

CS6200

Information Retrieval

David Smith

College of Computer and Information Science

Northeastern University



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Front matter (incl. table of notations) pdf

03

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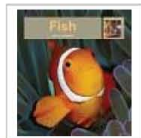
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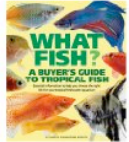



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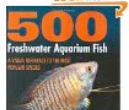
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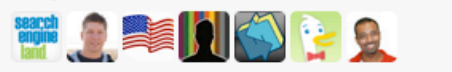
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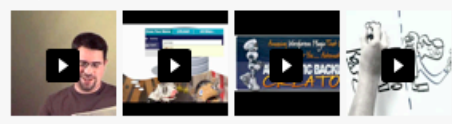
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Abstract We present an analysis of **information retrieval** as an **information-seeking** activity, supporting people's interactions with text. This analysis suggests that some assumptions underlying the standard model of **information retrieval** are inappropriate, and we suggest ...

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Course Goals

- To help you to understand search engines, evaluate and compare them, and modify them for specific applications
- Provide broad coverage of the important issues in information retrieval and search engines
- Books (Kindle editions OK):
 - *Search Engines: Information Retrieval in Practice*
 - Croft, Metzler, and Strohman
 - *Introduction to Information Retrieval*
 - Manning, Raghavan, and Schütze
 - Not required, but readings will be recommended

Topics

- *Overview*
- Architecture of a search engine
- Data acquisition
- Text representation
- Information extraction
- Indexing
- Query processing
- Ranking
- Evaluation
- Classification and clustering
- Social search
- More...

Course Evaluation

- Six assignments (50%)
 - All are worth equal points; lowest-scoring assignment dropped
 - Some require written answers and some short programming exercises.
 - Others involve more extensive programming and a short written report on your design choices and experimental results.
 - You may use any programming language installed on college Linux machines, so we can (compile and) run your code.
 - You may save work by using reasonable libraries that don't simply implement the goal of the assignment
 - E.g., HTTP request libraries are OK; web-crawling libraries are not.
- Two exams
 - Midterm (20%) in class
 - Final (30%)

Late Policy

- Assignments are due at the beginning of class on the announced due date.
- You may take a single homework extension of four calendar days, to be used at your discretion.
- After the first late assignment, unexcused late assignments will be penalized 10% per calendar day late. We normally will not accept assignments after the date on which the following assignment is due or after the solutions have been handed out, whichever comes first.
- If you are in circumstances that would cause you to turn in an assignment late, please contact me *in advance* to ask for an extension for cause.

Academic Honesty

- All work submitted for credit must be your own.
- You may discuss the assignments with your classmates, the TA, and the instructor. You must acknowledge the people with whom you discussed your work, and you must write up your own solutions.
- Any written sources used (apart from the text) must also be acknowledged; however, you may not consult any solutions from previous years' assignments whether they are student or faculty generated.

Contact

- Me
 - Office hours: Thursdays 3–5, Room 356
 - dasmith@ccs.neu.edu
- TAs
 - TBA
- Course website and Piazza list
 - <http://www.ccs.neu.edu/course/cs6200f15/>

Information Retrieval

- *“Information retrieval is a field concerned with the structure, analysis, organization, storage, searching, and retrieval of information.”* (Salton, 1968)
 - General definition that can be applied to many types of information and search applications
 - Primary focus of IR since the 50s has been on *text* and *documents*

What is a Document?

- Examples:
 - web pages, email, books, news stories, scholarly papers, text messages, tweets, MS Office, PDF, Facebook pages, blogs, forum postings, IM sessions, etc.
- Common properties
 - text content
 - some structure (e.g., title, author, date for papers; subject, sender, destination for email)

Documents vs. Database Records

- Database records (or *tuples* in relational databases) are typically made up of well-defined fields (or *attributes*)
 - e.g., bank records with account numbers, balances, names, addresses, social security numbers, dates of birth, etc.
- Easy to compare fields with well-defined semantics to queries in order to find matches
- Text is more difficult

Documents vs. Records

- Example bank database query
 - *Find records with balance > \$50,000 in branches located in Somerville, MA.*
 - Matches easily found by comparison with field values of records
- Example search engine query
 - *bank scandals in western mass*
 - This text must be compared to the text of entire news stories

Comparing Text

- Comparing the query text to the document text and determining what is a good match is the core issue of information retrieval
- Exact matching of words is not enough
 - Many different ways to write the same thing in a “natural language” like English
 - e.g., does a news story containing the text “*bank director in Amherst steals funds*” match the query?
 - Some stories will be better matches than others

Dimensions of IR

- IR is more than just text, and more than just web search
 - although these are central
- People doing IR work with different media, different types of search applications, and different tasks

Dimensions of IR

Content	Applications	Tasks
Text	Web search	Ad hoc search
Images	Vertical search	Filtering
Video	Enterprise search	Classification
Scanned docs	Desktop search	Question answering
Audio	Forum search	Summarization
Music	P2P search	
	Literature search	

Big Issues in IR

- Relevance
 - What is it?
 - Simple (and simplistic) definition: A relevant document contains the information that a person was looking for when they submitted a query to the search engine
 - Many factors influence users' decision about what is relevant: e.g., task, context, novelty, style, other documents they've already read
 - *Topical relevance* (same topic) vs. *user relevance* (everything else)

Big Issues in IR

- Relevance
 - *Retrieval models* define a view of relevance
 - *Ranking algorithms* used in search engines are based on retrieval models
 - Most models based on statistical properties of text rather than deep linguistic analysis
 - i.e., counting simple text features such as words instead of parsing and analyzing the sentences

Big Issues in IR

- Evaluation
 - Experimental procedures and measures for comparing system output with user expectations
 - IR evaluation methods now used in many fields
 - e.g. Netflix competition
 - Typically use *test collection* of documents, queries, and relevance judgments
 - Most commonly used are TREC collections
 - *Recall* and *precision* are two examples of effectiveness measures

Big Issues in IR

- Users and Information Needs
 - Search evaluation is user-centered
 - Keyword queries are often poor descriptions of actual information needs
 - Interaction and context are important for understanding user intent
 - Query refinement techniques such as *query expansion*, *query suggestion*, *relevance feedback* improve ranking

IR and Search Engines

- A search engine is the practical application of information retrieval techniques to large scale text collections
- Web search engines are best-known examples, but many others
 - *Open source* search engines are important for research and development
 - e.g., Lucene, Lemur/Indri, Galago
- Big issues include main IR issues but also some others

IR and Search Engines

Information Retrieval

Relevance

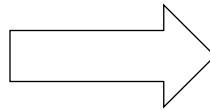
-Effective ranking

Evaluation

-Testing and measuring

Information needs

-User interaction



Search Engines

Performance

-Efficient search and indexing

Incorporating new data

-Coverage and freshness

Scalability

-Growing with data and users

Adaptability

-Tuning for applications

Specific problems

-e.g. Spam

Search Engine Issues

- Performance
 - Measuring and improving the efficiency of search
 - e.g., reducing *response time*, increasing *query throughput*, increasing *indexing speed*
 - *Indexes* are data structures designed to improve search efficiency
 - designing and implementing them are major issues for search engines

Search Engine Issues

- Dynamic data
 - The “collection” for most real applications is constantly changing in terms of updates, additions, deletions
 - e.g., web pages
 - Acquiring or “crawling” the documents is a major task
 - Typical measures are *coverage* (how much has been indexed) and *freshness* (how recently was it indexed)
 - Updating the indexes while processing queries is also a design issue

Search Engine Issues

- Scalability
 - Making everything work with millions of users every day, and many terabytes of documents
 - Distributed processing is essential
- Adaptability
 - Changing and tuning search engine components such as ranking algorithm, indexing strategy, interface for different applications

Search Engine Issues

- Spam
 - For web search, spam in all its forms is one of the major issues
 - Affects the efficiency of search engines and, more seriously, the effectiveness of the results
 - Proliferation of spam varieties
 - e.g. spamdexing or term spam, link spam, “search engine optimization”
 - New subfield called *adversarial IR*, since spammers are “adversaries” with different goals

Topics

- Overview
- *Architecture of a search engine*
- For background, read chapters 1 and 2 of *Search Engines* by Croft, Metzler, and Strohman