Performance Analysis of Biogeography Based Land Cover Feature Extractor for Building Hybrid Intelligent Models

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ABSTRACT

This paper is an analytical study of the performance governing factors of the biogeography based land cover feature extraction technique which is characterized by its ability to perform differently on different natural terrain features contained in a satellite image. From the discussion, we establish the fact that the classification efficiency of BBO for a given land cover feature is inversely proportional to the degree of disorder and directly proportional to the similarity index of the digital number (DN) values of the pixels comprising that land cover feature when viewed in any of the bands of the multi-spectral satellite image. In order to verify our proposed hypotheses, we calculated the entropies and similarity indices for each of the land cover feature in two bands on two different datasets and found the same results in both the bands for each of the datasets we took, thus validating the theory. This finding is of prime importance since a prior analysis of the performance of biogeography based feature extraction technique on different types of terrain under consideration will improve the analyst’s decisive capabilities for the selection of the most appropriate technique for the feature extraction task in hand. This in turn can be applied for building efficient artificially intelligent hybrid classifiers by applying the BBO technique on the extraction of those features on which it shows maximum classification efficiency as demonstrated in the paper.

Keywords: Entropy, Evolutionary Biogeography Based Optimization, Evolutionary Classifiers, Hybrid Classifiers, Land Cover Feature Extraction, Similarity Index, Swarm Intelligence, Terrain

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1. INTRODUCTION

Researchers have been continuously searching for new techniques that can extract maximum information from the remotely sensed image (Long, W., et al., 2004; DeMeters et al., 2006). Various swarm intelligence techniques such as the ACO (Dorigo, 2004; S. Parpinelli et al., 2002; Xiaoping Liu et al., 2008), PSO (Bratton, J. Kennedy et al., 2007; Omkar, S.N., 2007; Wang, Dong et al., 2008) and hybrid ACO2/PSO optimization (Omkar, S.N., 2007; Bansal, Shelly, et al., 2009) have been used for solving the problem of satellite image classification using the concepts of information sharing as demonstrated in our paper (Goel, L., et al., 2011b). In order to choose the best classifier for extracting land cover features, one should study the strengths and weaknesses of these algorithms and hence conducting a performance analysis of these algorithms is very important (Lillesand, et al., 2008).

In our recent work, we had adapted the original BBO algorithm (Simon, D., 2008) and applied it for landuse / landcover feature extraction from satellite images (Panchal, V.K., et al., 2009; Goel, L., et al., 2010a; Goel, L., et al., 2012). Enriched with our experience of the above mentioned works (Panchal, V.K., et al., 2009; Goel, L., et al., 2010b), we concluded that the main characteristic of the BBO technique for satellite image classification is that this technique is flexible to classify the desirable features more efficiently than the other features and hence it shows a wide range of efficiencies in classifying different features of an image. In this paper, we present a mathematical framework for the behavioral analysis of the BBO technique over natural terrain features for satellite image classification which shows that the BBO based classifier classifies the homogeneous regions more efficiently than the heterogeneous regions of the image. Below, we summarize the main contributions of the paper:

1. Performance analysis of BBO to establish that the classification efficiency of BBO based feature extractor for a given land cover feature is proportional to the degree of similarity index divided by the entropy for that feature;
2. We studied the behavior of BBO for individual land cover features of vegetation, water, urban, rocky, barren and snowy regions on two different datasets of Alwar and Patalganga region and calculated their entropies and similarity indices;
3. Based on the above fact, we concluded that BBO is able to classify the homogeneous regions more efficiently than the regions which show a greater degree of heterogeneity;
4. The performance governing model of BBO was applied to our hybrid classifier (Goel, L., et al., 2012) which further validated our performance analysis.

The organization of the paper is as follows: Section 2 presents a general presentation of BBO. Section 3 presents the biogeography based framework for land cover feature extraction. This section hence presents the behavioral analysis of biogeography based feature extractor. We also describe the proposed methodology in detail in this section. Section 4 presents the implementation details. Section 5 demonstrates the application towards building efficient hybrid bio-inspired classifier and also presents a comparison of classification results. Section 6 presents the conclusion and future scope of the work. See Appendix for abbreviations of key terms.

2. BIOGEOGRAPHY BASED OPTIMIZATION

BBO (Simon, D., 2008) is an evolutionary algorithm motivated by the migration mechanisms of ecosystems. In BBO each candidate solution is called as a habitat and is characterized by a habitat suitability index (HSI) which is determined by factors called as the suitability index variables (SIV). Habitats with a high HSI are characterized by greater number of species, higher immigration rate, lower emigration
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