Text Summarization - LexRank

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Text Summarization

What is a summary?

A summary is a text that is produced from one or more texts, that contains a significant portion of the information in the original text(s), and that is no longer than half of the original text(s). (*Hovy, 2008*)

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Humans have an incredible capacity to condense information down to the critical bit.

> *"He said he is against it."*

Calvin Coolidge, on being asked what a clergyman preaching on sin said.

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To give an overview of the original document in a shorter period of time.

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Summarization Applications

- *outlines or abstracts* of any document, news article etc.
- *summaries* of email threads
- *action items* from a meeting
- *simplifying* text by compressing sentences

Application: Generating Snippets

Robert O'Neill taking credit for killing Osama bin Laden sparks debate

Hindustan Times - 1 hour ago

Some special operations service members and veterans are unhappy that one of their own has taken credit publicly for killing Osama bin Laden.

It's been special knock as wait has been long: Rayudu

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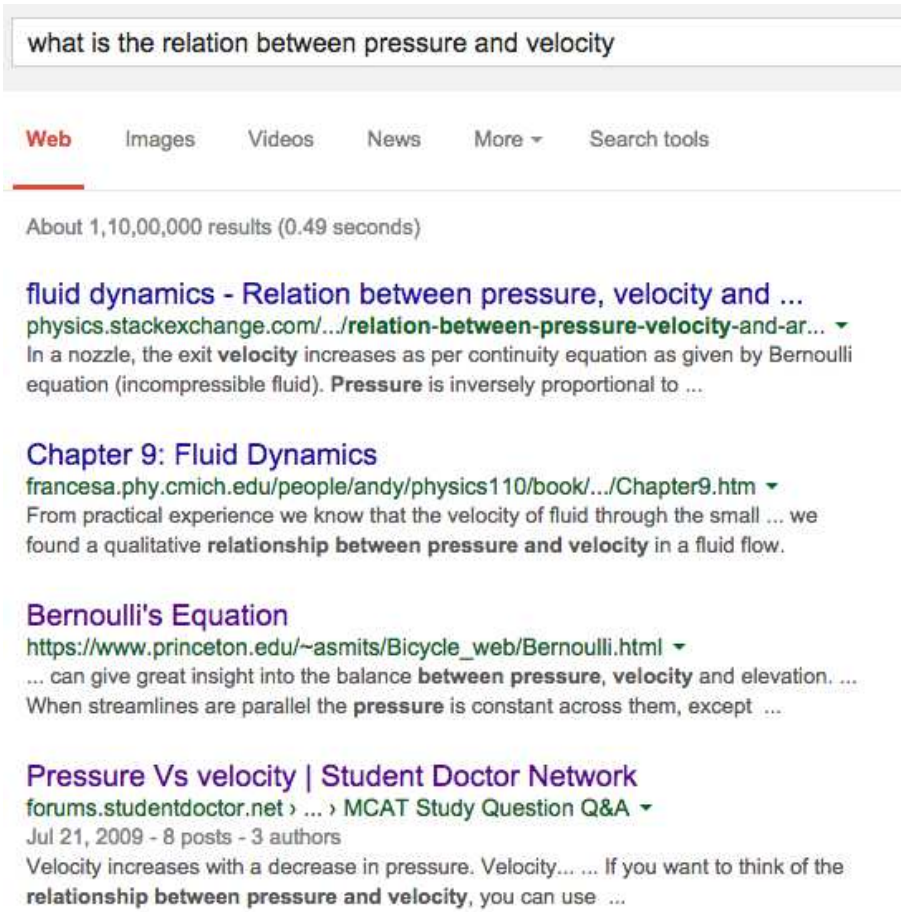

Automatic Text Summarization

Genres of Summary

- Extract vs. Abstract

  . . .lists fragments of text vs. re-phrases content coherently.

- Single document vs. Multi-document

  . . .based on one text vs. fuses together many texts.

- Generic vs. Query-focused

  . . .provides author's view vs. reflects user's interest.

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Query-focused summarization can be thought of as a complex question answering system

Summarization: Main stages

Content Selection

Choose sentences to extract from the document

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Information Ordering

Choose an order to place them in the summary

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Increase diversification by removing redundant sentences

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The most basic algorithm only does the first stage, *content selection*.

Unsupervised content selection; Luhn (1958)

Intuition

Choose sentences that have salient or informative words

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Choose sentences that have salient or informative words

Two approaches to define salient words

- *tf-idf:* weigh each word w_i in document j by tf-idf

$$weight(w_i) = tf_{ij} \times idf_i$$

- *Topic signatures:* choose a smaller set of salient words, specific to that domain

$$weight(w_i) = 1 \text{ if } w_i \text{ is a specific term (use mutual information)}$$

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Weighing a sentence

$$weight(s) = \frac{1}{|S|} \sum_{w \in S} weight(w)$$

LexRank: A Graph-based approach

Text Document

Computation is a process following a well defined model ...
A computation can be seen as a purely physical phenomena ...
...

processing

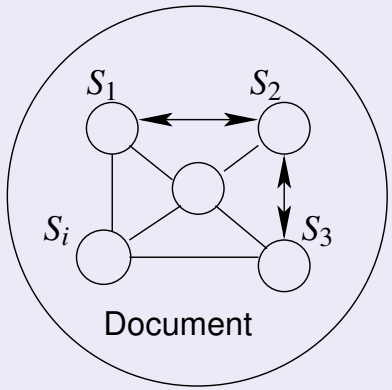
$S_1 \rightarrow \{(computation, 0.1), (process, 0.15), \ldots\}$
$S_2 \rightarrow \{(computation, 0.1), (seen, 0.05), \ldots\}$
$S_3 \rightarrow \ldots$

Machine-readable format

Document Representation

Underlying Hypothesis

Sentences that convey the theme of the document are more similar to each other

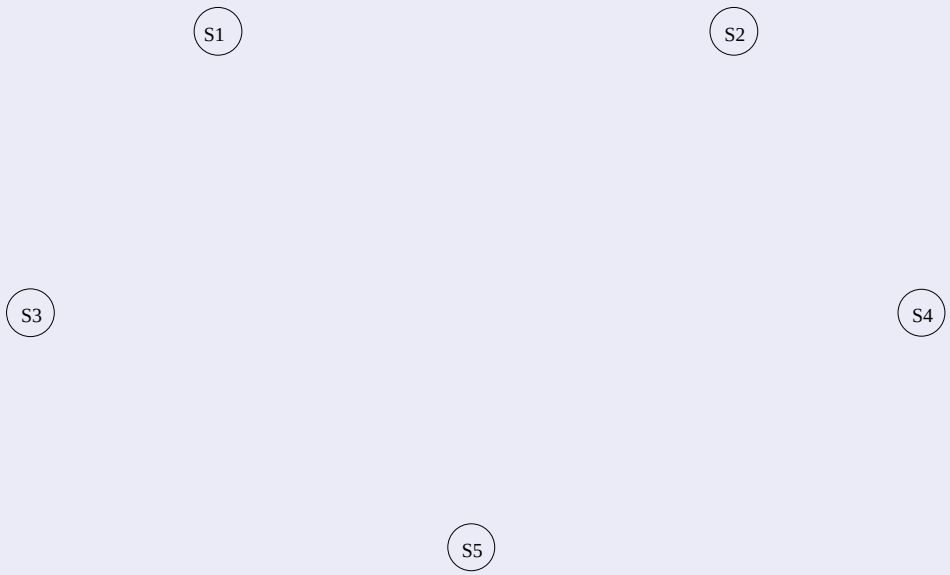


Finding the most salient sentences

Sentence Centrality Measure

Finding the most salient sentences

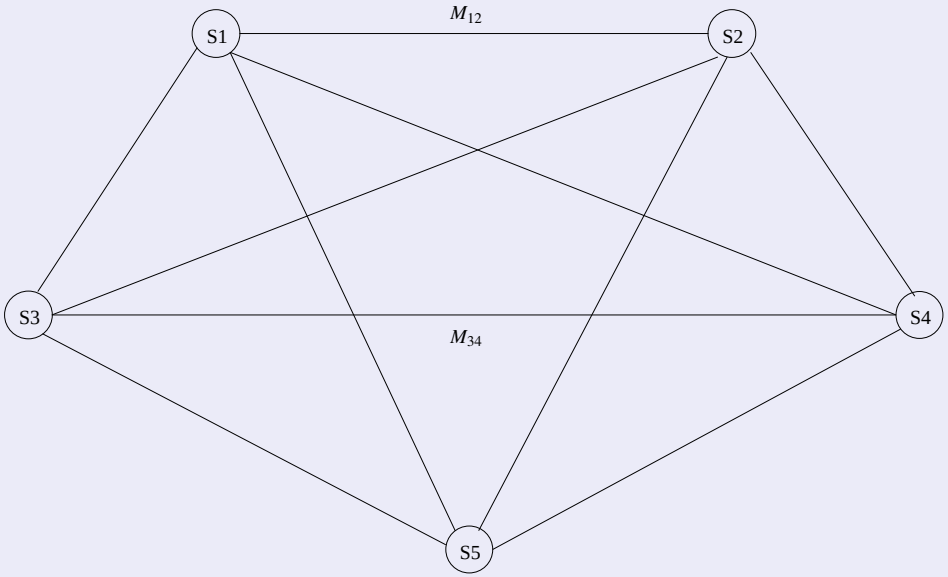
A document graph is constructed with sentences as the vertices



Sentence Centrality Measure

Finding the most salient sentences

A sentence similarity function is used to calculate the edge weights.

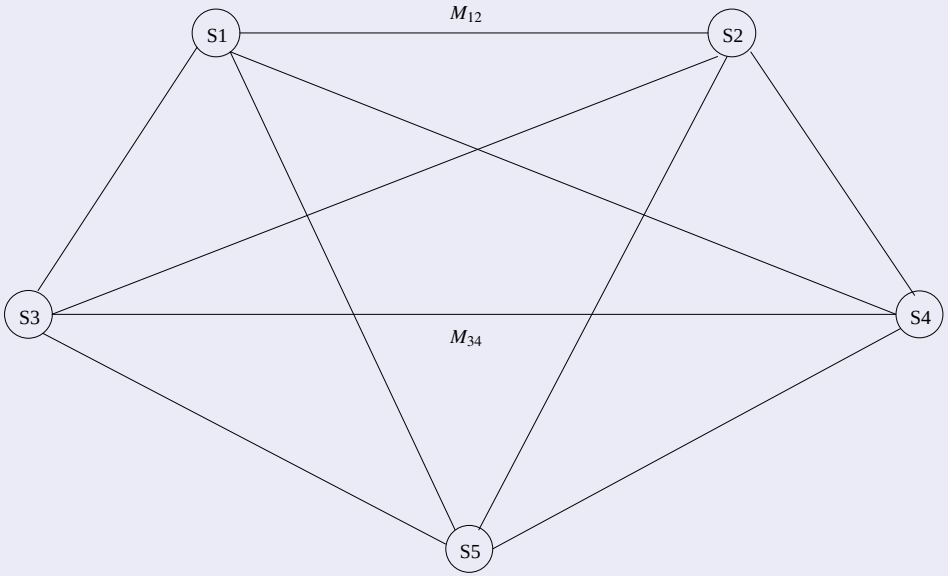


$$\tilde{M} = \begin{bmatrix} 0.0 & 0.5 & 0.0 & 0.4 & 0.1 \\ 0.5 & 0.0 & 0.5 & 0.0 & 0.0 \\ 0.0 & 0.5 & 0.0 & 0.5 & 0.0 \\ 0.4 & 0.0 & 0.4 & 0.0 & 0.2 \\ 0.3 & 0.0 & 0.0 & 0.7 & 0.0 \end{bmatrix}$$

Sentence Centrality Measure

Finding the most salient sentences

PageRank based algorithm is used to compute the sentence centrality vector I.



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$$I_j = \mu \cdot \sum_{\forall k \neq j} I_k \cdot \tilde{M}_{k,j} + \frac{1-\mu}{|S|}$$

$$I = \begin{bmatrix} 0.22 & 0.18 & 0.2 & 0.3 & 0.1 \end{bmatrix}$$

Removing Redundant Sentences

Maximal Marginal Relevance

- An iterative method for content selection from a selected list of important sentences
- Iteratively choose the best sentence to insert in the summary that is minimally redundant with the summary so far (Sum)

$$Inf(s)_{MMR} = max_{s \in D}(Inf(s) - \lambda \cdot sim(s, Sum))$$

where $Inf(s)$ denotes the informativeness score of a sentence