An Incremental Summary Generation System

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Outline

• Motivation
• Introduction
• Background
• Incremental Summary generation
• Conclusions
Motivation

- What is Information Overload Problem?
Huge number of documents on a topic

Also try: water on mars evidence, is there water on mars, More...

NASA Spacecraft Confirms Martian Water, Mission Extended
NASA mission news: Laboratory tests aboard NASA's Phoenix Mars Lander have identified water in a soil sample.

Water Ice on Mars Confirmed - SPACE.com
SPACE.com article about the Phoenix Mars Lander's confirmation of the existence of water ice on Mars.
www.space.com/missionlaunches/060731-phoenix-update.html - 68k - Cached

Water On Mars - News Results
Water-tanker seaplane takes residence on Lake Elsinore for firefighting season
The Press-Enterprise - Oct 10 12:07am
The Martin Mars firefighting seaplane should be back at Lake Elsinore by this weekend.
Yahoo! Shortcut - About

SPACE.com -- NASA announces discovery of evidence of water on Mars
Series of SPACE.com articles relating to NASA's announcement of discovering evidence of water on Mars.
Motivation

• Should user go through all the documents to satisfy her information need?
Motivation

• Should user go through all the documents to satisfy her information need?
• Why not Query Specific Text Summarization?
Motivation

• Should user go through all the documents to satisfy her information need?
• Why not Query Specific Text Summarization?
• Issues in Text Summarization
  ❖ Scalability
  ❖ Logical flow between sentences
  ❖ Redundancy
  ❖ Responsiveness etc.
Introduction

- Document collection is represented as a graph
- Each node in the graph is a sentence in a document
- Edge is placed between two sentences if the similarity value is above a threshold
- Most of the multi-document summarizers follow the above Integrated graph approach
Extractive Query Specific Multi-document Summarization Process
Background

Genres of Summaries

- Abstractive vs. Extractive
- Generic vs. Query Specific
- Indicative vs. Informative
- Single document vs. Multiple document
MEAD

• MEAD is initially developed for multi-document generic extractive summarization.

• Each sentence is given scores based on these measures:
  - Similarity with centroid of the documents.
  - Position of the sentence within the document.
  - Similarity with the first sentence of the document.
  - Penalty value similar to MMR.

• Top scored sentences are given as summary.

[Radev et. al. IPM 2004]
Overview of our past works

- **QueSTS** [C R Chowdary et. al. FLAIRS 2008]
  - Integrated Graph (IG) is constructed
  - Summary is generated on IG
  - Complexity is huge
  - Time taken = 29 minute/cluster

- **Sentence ordering** [C R Chowdary et. al. BNCOD 2008]
  - Sentence ordering within the summary is addressed

- **ESUM** [C R Chowdary et. al. ECIR 2009]
  - Efficient summarization using distributive approach
Incremental Summary Generation

- What is Incremental Summary?
  - Updating the current summary

- Why do we need it?
  - Saves time
  - Essential if the original set of documents are not accessible

- How to do it?
  - Sentence replacement method
Sentence Replacement Method

• Task
  ❖ Given - the current summary and the query
  ❖ Update current summary on the arrival of a new document

• Constraint
  ❖ Size of summary is fixed

• Method Outline
  ❖ Identify a sentence in the new document
    ➢ more informative than a sentence in current summary
  ❖ Exchange them
  ❖ Repeat till convergence
Sentence Replacement Method

• How to identify the pair of sentences
  ❖ Calculate the score of summary
  ❖ Identify prominent nodes in the new document
    ➢ with respect to the query
  ❖ Temporarily replace a node in the current summary with a prominent node from new document
    ➢ calculate the score of the resulting summary
  ❖ Find the pair of nodes
    ➢ That maximizes the score of the resulting summary
  ❖ Replace or swap the sentences
Sentence Replacement Method

• How to compute the score of a summary?
   Based on following properties
    ➢ Information biased towards the query
    ➢ Non-Redundant information
Sentence Replacement Method

• Completeness
  ❖ Presence of all query terms

• Non-Redundancy
  ❖ Non repetition of information

• How to measure these?
  ❖ Node score
  ❖ Contribution score
  ❖ Completeness score
Node Score

- Node score captures
  - Salience of a sentence w.r.t query terms
- $w_q(s)$ is the score of a node $s$ w.r.t query term $q$

\[
w_q(s) = d \frac{\sum_{m \in N} sim(s, q)}{\sum_{m \in N} sim(m, q)} + (1 - d) \sum_{v \in adj(s)} \frac{\sum_{u \in adj(v)} sim(s, v)}{\sum_{u \in adj(v)} sim(u, v)} \cdot w_q(v)\]

- $sim(x, y)$ : similarity between $x$ and $y$
  - $x$ and $y$ are term vectors
Summary Score

• Node Score
  
  $w_Q(s) = \sum_{q \in Q} w_q(s)$ where $Q$ is the query, $s$ is a sentence

• Contribution score
  
  captures the contribution of individual sentences in the summary $S$
  
  $CCS(S) = \sum_i (1 - \text{sim}(n_i, N_i))$ where $N_i = S - \{n_i\}$

• Completeness score
  
  $\text{count}(S, Q) = \text{No. of query terms in the query} - \text{No. of query terms not present in the summary}$

• Summary score – linear combination of above
Sentence Replacement Method

- Choose the best pair
  - One sentence from summary and another from document that maximizes the score of the summary
  - Swap the sentences
- Repeat till the best summary is formed
  - No more improvement in the summary score
Contribution Score Revisited

Previous: \[ CCS(S) = \sum_i (1 - \text{sim}(n_i, N_i)) \]

Current: \[ CCS(S) = \sum_i (1 - \text{MAX}_j(\text{sim}(n_i, n_j))) \]

• Summary score is linear combination of
  • Node score, contribution score and completeness
Experimental Setup

15 documents and query from each cluster are given as input to MEAD system.

Input → MEAD → Output

Summary → Next document (16, 17,..., 25)

Proposed System

No Summary → If Next document = 25

Yes

Output

Store
## ROUGE values (original CCS)

<table>
<thead>
<tr>
<th>Updated Summary</th>
<th>ROUGE-1</th>
<th>ROUGE-2</th>
<th>ROUGE-W</th>
<th>ROUGE-SU4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.36993</td>
<td>0.06744</td>
<td>0.08842</td>
<td>0.12246</td>
</tr>
<tr>
<td>2</td>
<td>0.36130</td>
<td>0.06260</td>
<td>0.08500</td>
<td>0.11675</td>
</tr>
<tr>
<td>3</td>
<td>0.35948</td>
<td>0.05986</td>
<td>0.08440</td>
<td>0.11431</td>
</tr>
<tr>
<td>4</td>
<td>0.35694</td>
<td>0.05854</td>
<td>0.08343</td>
<td>0.11334</td>
</tr>
<tr>
<td>5</td>
<td>0.35175</td>
<td>0.05627</td>
<td>0.08226</td>
<td>0.11065</td>
</tr>
<tr>
<td>6</td>
<td>0.34763</td>
<td>0.05405</td>
<td>0.08079</td>
<td>0.10803</td>
</tr>
<tr>
<td>7</td>
<td>0.34420</td>
<td>0.05341</td>
<td>0.08017</td>
<td>0.10698</td>
</tr>
<tr>
<td>8</td>
<td>0.34402</td>
<td>0.05195</td>
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<tr>
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<td>10</td>
<td>0.34545</td>
<td>0.05171</td>
<td>0.08031</td>
<td>0.10694</td>
</tr>
</tbody>
</table>
**ROUGE values of best system of DUC 2006**

<table>
<thead>
<tr>
<th>Updated Summary</th>
<th>ROUGE-1</th>
<th>ROUGE-2</th>
<th>ROUGE-W</th>
<th>ROUGE-SU4</th>
</tr>
</thead>
<tbody>
<tr>
<td>System24</td>
<td>0.41108</td>
<td>0.09558</td>
<td>0.11068</td>
<td>0.15529</td>
</tr>
</tbody>
</table>

*Note*: These values are on the whole cluster.
## ROUGE values (modified CCS)

<table>
<thead>
<tr>
<th>Updated Summary</th>
<th>ROUGE-1</th>
<th>ROUGE-2</th>
<th>ROUGE-W</th>
<th>ROUGE-SU4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.38661</td>
<td>0.08077</td>
<td>0.09380</td>
<td>0.13631</td>
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<td>0.38581</td>
<td>0.08033</td>
<td>0.09336</td>
<td>0.13566</td>
</tr>
<tr>
<td>3</td>
<td>0.38739</td>
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<td>0.38685</td>
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<td>0.38559</td>
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<td>9</td>
<td>0.38510</td>
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<tr>
<td>10</td>
<td>0.38523</td>
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<td>0.13516</td>
</tr>
</tbody>
</table>
Conclusions

• Incremental summary generation system was proposed
  ❖ Sentence replacement
• Score was given to summary based on
  ❖ Responsiveness
  ❖ Informativeness
  ❖ Non-Redundancy
• Experimental results show that our approach is effective
  ❖ Time taken 3.6 minute/summary
Sentence Replacement Method

• What is the problem with this method?
  - TIME
    - 3.6 minute/summary

• How to generate incremental summary generation efficient?
  - USUM
    - 7 second/summary!!
Thank You
Backup

- **Insertion Strategy**

Find similarity with all nodes in summary

Summary
Backup

• Insertion Strategy

If A is having highest similarity with 3
Then find similarity with 2 and 4
Insert A in between 2 and 3 if similarity with 2 is greater than similarity 4

Summary