

Performance Estimation of Encrypted Video Streaming Considering End-User Playback-Related Interactions



Ivan Bartolec, mag. ing. inf. et comm. techn.
(ivan.bartolec@fer.hr)

mentor: prof. dr. sc. Lea Skorin-Kapov,
University of Zagreb Faculty of Electrical Engineering and Computing



1. Introduction

Network traffic volume is growing, with video traffic accounting for most mobile data traffic as a result of Video-on-Demand (VOD) services (e.g., YouTube, Netflix) and others.

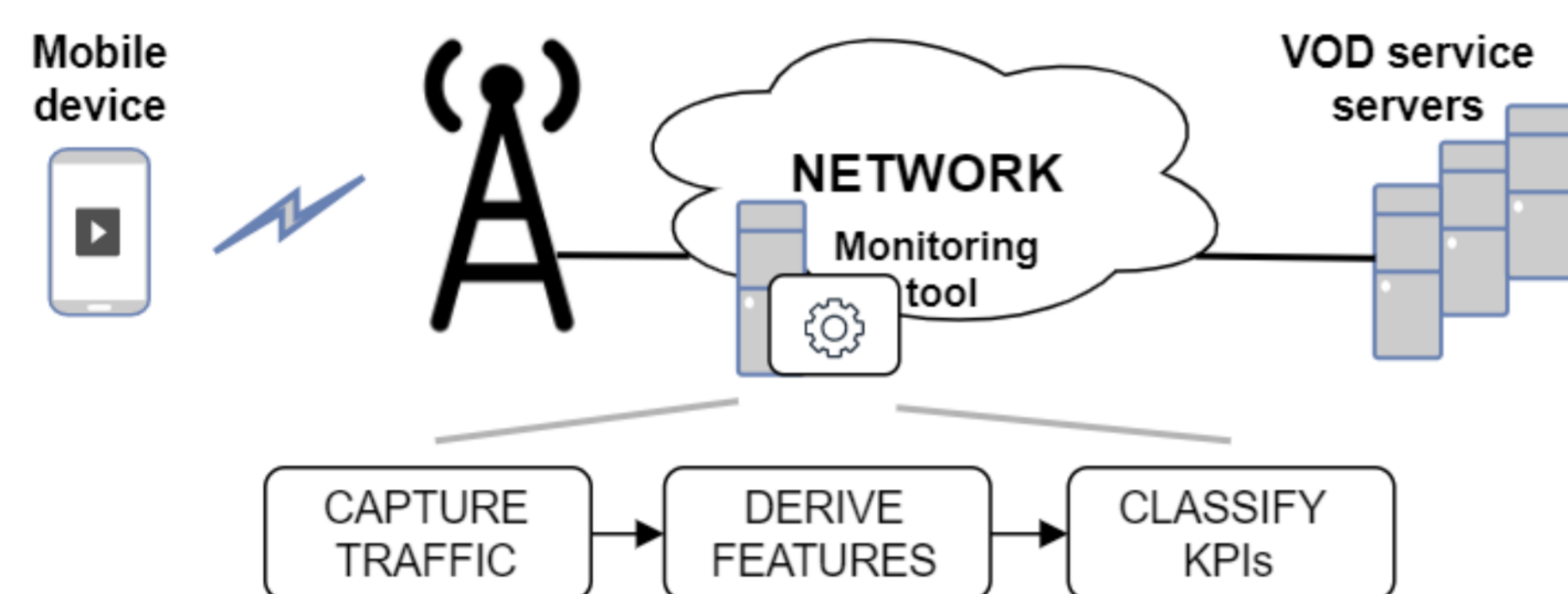
Mobile subscriptions globally
8.1 billion

Total monthly mobile traffic
65 exabytes

Video traffic share
69%

Network operators monitor **Quality of Experience (QoE)** to prevent customer churn and maintain video stream quality.

- Key Performance Indicators (KPI): resolution, bitrate, stalling.
- End-to-end traffic encryption imposes a challenge.
- KPIs are inferred by using **Machine Learning (ML)** methods.



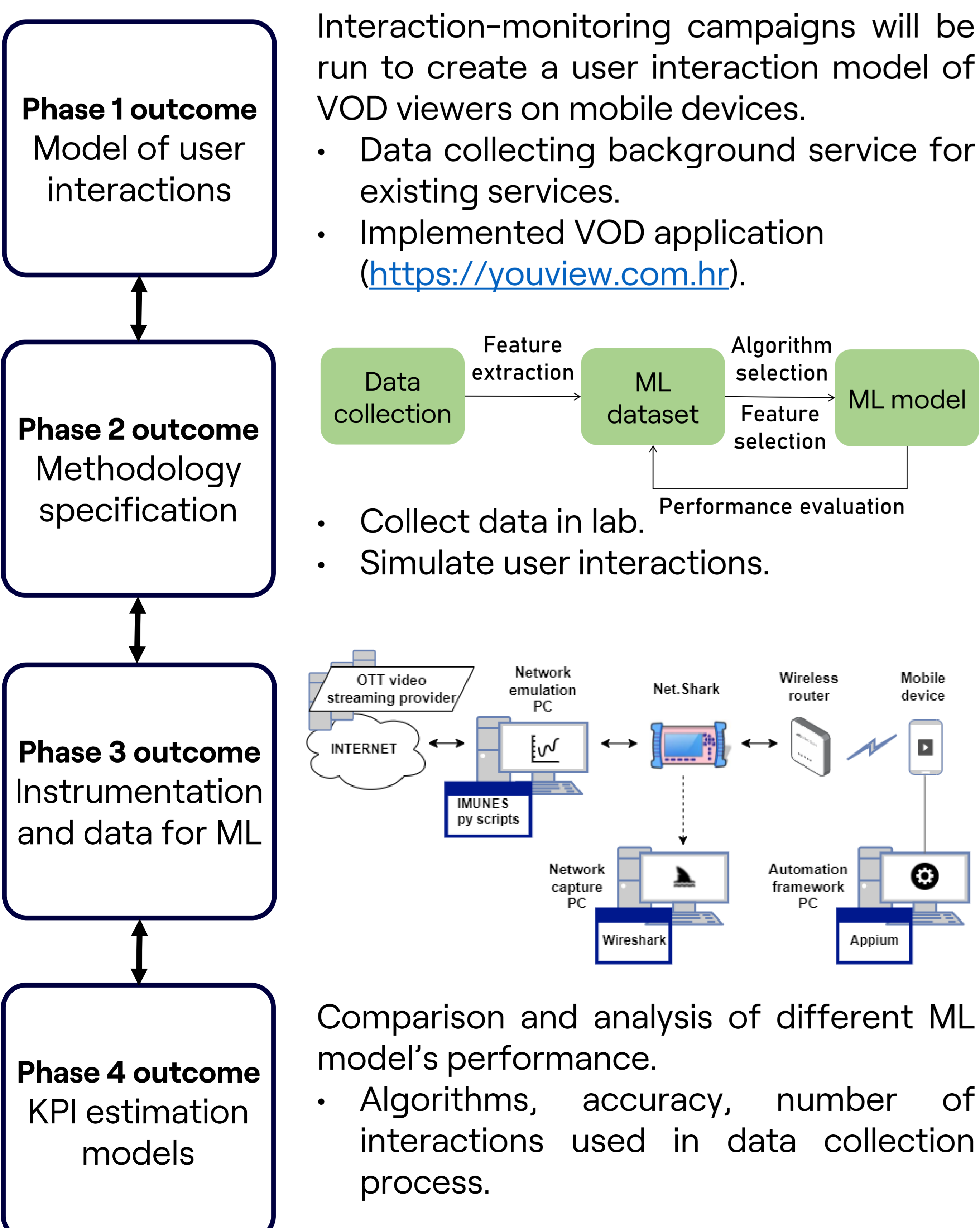
2. Research gap and objective

Viewers frequently interact with the video player, which most video QoE studies ignore.

- Interactions may impact traffic features and thus performance of models that rely on those features.

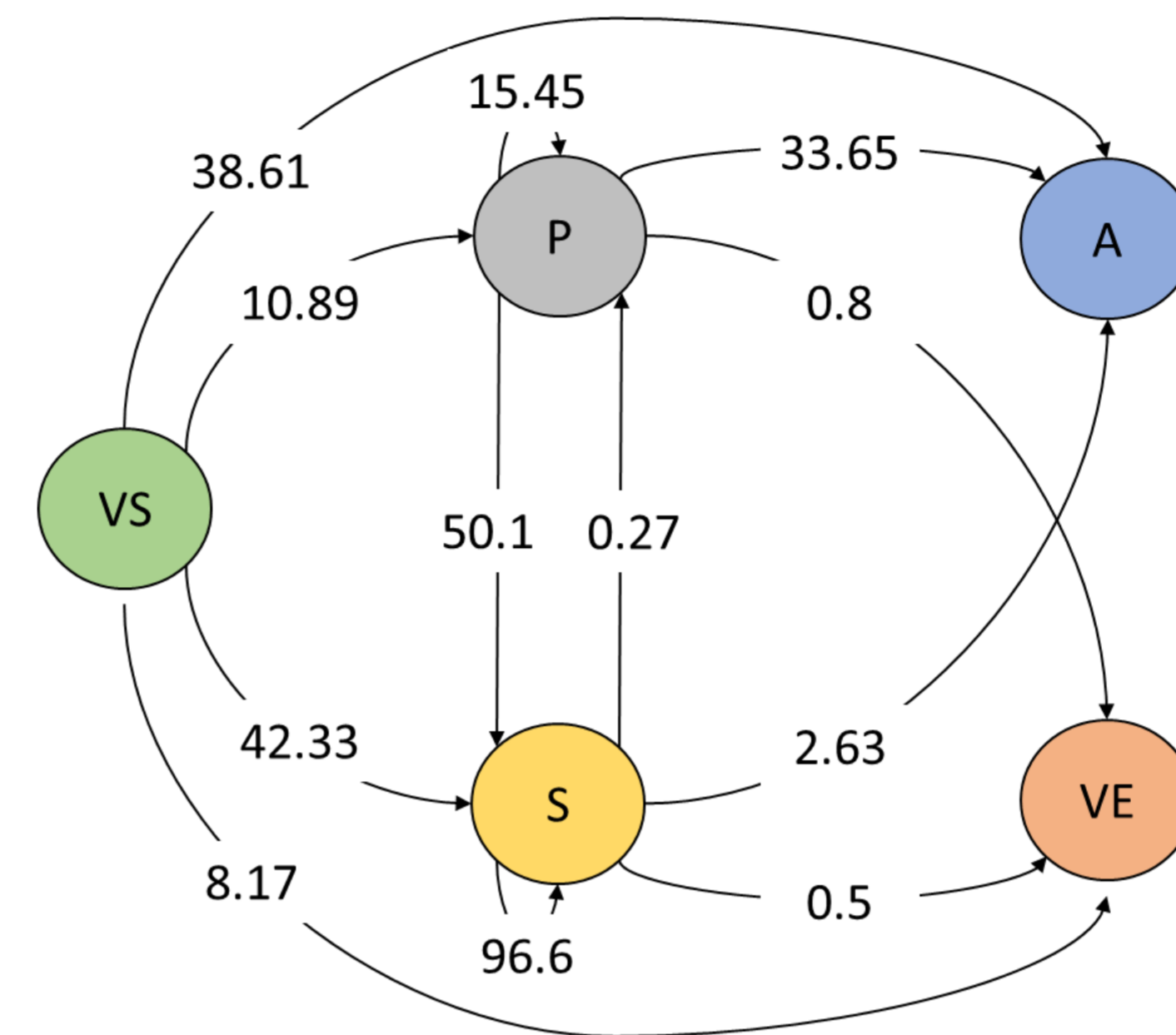
The main objective of this research is to specify an approach for **in-network estimation of KPIs of video sessions** containing **user interactions** (e.g., pausing, seeking, and abandonment).

3. Research plan and methodology



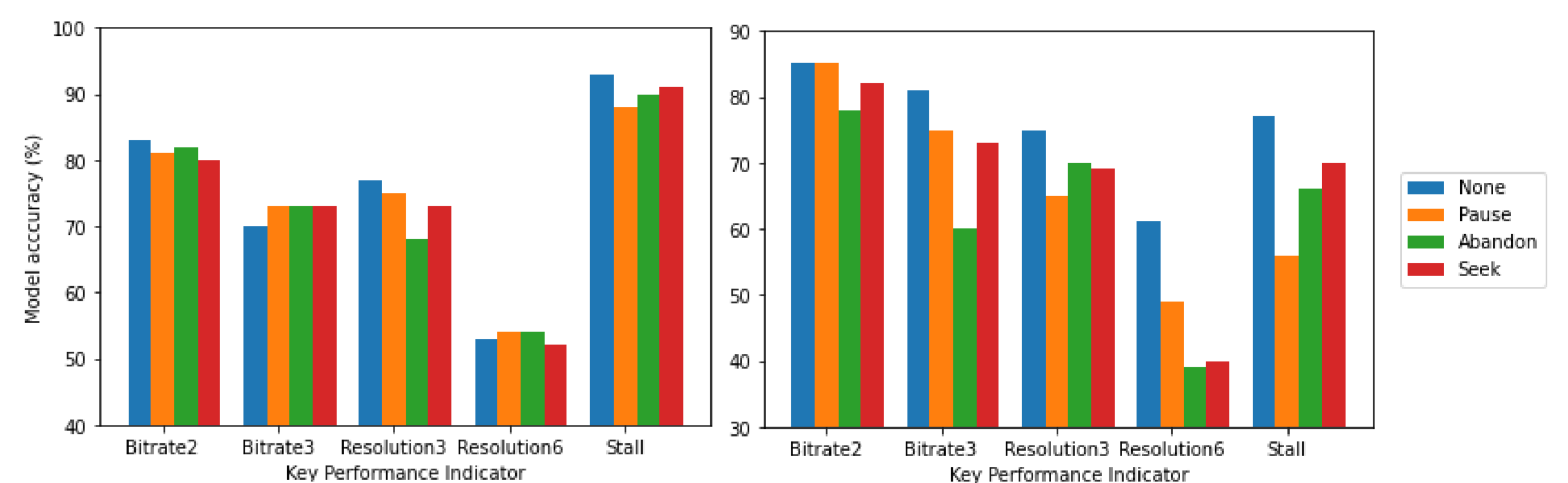
4. Results

How viewers watch YouTube? The figure below illustrates transition probabilities between interactions for viewers watching YouTube over a 4G network based on data collected between May and June 2021.



VS – playback start
VE – playback (video) end
P – pause
S – seek
A – playback terminated

Do interactions impact classification? In the case of session-based KPI classification, models perform worse when classifying KPIs of videos with interactions, whereas this was found to not be the case for real-time classification.



Performance of Random Forest classification models trained on datasets without interactions (left real-time, right session-based)

Should all interactions be included in the training process? By including videos with Abandonment and Pause interactions in the training dataset, models perform better when classifying videos without or with one user interaction.

Class yes Recall heatmap of Random Forest models for classifying Stalling in 2 classes.

		Trained on x =							
		{N}	{N,S}	{N,A}	{N,P}	{N,S,A}	{N,S,P}	{N,A,P}	{N,S,A,P}
Validated on	y = x	0.59	0.89	0.91	0.77	0.68	0.65	0.88	0.91
	y = {N,S,A,P} \ x	0.68	0.77	0.85	0.81	0.69	0.67	0.93	x
	Average	0.64	0.83	0.88	0.79	0.69	0.66	0.91	x

5. Conclusion

- Interaction-monitoring campaign revealed that 87% of videos were abandoned before they were completed, with seeking being the most common type of interaction.
- When models are trained on datasets without interactions, the performance of session-based KPI classification is degraded when videos with interactions are classified, as opposed to real-time classification.
- Only abandonment and pause interactions could be included in the data collection process while still achieving satisfactory KPI classification performance.

6. Project Acknowledgement

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