Chapter 13
Bio-Inspired Algorithms for Ecosystem Data Analysis

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ABSTRACT

Ecological systems are known by their relationships with the environment. They affect and are affected by various external factors such as climate and the basic materials that form the soil. Good distinctions of relationships is the first important point in the modeling of ecosystems. The diversity of these systems caused a large amount of data that became hard to analyze, which made researchers classify it as NP-Hard problems. This chapter presents a study of application of bio-inspired algorithms for ecosystem data analysis. The chapter contains application of four different approaches that were inspired by authors of the paper from four different phenomena, and they were applied for analysis of four different ecosystem data collected from real life cases. Results showed a very high accuracy and proved the efficiency of bio-inspired algorithms for supervised classification of real ecosystem data.

INTRODUCTION

A system is together of the interactions between several components. These interactions are guided according to rules from which the nature of the components play a role in the determination of the system and also the interaction of the system itself with its environment. If we speak of a set of organs interacting within an organism to perform a biological function, this system is called an ecological system. And if we speak of a set of axioms guided by vocabularies to form rules of deductions, we speak of a logical system.

Ecosystems or ecological systems are defined by interactions between living organisms in conjunction with non-living components of their environment (Odum, 1971). These components are linked by nutrient cycles and energy flows (Smith, 2012). Ecosystems differ in their networks of interactions; small ecosystems can be found at the cellular level (a leaf of a tree), an organ of a living being (tree trunk), or a living being (a tree). And we can also find large ecosystems containing relationships between a group of individuals or a society. What is important is that to properly define the term ecosystem or ecological system is a set of interactions between ecological units formed by plant and animal organ-

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isms and an environment defined by physical and chemical characteristics, this environment is called biotope. A key feature in ecosystems is that it is very difficult to find a closed ecological system. To say a closed system, its elements have no relation with the outside world, they have relations only among themselves. Ecological systems are known by their relationships with the environment, they affect and affected by various external factors such as climate, and the basic materials that form the soil. Unlike closed systems, open systems require a good distinction between the entities of the system that bind its entities with the environment, the relationships that bind the entities called relations within, they are Characteristics of the system. It is for his good distinction of relationships is the first important point in the modeling of ecosystems.

One of the great promising fields in the discovery of knowledge today is the detection of disturbances of the ecosystem, it includes many fields such as remote sensing, earth science, biology and oceans. Ecologists analyse the data to identify the relationships between a response and a set of predictors, using statistical models that do not accurately describe the main sources of variation in the response variable.

Knowledge discovery techniques are often more powerful, flexible and effective for exploratory analysis than statistical techniques, (Wesley, 2007) suggest useful ways in which data extraction and statistical analysis can Be integrated into an in-depth data analysis to facilitate the rapid creation of specific models by defining the distinctions between data mining analysis and parametric statistical analysis, and the strengths of data mining tools to generate Assumptions from the data. An example of done works in this field presented in (Jane, 2009) which shows one of the distribution species models as a model that relates to species distribution data with information on the environment and / or particular characteristics of Biological domains and scientific disciplines.

In technology and speed era, software plays a major role in all domains. A large part of the massive growth of energy consumption in the past few decades is due to the manufacture, the use of computing and communication technologies, and the technological advances they make possible. Software allows simulating earth system processes, assessing the implications, and exploring possible responses. All these are able by processing vast amounts of geo-scientific data, which help communities of experts to share data, explore scenarios and validate assumptions.

Nature contains a lot of sub-disciplines, a very big number of complex mechanisms that help life keep going on. Understanding these mechanisms is a principal source to inspire different algorithms and solution for problems in technology era. Over the last few decades, it has stimulated many successful algorithms and computational tools for dealing with complex and optimization problems. The 21st century became NP-hard problems era; this kind of problems took a large space in research areas. Researchers work and invent a lot of solutions for these problems. Biologically Inspired Computation is one of those areas. It is computation inspired by biological metaphor, also referred to as Bio-mimicry, and Bio-mimetics in other engineering disciplines. The intent of this field is to devise mathematical and engineering tools to generate solutions to computation problems. The field involves using procedures for finding solutions abstracted from the natural world for addressing computationally phrased problems. Bio inspired algorithms and metaheuristics in general are powerful solutions for hard problems in many technological fields. These solutions have been derived from the biological behavior systems, particle swarm optimization was developed based on the swarm behavior of birds and fish

Since ecological systems' studies are considered as NP-hard problems. The objective of this chapter is explaining the importance of using meta heuristics for study of different ecosystems. We will begin by giving an idea about ecosystems and different issues, then explaining use of meta heuristics and their advantages in order to prove their efficiency in ecosystems study.