Chapter 1.20
Computational Intelligence Techniques

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ABSTRACT

Computational intelligence (CI) encompasses approaches primarily based on artificial neural networks, fuzzy logic rules, evolutionary algorithms, support vector machines and also approaches that combine two or more techniques (hybrid). These methods have been applied to solve many complex and diverse problems. Recent years have seen many new developments in CI techniques and, consequently, this has led to many applications in a variety of areas including engineering, finance, social and biomedical. In particular, CI techniques are increasingly being used in biomedical and human movement areas because of the complexity of the biological systems. The main objective of this chapter is to provide a brief description of the major computational intelligence techniques for pattern recognition and modelling tasks that often appear in biomedical, health and human movement research.

INTRODUCTION

Computational intelligence is a branch of the study of artificial intelligence. Computational intelligence research aims to use learning, adaptive, or evolutionary algorithms to create programs that are, in some sense, intelligent. Computational intelligence research either explicitly rejects statistical methods, or tacitly ignores statistics.

Computational intelligence, as the name suggests, relies on number crunching. The field has developed enormously due to quantum jumps in computational power over the last two decades. The problems however, solved by computational intelligence techniques viz. search, optimization, adaptation and learning are age old. So, to understand computational intelligence, we must have a perspective of the other techniques that researchers have used to solve the same problems. These include statistical and syntactic approaches to solve the same problems.

The fundamental research question is: How to create a machine that can store information (not mere data) and interpret the learnt information in a useful manner? Add to this, the further requirement that the machine needs to be able to update its information database based on novel data and do this optimally. This objective takes different forms in different problems. For instance, in pattern recognition, the machine needs to be able to represent particular patterns, classify them, retrieve particular patterns if required, mark a novel pattern as previously unknown and generate a representation for it and so on. In this particular sense, all research problems in pattern recognition, classification, information retrieval, data mining, authentication etc are, in essence, pattern representation problems. If one can program a machine to "understand" data and extract reproducible information out of it, then, in principle, the machine is behaving "intelligently." Statistical approaches had a first shot at achieving this objective and were later overtaken by computational intelligence techniques, due in large part to the revolution in number crunching abilities of modern day computers.

In this chapter, we will cover the computational intelligence techniques along with an historical perspective and important landmarks in computational intelligence research. In order that our coverage is complete, we will cover the statistical techniques to solve problems for which computational intelligence (CI) techniques were later devised.

Figure 1. Overview of problems in computational intelligence and machine learning