Chapter 1

Computational Intelligence: Past, Today, and Future

Cengiz Kahraman, İhsan Kaya, and Didem Çınar
İstanbul Technical University, Department of Industrial Engineering, 34367- Maçka, Istanbul, Turkey
E-mails: {kahramanc, kayai, cinard}@itu.edu.tr

Computational intelligence is defined as the study of the design of intelligent agents. Since its relation to other branches of computer science is not well-defined, computational intelligence means different things to different people. In this chapter the history of computational intelligence with a wide literature review will be first given. Then, a detailed classification of the existing methodologies will be made. Later, the international computational intelligence journals will be handled and the characteristics of these journals will be examined. As an example, a special literature review on computational intelligence in complex decision systems will be also given. The direction of computational intelligence in the future will be evaluated.

1.1 Introduction

A definition of intelligence which is needed to be defined to research in a field termed artificial intelligence and computational intelligence has only rarely been provided, and the definitions in the literature have often been of little operational value. The intelligence was defined as the ability of solving the hard problems. However there are basic questions in this definition, such as how hard the problem is or who decides which problem is hard [11]. Intelligence comprises decision making. For any intelligent system, it must consistently make a decision to select of one from a number of alternative ways of allocating the available resources for a given purpose. Biological organisms satisfy the condition of intelligence as the derivation from their competition for the available resources. The primary goal of all living systems is survival and selection eliminates the weakest solutions variants while evolution as a process is purposeless. The weakest solution is the one which does
not demonstrate adequately suitable behavior and it is eliminated stochastically. This basic idea has been recurred through the transitions of generations. But intelligence involves more than being restricted to biological organisms. So intelligence is the basic property of decision maker. Chellapilla and Fogel [11] defined the intelligence as “the capability of a system to adapt its behavior to meet its goals in a range of environments and the life process itself provides the most common form of intelligence”.

The birth of Computational Intelligence (CI) is attributed to the IEEE World Congress on Computational Intelligence in 1994 Orlando, Florida. This term combines elements of learning, adaptation, evolution and fuzzy logic (rough sets) to create systems that is, in some sense, intelligent has been investigated by researchers until now. It is a necessity to answer the question what the “computational intelligence” is. CI can be broadly defined as the ability of a machine to react to an environment in new ways, making useful decisions in light of current and previous information. CI is generally accepted to include evolutionary computation, fuzzy systems, neural networks, and combinations thereof. CI, which consists of neural networks, fuzzy logic and evolutionary computing, and so on, is a novel technology to bring intelligence into computation. Compared with the traditional artificial intelligence, a significant characteristic of CI is that the precise model needs not to be established when dealing with imprecise, uncertain, and incomplete information.

IEEE Computational Intelligence Society defines its subjects of interest as neural networks, fuzzy systems and evolutionary computation, including swarm intelligence. The approach taken by the journals and by the book authors is to treat CI as an umbrella under which more and more methods will be added. A good definition of the field is therefore impossible, because different people include or exclude different methods under the same CI heading. Despite the relatively widespread use of the term CI, there is no commonly accepted definition of the term. Since that time not only a great number of papers and scientific events have been dedicated to CI, but numerous explanations of the term have been published. In order to have a brief outline of history of the term the founding and most interesting definitions will be summarized now:

The term CI was first introduced by Bezdek in 1994. Bezdek says “… A system is computationally intelligent when it: deals with only numerical (low-level) data, has a pattern recognition component, 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”.