Chapter 11
Bio-Inspired Computing through Artificial Neural Network

Nilamadhab Dash
C. V. Raman College of Engineering, India

Brojo Kishore Mishra
C. V. Raman College of Engineering, India

Rojalina Priyadarshini
C. V. Raman College of Engineering, India

Rachita Misra
C. V. Raman College of Engineering, India

ABSTRACT

Developing suitable mathematical or algorithmic model to solve real life complex problems is one of the major challenges faced by the researchers especially those involved in the computer science field. To a large extent Computational intelligence has been found to be effective in designing such models. Bio inspired computing is the technique which makes the machines intelligent by adapting the behavior and methods exhibited by the human beings and other living organisms while forming intelligent systems. These intelligent models include the intelligent techniques such as Artificial Neural Network (ANN), evolutionary computation, swarm intelligence, fuzzy system, artificial immune system accompanied by fuzzy logic, expert system, deductive reasoning. All these together form the area of Bio inspired computing. The chapter deals with various bio inspired technique, giving emphasis on issues, development, advances and practical implementations of ANN.

INTRODUCTION

Bio inspired computing (also biologically inspired computing or bio computing) is a field of computing that deals with the subfields related to the topics of connectionism, social behavior, and emergence. It closely related to the field of artificial intelligence, as many of its pursuits can be linked to machine learning. It relies heavily on the fields of biology, computer science, and mathematics. Biologically inspired computing is an important subset of natural computation. The concept of bio computing has a twofold definition: the use of biology or biological processes as metaphor, inspiration, or enabler in developing new computing technologies and new areas of computer science; and conversely, the use of information

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science concepts and tools to explore biology from a different theoretical perspective. In addition to its potential applications, such as DNA computation, nanofabrication, storage devices, sensing, and health care, bio inspired computing also has implications for basic scientific research. It can provide biologists, for example, with an IT-oriented paradigm for looking at how cells compute or process information, or help computer scientists construct algorithms based on natural systems, such as evolutionary and genetic algorithms. Bio computing has the potential to be a very powerful tool. It is well understood that the computational complexity of real-world problems is too high to be handled by the conventional approaches. Some of the popular conventional methods that have been widely used are mathematical optimization algorithms (such as Newton's method and gradient descent method that use derivatives to locate a local minimum), direct search methods (such as the simplex method and the Nelder–Mead method that use a search pattern to locate optima), enumerative approaches such as dynamic programming (DP), etc. Each of these techniques in general depends on several assumptions about the problem in order to suit a particular method, and may not be flexible enough to adapt the algorithm to solve a particular problem as it is, and may obstruct the possibility of modeling the problem closer to reality (S.Haykin, 1994). Many science and engineering problems generally involve nonlinear relationships in their representation; so linear programming (LP) may not be a suitable approach to solve most of the complex practical problems. The gradient-based nonlinear programming methods can solve problems with smooth nonlinear objectives and constraints. However, in large and extremely nonlinear environment, these techniques may fail to find appropriate solutions, or converging to suboptimal solutions depending upon the degree of nonlinearity and initial assumptions. Also, the conventional nonlinear optimization solvers are not applicable for problems with non-differentiable and/or discontinuous functional relationships. The efficiency of algorithms varies depending on the complexity of the problem. Thus, for one reason or the other, conventional methods have several limitations and may not be suitable for a broad range of practical problems. To address these problems, in recent times stochastic search and optimization algorithms inspired by nature and biological processes have been proposed and applied in various fields of science and engineering. This proposed book chapter will mainly focus on the practical applications of artificial neural network in order to address different types of problems.

BACKGROUND

The ideas from natural and biological activities have provoked the progress of many sophisticated algorithms. These algorithms are broadly categorized as evolutionary computation and swarm intelligence (SI) algorithms. Evolutionary computation is a term used to describe algorithms which were inspired by 'survival of the fittest' or 'natural selection' principles (McCulloch et al., 1943), whereas 'swarm intelligence' refers to the algorithms and distributed problems-solvers which are inspired by the cumulative intelligence of swarm or combined behavior of insect and other animal societies. This section tries to provide a brief idea about some of the contemporary algorithms in the field of bio inspired computing.

Evolutionary Algorithms

Evolutionary algorithms are probabilistic search methods that imitate the metaphor of natural biological evolution. Evolutionary algorithms operate on a population of potential solutions applying the principle of survival of the fittest to generate superior approximations to a solution. At each generation, a new set