NFV 환경에서의 DASH 스트리밍을 위한 기계 학습 기반 QoE 성능 분석

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Machine Learning-based QoE Performance Analysis for DASH Streaming in NFV

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Abstract

In this research, we present a machine learning-based research for QoE evaluation method which mainly focuses on DASH streaming in NFV. In detail, we virtualize each component of a QoE assessment system in NFV environment. All streaming session information is employed at a video optimizer and a QoE assessment component. We implement a machine learning method in the video optimizer, and QoE assessment critics the video optimizer to improve its mechanism of retrieving DASH segments.

1. Introduction

Multimedia delivery processes are facing many problems over the Internet because it must pass through many components of the Internet infrastructure which is deployed and implemented by service providers. For example, a video is produced in a Video Production department, and it is starting to be delivered from a database server, web server, firewall, and router. Video packets go through these components might has some error which degrades video quality. Therefore, it is crucial to measure the quality of the video (measure QoE) after transmitted compared to the original video and evaluate the streaming system.

Researcher has paid lots of attention recently for machine learning. It is widely applied in many research fields. Hence, in this research, we employ a multi-perception layer which is a well-known technique in machine learning. This technique supports us to detect and understand the causes of a DASH (Dynamic Adaptive Streaming over Hypertext Transfer Protocol) streaming system and adaptively adopt to the frequent change of a network environment such as bandwidth fluctuation.

In the next section, we present general knowledge of multilayer perceptron (MLP) and QoE assessment. Then, we describe our system overview. Subsequently, we seek to perform our proposed machine learning-based method. Finally, we conclude the research with future research perspective.

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2. Related Works

In this research, we involve one data mining technique for QoE assessment. Multilayer perceptron (MLP) [1] is a type of neutral artificial network. It consists of a minimum of three layers which are input, hidden and an output layer. Each neutron of a node is a neutron which applies a nonlinear activate function. Those functions assist the neutron network classifying objects into groups upon a conditioning dataset.

QoE [2] has been intensively researched since last twenty years at the emerging of multimedia over the Internet such as IPTV (Internet Protocol Based Television). QoE is an aspect which evaluates user satisfaction. It can be used during the development process of a service based on subjective assessment. For example, 5% packet loss could be invisible if it only affects slight background distort during UHD streaming. This result can be still a good streaming session if we get a good QoE score from users. However, a missed frame due to a 100ms delay can affect the whole streaming process.

3. System Overview

We employ FNCP (Future Network Computing Platform) [3] to build a video delivery streaming system. The FNCP is built based on the NFV (Network Function Virtualization) proposed by ETSI (European Telecommunications Standards Institute). Thanks to its virtualized functions, we can quickly place a database server or a web server within a short time (in minutes). Besides, we can also re-organize or re-construct network functions if we want to add or remove a component aiming to improve streaming quality. This task was intensively in the past because all of the tasks were done/processed with physical machines (computers). The illustration of our system is shown in Figure 1. We measure QoE between Service and User under a system infrastructure deployed by network virtualized functions.

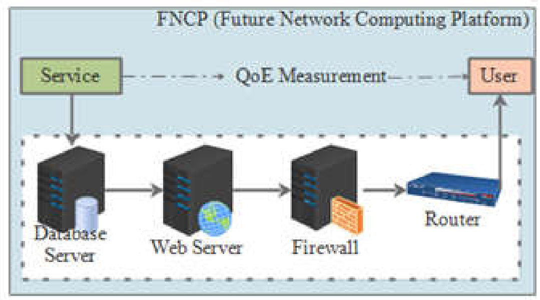

Figure 1. QoE evaluation with a system illustration

The overview of our proposed system streaming system is shown in Figure 2. A video is available on a Video Streaming Server which supports DASH. Then, video packets are transferred to a user via a Video Optimizer and a QoE assessment component. Every streaming session the Video Optimizer optimizes streaming video to reduce network resource consumption such as bandwidth. Subsequently, it forwards video packets to QoE assessment which evaluates the streaming quality session. If the streaming session is not optimized yet, it sends back a message to the Video Optimizer to improve the video quality.

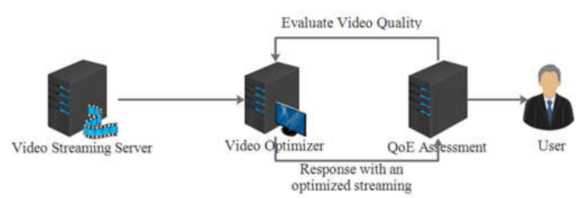

Figure 2. Overview of system streaming with QoE assessment component

This dataset is collected during the PoQeMoN project [4] where a crowd measurement platform is implemented to assess YouTube end user's QoE in mobile environments. This dataset concerns collecting a lot of QoE IFs (Influence Factors) using a VLC media player. The used platform consists on an Android-based application developed and installed on the end user device (phones and tablets).

The dataset has 30 features containing 29 QoE IFs and the Mean Opinion Score (MOS). We employ this data set to evaluate the quality of a video streaming.

4. Experiment

We utilize Weka Explorer as a tool to classify mean square error with the number of input are 29 features and output is the classification of Mean Opinion Score (MOS) which has four classes (5 -> Excellent, 4 -> Good, 3 -> Fair, 2 -> Poor, 1 -> Bad).

We first set up the experiment with two hidden layers (5 and 9 neutrons). Secondly, we run the experiment with three hidden layers (3, 6, 5 neutrons). Finally, we run the experiment with one hidden layer in two cases 5 neutrons, and 3 neutrons. All the above experiment has the same momentum 0.2, learning rate 0.3 and 500 epochs. In addition, we do one more experiment regarding the learning rate.

The first experimental results are shown in Table 1. We recognize that one hidden layer is enough for this classification problem. The higher number of neutrons is the more accuracy we get. In detail, the accuracy increases from 79.3% with three neutrons to 92.3% with 10 neutrons. The time to build the training model of these experiments is similar.

Table 1: Multilayer perception experiment result

Number of layers	2 (5,9)	3 (3,5,6)	1 (3)	1 (5)	1 (10)
Correctly instances	258 (86%)	236 (78.7%)	238 (79.3%)	266 (88.7%)	277 (92.3%)
Incorrectly instances	42 (14%)	64 (21.3%)	62 (20.7%)	34 (11.3%)	23 (7.7%)
Time seconds	2.23	2.11	1.65	1.88	2.37

From the first result, we do an additional experiment with learning rate. As shown in Table 2, we found that accuracy improvement is not different when we change the learning rate but if we decrease the learning rate it improves the accuracy a little with more time for building the training model.

Table 2: Multilayer perception experiment result with different learning rates

Learning rate	0.3	0.2	0.1	0.05
Correctly instances	279 (93%)	277 (92.3%)	281 (93.7%)	282 (94%)
Incorrectly instances	21 (7%)	23 (7.7%)	19 (6.3%)	18 (6%)
Time seconds	2.58	2.37	2.43	2.93

5. Conclusion

We presented multilayer perception-based research for QoE evaluation method for DASH streaming in NFV. In detail, we virtualized each component of a QoE assessment system in NFV environment. A DASH video is transmitted from a video streaming server. During a streaming session, a video optimizer employs multilayer perceptron to evaluate QoE of that streaming aiming to have high streaming representations. The weakness of this approach is that it does not cover for other video streaming assessment. Hence, in the future research, we intend to investigate in reinforcement learning algorithm which replaces MPL in this research.

Acknowledgement

This research was supported by the IT R&D program of MSIT(Ministry of Science and ICT), Korea / NIPA(National IT Industry Promotion Agency) 12221-14-1001, Next Generation Network Computing Platform Testbed. Besides, this research was supported by the MSIT(Ministry of Science and ICT), Korea, under the ITRC(Information Technology Research Center) support program(IITP-2018-2016-0-00314) supervised by the IITP(Institute for Information & communications Technology Promotion). Furthermore, this research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science, and Technology (MEST)(Grant No. NRF-2017R1D1A1B03034429). Finally, this work was supported by Institute for Information & communications Technology Promotion (IITP) grant funded by the Korea government (MSIT). [2018-0-00691, Development of Autonomous Collaborative Swarm Intelligence Technologies for Disposable IoT Devices].

References

[1] Tang, Jiexiong, Chenwei Deng, and Guang-Bin Huang. "Extreme learning machine for multilayer perceptron." IEEE transactions on neural networks and learning systems Vol. 27, No.4, pp. 809-821, 2016.

[2] Hossfeld, Tobias, Christian Keimel, Matthias Hirth, Bruno Gardlo, Julian Habigt, Klaus Diepold, and Phuoc Tran-Gia. "Best practices for QoE crowdtesting: QoE assessment with crowdsourcing." IEEE Transactions on Multimedia Vol. 16, No. 2, pp. 541-558, 2014.

[3] Van Ma, Linh, Van Quan Nguyen, Jaehyung Park, and Jinsul Kim. "NFV-Based Mobile Edge Computing for Lowering Latency of 4K Video Streaming." In 2018 Tenth International Conference on Ubiquitous and Future Networks (ICUFN), pp. 670-673. IEEE, 2018.

[4] Project collaboration platform quality evaluation mobile networks, "https://github.com/Lamyne/Poqemon-QoE-Dataset," Accessed: November, 16, 2018.