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Methodologies For Traffic Congestion Prediction For A Iot Based Smart City Using Machine Learning and CNN

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Abstract

This paper aims at providing a machine learning model for the traffic congestion for Iot based smart city. We assume that the city is well equipped with the sensors on the streets and all the necessary parts of the city. The convolutionneural networks (CNN) and various machine learning classification and prediction algorithms are used to check which algorithm gives more accuracy for the data set generated.

Keywords—convolution neural networks (CNN), machine learning,prediction,classification,internet of things (Iot), smart city, sensors**.**

I. INTRODUCTION

Traffic congestion is the major problem of almost all the metropolitan cities. The ratio of number of vehicles on road to the lane division of road is very less and this is one of the major causes for traffic congestion. Improper city planning and no proper traffic regulations are also the key factors to be considered. The fact that traffic can be re-routed at various city junction points which may reduce the traffic congestion to a particular extent. Google maps which uses dijkstra's algorithm to find shortest distance between source and destination doesn't show the traffic congestion ahead when a vehicle is at a particular junction, it is only concerned with the traffic congestion along the path specified. Thus, this paper focuses on getting real time traffic congestion at a given junction and re-route the traffic into the less congested path and thus avoiding the congestion along the path. While we proceed further we assume that the city to be smart city which has sensors embedded on the pathway and near the junctions of the traffic signals. The data generates from these sensors is used as data for training the data model and predicting the result.

II. WHY CLASSIFICATION AND REGRESSION?

Machine learning has made remarkable progress in the field of data analytics. The data available from various sources are used to identify the trends and patterns which can be used analysis, prediction or any sort of data computations. Machine learning algorithms are of three types supervised learning, unsupervised learning and reinforced learning. Supervised learning is that the machine learning task of learning an operation that maps associate input to associate output supported example input-output pairs. The distinction between the 2 tasks is that the incontrovertible fact that the dependent attribute is numerical for regression and categorical for classification. The data generated from various sensors are transmitted on to the network and act as data source for these classification and regression models for predicting the result. Various classification algorithms like decision trees, random forest etc. is used for classifying the data and linear regression is used to predict the presence of traffic congestion based on the model trained.

a. WHY CNN?

The accuracy obtained from classification and regression models is very less when compared to the accuracy obtained from the neural networks. In deep learning, a convolution neural network (CNN or ConvNet) may be a category of deep neural networks, most commonly applied to analyzing visual imagery. A convolutional neural network consists of associate input associated an output layer, as well as multiple hidden layers. The hidden layers of a CNN typically consist of convolution layers, RELU layer i.e. activation perform, pooling layers, fully connected layers and normalization layers. Description of the method as a convolution in neural networks is by convention. Mathematically it's a cross-correlation instead of a convolution. We're trying to propose a convolution neural network (CNN)-based method that learns traffic as images and predicts large-scale, network-wide traffic speed with a high accuracy. Spatiotemporal traffic dynamics area unit regenerate to photographs describing the time and area relations of traffic flow via a two-dimensional time-space matrix. A CNN is applied to the image following two consecutive steps: abstract traffic feature extraction and network-wide traffic speed prediction. The CNN can train the model in a reasonable time and, thus, is suitable for large transport network.

When compared to machine learning supervised algorithms the efficiency obtained from CNN is more when compared to the classification algorithms applied on the data. We compare the various algorithms such as k-

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nearest neighbors, ordinary least squares etc. Deep learning ways exploit a lot of deeper and a lot of complicated design than ANN, and can achieve better results than traditional methods. However, this tries still targeted chiefly on the prediction of traffic on a road section or atiny low network region.

III.IOT BASED SMART CITY

Internet of things (IoT) has made a remarkable progress in making different devices work on a common platform connected to each other using internet. In this paper we are proposing an idea for predicting traffic congestion by assuming the city to be a smart city. Smart city references to the point that city is well technically developed in all sorts of technical advancements. Various sensors like IR sensors, moisture and humidity sensors to measure the temperature, rainfall sensor, RFID sensor etc., are embedded all over the city. IR sensors and RFID sensors are embedded along the path at all the traffic junctions to monitor the number of vehicles on the path. RFID sensors emit radio waves which can be used to calculate the speed of the vehicles and IR sensors can be used to detect the density of vehicles by calculating number of vehicles on road.

IV. WORKINGOF MACHINE LEARNING MODELS V/S CNN

A. Machine learning:

The entire city is divided into divisions and each division has junctions and is termed as nodes. A vehicle at a given node can have eight possible directions to traverse and is marked using the vehicle identification number. The sensors are set up on the road and the continuous data is passed on to the real time database such as firebase. Each path is set up with a RFID tag at the junction which is used to calculate the speed of the vehicles by emitting radio waves. Thus each path has been initially setup with a threshold speed. If the vehicle density is more than the usual then the speed of the vehicles moving along the path will be less. If the speed of the vehicles is less than the threshold speed then we declare that path to be congested and update the same to the network.

If the speed of the vehicles on the given path is usual then the path is declared to be less congested and the traffic at the junction is redirected towards the less congested path which reduces the traffic congestion to a certain extent. The data collected from the sensors is utilized and is divided into two sets of data. One set of data is used for training the data model and another set of data is used for fitting prediction model

Machine Learning Techniques used			
Techniques	**Precision**	**Recall**	**Accuracy**
Decision Tree	100	99.4	99.88
Random forest	100	99.4	99.88
SVM	100	99.4	99.88
MLP	99.9	99.4	99.86
Logistic Regression	**100**	**99.5**	**99.9**

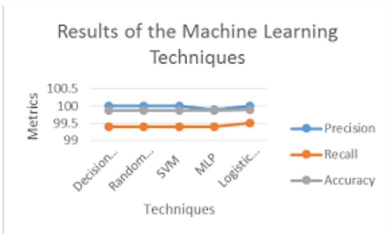

Figure 1: Results of various machine learning algorithms.

B. CNN

While the CNN uses the images for calculating the presence of congestion. A vehicle mechanical phenomenon recorded by a floating automotive with a fanatical GPS device provides specific info on vehicle speed and position at sure time. From the mechanical phenomenon, the spatiotemporal traffic info on every road phase may be calculable and integrated more into a time-space matrix that is time-space image. In the time dimension, time usually ranges from the beginning to the end of a day, and time intervals, which are usually 10 sec to 5 min, depend on the sampling resolution of the GPS devices. Generally, slim intervals, for example 10 sec, are meaningless for traffic prediction. Thus, if the sampling resolution is high, these knowledge could also be collective to get wider intervals like many minutes.

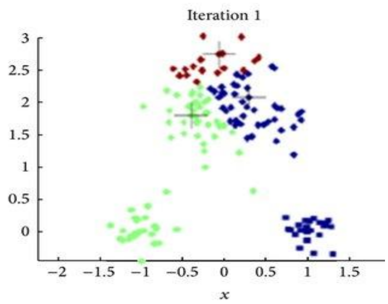

Figure 2: classification of data samples

In the space dimension, the selected trajectory is viewed as a sequence of dots with inner states including vehicle position, average speed, etc. This sequence of dots can be ordered simply and directly into linear and fitted to y-axis, but may result in high dimension and uninformative y-axis, because the sequence of dots is lengthy and a large number of regions in this sequence are stable and lack variety. Therefore, to form coordinate axis each compact and informative, the dots are grouped into sections, each representing a similar traffic state. The sections are then ordered spatially with reference to a predefined start point of a road, and then fitted into y-axis. Finally, a time-space matrix is made victimization time and area dimension data.

Two salient characteristics namely, (a) locally connected layers, which means output neurons in the layers are connected only to its local nearby input neurons, rather than the entire input neurons in fully connected layers. These layers will extract options from a picture effectively, as a result of each layer tries to retrieve a unique feature relating to the prediction downside. (b) pooling mechanism, which largely reduces the number of parameters required to train CNN while guaranteeing that the most important features are preserved (b) CNN is modified in the following aspects to adapt to the context of transportation. First, the model inputs ar totally different, i.e., the input images have only one channel valued by traffic speeds of all roads in a transportation network, and the pixel values in the pictures vary from zero to the utmost traffic speed or speed limits of the network. In distinction, within the image classification downside, the input images commonly have three channels, i.e. RGB values vary from zero to 255. Although variations exist, the model inputs are normalized to prevent model weights from increasing the model training difficulty. Second, the model outputs are different. In the context of transportation, the model outputs are predicted traffic speeds on all road sections of a transportation network, whereas, in the image classification problem, model outputs are image class labels. Third, abstract features have different meanings. In the context of transportation, abstract features extracted by the convolution and pooling layers are relations among road sections regarding traffic speeds. In the image classification downside, the abstract features can be shallow image edges and deep shapes of some objects in terms of its training objective. All these abstract options may be important for a prediction downside. Fourth, the coaching objectives disagree owing to distinct model outputs. In the context of transportation, as a result of the outputs ar continuous traffic speeds, continuous value functions ought to be adopted consequently. In the image classification downside, cross-entropy price functions can be sometimes used.

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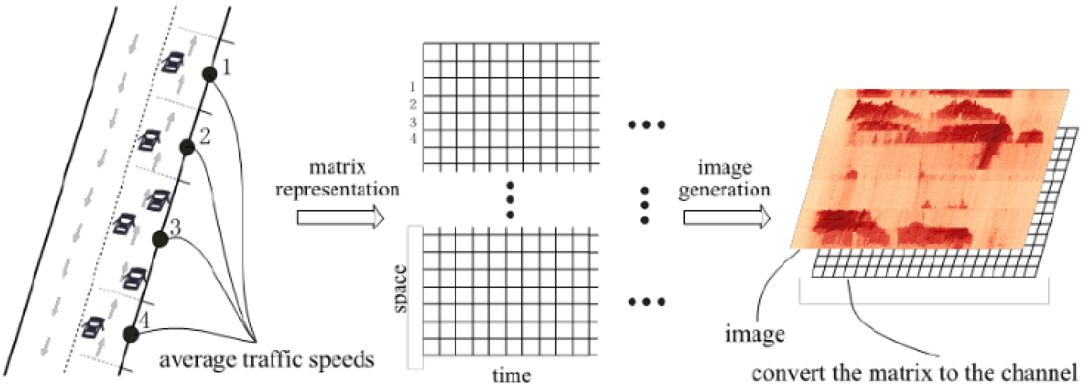

Figure 3: conversion of data collected into sparse matrix and mapped into image

Thus the images get processed and thus interpret the congestion of traffic on the specified path. The images processed may contain redundancy and may not give expected prediction thus a more efficient algorithm is to be developed, a normal CNN can't provide more accuracy.

VI. CONCLUSION

The paper aims to provide a solution to find traffic congestion of all the paths connected to a node when a vehicle approaches to a junction thus re-routing the traffic and reducing the congestion. The machine learning models may provide an accuracy of 40-43%,whereas cnn provides 60%-64% of efficiency but a much efficient algorithm is required to obtain more accuracy.

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