Chapter 63

Comparing the MLC and JavaNNS Approaches in Classifying Multi–Temporal LANDSAT Satellite Imagery over an Ephemeral River Area

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ABSTRACT

This chapter analyzes two pixel-based classification approaches to support the analysis of land cover transformations based on multitemporal LANDSAT sensor data covering a time space of about 24 years. The research activity presented in this paper was carried out using Lama San Giorgio (Bari, Italy) catchment area as a study case, being this area prone to flooding as proved by its geological and hydrological characteristics and by the significant number of floods occurred in the past. Land cover classes were defined in accordance with on the CN method with the aim of characterizing land use based on attitude to generate runoff. Two different classifiers, i.e. Maximum Likelihood Classifier (MLC) and Java Neural Network Simulator (JavaNNS) models, were compared. The Artificial Neural Networks (ANN) approach was found to be the most reliable and efficient when lacking ground reference data and a priori knowledge on input data distribution.

INTRODUCTION

In the Mediterranean area, river networks are characterized by an intermittent water flow regime. They are generally named ephemeral streams, being defined as "a stream or portion of a stream which flows briefly in direct response to precipitation in the immediate vicinity" (Levick et al. 2008). They play a significant role in the preservation of the environment and the efficiency

of the ecosystem, providing the same functions as perennial streams, such as the transport of sediment, nutrients and chemicals besides allowing connectivity within the watershed. Ephemeral streams are sometimes interested by floods even if data on channel changes in relation to flow events are still sparse and, due to their hydrological characteristics, most of them are still ungauged (Hooke 2007). Due to the lack of gauge data (Berezowski et al. 2012) their discharge is often estimated using the Soil Conservation Service-curve number (SCS-CN) method (Mishra & Singh 2006), with several factors affecting run-off generation, including soil type, land use, surface condition and antecedent moisture condition, being incorporated in a single parameter, named Curve Number (CN), whose estimate has to be based on uniform spatially distributed information. In the past, several methods were used for indirectly estimating the hydraulic characteristics of a defined land-use type (Prisloe et al. 2000), but changes in time within the same land-use class were not taken into account (Dams et al. 2008). Many methodologies can be used to generate land cover maps focused on retrieving impervious surface but some of them are expensive and generally not practical for mapping large areas (Bauer et al. 2002). The historical LANDSAT satellite data archive has played an important role across many disciplines to date, being used as a tool to achieve improved understanding of the Earth's land surfaces and human impacts on the environment (Gueler et al. 2007; Kidane et al. 2012; Karaburun et al. 2010). The instrument characteristics (30 m spatial resolution for VIR/NIR and 120 m for TIR, 185 km swath width and 16 day repeat cycle) are intentionally specified to detect the local and regional patterns of change characterizing the Earth's land processes.

The general objective of satellite data Land Use/Land Cover (LULC) classification is to assign all pixels in the image to particular classes or themes. The resulting classified image is essentially a thematic map of the original image. No single classification algorithm can be considered superior to the others as effective for any kind of task; hence, in order to choose the best algorithm for a specific task, users are advised to consider not only classification accuracy, but also comprehensibility, compactness, and robustness in training and classification (Chan et al. 2001).

The use of automated or semi-automated image interpretation methods, utilizing the multi-spectral information content of satellite imagery, substantially reduces the effort to derive the impervious surface cover (Figorito et al. 2012). Due to its broad applicability to many fields, machine learning has attracted great attention from both researchers and practitioners (Koc-San 2013; Koc-San 2014; Fernandez Luque et al. 2013; Nolè et al. 2012; Nolè et al. 2014) and, among various approaches, the Artificial Neural Networks (ANN) has been increasingly applied in recent years (Weng 2009). This method has several advantages, including its nonparametric nature, arbitrary decision-boundary capability, adaptation to different types of data and input structures, fuzzy output values, and generalization for use with multiple images (Paola & Schowengerdt 1995; Tayebi et al. 2013; Elatawneh et al. 2012). Although many neural-network models have been developed, the Multilayer Perceptron (MLP) feed-forward neural network is the most frequently used (Yuan et al. 2009; Sudheer et al. 2010). The method behaves as general pattern recognition systems assuming no prior statistical model for the input data and it can be considered as a suitable technique for change detection analysis when no ground reference data are available for historic satellite imagery.

The MLP has been applied in land-use/land-cover classifications (Kavzoglu and Mather 2003; Zhang & Foody 2001; Joshi et al. 2006), impervious surface estimation (Weng et al. 2008), landslide risk analysis (Biswajeet & Saro, 2009) and change detection (Li & Yeh 2002; Nemmour & Chibani 2006).

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