

AI-BASED NETWORK TRAFFIC FORECASTING FOR NEXT GENERATION 6G NETWORKS

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Abstract

The growth of cloud computing, IoT devices and online services has caused an increase in network traffic. Managing this traffic is a challenge in future 6G communication networks. This project proposes an AI-based system that forecasts network traffic using the Long Short-Term Memory (LSTM) model. The system looks at network traffic data to find patterns and predict future network conditions. Good predictions help use bandwidth reduce congestion and manage resources more effectively. The LSTM models performance is tested using RMSE and MAE. Compared to GRU and RNN models. The results show that the LSTM model gives accurate predictions and can help with intelligent traffic management, in 6G networks.

Keywords- AI, Network Traffic Forecasting, 6G Networks, LSTM, Deep Learning, Bandwidth Optimization, Traffic Prediction.

1. Introduction

The cloud computing and Internet of Things devices and online streaming platforms and smart communication services are making a lot of network traffic every day. This is happening because the number of devices is going up. So it is a challenge to manage network resources in a good way. The old ways of managing traffic are not working well with the traffic patterns and the fast speeds that will be needed for 6G communication networks.

We need to have reliable ways to forecast traffic so we can manage networks well. AI-Based Network Traffic Forecasting for Next Generation 6G Networks is a system that uses learning to predict what the network traffic will be like in the future. This system uses the Long Short-Term Memory model to look at what the traffic was like in the past and find patterns. Then it uses these patterns to predict what the traffic will be like in the future. This helps to reduce network congestion and use bandwidth better and allocate resources in a way. The system also checks how the Long Short-Term Memory model works compared to other models, like GRU and RNN. It uses things like RMSE and MAE to see which one is better. This is a way to manage traffic in a smart way and it helps to make 6G communication networks that are efficient and

reliable. Cloud computing and Internet of Things devices and online streaming platforms and smart communication services will keep making a lot of network traffic so we need to have ways to forecast this traffic.

2. Related Work

Aouedi et al: their team conducted a study on managing traffic in future communication networks. They found that Artificial Intelligence and deep learning are important for predicting network traffic. This helps reduce network congestion and improves bandwidth utilization in 5G and 6G networks. They also discussed how Software Defined Networking (SDN) supports intelligent traffic management. [1]

Zhang and Wang et al : studied machine learning techniques for predicting wireless network traffic. They observed that forecasting traffic helps optimize network resources, improves Quality of Service (QoS), reduces communication delays. [2]

Azzouni and Pujolle et al : Azzouni and Pujolle proposed an LSTM-based model for network traffic prediction. Their model effectively learns traffic

patterns over time and provides more accurate predictions traditional forecasting methods. [3]

Breiman et al : Breiman introduced the Random Forest algorithm for prediction and classification tasks. The algorithm performs well in analyzing complex network traffic patterns and improves prediction accuracy. [4]

Box and Jenkins et al : Box and Jenkins developed the ARIMA model for time-series forecasting. The model works well for predicting linear traffic patterns but has limitations when dealing with complex and dynamic network traffic. [5]

Hochreiter and Schmidhuber et al: developed the Long Short-Term Memory (LSTM) network. LSTM networks are effective in learning long-term patterns from sequential data and perform better than conventional recurrent neural networks in traffic prediction tasks. [6]

Cho et al: introduced the Gated Recurrent Unit (GRU) model. GRU provides faster computation while maintaining good prediction accuracy, making it an efficient alternative to the LSTM model. [7]

Medel et al: applied deep learning techniques for network traffic prediction in cloud computing environments. Their research showed that Artificial Intelligence helps improve resource utilization and bandwidth management. [8]

Tang et al: proposed a hybrid model that combines different deep learning techniques for network traffic prediction. Their model provides accurate forecasting results and adapts well to changing network conditions. [9]

Li et al: presented an intelligent traffic prediction model for wireless communication networks. Their study highlighted that accurate traffic prediction improves resource utilization, reduces network congestion, and enhances the overall performance of future 6G communication networks. [10]

3. Materials and Methods

The proposed system has four parts: data collection, data preprocessing training a deep learning model and predicting network traffic. We can see how the whole system works by looking at the system architecture and flowchart.

The AI-Based Network Traffic Forecasting System is designed to predict what network traffic will be like in the future in 6G communication networks using deep learning techniques. First it collects network traffic data with things like how much bandwidth's used how much traffic is on the network and how fast data is sent. Then it cleans up the data by getting

rid of anything that's missing or not needed. It also makes sure all the data is on the scale so the model can learn from it better.

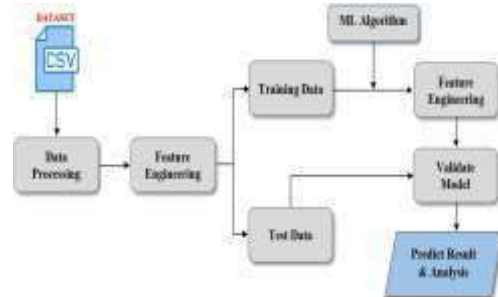


FIG. 1.1 Block Diagram of AI-Based Network Traffic Forecasting System

The AI-Based Network Traffic Forecasting System is designed to predict what network traffic will be like in the future in 6G communication networks using deep learning techniques. First it collects network traffic data with things like how much bandwidth's used how much traffic is on the network and how fast data is sent.

After that the cleaned-up data is given to the Long Short-Term Memory model. This model looks at what traffic was like in the past. Finds patterns. When the model is done learning it predicts what network traffic will be like in the future. We look at how good the predictions are by using things like RMSE and MAE.

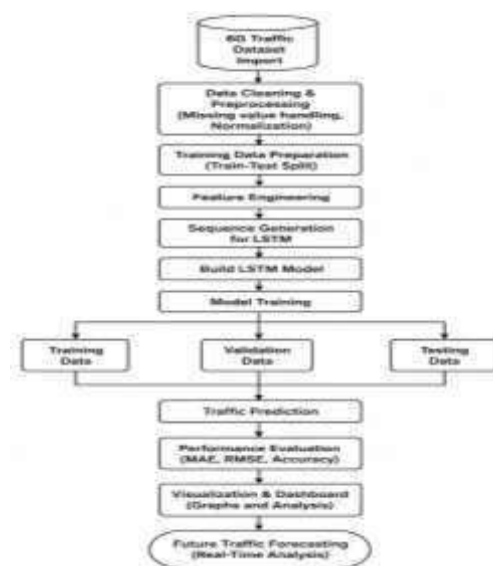


FIG. 1.2 Flow Chart of the Proposed System

Here is what the flowchart does. It starts by loading the network traffic data into the system. Then it

cleans up the data by getting rid of anything that's missing or not needed. It makes sure all the important features are on the scale. After that it splits the data into two parts: one for training and one for testing.

The cleaned-up data is then given to the Long Short-Term Memory model. The Long Short-Term Memory model learns from the data. While it is learning the model looks at what traffic was like in the past. It keeps updating its settings to make its predictions better. When it is done learning it predicts what network traffic will be like in the future based on what it learned.

Then we look at how good the predictions are by using things like RMSE and MAE. We compare the AI-Based Network Traffic Forecasting System to models like GRU and RNN. Finally we show the results using graphs and charts. This helps us understand what is going on with the network traffic. It helps us use bandwidth efficiently and make use of resources in 6G communication networks. The AI-Based Network Traffic Forecasting System is really good, at predicting network traffic. The AI-Based Network Traffic Forecasting System can help us make 6G communication networks work better.

4. Results and Discussion

The proposed system that uses Artificial Intelligence to forecast network traffic works in predicting future traffic. It uses a type of learning called LSTM. The LSTM model was trained with network traffic data that includes parameters such as usage, traffic load, packet flow, transmission rate and latency. This data helps the model learn traffic patterns and generate predictions for future network conditions. The model is good at predicting network traffic. The performance of the LSTM model was evaluated using two metrics: RMSE and MAE. The results were compared with two models, GRU and RNN. The LSTM model performed better in terms of prediction accuracy and error values. The generated graphs showed that the predicted traffic closely followed the traffic trend. This helps improve utilization reduce network congestion and support efficient resource allocation in future 6G communication networks. LSTM model and network traffic forecasting help make decisions related to traffic management.

The proposed system provides a solution for forecasting network traffic and can assist network administrators in making better decisions.

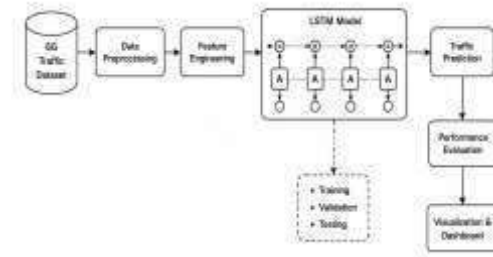


FIG. 1.3: LSTM-Based Network Traffic Prediction

Figure 1.3 shows the network traffic prediction generated using the LSTM model. The graph compares network traffic values with predicted values. The predicted curve closely follows the traffic pattern. This indicates that the model has successfully learned the behavior of network traffic over time and can generate predictions for future network conditions.

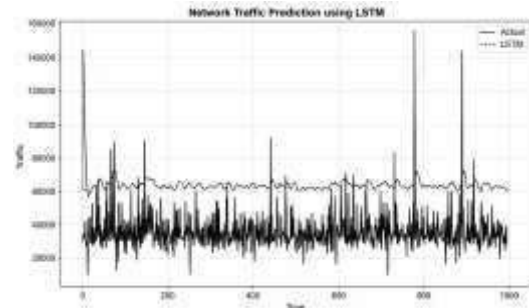


FIG.1.4:LSTM-Based Traffic Prediction Architecture

Figure 1.4 illustrates the working architecture of the proposed AI-based network traffic forecasting system. The process starts with collecting network traffic data from communication networks. The collected data is cleaned by removing values, duplicate records and unnecessary information before it is given to the LSTM model. The trained model analyzes traffic patterns. Predicts future network traffic based on previous communication behavior. The predicted results are evaluated using performance metrics such as RMSE and MAE. Are displayed through graphs, for analysis. This architecture helps improve management reduce network congestion and support better decision-making in next-generation 6G communication networks.

5. Conclusion

The proposed AI-Based Network Traffic Forecasting System is really good at figuring out what the network traffic will be like in the future for the 6G communication networks. It uses the Long Short-Term Memory deep learning model to look at what the network traffic was like in the past. Then it makes a pretty good guess about what it will be like in the future. The AI-Based Network Traffic Forecasting System is helpful because it can tell us

what the network traffic will be like and that helps us use the bandwidth better and not get much network congestion. The AI-Based Network Traffic Forecasting System also helps us make sure we are using our resources in the way possible. When we compared the Long Short-Term Memory model to the GRU and RNN models we found out that the Long Short-Term Memory model is better at guessing what the network traffic will be like and it makes mistakes.

The AI-Based Network Traffic Forecasting System can be a help to the people who take care of the networks because it helps them keep an eye on how the network is doing and make good decisions, about the network traffic. As Artificial Intelligence and deep learning and the new wireless communication technologies get better the AI-Based Network Traffic Forecasting System will be able to help us have networks that're smart and reliable and work really well for the future 6G communication systems.

References

- [1] O. Aouedi, K. Piamrat and B. Parrein wrote a paper called "Intelligent Traffic Management in Next-Generation Networks" that was published in the Future Internet journal, volume 14 number 2 in the year 2022.
- [2] X. Zhang and Y. Wang wrote a paper called "Machine Learning Approaches for Wireless Traffic Prediction" that was published in the IEEE Communications Tutorials, volume 22 number 4 in the year 2021. They used machine learning for traffic prediction in this paper. Traffic prediction is what they focused on.
- [3] A. Azzouni and G. Pujolle created a framework called "A Short-Term Memory Recurrent Neural Network Framework for Network Traffic Matrix Prediction" that was published in the year 2017. This framework is used for predicting network traffic. Network traffic prediction is the goal of this framework.
- [4] L. Breiman wrote a paper called "Random Forests" that was published in the Machine Learning journal volume 45 number 1 in the year 2001. Random Forests are useful for machine learning tasks. Machine learning tasks are what Random Forests are used for.
- [5] G. E. P. Box and G. M. Jenkins wrote a book called Time Series Analysis: Forecasting and Control that was published in the year 2015. This book is about time series analysis. Time series analysis is the topic of this book.
- [6] S. Hochreiter and J. Schmidhuber wrote a paper called "Long Short-Term Memory" that was published in the Neural Computation journal, volume 9 number 8 in the year 1997. Long Short-Term Memory is a type of network. This type of network is called Long Short-Term Memory.
- [7] K. Cho, B. Van Merriënboer, C. Gulcehre, D. Bahdanau, F. Bougares, H. Schwenk and Y. Bengio wrote a paper called "Learning Phrase Representations using RNN Encoder-Decoder for Statistical Machine Translation" that was published in the year 2014. This paper is about machine translation. Machine translation is what this paper focuses on.
- [8] M. Abadi and others created a tool called TensorFlow that was published in the year 2016. TensorFlow is a machine learning tool. Machine learning is what TensorFlow is used for.
- [9] W. McKinney wrote a paper called "Data Structures for Statistical Computing in Python" that was published in the year 2010. This paper is about data structures in Python. Data structures in Python is the topic of this paper.
- [10] A. Vaswani and others wrote a paper called "Attention Is All You Need" that was published in the year 2017. This paper talks about attention in networks. Attention in networks is what this paper is, about.