UP NEXT
Retrieval Methods for Large Scale Related Video Suggestion

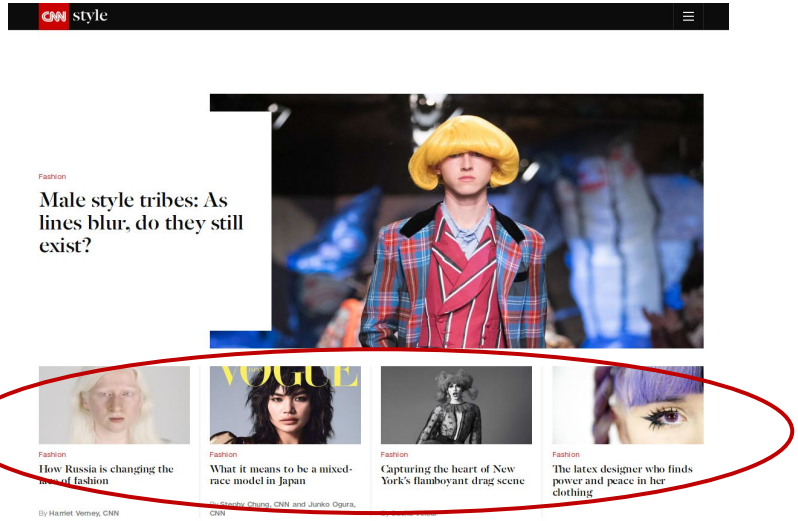
Tushaar G (15IT117)
Himadri Pal (15IT119)
Pratyush Prakash (15IT130)
Suraj Hegde (15IT146)

Agenda

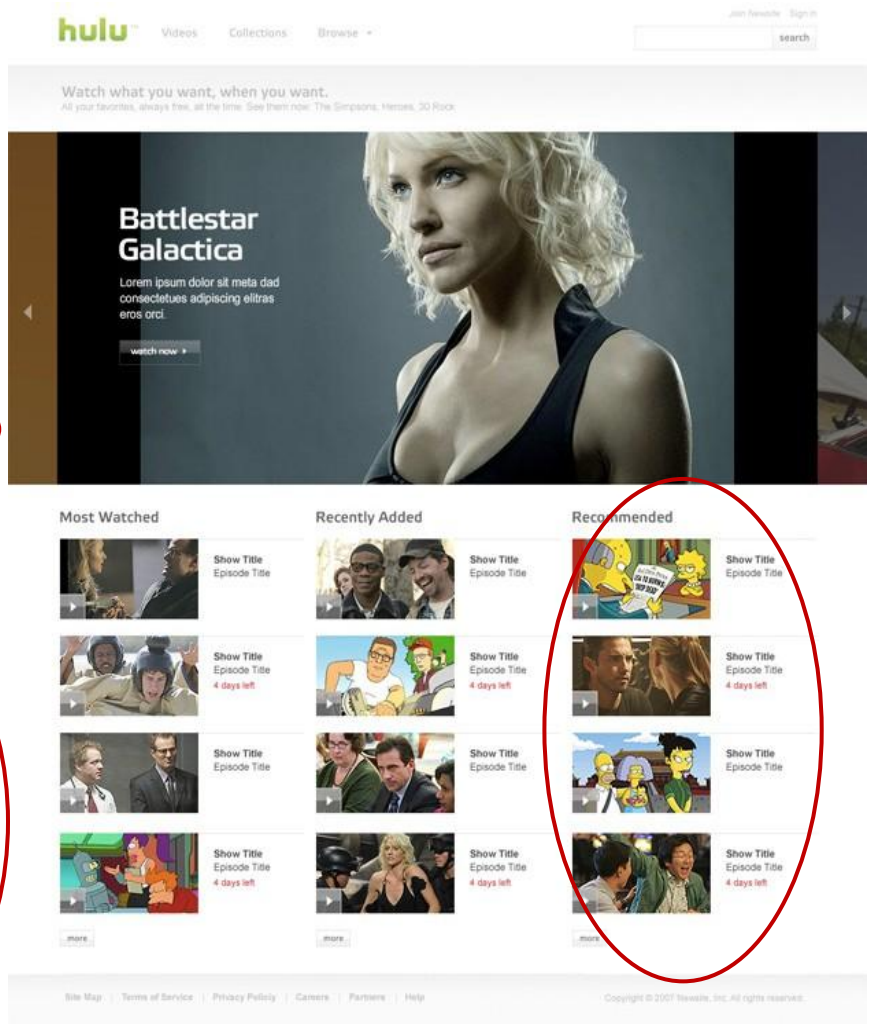
- Introduction
- Literature Survey
- Outcome of Literature Survey
- Motivation
- Problem Statement
- Objectives
- Proposed Work
- Conclusion
- Timeline of Project
- Individual Contribution
- References

Introduction

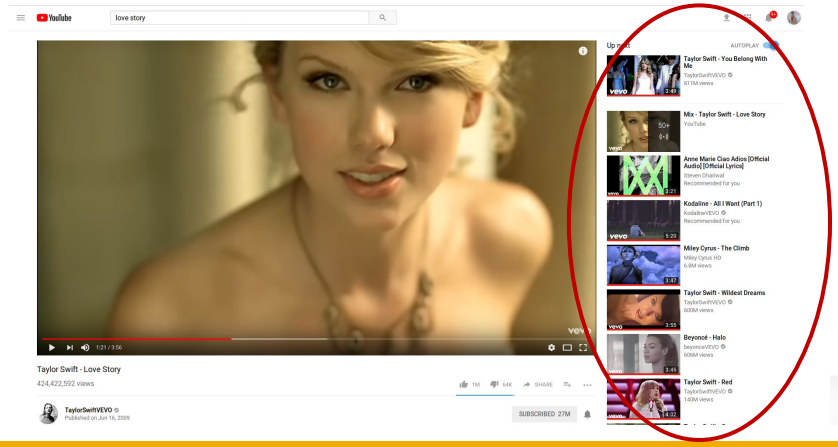
CNN



Hulu



YouTube



Literature Review

Authors	Methodology	Advantages	Limitations
J. Davidson et. al.	Collaborative filtering	Recommendations are more accurate	Presentation bias, only co-viewed videos
Shumeet Baluja et. al.	Co-view graph	Same as above	Same as above
Bo Yang et. al.	Hybrid model	Considers both video info and co-views (multimodal)	Small scale

Outcome of Literature Review

- Current state-of-the-art video suggestion systems are based on the *collaborative filtering analysis*– less applicable to fresh videos or tail videos with few views, since they have very sparse and noisy co-view data.
- Lack of *content based* video retrieval systems
- *Topic based indexing* retrieval has not be done on a large scale before

Issues and Challenges

- ***Hand-crafted* playlists**
  - Does not scale for large video collections
- ***Metadata/Topic* based playlists**
  - More of the same/non-diverse
  - Poor metadata
  - User feedback is not considered
- ***Co-view* counts**
  - Works well for popular videos with many views
  - Fresh/tail content will have very sparse and noisy co-view data

Motivation

- Abundance of content supply and demand: video retrieval, recommendation and discovery
- Least number of people are willing to spend more time on website
- Related video suggestion: ubiquitous on the web
- CNN, Netflix, Hulu, YouTube: related videos– improving these suggestions
- Improve "*user*" engagement and browsing experience (click-through analytics)

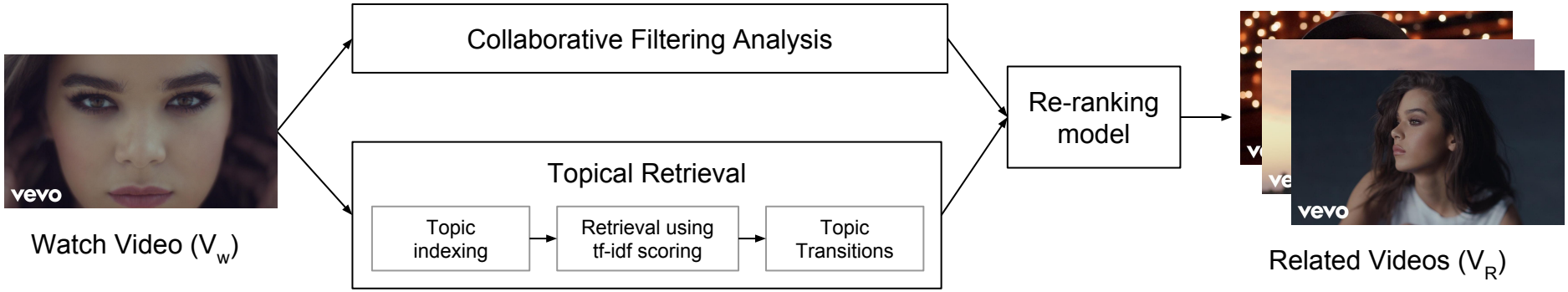
Problem Statement

- Model videos using *weighted topic vectors*
- Use an information retrieval approach to find related videos
  - **Inverted index**– topic → video index
  - **Query**– watch video
  - **Documents**– ranked videos
  - **Topic weights**– tf-idf / learn from user feedback

Research Objectives

- *Video Representation*
  - Topic Assignment
  - Topic Indexing
- *Retrieval* with weighted topics
- Learning *topical transitions* using implicit user feedback
- *Parallel-update* optimization
- *Re-rank* using hybrid model (co-view and topical representation)

Proposed Model



Methodology: Video Representation

- *Semantic representation* of video content
- Annotate video ‘V’ using *textual annotations, query logs, anchor text information*

metadata
uploader keywords
common search queries
playlist names
Freebase entities
Wikipedia articles
...

Soundtrack (0.335)
Fifty_Shades_Freed (0.894)
Hailee_Steinfeld (0.995)
Video_Song (0.112)

Methodology: IR Weights

Quality of video: likes, dislikes, age etc.

Topic count: topicality of 'V' w.r.t. 'τ'

$$sc(V_W, V_R) = q(V_R) \sum_{\tau \in V_W \cap V_R} \mathcal{I}_s(\tau) \frac{c(\tau, V_W)}{log(1+df(\tau))} c(\tau, V_R)$$

idf component: dampened

Indicator function: "stopword" removal

$$\mathcal{I}_s = \begin{cases} 1 & df(\tau) < df_{max} \\ 0 & else \end{cases}$$

some large constant

* Note that there is ***no need*** *for any document length normalization* since all the videos have roughly the same number of topics associated with them

Methodology: Implicit User Feedback

Click analytics: viewed (+), ignored (–)

Pair: related videos

$$P_R = \langle V_R^{(+)}, V_R^{(-)} \rangle$$

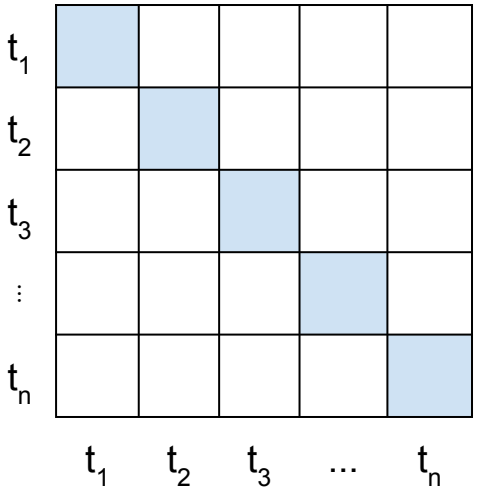
$$X_{P_R} = [I_{V^{(+)}}(\tau) - I_{V^{(-)}}(\tau) : \tau \in T]$$

Ternary feature: +1, -1 or 0

Transition function: τ_W to τ_R

$$\mathcal{I}_v(\tau_W, \tau_R) = \begin{cases} 1 & \tau_W \in V_W, \tau_R \in V_R \\ 0 & else \end{cases}$$

Methodology: Diagonal Transitions



- Capturing all possible transitions (T^2)
- *Sparse* transition matrix
- Only concerned with the transitions along the diagonal– *more reliable*

Work Done

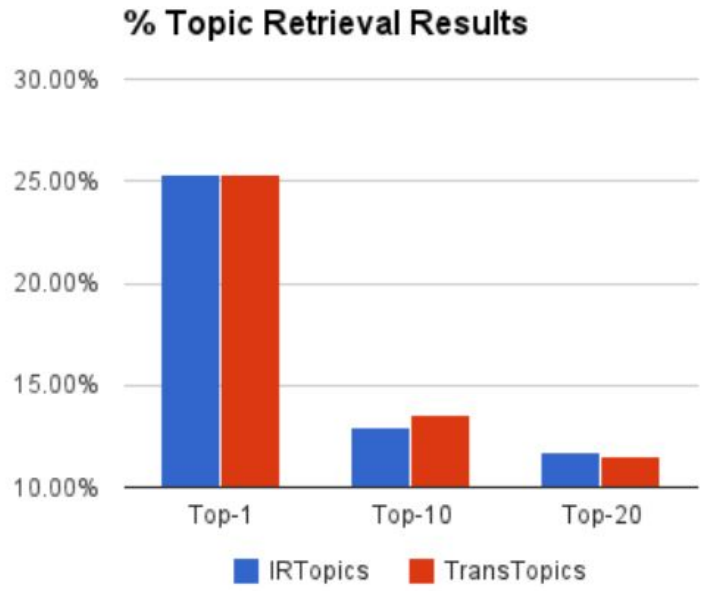
- **Evaluation Methodologies**
  - *Historical data*, *user studies*, *online evaluation*
  - *Choice of method*– population of users
- **Limitations to Large Scale Recommendations**
  - Biased Sample
  - Subjective w.r.t. users
  - Gap between *information need* and *information query*

Work Done

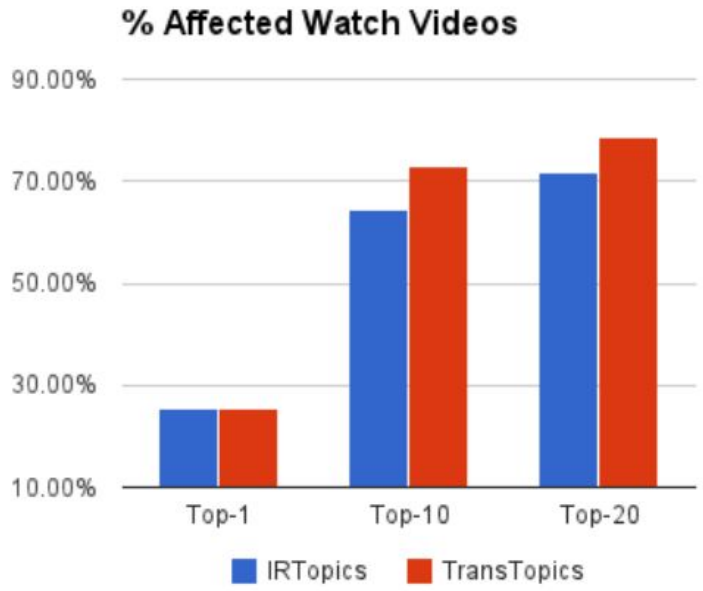
- **User Simulation**
  - Simulate typical user behaviour
  - Measure *number of results* returned by the *topic retrieval method* that are added to the *user's top related results*
- **Live experiment**
  - Large scale experiment: *Youtube traffic*
  - Metrics– *watchtime*, *completion rate*, *abandonment rate*

Results and Analysis

Co-view vs. Up Next



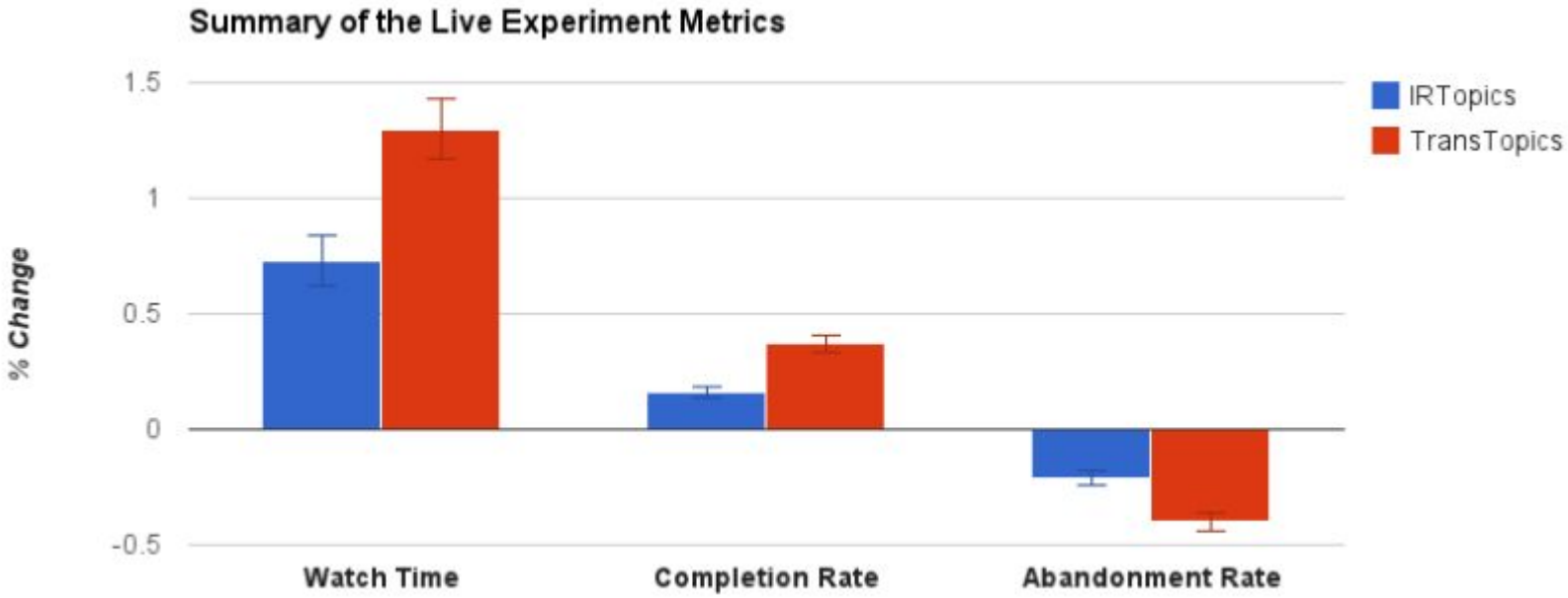
(a) Percentage of new related videos.



(b) Percentage of watch videos with new related videos.

Results and Analysis

Re-ranking: IR vs. Trans vs. Co-view (baseline)



Results and Analysis

Watch time metric breakdown (category and age)

	IRTopics	TransTopics
Video Category		
Music	*−0.64%* (±0.09%)	*+0.28%* (±0.09%)
Gaming	*+0.86%* (±0.68%)	*+1.14%* (±0.66%)
News	*+1.61%* (±0.41%)	*+3.53%* (±0.41%)
Science and Technology	*+2.43%* (±0.5%)	*+3.79%* (±0.51%)
Pets and Animals	*+3.70%* (±0.68%)	*+4.16%* (±0.66%)
Video Age		
< 1 month	*+0.99%* (±0.26%)	*+3.34%* (±0.26%)
1 month – 1 year	*+0.50%* (±0.11%)	*+2.24%* (±0.11%)
> 1 year	*+0.87%* (±0.07%)	*+1.06%* (±0.08%)

Timeline of Project

Milestones	Feb 2018	Mid-Mar 2018	End-Mar 2018	April 2018
Literature Survey	✔	✔	✔	✔
Topic Indexing		✔	✔	✔
Weighted Topic Retrieval (IRTopics)			✔	✔
Topic Transitions (TransTopics)			✔	✔
ReRanking Algorithm				✔
User Simulated metric evaluation (Testing)				✔

Individual Contribution

- *Tushaar*
  - Topic indexing
  - IRTopics
- *Himadri*
  - Topic indexing
  - TransTopic
- *Pratyush*
  - TransTopics
  - ReRanking
- *Suraj*
  - ReRanking
  - Evaluation

References

[1] Bendersky, M., Harmsen, J.J., Josifovski, V., Lepikhin, D., & Pueyo, L.G. (2014). Up next: retrieval methods for large scale related video suggestion. KDD.

[2] Broder, A. Z., Carmel, D., Herscovici, M., Soffer, A., & Zien, J. (2003, November). Efficient query evaluation using a two-level retrieval process. In Proceedings of the twelfth international conference on Information and knowledge management (pp. 426-434). ACM.

[3] Davidson, J., Liebald, B., Liu, J., Nandy, P., Van Vleet, T., Gargi, U., ... & Sampath, D. (2010, September). The YouTube video recommendation system. In Proceedings of the fourth ACM conference on Recommender systems (pp. 293-296). ACM.