

Paper Review

A Study of User Behavior in Online VoD Services

Computer Communications, 2014

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Background

- A big portion of Internet traffic is video
 - Netflix, Hulu, YouTube
 - China: **Tencent Video**, Youku and Tudou
- A good understanding of user behavior in online VoD help us design, configure and manage video content distribution



Video Browsing Behavior

- Users spend a lot of time **browsing**
 - Viewing part of one video after another, only occasionally (around 20% of the time) watching a video to its completion
- Consider **seek** as a specific form of browsing
 - Repeating partial viewing of the same video
- User behavior model
 - A user transitions through a random number of short views before a longer view

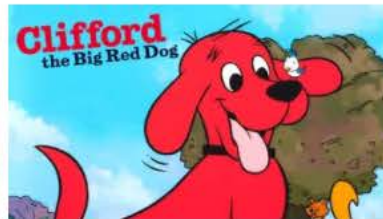
Top Picks for KIDS



Because you watched Zig & Sharko >



Common Sense Media Family Faves >



Data Collection

- Tencent Video
- 45 million users on a daily basis
- 1.5 million users online concurrently during busy hours
- Contents
 - Movie, TV episode, music/entertainment video
 - Short clips of news and sports
- Delivery protocol: HTTP/TCP
- One month period
- 490 GB, 540 million viewing records, 48.9 million users

Early Departure

- 56.4% videos are watched
 - for less than half of their distribution
- Reasons
 - Lack of interest in video content
 - Poor performance

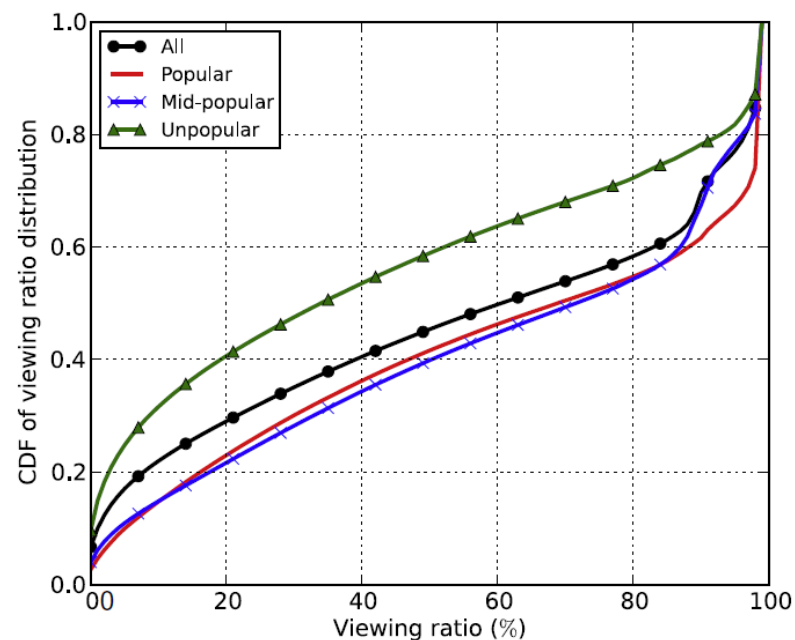


Fig. 1. Viewing ratio distribution for all views, views on popular, middle popular, and unpopular videos.

Viewing ratio $x_i = \frac{T_i}{L_{v_i}}$,

Viewing Ratio considering Seek

- Split a view with k seeks into $k + 1$ views
- More than 60% of views
 - Less than or equal to 0.2

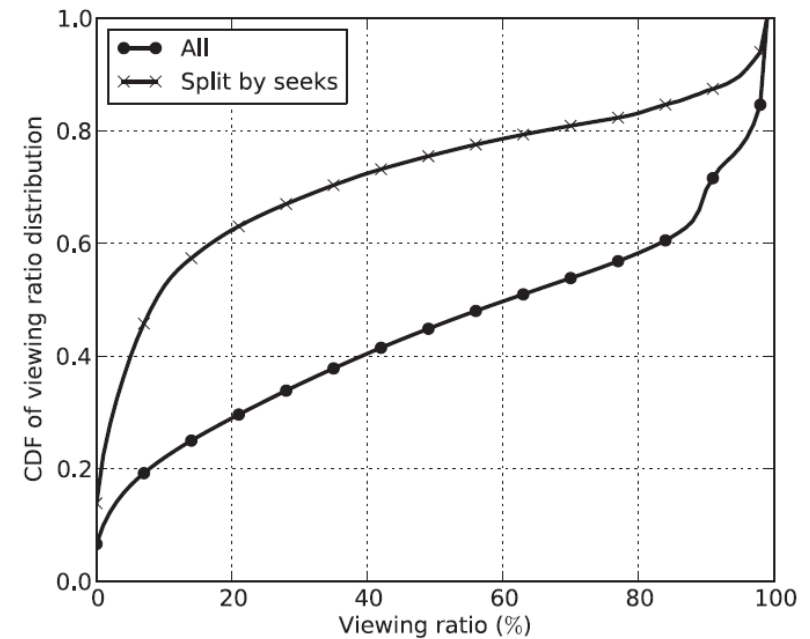


Fig. 2. Viewing ratio distribution for all views, and views split by seeks.

Viewing Ratio of Different Groups

- **Sport** videos have the largest fraction of complete views
- The early departure probability is highest for viewing **movies**
- User's engagement seems to be inversely correlated to the **length of videos**

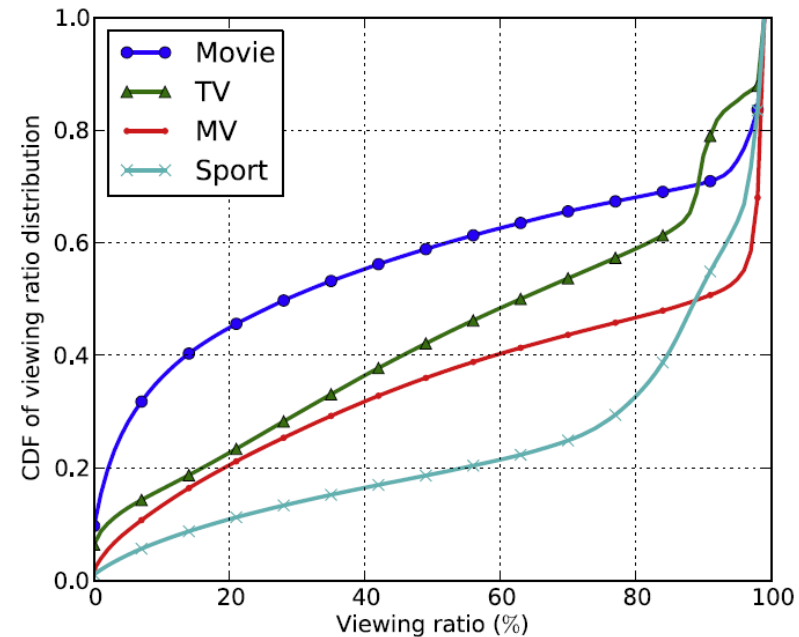


Fig. 3. Viewing ratio distribution for movie, TV, MV, and sport clips.

First View

- Popular videos are often selected for first view
- Success of recommendation system

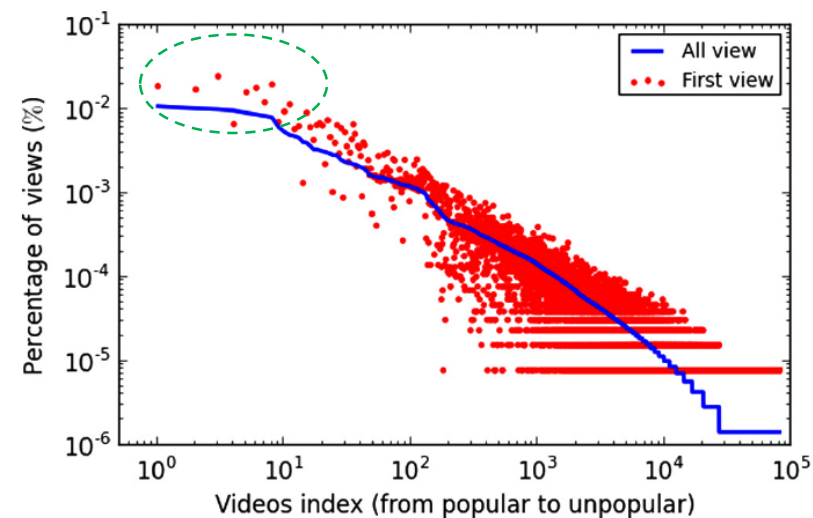


Fig. 5. Percentage of views for videos in all views and users' first views on the logarithmic scale.

Long View

- Long view
 - Views with viewing ratio > 0.5
- A user is more likely to be in the **browsing mode** earlier than later
 - Video browsing

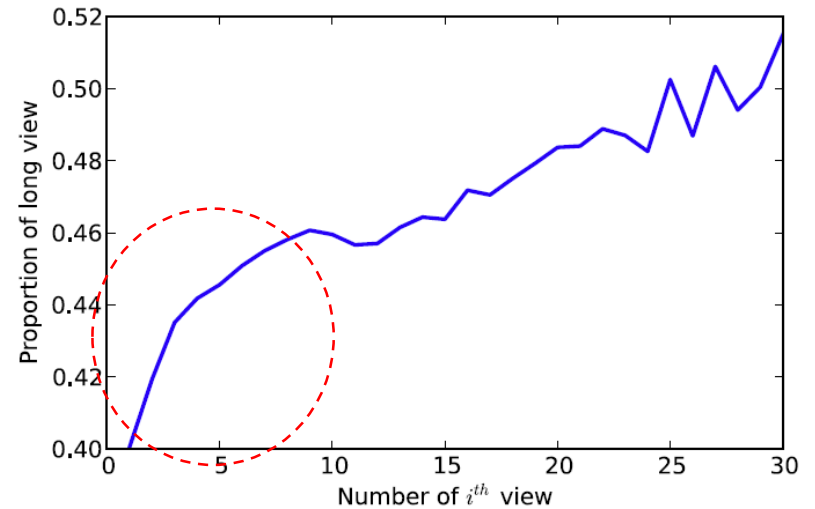


Fig. 6. Proportion of long view for i^{th} view.

Number of Views

- Number of views per day by a user
- $\frac{1}{4}$ users
 - One view per day
- $\frac{3}{4}$ users
 - More than one views per day

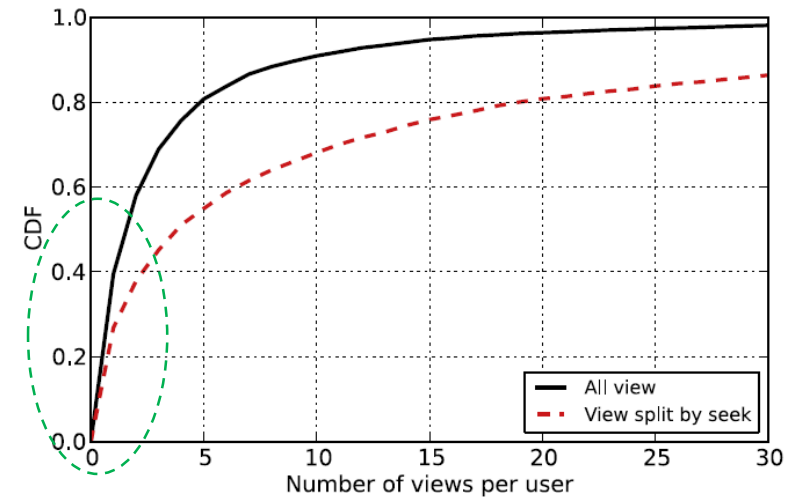


Fig. 7. Distribution of the number of views per user.

Short Views before Long View

- How many short views a user goes through before landing in a long view?
- 80% of long views are preceded by one to five short views.
- 15% of long views were not preceded by any short views.

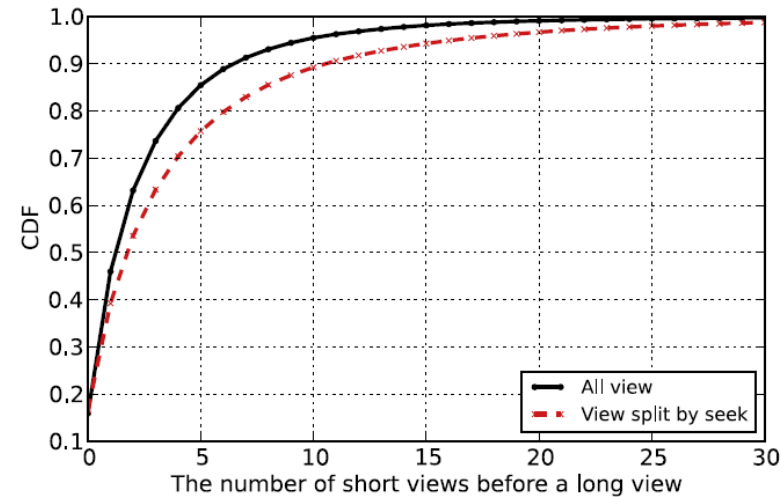


Fig. 9. Distribution for the short views before a long view per user.

Seek Behavior

- Seeks are a form of video browsing
- We look for some specific content in the video
- We try to finish the video at a fast speed than the playback rate

Table 3

Conditional probability of the number of seeks.

Action	Prob. (%)
$P\{\# \text{ of seeks} > 1 \text{seek occurred}\}$	76.1
$P\{\# \text{ of seeks} > 2 \text{seek occurred}\}$	68.9
$P\{\# \text{ of seeks} > 3 \text{seek occurred}\}$	63.9

Table 5

The relationship between video content and seek frequency.

Type of video	Movie	TV	MV	Sport	Popular video	Unpopular video
Avg. # of seek	9.36	8.47	4.76	4.52	5.9	6.3

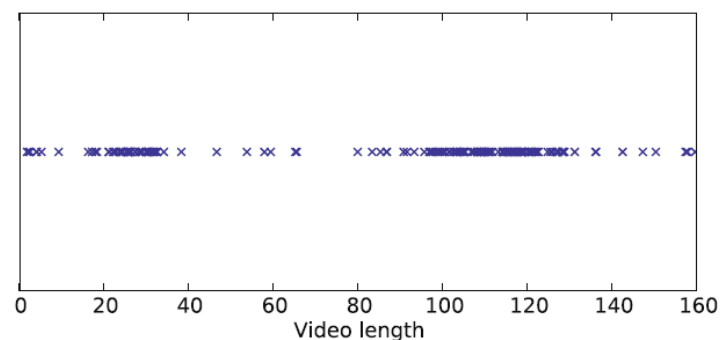


Fig. 10. Distribution of seek positions for one specific video.

How to Apply User Behavior ?

- In the paper, authors propose how to estimate video popularity
 - View count?
 - Viewing-time-based video rating?
- We want to develop a content location problem considering user behavior
 - Early departure
 - Video seek: highlight

User Behavior-Aware Content Placement Problem

- Given
 - User behavior, contents, storage places, network
- Objective
 - To improve user satisfaction
 - stay longer on the site and consume more contents
 - (Increase interest of contents and improve performance)
- Constraints
 - Storage and bandwidth (energy)

Things to Consider

- Video browsing user behavior: early departure, video seek (highlight)
 - Lack of interest → personalized recommendation contents, cover image, video highlight
 - poor performance → put the user-preferred contents nearby clients
- Different storages: client devices, home router, MEC or CDN, and cloud
 - Storage constraints → hierarchical content placement with tradeoff of storage volume and response time
- Temporal dynamics: user behavior, content distribution
 - Periodic content placement, relocation, deletion strategy
- Contents
 - Cover image: highlight image or animation of highlight
 - First chunks
 - Video highlights for a content
 - Whole video file
- Collaborative filtering
 - Content-based vs user-based
 - Top N: genre or category

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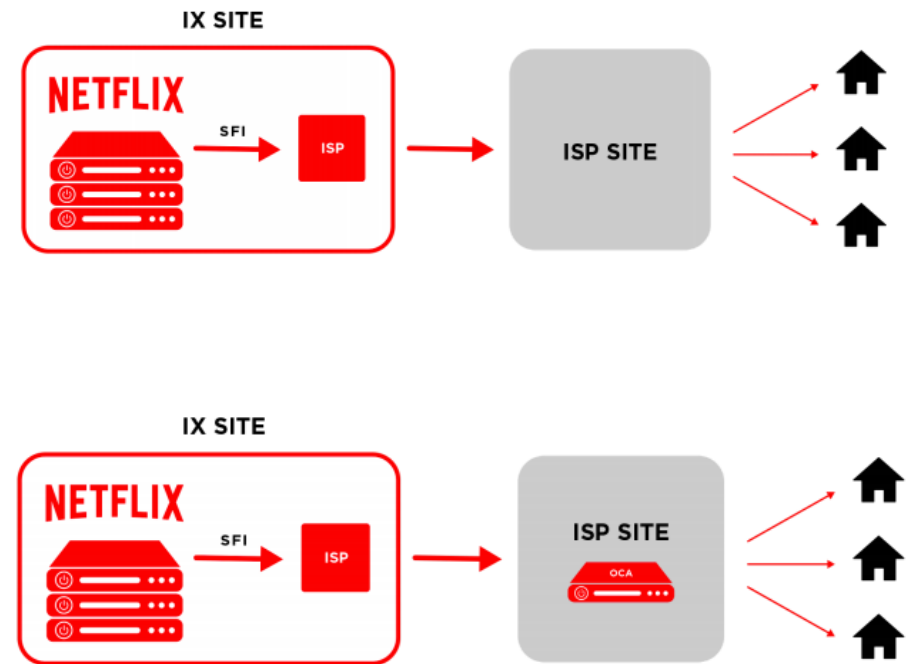


Common Sense Media Family Faves >



Netflix Content

- Data
 - Low (0.3 GB per hour)
 - Medium (SD: 0.7 GB per hour)
 - High (Best video quality, up to 3 GB per hour for HD and 7 GB per hour for Ultra HD)
- Video catalog in US
 - TV series: 1326, Movie: 4339
- CDN: Netflix Open Connect Appliance(OCA)
 - Netflix global network of thousands of OCAs are deployed in two ways



settlement-free public or private peering (SFI)

