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Artificial Neural Network for Ecosystems Analysis (ANEA), A Neural Ecosystem Analyzer

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ABSTRACT

The application of environmental science especially in ecological systems provide many opportunities and challenges for the technologies of modelling, control and analysis .This paper presents an overview of the impact of Artificial Intelligence techniques on the definition and development of ecosystems data.
An artificial neural network (ANN) is a system based on the emulation of biological neural system. In other words, Artificial neural networks (ANNs) are non-linear mapping structures based on the function of the human brain. They have been shown to be universal and highly flexible function approximates for any data. These make powerful tools for models, especially when the underlying data relationships are unknown. In this paper, we briefly introduce algorithms frequently used; which is the back propagation algorithm. The future development and implementation of ANNs for ecosystems analysis is discussed in the present work. The paper includes selection of successful applications to a wide range of ecosystem problems.

INTRODUCTION

Artificial Neural Networks (ANNs) have been applied to an increasing number of real world problems of considerable complexity. Their most important advantage is in solving problems that are too complex for conventional technologies problems that do not have algorithmic solutions or for which an algorithmic Solution is too complex to be found. In general, because of their abstraction from the biological brain, ANNs are well suited to problems that people are good at solving, but for which computers are difficult to be solved.
The main focus of this research is trying to apply ANNs in an ecological system instead of statistical analysis and process. The neural network uses the well known Back propagation Algorithm with the delta rule for adaptation of the system.

The back propagation algorithm uses supervised learning, which means that we provide the algorithm with examples of the inputs and outputs we want the network to compute, and then the error (difference between actual and expected results) is calculated. The idea of the back propagation algorithm is to reduce this error, until the ANN learns the training data. The training begins with random weights, and the goal is to adjust them so that the error will be minimal.

Initial Analysis and Problem Statement

The general problem of simulating (or creating) intelligence has been broken down into a number of specific sub-problems. These consist of particular traits or capabilities that researchers would like an intelligent system to display. The traits described below have received the most attention. Deduction, reasoning, problem solving. The research is trying to Study and produce intelligent a neural ecosystems analyzer, publications, and services that are beneficial to the environment especially ecological sciences.

Here we apply Artificial Neural net works (ANNs) for Application of Neural computation to classification of ecology systems area which deal with Deduction, reasoning, problem solving like marine field, soil analysis and air pollutions (Variations of ozone (O3) in specific industrial area in Malaysia) .Scope of the research to develop an expert ecosystem analyzer for classifications data problems in ecology field.

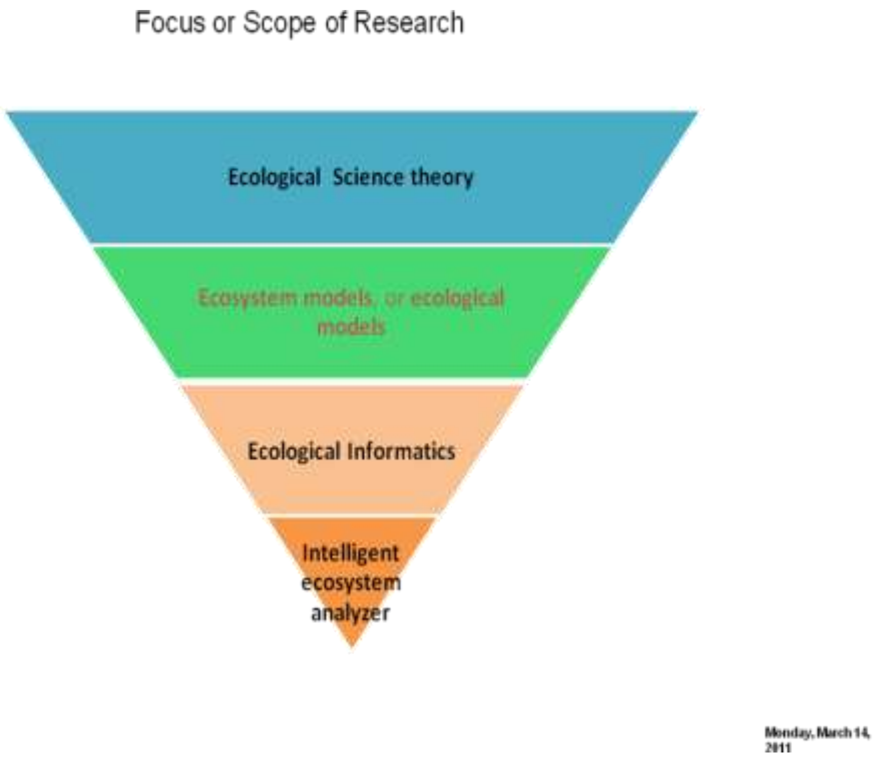

Figure 1 represents the stages of ecological informatics.

Related work

Since the late 1990s, however, several well-known studies have codified ecosystem services into generally accepted lists or typologies (Daily 1997; DeGroot, Wilson et al. 2002) The Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2002; Mooney, Cropper et al. 2004; Pereira, Queiroz et al. 2005) classified ecosystem services into “supporting services,” the ecological processes and functions that generate other ecosystem services, “regulating services” that maintain global and local conditions at levels appropriate for human survival, “provisioning services” that offer physical resources directly contributing to human well-being, and “cultural services” that satisfy psychological, emotional, and cultural needs. This classification has been extremely useful for communicating nature’s importance in satisfying different domains of human well-being. Yet recent authors have noted that the MA ecosystem services classification does not lend itself well to economic decision-making (Hein and van Ierland 2006; Boyd and Banzhaf 2007; Wallace 2007). This is because the MA categories do not explicitly link specific benefits to specific human beneficiaries of ecosystem services. Improved definition of these benefits and beneficiaries, combined with their spatial mapping, could aid in ecosystem service valuation, environmental accounting (Boyd and Banzhaf 2007), identification of winners and losers in conservation and development choices, and in supporting payments for ecosystem services programs.

From a spatial perspective, the supply side of ecosystem services has been relatively well-explored. A number of recent studies have used GIS analysis to measure the ecological factors contributing to the provision of certain services (Naidoo and Ricketts 2006; Beier, Patterson et al. 2008; Nelson, Mendoza et al. 2009). These studies explore how the provision of ecosystem services varies across the landscape. However, far fewer studies have explicitly identified the demand side, or human beneficiaries (Hein et al. 2006) or mapped these beneficiaries (Beier et al. 2008). Yet the need for such mapping is becoming increasingly recognized (Naidoo, Balmford et al. 2008). Supply and demand side mapping are complex, since ecosystem services provision and use often occur across different spatial and temporal scales (Hein et al. 2006). Others (Tallis and Polasky 2009) clearly describe the “spatial flow problem” in ecosystem services. The ecosystem services research community has as yet been unable to move beyond “static maps” to consider the cross-scale flows of ecosystem service to different groups of human beneficiaries. Existing attempts to categorization (Costanza 2008) break ecosystem services into coarse categories based on how their benefits spatially flow to beneficiaries but stop short of providing a quantitative conceptualization. In order to promote a breakthrough in ecosystem services assessment, we must start from the concepts of the MA framework, incorporate several key elements proposed by others, and move towards a science of ecosystem services that quantitatively assesses spatio-temporal flows of clearly identified benefits towards clearly identified beneficiaries.

Techniques and Method

Artificial intelligence methods include a wide variety of computational and algorithmic approaches to problem solving. Their common theme, however, is that they attempt to provide computers with a capability to solve problems in ways that have traditionally been the purview of humans. This means that AI methods incorporate such human cognitive abilities as: reasoning with anecdotal information and best-guess judgment (knowledge-based systems), using vague and commonplace descriptions of objects and events (fuzzy logic), making decisions based on learned patterns with little explicit knowledge or rationale (artificial neural networks), and dealing with large amounts of uncertain, yet interrelated, data and information (Bayesian belief networks).

Background and ecological applications of ANNs

An artificial neural network (ANN), or, more generally, a multilayer perception, is a modeling approach inspired by the way biological nervous systems process complex information.

The key element of the ANN is the novel structure of the information processing system, which is composed of a large number of highly interconnected elements called neurons, working in unity to solve specific problems. The concept of ANNs was first introduced in the 1940s (McCulloch and Pitts 1943); however, it was not popularized until the development of the back propagation training algorithm by Rumelhart et al. (1986). The flexibility of this modelling technique has led to its widespread use in many disciplines such as physics, economics, and biomedicine.

Researchers in ecology have also recognized the potential mathematical utility of neural network algorithms for addressing an array of problems. Previous applications include the modelling of species distributions (Mastrorillo et al. 1997; O¨ zesmi and O¨ zesmi 1999), species diversity (Gue´gan et al. 1998; Brosse et al. 2001; Olden et al. 2006b), community composition (Olden et al. 2006a), and aquatic primary and secondary production (Scardi and Harding).

Conclusions and Future work

Jobs being under investigation are to improve further the success rate, enhancement of both the underlying neural network structure and the adopted back-propagation learning algorithm.

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