A Survey on Traffic Flow Prediction By Using Artificial Intelligence

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Abstract- *This paper represents a novel design and control Nowadays traffic flow is major problem. Approximately 1.3 million people die each year because of accidents according to WHO in 2022. Knowing how traffic will move is important for managing traffic, easing congestion, and making transportation smarter. This research focuses on deep learning techniques within AI(artificial intelligence) domain to predict traffic flow. To resolve this method need to develop an accurate model to predict traffic flow. Here I involve the integration of LSTM(long short-term memory) and RNN(recurrent neural network) to capture traffic data and dependencies. Using past traffic information, weather conditions, and special events helps the model get good at understanding and handling tricky and complicated traffic situations. Our main aim to develop a proposed system to predicting accuracy model.*

Keywords- Recurrent Neural Network, Long Short Term Memory, Traffic, Accident Prediction, Deep Learning

I. INTRODUCTION

Traffic flow prediction (TFP) means predicting the volume and density of traffic flow, usually to control vehicle movement, reduce traffic jams, and create the optimal (least time or energy-consuming) route.[1] Traffic flow prediction is an essential part of the Intelligent Transport System (ITS). This helps traffic stakeholders to make safer and smarter use of transport networks can assist ITS in forecasting traffic flow.[3] With the recent advancement in Artificial intelligence, Machine learning (ML), Deep learning (DL), and Big data, research in the field of predicting traffic flow has been expanded extensively.[3] Large cities have exceedingly difficult traffic regulations. many countries have adopted ITS to reduce the costs associated with traffic congestion. This study reviews the application of artificial neural network (ANN), ML, DL and other techniques and models for TFP. To resolve this method, need to develop accurate model to predict traffic flow. Here I involve the integration of LSTM(long short-term memory) and RNN(recurrent neural network) to capture traffic data and dependencies. Finally, we will propose our own predictive model using DL, train and test it, analyse the accuracy and compare the accuracy of our model with other models.

AI(Artificial Intelligence):

Artificial intelligence is the process of creating a computer, computer-controlled robot, or software object that is as intelligent like the human mind.[5]

AI Forms the basis for all computer learning and is the future of all complex decision making.

Application:

- Gaming
- Natural Language Processing.
- Robotics
- Social Media
- Businesses Management
- Voice Assistants
- Health Care
- E-Commerce
- Travel & Transportation

Introduction on Deep Learning:

Deep learning is kind a sub set of the Machine Learning, which is an algorithm inspired by Structure of human brain called ANN (Artificial Natural Network).[5] Is take a More time to the training a model , and take less time to testing a Model as compare to Machine learning. [6]

ANN (Artificial Natural Network): It is a Simply systems inspire by the Biological Natural Network. ANN is a Model that Consist several processing, that receive input and deliver output based on their predefine activation function.[7]

Input layer: In this layer enter input to hidden layer.[7]
Hidden layer: This layer is responsible for the mathematical computation or feature extraction of our inputs.[7]

Output layer: This layer responsible given us appropriate result for the given input.[7]

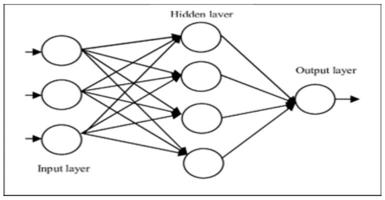


Fig.1.3 Architecture of ANN[10]

II. RNN(RECURRENT NEURAL NETWORK)

RNNs are called *recurrent* because they perform the same task for every element of a sequence, with the output being depended on the previous computations.[11]

Input: *x(t)* is taken as the input to the network at time step *t.* For example, *x1*,could be a one-hot vector corresponding to a word of a sentence.[11]

Hiddenstate*: h(t)* represents a hidden state at time t and acts as "memory" of the network. *h(t)* is calculated based on the current input and the previous time step's hidden state: h(t) = *f*(*U* x(t) + *W* h(t−1)). The function *f* is taken to be a non-linear transformation such as *tanh*, *ReLU.[11]*

Weights: The RNN has input to hidden connections parameterized by a weight matrix U, hidden-to-hidden recurrent connections parameterized by a weight matrix W, and hidden-to-output connections parameterized by a weight matrix V and all these weights (*U*,*V*,*W)* are shared across time. .[11]

Output: *o(t)* illustrates the output of the network. In the figure I just put an arrow after *o(t)* which is also often subjected to non-linearity, especially when the network contains further layers downstream.

In the case of Long Short-Term Memory (LSTM) networks, the update equations become more complex and include components such as input gates, forget gates, and output gates.

The purpose of these gates is to control the flow of information into and out of the cell state, addressing the vanishing and exploding gradient problems associated with basic RNNs.

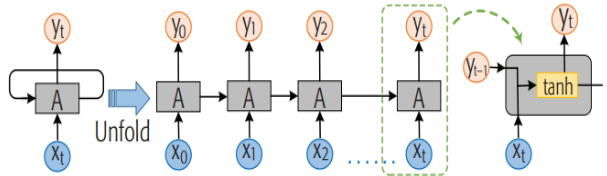


Fig.1.5 Structure of RNN[9]

III. METHODOLOGY

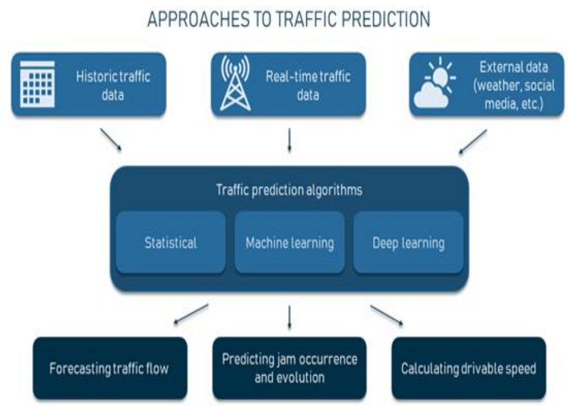


Fig.3.1Approaches traffic flow prediction[21]

IV. ALGORITHMS FOR GENERATING TRAFFIC PREDICTIONS (MODELS)

KNN (K-Nearest Neighbors): The K-Nearest Neighbors (KNN) algorithm is a nonparametric method employed for both classification and regression tasks. In the context of this paper, KNN is utilized to select neighboring stations most closely related to the test station. The algorithm relies on a database to identify data points that bear similarity to the current data, and these identified data points are referred to as the nearest neighbors of the current data.[14]

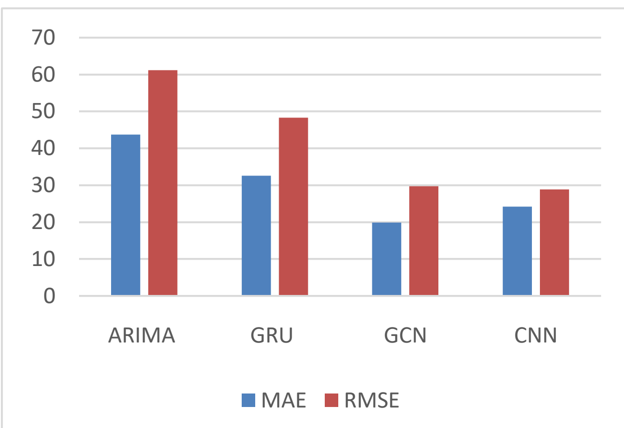
RNN(Recurrent Neural Network): Recurrent Neural Networks (RNN) form a specialized type of neural network designed for processing time sequences. In contrast to conventional networks, RNNs possess the unique capability to retain a "memory" of previous inputs within their internal state, influencing subsequent network outputs. Traditional RNNs demonstrate excellent proficiency in modelling nonlinear time sequence problems, including applications such as speech recognition, language modelling, and image captioning.[14]

ARIMA(Autoregressive Integrated Moving Average):ARIMA is effective for time series data with clear patterns and can be particularly useful in forecasting financial market trends, economic indicators, and various other time-dependent phenomena. However, it may not perform well when dealing with highly nonlinear or irregular patterns. It's also crucial to consider the assumptions underlying ARIMA, such as the stationarity of the time series.[22]

GNN(GRAPH NEURAL NETWORK): Graph Neural Networks (GNNs) are a class of deep learning methods designed to perform inference on data described by graphs. GNNs are neural networks that can be directly applied to graphs, and provide an easy way to do node-level, edge-level, and graph-level prediction tasks.GNNs can do what Convolutional Neural Networks (CNNs) failed to do.

Method	**MAE**	**RMSE**
ARIMA	43.77	61.16
GRU	32.58	48.33
GCN	19.85	29.70
CNN	24.16	28.85
KNN	14.91	17.59

Table 1: Comparison of prediction performance of different methods.



GRAPH 1:COMPARISON OF METHODS

V. CONCLUSION

Among the methods considered, KNN stands out as the best-performing model based on the provided MAE. It exhibits the smallest error in predicting traffic flow. However, a comprehensive evaluation should consider additional metrics and real-world application requirements. The choice of the best model may depend on factors such as computational efficiency, interpretability, and the specific characteristics of the traffic flow data. KNN appears to be a promising choice for traffic flow prediction based on the presented metrics, but further investigation and comparison with additional models and metrics could provide a more nuanced understanding of the methods' performance.

REFERENCES

[1] https://www.altexsoft.com/blog/traffic-prediction/
[2] https://www.kavout.com/wp-content/uploads/2018/11/324324-1
[3] AnirudhAmeya Kashyap, Shravan Raviraj, Ananya Devar akonda, Shamanth R Nayak K, Santhosh K V & Soumya J Bhat | Fabio Galatioto (Reviewing editor) (2022) Traffic flow prediction models – A review of deep learning techniques, Cogent Engineering, 9:1, DOI: 10.1080/23311916.2021.2010510
[4] Sayed, S.A., Abdel-Hamid, Y. &Hefny, H.A. Artificial intelligence-based traffic flow prediction: a comprehensive review. Journal of Electrical Systems and Inf Technol 10, 13 (2023). https://doi.org/10.1186/s43067-023-00081-6
[5] https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/what-is-artificial-intelligence#:~:text=Artificial%20Intelligence%20is%20a%20method,develops%20intell
[6] https://www.youtube.com/watch?v=Y4qO9unerGs
[7] https://www.whyofai.com/blog/ai-explained
[8] Wenqi, L., Dongyu, L., &Menghua, Y. (2017). "A model of traffic accident prediction based on convolutional neural network." 2017 2nd IEEE International Conference on Intelligent Transportation Engineering (ICITE).
[9] Liu, Zhidan, et al. "Urban traffic prediction from mobility data using deep learning." Ieee network 32.4 (2018): 40-46.
[10] https://www.researchgate.net/figure/ANN-Architecture-Several-ANN-architectures-have-been-developed-such-as-feedforward-NN_fig3_261206036
[11] .https://towardsdatascience.com/recurrent-neural-networks-rnns-3f06d7653a85
[12] Zheng, Jianhu, and Mingfang Huang. "Traffic flow forecast through time series analysis based on deep learning." IEEE Access 8 (2020): 82562-82570.
[13] Li, Zhihong, Xiaoyu Wang, and Kairan Yang. "An Effective Self-Attention-Based Hybrid Model for Short-Term Traffic Flow Prediction." Advances in Civil Engineering 2023 (2023).
[14] Li, Bao, et al. "A Dynamic Spatio-Temporal Deep Learning Model for Lane-Level Traffic Prediction." Journal of Advanced Transportation 2023 (2023).
[15] Gao, Zihang. "5G traffic prediction based on deep learning." Computational Intelligence and Neuroscience 2022 (2022).
[16] Dai, Guowen, Jinjun Tang, and Wang Luo. "Short-term traffic flow prediction: An ensemble machine learning approach." Alexandria Engineering Journal 74 (2023): 467-480.

[17] Lee, Kyungeun, et al. "Short-term traffic prediction with deep neural networks: A survey." IEEE Access 9 (2021): 54739-54756.
[18] Lei, Yi, et al. "Traffic flow prediction model based on gated graph convolution with attention." Journal of Physics: Conference Series. Vol. 2493. No. 1. IOP Publishing, 2023.
[19] Ren, Chuanxiang, et al. "Short-term traffic flow prediction: A method of combined deep learnings." Journal of Advanced Transportation 2021 (2021): 1-15.
[20] https://www.researchgate.net/figure/Simple-LSTM-network_fig1_261635371
[21] https://www.altexsoft.com/static/blog-post/2023/11/c70bc99f-0197-491b-8716-012e2732e0ba.webp
[22] https://www.machinelearningplus.com/time-series/arima-model-time-series-forecasting-python/