Introductions

• Hello, my name is ______.
• However, I’d rather be called ______. (optional)
• I’m in the ______ program.
• I’m taking this course because I’d like to learn about ______.
What is Information Retrieval?

- Information retrieval (IR) is the science and practice of matching information seekers with the information they seek.
What is Information Retrieval?

• This course mainly focuses on search engines
• Given a query and a corpus, find relevant items
  
  query: a user’s expression of their information need
  corpus: a repository of retrievable items
  relevance: satisfaction of the user’s information need
What is Information Retrieval?

- Gerard Salton, 1968:

  Information retrieval is a field concerned with the structure, analysis, organization, storage, and retrieval of information.
Gerard Salton

From Wikipedia, the free encyclopedia

Gerard Salton (8 March 1927 in Nuremberg - 28 August 1995), also known as Gerry Salton, was a Professor of Computer Science at Cornell University. Salton was perhaps the leading computer scientist working in the field of information retrieval during his time. His group at Cornell developed the SMART Information Retrieval System, which he initiated when he was at Harvard.

Salton was born Gerhard Anton Sahlimann on March 8, 1927 in Nuremberg, Germany. He received a Bachelor's (1950) and Master's (1952) degree in mathematics from Brooklyn College, and a Ph.D. from Harvard in Applied Mathematics in 1958, the last of Howard Aiken's doctoral students, and taught there until 1965, when he joined Cornell University and co-founded its department of Computer Science.

Salton was perhaps most well known for developing the now widely used Vector Space Model for Information Retrieval[1]. In this model, both documents and queries are represented as vectors of term counts, and the similarity between a document and a query is given by the cosine between the term vector and the document vector. In this paper, he also introduced TF-IDF, or term-frequency-inverse-document frequency, a model in which the score of a term in the a document is the ratio of the number of terms in that document divided by the frequency of the number of documents in which that term occurs. (The concept of inverse document frequency, a measure of specificity, had been introduced in 1972 by Karen Sparck-Jones[2].) Later in life, he became interested in automatic text summarization and analysis[3], as well as automatic hypertext generation[4]. He published over 150 research articles and 5 books during his life.

Salton was editor-in-chief of the Communications of the ACM and the Journal of the ACM, and chaired SIGIR. He was an associate editor of the ACM Transactions on Information Systems. He was an ACM Fellow (elected 1995), received an Award of Merit from the American Society for Information Science (1989), and was the first recipient of the SIGIR Award for outstanding contributions to study of information retrieval (1983) -- now called the Gerard Salton Award.

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but, the main content of the page is in the form of natural language text, which has little structure that a computer can understand.
but, the main content of the page is in the form of natural language text, which has little structure that a computer can understand.

As it turns out, it’s not necessary for a computer to understand natural language text for it to determine that this document is likely to be relevant to a particular query (e.g., “Gerard Salton”)

Gerard Salton (8 March 1927 in Nuremberg - 28 August 1995), also known as Gerry Salton, was a Professor of Information Retrieval at the University of Cambridge. He was a pioneer in information retrieval and text processing, and is best known for his work on the SMART information retrieval system. He received a Bachelor's (1950) and Master's (1952) degree in Applied Mathematics in Cambridge and Cornell University and received his PhD (1956) in the same field in Cambridge and then joined the Cambridge University Library in 1955. He later was a professor at the University of Wisconsin-Madison, University of Michigan, and American University [1].

References

Information Retrieval

collection structure
Information Retrieval
analysis: classification

Gerard Salton

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References


Categories: 1927 births | 1995 deaths | American computer scientists | Computer pioneers | Harvard University alumni | Harvard University faculty | Cornell University faculty | Fellows of the Association for Computing Machinery | Guggenheim Fellows
Information Retrieval
organization: cataloguing

http://www.dmoz.org
Information Retrieval
organization: cataloguing

http://www.dmoz.org
Information Retrieval
analysis and organization: reading-level

- **Blue** - Wikipedia, the free encyclopedia
  - [en.wikipedia.org/wiki/Blue](en.wikipedia.org/wiki/Blue) - Cached
  - Blue is a color, the perception of which is evoked by light having a spectrum dominated by energy with a wavelength of roughly 440–490 nm. ...

- Images for blues clues - Report images

- Researching Blue’s Clues: Viewing behavior and impact
  - [www.cmch.tv/research/fullrecord.asp?id=1773](www.cmch.tv/research/fullrecord.asp?id=1773) - Cached

- Do children learn how to watch television? The impact of extensive ...
  - [www.cmch.tv/research/fullrecord.asp?id=1932](www.cmch.tv/research/fullrecord.asp?id=1932) - Cached
  - The impact of extensive experience with Blues Clues on preschool children’s ...
Information Retrieval
organization: recommendations

http://www.yelp.com/biz/cosmic-cantina-chapel-hill
(not actual page)
How might a web search engine view these pages differently in terms of storage?
Information Retrieval

Efficiency: retrieving results in this lifetime (or, better yet, in 0.18 seconds)

Effectiveness: retrieving results that satisfy the user’s information need (more on this later)

We will focus more on effectiveness

However, we will also discuss in some detail how search engines retrieve results as fast as they do
Information Retrieval
retrieval effectiveness
Many Types of Search Engines
Many Types of Search Engines
The Search Task

- Given a **query** and a **corpus**, find **relevant** items
  
  **query**: user’s expression of their information need  
  **corpus**: a repository of retrievable items  
  **relevance**: satisfaction of the user’s information need
Search Engines
web search

query

facebook and productivity

results

corpus

web pages
Search Engines

digital library search

query

results

1. Effective teaching practices using free Google services: conference tutorial
   Paul Gestwicki, Brian McNulty
   October 2010 Journal of Computing Sciences in Colleges, Volume 26 Issue 1
   Publisher: Consortium for Computing Sciences in Colleges
   Full text available: PDF (22.76 KB)
   Bibliometrics: Downloads (6 Weeks): 2, Downloads (12 Months): 48, Downloads (Overall): 48,
   In this 90-minute tutorial, we will share our experiences using free Web services from Google,
   teaching effectiveness. Participants will engage with these services as part of the tutorial. We have used and studied
   these technologies, ...

2. Model-Based Engineering of Software: Three Productivity Perspectives
   Shawn A. Bohner, Sriram Mohan
   Publisher: IEEE Computer Society
   Full text available: Publisher Site
   Bibliometrics: Downloads (6 Weeks): n/a, Downloads (12 Months): n/a, Downloads (Overall): n/a, Citation Count: 0
   Evolving software products is a tricky business, especially when the domain is complex and changing rapidly. Like
   other fields of engineering, software engineering productivity advances have come about largely through abstraction
   reuse, process, and...
   Keywords: Agent-Based Software Systems, Model-Driven Architecture, Model-Driven Development, Model-Based
   Software Development, Model-Based Software Engineering

   Michael Miller
   Publisher: Que Publishing Company
   Bibliometrics: Downloads (6 Weeks): n/a, Downloads (12 Months): n/a, Downloads (Overall): n/a, Citation Count: 0
   Everything casual users need to know to get the most out of their new Windows 7 PCs, software, and the Internet
   The best-selling beginner's guide, now completely updated for Windows 7 and today's most popular Internet tools -
Search Engines

news search

query

emily

results

Tropical Storm Emily Heads Toward Haiti, Dominican Republic
Voice of America - 23 minutes ago
August 03, 2011 Tropical Storm Emily Heads Toward Haiti, Dominican Republic VOA News Tropical storm warnings and watches are posted for parts of the ...

Video: Tropical Storm Emily on Path Toward Haiti The Associated Press
LOCAL: Emily could reach hurricane strength Samoa's Herald-Tribune (blog)
Blog: Muharrik Trias Begins: Tropical Storm Emily Threatens East Coast NPR (blog)
The Guardian - Fox News
11804 news articles »

Emily Heads For Hispaniola
WAVY-TV (blog) - Jimmy Wheeler - 2 hours ago
Emily has had little change in strength since yesterday. She has winds of 50mph. The pressure is down a little to 1003 mb (millibars of pressure). ...

Tropical Storm Emily remains weak, hits Haiti tonight Examiner.com
August 2, 2011 Midday Tropics Update: T3 Emily Now Moving More ... Wikulla.com
Emily the Eliforsete Caribbean Hurricane Network
all 4 news articles »

'Snow White' Writer to Pen Universal's 'Emily the Strange' (Exclusive)
Hollywood Reporter - Boys Kit - 13 hours ago
Melissa Wallack, who wrote the script that became Relativity's high-profile Snow White project, has been drafted by Universal to pen Emily the Strange. ...

Early Edition: Emily the Strange to Darken Big Screen Vorce News Moviefone (blog)
Writer Melissa Wallack Will Follow SNOW WHITE WITH EMILY THE STRANGE Collider.com
Details on the upcoming 'Emily the Strange' movie Examiner.com
ComingSoon.net - 411mania.com
all 7 news articles »

High heat in Midwest and South
Reuters - Tim Sharp - Kevin Murphy - 22 hours ago
By Wendell Marsh WASHINGTON (Reuters) - Record-breaking heat continued to broil central and southern states on Tuesday as Tropical Storm Emily threatened to ...
Search Engines
local business search

query

```
mexican food
```

results

Places for mexican food near Chapel Hill, NC
- Bandido's Mexican Cafe & Cantina - 4.0 stars - 14 reviews - Place page
  www.bandidoscafe.com - 159 1/2 East Franklin Street, Chapel Hill - (919) 967-5048
- Las Potrillos Mexican Restaurant - 4.0 stars - 9 reviews - Place page
  www.laspotrillos.net - 220 West Rosemary Street, Chapel Hill - (919) 932-4301
- Monterey Mexican Restaurant - 4.0 stars - 17 reviews - Place page
  monterreycafechapelhill.com - 237 South Elliott Road, Chapel Hill - (919) 969-8750
- Margaret's Cantina - 4.0 stars - 19 reviews - Place page
  www.margaretscantina.com - 1129 Weaver Dairy Road, Chapel Hill - (919) 942-4745
- Qdoba Mexican Grill - 3.5 stars - 19 reviews - Place page
  www.qdoba.com - 100 West Franklin Street, Chapel Hill - (919) 929-8998
- Cinco de Mayo - 3.5 stars - 11 reviews - Place page
  www.cincodemayorestaurants.net - 1502 East Franklin Street, Chapel Hill - (919) 929-6566
- Chipotle Mexican Grill - 4.0 stars - 15 reviews - Place page
  www.chipotle.com - 301 W. Franklin St., Chapel Hill - (919) 942-2091

Google maps
corpus
curated/synthesized business listings
Search Engines
desktop search

query

results

corpus

files in my laptop
Search Engines
micro-blog search

query

twitter and productivity

results

neenjames Neen James
Productivity tip: Follow ppl on Twitter that inspire, challenge and inform you - delete the clutter!
4 minutes ago

mr_Ostentatious Jason Pitts
Took a day off from twitter to increase my productivity and ended up having a productive day!
1 hour ago

adamwiebe Adam Wiebe
Social media at work is here. Be wary of what is and is not productive. http://lnkd.in/DW3z8J
3 hours ago

ViggosDaddy Gert van der Linde
A brief look: To tweet, or not to tweet? - How does Twitter affect our productivity, influence and how informe... http://tinyurl.com/3wbz3rn
6 hours ago

IncorrectMystic Raghavender | raGz
#productivity day - So going be off twitter and other social networks till work is over :) bye tweeples for a while
6 hours ago

corpus

tweets
Search Engines
people/profile search

query

michael jordan

results

Michael Jordan
Page
12,856,455 people like this.

Michael Jordan
Carnegie Mellon

Michael Jordan
1 mutual friend

Michael Jordan
Page
215,268 people like this.

Michael Jordan
Page
225,371 people like this.

MICHAEL JORDAN
Page
190,013 people like this.

Michael Jordan
Page
58,003 people like this.

corpus

profiles
Information Retrieval Tasks and Applications

digital library search
desktop search
web search
question-answering
enterprise search
federated search
news search
social search
local business search
expert search
image search
product search
video search
patent search
(micro-)blog search
recommender systems
community Q&A search
opinion mining
The Search Task

- Given a query and a corpus, find relevant items
  query: user’s expression of their information need
  corpus: a repository of retrievable items
  relevance: satisfaction of the user’s information need
The Search Task in this course

• Given a query and a corpus, find relevant items

**query**: user’s expression of their information need
  ‣ a textual description of what the user wants

**corpus**: a repository of retrievable items
  ‣ a collection of *textual* documents

**relevance**: satisfaction of the user’s information need
  ‣ the document contains information the user wants
Why is IR fascinating?

• Information retrieval is an uncertain process
  ‣ users don’t know what they want
  ‣ users don’t know how to convey what they want
  ‣ computers can’t elicit information like a librarian
  ‣ computers can’t understand natural language text
  ‣ the search engine can only guess what is relevant
  ‣ the search engine can only guess if a user is satisfied
  ‣ over time, we can only guess how users adjust their short- and long-term behavior
Queries and Relevance

‣ soft surroundings
‣ trains interlocking dog sheets
‣ belly dancing music
‣ christian dior large bag
‣ best western airport sea tac
‣ www.bajawedding.com
‣ marie selby botanical gardens
‣ big chill down coats
‣ www.magichat.co.uk
‣ marie selby botanical gardens

‣ broadstone raquet club
‣ seadoo utopia
‣ seasons white plains condo
‣ priority club.com
‣ aircat tools
‣ epicurus evil
‣ instructions
‣ hinds county city of jackson
‣ last searches on aol a to z
‣ riverbank run

(AOL query-log)
AOL apologizes for release of user search data

By Dawn Kawamoto and Elinor Mills
Staff Writers, CNET News
Last modified: August 7, 2006 2:30 PM PDT

AOL apologized on Monday for releasing search log data on subscribers that had been intended for use with the company’s newly launched research site.

The randomly selected data, which focused on 658,000 subscribers and posted 10 days ago, was among the tools intended for use on the recently launched AOL Research site. But the Internet giant has since removed the search logs from public view.

"This was a screw-up, and we're angry and upset about it. It was an innocent enough attempt to reach out to the academic community with new research tools, but it was obviously not appropriately vetted, and if it had been, it would have been stopped in an instant," AOL, a unit of Time Warner, said in a statement. "Although there was no personally identifiable data linked to these accounts, we're absolutely not defending this. It was a mistake, and we apologize. We've launched an internal investigation into what happened, and we are taking steps to ensure that this type of thing never happens again."

Although AOL had used identification numbers rather than names or user IDs when listing the search logs, that did not quell concerns of privacy advocates, who said that anyone among the 658,000 could easily be identified based on the searches each individual conducted.

"We think it's a major privacy concern, and we're glad to see AOL is taking it seriously," said Ari Schwartz, deputy director of the Center for Democracy and Technology. "Companies that deal in search results have to understand that they carry very sensitive information, even if it doesn't have what we would traditionally consider to be personally identifiable information involved."
Queries and Relevance

- A query is an impoverished description of the user’s information need
- Highly ambiguous to anyone other than the user
Queries and Relevance

the input to the system

- Query 435: curbing population growth

what is in the user’s head

- Description: What measures have been taken worldwide and what countries have been effective in curbing population growth? A relevant document must describe an actual case in which population measures have been taken and their results are known. Reduction measures must have been actively pursued. Passive events such as decease, which involuntarily reduce population, are not relevant.

(from TREC 2005 HARD Track)
Queries and Relevance

• Query 435: curbing population growth

• Description:

(from TREC 2005 HARD Track)
Queries and Relevance

- **Query 435**: curbing population growth
- Can we imagine a relevant document without all these query terms?
Queries and Relevance

- **Query 435:** curbing population growth
- The same concept can be expressed in different ways

**Human population control**

From Wikipedia, the free encyclopedia

**Human population control** is the practice of artificially altering the rate of growth of a human population.

Historically, human population control has been implemented by limiting the population’s birth rate, usually by government mandate, and has been undertaken as a response to factors including high or increasing levels of poverty, environmental concerns, religious reasons, and overpopulation. While population control can involve measures that improve people's lives by giving them greater control of their reproduction, some programs have exposed them to exploitation.¹

Worldwide, the population control movement was active throughout the 1960s and 1970s, driving many reproductive health and family planning programs. In the 1980s, tension grew between population control advocates and women’s health activists who advanced women's reproductive rights as part of a human rights-based approach.² Growing opposition to the narrow population control focus led to a significant change in population control policies in the early 1990s.³
Queries and Relevance

• **Query 435:** curbing population growth

• Can we imagine a non-relevant document with all these query terms?
Queries and Relevance

- **Query 435:** curbing population growth
- The query concept can have different “senses”
Queries and Relevance

• This is why IR is difficult (and fascinating!)

• Croft, Metzler, & Strohman:

  Understanding how people compare text and designing computer algorithms to accurately perform this comparison is at the core of information retrieval.

• IR does not seek a deep “understanding” of the document text

• It uses statistical properties of the text to predict whether a document is relevant to a query
  ‣ easier and often times sufficient
What types of evidence can we use to predict that a document is relevant to a query?

- **query-document evidence**: a property of the query-document pair (e.g., a measure of similarity)
- **document evidence**: a property of the document (same for all queries)
Query: bathing a cat
Query-Document Evidence

- **Query:** bathing a cat
- The important query terms occur frequently
- Both terms occur
- Terms occur close together
- Terms occur in the title
- Terms occur in the URL
  - www.wikihow.com/bathe-your-cat
- Any other ideas?
Query-Document Evidence

- Terms occur in hyperlinks pointing to the page
- Same language as query
- Other terms semantically related to query-terms (e.g., feline, wash)
• Does not contain “.com”
• [verb] [article] [noun]
• Not one of the most popular queries
• Does not contain the term “news”
Query-Document Evidence

- We can also use previous user interactions, e.g.:
  - The query is similar to other queries associated with clicks on this document
  - The document is similar to other documents associated with clicks for this query
Document Evidence

- Lots of in-links (endorsements)
- Non-spam properties:
  - grammatical sentences
  - no profanity
- Has good formatting
- Anything other ideas?
Document Evidence

- Author attributes
- Peer-reviewed by many
- Reading-level appropriate for user community
- Has pictures
- Recently modified (fresh)
- Normal length
- From domain with other high-quality documents
Predicting Relevance

• IR does not require a deep “understanding” of information
• We can get by using shallow sources of evidence, which can be generated from the query-document pair or just the document itself.
The Search Task

• **Output**: a ranking of items in descending order of predicted relevance (simplifies the task)

• **Assumption**: the user scans the results from top to bottom and stops when he/she is satisfied or gives up
So, how good is a particular ranking?

Suppose we know which documents are truly relevant to the query...
Evaluating a Ranking

• Which ranking is better?
In general, a ranking with all the relevant documents at the top is best (A is better than B).
Evaluating a Ranking

- Which ranking is better?
Oftentimes the (relative) quality of a ranking is unclear and depends on the task.
Evaluating a Ranking

- Web search: ??????
Evaluating a Ranking

- **Web search:** A is better than B
- **Many documents (redundantly) satisfy the user; the higher the first relevant document, the better**
Evaluating a Ranking

- Patent search: ??????
Evaluating a Ranking

- **Patent search**: B is better than A
- **User wants to see everything** in the corpus that is related to the query (high cost in missing something)
Evaluating a Ranking

- Exploratory search: ??????
Exploratory search: A is better than B

Satisfying the information need requires information found in different documents
Evaluating a Ranking
evaluation metrics

- Given a ranking with known relevant/non-relevant documents, an evaluation metric outputs a quality score
- Many, many metrics
- Different metrics make different assumptions
- Choosing the “right one” requires understanding the task
- Often, we use several (sanity check)
Summary

- Information retrieval is the science and practice of matching information-seekers with the information they seek
- There is uncertainty at every step
- There are many types of search engines
- Users expect different things, depending on the task
- My goal is convince you that IR is a fascinating science
Course Overview

Jaime Arguello
jarguell@email.unc.edu

January 14, 2012
Course Objectives

• How do search engines work?
  ‣ effectiveness and efficiency
• How do users behave with them?
  ‣ how do users determine usefulness of information?
  ‣ how can a search engine mimic this process?
• Why do search engines fail?
  ‣ the user? the corpus? the system? something else?
• How can they be evaluated (off-line)?
• How can they be monitored and tuned (on-line)?
• How can they be improved?
Why are these important questions?

- Most of the world’s information is in natural language text
  - the world wide web
  - scientific publications
  - books
  - social media interactions

- The amount of this information is growing quickly; human capacity is not (evolution doesn’t move that fast)

- We need smarter tools

- IR provides tools for analyzing and organizing this information to facilitate search, discovery, and learning
Course Structure

• Information retrieval is an interdisciplinary problem

- people who want to understand people
- people who care about information retrieval
- people who want to understand how computers can solve problems

• We need to understand both ends of the spectrum
Course Structure

• IR: computer-based solutions to a human problem

![Diagram showing the system and the user with their respective sections of the semester]

• Understanding IR systems requires math!
Road Map

• Introduction to ad-hoc retrieval
  ‣ controlled vocabularies
  ‣ full-text indexing
• Boolean retrieval
• Indexing and query processing
• Statistical Properties of Text
• Document Representation
• Retrieval Models
  ‣ vector space model
  ‣ language modeling
  ‣ others (depending on how quickly we progress)
Road Map

• Evaluation
  ‣ test-collection construction
  ‣ evaluation metrics
  ‣ experimentation
  ‣ user studies
  ‣ search-log analysis

• Users and their definition of relevance

• Federated Search

• Clustering

• Text Classification
Grading

- 30% homework
  - 10% each
- 10% midterm
- 20% final exam
- 30% literature review
  - 5% proposal
  - 10% presentation
  - 15% paper
- 10% (and chocolates) participation
Grading for Graduate Students

- H: 95-100%
- P: 80-94%
- L: 60-79%
- F: 0-59%
Grading for Undergraduate Students

- A+: 97-100%
- A: 94-96%
- A-: 90-93%
- B+: 87-89%
- B: 84-86%
- B-: 80-83%
- C+: 77-79%
- C: 74-76%
- C-: 70-73%
- D+: 67-69%
- D: 64-66%
- D-: 60-63%
- F: <= 59%
Homework vs. Midterm vs. Final

• The homework will be challenging. It should be, you have more time.
Literature Review

• See description on the syllabus
• Form groups of 2 or 3
• Choose an IR task (next slide)
• Write a short proposal (mostly for feedback)
• Review the literature
  ‣ not just the different solutions to the problem
  ‣ the best solutions to the problem!
• Write a paper (20 pages double-spaced)
• Make a presentation
  ‣ 10 minute presentation + 5 minutes Q&A
Literature Review
example tasks

• Personalized information retrieval
• Session-based information retrieval
• Clustering of search results
• Book search
• Multimedia search (over items not inherently associated with text)
• Social-media data for forecasting and event-detection
• Faceted search
• Federated search
• Snippet generation
Literature Review tips

• Be thorough

• Be scientific
  ‣ don’t focus on the writing of the papers you review
  ‣ focus on the science (the proposed method and the evaluation)

• Be constructive

• Contribute new insight and structure
  ‣ your literature shouldn’t read like a “list”
  ‣ connect dots that haven’t been connected

• Say what you think!
Course Tips

• Work hard
• Do the assigned readings
• Do other readings
• Be patient and have reasonable expectations
  ‣ you’re not supposed to understand everything we cover in class during class
• Seek help sooner rather than later
  ‣ office hours: manning 305, T, Th 9:30-10:30am
  ‣ questions via email
• Keep laptop usage to a minimum (live in the present)
Questions?