Neural Network-Based Real-Time Traffic Prediction

By
M.QasimTanvir
(BSCS**)**

Supervised
by
Muhammad Arsalan Ahmad

ABSTRACT:

Prediction of traffic in real time is very important for less traffic jams and make roads safer. Old methods had a hard time dealing with the complicated traffic in cities but Neural Networks and AI have transformed this field. Models like RNNs, LTSMs and hybrid models use data from past, previous records, data regarding climatic conditions, events details (sports, concert etc.) and GPS devices to predict the traffic efficiently. This research is about developing Neural Based Network model to make traffic flow better, improve traffic management in the smart cities. For this very purpose, hybrid model plays very crucial role in predicting traffic. These hybrid models use CNNs and LSTMs networks for traffic prediction. Challenges such as data quality, data maintenance, model understanding and continuously data changing are still the main issues in predicting traffic. But the improvements and advancements in Artificial Intelligence and deep learning offer a better future and better solutions for managing real time traffic prediction and thus roads become more safer and with less traffic jams.

Table of Contents

1. Overview

Prediction of traffic is very vital and critical for making the roads safe and not crowded. Patterns of traffic can be predicted to avoid the traffic jams, so it can save time and thus pollution can be reduced. Methods used in the past which did not work well and which did not to be provedefficient with changing conditions of roads were used to predict the traffic conditions. So, to improve these situations and conditions, and thus needing and requiring more accurate results, traffic prediction can be made easier with the help of Artificial Intelligence.

To achieve these very results, Neural Networks are very useful and important. Neural Network is a sub-domain/field of AI which learns from data and make predictions on the basis of previous data. Traffic on roads, accidents and mishaps and conditions regarding weather can be used to predict what will be the traffic in the next coming days or in future. This makes the work easier to predict future traffic, so that smart cities and urban areas in which traffic jams accurs often can be reduced.

2. Purpose/Goals

Following are the main objectives of this research:

- To develop a model using neural networks that can predict traffic for future.
- To check and determine what nature of data is required for improving the accuracy and efficiency.
- To examine the ways how these models help with real time traffic management and tocheck navigation processes (access quick location using google maps).

3. Review of Literature

3.1. Old models for Traffic Prediction

Predicting difficult urban traffic was not easy for outdated and old methods which were very helpful and more effective for simple traffic predictions.

3.2. Machine Learning Techniques

Using techniques and methods related to machine learning have improvedpredictions regarding traffic but they also still have some issues.

3.3. Concept of Deep learning

With the help of deep learning, real time traffic predictions is now very easy nowadays.

3.4. Current Scenarios for predicting traffic

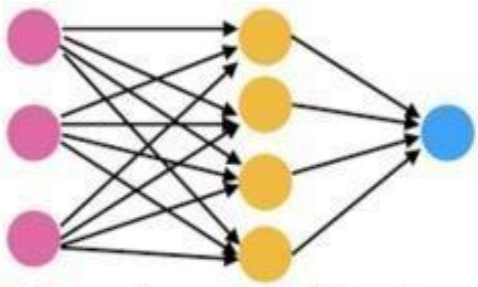
Using hybrid models, which uses both time and spatial data are now becomingpopular in the market, because these models get data from GPS, and internet related devices (IOT) which have been improved as time goes.

4. Overview of Traffic Prediction Using Neural Networks

4.1. Neural Networks:

Neural Networks is a branch of AI. Similarly, AI, these networks get data, thenprocesses it and give results. **Example of neural networks is like digital brain.**

In these networks, there are layers called neurons, that are over one another. Thus, the network grows very efficiently as the time passes and predict traffic more accurately.



Structure of a neural network with 1 input layer, 1 hidden layer and 1 output layer

There are 3 layers of neural network which are connected with each other and theircombination predicts the traffic.

Input Layer:

This layer takes the data as input, whether it is from past or current data.

Hidden Layer:

This layer serves as the processing between input and output layer.

Output Layer:

This layer is used to predict the traffic in real time such as volume of traffic or condition of traffic in any area.

4.2. Types

Following are the types of Neural networks used widely for traffic prediction:

- **FNNs:**
  It stands for Feedforward Network, these are simple network models used to predicts traffic fastly and accurately.

- **RNNs:**
  It stands for Recurrent Neural Network, these are used to predict traffic on hourly basis and some days.

- **LSTMs:**
  It stands for Long Short-Term Memory Networks. From the name it suggests, these networks predict traffic for weekly cycles, and have a long term memory to predict traffic even with longer time very efficiently and so they are more flexible.

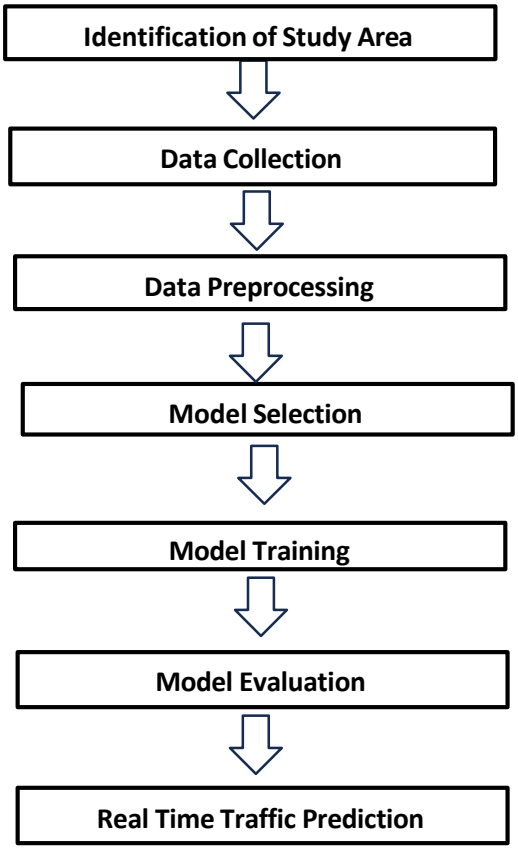
- **CNNs:**
  It stands for convolutional Neural Network, these are used to predict traffic over the whole regions and entire city.

4.3. Why need of Hybrid Models

Hybrid means combining more than one model, hybrid model is very important part for predicting traffic prediction in real time. In neural networks, hybrid model combines CNNs and LSTMs models, for predicting the traffic and manage its smoothness efficiently. In this case, CNNs are used for spatial **(occupying space/location)** data collection while LSTM are used to handle temporarily sequence data and combiningthese networks make a hybrid model and traffic can be predicted for coming days.

5. Methodology/Flowchart

Below is the working process of real time traffic prediction



6. What information do we need for real-time traffic prediction?

To predict traffic conditions, following Data need for this very purpose includes:

- **Past/Historical Data**

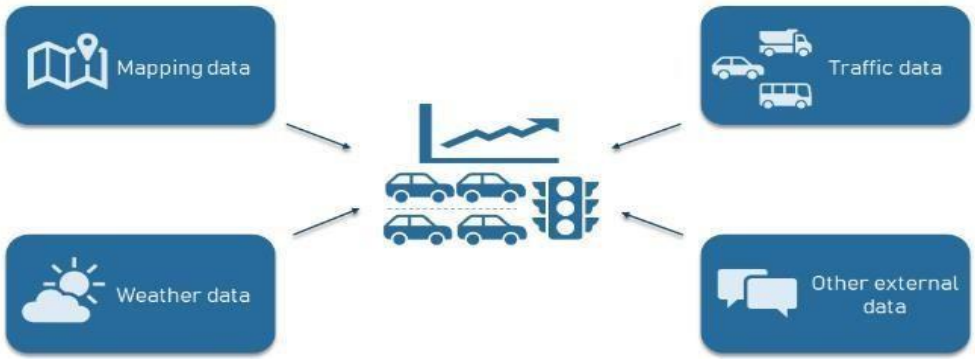
  This includes past and previous traffic conditions/records which reviews and checks the situations of specific areas throughtout the day. By analyzing these records, model can easily predict the traffic conditions for future.

- **Climate Data**
  This includes weather conditions like snow and rain, which can make traffic slower. By training the data on the basis of these information, a model can predict traffic and can tell easily where there is raining conditions and where there is snow, so model can easily suggest these and traffic can be managed efficienlty.

- **Data regarding special events**
  This includes information relating special events such as concerts, football match, cricket match and other events related to sports, these events cause traffic issues, by predicting and checking these events the model can mange the traffic very smoothly and easily and thus traffic jams can be reduced.

- **Current Data**
  This includes real time data and information which is gathered from GPS devices in cameras and cars and sensors. These devices tell the current and real time information what is happening on the roads and what are traffic conditions on that road.

- **Other Data**
  This refers to Geographical data and information and checks the accident reports, their notifications and traffic light signals. By predicting and analyzing these data, model can easily predict/mange movement of traffic**.**



7. Real Time/current Data for Predicting Traffic

Below is the table that shows how the various data are first analyzed andthen tells the traffic predictions.

DATA TYPE	Input data	Predict Traffic
Traffic volume	2000 vehicles/hour	85% traffic
Traffic speed	30 km/h	Slow moving traffic
Traffic signals	Green light	45 sec wait
Weather conditions	Raining heavily	Slow speed (8 % km/h)
Event Information	Cricket match	35% percent increase in traffic
Traffic density	60% traffic	15 min delay

By analyzing the current data such as climate conditions and no. of vehicles and their speed,

model predicts the current traffic situations and traffic is managed smoothly and thus reducing traffic jams, accidents and other mishaps can be reduced on very large scale.

8. Data Preparation

For good performance and efficiency, neural network requires data accuracy in predicting future traffic prediction:

- **Normalizing data/Data Adjustment:**
  For traffic data, there are different units to be used for representation, such as kilometer pr hour(km/h) and vehicles per hour (for no of vehicles), by these representations, model can be easily analyzed the data and predict the traffic.

- **Time series analysis:**

  As the traffic changes over time and time, the model analysis the situationsand can tell easily at which there is heavy traffic and at what time there is low traffic.

- **Data Incompletion:**
  Sometimes, the data is not complete which cause errors and predicting inaccurate traffic predictions. By ensuring that data is accurate, trained the model by appropriate techniques.

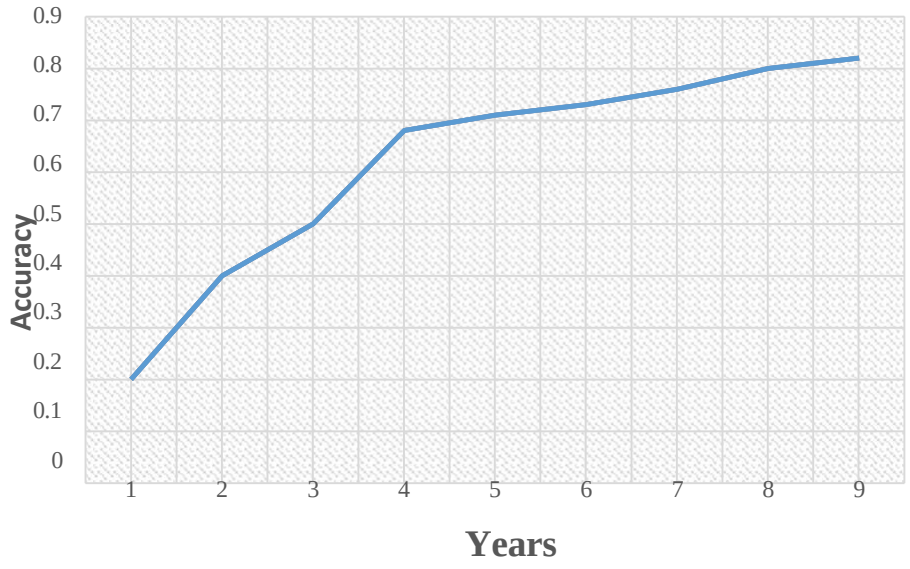
- **Data Transformation:**
  This process is also known as feature engineering. It means getting and generating valuable data from previous information and systems. By getting data from past, data can be improved its efficiency significantly.

9. Training & Testing Model

9.1. How to train Neutral Network

Training of neutral network model involves changing and adjusting the model according to the past data so that its efficiency can be increased and make accuratetraffic predictions.

For model to train, a lot of data or past information is required, which the model gets it, learn it and make accurate predictions at a right time. Throughout the training process of model, the neural network continuously improved its accuracy and efficiency to predict traffic.

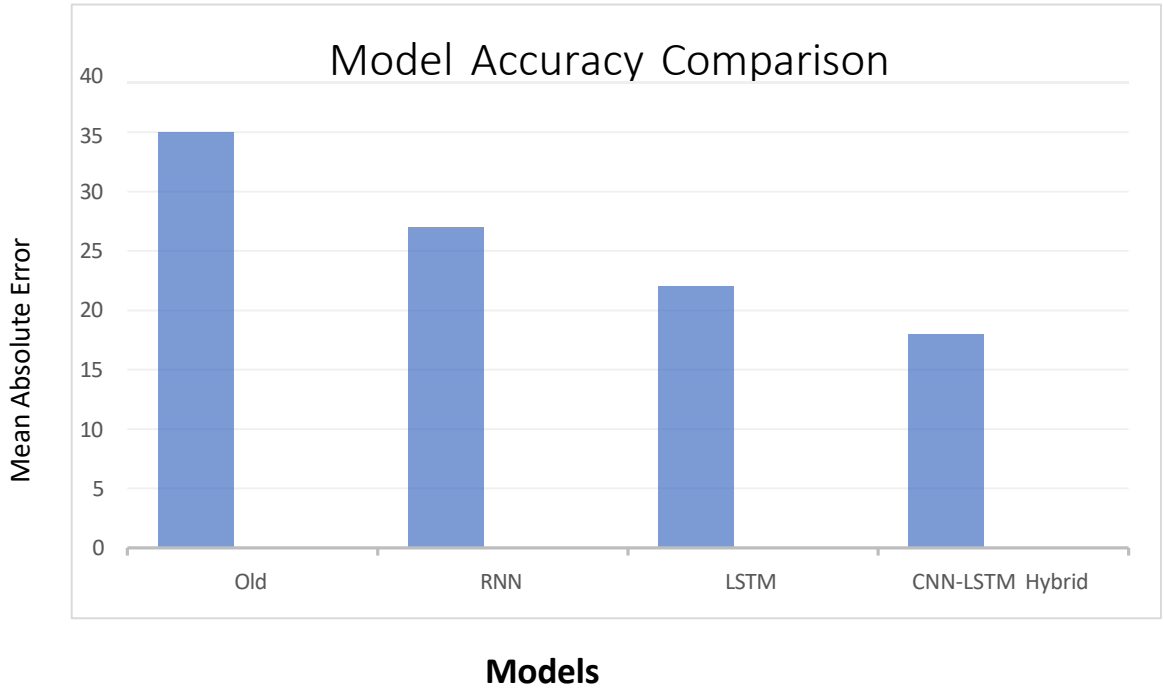


Above chart shows that the model keeps improved its efficiency as time goes of its training.

9.2. How to measure success

Following are the key/important factors that check the success of neural network model whether it is improved or not, or if it is improved then how much:

- **Accuracy:**
  Accuracy of the model means how much the model provides the correct predictions.
- **MAE:**
  It stands for mean absolute error. Mean absolute error refers to average or half, it shows the average size of mistakes or errors a neutral network model do.
- **RMSE:**
  This demonstrates the large errors that occurs between predicted and actual traffic values.



Above table shows different models that are used for traffic prediction, but of all models **CNN-LSTM (Hybrid)** has very less mean absolute error as compared to other models that's why this model is widely and most commonly used for neural network traffic prediction in now-a-days.

10. Traffic Prediction in Real Time

Model can be able to predict traffic in real time when it has fully trained. Following are ways which model predicts:

- **Navigation Apps:**
  App "Google Map" is the perfect example of traffic prediction. By predicting and guessing traffic conditions, anyone can find the quickest ways to get places.

- **Traffic Signals Predictions:**
  In modern world, traffic can be managed smoothly with the use of trafficsignals or lights, traffic can be stopped on the basis of traffic signals and can flow because of this as well. This is all due to use of deep learning and neural networks.

- **Autonomous Vehicles:**
  Self-driving cars and vehicles also work on neural networks. These vehicles adjust their driving speed and behavior, can change their directions and routes toensure smooth traffic flow

11. Problems and Challenges in Traffic Prediction

There are various problems and challenges in predicting traffic in real time:

- **Large Amount of Data:**
  For training of the model, there requires large data to predict the real thetraffic. Such as data collection for entire city or region.

- **Data Quality:**
  Data Quality also matters in predicting traffic because if data is incomplete the model cannot predict traffic situations accurately.

- **Model Understanding:**
  There is also a difficulty for model understanding. Sometimes, model cannot easily understand the data which it gets, and thus can take a long of time.

- **Changing traffic Continuously:**
  As the traffic changes time by time, it can be hard for model to predict traffic. In these situations, models need to upgrade time by time which is very difficult.

12. Summary & Conclusion

To predict real time traffic, using neural networks are used to improve traffic flow, reduce pollution and accidents and many other. Older models are not so accurate as compare to these models' efficiency which ensures smooth travel, making roads safer by reducing accidents, and also results in better traffic management. However, there are some hurdlesin predicting real time traffic but as the technology like ML, AI, Deep learning advances, the future of real time traffic prediction looks very bright and promising.