

# High-quality content, encoded and delivered to members with best possible experience



*How will Netflix members rate the visual quality of this video – poor, average or excellent?*

*Which video clip looks better – encoded with Codec A or Codec B?*

*For this episode, at 1000 kbps, is it better to encode with HD resolution, with some blockiness, or will SD look better?*

# Need a better perceptual metric

- Accurately measures **human perception** of video quality
- Consistent across content
- Can be run at scale
- Works well for picture artifacts relevant to adaptive streaming
  - Compression artifacts
  - Scaling artifacts

Image removed

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**VMAF**: **V**ideo **M**ultimethod **A**ssessment **F**usion

# VMAF: The Journey Continues

Zhi Li

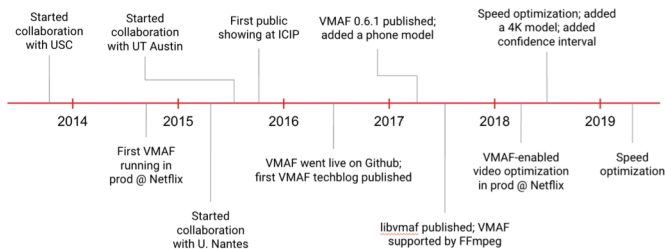
*Encoding Technologies, Netflix*

Mile High Video

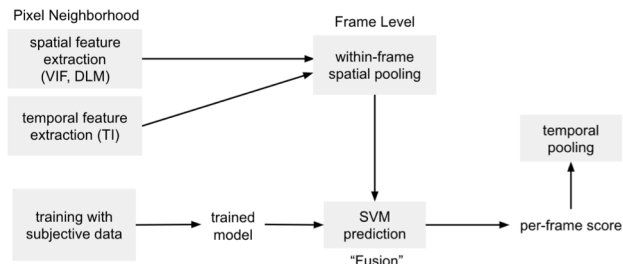
Denver, CO, 7/30/2019

**NETFLIX**

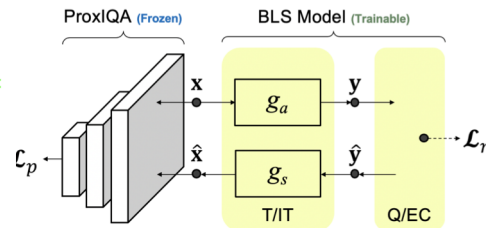
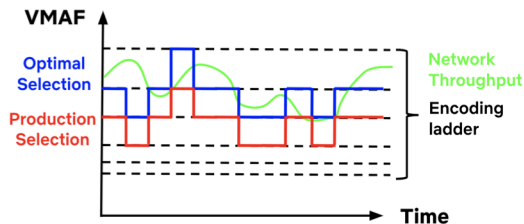
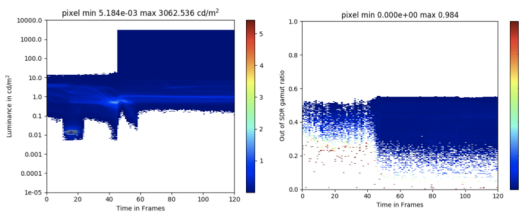
This talk will cover VMAF's brief history, its basic principles and our recent work in progress.



## A Brief History of VMAF

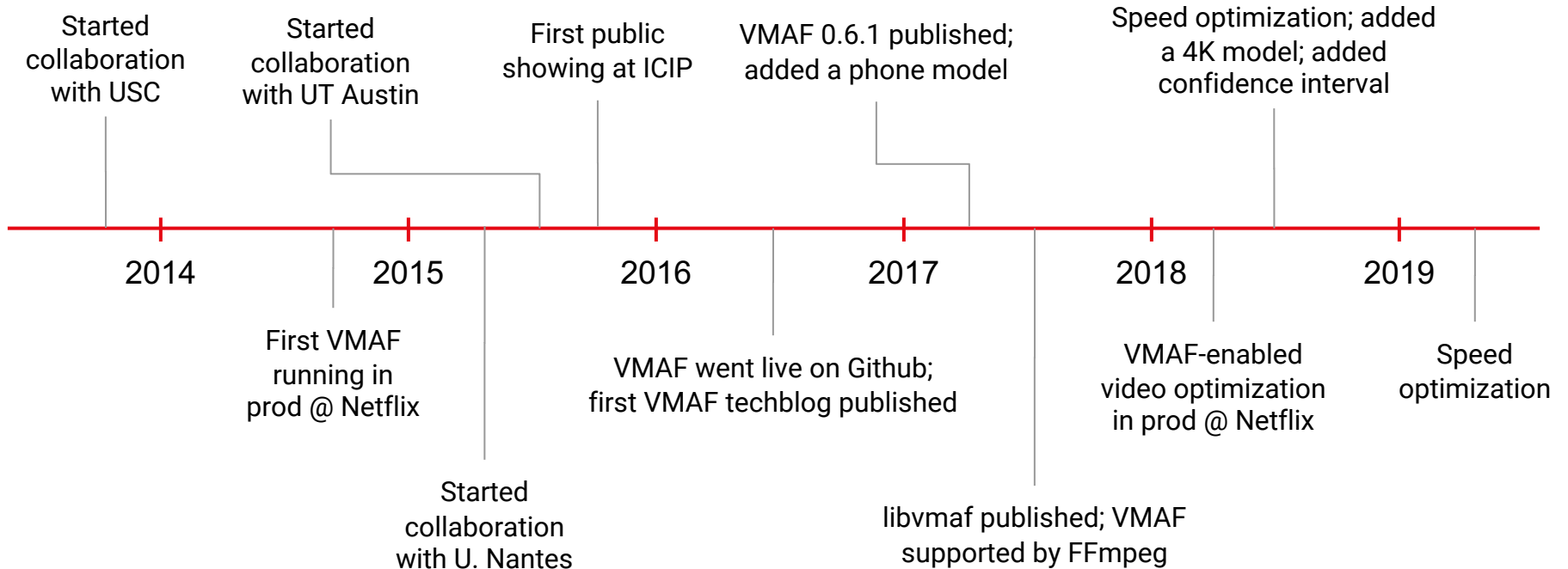


## How VMAF Works



## Work in Progress

# The VMAF chronicle



# VMAF open-source project

Netflix / vmaf

Unwatch 383

★ Star 1,182

Fork 260

Code

Issues 42

Pull requests 4

Projects 0

Security

Insights

Settings

Perceptual video quality assessment based on multi-method fusion.

Edit

Manage topics

955 commits

16 branches

13 releases

35 contributors

Apache-2.0

Branch: master

New pull request

Create new file

Upload files

Find File

Clone or download



li-zhi Merge pull request #326 from legrosbuffle/master

Latest commit d8642b2 12 days ago

feature

Merge pull request #326 from legrosbuffle/master

12 days ago

libsvm

Feature/revamp2 (#23)

3 years ago

matlab

Add matlab imports in run\_testing; run mex for ST-MAD.

7 months ago

model

Change default bootstrap model to plain bootstrapping; modify docs.

7 months ago

pthreads

Fix incorrect VMAF score on VS2015 and refactor MSVC project files

6 months ago

# Integration in 3rd-party tools

FFmpeg

## 10.107 libvmaf

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Developers

Obtain the VMAF (Video Multi-video).  
The obtained VMAF score is p  
It requires Netflix's vmaf lib  
library it can be enabled using  
. If no model path is specified  
The filter has following option

**model\_path**  
Set the model path w  
"vmaf\_v0.6.1.pkL"

**log\_path**  
Set the file path to be used

**log\_fmt**

## MSU Video Quality Measurement Tool

[MSU Graphics & Media Lab \(Video Group\)](#)

Projects, ideas: Dr. Dmitry  
Implementation: Alexey Moskvina, Oleg Petrov, Sergey Putilin, Sergey Grishin, Arsaev, Georgy

▼ Why VQMT?

- Basic Information
- Why update?
- PRO Version (with command-line interface) benefits [Full]
- Key Contributors

▼ Support

- Setting & Screenshots (advanced files settings, visualization setti)
- Metrics Info (VMAF, NIQE, PSNR, MSE, MSAD, SSIM, VQM, MSU E)
- FAQ (Frequently Asked Questions)
- Plugins & Plugin SDK
- MSU VQMT program performance
- Subjective quality metrics comparison

## ZOND 265 — your indispensable tool

- Visualized bits distribution statistics to facilitate encoding of CU, PU, and TU data
- Quality estimation by Netflix VMAF, PSNR and MSSIM metrics
- Fast translucent overlays of encoded file image (CU, PU, TU, QR, Bits, RefIdx, PNSR) for Ultra HD files.
- HEVC stream validation conformance according to the specification in GUI

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**elecard**  
VIDEO COMPRESSION GURU

## Video Quality estimator

Video Quality measurement tool designed to compare quality of encoded streams based on objective metrics, such as PSNR, APSNR, SSIM, DELTA, MSE, MSAD, VQM, NQI, VMAF and VMAF phone.

Contact Us Try for Free

## VideoClarity

Tools for Video Analysis

### Automated Testing Solutions

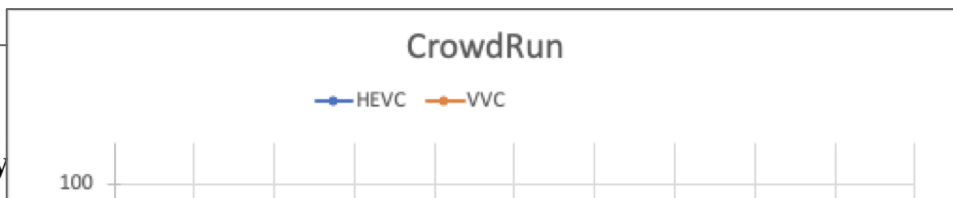
#### ClearView – Video Quality Measurement and Analysis Systems

- Resolution and frame rate independent picture quality analyzers with multiple models
- Versatile input/output with 12G-HDSDI, 10G IP, HDMI, IP stream decode/capture
- Comprehensive media ingest with full featured file decoder application
- Quantitative picture quality metrics VMAF, NIQE, MS-SSIM/DMOS, PSNR, and Sarnoff JND (option)
- Test for HDR color just noticeable differences with  $\Delta E_{ITP}$
- Test for source sequence complexity using Temporal and Spatial metrics
- Performance testing for audio using aFreq metric for audio quality with AV offset (lip-sync) measurement and aPeak metric for standardized loudness testing
- Automatic temporal and spatial alignment, comparison playback of uncompressed video via HDSOI or HDMI outputs with interactive side-by-side views up to 8K and 4K @ 60 Hz
- Picture zoom up to 16X with pan and scroll provides unmatched inspection of compression artifacts during any play mode for a detailed view of one or a comparison of two videos
- Desktop window of comparison play modes provides for machine room or data center use without video output connectivity

# Use case: compare codecs

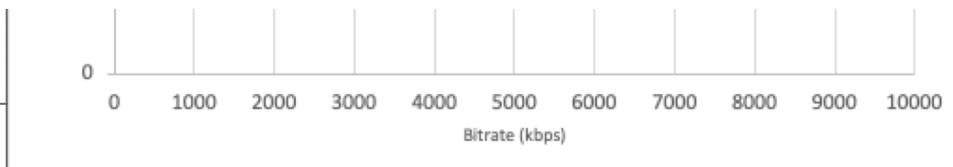


Joint Video Experts Team (JVET)  
of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/W  
15th Meeting: Gothenburg, SE, 3–12 July 2019



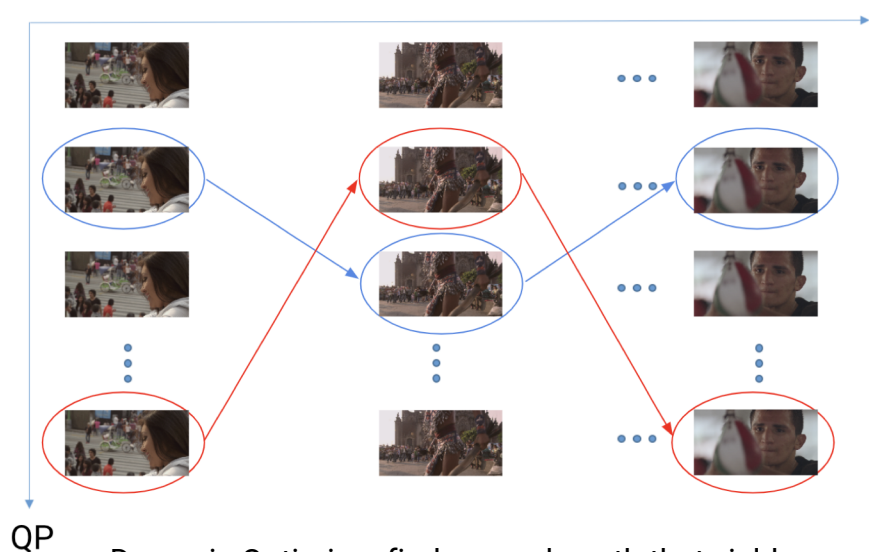
Resolution	BD-rate (PSNR)	BD-rate (VMAF)	BD-rate (MOS)
HD	-31.24%	-35.18%	-36%
UHD	-34.42%	-40.44%	-40%

Source: Orange, INSA Rennes and b◇com

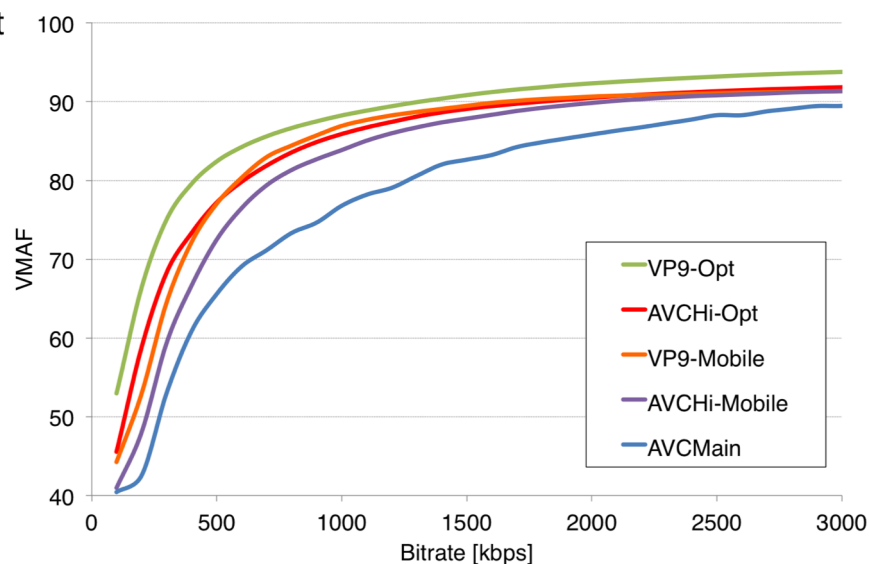


[Source: JVET-O0451 Subjective Comparison of VVC and HEVC,  
JVET 15th meeting: Gothenburg, SE, 3–12 July 2019]

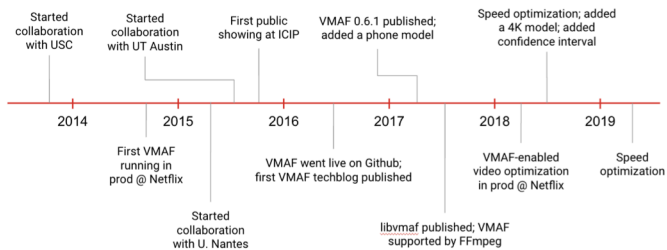
# Use case: guide encoding decisions



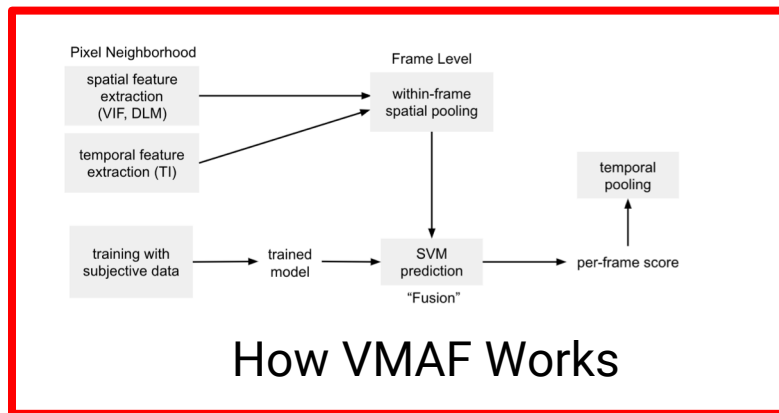
Dynamic Optimizer finds encode path that yields the best average VMAF for the given bitrate



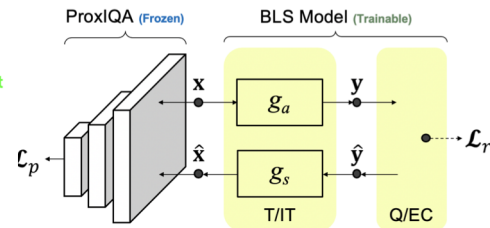
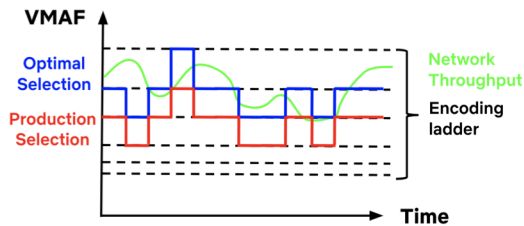
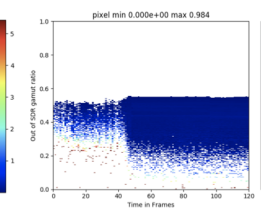
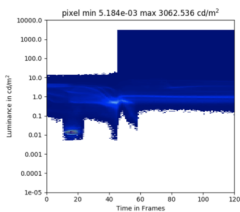
[Source: Dynamic optimizer—a perceptual video encoding optimization framework, Netflix Techblog, Mar 6, 2018; Optimized shot-based encodes: Now Streaming! Netflix Techblog, Mar 10, 2018]



## A Brief History of VMAF



## How VMAF Works



## Work in Progress

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PSNR 37.1 dB, VMAF 71.1

Image removed

PSNR 32.9 dB, VMAF 70.2

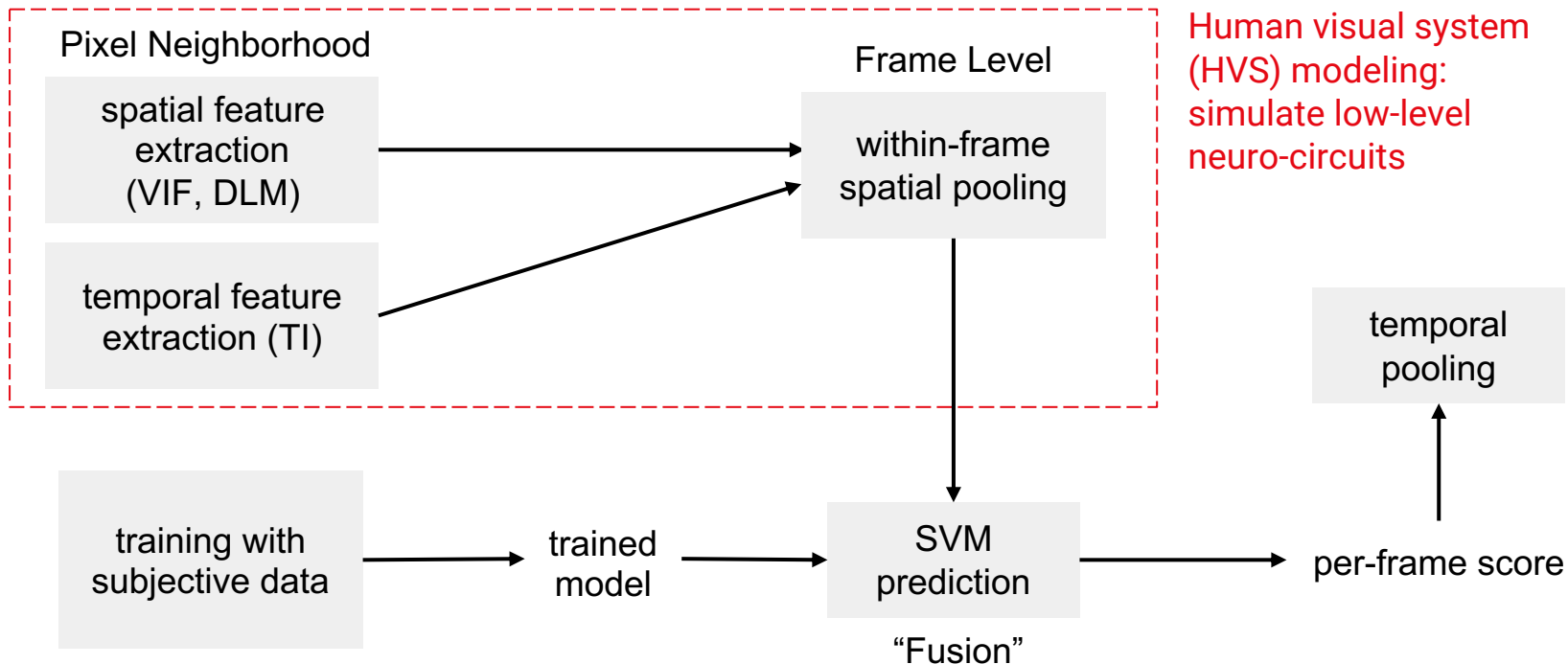
Image removed

PSNR 29.1 dB, VMAF 20.4

Image removed

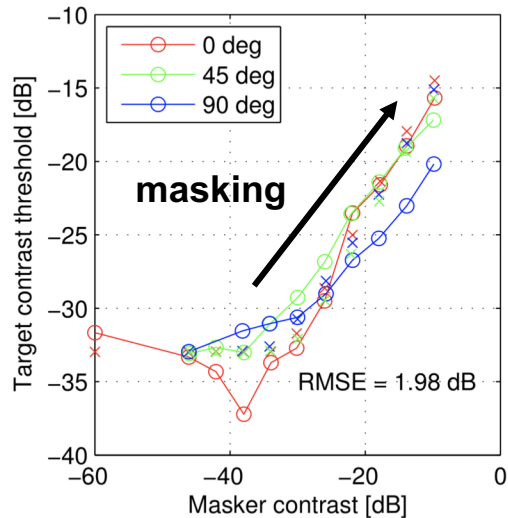
PSNR 29.3 dB, VMAF 69.8

# VMAF framework



# HVS modeling: contrast masking

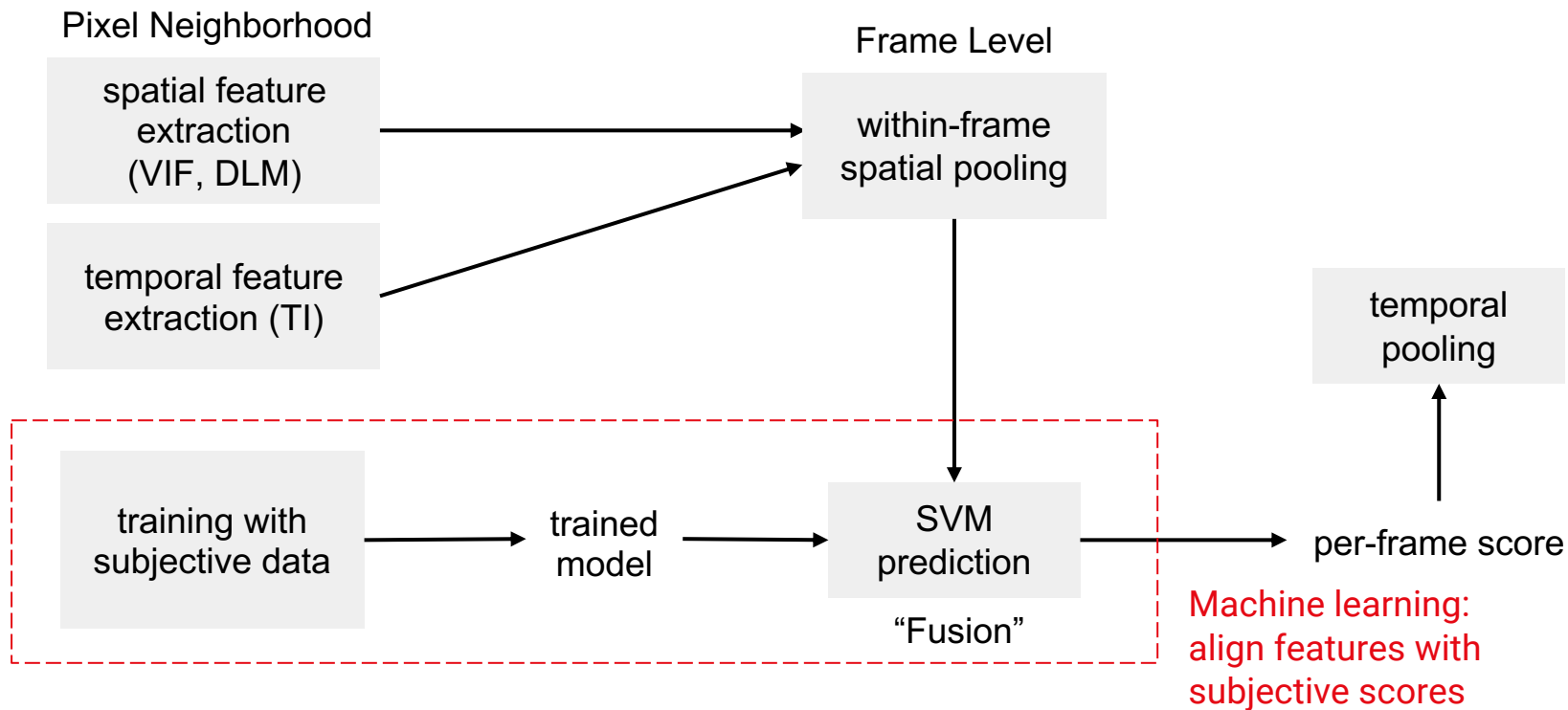
- When the compression or scaling artifacts gets superimposed on the pristine source signal with similar frequency and orientation, the artifacts becomes less noticeable by human eye



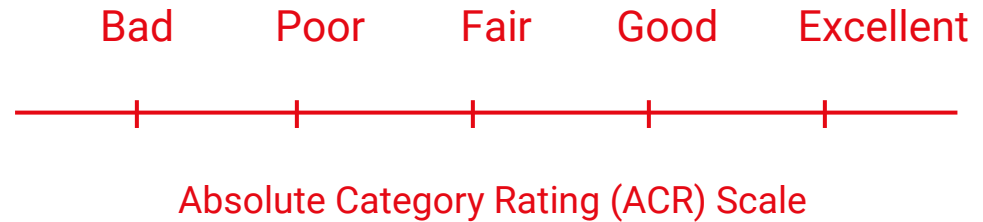
[Source: HDR-VDP2, Mantiuk et al. 2011]



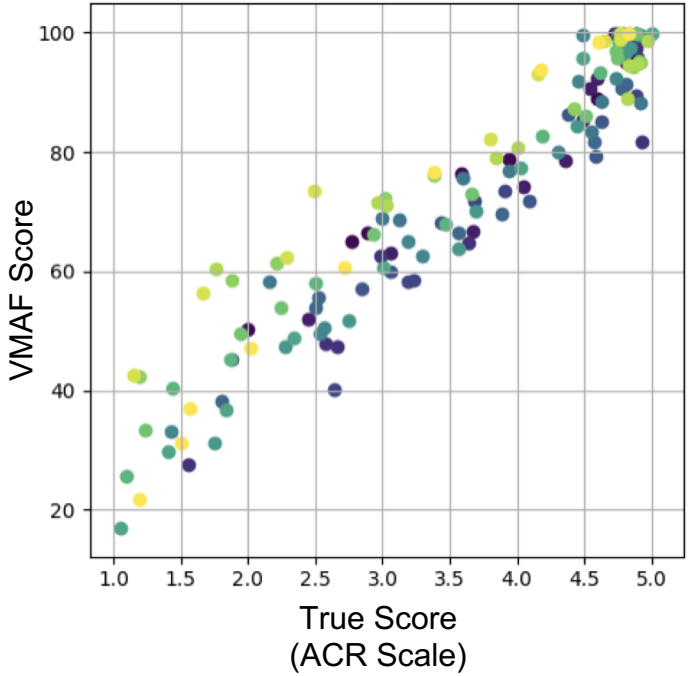
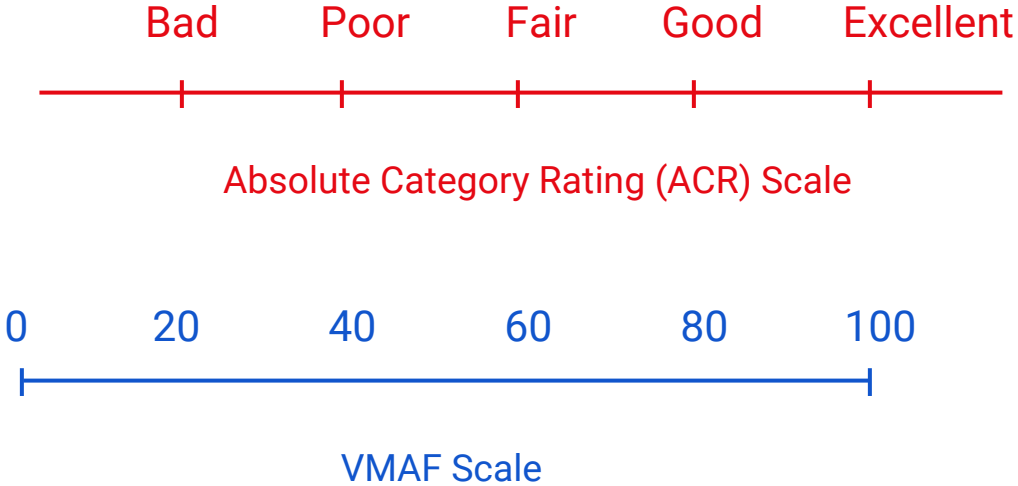
# VMAF framework



# Lab test: collect subjective scores



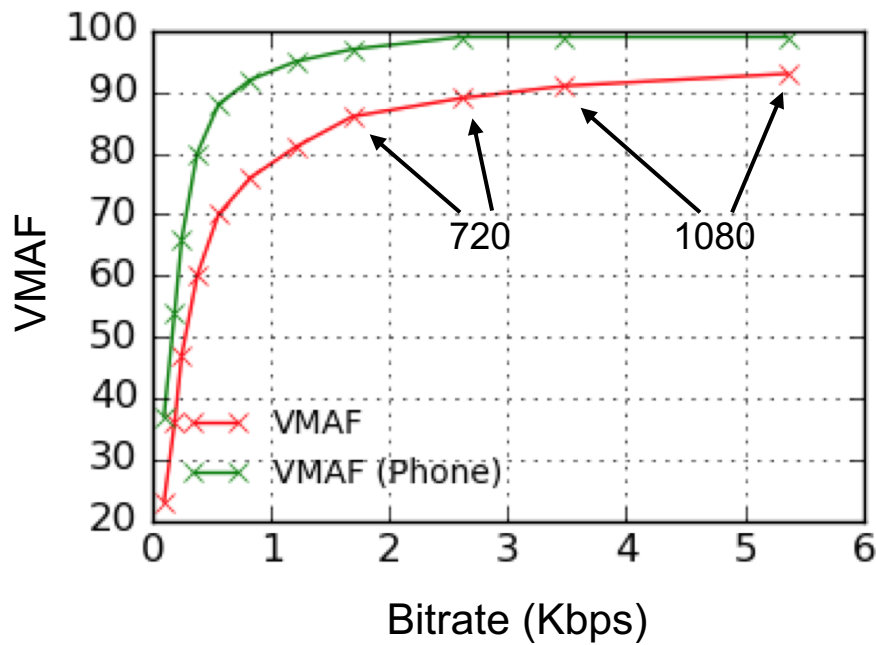
# Map ACR scale to VMAF score

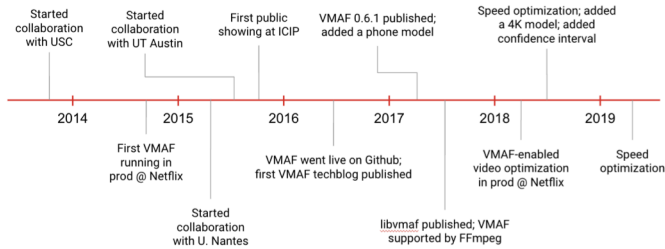


# Viewing distance / screen size matters

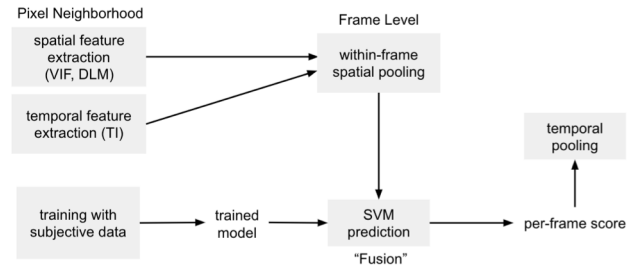


# VMAF phone model

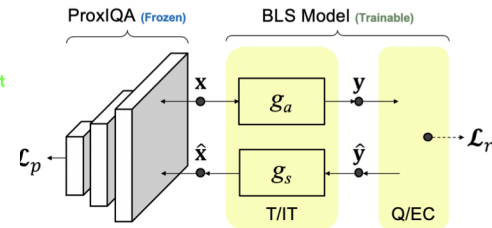
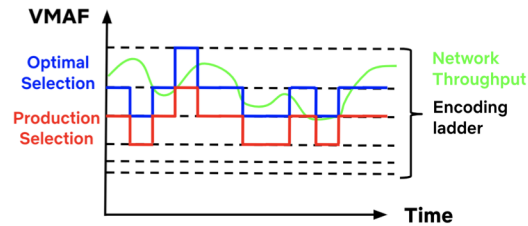
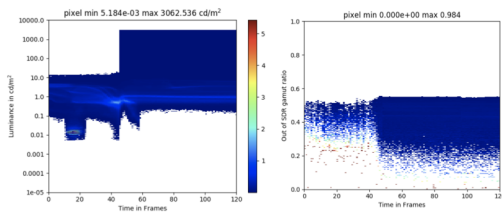




## A Brief History of VMAF

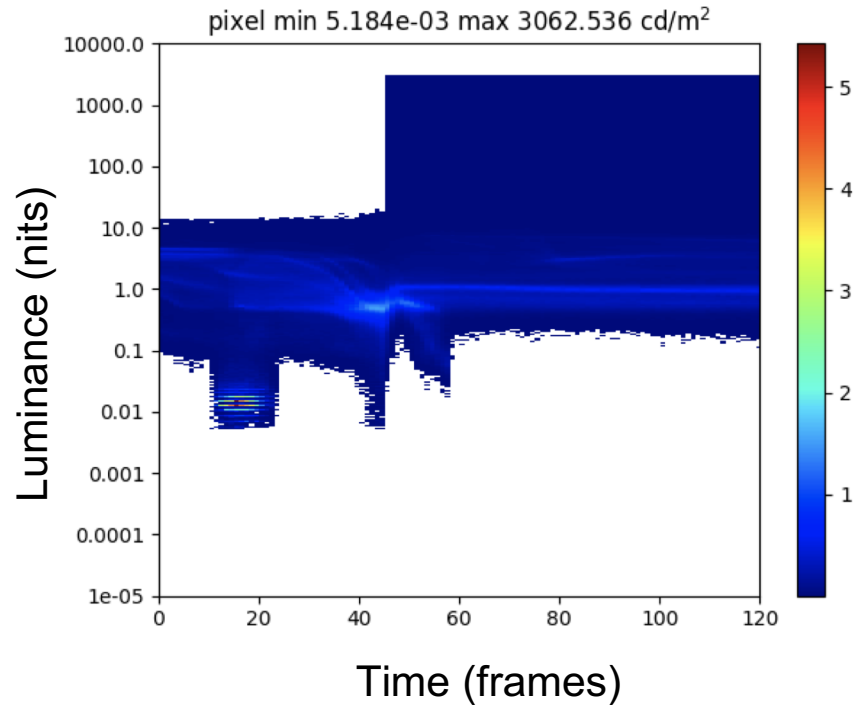


## How VMAF Works



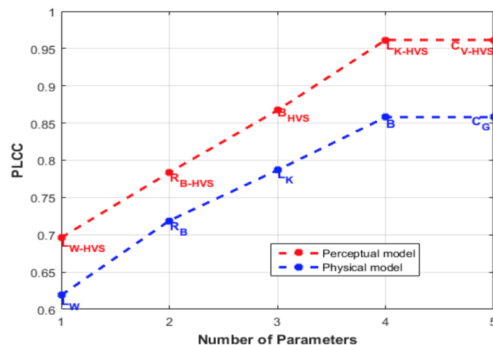
## Work in Progress

# Source in HDR P3D65 (max 3000 nits)



# VMAF for HDR

- Goals:
  - Capture the perceptual benefit of HDR videos over SDR
  - More generally, extend the quality prediction of VMAF to HDR range
- Challenges
  - Need to capture the most pre-dominant factors impacting quality (e.g. max luminance)
  - Need new human vision models to extend beyond SDR
  - Complex interactions between luminance and compression artifacts



[Source: Dolby, Choudhury'17]

## Device physical characteristics

- Max luminance ( $L_w$ )
- Backlight resolution (RB)
- Minimum luminance ( $L_k$ )
- Bit depth (B)
- Color Gamut ( $C_g$ )



**Tad Legler** @TadLegler · Aug 25

Come on [@netflix](#), you can't **rebuffer** Big Trouble in Little China during the climactic battle sequence - I have to know what happens!



1



**Malena** @\_anelam\_ · Jan 5

How many times does my **Netflix** have to **rebuffer** 🤔🤔🤔



1



**Lauren P. Koester** @LPKess · Jan 18

Why does **Netflix** **rebuffer** so much??



2



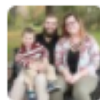
**Baitless Bob** @C\_Errrr · Oct 1

Nothing annoys me more than when **netflix** goes from **hd** to **pixelated** for no fucking reason



**Stuart McCullagh** @DeatGaming · Jul 9

[@NetflixUK](#) Why does the **Netflix** Windows App **take so long to start** playing a single episode, mines is taking like 2 minutes.



**Em.** ✨ @emmaalysann72 · Jun 12

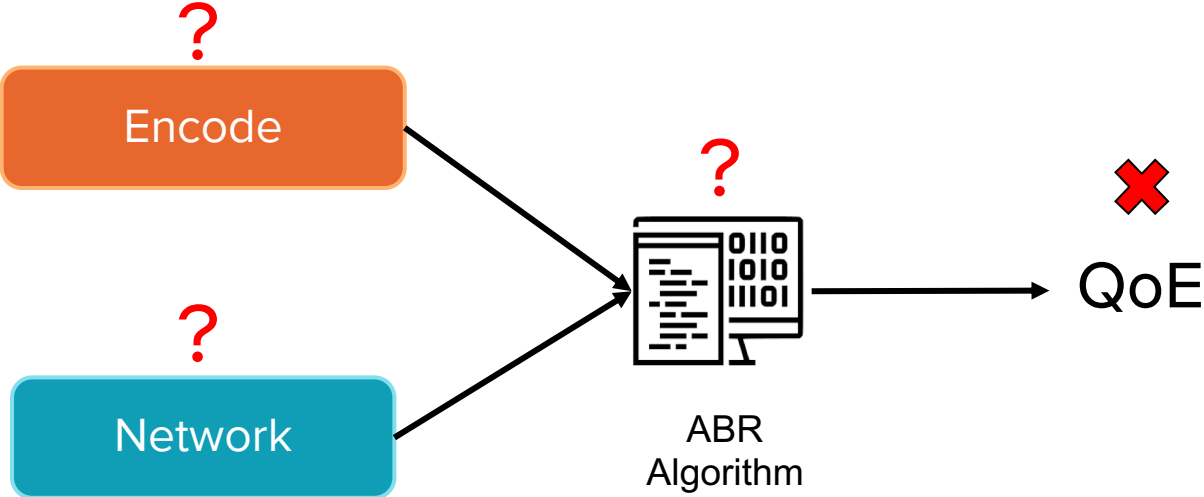
Why does **Netflix** **take so long** to automatically **start** the next episode? Yes I want to watch the next one! I don't need 15 seconds to decide.



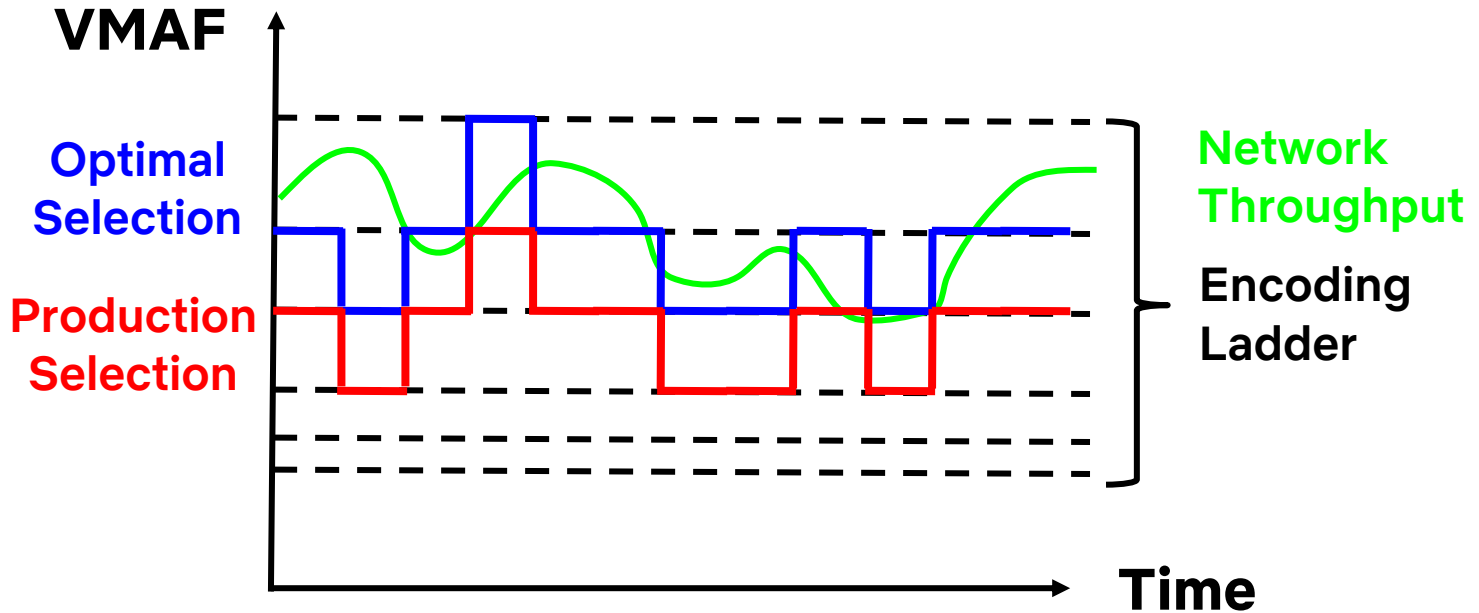
11



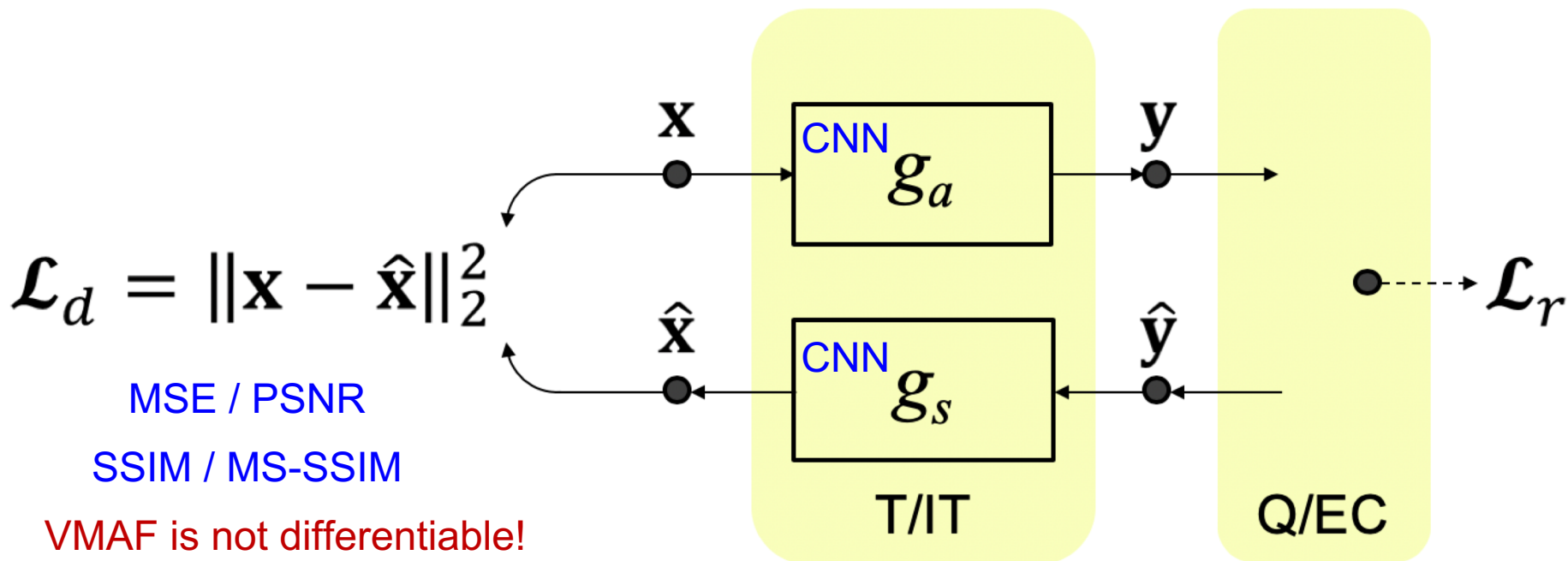
# Diagnosis of a QoE issue



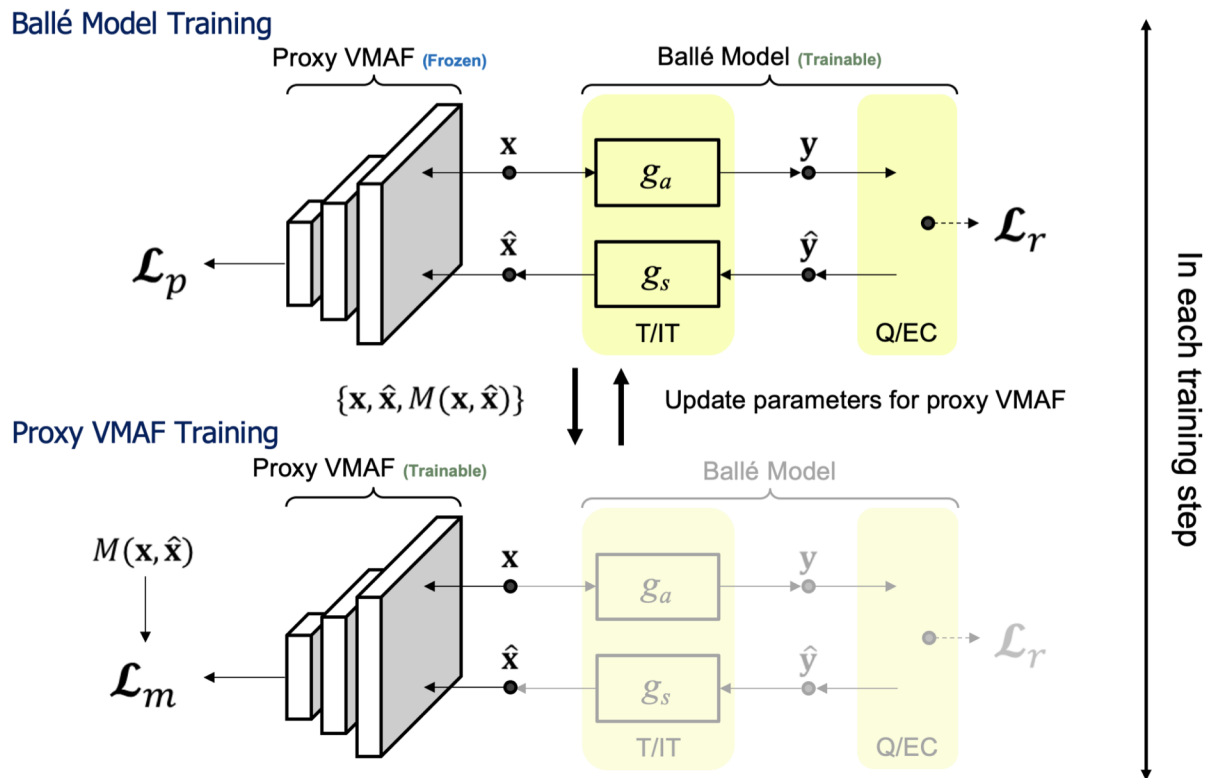
# Hindsight: evaluate ABR algorithm



# Learned image compression [Ballé 2017]

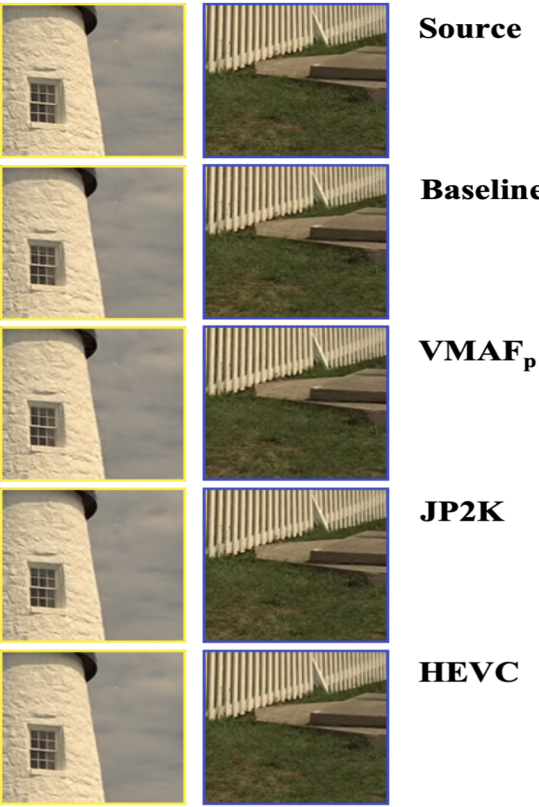
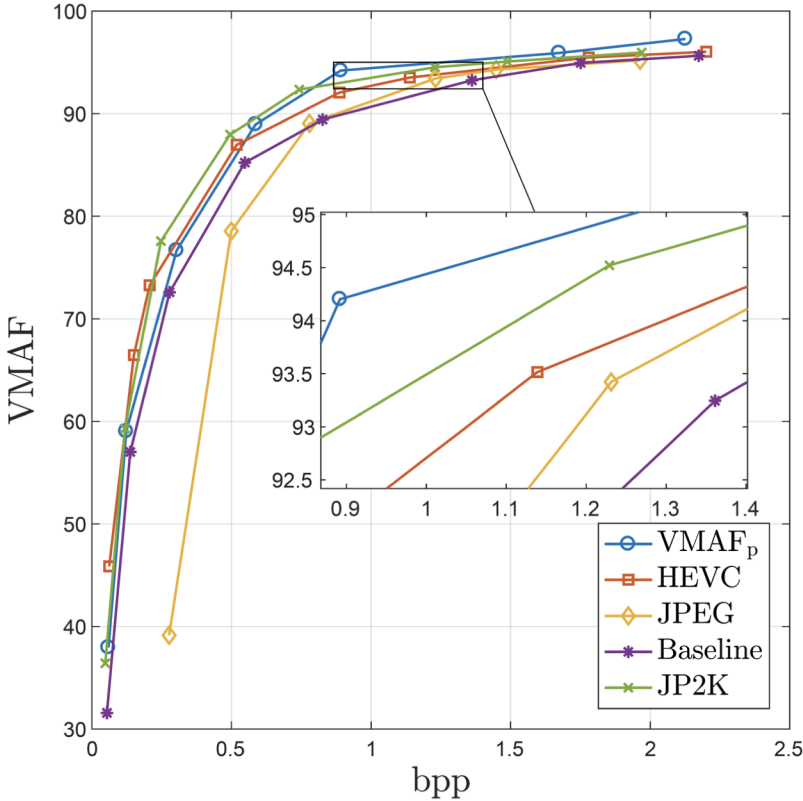


# Train a differentiable “proxy” VMAF network

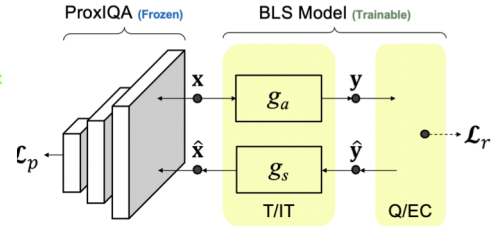
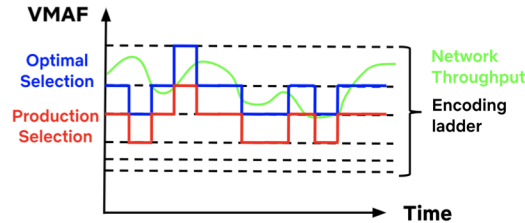
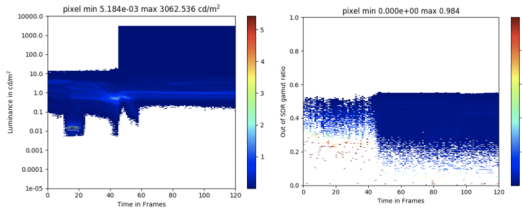
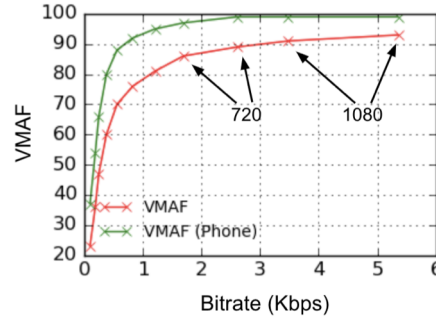
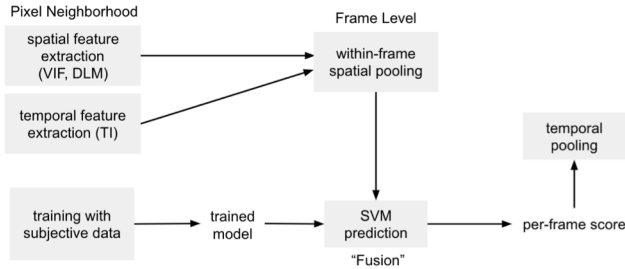


[Li-Heng Chen et al., joint work Netflix / UT Austin]

# Kodim 19 (VMAFp – VMAF proxy)



Together with the open-source community, we are committed to evolve VMAF to deliver better video quality over the Internet. The journey continues.



Questions?