Chapter 42
Neural Network (NN) Based Route Weight Computation for Bi-Directional Traffic Management System

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ABSTRACT

Low-cost, flexible, easily maintainable and secure traffic management support systems are in demand. Internet-based real time bi-directional communication provides significant benefits to monitor road traffic conditions. Dynamic route computation is a vital requirement to make the traffic management system more realistic and reliable. Therefore, an integrated approach with multiple data feeds and Backpropagation (BP) Neural Network (NN) with Levenberg-Marquardt (LM) optimization is applied to predict the road weights. The results indicate that the proposed traffic system/tool with NN based dynamic weights computation is much more effective to find the optimal routes. The BP NN with LM optimization achieves 96.67% accuracy.

INTRODUCTION

Traffic jam is an on-going challenge, and is not showing any signs of improvement. It results losing valuable time being stuck in traffic jams and increases CO2 emissions due to the present traffic situation. As a result, an up-to-date technological based traffic management support system/tool has become a need for metro cities.

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A new internet-based (WebSocket (HTML5 Web Sockets, 2015) over HTTP) traffic management support system with real time bi-directional communication is implemented in Rahman et al., (2015a; 2015b; 2015c) to assist the traffic system to reduce the traffic and create a more sustainable environment. It also supports low cost implementation, flexibility, maintainability and infrastructure security. Thus, provides significant benefits over the existing surveillance technologies in use to monitor road traffic condition. However, this work is based on static or manual weight updates. Optimal paths/routes are calculated from the given static weights.

Weights are calculated from current road situations including-construction status, damaged status, accident status, traffic status, environmental disaster status etc. The value of the statuses are intelligently crawled by search engine, with metadata indexing (title, description, keyword etc.), directly from the multiple data feeds (like web site, RSS feeds, web service etc.). Crawled data are simplified (structured) and stored in a historic table. The decision to update the weights is decided by the DT (Rahman & Akhter, 2015a; 2015b; 2015c) and Dijkstra algorithm (Dijkstra's Algorithm, 2015) is applied to calculate the optimal path/route using the dynamic route weights. However, DT takes long time to be trained for large data sets. It is also not good for online learning as continuous data needs frequent updating/changing in the model. Since any data includes some exceptional situation will force the DT model to be fall apart and needs to be constructed again. In addition, ID3 (Rahman, 2012) does not apply any pruning procedures nor does it handle numeric attributes or missing values (Rokach, & Maimon, 2011).

Evolutionary searching techniques e.g., genetic algorithm (Goldberg, 1989) can perform a directed search of the solution space and takes a long time to find an acceptable solution for each testing. However, when we have a number of items in different classes, NN can learn to classify items it has not seen before. In addition, NN takes some time to learn, but then it can almost instantly classify new inputs. In addition, NN is capable of reflecting the information of new instance on a model very efficiently by just changing the weight values. Thus, the DT model is replaced by the Backpropagation (BP) Neural Network (NN) and is implemented over the simplified data to adjust the route weights in database. Moreover, the Levenberg-Marquardt (LM) optimization is applied on BP to reduce the number of hidden layers as well as the training iterations. In addition k-fold cross validation and confidence interval is used to trace the NN overall performance.

BACKGROUND STUDY

The traditional traffic information services available through the radio and television, several web sites offer on-line current traffic information, not predicting traffic condition. Over the time different solutions in (Verma, 2012; Aloul et al., 2012; Dhar, 2008; Romão, 2006; Angel et al., 2003) have been proposed to solve the traffic management problem. The solutions vary in their core technologies, as some of them used infrared sensors, CCTV cameras, machine vision (image processing), GSM and/or cellular towers, RFID gateways, sound sensors, aerial surveillance and remote sensing etc. In (Romão, 2006), high quality CCTV cameras were used to capture vehicle images and machine vision technique was applied to process them on a terminal for necessary information. The procedure was very expensive due to high cost of CCTVs and also required heavy installations and regular maintenances. In addition, machine vision had limitations during heavy snowfall, sand storm, rainfall, and foggy weather. In (Aloul et al., 2012; Dhar, 2008), RFID Sensor was used. This technology required RFID gates to be installed and