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# VideoForest: Interactive Visual Summarization of Video Streams Based on Danmu Data

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- Motivation
- System
  - Architecture
  - System overview
  - Preprocessing
  - Analysis
  - Visualization
- Evaluation
- Conclusion





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## Video Summarization on Youtube

Filters ▾ About 9,560,000 results

**Presidential Election 2016 LIVE | ABC News FULL BROADCAST** ← Title

ABC News ✓  
2 weeks ago • 4,666,494 views  
2016 Presidential Election Results | Get the latest updates and state-by-state analysis of the 2016 US Presidential Election. ← Description

 ← Screenshot

Streamed live on Nov 8, 2016  
2016 Presidential Election Results | Get the latest updates and state-by-state analysis of the 2016 US Presidential Election.  
The long-awaited 2016 election day is finally here, and it could be a historic one for a number of different reasons. The United States could elect its first female president Hillary Clinton; Republicans could take back the White House with Donald Trump after two terms of Democratic control; there could be record voter turnout and the leading campaign election night parties will both be in New York. ← Summary

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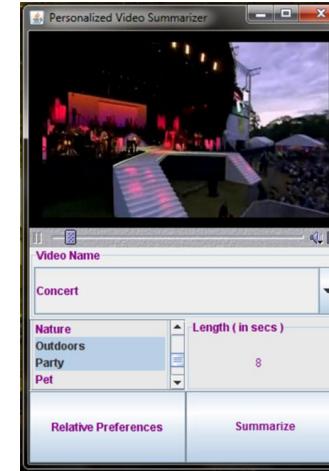
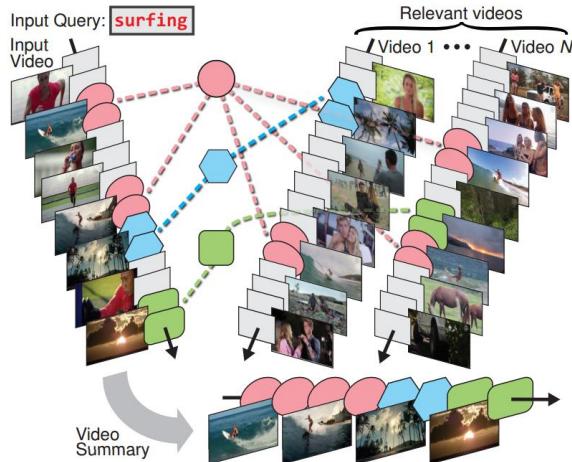
  
Song Master 1 day ago  
At the end she says "this will test American Democracy", perhaps. Electing Hillary Clinton would have ended Democracy as we know it. Congratulations to President Trump and to the preservation of the Nation.  
Reply • 1

  
MSNBC 13:08  
Top Talkers: Donald Trump has been elected United States president, and the Morning Joe panel considers the polling data and ...



## Summarization of Video Streams

- Internal summarization techniques
  - Video, audio, linguistic features
- External summarization techniques
  - Audience's preferences and interests



*Video co-summarization [Chu et al. 2015]   User preferences based [Kannan et al. 2013]*



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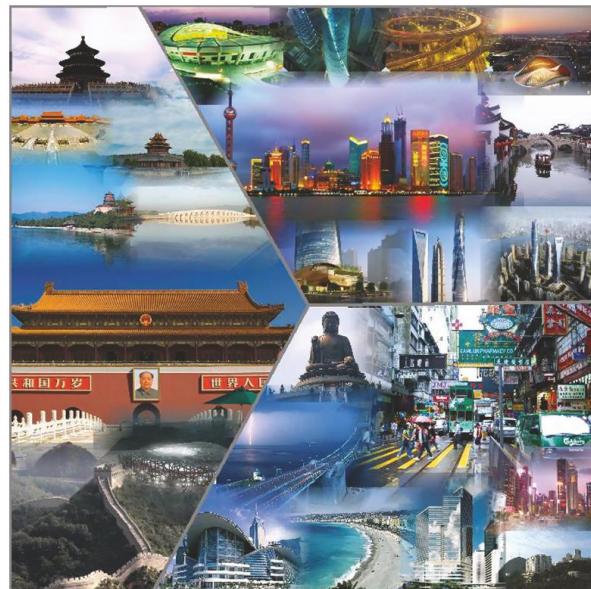
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## Summarization of Video Streams

- Summarization representation
  - Matrix form [Lu and Grauman 2013]
  - Illustration: Visual storyline & Imagehive



*Visual storylines* [Chen et al., 2012]



*Imagehive* [Tan et al., 2011]



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## Live Streaming Platforms





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## Video Platforms with Danmu



求大白 (•—•) 我也觉得一般,(大白也就(是)个机器人) 人们把需要投票(要投票)上(•—•) (•—•) 好  
! ! ! (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
白白 (•—•) 大白 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
超级好看 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
balalalala (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
为嘛感觉卡 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
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喜欢大 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
我总觉 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
吧 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
我睫毛长 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
好喜欢哥哥qaq (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
23333333333 (•—•),  
情节确实扯淡, 为啥不能吐槽 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
这片子不只有大白吧... (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
确定第二部; 反派是 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)

弹幕呢 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
づ 算不上好片 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
拍续集好像 大白萌萌哒 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
哥哥好帅! (+1) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
哥哥这便当吃的我都哭了 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
哥哥没死第二部变反派了 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
集体来一发 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)

我一点也没看过... (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
刮就是大白才这么萌 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
为了哥哥而来的只有我? (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
觉得大白 (•—•) 不萌的 +1 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)  
为什么那么多人刷大眼厄齐尔 (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•) (•—•)

超能陆战队

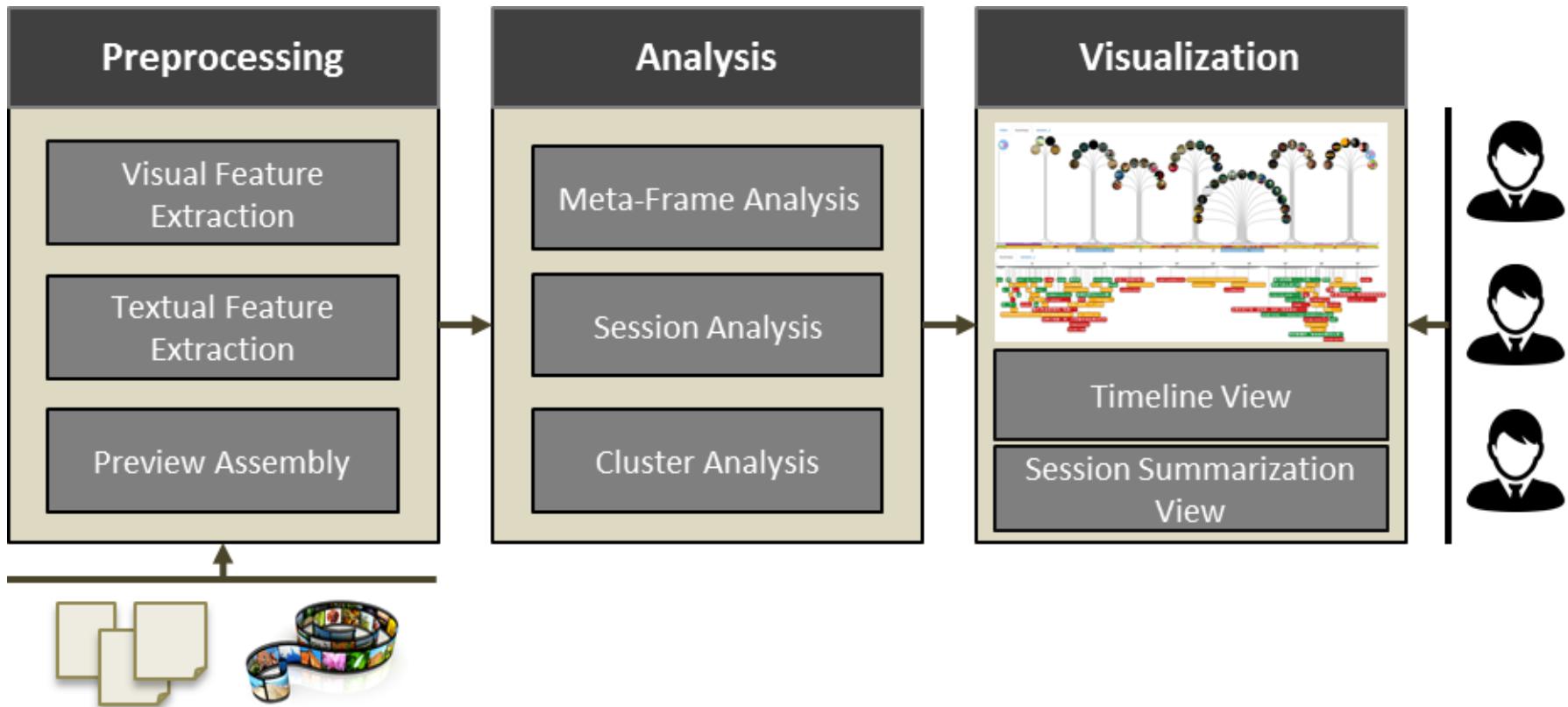
Danmaku is screen capture

VideoForest, HCI Initiative, HKUST



## System Architecture

**Goal:** Video + Danmu + Interaction → Summarization





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# Video Demo

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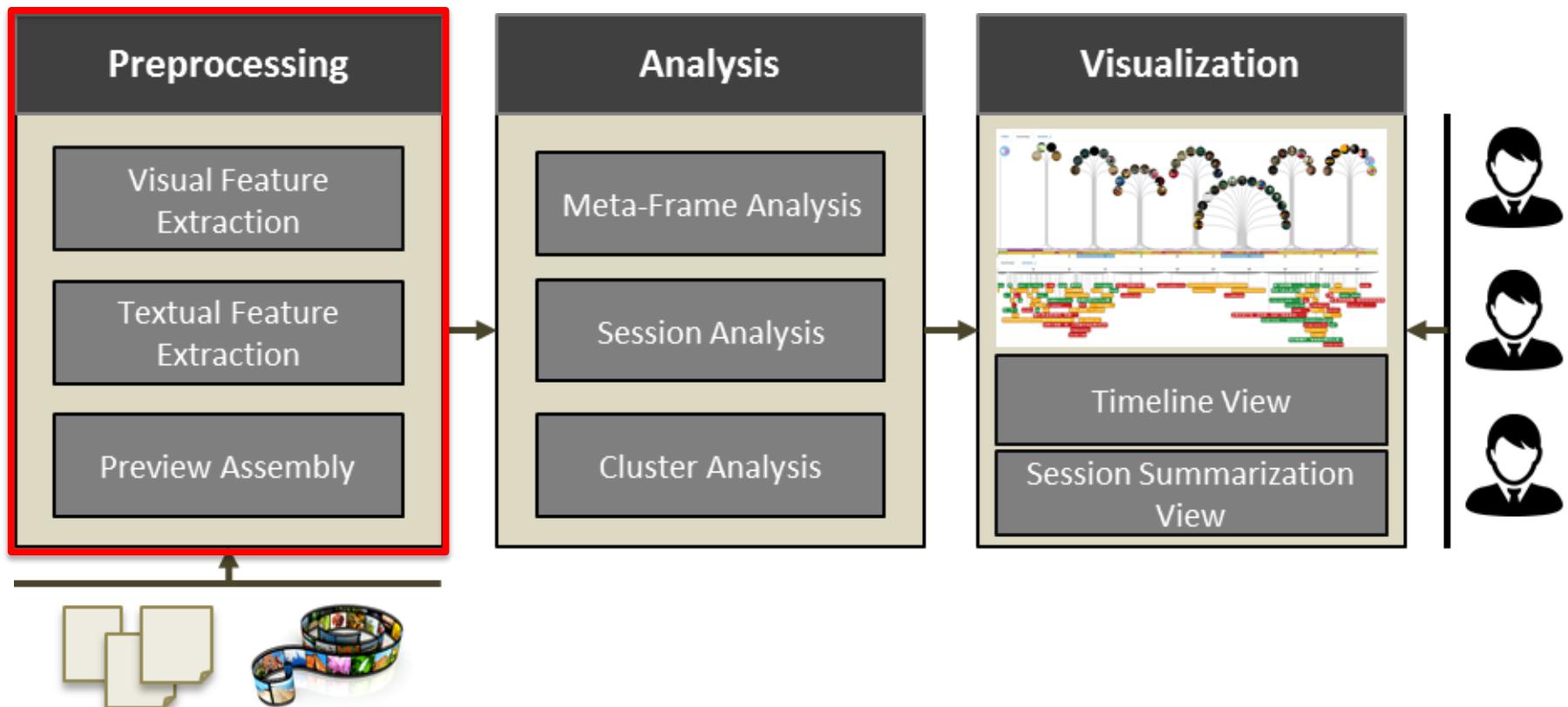




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# Processing





## Feature Extraction

- Visual feature extraction
  - Key frames extraction from compressed video



Hierarchical structure of a video sequence [Mendi and Bayrak 2010]



- Textual feature extraction
  - syntactic and semantic analysis



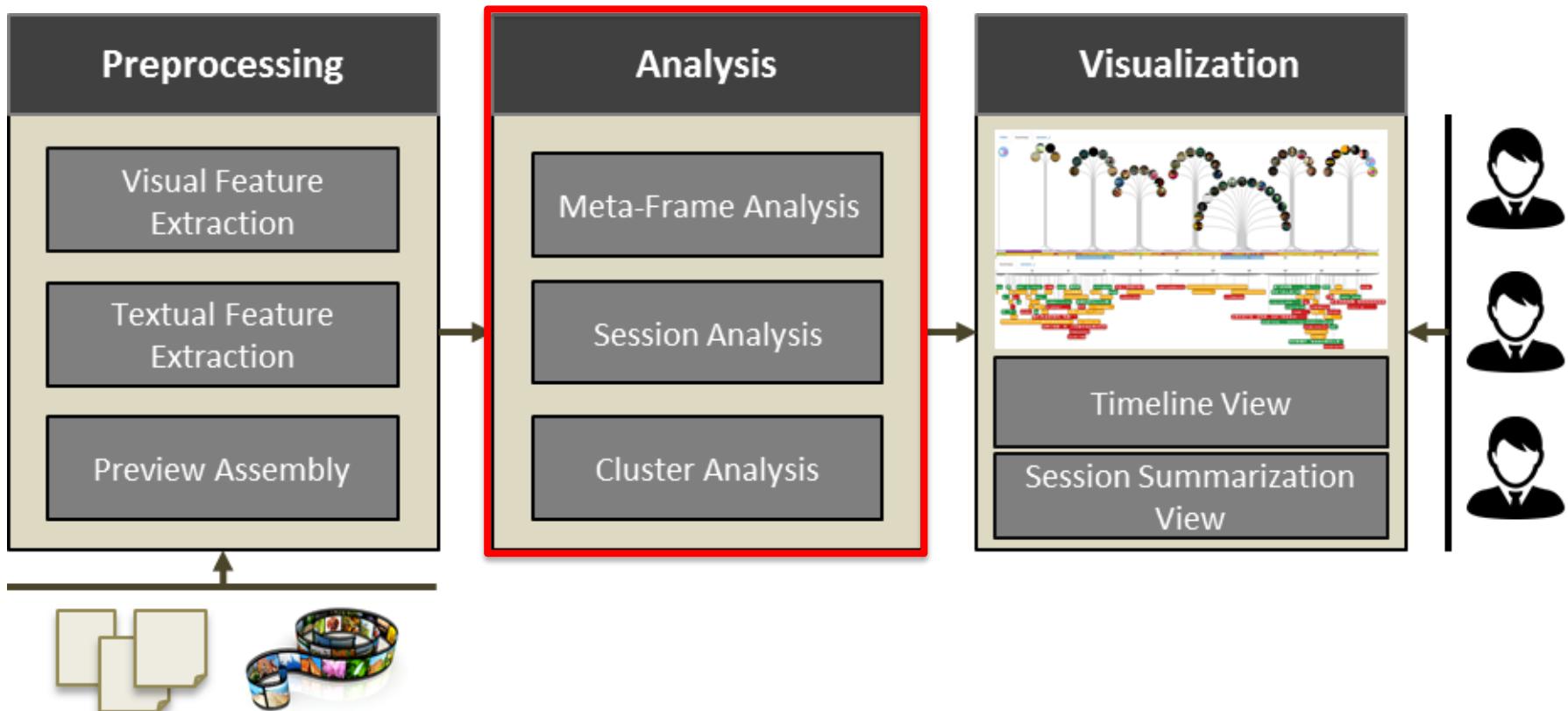
Similarity  
Sentiment  
Topic  
Function  
Symbol  
Pattern



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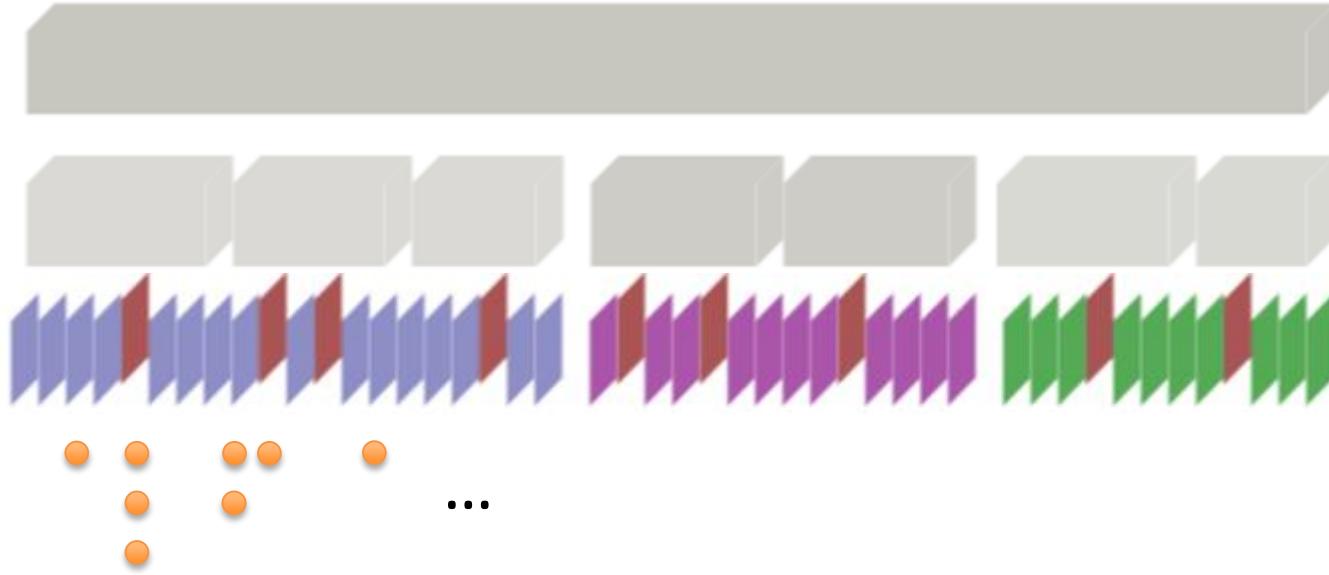
# Analysis

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## Meta-frame, Session and Scene Cluster



### Meta-frame

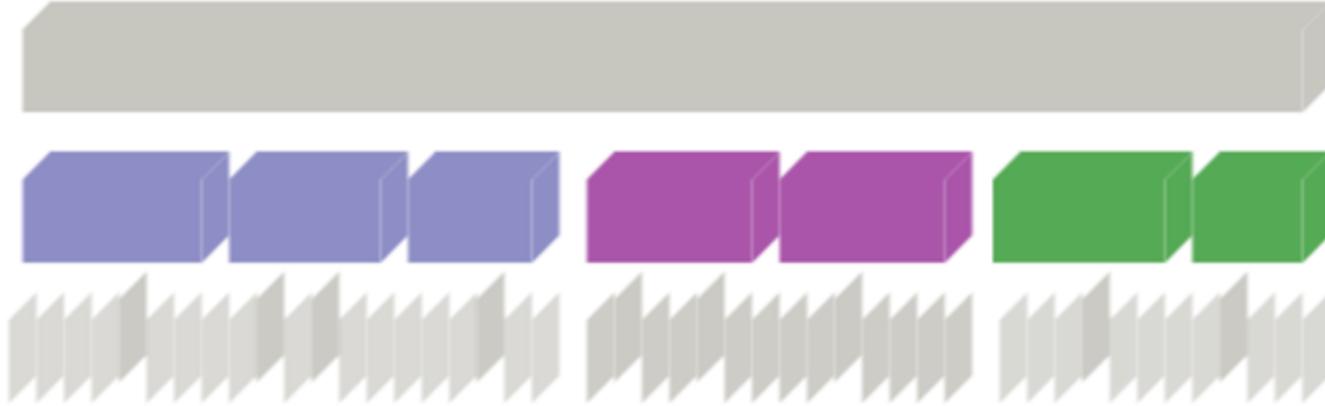
- Visual attributes: image content
- Textual attributes: audience's reaction



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## Meta-frame, Session and Scene Cluster



### Session

- Color palette of the entire session
- Synoptic linguistic attributes of danmu in the time range



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## Meta-frame, Session and Scene Cluster



### Scene cluster

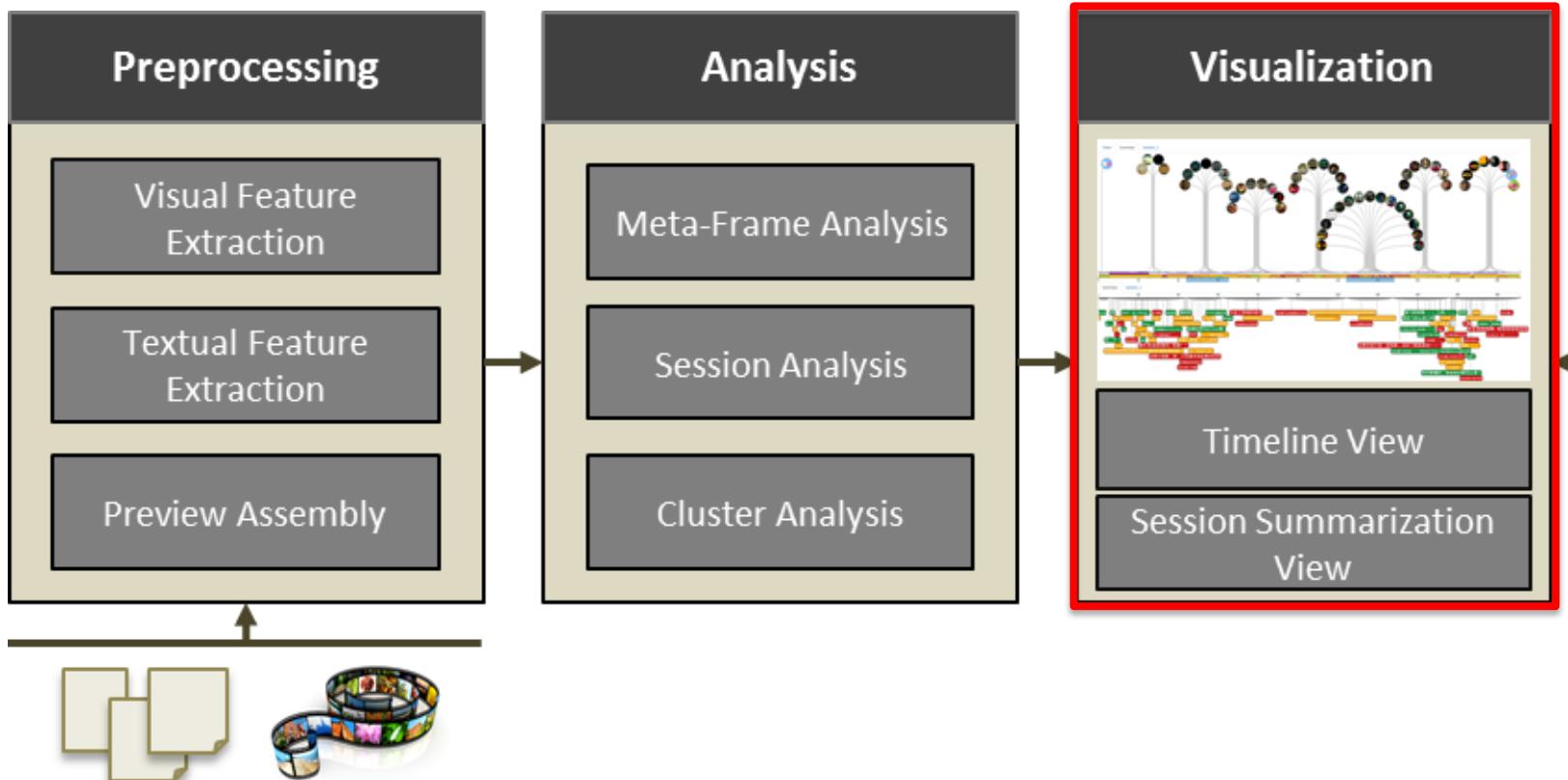
- Danmu commentary density



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# Visualization

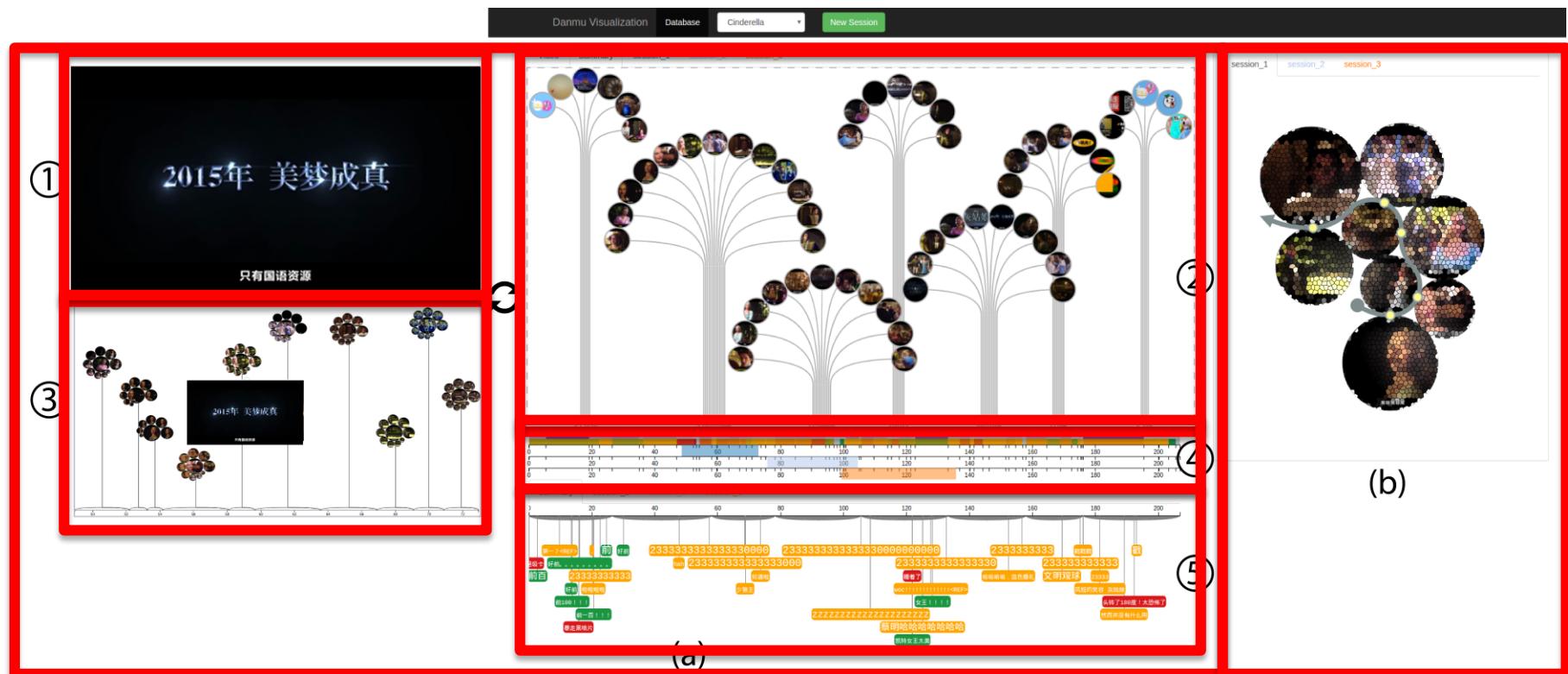




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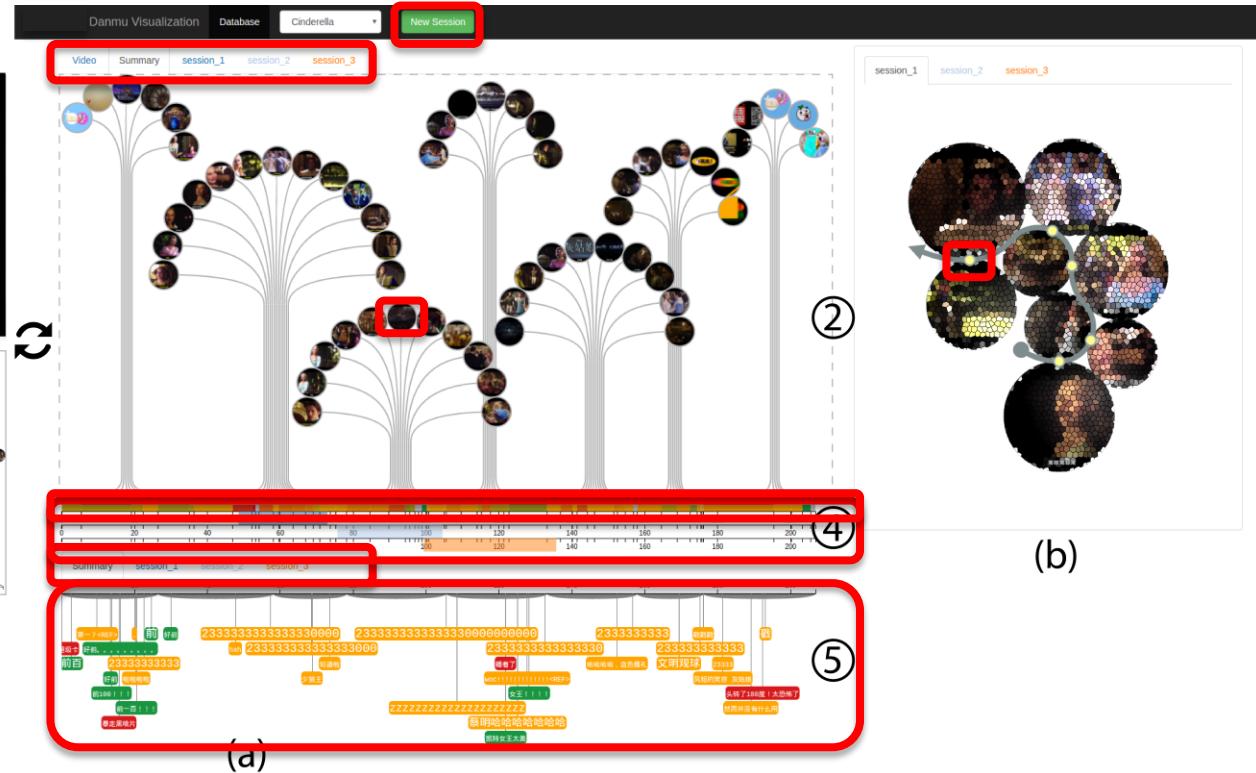
# System Interface Overview





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# Interactions



Smart summarization  
New session generating

Scene preview

Highlighting  
View switching

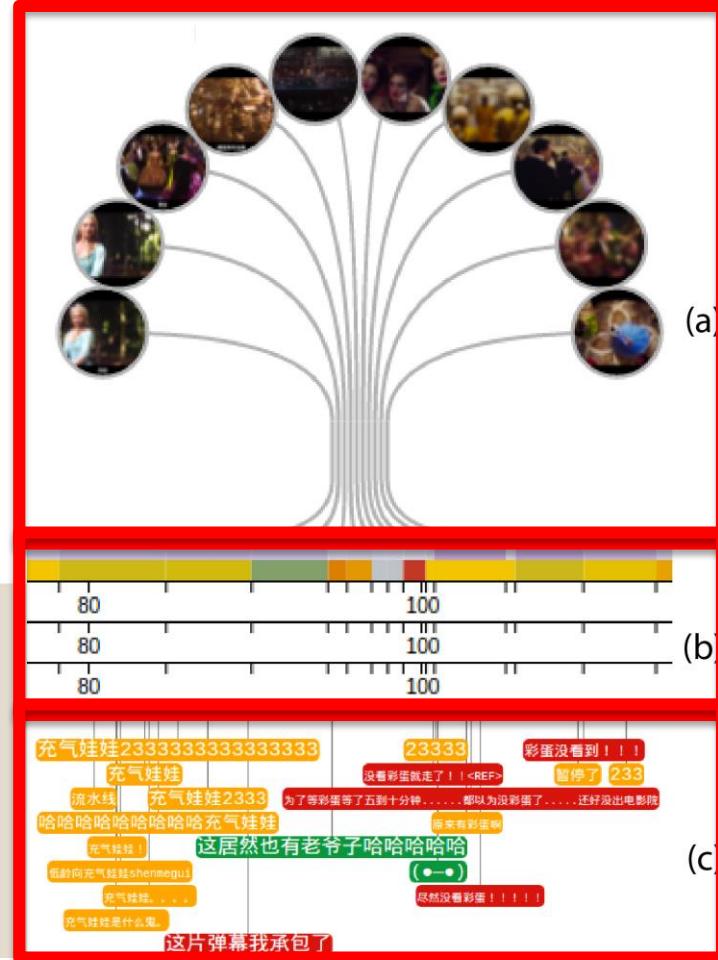


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# Visual Metaphor and Encoding





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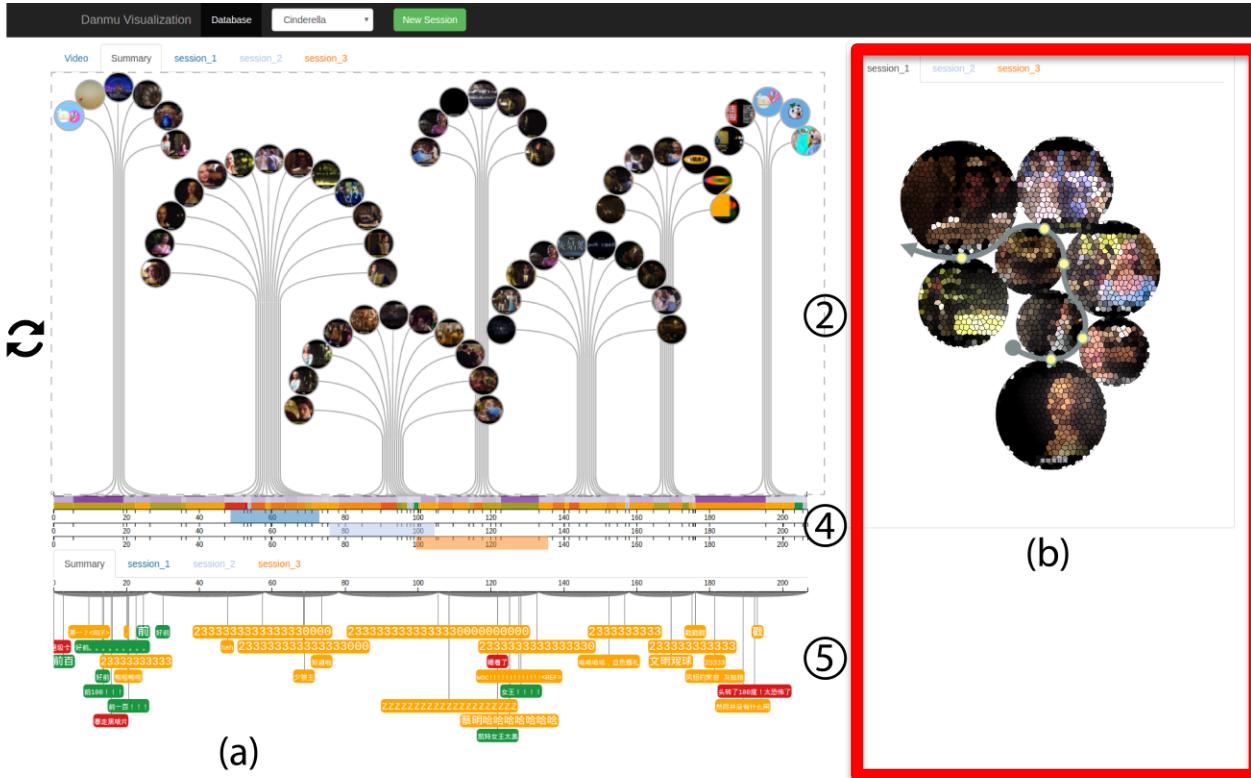
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# Session Summary View

①



③

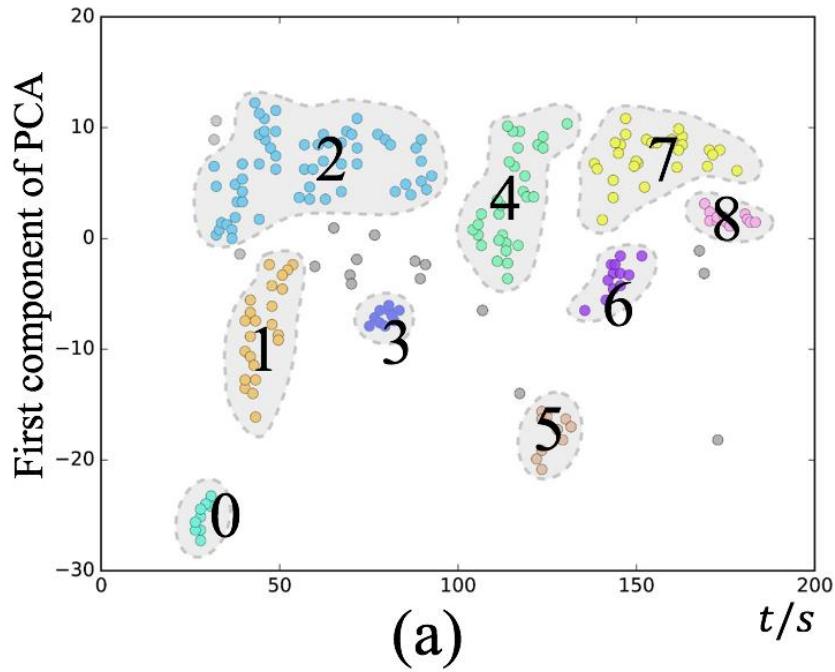




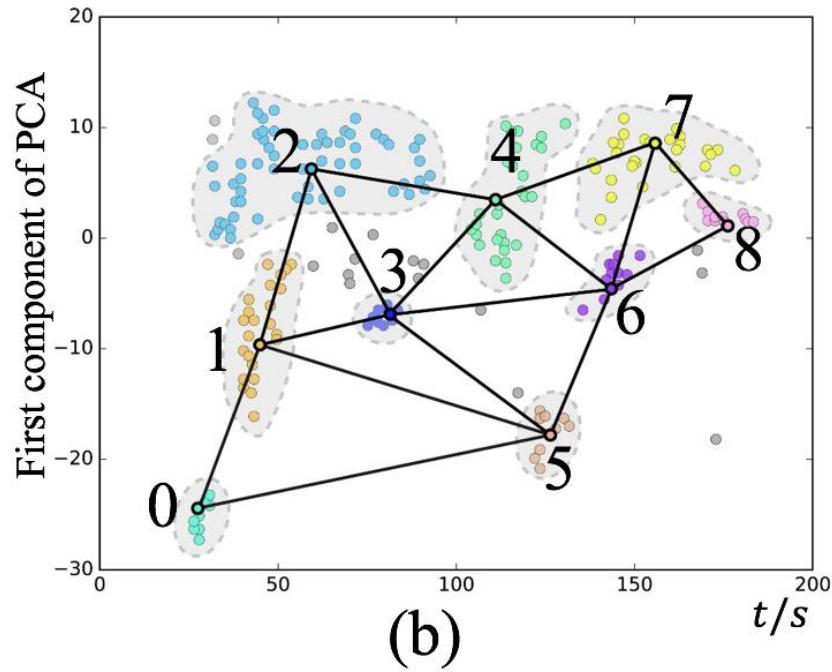
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## Meta-frame aggregation



(a)



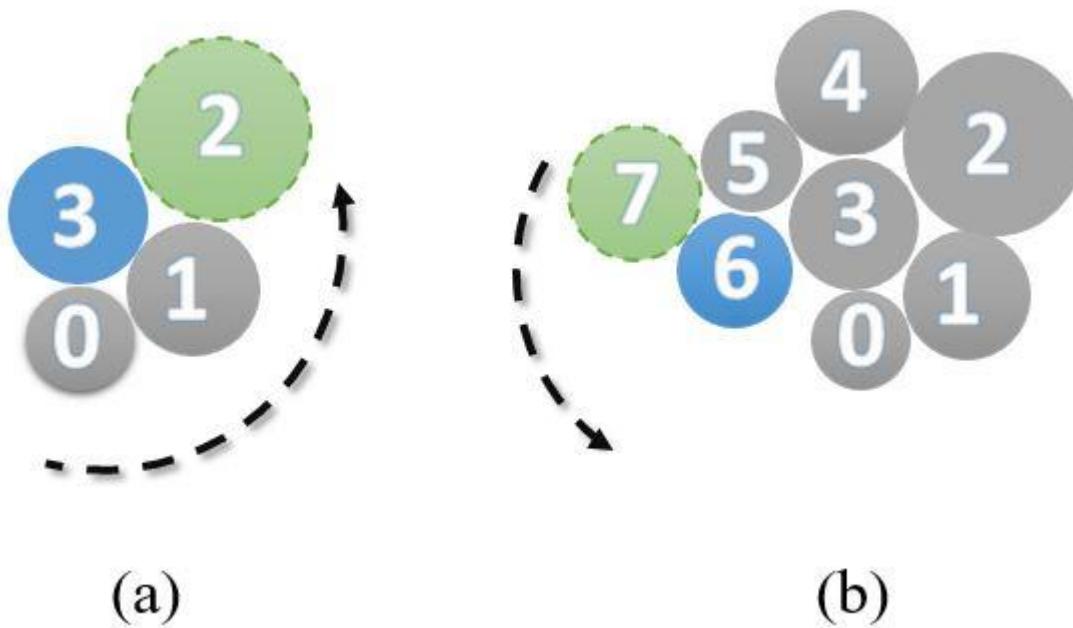
(b)



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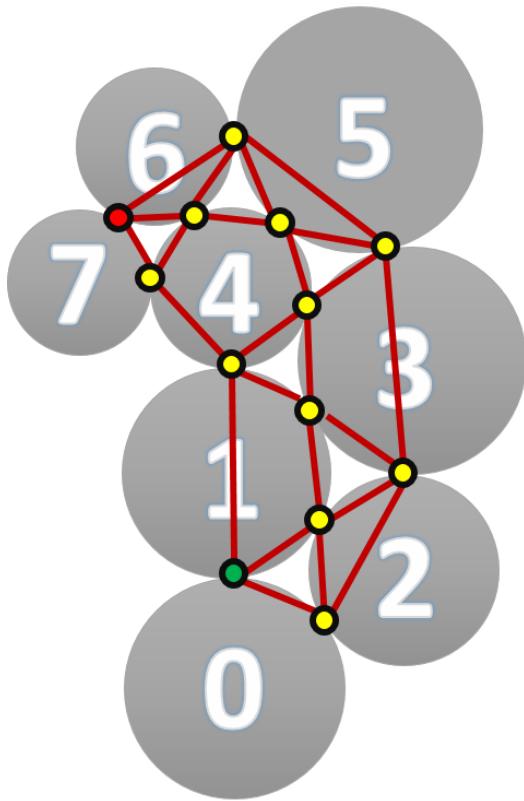
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## Circle Image Packing

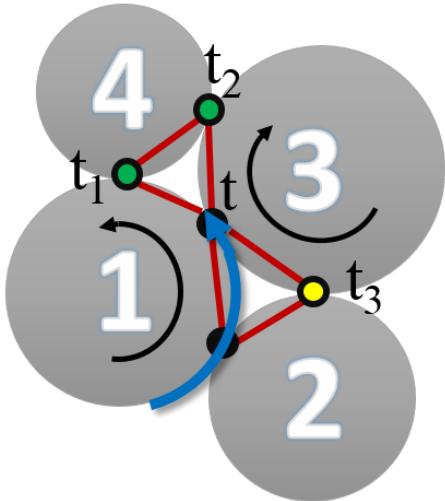




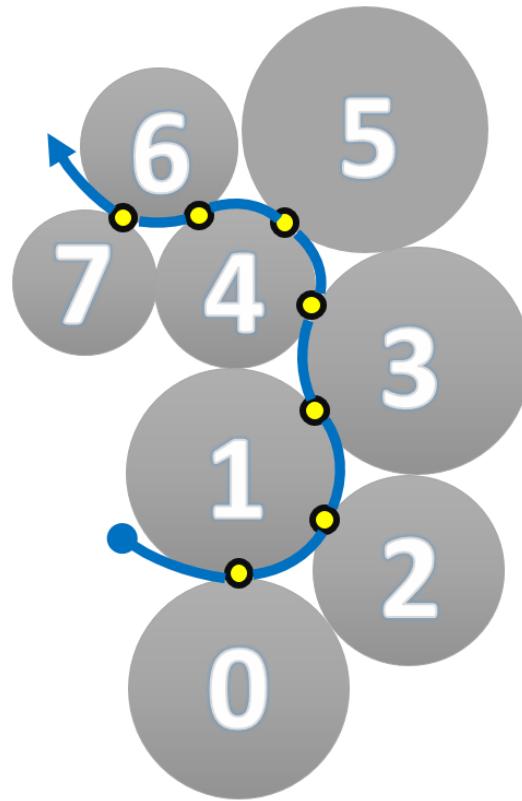
## Storyline threading



(a)



(b)



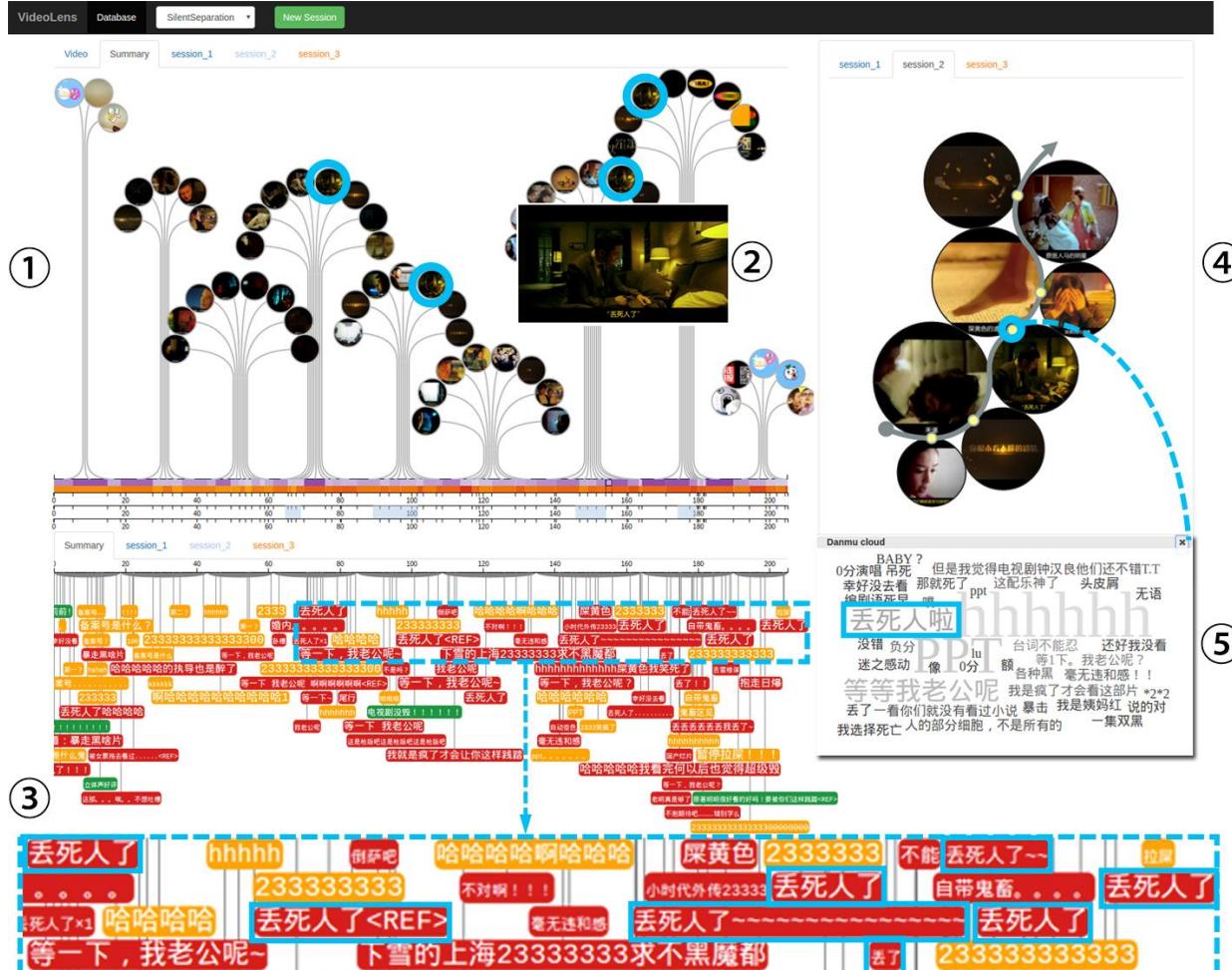
(c)



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# Case study

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- 205 seconds long
- 2052 danmu posts
- 61 I-frames
- 1804 P-frames
- 61 sessions
- 9 scenes



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## User observation

- Thirteen experts
- Live demo
- Interview & open discussion
  - Insights
  - Applications

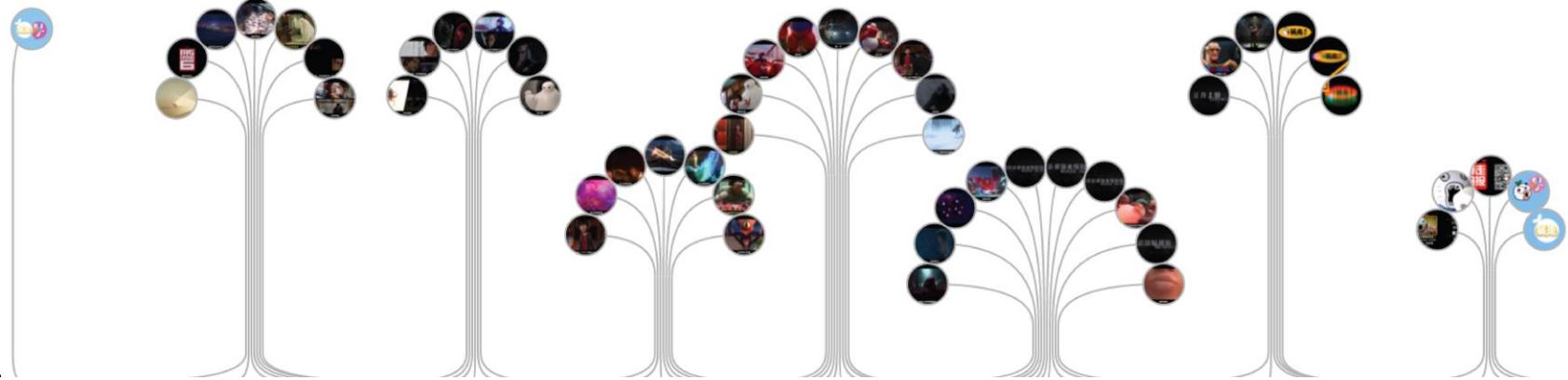


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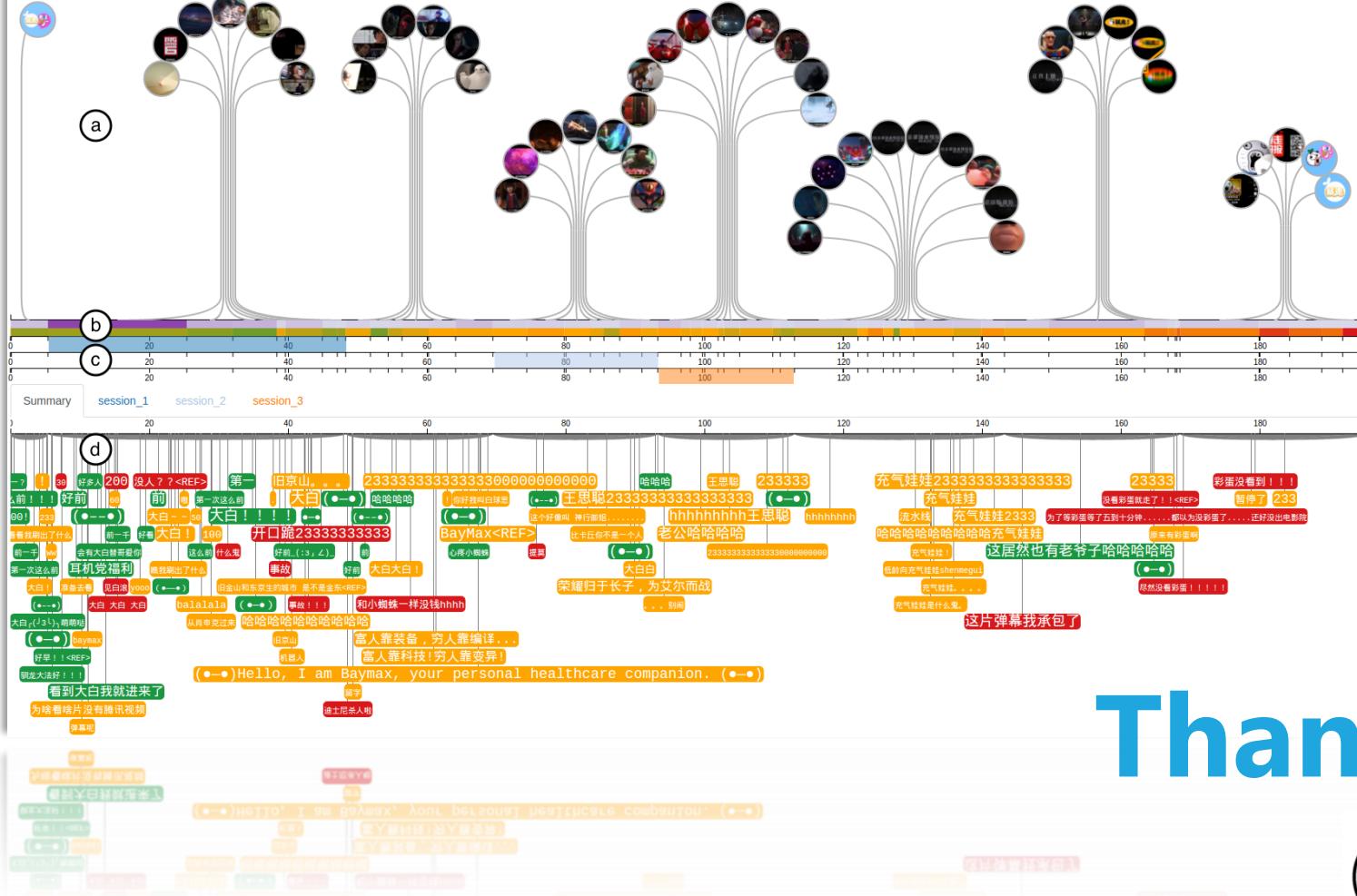
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## Future Work and Conclusion

- Conclusion



- Future work
  - Long video stream scalability
    - Hierarchical aggregation
  - Advanced video analysis techniques



# Thank you

