15-826: Multimedia Databases and Data Mining

Lecture #17: Text - part IV (LSI)

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Must-read Material


Outline

Goal: ‘Find similar / interesting things’
- Intro to DB
- Indexing - similarity search
- Data Mining
Indexing - Detailed outline

- primary key indexing
- secondary key / multi-key indexing
- spatial access methods
- fractals
- text
  - SVD: a powerful tool
  - multimedia
  - ...

Text - Detailed outline

- text
  - problem
  - full text scanning
  - inversion
  - signature files
  - clustering
  - information filtering and LSI

LSI - Detailed outline

- LSI
  - problem definition
  - main idea
  - experiments
Information Filtering + LSI

- [Foltz+, '92] Goal:
  - users specify interests (= keywords)
  - system alerts them, on suitable news documents
- Major contribution: LSI = Latent Semantic Indexing
  - latent ('hidden') concepts

Main idea
- map each document into some ‘concepts’
- map each term into some ‘concepts’

‘Concept’: a set of terms, with weights, e.g.
- “data” (0.8), “system” (0.5), “retrieval” (0.6) -> DBMS_concept

Pictorially: term-document matrix (BEFORE)

<table>
<thead>
<tr>
<th></th>
<th>'data'</th>
<th>'system'</th>
<th>'retrieval'</th>
<th>'lung'</th>
<th>'eat'</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR3</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR4</td>
<td></td>
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<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Information Filtering + LSI

Pictorially: concept-document matrix and...

<table>
<thead>
<tr>
<th>'DBMS-concept'</th>
<th>'medical-concept'</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1</td>
<td>1</td>
</tr>
<tr>
<td>TR2</td>
<td>1</td>
</tr>
<tr>
<td>TR3</td>
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</tr>
<tr>
<td>TR4</td>
<td>1</td>
</tr>
</tbody>
</table>

... and concept-term matrix

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>data</td>
<td>1</td>
</tr>
<tr>
<td>system</td>
<td>1</td>
</tr>
<tr>
<td>retrieval</td>
<td>1</td>
</tr>
<tr>
<td>lung</td>
<td>1</td>
</tr>
<tr>
<td>ear</td>
<td>1</td>
</tr>
</tbody>
</table>

Q: How to search, eg., for ‘system’?
Information Filtering + LSI

A: find the corresponding concept(s); and the corresponding documents

<table>
<thead>
<tr>
<th>Concept</th>
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<th>medical-concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>System</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Retrieval</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ring</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ear</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Thus it works like an (automatically constructed) thesaurus: we may retrieve documents that DON’T have the term ‘system’, but they contain almost everything else (‘data’, ‘retrieval’)
LSI - Detailed outline

• LSI
  – problem definition
  – main idea
  – experiments

LSI - Experiments

• 150 Tech Memos (TM) / month
• 34 users submitted 'profiles' (6-66 words per profile)
• 100-300 concepts

LSI - Experiments

• four methods, cross-product of:
  – vector-space or LSI, for similarity scoring
  – keywords or document-sample, for profile specification
• measured: precision/recall
LSI - Experiments

- LSI, with document-based profiles, were better

<table>
<thead>
<tr>
<th>Precision</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.25, 0.65)</td>
<td>(0.50, 0.45)</td>
</tr>
<tr>
<td>(0.75, 0.30)</td>
<td></td>
</tr>
</tbody>
</table>

LSI - Discussion - Conclusions

- Great idea,
  - to derive 'concepts' from documents
  - to build a 'statistical thesaurus' automatically
  - to reduce dimensionality
- Often leads to better precision/recall
- but:
  - Needs 'training' set of documents
  - 'concept' vectors are not sparse anymore

Observations

- Bellcore (→ Telcordia) has a patent
- used for multi-lingual retrieval

How exactly SVD works?
Indexing - Detailed outline

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