A New Evolutionary Neural Network and Its Application for the Extraction of Vegetation Anomalies

Yan Guo\textsuperscript{1}, Lishan Kang\textsuperscript{1,3}, Fujiang Liu\textsuperscript{2}, and Linlu Mei\textsuperscript{2}

\textsuperscript{1} School of Computer, China University of Geosciences, Lumo Road 388, 430074 Wuhan, China
\textsuperscript{2} Faculty of Information Engineering, China University of Geosciences, Lumo Road 388, 430074 Wuhan, China
\textsuperscript{3} School of Computer Sciences, Wuhan University, Luojia Hill, 430072 Wuhan, China

\texttt{guoyanwuhan@yahoo.com.cn, kang_whu@yahoo.com, felixwuhan@yahoo.com.cn, meilinlu@163.com}

Abstract. This paper proposes an evolutionary neural network (ENN). In this ENN model evolutionary algorithms (EAs) are adopted to train the multilayer perceptrons (MLPs) to overcome backpropagation (BP) algorithm shortcomings. The proposed ENN technique was used to the extraction of vegetation anomalies in remote sensing imagery compared against MLPs with BP algorithm. The experiments of extracting vegetation anomalies were carried out by ENN classifiers and BP classifiers in a 1241×1149 pixel Landsat-7 Enhanced Thematic Mapper plus (ETM+) high-resolution image of Zhaoyuan gold deposits, Shandong, China. We found that the use of EAs for finding the optimal weights of MLPs results mainly in improvements in overall accuracy of MLPs.

Keywords: Evolutionary neural networks, evolutionary algorithms, BP algorithm, vegetation anomalies, extraction, remote sensing.

1 Introduction

Satellite remote sensing has provided us an effective method for mineral surveying. Biogeochemical prospecting techniques have proven useful for mapping rock distributions, faults, and mineral anomalies [1]. Sources with vegetation anomalies are of particular interest and extraction vegetation anomalies become a key methodology within the mineral surveying field as they indicate the presence of mineral. Scientists currently identify the vegetation anomalies by Normalized Difference Vegetation Index (NDVI) and principal component analyses (PCA) [2], [3], which are adaptive to the region of small coverage area with strong anomalies information while failure to the area with weak anomalies information.

Our goal is to bring automation to the extraction of vegetation anomalies from remote sensing data using intelligent techniques, such as neural networks (NNs) to increasing classification accuracy of weak anomalies information. NNs were used in this research to determine the relationship of spectrum and vegetation anomalies in remote sensing imagery. Multilayer perceptrons (MLPs) are the most common type of
NNs used for remote sensing studies and have proved to be effective in comparable studies [4].

But the training of the MLPs, normally featured with backpropagation (BP) algorithm or other gradient-descent-based algorithms, still faces certain drawbacks, e.g., very slow convergence, easily getting stuck in a local minimum, and inconsistent results due to random initial connection weights, etc.

One way to overcome gradient-descent-based training algorithms is evolutionary neural networks (ENNs) in which evolutionary algorithms (EAs) is adopted to formulate the training process as the evolution of parameters (including connection weights and bias) [5]. EAs refer to a class of population-based stochastic search algorithms that are developed from ideas and principles of natural evolution. One important feature of EAs is their population-based search strategy. Individuals in a population compete and exchange information with each other in order to perform certain tasks. EAs can be used effectively in the training of connection weights to evolve and find a near-optimal set of connection weights globally without computing gradient information. Unlike the case in gradient-descent-based training algorithms, the fitness (or error) function does not have to be differentiable or even continuous since EAs do not depend on gradient information. Moreover, another major advantage to the evolutionary approach over BP algorithm is the ability to escape local optima. More advantages include robustness and ability to adopt in a changing environment.

Our objective is to demonstrate that evolutionary algorithms can successfully address the training problems of MLPs, resulting in accurate networks with good generalization abilities.

This paper describes the MLPs with EAs-based training algorithm, called ENN classifiers, and their application to the identification of vegetation anomalies from remote sensing imagery. As an example, a land-cover classification experiment was carried out by ENN classifiers in a 1241×1149 pixel Landsat-7 Enhanced Thematic Mapper plus (ETM+) high-resolution image of Zhaoyuan in Shandong province in eastern China. Moreover the MLPs with BP algorithm, called BP classifiers, were employed to comparing the performance with ENN classifiers. The experiments showed that ENN classifiers produced significantly more accurate classification result than we could obtain by BP classifiers.

This paper is organized as follows: Section 2 outlines the problem of extracting vegetation anomalies in the remote sensing data, and provides details about the study area and data set. Section 3 describes the ENN algorithms in which EAs are adopted to train MLPs. Section 4 presents our experiments and reports the results. The paper concludes with our observations and plans for future work.

2 Study Area and Data Set

In vegetation area, as a result of that the plant absorb Au from rocks and soils, the contents of Au, pigment and water, the surface temperature, and the cells structure vary in the poisoned leaves, even the plant cause abnormality of biogeochemical effect, thus it appear abnormality in the spectral information of remote sensing image. For instances, the spectral reflectance of the poisoned leaves is 5%-30%lower than that in the normal areas in band 4 in spectrum curves of normal and anomalous