Information Retrieval & Text Mining

Text Access

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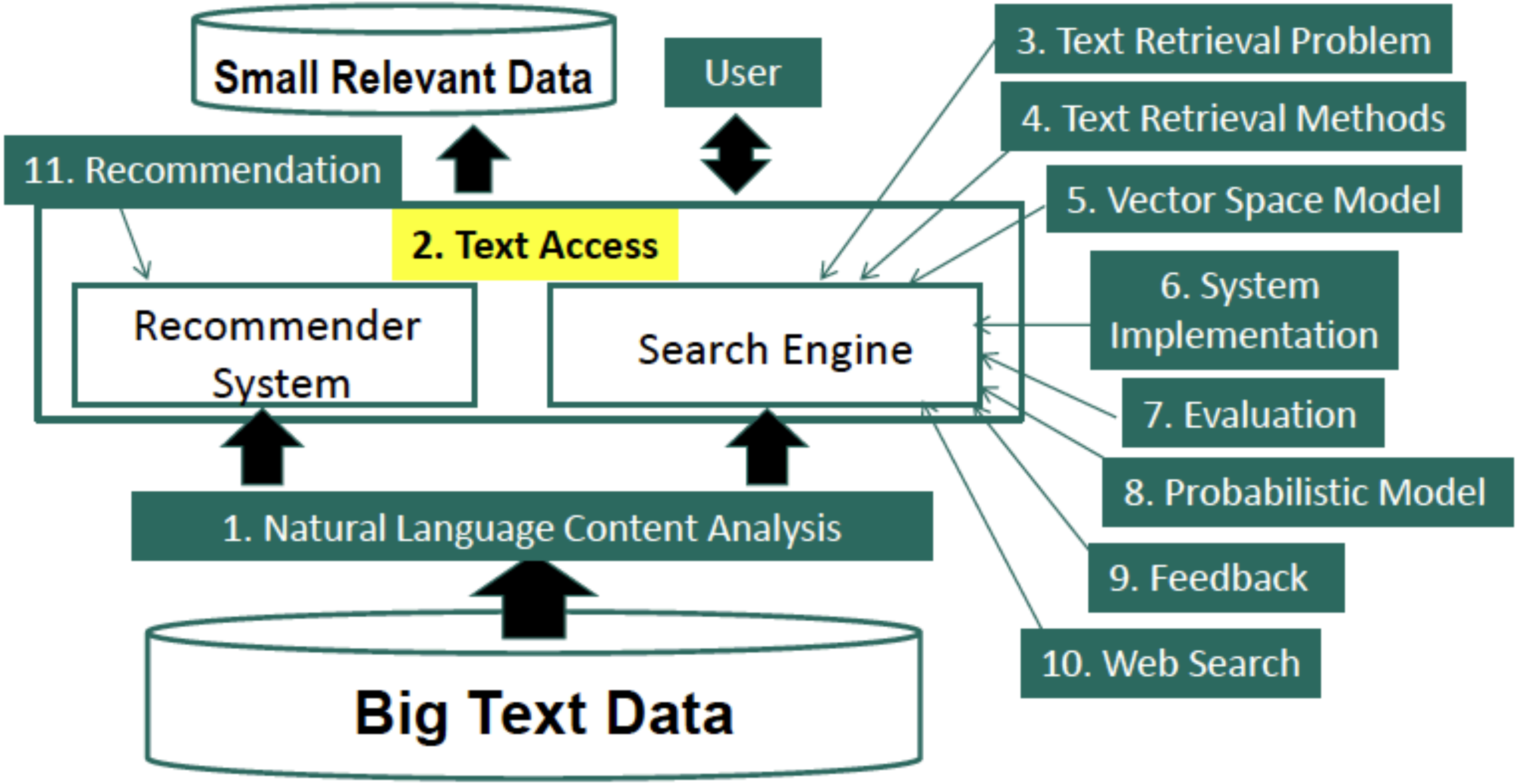
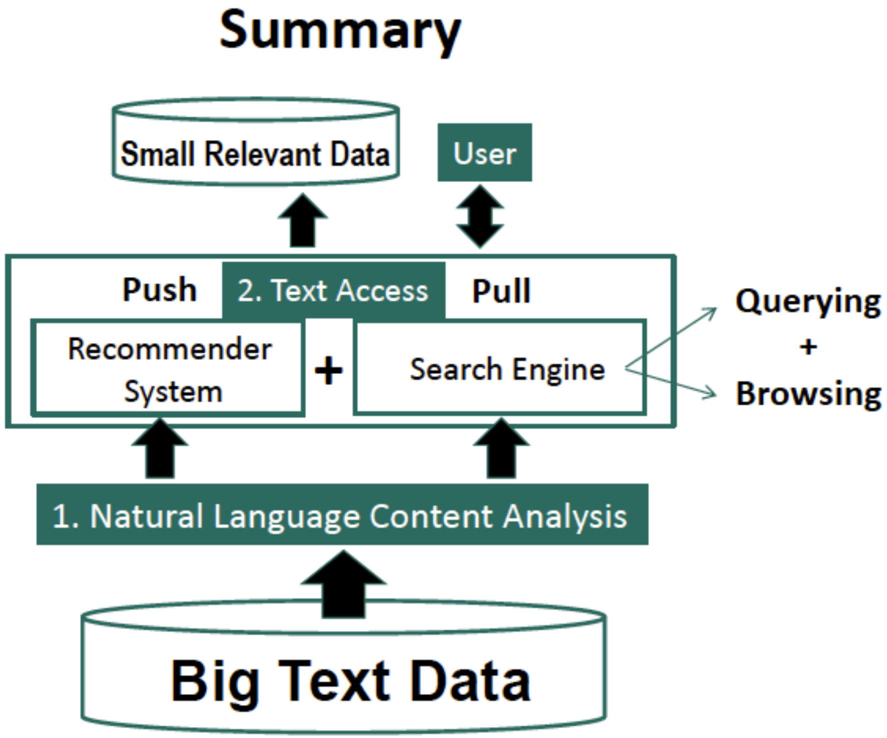
Course Schedule



Access to Relevant Text Data

How can a text information system help users get access to the relevant text data?

- Push vs. Pull
- Querying vs. Browsing



Two Modes of Text Access: Pull vs. Push

Which party takes the initiative??

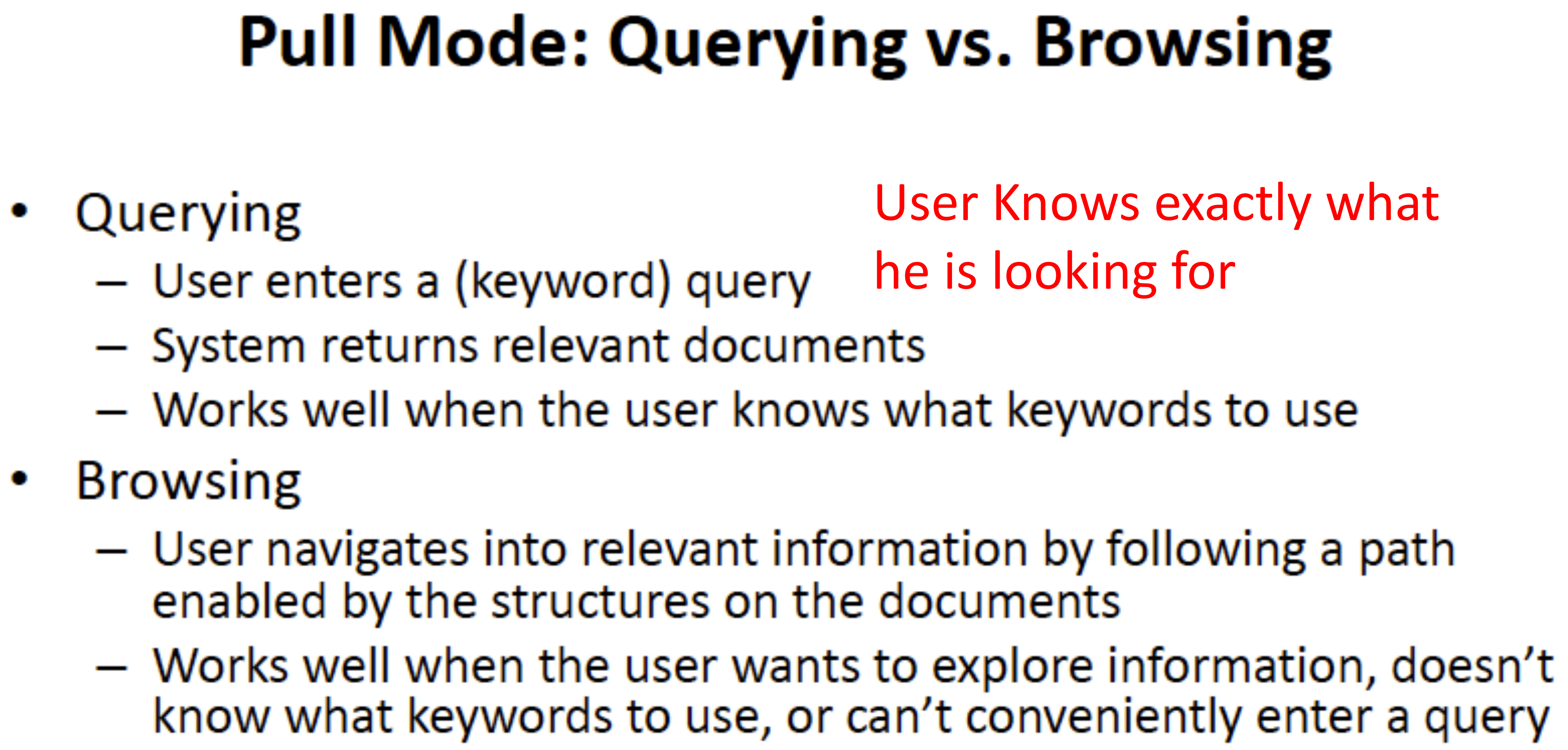
- **Pull** Mode (**search engines**)
  - Users take initiative
  - Ad hoc information need

Temporary Information needs

- **Push** Mode (**recommender systems**)
  - Systems take initiative
  - Stable information need or system has good knowledge about a user's need

Research Interests, Hobbies, News filters, Advertisement

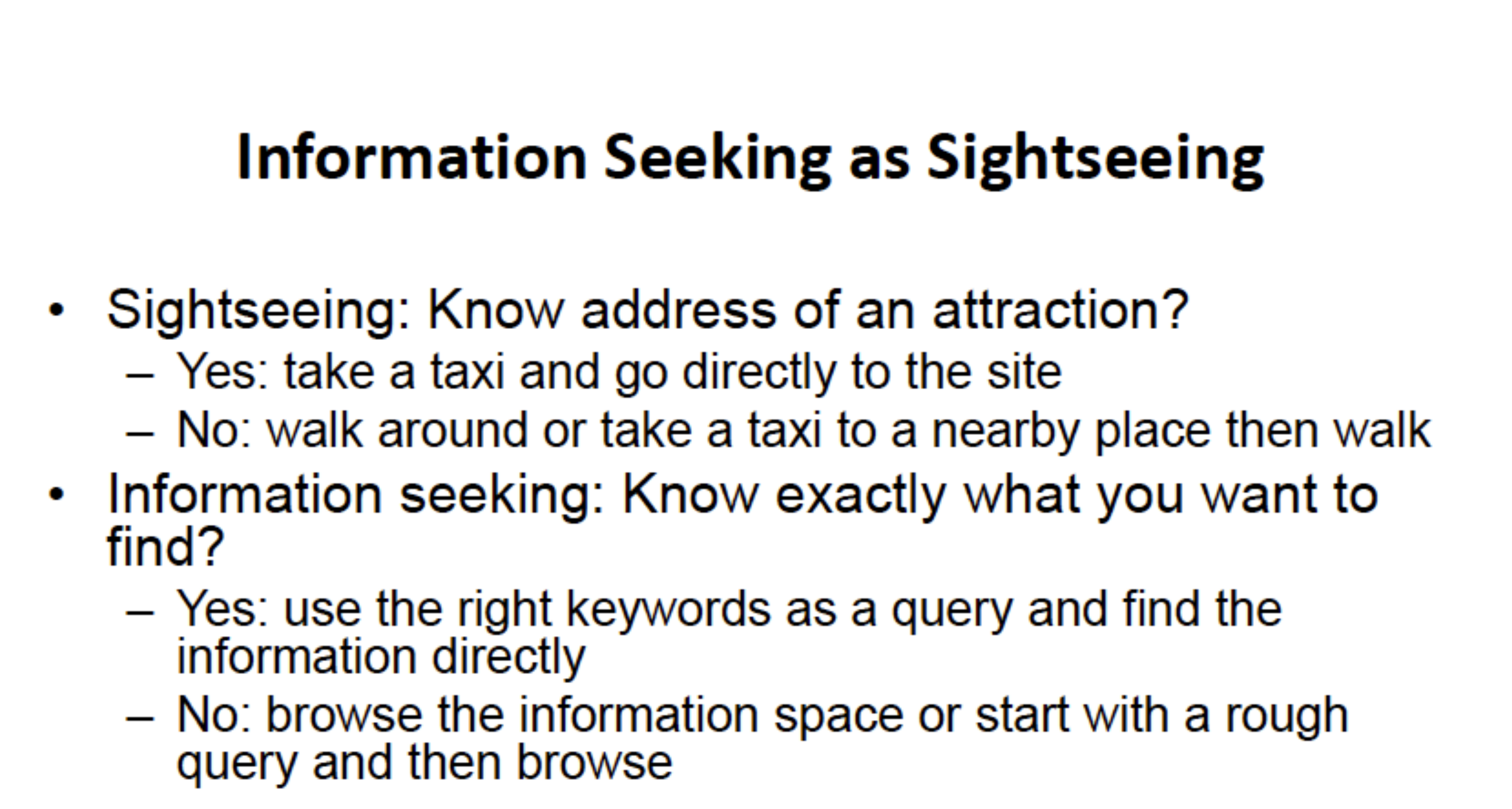
Systems has good knowledge about the user needs.



Pull Mode: Querying vs. Browsing

- Querying
  - User enters a (keyword) query
  - System returns relevant documents
  - Works well when the user knows what keywords to use
- Browsing
  - User navigates into relevant information by following a path enabled by the structures on the documents
  - Works well when the user wants to explore information, doesn't know what keywords to use, or can't conveniently enter a query

User Knows exactly what he is looking for

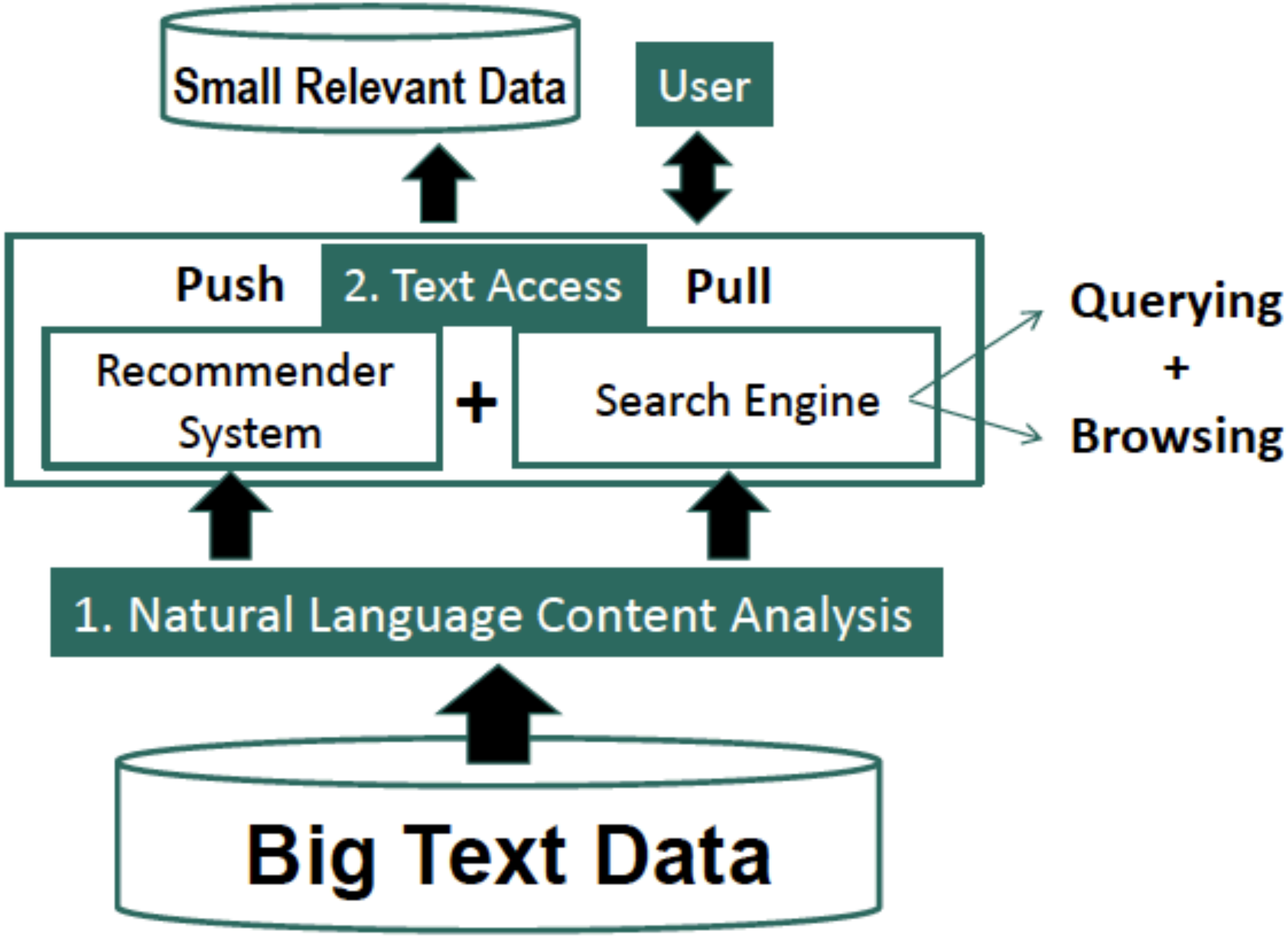


Information Seeking as Sightseeing

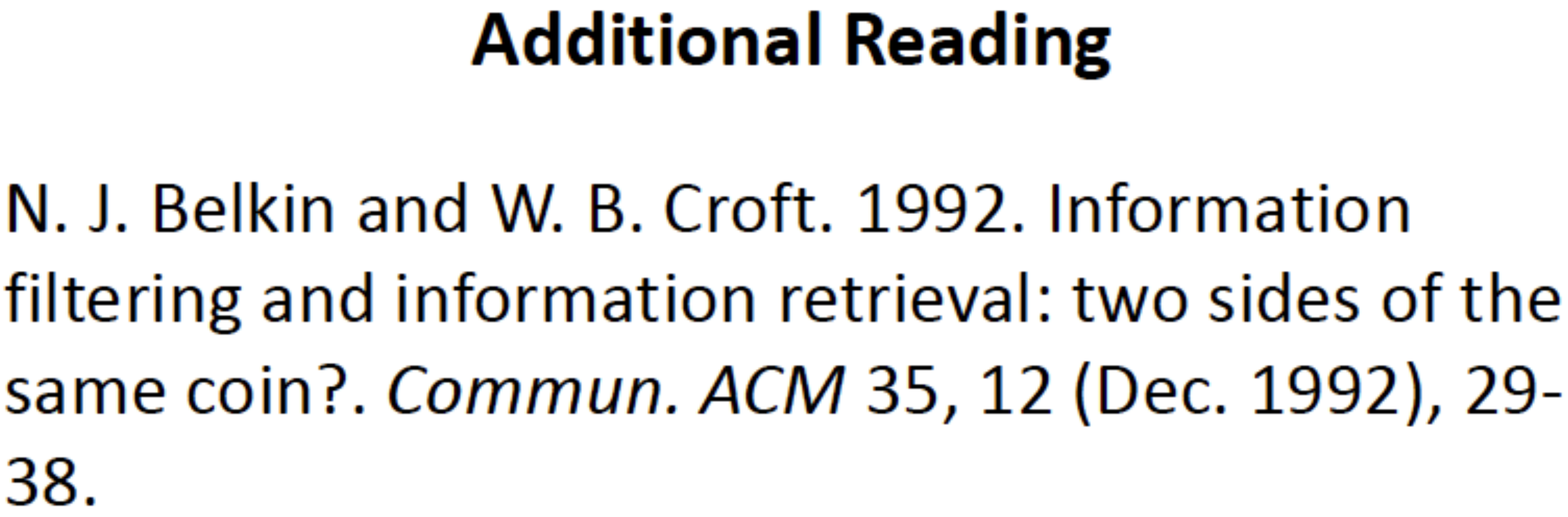
- Sightseeing: Know address of an attraction?
  - Yes: take a taxi and go directly to the site
  - No: walk around or take a taxi to a nearby place then walk
- Information seeking: Know exactly what you want to find?
  - Yes: use the right keywords as a query and find the information directly
  - No: browse the information space or start with a rough query and then browse

Map to walk arround

Summary



Small Relevant Data
User
Push
2. Text Access
Pull
Recommender System
+
Search Engine
Querying
+
Browsing
1. Natural Language Content Analysis
Big Text Data



Additional Reading

N. J. Belkin and W. B. Croft. 1992. Information filtering and information retrieval: two sides of the same coin?. *Commun. ACM* 35, 12 (Dec. 1992), 29-38.

Informational filtering is similar to information recommendation or the push mode of information access.

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Text Retrieval Problem

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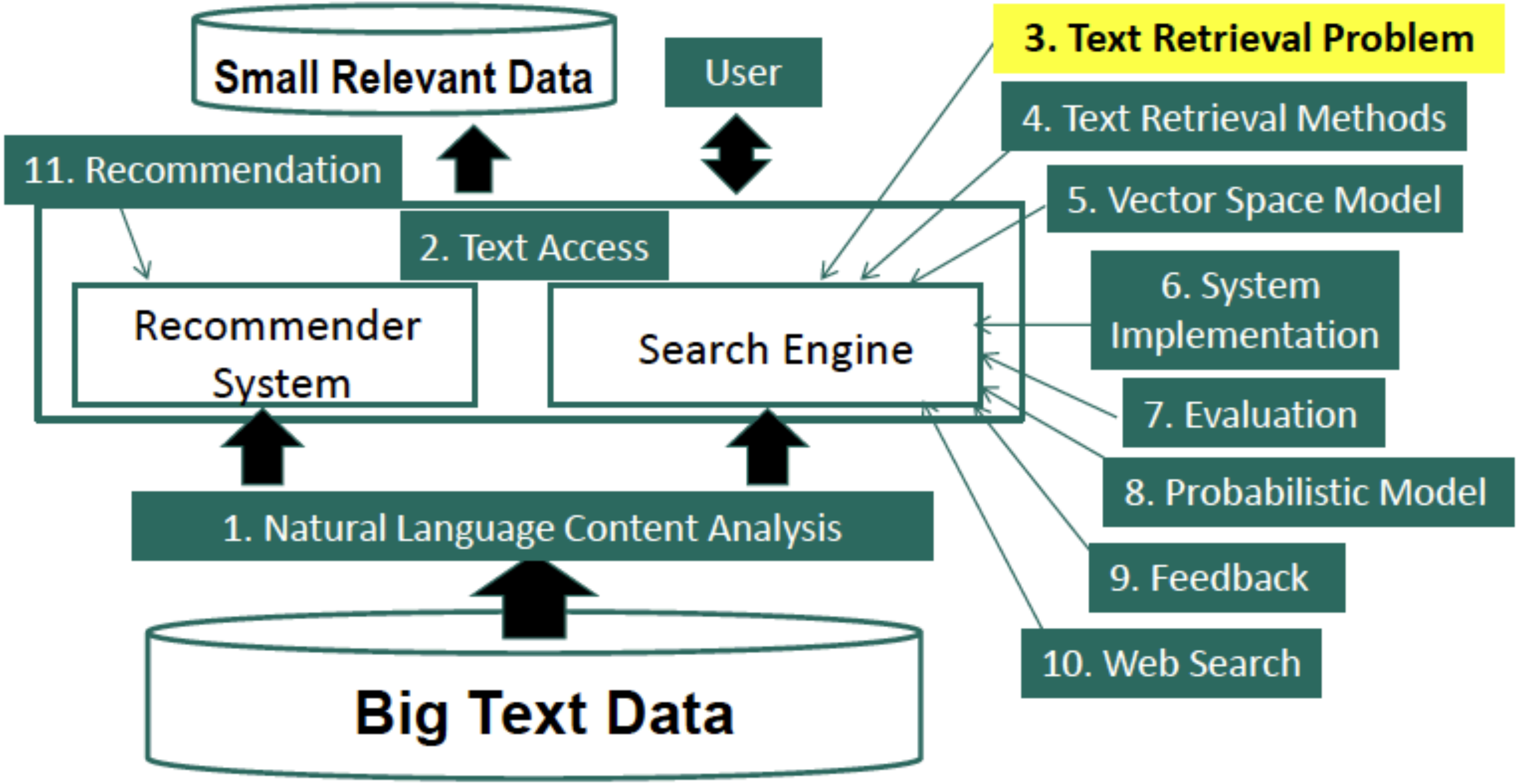


Overview

- What is Text Retrieval?
- Text Retrieval vs. Database Retrieval
- Document Selection vs. Document Ranking

What Is Text Retrieval (TR)?

- Collection of text documents exists

Webpages on the web, or all the literature articles in the digital library. Or maybe all the text files in your computer.

- User gives a query to express the information need
- Search engine system returns relevant documents to users
- Often called “information retrieval” (IR), but IR is actually much broader
- Known as “search technology” in industry

Other mode of information: Audio, Video, images, we match companion text of the data, with the query text

TR vs. Database Retrieval

- Information
  - Unstructured/free text vs. structured data
  - Ambiguous vs. well-defined semantics
- Query
  - Ambiguous vs. well-defined semantics SQL Queries
  - Incomplete vs. complete specification Keyword Queries or NLP Queries
- Answers
  - Relevant documents vs. matched records
- TR is an empirically defined problem
  - Can't mathematically prove one method is better than another
  - Must rely on **empirical evaluation** involving users!

Formal Formulation of TR

- **Vocabulary**: $V=\{w_1, w_2, \ldots, w_N\}$ of language
- **Query**: $q = q_1,\ldots,q_m$, where $q_i \in V$
- **Document**: $d_i = d_{i1},\ldots,d_{im_i}$, where $d_{ij} \in V$
- **Collection**: $C= \{d_1, \ldots, d_M\}$
- **Set of relevant documents**: $R(q) \subseteq C$
  - Generally unknown and user-dependent
  - Query is a “hint” on which doc is in R(q)
- **Task** = compute R’(q), an approximation of R(q)

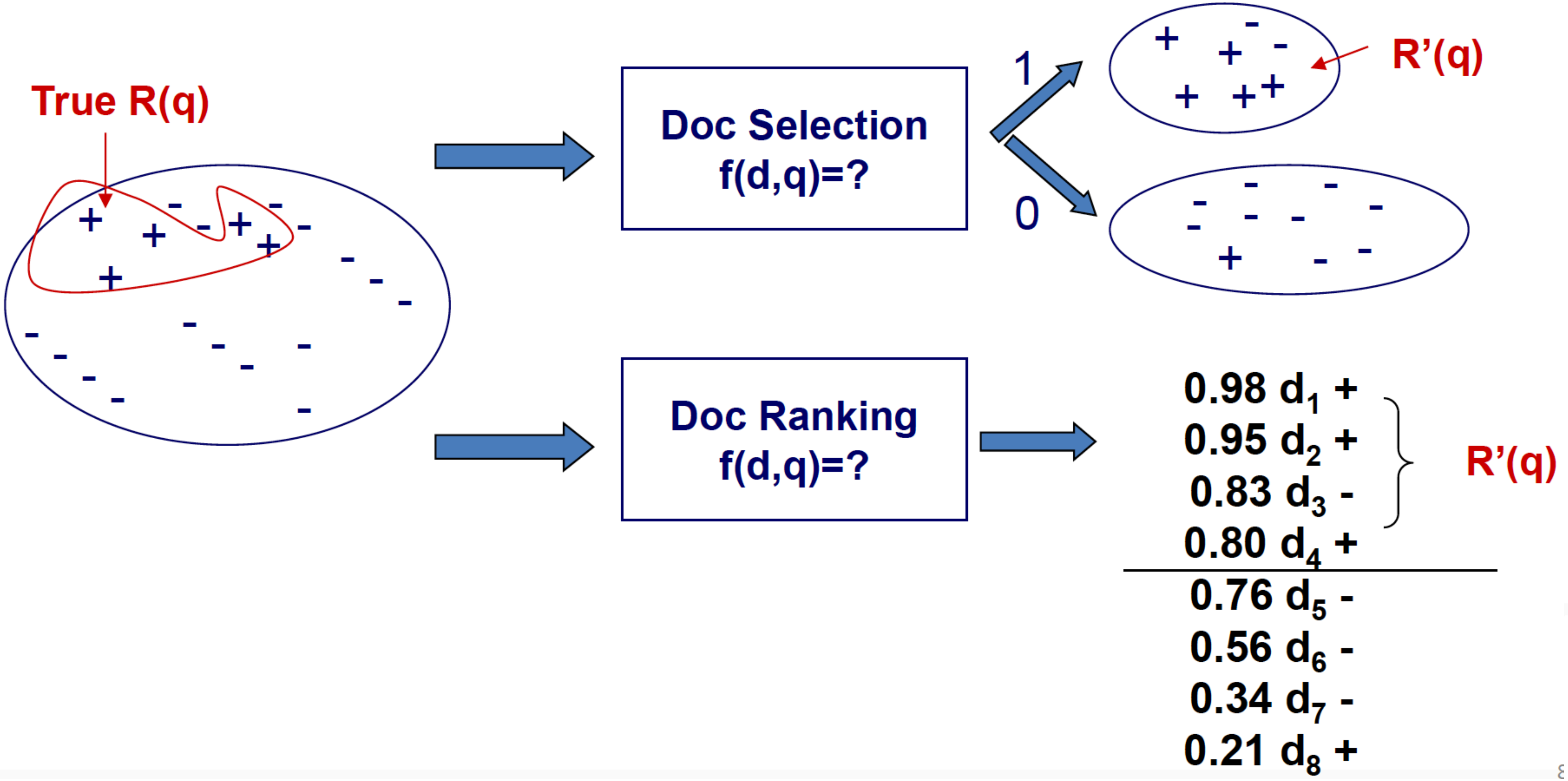
Sometime query is longer than documents, i.e. tweets

The best search system can do is to compute an approximation of this relevant document set.

How to Compute R’(q)

- Strategy 1: Document selection
  - $R'(q)=\{d \in C \mid f(d,q)=1\}$, where $f(d,q) \in \{0,1\}$ is an indicator function or binary classifier
  - System must decide if a doc is relevant or not (**absolute relevance**)
- Strategy 2: Document ranking
  - $R'(q) = \{d \in C \mid f(d,q)>\theta\}$, where $f(d,q) \in \Re$ is a relevance measure function; θ is a cutoff determined by the user
  - System only needs to decide if one doc is more likely relevant than another (**relative relevance**)

Document Selection vs. Ranking



True R(q)

Doc Selection f(d,q)=?

1

0

R'(q)

Doc Ranking f(d,q)=?

0.98 d_1 +

0.95 d_2 +

0.83 d_3 -

0.80 d_4 +

0.76 d_5 -

0.56 d_6 -

0.34 d_7 -

0.21 d_8 +

R'(q)

Problems of Document Selection

- The classifier is unlikely accurate
  - “Over-constrained” query ➔ no relevant documents to return
  - “Under-constrained” query ➔ over delivery
  - Hard to find the right position between these two extremes
- Even if it is accurate, all relevant documents are not equally relevant (relevance is a matter of degree!)
  - Prioritization is needed
- Thus, ranking is generally preferred

Theoretical Justification for Ranking

- **Probability Ranking Principle** [Robertson 77]: Returning a ranked list of documents in descending order of probability that a document is relevant to the query is the optimal strategy under the following two assumptions:
  - The utility of a document (to a user) is **independent** of the utility of any other document
  - A user would browse the results **sequentially**
- Do these two assumptions hold?

Similar Contents of documents, user donot browse sequentially.

Summary

- Text retrieval is an empirically defined problem
  - Which algorithm is better must be judged by users
- Document ranking is generally preferred to
  - Help users prioritize examination of search results
  - Bypass the difficulty in determining absolute relevance (users help decide the cutoff on the ranked list)
- Main challenge: design an effective ranking function **$f(q,d)$ =?**

Additional Readings

- S.E. Robertson, The probability ranking principle in IR. *Journal of Documentation* **33**, 294-304, 1977
- C. J. van Rijsbergen, Information Retrieval, 2nd Edition, Butterworth-Heinemann, Newton, MA, USA, 1979
  - A must-read for anyone doing research in information retrieval. Chapter 6 has an in-depth discussion of PRP.

Additional Material

MeTA: A Unified Toolkit for Text Retrieval and Analysis

https://aclanthology.org/P16-4016/

https://github.com/meta-toolkit/meta/tree/master/src

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