Modeling Gaming Quality of Experience
Streaming video games

- Twitch TV
  - 4th in Peak US Internet Traffic [1]
  - Ahead of Hulu, Facebook, Valve, and Amazon, among others
  - 100 million visitors per month in 2015
  - End users stream the gameplay and twitch then broadcast that

[1]. https://blog.twitch.tv/twitch-is-4th-in-peak-us-internet-traffic-90b1295af358
CLOUD GAMING

- The main bottleneck is the delay.
ITU ACTIVITIES

- 3 work items in study group 12:
  - ITU-T -G.1032: Factors affecting QoE in gaming applications (Q.13/SG12)
  - ITU-T -P.GAME: Subjective testing methodology (Q7/SG12)
  - ITU-T –G.OMG Opinion model for gaming applications (Q13/SG12)
GAME CHARACTERISTICS

- Game is a **rule-based** system that has special characteristics.
- Usually games have a few **feedback elements** that communicate the details about the game’s inner states.
- **Field of view** (FoV) in a video game plays an important role in video complexity.
- **Size of game world** can dramatically affect coding strategy.
- A game is usually constructed from a **pool of predesigned objects** which result in different level of details.
DATA SET

- 16 video games, each two raw video sequences of 30 sec, with resolution of 1080p and 30 fps.
- Encoded into 3 Resolutions, and 4 bitrates (one pass, CBR) both H.265 and H.264.
  - Resolutions: 1080, 720, 480
  - Bitrate: 500, 1000, 1500, 2000, 3000, 4000, 10000.
Mean Average Difference (MAD) has been used in h.264 for video complexity estimation as calculated as follow:

\[
MAD = \sum_{i,j} |\text{residual}(i, j)| = \sum_{i,j} |\text{source}(i, j) - \text{prediction}(i, j)|
\]
MAD ANALYSIS

- Mean Average Difference (MAD) has been used in h.264 for video complexity estimation as calculated as follow:
Average and variance of PSRN, SI and TI over 30 seconds?

Is there a pattern for a specific game?

How that could affect the quality assessment?
## SPATIAL AND TEMPORAL FEATURES

<table>
<thead>
<tr>
<th>Game</th>
<th>Original Frame</th>
<th>MAD heatmap</th>
<th>PPSNR with threshold of 35</th>
<th>Heatmap of Average of SI</th>
<th>Heatmap of Variation of SI</th>
<th>Heatmap of Average of TI</th>
<th>Heatmap of Variation of TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dota 2</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
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<td><img src="image6.png" alt="Image" /></td>
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<tr>
<td>LoL</td>
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<td><img src="image31.png" alt="Image" /></td>
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- Modeling the effect of video degradation on quality features.
- Design a study to get some insight:
  - Bitrate (1, 5 and 30 Mbps)
  - Frame rate (10, 15, 25, 60)
  - Two games: GTA and Project Cars
Structural QOE Modeling

\[ \text{MOS} = 1.102 + 0.59 \cdot \text{PosAffec} + 0.24 \cdot \text{Reactivity} + 0.25 \cdot \text{Video Quality} \]

GTA 5

Project Cars

Frame rate: 5 10 25 60

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STRUCTURAL QOE MODELING

Bitrate: 1,500 kbps

Bitrate: 30,000 kbps

MOS

Quality PosAffect NegAffect Competence Challenge Flow Tension Immersion

Framerate 5 10 25 60

1 2 3 4 5

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STRUCTURAL QOE MODELING

- Relation between overall quality and quality features:

\[
MOS = 1.102 + 0.59 \cdot \text{PosAffect} + 0.24 \cdot \text{Reactiveness} + 0.25 \cdot \text{VideoQuality}
\]

\[
\text{Reactiveness} = \exp(0.84 + 4.43/\text{Framerate})
\]

\[
I_{\text{coding}} = 3.52 - 0.094 \cdot BR - 0.062 \cdot FR \\
+ 0.00063 \cdot BR^2 + 0.00115 \cdot FR^2 - 0.00017 \cdot BR \cdot FR
\]
## Modeling Gaming QoE

<table>
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<tr>
<th>Video Quality Model</th>
<th>Reactiveness</th>
<th>Quality Dimensions</th>
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**Video Quality Model**
- No reference metric
- Bit stream model

**Reactiveness**
- Classifying games based on their sensitivity to delay.
- Considering variation of delay.

**Quality Dimensions**
- Positive affect and flow are two main candidates.
Any question?