

# DD2476: Search Engines and Information Retrieval Systems

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Johan Boye\*

KTH

Lecture 1

\* Many slides inspired by Manning, Raghavan and Schütze

# Contents

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- First part of the course (period 3):
  - 3 individual Java programming assignments (graded A-F)
  - allows you to learn IR basics
- Second part of the course (period 4):
  - group project (~4 persons/group, graded A-F)
  - allows you to go more into depth in some topic(s)

# People

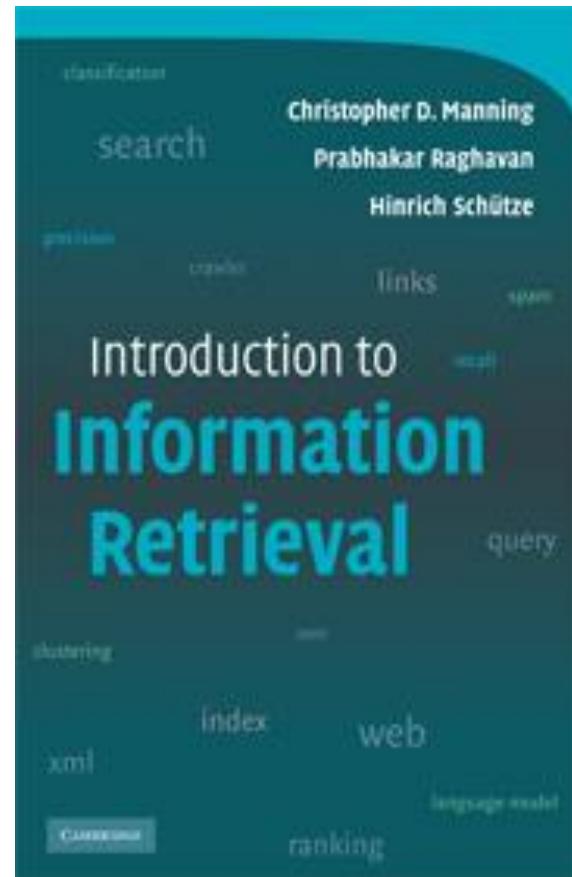
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- Johan Boye
  - Examiner, course leader, lecturer
- Jussi Karlgren, Viggo Kann, Bob Sturm,  
Hossein Azizpour
  - Lecturers
- Dmytro Kalpakchi, Thomas Vakili, Martin Pola  
Gudjón Ragnar Brynjarsson
  - Teaching assistants

# Literature

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- C. D. Manning, P. Raghavan and H. Schütze, *Introduction to Information Retrieval*, Cambridge University Press, 2008
  - available as **free** pdf
  - see course page
  - we will cover Chapters 1-4, 6-9, 21



# Examination

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- Three individual assignments (ECTS 6, A-F), reviewed in three sessions:
  - Wed 6 Feb, 13-18 in Magenta (*Assignment 1, ch 1-4*)
  - Tue 26 Feb, 13-18 in Magenta (*Assignment 2, ch 6-8, 21*)
  - Tuesday 26 Mar, 13-18 in Magenta (*Assignment 3, ch 9*)
  - Friday 3 May, 13-16 in Magenta (*Extra*)
- Final group project (ECTS 3, A-F):
  - Poster presentation Friday 17 May 8-12 in Fantum
  - Written report, deadline 17 May at 09.00.

# Grading

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- Grades on the individual assignments are cumulative
  - implement this much for an D, implement some more for a C, etc.
- Missed deadlines → deduction in grade

# Assignments grade

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Grade	Grades for individual assignments, regardless of order
A	(A,A,A), (A,A,B)
B	(A,A,C), (A,A,D), (A,A,E), (A,B,B), (A,B,C), (A,B,D), (A,C,C), (B,B,B), (B,B,C)
C	(A,B,E), (A,C,D), (A,C,E), (A,D,D), (A,D,E), (B,B,D), (B,B,E), (B,C,C), (B,C,D), (B,C,E), (B,D,D), (C,C,C), (C,C,D)
D	(A,E,E), (B,D,E), (B,E,E), (C,C,E), (C,D,D), (C,D,E), (C,E,E), (D,D,D), (D,D,E)
E	(D,E,E), (E,E,E)

# Grade decay

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Grade assignment 1

		Feb 6	Feb 26	Mar 26
A	A	B	C	
B	B	C	D	
C	C	D	E	
D	D	E	E	
E	E	E	E	

# Grade decay

---

Grade assignment 2

	Feb 26	Mar 26	May 3
A	A	B	C
B	B	C	D
C	C	D	E
D	D	E	E
E	E	E	E

# Grade decay

---

## Grade assignment 3

		Mar 26	May 3	TBD
A		A	B	C
B		B	C	D
C		C	D	E
D		D	E	E
E		E	E	E

# Project

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- You will be placed in a group in ~4 people.
- The groups are formed based on the grades on the first two assignments.
- Groups will be formed after the 3rd review session on March 26.
- If you haven't passed assignment 2 by then, you will **not** be placed in a group.
- (We will form groups of latecomers after the 4th review session on May 4 – if there are enough latecomers)

# Project topics

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- We will publish a list of project topics to choose from.
- ... but you can also suggest your own topic (if all group members agree).

# Course grade

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## Project

Computer Assignments

	A	B	C	D	E
A	A	A	B	B	C
B	B	B	B	C	C
C	B	C	C	C	D
D	C	C	D	D	D
E	C	D	D	E	E

# Honor code

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- The individual assignments are individual:
  - Don't look at somebody else's code
  - Don't show your code to anyone
  - Don't post your code online
- Final project:
  - You are welcome to use software libraries etc., but cite it in your report

# Information Retrieval (IR)

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- **Finding relevant information**
  - in **unstructured large** sets of material (usually **documents**),
  - satisfying an **information need** of the user.

# What IR is not

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- An IR system is **not** a database system
- Databases
  - are **structured**
  - allow for **exact** and **deterministic** search
- IR is **inexact** in several regards:
  - information need, search query, relevance

# Example IR system

Webb

Bilder

Videoklipp

Kartor

Nyheter

Utforska

403 000 RESULTAT

Datum ▾

Språk ▾

Region ▾

## Bilder av **medieval hygiene**

[bing.com/images](http://bing.com/images)



[Se fler bilder på medieval hygiene](#)

### Middle-Ages: **Middle Ages Hygiene** Översätt den här sidan

[www.lordsandladies.org/middle-ages-hygiene.htm](http://www.lordsandladies.org/middle-ages-hygiene.htm) ▾

Middle Ages Hygiene. Interesting facts and information about life and the lives of men and women in the Medieval period of the Middle Ages

### **Medieval Hygiene - Medieval Life and Times** Översätt den här sidan

[www.medieval-life-and-times.info/medieval-life/medieval-hygiene.htm](http://www.medieval-life-and-times.info/medieval-life/medieval-hygiene.htm) ▾

Medieval Hygiene . Medieval Monks & Crusaders. Step back into history get Medieval facts and information about life for people who lived in Medieval Times

### **History Undressed: History of Hygiene: Bathing, Teeth ...** Översätt den här sidan

[www.historyundressed.com/2008/07/history-of-hygiene-bathing-teeth.html](http://www.historyundressed.com/2008/07/history-of-hygiene-bathing-teeth.html) ▾

2008-07-14 · Labels: bathing, cleaning teeth, copper tub, deodorizing, elizabethan, garderobe, history of hygiene, medieval, nose gay, privy, regency. 48 comments:

# Example IR system

https://www.ebay.com

Hi! Sign in or register | Daily Deals | Sell | Help & Contact

My eBay |

**ebay** Shop by category ▾ Search for anything All Categories ▾ **Search** Advanced

Home | Saved | Electronics | Fashion | Health & Beauty | Motors | Collectibles | Sports | Home & Garden | Deals | Under \$10

**Time for a Top Deal**

Find your signature timepiece at a low price.

[Shop Now](#)

The banner features a blue background with white text for the headline and a smaller blue circle containing a white percentage sign over the second watch.

# Example IR system

WestlawNext™ powered by WestSearch™ WESTLAWNEXT | Folders ▾ | History ▾ | Alerts | Sign Off

robbery Minnesota SEARCH advanced New Folder (0)

VIEW: Overview 13 Cases 2,583 Statutes 178 Regulations 31 Administrative Decisions & Guidance 49 Trial Court Orders 19 Secondary Sources 10,000 Forms 111 Briefs 433 Trial Court Documents 714 Expert Materials 15 Jury Verdicts & Settlements 4 Proposed & Enacted Legislation 84 Proposed & Adopted Regulations 0 Arbitration Materials 0 All Results 14,221

Cases (2,583) 1-20 Sort by: Relevance

Select all items | No items selected

**1. State v. Moss**  
Supreme Court of Minnesota. | July 14, 1978 | 269 N.W.2d 732

Defendant was convicted before the District Court, Hennepin County, William Posten, J., of aggravated robbery, and he appealed. The Supreme Court held that: (1) where defendant under...  
...[2][3] Reading s 609.02, subd. 6 in connection with the armed robbery portion of the aggravated robbery statute, s 609.245, we think it is clear that a defendant who has either the first or second type of weapon on his person during the robbery commits armed robbery whether or not he uses the weapon or intends to use it....  
...Now, the difference between Simple Robbery and Aggravated Robbery is essentially this: In an Aggravated Robbery, the State must show that a dangerous weapon was used, and in this case it would be a scissors....

**2. State v. Hines**  
Court of Appeals of Minnesota. | September 04, 1984 | 354 N.W.2d 91

Defendant was convicted in the District Court, Ramsey County, James M. Lynch, J., of simple robbery, burglary, theft, and two counts of receiving stolen property, and he appealed. ...  
... The Court of Appeals, Wozniak, J., held that: (1) admission of evidence of three prior burglaries committed by defendant, to show identity and common plan or scheme, was not reversible error; (2) defendant could not be convicted of robbery and also be convicted of theft from the person robbed; (3) defendant could not be convicted of robbery and also be convicted of receiving property stolen in the robbery, where the receiving stolen property count was based on possession of the property one day after the robbery; but (4) defendant could be convicted both of robbery and of receiving property stolen in the robbery...

» RELATED DOCUMENTS  
Secondary Sources  
Admissibility, in robbery prosecution, of evidence of other robberies  
42 A.L.R.2d 854 (Originally published in 1955)  
The ALR databases are made current by the weekly addition of relevant new cases.  
American Law Reports ALR2d  
...Defendant's alleged robberies were sufficiently similar to charged robbery to make alleged robberies admissible to show identity; evidence showed that defendant used a paper bag to hide his right hand during alleged robberies and charged robbery, that defendant used his left hand to take money from the registers during alleged robberies and charged robbery, that defendant employed threats or actual violence to force employee compliance during alleged robberies and charged robbery...

# Key idea: Inverted index

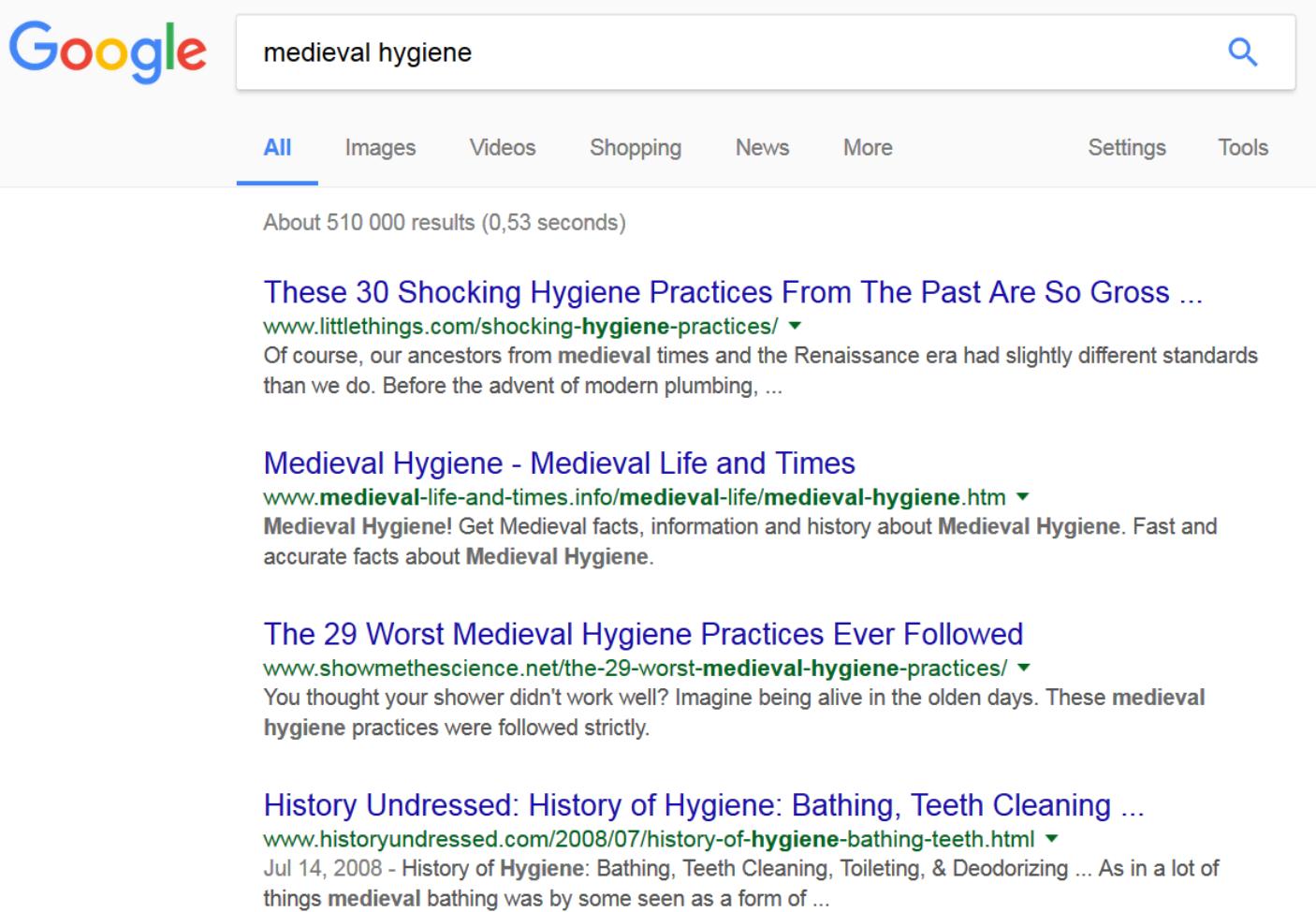
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# Another key idea: Ranking

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A screenshot of a Google search results page. The search query "medieval hygiene" is entered in the search bar. The "All" tab is selected, showing approximately 510,000 results in 0.53 seconds. The first result is a link to a website about shocking hygiene practices from the past. The second result is about medieval hygiene facts. The third result is about the 29 worst medieval hygiene practices. The fourth result is about the history of hygiene, mentioning bathing and teeth cleaning.

Google

medieval hygiene

All Images Videos Shopping News More Settings Tools

About 510 000 results (0,53 seconds)

[These 30 Shocking Hygiene Practices From The Past Are So Gross ...](#)  
[www.littlethings.com/shocking-hygiene-practices/](http://www.littlethings.com/shocking-hygiene-practices/) ▾  
Of course, our ancestors from medieval times and the Renaissance era had slightly different standards than we do. Before the advent of modern plumbing, ...

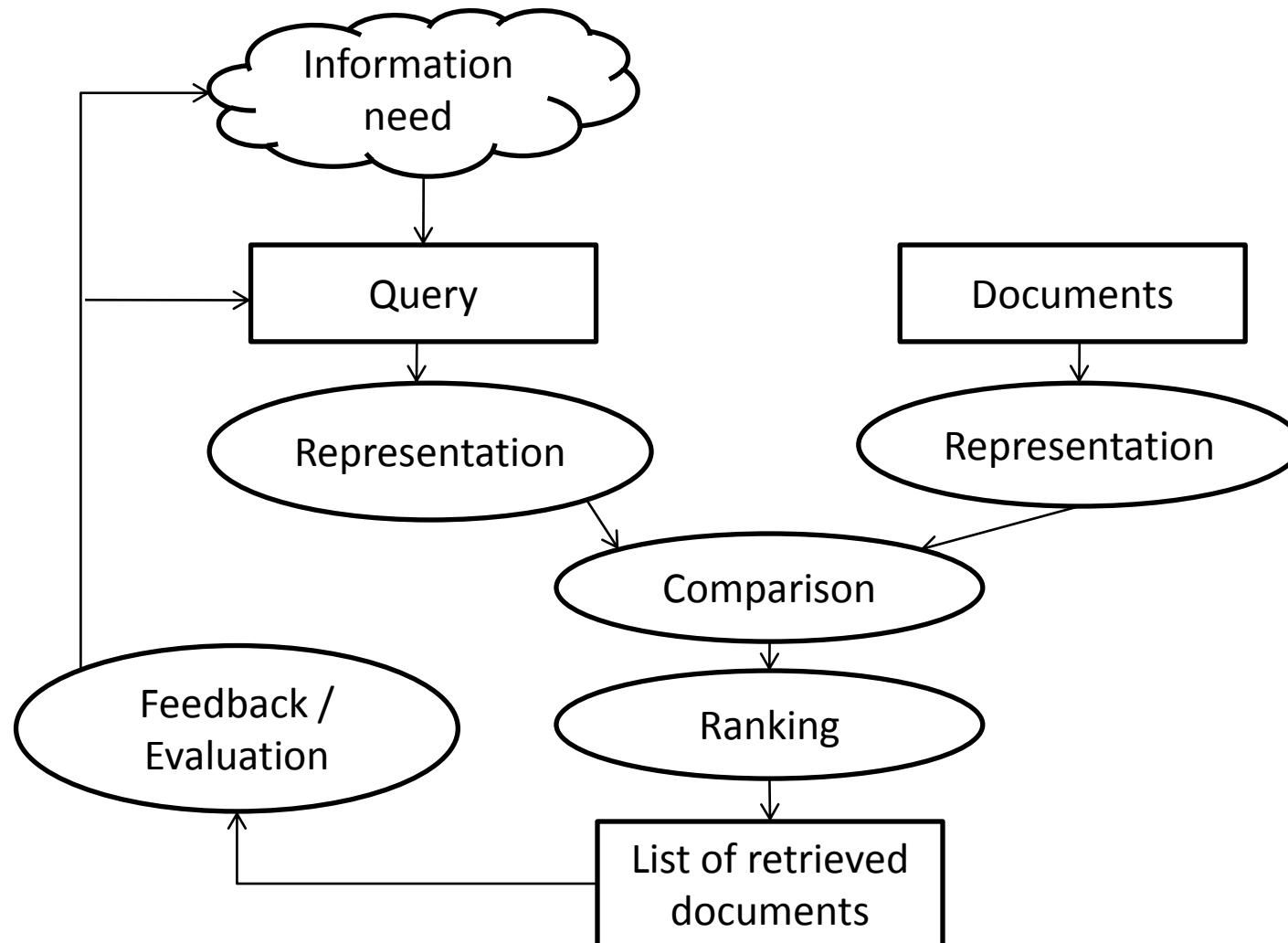
[Medieval Hygiene - Medieval Life and Times](#)  
[www.medieval-life-and-times.info/medieval-life/medieval-hygiene.htm](http://www.medieval-life-and-times.info/medieval-life/medieval-hygiene.htm) ▾  
Medieval Hygiene! Get Medieval facts, information and history about Medieval Hygiene. Fast and accurate facts about Medieval Hygiene.

[The 29 Worst Medieval Hygiene Practices Ever Followed](#)  
[www.showmescience.net/the-29-worst-medieval-hygiene-practices/](http://www.showmescience.net/the-29-worst-medieval-hygiene-practices/) ▾  
You thought your shower didn't work well? Imagine being alive in the olden days. These medieval hygiene practices were followed strictly.

[History Undressed: History of Hygiene: Bathing, Teeth Cleaning ...](#)  
[www.historyundressed.com/2008/07/history-of-hygiene-bathing-teeth.html](http://www.historyundressed.com/2008/07/history-of-hygiene-bathing-teeth.html) ▾  
Jul 14, 2008 - History of Hygiene: Bathing, Teeth Cleaning, Toileting, & Deodorizing ... As in a lot of things medieval bathing was by some seen as a form of ...

# The IR process

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# Evaluation

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- IR is an empirical discipline; it is important to **evaluate** the results

- Precision

$$p = \frac{|ret \cap rel|}{|ret|}$$

- Recall

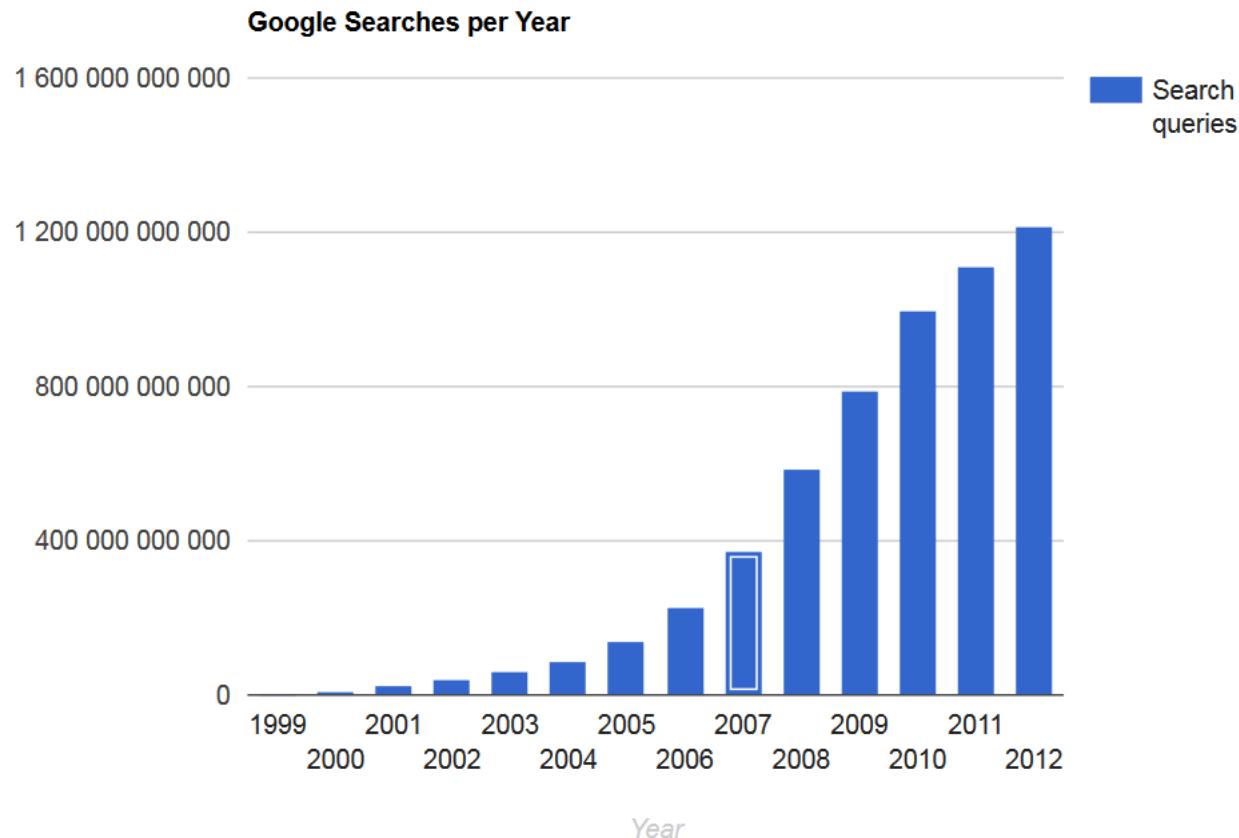
$$r = \frac{|ret \cap rel|}{|rel|}$$

where  $|rel|$  = number of relevant documents

$|ret|$  = number of returned documents

# IR is now an indispensable tool...

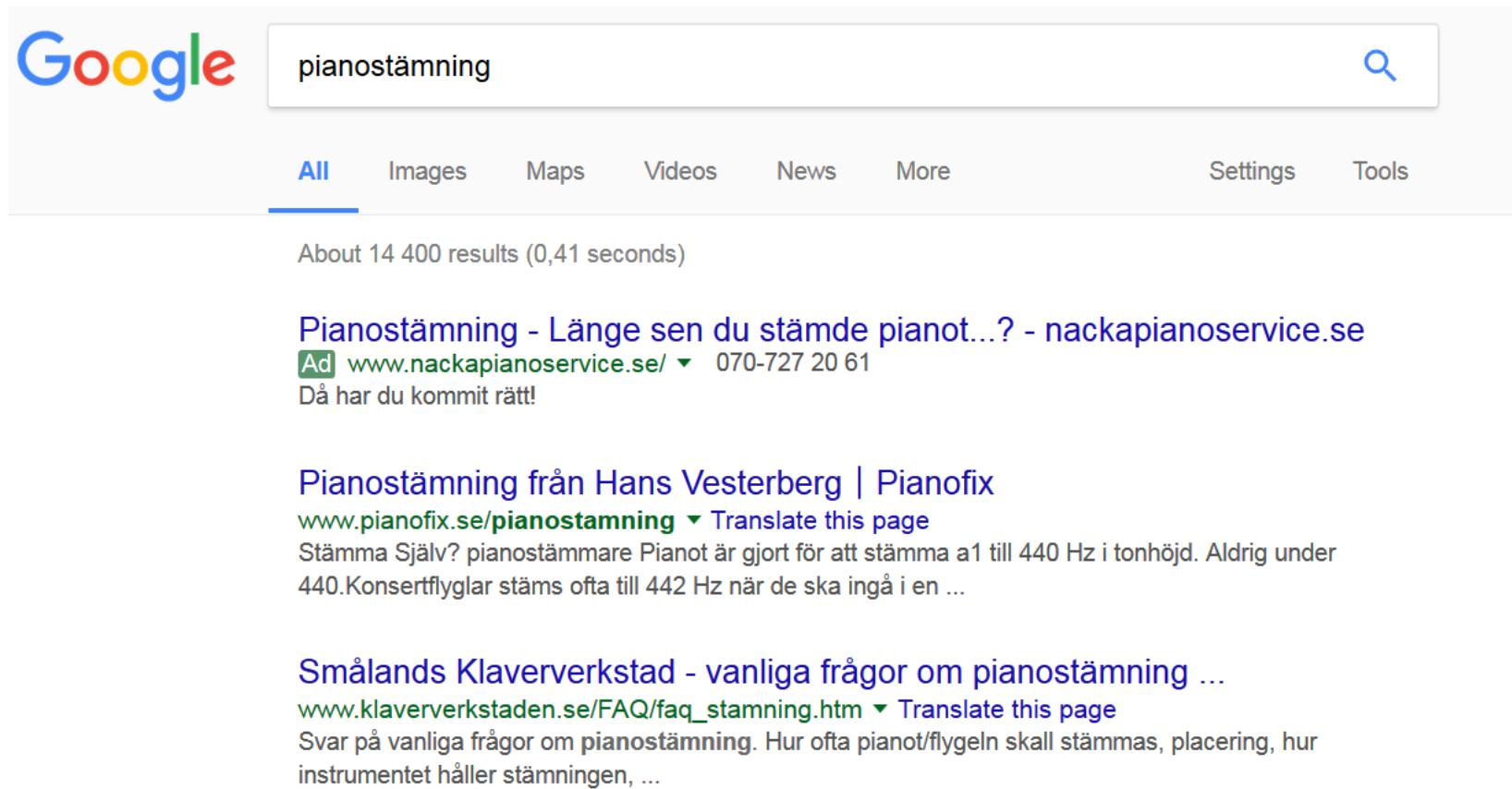
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Source: <http://www.internetlivestats.com/google-search-statistics/>

# It can be essential to get a high ranking...

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A screenshot of a Google search results page. The search query "pianostämning" is entered in the search bar. The results are filtered by "All". There are approximately 14,400 results found in 0.41 seconds.

The first result is a paid advertisement from [www.nackapianoservice.se/](http://www.nackapianoservice.se/) with the headline "Pianostämning - Länge sen du stämde pianot...? - nackapianoservice.se". It includes the phone number 070-727 20 61 and the text "Då har du kommit rätt!".

The second result is a link to [www.pianofix.se/pianostamning](http://www.pianofix.se/pianostamning) with the headline "Pianostämning från Hans Vesterberg | Pianofix". It includes the URL and a "Translate this page" link. The snippet describes piano tuning: "Stämma Själv? pianostämmare Pianot är gjort för att stämma a1 till 440 Hz i tonhöjd. Aldrig under 440. Koncertflyglar stäms ofta till 442 Hz när de ska ingå i en ...".

The third result is a link to [www.klaververkstaden.se/FAQ/faq\\_stamning.htm](http://www.klaververkstaden.se/FAQ/faq_stamning.htm) with the headline "Smålands Klaververkstad - vanliga frågor om pianostämning ...". It includes the URL and a "Translate this page" link. The snippet discusses common questions about piano tuning: "Svar på vanliga frågor om pianostämning. Hur ofta pianot/flygeln skall stämmas, placering, hur instrumentet håller stämningen, ...".

# Some say IR is influencing our thoughts...

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politics sport football opinion culture business lifestyle fashion environment technology  
europe US americas asia australia africa middle east cities development

## Angela Merkel: internet search engines are 'distorting perception'

A lack of transparency about algorithms is endangering debate, German chancellor tells media conference



Source: The Guardian (US edition), Oct 27, 2016

# Google is not 'just' a platform. It frames, shapes and distorts how we see the world

Carole Cadwalladr



Last week, we reported how extremist sites 'game' the search engine, boosting their propaganda. In response, the web giant appears to have modified some results, but would like us not to notice

did the holocaust happen

did the holocaust happen  
did the holocaust happen during ww2  
did the holocaust really happen yahoo  
did the holy grail exist

Top 10 reasons why the holocaust didn't happen. - Stormfront  
<https://www.stormfront.org> › General › History & Revisionism ▾  
19 Dec 2008 - 10 posts - 8 authors  
The Holocaust Lie more than anything else keeps us down. The twin ... You can believe what you want, but i believe the holocaust did happen.

Holocaust denial - Wikipedia  
[https://en.wikipedia.org/wiki/Holocaust\\_denial](https://en.wikipedia.org/wiki/Holocaust_denial) ▾  
Holocaust denial is the act of denying the genocide of Jews and other groups in the Holocaust ... denial movement bases its approach on the predetermined idea that the Holocaust, as understood by mainstream historiography, did not occur.  
Laws against Holocaust denial · Criticism · Order of magnitude

The Holocaust Hoax; IT NEVER HAPPENED | E.T.P.  
<https://expelthe parasite.com/2013/10/28/the-holocaust-hoax-it-never-happened/> ▾  
28 Oct 2013 - Truth does not fear investigation, nor does it require force of law to ... are "undeniable proof that the holocaust really happened, even with ...

Did the holocaust happen? Google search for Carole Cadwalladr Photograph: Google

Source: The Guardian (US edition), Dec 11, 2016

Morning Mix

# Google faulted for racial bias in image search results for black teenagers

By Ben Guarino June 10



## Most Read

- 1 A treasure hunt tons of sunken j can't leave jail t where it is
- 2 People were act weird.' Off-duty sensing the re packed restaura lethal gas
- 3 Video shows off dragging woma flight after boar
- 4 Police: NYC Mu bias report is fa
- 5 A Saudi woman photo of herself hijab. Police ha her.

## Our Online Games

Play right from this pag



Source: Washington Post, Jun 10, 2016

## Business

# Why Facebook and Google are struggling to purge fake news



Mark Zuckerberg, chief executive and founder of Facebook, speaks at the Techonomy conference in Half Moon Bay, Calif., on Nov. 10. (David Paul Morris/Bloomberg News)

By Elizabeth Dwoskin, Caitlin Dewey and Craig Timberg November 15

## Most Read

- 1 A Trump team member just compared climate science to the flat-Earth theory



- 2 Federal Reserve raises interest rates for second time in a decade



- 3 Scientists are frantically copying U.S. climate data, fearing it might vanish under Trump



- 4 A year after food safety scares, Chipotle has a new set of problems



- 5 Trump transition says request for names of climate scientists was 'not authorized'



## Market Watch

DJIA -0.6% NASDAQ -0.5%

Co. name or symbol

Get qu

Source: Washington Post, Nov 15, 2016

# IR: A hot topic

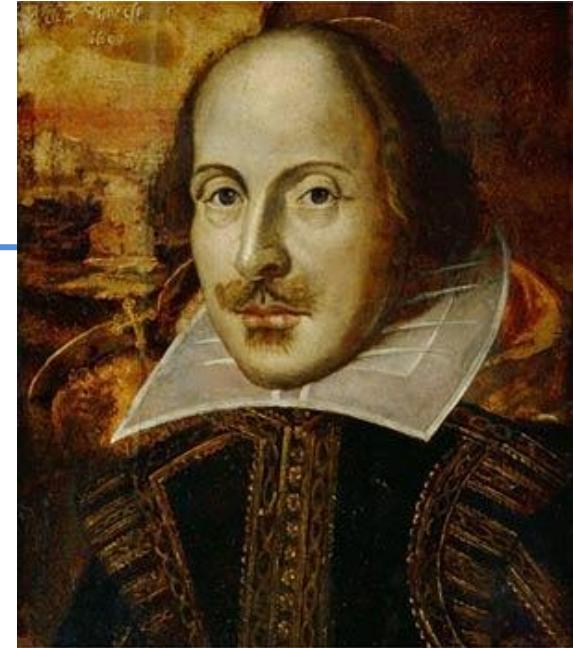
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- Competence in IR + Natural Language Processing + Machine Learning is in high demand
  - nice career opportunities
- IR influences the lives of many people
  - information acquisition
  - decision making
  - info wars

# A first IR example

---

- Which plays by Shakespeare contain the words “**Brutus**” AND “**Caesar**” but NOT “**Calpurnia**”?
- Suggestion:
  - Search for “**Brutus**” in all plays → resulting set R1
  - Search for “**Caesar**” i R1 → resulting set R2
  - Search in R2 and return plays that do **not** contain “**Calpurnia**”
  - `grep Brutus *.txt | grep Caesar | grep -v Calpurnia`
- Is there something wrong with this solution?



# Term-document matrix

---

	Antony and Cleopatra	Julius Caesar	Tempest	Hamlet	Othello	Macbeth
Antony	1	1	0	0	0	1
Brutus	1	1	0	1	0	0
Caesar	1	1	0	1	1	1
Calpurnia	0	1	0	0	0	0
Cleopatra	1	0	0	0	0	0
mercy	1	0	0	1	1	1
citizen	1	1	0	0	1	0

1 if the play contains  
the term, 0 otherwise

# Boolean search

---

- The terms can be represented by **bit vectors**:
  - Brutus: 110100, Caesar: 110111, Calpurnia: 010000,  
NOT Calpurnia 101111
  - Bitwise AND:  $110100 \ \& \ 110111 \ \& \ 101111 = 100100$
  - The answer is the first and fourth column of the matrix:  
**Antony and Cleopatra and Hamlet**



# Boolean search: Advantages

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- Simple model to understand and implement
- A Boolean query has a (a mathematically) precise meaning
- Works well for **expert users** working with a **well-defined** document collection (e.g. librarians)

# Boolean search in Google

---

- marathon -running
  - looks for documents containing “marathon” but NOT “running”
- marathon OR sparta
  - looks for documents that contains “marathon” or contains “sparta”
- marathon sparta
  - looks for documents that contains “marathon” and contains “sparta”

# Indexing pipeline

Documents



Byte stream

F r i e n d s , r o m a n s , a n d c o u n t r y m e n

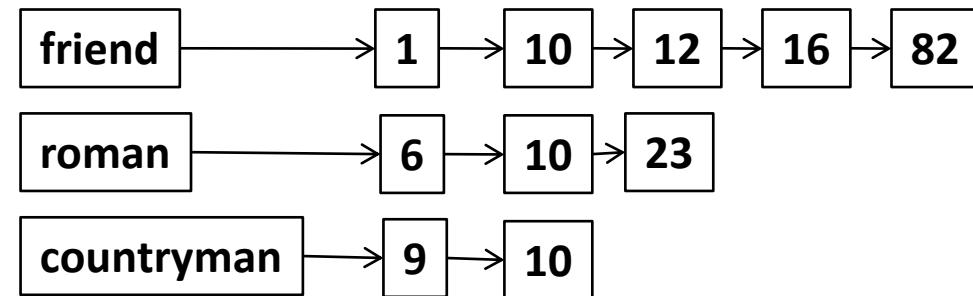
Token stream

Friends romans countrymen

Term stream

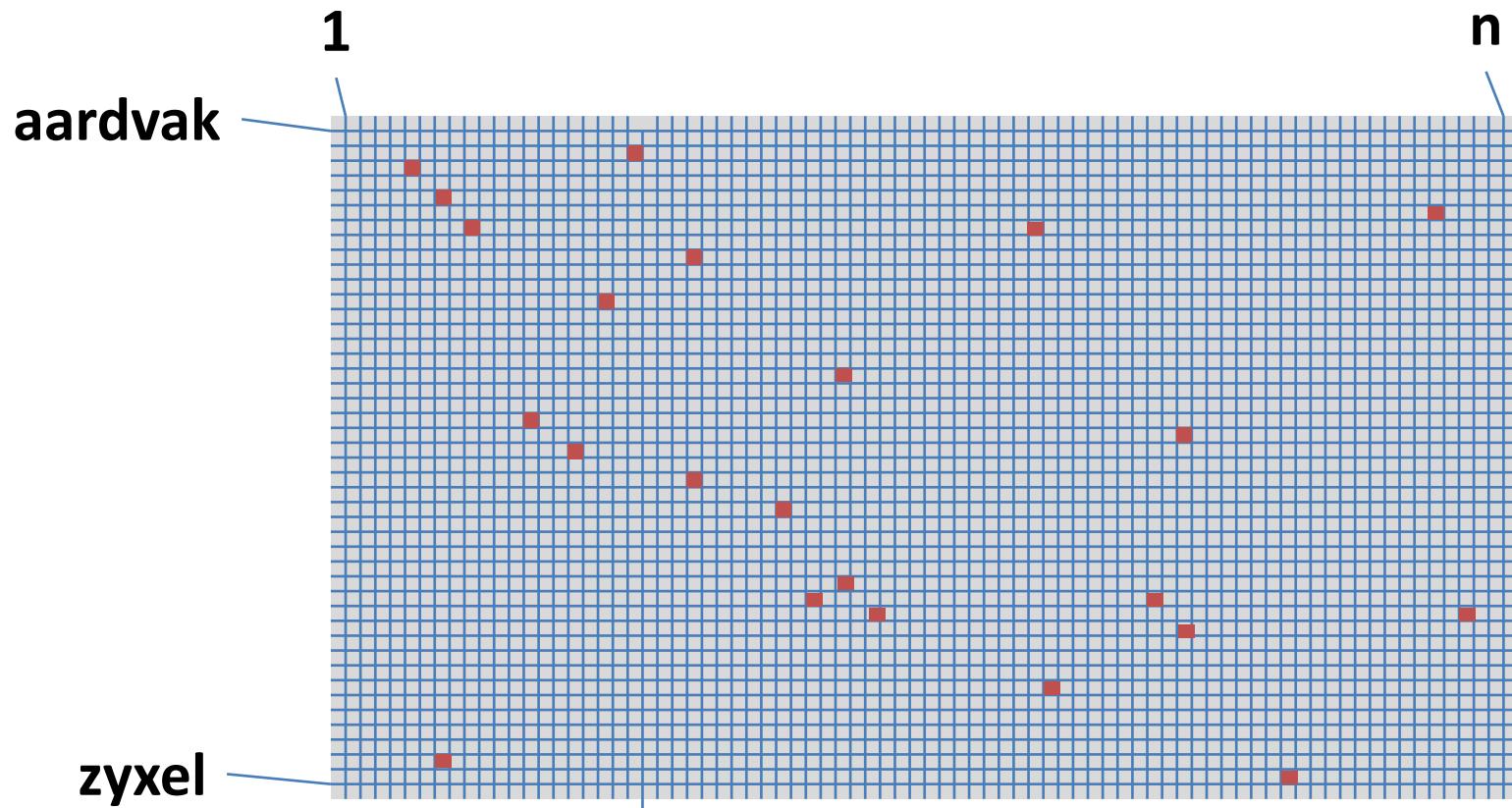
friend roman countryman

Inverted index



# The index

- Conceptually: the **term-document matrix**



# Practical indexing

---

- We need a **sparse matrix representation**.
- In the computer assignments we use:
  - a **hashtable** for the dictionary
  - **arraylists** for the rows
- Rows are called **postings lists**.

# One-word queries

---

**denmark**

- Return all the documents in which '**denmark**' appears.

# Multi-word queries

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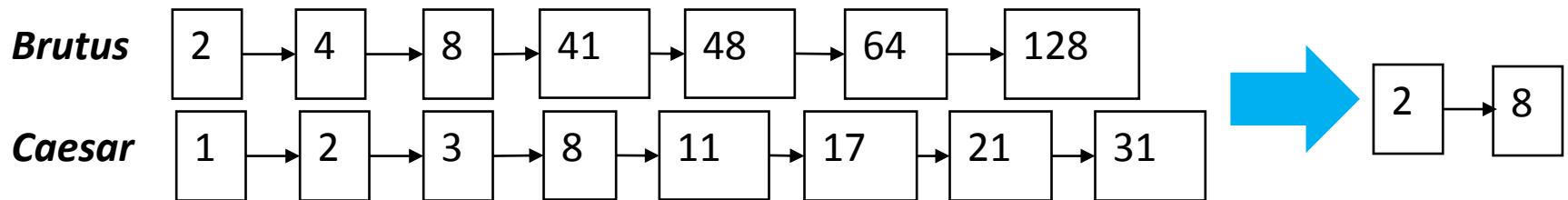
copenhagen denmark

- **Intersection** query
- **Phrase** query
- **Union** query

# Intersection

---

- Walk through two postings lists simultaneously



- Runs in  $O(n+m)$ , where  $n,m$  are the lengths of the lists

# Boolean search: Problems

---

- Many users have difficulties formulating search queries
- Often returns **too many** or **too few** results
  - "zyxel P-660h" → 192 000 results
  - "zyxel P-660h" "no card found" → 0 results
- Requires skill to formulate a search query returning a manageable number of results
- **No ranking** of results
- All terms equally important

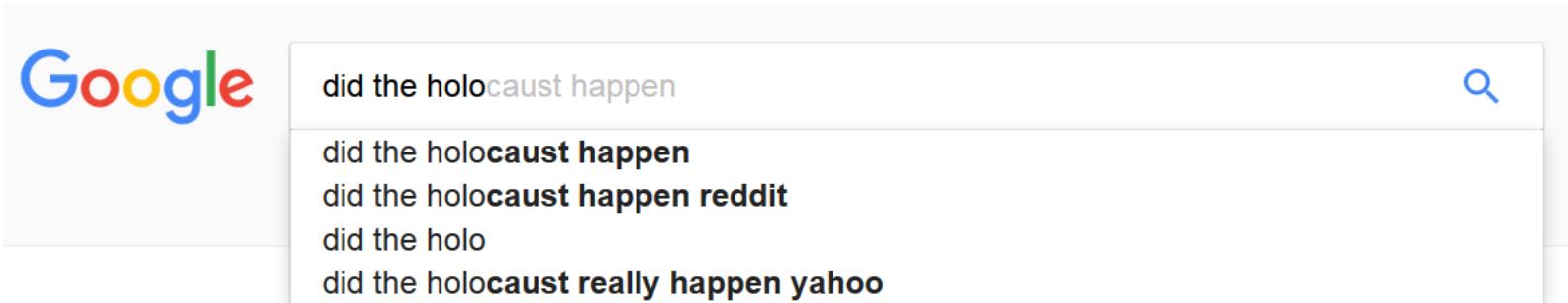
# Extensions

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- A search engine needs some extensions to be truly useful:
  - Query completion
  - Spell checking
  - (Wildcard queries)
  - NLP: treating synonyms, inflections, derivations, compound words, etc.
  - Information extraction (for snippets)
  - Clustering

# Query completion

---



The image shows a Google search results page. The search bar contains the query "did the holocaust happen". Below the search bar, a dropdown menu displays several suggested queries:

- did the holocaust happen
- did the holocaust happen
- did the holocaust happen reddit
- did the holo
- did the holocaust really happen yahoo

Below the suggestions, the first search result is a link titled "Did the Holocaust happen?" from the website [www.didtheholocausthappen.co/](http://www.didtheholocausthappen.co/). The snippet for this result states: "Did the Holocaust happen? Yes, yes it did. There's irrefutable proof spread across history and the Internet."

Further down the page, another search result is shown: "Google's top results for 'Did the Holocaust happen' now expunged of ...". This result is from [searchengineland.com/google-holocaust-denial-site-gone-266353](http://searchengineland.com/google-holocaust-denial-site-gone-266353). The snippet for this result discusses a change in Google's search ranking.

# Spell checking

Google search results for "information retreival". A red oval highlights the search bar and the first result.

information retreival

All Images Videos News Books More Settings Tools

About 12 700 000 results (0,28 seconds)

Showing results for information **retrieval**  
Search instead for information retreival

**Information retrieval** (IR) is the activity of obtaining **information** resources relevant to an **information** need from a collection of **information** resources. Searches can be based on full-text or other content-based indexing.

**Information retrieval - Wikipedia**  
[https://en.wikipedia.org/wiki/Information\\_retrieval](https://en.wikipedia.org/wiki/Information_retrieval)

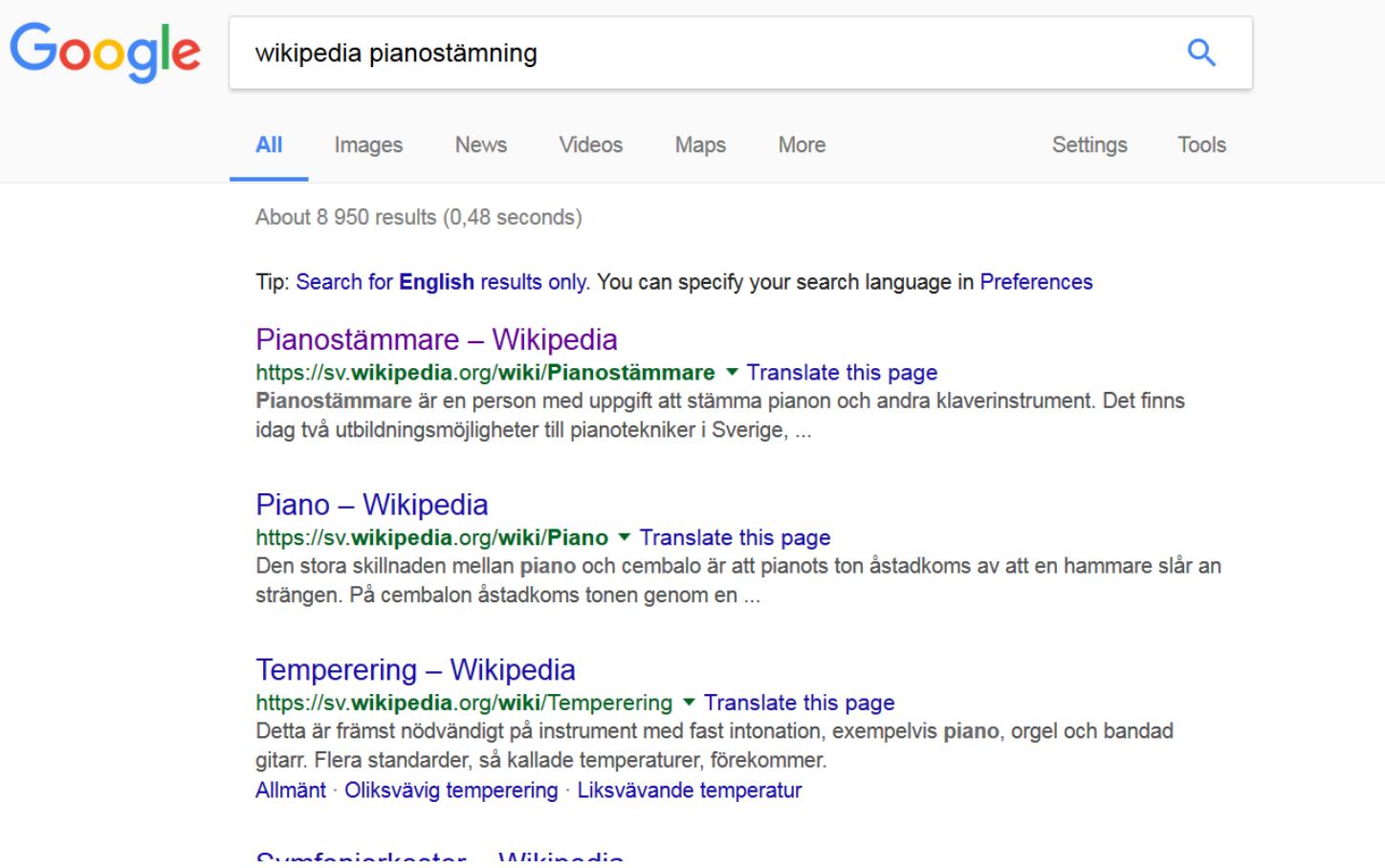
Properties of Information Retrieval

	without document dependencies	with document dependencies
self-referential	Uninformed Retriever → Controlled Retriever → Generalized Retriever → Adaptive Retriever → Specific Retriever → Rule-based Retriever → Reinforcement Learning Retriever	Topic-based Retriever → Standard Document Relevancy → Semantic Document Relevancy
symbolic	Vector Space	Generalized Vector Space → Latent Semantic Indexing → Topic-based Vector Space → Reinforcement Learning Vector Space
probabilistic	Information Retrieval → Probabilistic Models	Language → Natural Language Processing

About this result • Feedback

# Natural Language Processing

---



A screenshot of a Google search results page. The search query "wikipedia pianostämning" is entered in the search bar. The results are filtered under the "All" tab. There are 8,950 results found in 0.48 seconds.

**Tip:** Search for English results only. You can specify your search language in Preferences

**Pianostämmare – Wikipedia**  
<https://sv.wikipedia.org/wiki/Pianostämmare> ▾ Translate this page  
Pianostämmare är en person med uppgift att stämma pianon och andra klaverinstrument. Det finns idag två utbildningsmöjligheter till pianotekniker i Sverige, ...

**Piano – Wikipedia**  
<https://sv.wikipedia.org/wiki/Piano> ▾ Translate this page  
Den stora skillnaden mellan piano och cembalo är att pianots ton åstadkoms av att en hammare slår an strängen. På cembalon åstadkoms tonen genom en ...

**Temperering – Wikipedia**  
<https://sv.wikipedia.org/wiki/Temperering> ▾ Translate this page  
Detta är främst nödvändigt på instrument med fast intonation, exempelvis piano, orgel och bandad gitarr. Flera standarder, så kallade temperaturer, förekommer.  
Allmänt · Olikvävig temperering · Liksvävande temperatur

# Natural Language Processing

[Inte inloggad](#) [Diskussion](#) [Bidrag](#) [Skapa konto](#) [Logga in](#)

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[Sök på Wikipedia](#)

## Pianostämmare [\[redigera\]](#) [\[redigera wikitext\]](#)

**Pianostämmare** är en person med uppgift att stämma [pianon](#) och andra [klaverinstrument](#).

Det finns idag två utbildningsmöjligheter till pianotekniker i Sverige, [Oskarshamns folkhögskola](#) och [Kungliga Musikhögskolan](#).

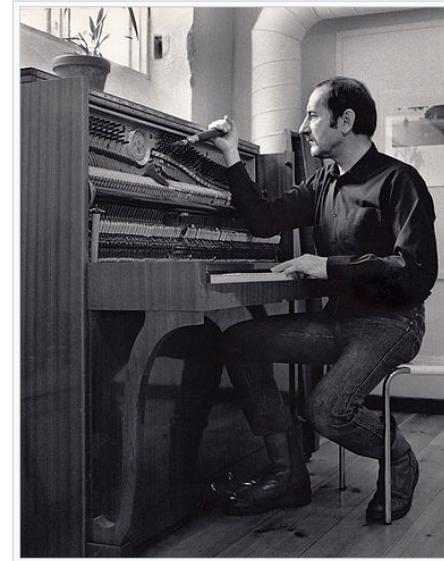
Pianostämmarutbildning förekom förr som en utbildning för blinda personer, bland annat vid [Tomtebodaskolan](#).<sup>[1][2]</sup>

## Referenser [\[redigera\]](#) [\[redigera wikitext\]](#)

1. ^ Blindundervisning i [Nordisk familjebok](#) (andra upplagan, 1905)
2. ^ "Tomtebodaskolan". Solna Stad. Läst 18 mars 2012.

## Externa länkar [\[redigera\]](#) [\[redigera wikitext\]](#)

- [Sveriges pianostämmare och teknikerförening](#)



André Studenki stämmer ett piano på en kulturförening i Malmö 1987.

# Clustering

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*In order to show you the most relevant results, we have omitted some entries very similar to the 60 already displayed.*

*If you like, you can repeat the search with the omitted results included.*

< Gooooooooogle

Previous

1 2 3 4 5 6

# Clustering

## Leonardo da Vinci – Wikipedia

[https://sv.wikipedia.org/wiki/Leonardo\\_da\\_Vinci](https://sv.wikipedia.org/wiki/Leonardo_da_Vinci) ▾

Leonardo föddes i den lilla staden Anchiano nära samhället Vinci i Toscana i Italien som

utmärktskaplig son till Ser Piero, notarie i Vinci, som då tillhörde ...

Leonardo da Vincis · Kategori:Leonardo da Vinci · Mona Lisa · Nattvarden

## Leonardo da Vincis upfinningar – Wikipedia

[https://sv.wikipedia.org/wiki/Leonardo\\_da\\_Vincis\\_upfinningar](https://sv.wikipedia.org/wiki/Leonardo_da_Vincis_upfinningar) ▾

Leonardo da Vinci (1452–1519) var ett italienskt mångsidigt geni som anses som den sanna formen av en "renässansman" och han upprörde stor kunskap ...

## Leonardo (olika betydelser) – Wikipedia

[https://sv.wikipedia.org/wiki/Leonardo\\_\(olika\\_betydelser\)](https://sv.wikipedia.org/wiki/Leonardo_(olika_betydelser)) ▾

Leonardo kan syfta på: ... en italiensk läkare och anatom; Leonardo Bruni, en humanist, historiker och kansler av Florens ... Leonardo (djur) – ett släkte av fjärilar ...

## Leonardo

[www.leonardocompany.com/en](http://www.leonardocompany.com/en) ▾ Översätt den här sidan

Leonardo - a global high technology company & key player in Aerospace, Defence & Security.

## Leonardo | SVT Play

<https://www.svtplay.se/leonardo> ▾

Leonardo da Vinci är i tonåren och arbetar som konstnärlärling under mästaren Verrocchio. Han umgås flitigt med sina vänner Mac (Machiavelli) och Lorenzo, ...

## Hem - Leonardo

[www.leonardogbg.se/](http://www.leonardogbg.se/) ▾

Vi på Leonardo Tapas & Lounge profilerar oss som en mingel plats mitt i underbara Olskroken, Göteborg. Missa inte heller vår uteservering som har öppet ...

## Leonardo da Vinci - Uppslagsverk - NE.se

<https://www.ne.se/uppslagsverk/encyklopedi/lång/leonardo-da-vinci> ▾

Leona'rdo da Vi'nci [-tʃi] (egentligen Lionardo da Vinci), född troligen 15 april 1452 i Anchiano vid Vinci i Toscana, död 2 maj 1519 i Amboise i Frankrike, ...

## Leonardo DiCaprio

Skådespelare



Leonardo Wilhelm DiCaprio, född 11 november 1974 i Hollywood, Los Angeles, Kalifornien, är en amerikansk skådespelare och filmproducent. Efter ha gjort flera småroller slog han 1993 igenom i filmen *Gilbert Grape* som den utvecklingsstörde Arnie, men det var i *Titanic* som han fick sitt stora internationella genombrott. [Wikipedia](#)

Född: 11 november 1974 (ålder 44 år), Hollywood, Los Angeles, Kalifornien, USA

Längd: 1,83 m

Utmärkelser: Oscar för bästa manliga huvudroll, MER

Föräldrar: George DiCaprio, Irmelin Indenbirken

Kommande film: *Once Upon a Time in Hollywood*

## Filmer

Visa drygt 40 till



Titanic  
1997



The Revenant  
2015



The Wolf of Wall Street  
2013



Romeo & Juliet  
1996



Inception  
2010

## Andra söker även efter

Visa drygt 15 till



# More extensions

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- Nowadays, modern search engines also contain this:
  - Support for multiple languages and alphabets
  - Multimedia indexing (video, images, news, ...)
  - Direct question-answering
  - Personalized ranking function
  - Collaborative filtering and recommendation
  - ...
- We will explore some of these ideas in the projects.

# Next time

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- Chapter 2
  - tokens, terms and postings lists
  - phrase retrieval
- Chapter 4
  - storing the index on disk