The application of artificial intelligence in public administration for forecasting high crime risk transportation areas in urban environment

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Abstract

Public administration has adopted information and communication technology in order to construct new intelligent systems and design new risk prevention strategies in transportation management. The ultimate goal is to improve the quality of the transportation services and also to ensure public transportation safety. In this research, a combination of spatial clustering methods and artificial neural network models was used in order to predict the high crime risk transportation areas. Geographic information systems were used to perform spatial analysis so as to identify the regions with a high concentration of crime incidents. Artificial intelligence was used in this study in order to build artificial neural network predictive models. The neural network predictive models were evaluated by using the Mean Squared Error (MSE) in order to find the optimal forecasting model. The optimal forecasting model was used in order to predict the high crime risk transportation areas. The scaled conjugate gradient algorithm was utilized as the training algorithm for the construction of the feedforward neural network models, since it is considered as one of the fastest learning algorithms compared to several other algorithms such as backpropagation learning algorithms.

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1. Introduction

Several researches have studied the transportation risk management strategies that must be adopted by the authorities in order to improve public transportation safety and reduce transportation risk in urban areas (Abkowitz 2002; Liu et al. 2011). Crime violence against citizens in urban environment has a negative impact on people’s lives and should be considered as an important factor in public transportation management and planning and in constructing the transportation infrastructure in urban areas. The development of communication and information technologies has led to the development of new technology-based management systems in public administration (Kouziokas 2016) and also to new intelligent systems for transportation management in urban areas which facilitate decision making in choosing the optimal routes in public means of transport (Grant-Muller and Usher 2014).

Furthermore, the development of geographic information systems and geospatial technologies has led to new crime analysis and prediction methods focusing on the spatial dimensions of crime incidents (Leitner 2013; Wolff and Asche...
Several researches studied the application of artificial intelligence in crime analysis and forecasting in combination with geographic information system based methods and techniques (Lee and Phillips 2008; Liu 2008; Lo et al. 2015; Palocsay et al. 2000).

Several researchers have proposed intelligent systems or techniques to improve public safety of citizens when travelling by public means of transport in urban areas (Di Bella et al. 2014; Hadayeghi et al. 2013; Lord and Persaud 2004; Sham et al. 2013). Sham et al. (2013) proposed a smart tracking security system to improve travel safety against crime occurred on buses, taxis and trains. The aim of the study was to develop an improved GPS- based tracking system for people that travel in urban areas. Hadayeghi et al. (2013) developed prediction models to forecast the number of accidents in planning zones in the urban area of the city of Toronto by using weighted regression method to investigate the spatial variations in the estimated factors. Lord and Persaud (2004) estimated future traffic safety of transportation networks in urban areas by using transportation planning models. The results revealed that it is possible to predict crashes on transportation networks, but the accuracy of the forecasts depends on the precision of the traffic flow estimations.

In this research, crime risk prediction is examined as an important factor that contributes to safer travelling in urban areas in public transportation places where many people are gathered and must be protected efficiently by the police forces from crime committers.

2. Theoretical background

2.1 Geographic Information Systems

Spatial data include the coordinates and the topology in their features and can be processed and analyzed by Geographic Information Systems (GIS). Geographic information systems are considered as an emerging technique for visualizing and analyzing spatial features. Geospatial analysis methods are used to analyze spatial characteristics and produce results regarding the optimal allocation of a place or spatial distribution of geographic features.

2.2 Spatial clustering

Spatial clustering is defined as the process of aggregating a set of spatial objects into groups (clusters) according to their geographical attributes (Wang and Wang 2011). There are several methods of spatial clustering such as hierarchical, density-based (e.g. kernel density estimation), thematic mapping and grid-based (Chainey et al. 2008; Han et al. 2009). Hotspot Analysis is a geospatial analysis method that uses techniques to discover areas with increased concentration of incidents (clusters). The most commonly used spatial analysis methods for hotspot analysis are kernel density estimation (Borruso 2008; Silverman 1986) and Getis-Ord Gi* statistic (Getis and Ord 1992).

2.3 Artificial neural networks

Artificial Neural Networks (ANNs) can be defined as computing systems that simulate the structure of the brain system. A neural network elaborates data from the input parameters. The information traverses via connections to produce an output according to the input values (Basheer and Hajmeer 2000; Svozil et al. 1997). Artificial neural networks are used in this study to forecast values related to crime data in transportation stations since they can model non-linear relationships between input and output. A feedforward multilayer perceptron (MLP) was utilized in this study, as many researchers consider it as one of the most appropriate for time series forecasting problems (Hornik 1991; Koskela et al. 1996). A typical artificial neural network consists of the input and the output layer and the hidden layer or layers. Every layer has a specific number of neurons. In a feedforward neural network, the input signal traverses the neural network in a forward direction from the input layer to the output layer through the hidden layer or layers. A typical feedforward neural network and its structure is illustrated in Figure 1.
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