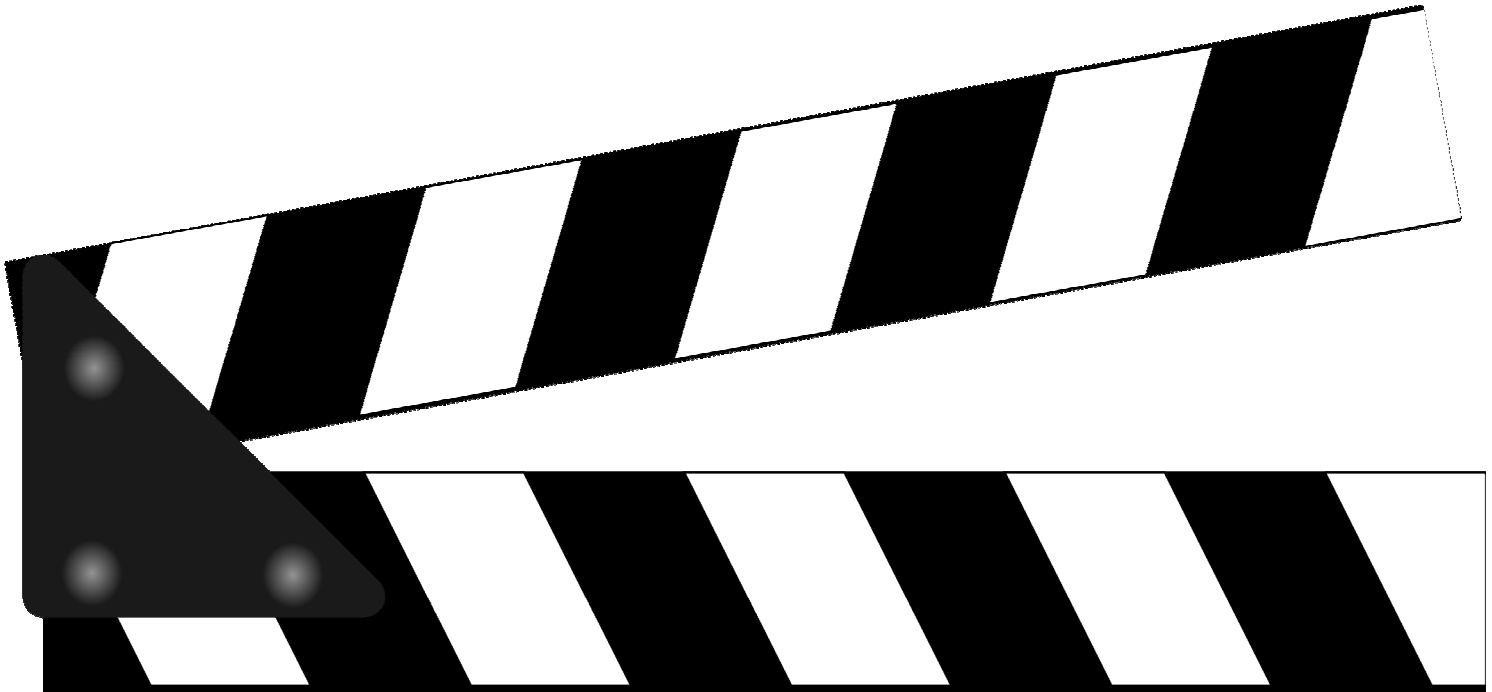


NIST
National Institute of Standards and Technology

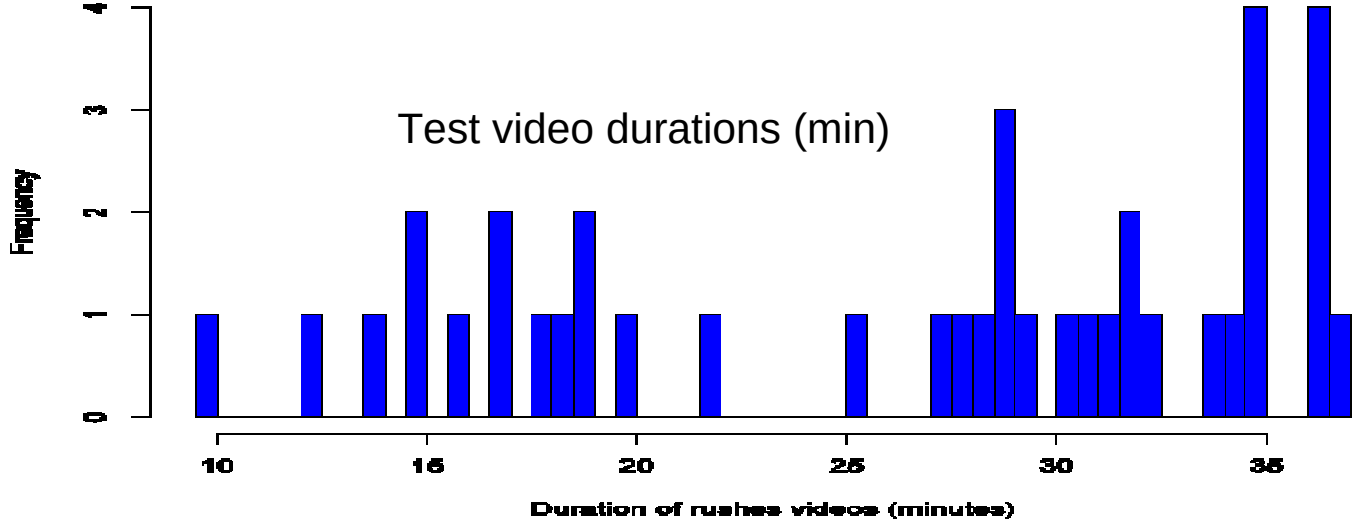
DCU
DUBLIN CITY UNIVERSITY

Video Summarisation

- Summary == condensed version of something so that judgments about the full thing can be made in less time and effort than using the full thing
- Summaries have widespread application as surrogates resulting from searches, as previews, as familiarisation with unknown collections
- Video summaries can be keyframes (static storyboards, dynamic slideshows), skims (fixed or variable speed) or multi-dimensional browsers
- Literature & previous work shows interest in evaluating summaries, but datasets always small, single-site, closed

Summarisation Data

- 42 files as development data, 40 files as test data (- one withdrawn)
- **Mostly scripted dialogue**, environmental sounds, much repeating (==redundancy), wasted shots, clapboards and colourbars



- Test videos - mean duration: 26.6 min (max: 36.9 min.; min 9.8 min.)
- Example of full one full rushes video MS221050

System task

- Create an MPEG-1 summary of each file
- Each summary <= 2% of the original
  - twice as compact as in 2007
- Dual evaluation criteria were to
  - Eliminate redundancy
  - Maximise viewers' efficiency at recognising objects & events as quickly as possible
- Interaction limited to:
  - Single playback via mplayer in 125 mm x 102 mm window at 25 fps with unlimited optional pauses

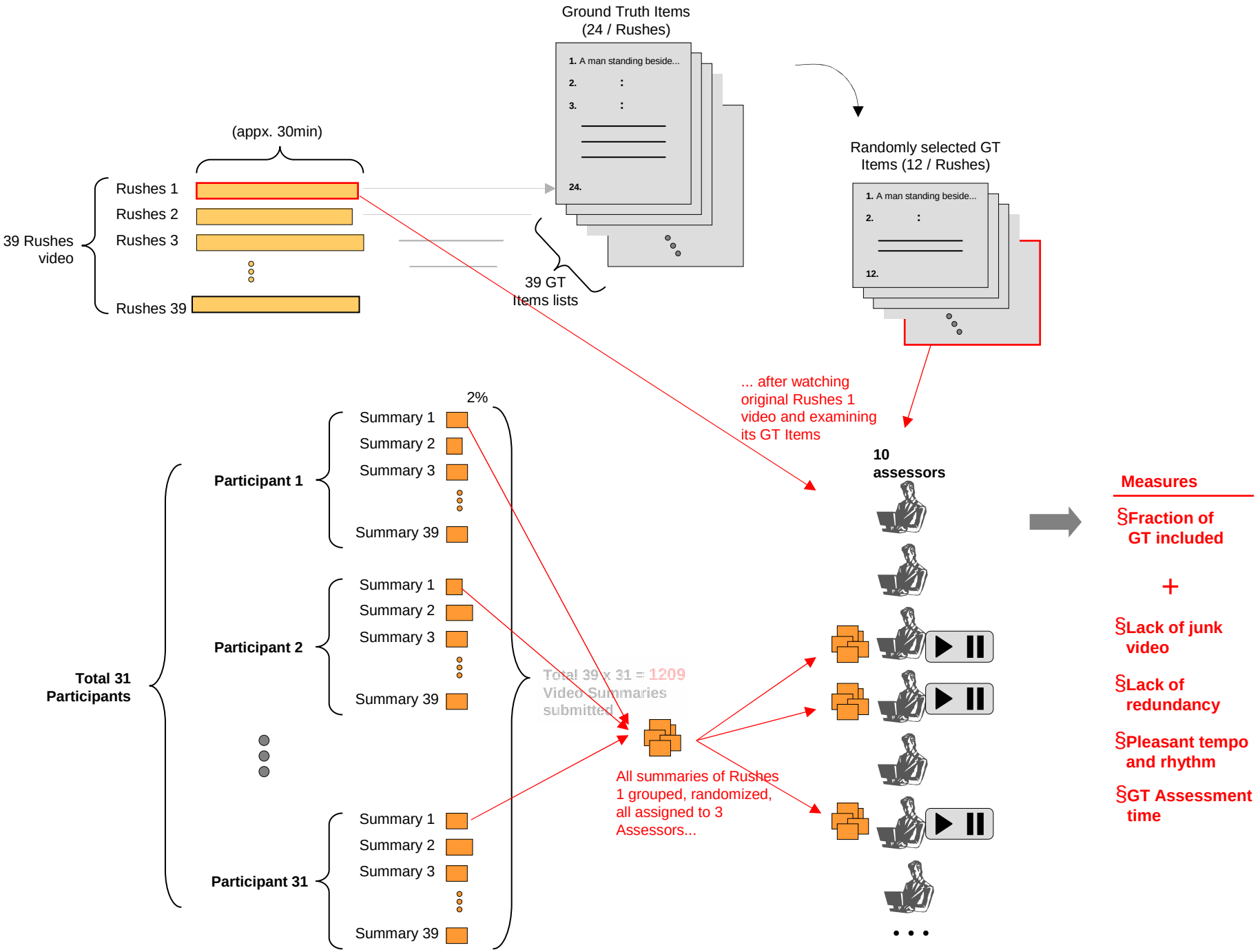
How to evaluate the rushes summaries?

- Seems intractable in the general case:
  - Formally identify all the content of an original video
  - Do likewise for a summary, and then
  - Compare them, in a way which is repeatable and affordable

- So we approximated for the data at hand:
  - Humans created partial ground truth for the original (40) videos
    - Identify important segments using any distinctive object/event
    - Accept variability due to differences in human judgment
  - Human viewed each summary and judged it against the list of important segments (ground truth)

Sample ground truth (MS221050)

- 2 men in white carry man in hooded blue shirt
- Head and shoulders of red-headed woman visible
- Close up of red-headed woman (head and neck only visible)
- Red-headed woman & man in leather jacket (waist up visible) stand while man in white enters.
- Man in blue shirt and man in suit stand and talk, head and shoulders of both visible
- Man with purple shirt and man in blue shirt stand and talk, head and shoulders of both visible
- Man in white coat seated, waist up, side view
- Close up (head visible) of black man
- Close up (head visible) of black man with blue wrap on shoulders
- Group of people walking toward camera carrying large chest
- Group of people sitting around desk
- 3 people enter and stand left of desk
- Man and woman seated, face camera, head and shoulders visible
- Man in blue shirt and red-headed woman stand (head and upper chest visible)


Ground Truth Items
(24 / Rushes)
1. A man standing beside...
2. :
3. :
24.
(appx. 30min)
Rushes 1
Rushes 2
Rushes 3
Rushes 39
39 Rushes video
39 GT Items lists
Randomly selected GT Items (12 / Rushes)
1. A man standing beside...
2. :
12.
... after watching original Rushes 1 video and examining its GT Items
10 assessors
2%
Summary 1
Summary 2
Summary 3
Summary 39
Participant 1
Participant 2
Participant 31
Total 31 Participants
Total 39 x 31 = 1209 Video Summaries submitted
All summaries of Rushes 1 grouped, randomized, all assigned to 3 Assessors...
Measures
§Fraction of GT included
+
§Lack of junk video
§Lack of redundancy
§Pleasant tempo and rhythm
§GT Assessment time

Measures

- Subjective:
  - Fraction of (up to 12 items of) ground truth found
  - Lack of junk (color bars, clapboards, all white/black frames)
  - Pleasant tempo and rhythm
  - Lack of redundant video
- Objective:
  - Assessment time to judge included ground truth
  - Summary duration
  - Summary creation compute time
- Additional data:
  - Number/duration of pauses in assessment of included segments
  - Feedback on assessment software, procedure, experience

Participating groups' approaches

- 26 of 31 groups had papers at the TVS'08 ACM MM workshop so we know a bit about their approaches - though no structured description
- Most groups, almost all, explicitly searched for and removed junk frames;
- Most groups, majority, used some form of clustering of shots/scenes in order to detect redundancy;
- Several groups included face detection as some component;
- Most groups used visual-only, though some also used audio in selecting segments to include in summary;
- Camera motion/optical flow was used by some groups;
- Finally, most groups used whole frame for selecting, though some also used frame regions;

Summary generation

- There was much more variety among techniques for summary generation than among techniques in summary selection;
- Many groups used FF or VS/FF video playback;
- Several groups incorporated visual indicator(s) of offset into original video source, within the summary;
- Some used an overall storyboard of keyframes;
- Some used keyframe playback but most used the unaltered original video, perhaps using sub-shots only;
- Some used non-hard cut shot transitions, and one did progressive summary generation, on-the-fly;

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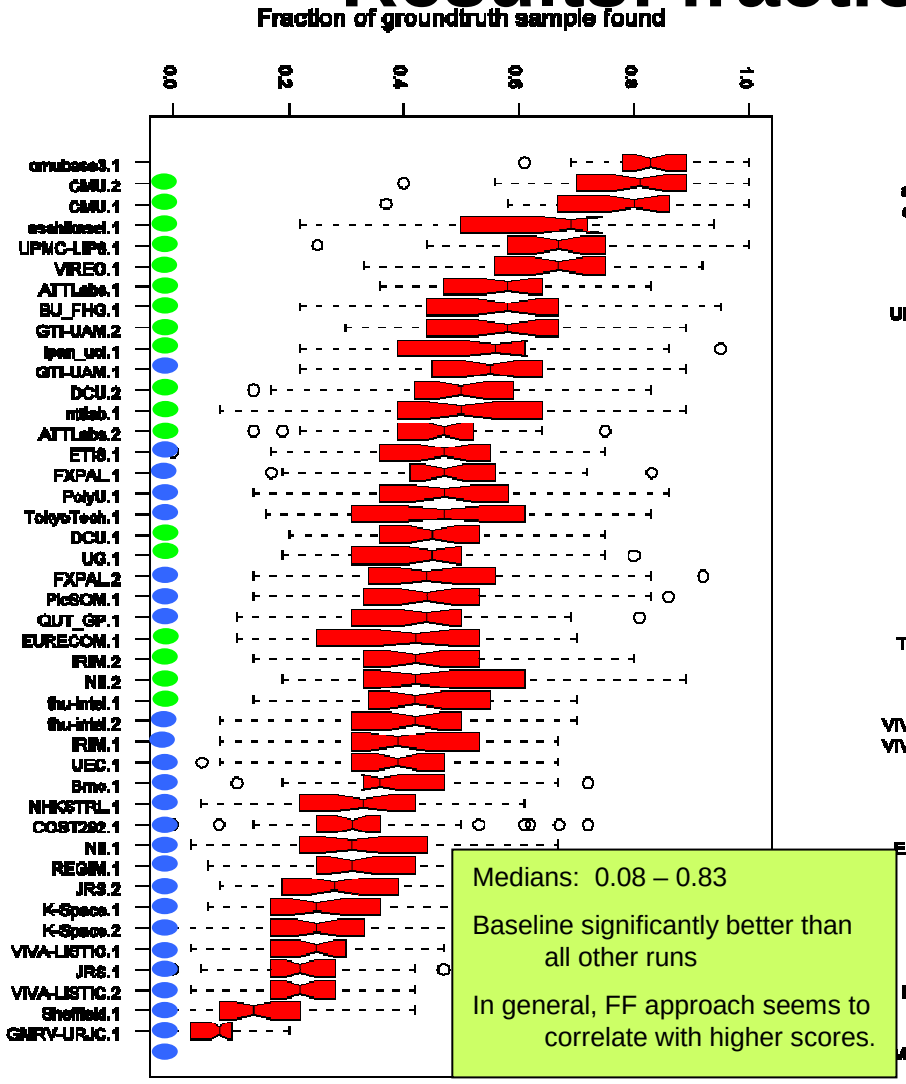
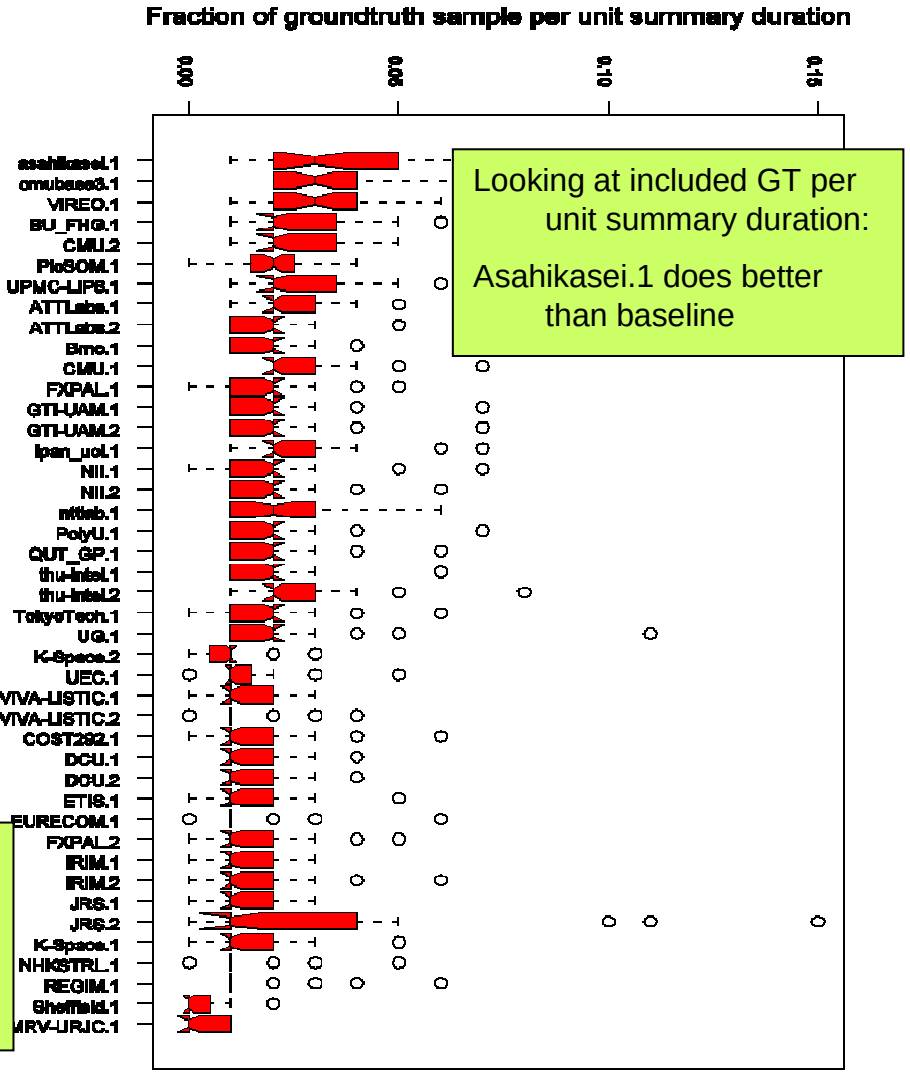
Results: fraction GT included



Medians: 0.08 – 0.83

Baseline significantly better than all other runs

In general, FF approach seems to correlate with higher scores.



Looking at included GT per unit summary duration:

Asahikasei.1 does better than baseline

FF

No FF

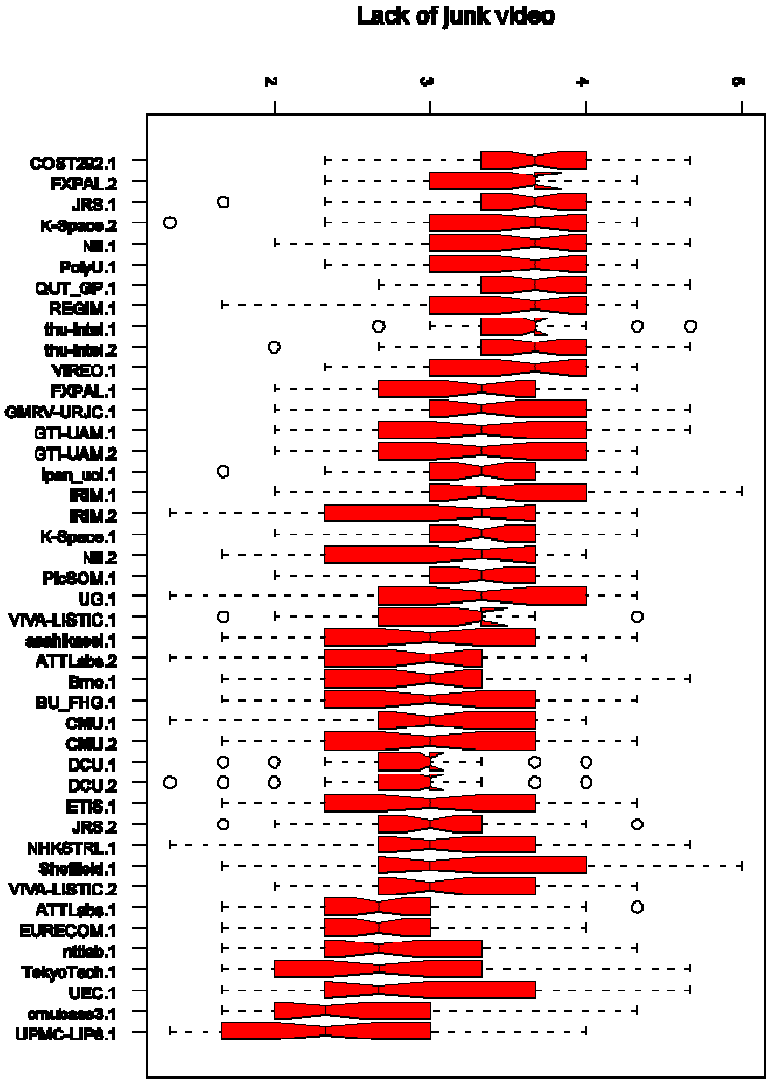
Results: lack of junk

Medians: 2.33 – 3.67

Baseline drops to bottom – as expected if the evaluation is working, since baseline makes no attempt to remove junk, just to move it past the viewer faster

Most scores in a narrow range

Bottom systems are all and only the FF systems???

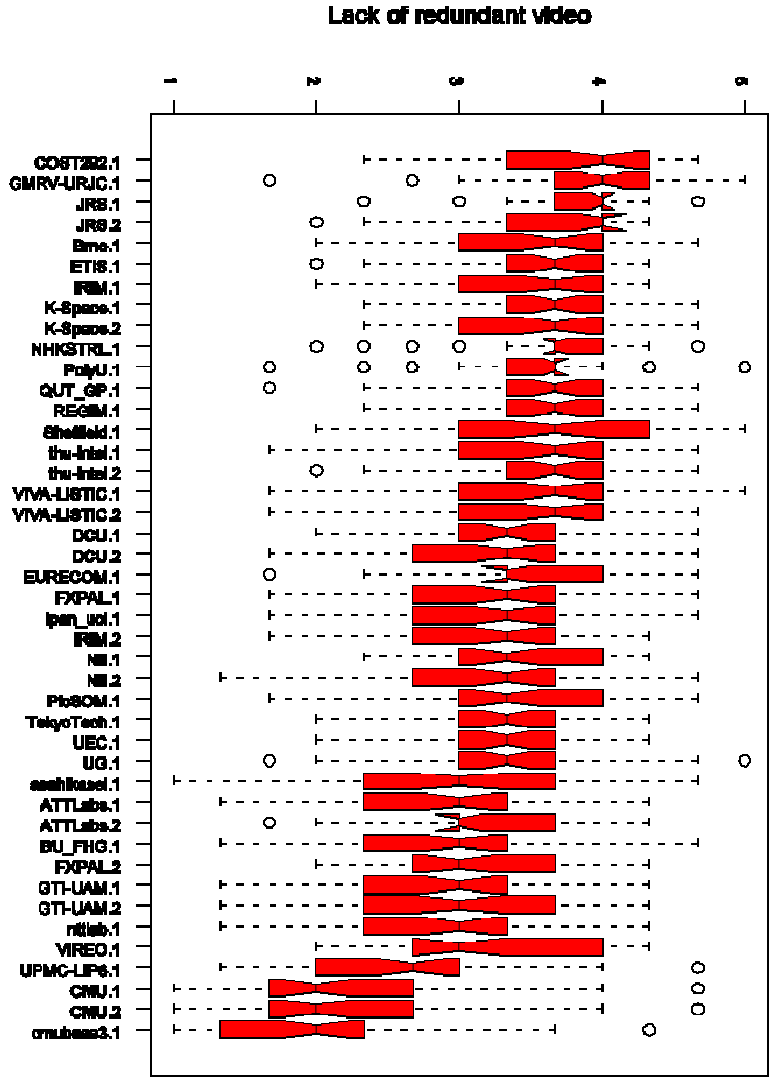


Results: lack of redundancy

Medians: 2 - 4

Again, baseline drops to bottom as expected (no attempt to remove redundancy)

Most scores in an even narrower range than “lack of junk”

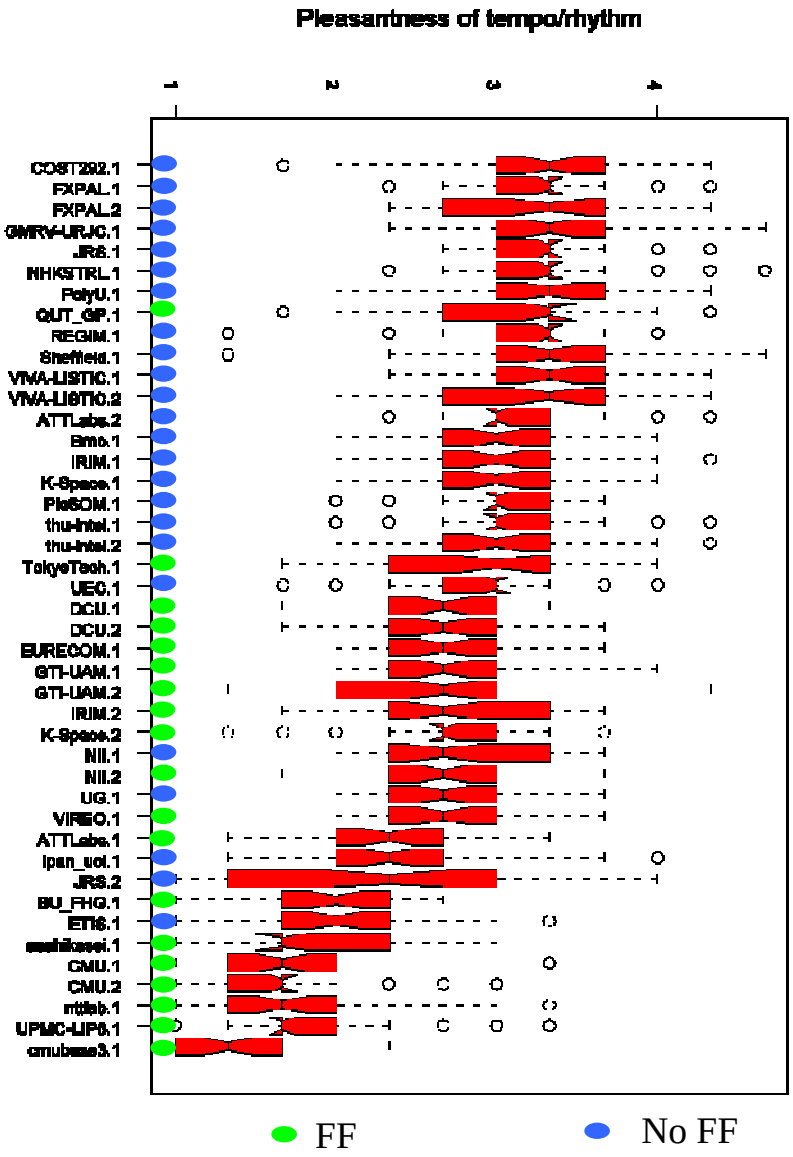


Results: pleasant tempo

Medians: 1.33 – 3.33

Wider range at low end

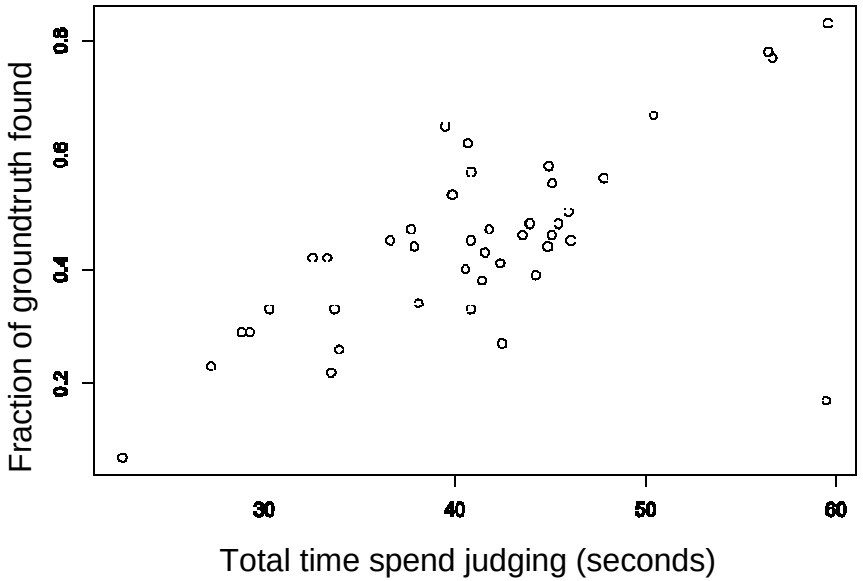
Using FF correlates with low scores on pleasant rhythm?

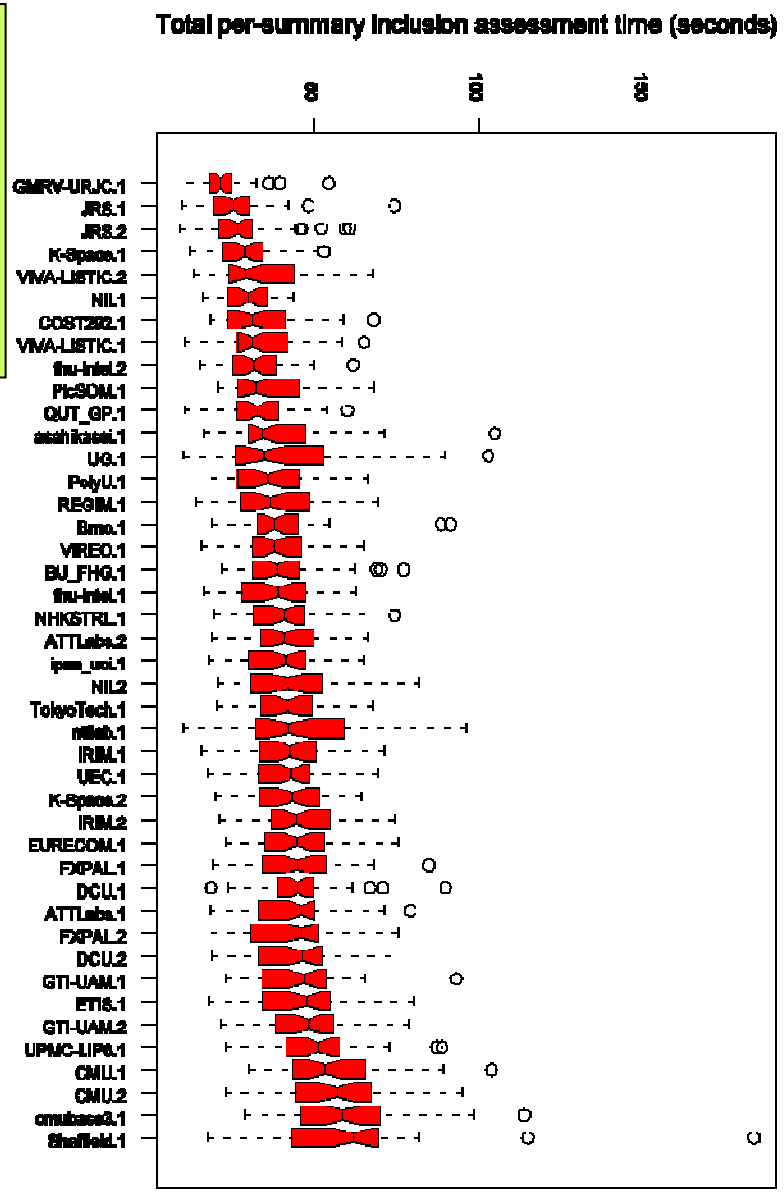


Results: assessment time

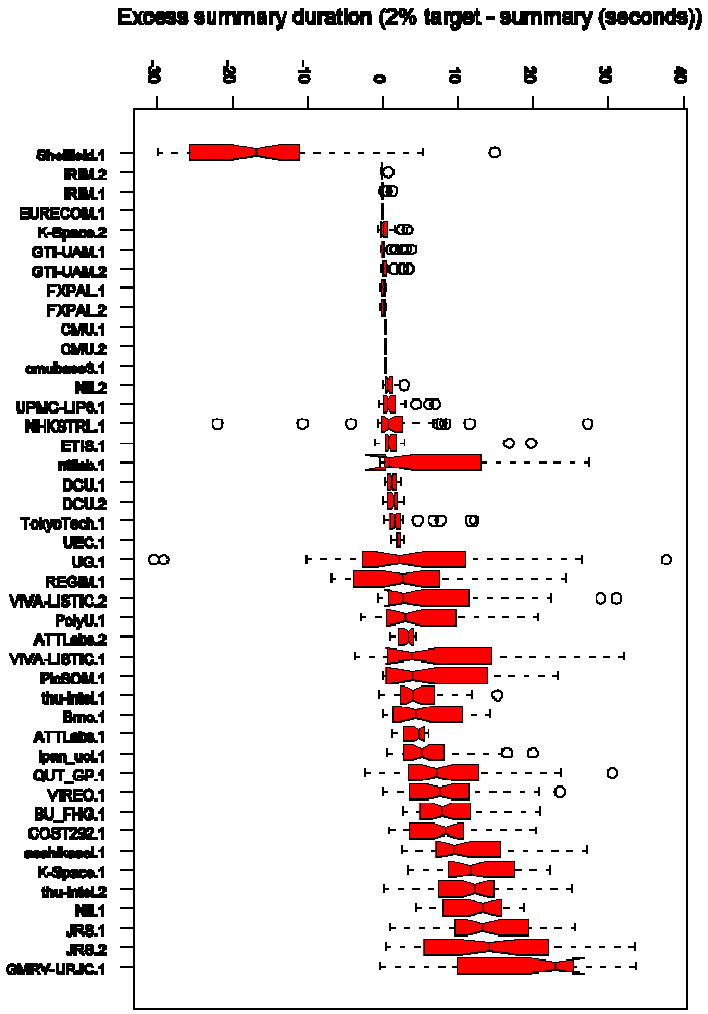
Medians: 21.67 – 61.67 (s)

Seems more time spent judging again correlated with higher inclusion scores .. But which was cause and which was effect ?





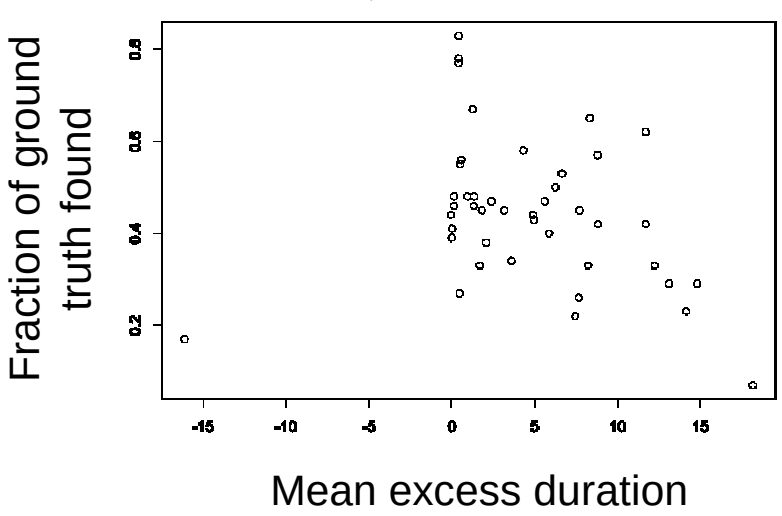
Results: summary duration



Almost all smaller than target

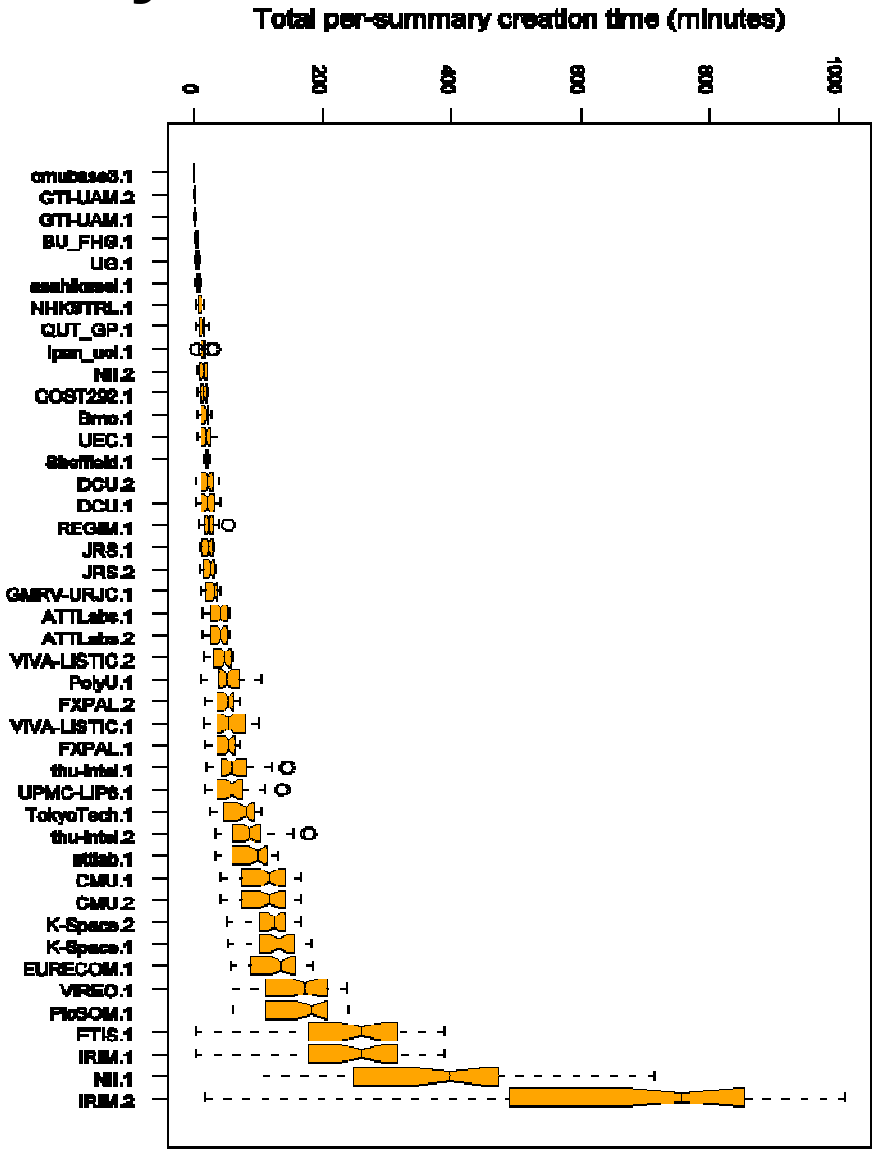
No penalty, no reward in the measures

Longer summaries don't imply more ground truth included



Results: summary creation time

- Median times just under 20 minutes
- Some very fast
- Some very expensive (unoptimized for time, e.g. IRIM genetic algorithm)



Evaluating the evaluation

- No problems in ground truth creation or assessment
- Agreement in binary judgments of included ground truth good again 81% (versus 78% in 2007; 50% expected by chance)
  - Fraction of agreement on a judgment of “no inclusion” was 53.8% (about the same as in 2007 (57.2%))
- Pairwise differences in well-formedness judgments smaller than in 2007
  - 2008 mean and median differences: ~ 1.0
  - 2007 mean differences:
    - 1.442 for ease of understanding
    - 1.366 for redundancy

Final observations

- Evaluation framework passes sanity checks again
- Systems achieved compression target of 2%, moving from 4% in 2007 – let's not underestimate this challenge
- Use of fast forward spread to ~ 50% of runs
- Baseline really only aimed to include ground truth – not a baseline for well-formedness
  - very high on included ground truth
  - very low on usability measures
- Computation time to generate summaries varied wildly
- Is this problem now solved ?
- What should summarisation move on to next ?

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Thanks to ...

- BBC Archives and Richard Wright
- NIST and Intelligence Advanced Research Projects Activity (IARPA)
- European Commission under contract FP6-027026 (K-Space)
- The assessors at NIST who created the ground truth and the assessors at Dublin City University for the evaluation
- Philip Kelly at Dublin City University for helping to organize the judging
- Carnegie Mellon University for providing the baseline results once again
- Several sites for mirroring the video data
- The program committee and others for reviewing papers
- All the participating groups for taking part

20

Possible continuations…*mobisodes*?

- More BBC rushes video is available, but
  - Systems are doing well on the current measures
    - time to see how well real users like the results
  - System approaches are converging
- BBC also interested in automatic summarization of
  - produced video for mobile devices (mobisodes)
    - catch-up: find the video in episode x needed to understand episode x+1
    - preview: find the video in an episode that will make a viewer want to see the episode but without destroying suspense
- Lots of questions remain:
  - availability of production data beyond video?
    - audio description
    - script
    - closed captioning
  - how to evaluate
    - effectiveness
      - manually describe needed video as was done with rushes?
    - usability (especially for a mobile device … Which? In what setting? By whom?)

21