Land Cover Mapping of Isfahan City Using Artificial Multilayer Perceptron Neural Network and Fuzzy ARTMAP Classifiers

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Extended Abstract

Introduction

Physical development of cities is inevitable and a dynamic process which will change the land cover areas. Urban growth must be led by the most appropriate land use planning. Urban land cover/use maps are used for current and future land use and urban planning. Remote sensing technology and application of satellite data in mapping land cover often will reduce costs, save time, and increase accuracy and speed. There are several methods to classify land cover. If we classify the methods of supervised classification algorithms based on complexity and accuracy, they can be divided into two main methods (the average distance to the minimum, maximum likelihood, etc.) and advanced methods (neural network, fuzzy classification methods and knowledge base methods). In support of image classification, two different methods including, Fuzzy ARTMAP classifier and Multilayer perceptron neural network classifier were used. In this study, in order to produce land cover map of Isfahan city, digital image of LISS-III scanner that was acquired on 8th August 2008 were employed.

Methodology

The study area is 34,500 ha within the Isfahan city. We use image sensor LISS-III of satellite IRS-1D to do land cover classification. First of all, geometric correction was applied. Then, the satellite data was studied using spectral and spatial profiles to ascertain the digital numbers (DNs) of different land cover categories prior to classification. Training samples were selected. In support of image classification, two different methods including, Fuzzy ARTMAP classifier and multilayer perceptron neural network classifier were used. Finely, land cover map of the study region was classified into five classes: water, residential area, barren lands, vegetated areas and road.

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The Fuzzy ARTMAP
Adaptive Resonance Theory (ART) based neural network as developed by Grossberg and Carpenter (1991) has evolved from the biological theory of cognitive information processing. Fuzzy ART is a clustering algorithm that operates on vectors with fuzzy analog input patterns (real numbers between 0.0 and 1.0) and incorporates an incremental learning approach which allows it to learn continuously without forgetting previous learned states. Fuzzy ARTMAP for supervised classification, has four layers, F1 (input layer) and F2 (category layer), the map field layer and output layer. F1 and F2 layers make up the ART (a) model. The F1 layer represents the input feature vector and thus has neurons for each measurement dimension. These two layers make up the ART (b) model. The output and map field layers consist of \( m \) neurons each, where \( m \) is the output class dimension. There exists a one-to-one connection between these two layers.

Multilayer Perceptron Neural Network
A multilayer perceptron usually consists of an input layer, one or more hidden layers and an output layer. Order to receive process information and represent.

MLP undertakes the classification of remotely sensed imagery through a Multi-Layer Perceptron neural network classifier using the back propagation (BP) algorithm.

The multi-layer perceptron used in BP back-propagation (BP) learning algorithm is one of the most widely used neural network models. A typical BP contains nodes, indicating unequal connecting weights. The function of the hidden layer nodes is to give an analogy; equivalent to lines that can discriminate points and feature space into several groups.

Back propagation involves two major steps, forward and backward propagation, to accomplish its modification of the neural state. During training, each sample is fed into the input layer and the receiving node sums the weighted signals from all nodes to which it is connected in the preceding layer.

The purpose of training the network is to get the proper weights for both the connection between the input and hidden layer, and between the hidden and the output layer for the classification of the unknown pixels. The input pattern is classified into the class that is associated with the node with the highest activation level.

Results and Discussion
Land cover maps of the study region were classified into five classes (fig. 1). To assess the classified land cover map precision, it was controlled for ground-truthing with 100 control data GPS in 3500 ha and the error matrices were defined.
Figure 1. (a) Classified Land cover map by Fuzzy ARTMAP classifier
(b) by Multilayer perceptron neural network classifier

Geometric correction with RMSE 0.58 pixel was applied, and results show the high accuracy of geometric correction. After choosing the best educational samples, supervised classification with fuzzy ARTMAP classifier and Multilayer perceptron neural network classifier were applied on image LISS-III bands and the land cover maps were obtained on 5 classes. To assess the classified land cover map precision, it was controlled for ground-truthing with a GPS and the overall accuracies were 88% and 93.29% for fuzzy ARTMAP classification, multilayer perceptron networks, respectively.

Conclusion
Fuzzy ARTMAP classifier separated vegetation class from the other cover classes. Residential areas, water and vegetated areas classes were recognized. The influence of surfaces area including roads and residential areas has a large overlap with each other and fuzzy classifier
classifier. User accuracy of Multilayer perceptron networks in all classes higher than the fuzzy ARTMAP. Fuzzy ARTMAP classifier cannot separate residential areas class in the study area due to mixed pixel class with the barren lands and the road. Multi-layer perceptron neural network classification method has the highest overall accuracy and is able to distinguish five types of coverage from each other. Although our results show that using neural networks has higher accuracy classification compared of fuzzy ARTMAP, but The fuzzy ARTMAP method provided a high accuracy for land cover classification in this study. Fuzzy ARTMAP classification accuracy was equivalent to 88.03 percent but the overall accuracy is recommended higher 85 percent for proper classification.

Keywords: Land Cover Maps, Fuzzy ARTMAP, Multilayer Perceptron Neural Network, Isfahan.