Introduction to Information Retrieval and Boolean Query

Lecture 1

CS 510

Information Retrieval on the Internet

Information retrieval

"Information retrieval (IR) deals with the representation, storage, organization of, and access to information items."

- Baeza-Yates and Berthier Ribeiro-Neto in Modern Information Retrieval, p. 1

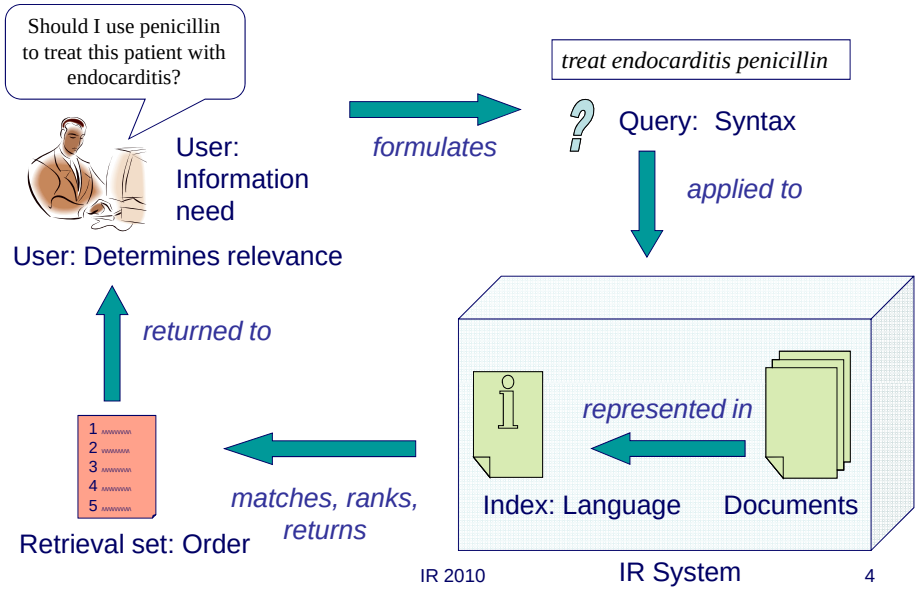
"*Information retrieval* is often regarded as being synonymous with *document retrieval* and, nowadays, with *text retrieval*, implying that the task of an IR system is to retrieve documents or texts with information content that is *relevant* to a user's information *need* ... the approaches that have been developed for this purpose are also applicable to a whole family of related information processing tasks that lie between, on the one hand, *data retrieval* and, on the other, *fact* or *knowledge retrieval*."

- Sparck Jones and Willett in Readings in Information Retrieval, p. 1

Information Retrieval

- History
  - Early work in IR in the 50's and 60's
  - Roots in library science much older, e.g.
    - Dewey Decimal system 1870s
    - Library of Congress Classification 1890s
- Important Components:
  - Indexing
  - Searching
  - User-system interaction

Typical information retrieval (IR) system

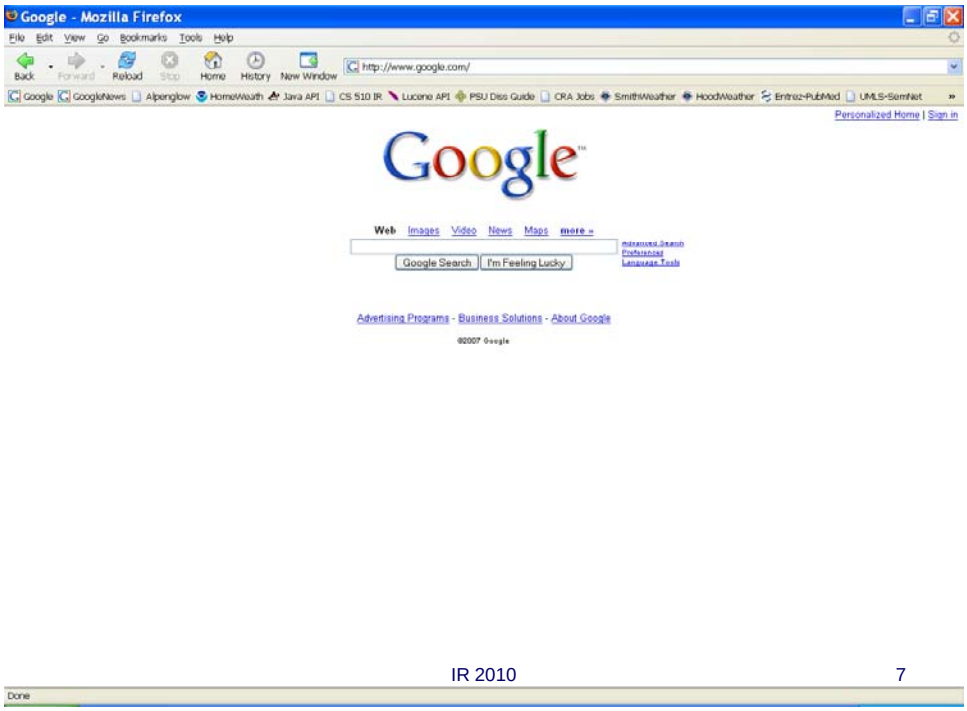


IR systems vs. DBMS

	DBMS	IR System
Target	Data (structured)	Information (text, multimedia)
Query/ Query language	Precise specification SQL	Imprecise specification Controlled vocabulary?
Matching	Exact match	“Similarity”
Results	Set of records	Set or ranked list of documents

General types of IR systems

- Web
- Full text documents
- Bibliographic
- Distributed variations
  - Metasearch
  - Virtual document collections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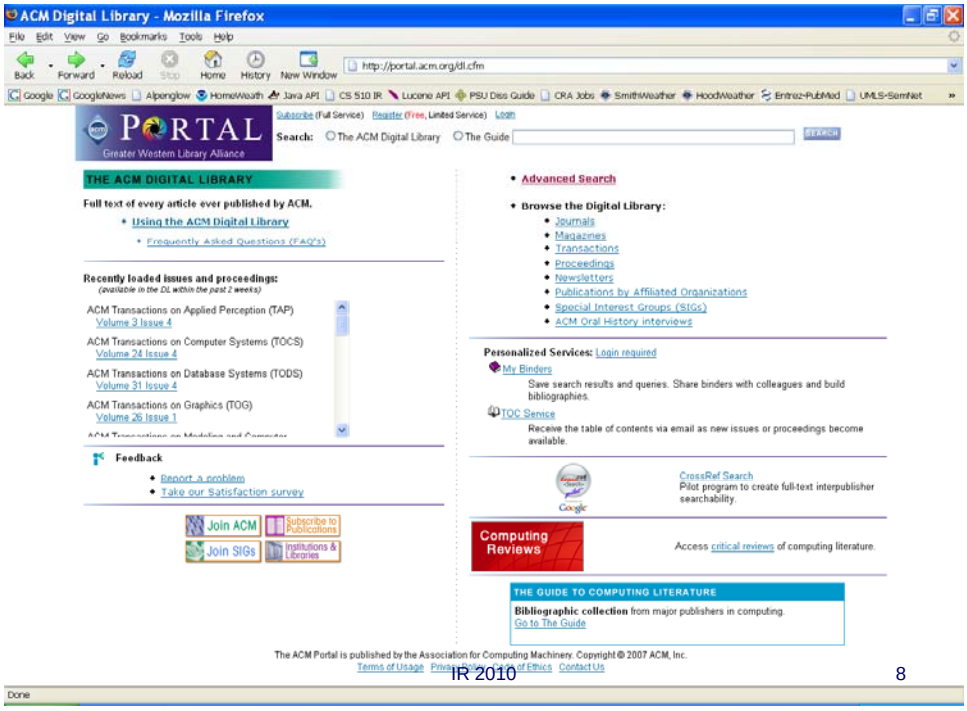
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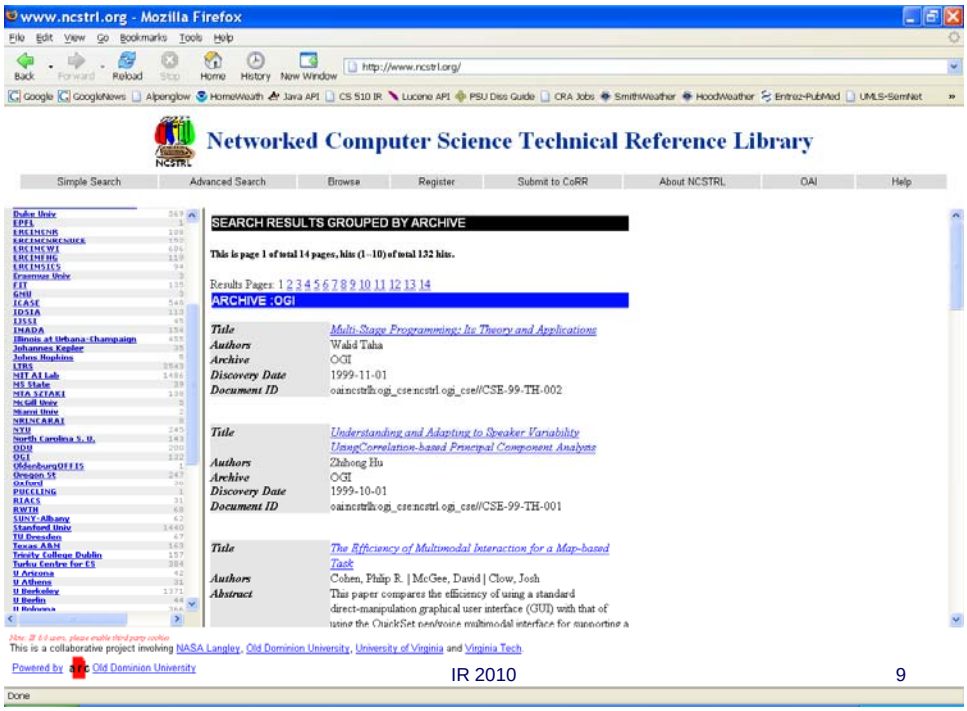
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Zhihong Hu
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Document ID
oaincstrlk:ogi_cse:ncstrl.ogi_cse//CSE-99-TH-001
Title
The Efficiency of Multimodal Interaction for a Map-based Task
Authors
Cohen, Philip R. | McGee, David | Clow, Josh
Abstract
This paper compares the efficiency of using a standard direct-manipulation graphical user interface (GUI) with that of
This is a collaborative project involving NASA Langley, Old Dominion University, University of Virginia and Virginia Tech.
Powered by Old Dominion University
Done


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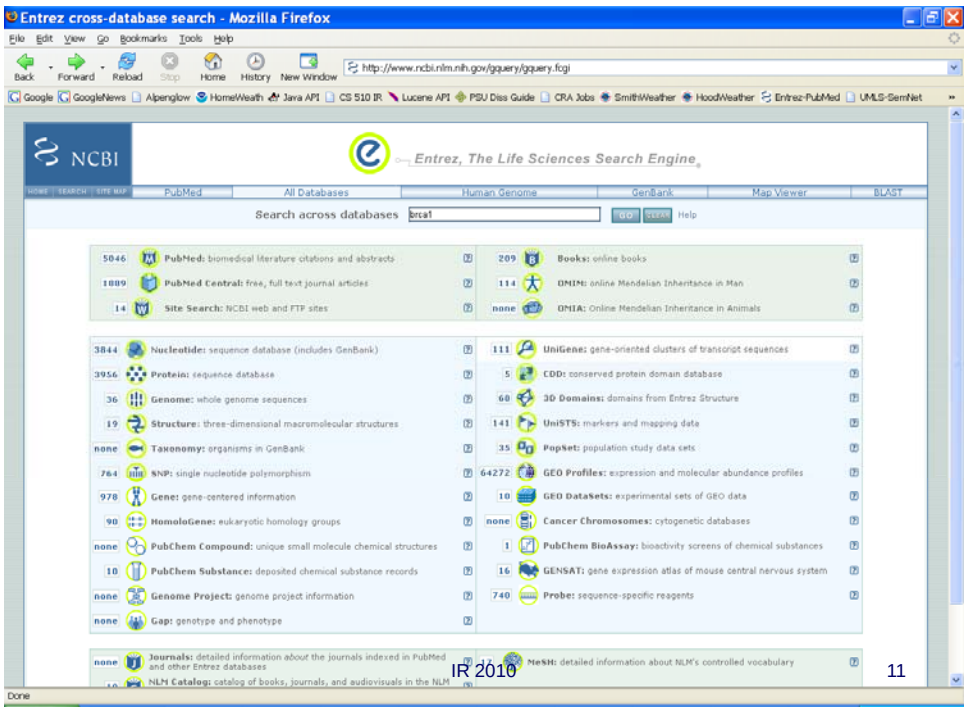


Facets of IR systems: Scope

- Web
- Limited in Focus, Kind or Location
  - PubMed
  - Patents, News Articles
  - Company documents
- Local
  - Files
  - Email

Facets of IR systems: Documents

- Format
  - HTML
  - PDF
  - Word processed
  - Scanned OCR
- Type
  - Text
  - Multimedia
  - Semistructured (XML)
- Dynamic

Facets of IR systems: Engine

- Supported tasks: search, browse
- Basic model: Boolean vs. ranked results
- Indexing language: controlled keywords vs. natural language
- Indexing target: bibliographic data vs. full text
- Search syntax; available operations

Fact of IR Systems: Content vs. Context

- Content only
  Boolean Query – presence or absence of term
- Extended content
  Meta-data, anchor text
- Collection statistics
  Word frequency: “snake” vs. “anaconda”
- Collection structure
  In-links

User Tasks

- Mode
  – Search (retrieve)
  – Browse
- Purpose
  – Overview
  – Question answering/fact finding
  – Comprehensive research
  – Finding known item (document, page, or site)
  – Transaction (e.g. buy a book, download a file)

Document Representation: Logical

- Goal:
  - Represent the content
  - Represent other aspects (sometimes)
- Methods:
  - Assign descriptors (usually selected from a predetermined list)
  - Extract features (usually words or phrases if text document)
  - Descriptors provided by others: taggin

Document Representation: Logical

- History
  - Early systems mostly bibliographic
    - Systems contained brief surrogates for documents
      - Title, author, abstract, location of full document
      - Remember card catalogs??
    - Provided reference to the full document
  - Limited by available storage and processing power
  - Affected the way document content was represented

Document Representation: Logical

- Methods:
  - Manual
    - usually assign terms from a controlled vocabulary
  - Automatic
    - usually extract terms from the document
- Considerations:
  - Size of the representation
  - Improve likelihood of appropriate matching to queries

Document Representation: Logical

Abstract: The objectives of this study were to determine if (1) children with migraine experience greater sleep disturbances than their siblings, (2) those with more severe migraine have greater levels of sleep disruption, and (3) these sleep disturbances lead to greater behavioral problems and more missed school. Children aged 6 to 18 years with a diagnosis of migraine for > 6 months, who had at least one sibling without migraine in the same age range, were identified through our neurology clinic database or at the time of the clinic visit. Parents completed the (1) demographic, general health, and migraine information questionnaire; (2) Child Sleep Habits Questionnaire; and (3) Behavior Assessment System for Children: Second Edition (BASC-2) Parent Rating Scales for each child. Cases with migraine had higher total sleep (P < .02), sleep delay (P < .03), and daytime sleepiness scores (P < .001) than controls. Cases with more severe migraines had higher total sleep (P < .01) and sleep duration scores (P < .03) than those with milder headaches. In cases, higher total sleep...

Assigned Indexing Terms:
Activities of Daily Living
Adolescent
Case-Control Studies
Child
Child Behavior
Disorders/*complications/psychology
Circadian Rhythm/physiology
Female
Humans
Male
Migraine
Disorders/*complications/psychology
Severity of Illness Index
Sleep
Disorders/*complications/psychology
Sleep Stages/physiology
Wakefulness/*physiology

Document Representation: Logical

- Techniques to improve representation
  - Remove stopwords
  - Stemming
  - Exploit document structure (title, subject:)
- Possible text processing steps
  - Determine *what* to index (frames? page title? metadata?)
  - Strip formatting (e.g. html tags, w.p. instr.)
  - Recognize structure
  - Recognize words (or phrases)

Document Representation: Physical

- Associate document identifier with various descriptors
- If descriptors are extracted terms, may also include
  - Frequency of terms
  - Position of terms
- Considerations
  - Efficient storage
  - Representations that can be searched to allow a fast response to user requests

Queries

- User has an information need
- Information need communicated to IR system as a request
- Request encoded in a query expression
- Query expression must be interpretable by the system (query language)
  - Encoded in the interface
  - Terms and operators
  - Pattern syntax

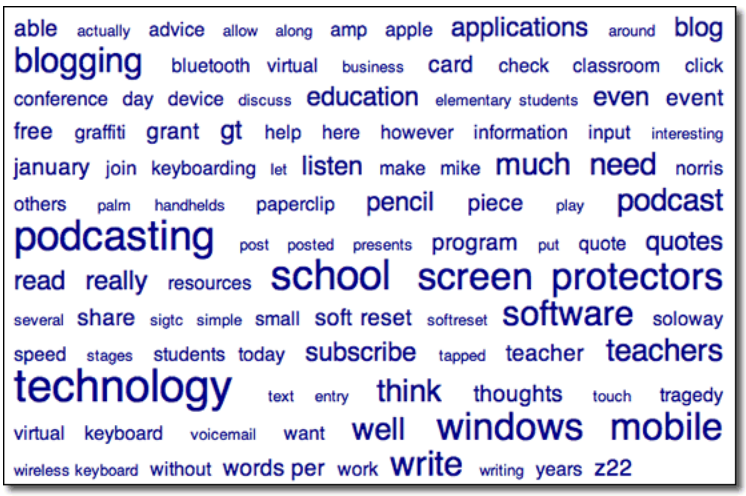
Retrieval

- Match information request representation (query) to document representations (stored in an index)
- Use an algorithm to compute the matching
  - Yes/no match (Boolean expressions)
  - Similarity match
- Order and Organize results
  - Ranked by similarity (or other)
  - Clustered
  - Organized by type (images, news articles)

Unit of Retrieval

- Single page or file
- Site or cluster of documents
- Document fragment
- Summary or important terms (word cloud)
- Structured facts

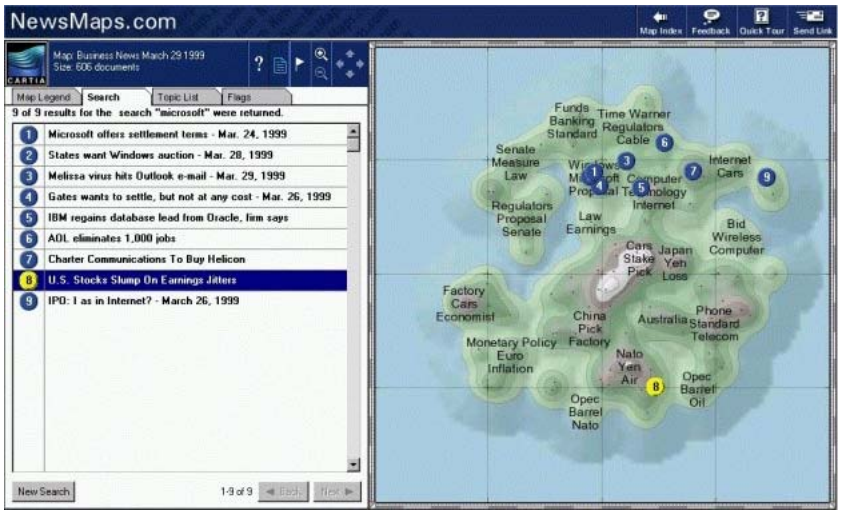
Word Cloud



Other IR Tasks

- Classification
- Clustering
- Synoptic view
- Question answering
- Segmentation
- Summarization
- Information extraction

Themescape



System Issues

- Index organization and construction
- Scaling
- Collection building
- “Publicizing”

Course Organization

http://web.cecs.pdx.edu/~maier/cs510iri/index.htm

Please print off your own lecture notes for subsequent classes

Boolean Search

Example of retrieval process

- Model: Document as set of words
- Query: Boolean combination of words
- Index: Inverted file
- Retrieval: Merging of lists

Boolean Search: Model

Document: Unit of retrieval

Term: Basic constituent of documents and queries

- Words: `snake, cobra, python`
- Stems: `mak-, determin-`
- Phrases: `"garter snake"`
- Special Chars: `1978, s70, help@ask.com`

Document is a set of terms

- `"to be or not to be"` → `{to,be,or,not}`
- Term is in a document or not (not count, not position)

Boolean Search: Query

Terms connected with `AND, OR, NOT`

```
cobra AND python
(cobra OR python) NOT language
```

Could be entered through a form

Get all documents that satisfy condition, none that don't

Boolean Search: Indexing

Inverted file: for each term, as list of documents (IDs) containing the term

- Usually sorted, elements called "postings"

```
cobra: 1,6,7,9,12
python: 1,5,8,9,11,12
language: 2,3,5,7,8,10,13,…
```

Terms organized in a dictionary, pointing to appropriate list

Boolean Search: Retrieval

Union (OR), Intersection(AND), Different (NOT) of lists

```
cobra AND python
   cobra: 1,6,7,9,12
   python: 1,5,8,9,11,12

(cobra OR python) NOT language
   t1 = cobra OR python
   cobra: 1,6,7,9,12
   python: 1,5,8,9,11,12

   t1 NOT language
   language: 2,3,5,7,8,10,13,…
```


Optimization

Look at sizes of lists to decide merge order

```
snake AND cobra AND python
11,345     280       156
```

Rewrite for smaller intermediate results

```
(snake OR language) AND python
 11,345    23,667        156
(snake AND python) OR
 (language AND python)
```

Extensions

Proximity of words

```
python NEAR language
python NEAR(3) language
python /P language
```

(same paragraph)

How can we process such queries?