Multimodal Annotation, Summarization, and Inference

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Goals

• Note-taking system
  – Using Tablet PC
  – Personalized and intuitive
• Note review system
  – Search
  – Summary
• Note improvement
  – Semi-automatic
  – Discovery of inconsistencies

Challenges

• What other programs are lacking:
  – Video-centric organization
  – Organization with personalization
  – Search and Summarization

Approach

• Develop an application that uses summarization and suggestion to improve upon the current model of Tablet PC-based educational tools.

Note-Taking and Recording

Note Event Organization

User Input

Adjusted Weights

Initial Weights

Ranking

Searching and Reviewing

Note-Taking and Recording

Video File

VideoTAG

Notes

Annotations

Tags
**Live Demonstration**
- Annotating
- Searching
- Reviewing

**Ranking**
- Needed in order to summarize the information
- Score determined by the three note components: ink, text, and tags

**Ranking**
- Individual Ranking Calculation:
  
  \[
  I_i = k_1 \cdot W \cdot h + k_2 \cdot (\# \text{strokes}) \\
  I_w = (\# \text{chars}) \\
  I_r = \sum_{i}^{} T_i(t_i)
  \]

  - Note event raw score is average of these values

**Ranking**
- Raw score is not helpful over long-term because certain things can change:
  - Note-taking style
  - The amount of information covered in class
- As a result, summary of top \( n \) events would be lopsided

**Adjustment**
- Example local maximum

**Adjustment**
- Instead, rate score over a rolling window \( w \) using SNR
  - Examine a set of events \( w/2 \) time in either direction from the concerned event
  - Signal-to-noise ratio \( N \) is:

\[
N = 20 \log_{10} \frac{E}{A_W}
\]

- Where \( E \) is the raw score and \( A_W \) is the average score from the set of raw scores of all the events in the window \( w \).
Improvement

• What if summaries are not acceptable to the user?
• Predefined parameters like $w$ are somewhat arbitrarily chosen, but may not supply satisfactory summaries to the user
• User must be able to supply feedback in order to allow some “flexibility” of ranking algorithm and personalize the summarized output

Improvement

• Note improvement
  – When reviewing a list of summarized events that have been marked as important, the user can manually flag an event as not belonging in the summary.
  – In order to continue using the ranking algorithm, the parameters $w$, $k_{1,2}$, and $c_{1,2,3}$ must be changed

Improvement

• Solution:
  – Separate events that have been marked important and events that must be not important into two sets, $E_i$ and $E_j$.
  – The function:
    $$f(x,y,a) = \sum (E_i(x,y)-M(x,y))^2 + \sum (E_j(x,y)-0)^2$$
can be used for a “least squares” type optimization with the parameters $k$, $c$, and $w$ and data consisting of the note events and previous correctly-generated summaries

Improvement

• Solution (cont):
  – The optimization function boils down to a system of equations which will be over constrained assuming a reasonable set of note events, so an approximate solution can be determined

What’s next?

• Implement the ranking and summarization
• Testing phase planned for Fall 2006
  – Record CS251 (Data Structures) lectures
  – Have students annotate lectures, give feedback