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Simulate Congestion Prediction in a Wireless Network Using the LSTM Deep Learning Model

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Abstract

Achieved wireless networks since its beginning the prevalent wide due to the increasing wireless devices represented by smart phones and laptop, and the proliferation of networks coincides with the high speed and ease of use of the Internet and enjoy the delivery of various data such as video clips and games. Here's the show the congestion problem arises and represent aim of the research is to avoid congestion at APs to wireless networks by adding a control before congestion occurs. A wireless connection was made using the Android system, and congestion was predicted based on the analysis of wireless communication packages around the access point using the LSTM deep learning model. The results show that if the amount of information in the input data is large, a more accurate prediction can be made.

Keywords: AP; Android; Congestion; Deep learning; LSTM; Wireless networks.

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1. Introduction

Modern societies were characterized by technologies to receive different services over wireless networks and under different circumstances, and thus emerged wireless devices with various forms such as smart phones and tablets, Internet Protocol (IP) traffic across global networks will increase from all previous Internet years combined, and traffic will be larger in 2022 and 60 percent of the world's population will be Internet users; more than 28 billion devices and Internet connections. Video will account for 82 percent of total IP traffic (Cisco Predicts More IP Traffic in the Next Five Years Than in the History of the Internet, 2018).

And so We find data transfer such as music, video and games require high capacity connections And speed,. To resolve this issue, Is made automatically turn on Wireless Fidelity (Wi-Fi) networks (Al-Alawi, 2006), Nearby which are previously logged in to wireless data connections between congested wireless devices and base stations, Due to the increase in the number of terminals reaching the wireless network, there may be a significant amount of data communication between the wireless device and the Access Point (AP) and an increase in congestion. The Transmission Control Protocol (TCP) is used to control congestion (Thomas, 2000), and the algorithm that based on loss the packages and which used by Linux and Android reduces the amount of transmission due to congestion. Therefore, the main objective of this research is to avoid congestion of access points to wireless networks, and to check the congestion predictability in order to achieve this goal. If congestion can be detected in advance, the amount of packet transmission before congestion can be reduced by correcting the congestion window (CWND) (Marwa O Al-Enany, 2014), it determines the amount of data that TCP can send to the network before receiving the (ACK) acknowledgment. So it regulates the flow of data in TCP connections, reducing congestion, and improving network performance.

As a result, it is possible to achieve congestion control without package loss and with all terminals connected to the wireless network, ensuring equal productivity and steady.

2. The aim of research

The research aims to analyze communication traffic wireless, congestion is revealed at a very early stage, and predict congestion. The data connection is made using the Android terminal, package are obtained around the wireless network and used as an input set. During a connection, the Round Trip Time (RTT) (Ghoumid, Ameziane, & El Mrabet, 2013) value is measured and recorded, which is the length of time it takes for the signal to be transmitted as well as the length of time it takes to acknowledge receipt of that signal between the terminals and AP using a ping command to AP.

Deep learning was performed using this data, and the possibility was verified traffic forecasting. The command ping is from command that use on command line that, when executed, sends data over the network to another party, the other party receives that data and then returns it back to the sending party. When you send this data over the network, you want to make sure that the party is connected to the network, and this simple process provides additional information that makes this simple command useful and effective for information security professionals and those working in the field of networks.

3. Congestion in wireless networks

A network like the Internet consists of many network devices such as routers. These devices are connected wirelessly, but the amount of data these communication media can send per unit time is limited. There is also an upper limit on the amount of data that the device itself can process per unit of time (Ali et al., 2014)

If flows the amount of data that exceeds the limit to the network, the amount of data stored in the network device's buffer (memory) will increase, and data beyond this capacity will be lost. If you can quickly locate congestion and its causes and take countermeasures, it will be fast, but it is practically impossible in a network of many different entities, such as the Internet (Khasawneh, 2017).

To prevent this congestion, TCP contains a congestion control algorithm and has two main types of congestion control methods: (1) loss-based method, and (2) delay-based method. This problem may become apparent if the network environment changes as technology advances.

4. Previous studies

(1) Development a tool Kernel Monitor (Miki, et al., 2011): Android has drawn attention to the fact that it is a platform for a built-in system, and its ability to network computing It is a system Included has a different structure than those on public computers, in this study, was developed Kernel Monitor tool suitable for a capable built-in system On kernel behavior monitoring. This tool was applied to the transport layer in Android. It has been shown that the relationship between productivity and CWND behavior for Android can be analyzed while connected.

(2) The model of Statistical Adjusted End - Use (SAE) (Yisheng et al., 2015): This research discusses the problem of traffic flow prediction based on deep architecture models with large traffic data using auto coding devices to represent traffic flow features to predict, and experiments have proven that the proposed method has Superior performance.

(3) Deep TFP (Yuanfang, Wangz., 2017) is a time-series model based on deep learning, which is used to predict the flow of movement of transport systems. Utilizing the effectiveness of time series functionality in sequencing data analysis and deep learning to extract traffic flow features, it improves the performance of traffic flow forecasting by extracting traffic data as a basis for time. The performance of the proposed model has been demonstrated using different experiments.

5. Deep learning

It is a technology that enables computers to make more precise and effective judgments on objects and data by imitating the neural circuits in the human brain.

The circle of human cranial nerves is extremely complex, but by imitating part of its structure and perform calculations, computers can dramatically improve the results of conventional methods. Figure 1 is a deep learning structure that is a neural network that contains two or more middle or hidden layers and also deep learning using brain simulation is the best way to develop Artificial Intelligence (AI). (Kar-Han , Boon Pang , 2018).

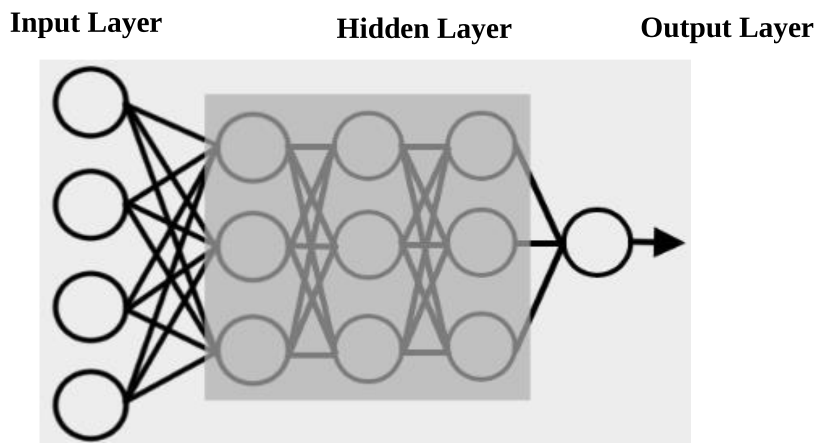

Figure 1. Deep learning structure

There are different types of neural networks (deep learning), including:

(1) Recurrent Neural Network (RNN): Is a powerful architecture for dealing with time series or texts analysis. The previous input can be saved by incorporating a loop into the middle layer. This means that you can understand the meaning of the word from the context before and after. Or, the previous output is retained within the network memory over time to be used again as input. Mainly used for machine translation, sentence generation, speech recognition, etc. (Bianchi, et al., 2017) and Figure 2 represents RNN.

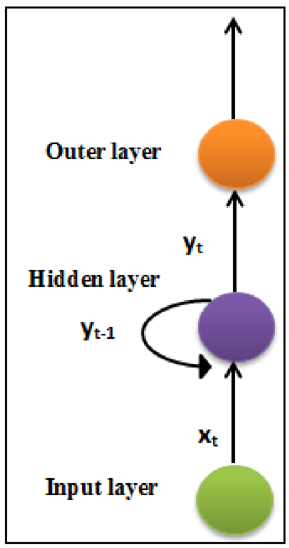

Figure 2. Recurrent Neural Network

(2) Long Short-Term Memory (LSTM) (Sak, Senior & Beaufays, 2014): Is a special type of RNN networks that is able to connect previous information to the current task,

- LSTM has a chain in which it is typical unit has a different structure, instead of having one neural network layer, there are four, reacting in a very special way.
- LSTM has the ability to remove or add information to the state of a cell, and is carefully regulated by structures called gates, a way to allow the selection of information through it. LSTM has three of these gates to protect cell condition and control
- LSTM works very well on a large variety of problems, and is now widely used.

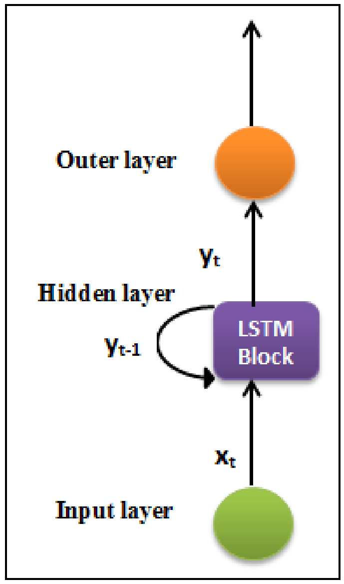

Figure 3. Long Short-Term Memory

Because this study analyzes packages representing time series data, deep learning is performed using LSTM as a model.

6. The proposed environment

The correct answer data is set for deep learning by monitoring the behavior of each parameter. Where an experiment is performed to determine which parameter should be used as a value indicating congestion. To monitor each parameter, connections are made using six Android devices with the upgraded kernel screen, and TCP parameters are obtained during the connection. In the meantime, the RTT value between the computer and the AP is measured using a ping command from the computer device. Figure 4 shows the proposed environment.

The parameters were obtained for 90 seconds to monitor the occurrence of congestion. In 0-15 seconds, no any packages were sent from the Android terminal, in about 15 seconds, packages from 6 Android devices were sent at once to the server via iperf (It is a widely used tool for measuring and adjusting network performance. It is important as a multi-platform tool that can produce performance benchmarks for any network. Iperf has client and server functionality, and it can create data flows to measure productivity between the parties in one direction or in both directions. A typical Iperf output contains a time-stamped report with the amount of data transferred and the measured productivity).

Congestion was due to severe data connection with or without sending packages at all terminals.

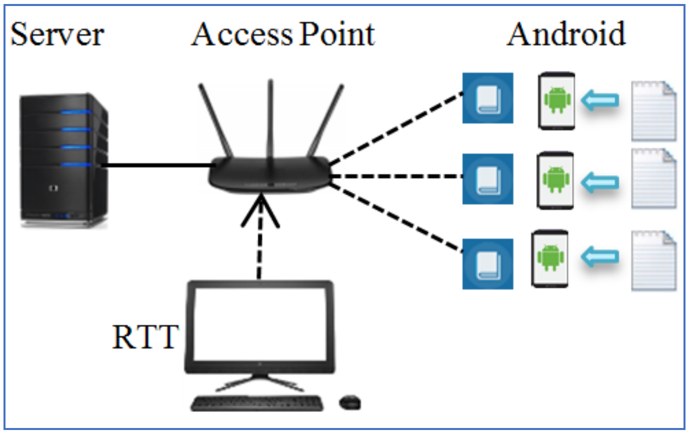

Figure 4. Proposed environment

7. Simulation

The simulation was performed to assess whether congestion can be predicted when making a data connection using an Android terminal under different conditions. Experiments are conducted to determine the degree of prediction by changing the amount of input data and learning time.

The data set used for deep learning is also described. To obtain the correct data, an RTT value is used between the computer and the AP.

The deep learning framework used in this experiment is Chainer. It is an open source deep learning framework written in Python that provides a flexible, intuitive and high-performance way to implement the full range of deep learning models. (Tokui, et al., 2015)

8. Simulation results

Figure 5 shows the results of the congestion window behavior measurement (CWND) of six connected Android devices because the connection not done Up to 15 seconds, the value is constant at 0. However, each party sends packages free from about 15 seconds when sending packages, TCP controls each station, it can be seen. About 15 seconds ago when I started sending packages from an Android terminal, TCP, which detected congestion, changed and controlled the CWND value. The loss-based algorithm, the congestion control algorithm Adopted by system Android, determines that congestion is detected by detecting packet loss. Therefore, given the behavior of the CWND in Figure 5, each terminal sends a large number of packages freely, and the CWND increases significantly until packet loss occurs. As a result, congestion occurs and it can be ensured that the TCP that detected the packet loss is controlled by changing the CWND value.

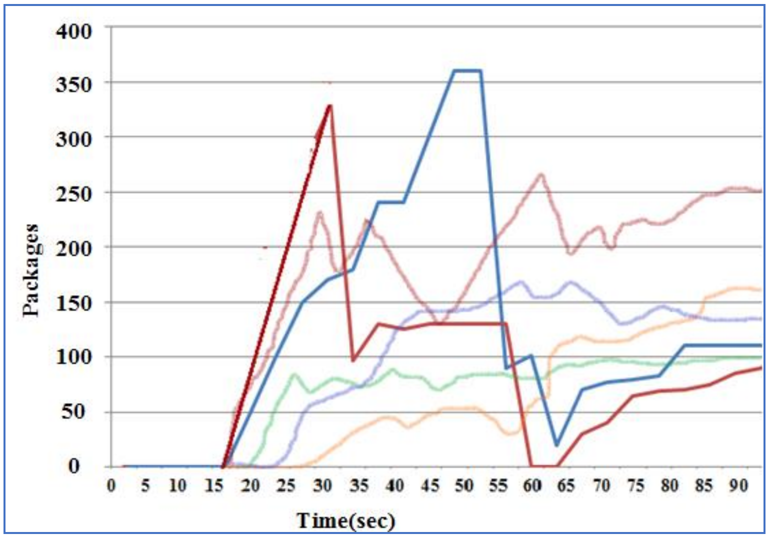

Figure 5. Behavior of CWND with 6 devices

Figure 6 shows the results of measuring the RTT value behavior between an Android device and the server. The RTT value gradually increased from about 15 seconds when the packet transfer started. The queue does not yet accumulate within 15 seconds when sending packages, and the RTT value does not increase significantly because packages can be handled appropriately; however, each party sends a large amount of packages after 15 seconds. As it continues, the packages cannot be processed after 60 seconds, and the RTT value is considered to be at a significant height.

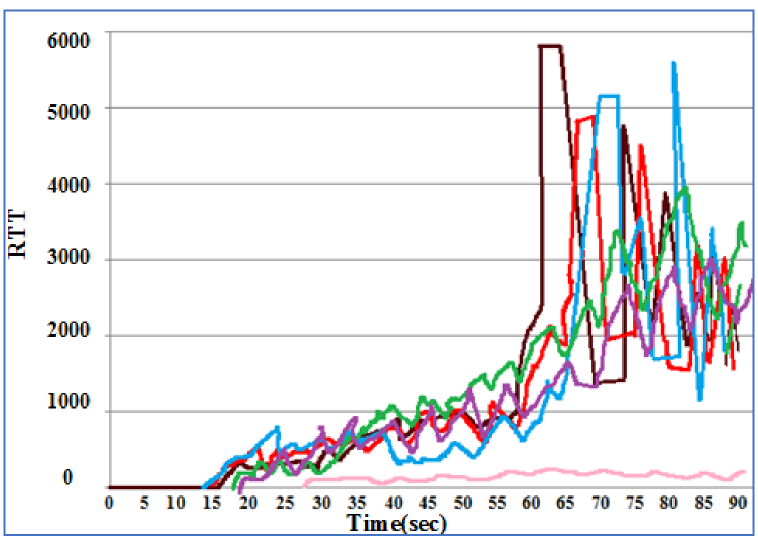

Figure 6. RTT between Android and server

Finally, Figure (7) shows the results of measuring the RTT behavior between the computer and the AP. The part where the line disappears from the graph is that there is no response to the RTT measurement request and timeout. If no response is returned, access points are very crowded and congestion occurs.

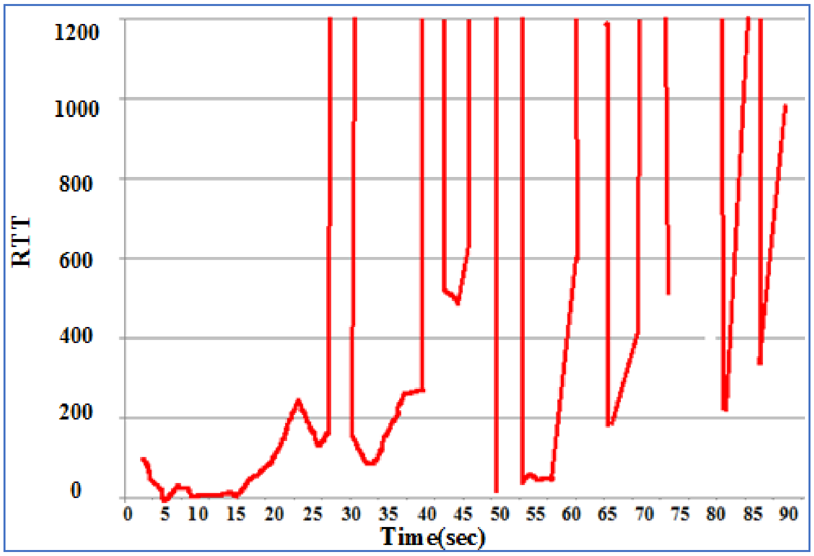

Figure 7. RTT between computer and AP

The data is determined using the RTT value between the computer and the AP measured using the ping command from the computer during the data connection on the Android terminal as valid data. From Figure 5 and Figure 7, the RTT value increases between the computer and the AP when congestion occurs, and the increase in the RTT value indicates AP congestion.

9. Conclusionsrange of deep learning models, including state-of-the-art models such as recurrent

Communicate multiple stations connected to the AP with each other. In case of congestion occurrence, traffic prediction was performed using deep learning in order to detect congestion at an early stage and to detect signs. Specifically, the data connection is made using an Android terminal connected to a wireless network, and the packet is captured using the device.

We've found a better explanation of the results and obtained by increasing input data information by knowing longer time data, traffic was predicted using the appropriate LSTM model for time series data, As good results are obtained it is possible to predict in the simpler situations where data communication is made from the terminals, improving the accuracy of prediction through simpler experiments, and the Congestion is created by sending a large number of packages at once.

Expected results from training data. Although the exact value is unpredictable, the time is predictable the RTT value rises between the computer and the AP and the time it lands.

10. Recommendations

One future issue is to improve the accuracy of forecasting when making a data connection in different situations. They increase the amount of information in the input data. Accuracy is improved once input data is changed.

Make predictions accurately not only when the terminals communicate at the same time, but also when they communicate randomly.

The use of Preferred Networks (PFN) promotes deep learning, robotics technology and innovation in various fields. The software framework, algorithms and devices that support R&D, and many of the projects they use are being developed simultaneously. Thus, expanding their own application areas.

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