

Chapter 8

Quality of Experience Models for Multimedia Streaming

Vlado Menkovski

Eindhoven University of Technology, The Netherlands

Georgios Exarchakos

Eindhoven University of Technology, The Netherlands

Antonio Liotta

Eindhoven University of Technology, The Netherlands

Antonio Cuadra Sánchez

Telefonica R&D, Spain

ABSTRACT

Understanding how quality is perceived by viewers of multimedia streaming services is essential for efficient management of those services. Quality of Experience (QoE) is a subjective metric that quantifies the perceived quality, which is crucial in the process of optimizing tradeoff between quality and resources. However, accurate estimation of QoE often entails cumbersome studies that are long and expensive to execute. In this regard, the authors present a QoE estimation methodology for developing Machine Learning prediction models based on initial restricted-size subjective tests. Experimental results on subjective data from streaming multimedia tests show that the Machine Learning models outperform other statistical methods achieving accuracy greater than 90%. These models are suitable for real-time use due to their small computational complexity. Even though they have high accuracy, these models are static and cannot adapt to environmental change. To maintain the accuracy of the prediction models, the authors have adopted Online Learning techniques that update the models on data from subjective viewer feedback. This method provides accurate and adaptive QoE prediction models that are an indispensable component of a QoE-aware management service.

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INTRODUCTION

Advances in the telecommunication systems open opportunities for multimedia services of higher quality, which were previously demanding excessive network resources. As these services are becoming more common many service providers are facing the problems of their efficient management. Streaming multimedia services such as IP TV or Video conferencing have high resource demands and stringent requirements. Efficient management of multimedia services depends on understanding the value they bring to the viewers, which in turn depends on the service perceived quality. The perception of quality from a particular multimedia service is closely related to many factors such as the image fidelity, image resolution, type of device, content, audio fidelity. Traditional approaches to network service management solely focus on the transport and encoding quality such as the Quality of Service parameters and neglect many additional factors. Thus, many multimedia services are under- or over-provisioned. The encoding parameters are not adapted to the presentation device or the type of content, and none take into account the user's expectations. As this data-centric service management is not aware of the customer's perceived quality, it cannot be as efficient with the system's resources as user-centric management approach. To improve the service management, a shift to a user-centric or user-aware multimedia service management is necessary (Agboma & Liotta, 2008). To execute user centric management a model for the perceived quality or Quality of Experience (QoE) is necessary. QoE is a subjective metric that quantifies the perceived quality of a service by the viewers. As such, QoE needs to correlate numerous parameters that affect the perceived quality such as the encoding, transport, content, type of terminal, as well as the user's expectations (Agboma & Liotta, 2007). The QoE

management approach aims at maximizing the perceived quality of the viewers while minimizing the impact on the system's resources.

Since QoE is a subjective metric the most accurate estimation methods are execution of subjective studies and calculation of the Mean Opinion Score (MOS) values from user feedback. However, subjective studies involve a complex selection procedure of an appropriate and statistically viable testing group and of the exact test conditions. Organizing such tests is a cumbersome and expensive effort and is not feasible for live streaming content. The method proposed here builds QoE prediction models based on data from initial limited subjective studies. Building the prediction models is done with Machine Learning (ML) algorithms that yield highly accurate QoE models which require low processing power for execution.

To sum up, the proposed QoE prediction model aims at maintaining high perceived quality at the user end with a low resource cost on the delivery network. The product of these models is the QoE estimation to be used for fine-tuning of service parameters. This can be an on-going process as viewers' expectations or conditions change over time with introduction of new content and viewing devices. Environment alterations cause their accuracy to drop, rendering new subjective tests necessary. Online Learning techniques, adopted for maintaining the prediction accuracy, can help with building adaptive models updated with subjective feedback from the users. Our results show that the models adapt quickly to changes (with a small number of feedback responses) and reach high accuracy closely comparable to the static models. Overall this method provides a means for estimating the QoE of multimedia content using prediction models and the ability to keep those models accurate in dynamic environments.

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