is listing neural networks as one of the building blocks of CI, the others being genetic algorithm, fuzzy systems, evolutionary programming, and artificial life.

Eberhart et al. (1996) elaborate further on the very notion of CI and relate their vision to that of Bezdek. Their view is summarized as that CI is defined as a methodology involving computing that exhibits an ability to learn and/or deal with new situations such that the system is perceived to

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