UB at the NTCIR-12 SpokenQuery&Doc-2: Spoken Content Retrieval Using Multiple ASR Hypotheses and Syllables

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Background and Motivation

• MEI project at Summer 2000 JHU Workshop
  • Query-by-example: English news stories (AP and NYTimes) to retrieve Mandarin news broadcast (VOA)
  • Multi-scale paradigm: use of words, and subwords (Chinese characters and syllables)

• MALACH Project / CLEF-CLSDR track
  • Information access to Holocaust survivor testimonies: multilingual, spontaneous, oral history

• Online programs at UB/GSE/DLIS
  • MS in Information and Library Science, MS in School Librarianship: >90% courses are now online
  • Large volume of recorded lectures
Challenges and Techniques

• Challenges
  • ASR errors, topic boundaries, ...
  • Information needs, users, user-system interfaces, ...

• Techniques
  • (Most commonly) first converting speech to text and then applying text-based IR
  • Exploring rich features of ASR: words, subwords, time stamps, ...
Our Areas of Interest

• Using multiple ASR hypotheses
  • Is it better than using only the “best” hypothesis?

• Using ASR syllables
  • Can it help when coupled with word-based retrieval?

• Comparing ASR engines (Julius and KALDI)
  • Do they result in different retrieval effectiveness?
Test Collection: Documents

98 conference lectures from SDPWS1-7
- Speech audio in wav format, divided into inter pausal units (IPUs)
- Manual transcriptions
- Reference automatic transcriptions, generated by two ASR engines (Julius and KALDI), at both word and syllable level
- Slide transition information
- Slide group segment information
- Slide to IPU alignment information

A “document” is defined as a slide group segment, which may contain one or more contiguous slides corresponding to a topic

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Document Processing

• Creating document collections
  • Based on information of slide group segment and slide-to-IPU alignment
  • Multiple collections were created
    • Manual transcription
    • ASRs: word- or syllable-based, top-n hypotheses, Julius or KALDI
  • 2,259 documents per collection

• Segmenting Japanese text
  • Using MeCab Japanese Morphological Analyzer

• Converting into hexadecimal codes
  • For easy handling by the IR system

• Indexing each document collection
  • Multiple ASR hypotheses were treated as independent terms
Query Formulation

• Creating multiple query sets using
  • Manual transcription (verbose)
  • ASR texts: top-n words or syllables generated by the two ASR engines

• Segmenting

• Converting to hexadecimal codes
### Average Document/Query Length

<table>
<thead>
<tr>
<th>Term</th>
<th>Document</th>
<th>Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words of manual transcription</td>
<td>194</td>
<td>140</td>
</tr>
<tr>
<td>1-best ASR words by Julius</td>
<td>171</td>
<td>136</td>
</tr>
<tr>
<td>5-best ASR words by Julius</td>
<td>860</td>
<td>699</td>
</tr>
<tr>
<td>1-best ASR syllables by Julius</td>
<td>295</td>
<td>226</td>
</tr>
<tr>
<td>1-best ASR words by KALDI</td>
<td>174</td>
<td>180</td>
</tr>
</tbody>
</table>
IR System

Perl Search Engine (PSE): a Perl implementation of Okapi BM25 weighting

\[ \sum_{w \in q} \left[ \log \left( \frac{N - df(w) + 0.5}{df(w) + 0.5} \right) \right] \left[ \frac{(k_1 + 1) \times c(w, d)}{k_1((1 - b) + b \frac{dl(d)}{avdl} + c(w, d))} \frac{(k_3 + 1) \times c(w, q)}{k_3 + c(w, q)} \right] \]

Where

\[ k_1 = 1.2, \; b = 0.75, \; k_3 = 7 \]
## Official Runs and Results

<table>
<thead>
<tr>
<th>Run id</th>
<th>Document term</th>
<th>Query term</th>
<th>MAP</th>
<th>Relative MAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQSCR-UB-SGS-TXT-1</td>
<td>Words of manual transcription</td>
<td>Words of manual transcription (verbose)</td>
<td>0.1953</td>
<td>Reference run</td>
</tr>
<tr>
<td>SQSCR-UB-SGS-TXT-2</td>
<td>1-best ASR words of Julius</td>
<td>1-best ASR words of Julius</td>
<td>0.1128</td>
<td>57.8%</td>
</tr>
<tr>
<td>SQSCR-UB-SGS-TXT-3</td>
<td>5-best ASR words of Julius</td>
<td>1-best ASR words of Julius</td>
<td>0.0994</td>
<td>50.9%</td>
</tr>
<tr>
<td>SQSCR-UB-SGS-TXT-4</td>
<td>1-best ASR words of Julius</td>
<td>5-best ASR words of Julius</td>
<td>0.1127</td>
<td>57.7%</td>
</tr>
<tr>
<td>SQSCR-UB-SGS-TXT-5</td>
<td>5-best ASR words of Julius</td>
<td>5-best ASR words of Julius</td>
<td>0.0966</td>
<td>49.5%</td>
</tr>
<tr>
<td>SQSCR-UB-SGS-TXT-6</td>
<td>1-best ASR syllables of Julius</td>
<td>1-best ASR syllables of Julius</td>
<td>0.0253</td>
<td>13.0%</td>
</tr>
<tr>
<td>SQSCR-UB-SGS-TXT-7</td>
<td>1-best ASR words of KALDI</td>
<td>1-best ASR words of KALDI</td>
<td>0.1946</td>
<td>99.7%</td>
</tr>
</tbody>
</table>

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Comparison of Runs

• ASR vs manual transcription
  • Julius: significantly lower MAP regardless of index terms
  • KALDI: statistically indistinguishable MAP on 1-best words

• ASR words vs ASR syllables
  • Significantly higher MAP on ASR words

• Multiple ASR hypotheses (words)
  • Not showing improvement of MAP

• Julius vs KALDI
  • Significantly higher MAP on KALDI 1-best words
Query-by-Query Comparison

Runs: 1-best Julius ASR words vs manual transcription

- Among 29 queries that have an AP of >=0.2 on manual transcription (reference run), 16 queries achieved only less than 20% AP of the reference run on 1-best Julius ASR words
- Detailed analysis is needed for these 16 queries/topics
Conclusions and Future Work

- Noisy ASR text degrades the retrieval effectiveness of spontaneous spoken content
  - But systems can produce ASR texts leading to results comparable to those of manual transcriptions
  - Comparative analysis of ASR texts by different systems are needed
- ASR syllables alone are not reliable for SCR
  - Maybe should better be combined with words
- Treating multiple ASR hypotheses as independent terms does not help improve retrieval effectiveness
  - More sophisticated term weighting techniques might work
- Failure analysis on problematic queries shall tell more about both ASR and IR