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A Survey on Traffic Prediction and Classification in SDN

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Abstract. The network traffic has been grown tremendously in the past decade due to the advances in the current technology. The modern computer network has evolved to manage the challenges and difficulties that have been put forth by the present network scenario. Software defined networking (SDN) has emerged to address the problems in the current network structures. SDN decouples the data plane and control plane in the traditional network and aids network programmability in a real network. It paves the way for the intelligence in the network by having a global view of the network in the centralized controller. This intelligence facilitates traffic prediction and classification that can assist activities like traffic analysis, dynamic updating of flow rules, intelligence routing, flow scheduling and security. In this paper, we discussed the existing traffic prediction and traffic classification methods in the SDN.

Keywords. SDN, Traffic Prediction, Traffic Classification

1. Introduction

The current network is getting complicated because of the massive growth in the advances of technologies [1] and results in tremendous network traffic flow. The massive network traffic has resulted in network congestion. It also paved way for the problems in network management and traffic measurement [2]. In first place, the traditional network suffers a lot because of its uniqueness and lack of standards to accomplish consistency across networks. Secondly, the continuously evolving and dynamic behaviour of the network prohibits the fixed set of network operation and management. Also it is impractical to maintain the network manually with the network administration [3]. SDN overcomes the traditional network problems by providing a centralized controller [4] that will monitor and collect all network parameters for efficient resource management and intelligent routing. Hence SDN gets a global view of the entire network. SDN separates the control plane from the forwarding plane so that the network intelligence is centrally present in the control plane software controllers [5]. This centralization provides the means of network programmable. The networking devices will simply do forwarding without any intelligence. The networking devices will have flow table which contains set of rules and actions to forward and it is controlled by controller in the control plane. The communication between the planes will be done through the open interface called Open Flow Protocol. The Network Programmability [6] in SDN promotes Network management, Traffic management, Dynamic Resource management and Security in a very effective way. Traffic Prediction in SDN will forecast the future traffic expected and network congestion using offline historical past data and online real time traffic data.

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The network congestion prediction based on the predicted future traffic is very much essential to maintain high Quality of Service in the network communication.

Traffic classification [7] is the process of categorizing applications in network to make use of the bandwidth efficiently by prioritizing the packets flow. It is the process of correlating network traffic to predetermined classes of interest. Traffic classification will aid network operators to perform a lot of activities like security and intrusion of detection, QoS [8], performance monitoring, effective bandwidth utilization.In this survey, we reviewed traffic prediction and traffic classification methods in SDN.

2. Literature Review of Traffic Prediction Methods

HaipengYae et al [9] proposed a load balancing routing by considering the queue exploitation at the next time period to reduce the congestion. The prediction is made with the help of neural network algorithms and the proposed algorithm is compared with the classical algorithms. The features of the network are first extracted using Principal Component Analysis. Secondly, a model to establish the relationship between the topology, traffic states and the queue of the router to predict the Queue utilization is built using machine learning algorithms. Lastly the authors framed dynamic routing scheme based on the prediction. AbdelhadiAzzouni et al. [10] developed a framework for Traffic Matrix prediction based on recurrent neural network and deployed the framework on SDN. The authors developed a Long Short Term Memory (LSTM) RNN network for Traffic Matrix prediction. They implemented the LSTM framework and mounted it on SDN and evaluated LSTM models at different configurations. F. Tang et al [11] developed an adaptive channel assignment algorithm in SDN-IoT based on the predicted future network traffic and congestion. The prediction is based on the deep learning algorithms. Abdullah Baz [12] framed a flow prediction algorithm using a bayesian machine learning (BML) to reduce the overhead of communicating with controller in handling traffic. The authors proposed a mathematical approach based on BML, Dirichlet process and inference process for floe prediction. B. Guan Xu et al [13] focused to reduce the energy consumption in the data center network by framing a flow scheduling algorithm which is based on utilization of links and the switches in the network.

By finding new patterns and predicting traffic congestion, S. Jain et al [14] improve the QoS management in SDN. They applied Big data and machine learning algorithms to find out correlations quantitatively to manage QoS requirements in SDN. Cortez et al. [15] predicted TCP/IP traffic using neural network ensemble and time series prediction considering the two real world data set from two internet service providers. They compared the Neural Network Ensemble (NNE) methods with Naïve benchmark method, Holt Winters, and Auto Regressive Integrated Moving average (ARIMA) and NNE outperform all. Yi Li et al. [16] focused to reduce the Congestion in inter data center network by predicting future network traffic using artificial neural network and it is found to be having less prediction errors. Zhitang Chen et al.[17] predicted the future traffic volume using recurrent neural network and Kernel Bayes Rule based on the flow count. It was intended to reduce the burden of collecting traffic volume, but the performance is compensated. SanamNarejo et al [18] focused on predicting internet traffic using deep belief network of three different architectures and it is found that it produced a very small root mean square error.

Mohammad Mahdi Tajiki et al [19] focused to decrease the packet loss and

raise the throughput by predicting the traffic using linear programming. Based on the predicted traffic, the authors framed a resource allocation for QoS aware applications. They exploited the predicted flow to reorganize the network dynamically. Their proposed algorithm supported the traffic with different classes of QoS requirements.

3. Literature Review of Traffic Classification Methods

Mohammed Reza Parsaei et al [20] compared the network classification accuracy of four different neural network estimators such as Feed Forward Neural network, Multi layer perceptron, Non-linear Autoregressive Exogenous Multi layer perceptron (NARX) and Levenberg Marquardt and it is found that naive bayes provided the highest accuracy. They have considered both the online real data traffic and offline historical data. Z. Fan et al [21] studied the traffic classification with two machine learning algorithms like support vector machine and K means and it produced an accuracy of 95%. It has been concluded that performance could be improved with proper feature selection and careful tuning of parameters. James Daly et al [22] devised an algorithm called TupleMerge(TM) for online packet classification to classify incoming packets and update rules in flow table fastly. The effectiveness of TM is tested both in simulation and deployment in software router called Vector Packet Processor (VPP). TupleMerge performs better than the other state of art methods. Pu Wang et al [23] classified the network traffic based on QoS specifications using machine learning algorithm.

4. Conclusion

In this paper, we presented the basics of SDN and the importance of Traffic Engineering in SDN. SDN decouples the data plane from the control plane and hence entire intelligence is present within the control plane and control plane determines how to forward packets in the data planes. The networking switches will simply act as a forwarding device, just following the instructions set by the control plane in terms of flow table. The forward decisions will be made by the software based controller and it will be communicated to the data plane through the open interface called Open Flow. Machine Learning plays a major role in Traffic Engineering because of huge data available. It opens the avenues for processing network traffic because of the programmability in SDN. The network programmability of the SDN paves way for the adaptability of Machine Learning in networking. In the first section we explained the Traffic Prediction in SDN and compared the various Traffic prediction methods in SDN and their limitations. Now a days, most of the traffic predictions are based on the machine learning algorithms. In the literature review presented, most of the methods are based on machine learning and they offered good prediction accuracy of traffic. In the second section, we explained the Traffic Classification and compared the various Traffic Classification methods in SDN.they are based on the machine learning algorithms. many shortcomings have been pointed out. In our research, we will be focusing issues like inclusion of both online real data and offline historical data for traffic prediction. We also consider link bandwidth while constructing the topology of the network in our work. We will work towards an effective dynamic routing in SDN based on traffic prediction in datacenter network,without compensating the performance of the network in terms of packet loss, end-end delay and throughput.

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