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Elevating Your Streaming Experience with Just Noticeable Difference (JND)-based Encoding

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ABSTRACT

With the growing number of video streaming applications, intelligent video streaming has become increasingly important. By considering JND, video delivery can be improved by avoiding the selection of encodings with similar quality for a bitrate ladder. In this paper, we present an overview of the existing methods for modeling and predicting JND in the context of video streaming applications.

CCS CONCEPTS

• Information systems → Multimedia streaming.

KEYWORDS

Just Noticeable Difference (JND), Satisfied User Ratio (SUR)

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1 OVERVIEW AND RESULTS

We currently witness the rapidly growing importance of intelligent video streaming quality optimization and reduction of video delivery costs [4, 5]. One area that is of critical importance in optimizing video streaming is finding the optimal bitrate ladder. A bitrate ladder is composed of multiple versions of the same video, each encoded at different bitrates and resolutions. By providing multiple versions of the video, the adaptive bitrate streaming technology allows clients to select the most appropriate version of the video that matches their network conditions and device type. This ensures a seamless and uninterrupted viewing experience for the client, even if their internet speed fluctuates. A fixed bitrate ladder, *i.e.*, a fixed set of bitrate-resolution pairs, was typically used for all video contents regardless of their characteristics. Per-title encoding [1, 3], in contrast to a fixed bitrate ladder, shows significant promise to deliver higher quality video streams by addressing the trade-off between compression efficiency and video characteristics

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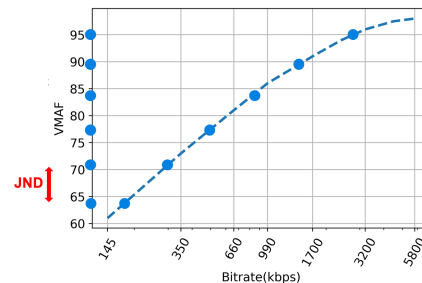


Figure 1: JND-based bitrate ladder construction

such as resolution and frame rate. Selecting encodings with noticeable quality differences in between prevents the construction of an inefficient bitrate ladder that suffers from having similar quality representations [6] (see Figure 1). The Human Visual System (HVS) is capable of differentiating only a few discrete levels of distortion in compressed videos over a wide range of bitrates, as demonstrated in [8]. The minimum visual difference that can be perceived by HVS, *i.e.*, the difference between two adjacent perceptual distortion levels, is referred to as one Just Noticeable Difference (JND)[7]. The first JND point denotes the transitional point from perceptually lossless to perceptually lossy coding. By selecting encodings with one JND between them, an optimized bitrate ladder can be achieved, as this prevents the inclusion of encodings with similar quality. Satisfied-User-Ratio (SUR) curve has been widely used for JND modeling and prediction. It is the complementary cumulative distribution function of the individual JNDs of a group of viewers. One JND occurs when a certain percentage of users can perceive a difference in quality between two videos.

In this talk, we explore ways to optimize the JND subjective test methodology and the mathematical modeling of SUR curves from the subjective JND test data in the context of video compression. Additionally, we predict JND values using proxies such as Video Multimethod Assessment Fusion (VMAF) [2, 10] and Quantization Parameter (QP) [9] with machine learning methods. The experimental results indicate that Gaussian distribution is not the optimal choice for modeling the satisfied-user-ratio (SUR) curve. Moreover, predicting the optimal parameters for SUR modeling instead of individual points on the curve results in higher accuracy and less complexity. Finally, using the publicly available JND dataset VideoSet [8], we demonstrate the optimization of the JND search method based on binary search [8] and evaluate the performance of prediction models for both SUR and JND [11]. We would like to highlight that for streaming optimization, different proxies such as VMAF, quantization parameter (QP), and bitrates can be utilized for different use cases.

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