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Exploiting Temporal Information in Retrieval of Archived Documents

Nattiya Kanhabua
(Supervised by Prof. Kjetil Nørvåg)

Database System Group
Norwegian University of Science and Technology
Trondheim, Norway

Agenda

- Motivation
- Research Questions
- Proposed Approaches
- Previous and Current work
- Issues for Discussion

Records Management over Decades

- Initiated by *Det Norske Veritas* with initial motivations:
  - Long-term* digital storage of ship drawings
  - Validation and notary services (trusted third-party roles taken by DNV)
  - Certification of maturity wrt. long-term management of data
  - Funding: Norwegian Research Council 1.12 M€, partners 3.36 M€

*A domain where documents are preserved for more than 10 years

- Partners including:
  - The National Library of Norway
  - The National Archives of Norway
  - Ministry of Foreign Affairs
  - Fast Search & Transfer (a Microsoft subsidiary)
  - StatoilHydro

- Objective:
  - Persistent, reliable and trustworthy long-term archival of digital information records, with emphasis on availability and use of the information
    - Enable the digital representation as the original version
    - Enable long-term usability over decades
    - Explore the potential for commercial products/services in this area

Research Questions

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The main research question:

"How to improve the quality of search in a document archive using temporal information?"

Q1. How to handle large number of documents retrieved?

- This decreases the accuracy of search since users have to spend more time in exploring the information needed.

Q2. How to search with awareness of language changes?

- With time, terms might change semantics, e,g, "awesome", or original terms are obsolete, e.g. "Siam" – *terminology evolution*.

Q3. How to rank search results wrt. temporal information?

- In other research, hit lists are listed *chronologically* (newer pages are more important). In some cases, a chronological order is *not* always needed.

Approach I: Handling Large Number of Documents Retrieved

Problem: The accuracy of search is decreased since users have to spend more time in exploring the information needed.

Proposed approach : Re-ranking for presentation or including a temporal relationship with respect to a query, i.e., extending keyword search with a creation or update date of documents – *temporal criteria*

strongly time-related
e.g. "tsunami" or "presidential election"

Two ways to obtain
1) provided by users, or
2) determined by the system

Challenge :

1. **How to find time related to a query and attach time to the query implicitly, and retrieve results created within that time.**
2. **Note: users have *no clue* regarding possible time of a query, thus no time can be explicitly provided for search.**

Approach II: Searching with Awareness of Language Changes

Problem: With time, terms might change semantics, e.g. “awesome”, or original terms are obsolete, e.g., “Siam” – *terminology evolution*.

Proposed approach : Use a dictionary linking **concepts and entities** ***based on time***, example for the concept of current Thailand can be defined as follows:

Thailand → Siam[0,1939]

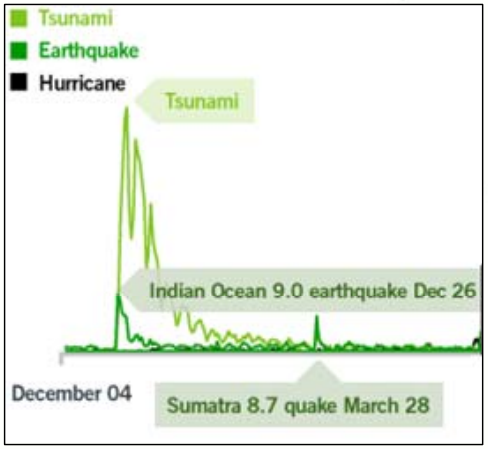
Challenge :

1. **For a query for “Thailand”, the query might be expanded to “Thailand or Siam”.**
2. **For a query for documents written at a certain time (before 1939) the query might be *rewritten* from “Thailand” to “Siam”.**
3. **How can such a time-concept table be machine-generated?**

Approach III: Temporal Ranking of Search Results

Problem: In other research, hit lists are listed *chronologically* (newer pages are more important). A chronological order is *not* always needed, e.g. taking into account topical trend.

Proposed approach : Analyze a document collection to obtain a ***topical trend*** – the trend of a topic – that can be represented as the weight of a topic over time.



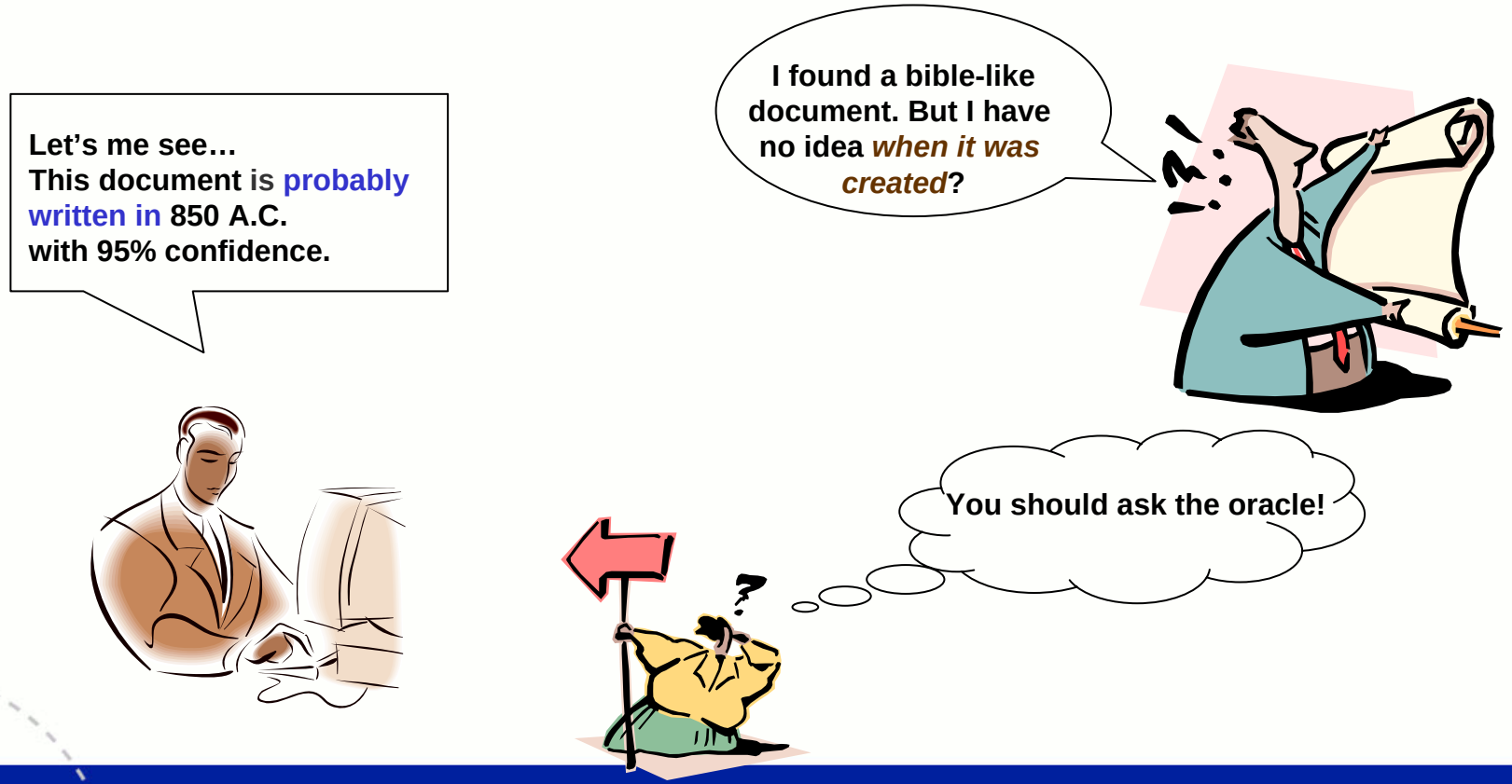
Challenge :

1. **When a query is "tsunami", documents written in 2004 should receive a higher weight than those written in other years, e.g. 2006, according to stronger relevance in the past.**
2. **The ranking of documents retrieved wrt. temporal criteria are similarity scores (term frequency) *plus* weights to topical trend.**

Overview of the ECDL 2008 Paper

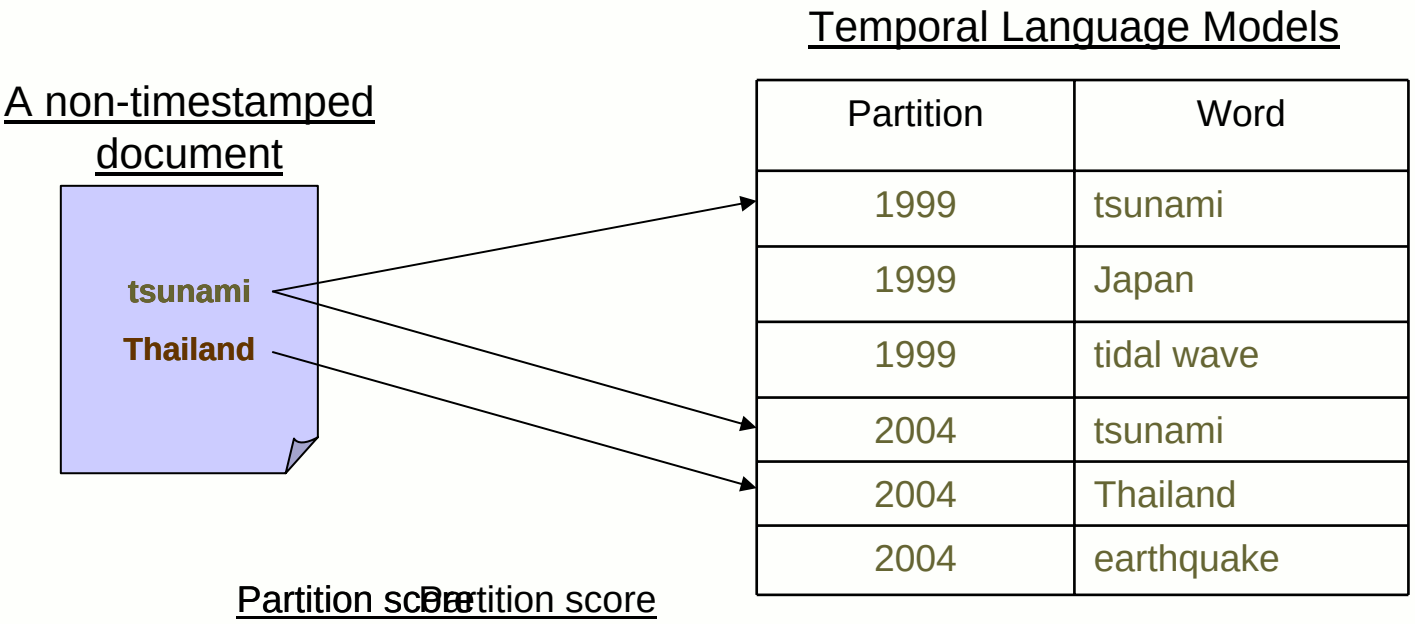
Problem: Due to decentralized nature and the lack of standards for date/time, it is difficult to find accurate and trustworthy timestamp for web documents.

“ For a given document with uncertain timestamp, can the contents be used to determine the timestamp with a sufficiently high confidence? ”



A Model for Dating Documents

- Temporal Language Models proposed by *de Jong et al.* in *AHC*'05
- Based on the statistic usage of words over time.
- Compare a non-timestamped document with a reference corpus.
- A reference time partition *mostly overlaps* in term usage -- the tentative timestamp.



Improving temporal language models

Three ways:

- Data preprocessing
  - Semantic-based preprocessing, i.e. part-of-speech tagging, collocation extraction, word sense disambiguation, concept extraction, word filtering
- Word interpolation
  - Different smoothing (*zero probability*) for 2 classes of terms depending on characteristics in time: recurring & non-recurring
- Similarity score
  - A term weighting concerns temporality, Temporal Entropy
    - How well a term is suitable for separating time partitions?
    - How important a term is in a specific time partition?
  - Taking into account external search statistics (Google Zeitgeist)
    - Integrated as an additional score to increase probabilities of time partitions.

Handling Semantic Gaps in Temporal Search

Problem Statement:

- Synonyms are *alternative words* referring to the same thing.
- When searching with a named entity (i.e. person, location or company), synonyms should be considered to improve *recall*.

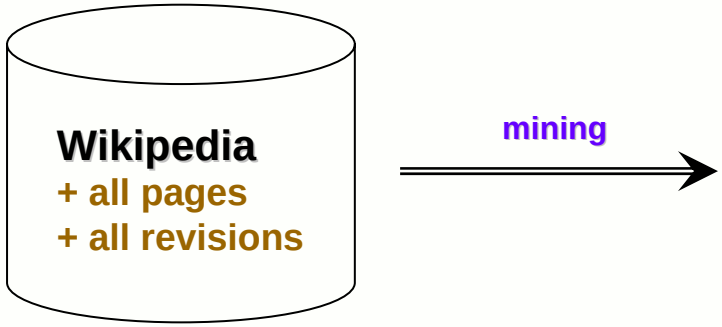
Example:

- In a temporal search, when a query is "US president", only documents exactly containing "US president" are retrieved.
- Documents about "Bush" OR "Obama" should also be retrieved since they refer to the same person.

Proposed approach :

1. **Create a time-dependent dictionary of synonyms using Wikipedia.**
2. **Use the dictionary to expand a query for improving a search quality.**

A Time-dependent Dictionary of Synonyms



Word	Synonyms	Time
US president	Clinton	1993 - 2000
	Bush	2001 - 2008
	Obama	2009 - present

How this information can be used?

- **A query "US president" can be expanded with synonyms (all former presidents) of all the times we know**
  - E.g., "US president" → "US president" **OR** "Clinton" **OR** "Bush" **OR** "Obama"
- **Alternatively, if a query is for a particular time, it can be expanded into its synonyms list as it was at that particular time**
  - E.g., "US president 1997" → "US president" **OR** "Clinton"

Issues for Discussion

Our dataset of the ECDL paper:

- **Manually crawled from the Internet Archive**
- **Web pages of news history from 15 sources, e.g. ABC News, CNN, NewYork Post.**
- **8 years on averaged for each source**
- **~ 9,000 documents (one page in every 5 days)**

1. The lack of proper dataset for evaluating the effect of changing languages
   - ➢ A corpus collection that satisfies two properties:
     1) covering more than ten years period
        - ✓ *the need of a long time-spanned dataset*
     2) evenly spread over time span
        - ✓ *the need of a well-distributed dataset*.
2. No standard test set for evaluating temporal ranking
   - ➢ This issue is critical. What we need are:
     - ✓ A set of sampled queries
     - ✓ Associated documents to each query
     - ✓ Relevance judgments of these documents

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