Paper Review
A Study of User Behavior in Online VoD Services
Computer Communications, 2014
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April 20, 2018
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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
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 \( x_i = \frac{T_i}{L_i} \).
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.

![Graph showing viewing ratio distribution for movie, TV, MV, and sport clips.](image)
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
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
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
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
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)