What is Information Retrieval (IR)?

COMP3009J: Information Retrieval

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What is Information Retrieval?

- For now, think of an internet search engine.
- As a user, there is some information that you want to know.
- The search engine has access to billions of web pages of information.
  - Its job is to let you know which pages contain the information that you are looking for.
  - **Efficiency and scalability are key!**
- You describe what you want using a **query**.
- We will look at a more formal definition later.

What is Information Retrieval (IR)?

- As computer and internet users, we use IR systems regularly:
  - Web Search Engines (e.g. Baidu, Bing, Google, etc.)
  - Desktop Search
  - Mobile Search
  - Library Catalogue Searches
  - Searching Individual Web Sites (e.g. newspaper archives, company document repositories, etc.)

What is Information Retrieval?

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

The representation and organization of the information items should provide the user with easy access to **the information in which he is interested**.

- Baeza-Yates and Ribeiro-Neto

What is Information Retrieval? Information Items

- This definition provides us with a number of issues that need to be addressed when considering what constitutes an IR system:
  - **Information Item:** Historically, "information items" have been books, documents or other written material that contain information in an **unstructured form**.
    - In IR, we frequently use the word "document" to refer to these items. However, in more modern times, IR systems have developed to cover other forms of information, and may be asked to include such things as video, images, etc.

What is Information Retrieval? Structured vs Unstructured Data

- Structured data tends to refer to information in "tables" (e.g. database, spreadsheet).

Employee	Manager	Salary
Smith	Jones	50000
Chang	Smith	60000
Ivy	Smith	50000

Typically allows numerical range and exact match (for text) queries, e.g.,
Salary < 60000 AND Manager = 'Smith'.

What is Information Retrieval? Structured vs Unstructured Data

- Unstructured data:
  - Typically refers to **free-form text** written in **natural language**.
    - "Natural" languages are those used by humans to communicate, e.g. English, Mandarin Chinese, French, etc.
  - Allows for:
    - **Keyword queries**, including operators (AND, OR, NOT, etc.)
    - More sophisticated **"concept" queries**, e.g.,
      - "find all web pages dealing with *drug abuse*".
  - In reality, most documents are **semi-structured** (e.g. we can identify the headings, titles and body text).
    - Also, it often fits the structure of the language it is written in.

What is Information Retrieval?: Representation

- **Representation:** In order to allow users to perform searches, documents must be **represented** in some way.
  - Searching through the raw text of millions of documents is a **very slow** process, so some **mathematical representation** of the information is typically used.
  - **Why?**
    - Computers are much quicker at doing mathematical calculations than they are at text processing.
    - We try to represent textual documents in some mathematical form so retrieval is faster (e.g. vectors, sets, bit-strings).

What is Information Retrieval? Storage, Organisation and Access

- **Storage and Organisation:** There are important considerations in terms of storing documents also. They must be organised so as to be **quickly accessible**. This is particularly important with large document collections.
- **Access:** The key attribute of an IR system is to allow users to access the information in question. This should happen in a **timely** and **efficient** manner.

What is Information Retrieval? Information Need

The representation and organization of the information items should provide the user with easy access to **the information in which he is interested**.

- Users only use IR systems when there is some information that they are interested in reading.
- We call this the **"information need"** of a user.
- This phrase was coined by Robert Taylor in 1962, and is defined as having four stages.

Information Need: 4 Stages

1. the actual, but unexpressed need for information **(visceral need)**: "a vague sort of dissatisfaction ... probably inexpressible in linguistic terms".

2. the conscious within-brain description of the need **(conscious need)**: "an ambiguous and rambling statement". i.e. "I know what I'm looking for but I don't know how to say it".

3. the formal statement of the question **(formalised need)**

4. the question as presented to the information system **(compromised need)**

Expressing an Information Need

- The third stage, the *formalised need*, is typically easy to express in a natural language:
  - What is the capital city of Cyprus?
  - Who are the 10 best golfers in the world?
  - What common arguments are made in favour of, or against, the use of nuclear power?
  - What were the effects of Joe Biden's policies as President of the USA?
- Some information needs are simple; others are much more complex.

Presenting an Information Need to an IR System: Queries

- A **query** is the expression of an information need (*compromised need*) that is provided to an IR system to explain what information is required by the user. There are several different methods of expressing queries:
  - **Keyword-Based Querying:** A keyword (or list of keywords) is supplied to the IR system. This is by far the most common form of querying in web search (but this is changing). The average query consists of 2-3 keywords.
  - **Context Queries:** These specify sequences of words that should appear close together in documents that are retrieved. Physical proximity has semantic value.

Presenting an Information Need to an IR System: Queries

- **Types of Queries (continued)**
  - **Boolean Queries:** The oldest method of combining keywords allows a user to specify keywords that should or should not be contained in the documents that are desired, using the Boolean operators AND, OR and NOT.
    - e.g. "information AND (retrieval OR extraction) NOT data".

Presenting an Information Need to an IR System: Queries

- **Types of Queries (continued)**
  - **Natural Language Queries:** Queries are provided in their natural form. In the past, this form of querying has not been very successful, as Natural Language Processing is a difficult task.
    - For a long time, http://www.askjeeves.com was the most famous natural language web search engine, but it reverted to keyword-based searching in 2006.
    - Microsoft spent $100m to acquire http://www.powerset.com in 2008 in a new attempt at the concept.
    - Other examples: hakia (closed in 2014), Lexxe (closed 2015)
    - Now, many search engines will try to automatically detect natural language queries, but support keyword search also.
      - Most voice-activated interfaces support natural language queries (e.g. Apple's Siri, Amazon's Alexa), although their understanding is often quite basic.
    - More recently (2023), Microsoft and OpenAI announced that they will integrate the Bing search engine with the ChatGPT language model, which will allow for more conversational search. This product is known as Microsoft Copilot.

The Role of an IR System

The Role of an IR System

An information retrieval system does not inform (i.e. change the knowledge of) the user on the subject of his inquery. It merely informs on the **existence** (or non-existence) and **whereabouts** of documents relating to his request.

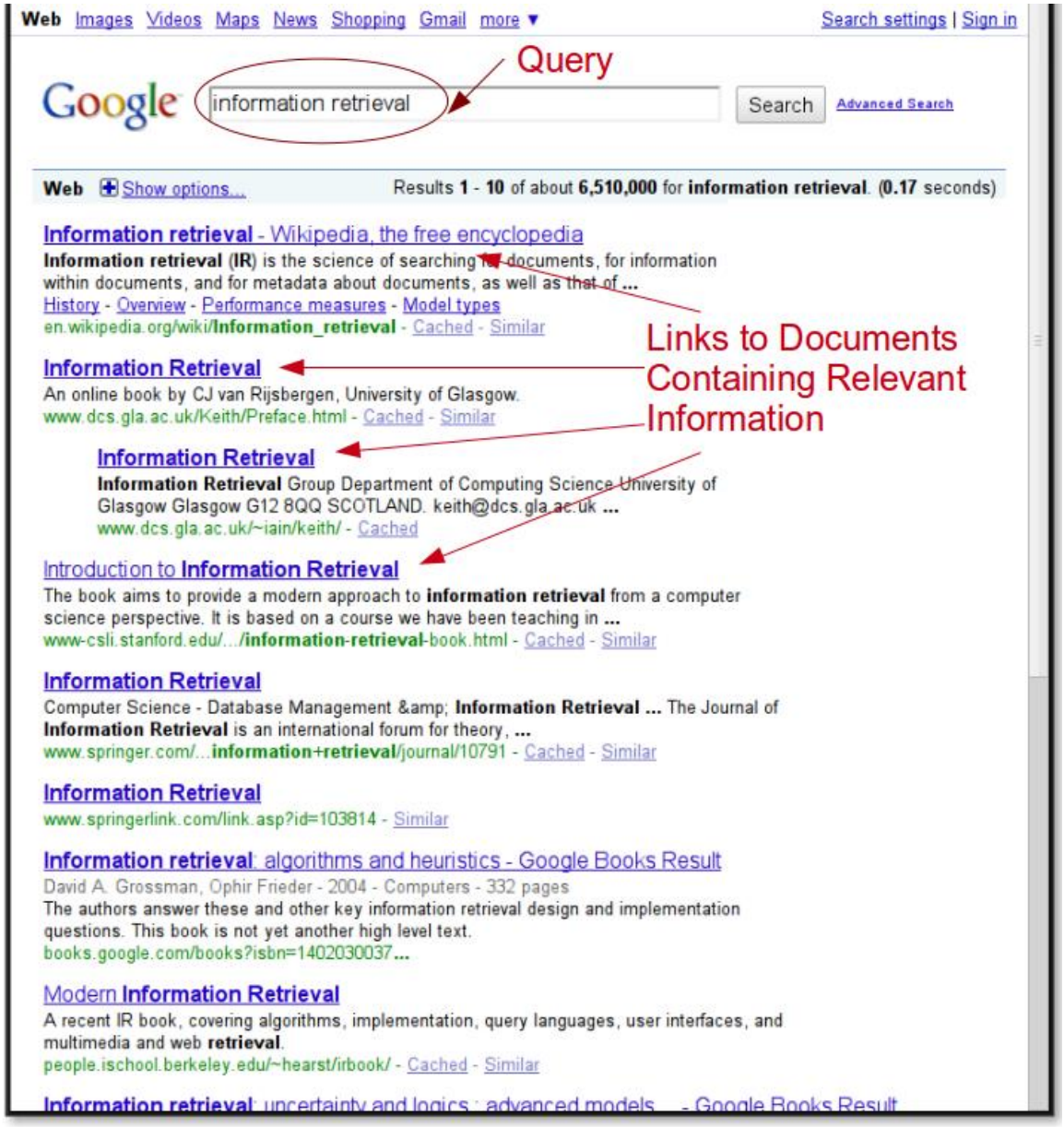
– C. J. van Rijsbergen

- **Existence:** Tells the user that a document exists that helps to satisfy the information need.
- **Whereabouts:** Tells the user where that document is.

- The user learns nothing unless they then read the document.

The Role of an IR System

- This helps us to define the role of an IR system:
  - The principal function of an IR system is to give users a **list of documents** that are **relevant** to the user's information need.
  - It makes no attempt to take a subset of the information contained in a document and present that to the user: it is the task of the searcher to do this.
  - With most systems, this list is ranked, with the document the system believes to be of most relevance at the top of the list.


Web Images Videos Maps News Shopping Gmail more ▼
Search settings | Sign in
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information retrieval
Search
Advanced Search
Query
Web Show options...
Results 1 - 10 of about 6,510,000 for information retrieval. (0.17 seconds)
Information retrieval - Wikipedia, the free encyclopedia
Information retrieval (IR) is the science of searching for documents, for information within documents, and for metadata about documents, as well as that of ...
History - Overview - Performance measures - Model types
en.wikipedia.org/wiki/Information_retrieval - Cached - Similar
Information Retrieval
An online book by CJ van Rijsbergen, University of Glasgow.
www.dcs.gla.ac.uk/Keith/Preface.html - Cached - Similar
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Information Retrieval Group Department of Computing Science University of Glasgow Glasgow G12 8QQ SCOTLAND. keith@dcs.gla.ac.uk ...
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Introduction to Information Retrieval
The book aims to provide a modern approach to information retrieval from a computer science perspective. It is based on a course we have been teaching in ...
www-csli.stanford.edu/.../information-retrieval-book.html - Cached - Similar
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www.springerlink.com/link.asp?id=103814 - Similar
Information retrieval: algorithms and heuristics - Google Books Result
David A. Grossman, Ophir Frieder - 2004 - Computers - 332 pages
The authors answer these and other key information retrieval design and implementation questions. This book is not yet another high level text.
books.google.com/books?isbn=1402030037...
Modern Information Retrieval
A recent IR book, covering algorithms, implementation, query languages, user interfaces, and multimedia and web retrieval.
people.ischool.berkeley.edu/~hearst/irbook/ - Cached - Similar
Information retrieval: uncertainty and logics : advanced models ... - Google Books Result
Links to Documents Containing Relevant Information

Why is Information Retrieval Important?

- The term "Information Overload" coined by Alvin Toffler as far back as 1970.
- This describes the situation where there is so much information being made available to us that it is impossible for people to absorb all of it.
- This problem has become much worse as a result of the Internet, with millions of people publishing material every day.
- IR systems are vital in providing users with access to this information
- Reliable sources on how many queries search engines like Baidu and Google handle per day are difficult to find. But most sources agree that they handle **billions** of search queries daily. Approximately 15% of Google queries have never been seen before.

Google Searches over Time

Year	Number of Searches (approx)
1998	1,000,000,000 (1 billion)
2000	14,000,000,000 (14 billion)
2001-2003	Over 55,000,000,000 (55 billion)
2004-2008	73,000,000,000 (73 billion)
2009	Over 365,000,000,000 (365 billion)
2012-2015	1,200,000,000,000 (1.2 trillion)
2016	Over 2,000,000,000,000 (2 trillion)

Source: https://searchengineland.com/google-now-handles-2-999-trillion-searches-per-year-250247

Relevance

- This concept of "**relevance**" is very important in IR:
  - A document is "relevant" if its content satisfies (or helps to satisfy) the user's information need.
  - The system alerts the user to the existence and location of a document: it's up to the user to read the document.
  - It is important to note that this is, in theory, a **subjective** concept, that is entirely up to the user to judge.
  - Remember that a query is just an expression of an information need.
    - For example, if a user searches for "jaguar", documents that discuss luxury cars may **appear to be relevant**, but will be of no use to a user who is researching big cats.

How do we know if the system is good?

- An IR system has been successful if the documents it returns satisfy the information need.
- The only person qualified to judge this is the user, which is a problem when trying to evaluate IR systems.
- Laboratory experiments use "test collections" for which **standard queries** have been created.
- Documents in these collections have been **judged** by human judges as to whether or not they are relevant to each query.
- This method becomes more difficult as document collections grow.

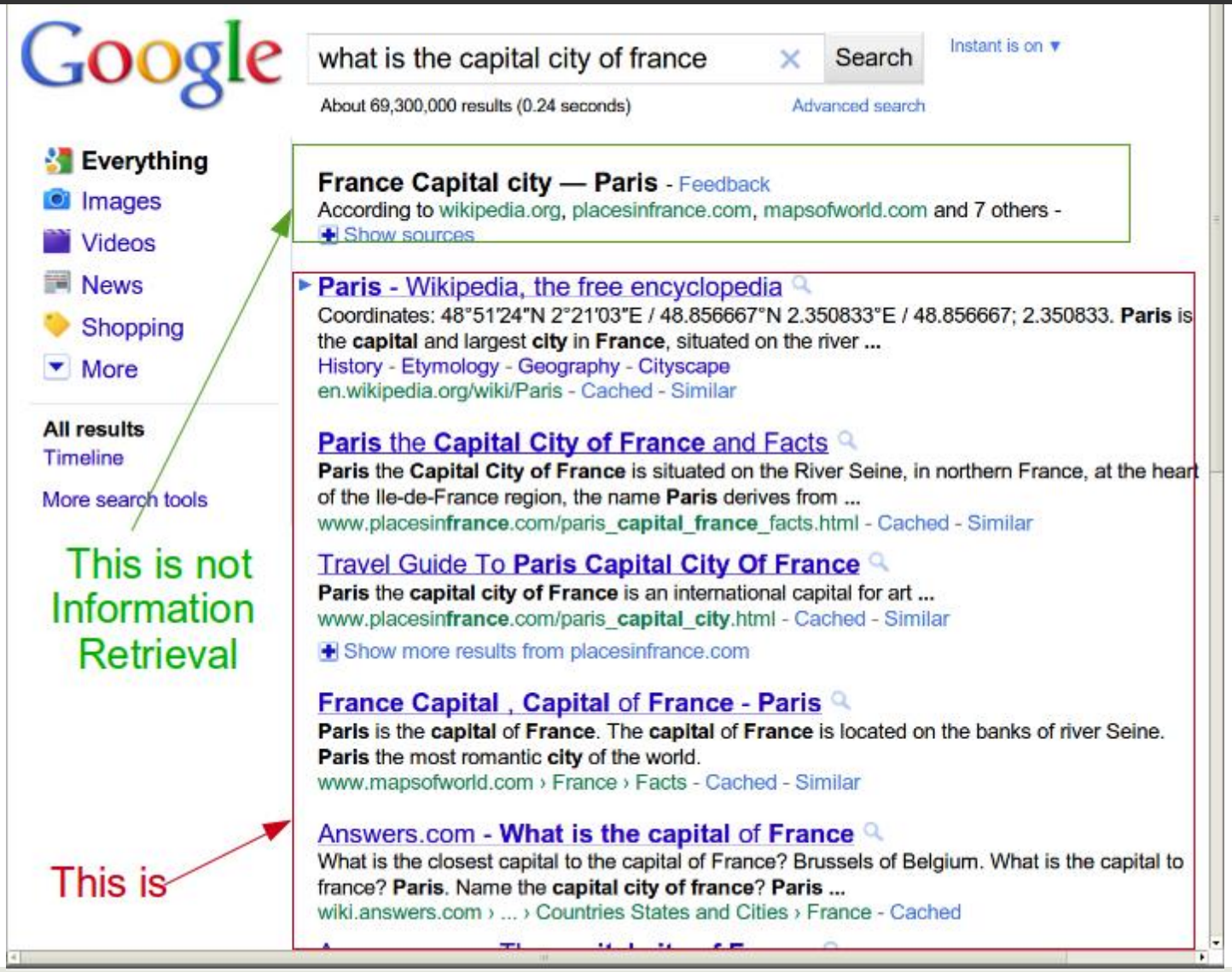
Related Research

There are a number of other research areas that are not traditionally considered to be “Information Retrieval”, but are closely related.

Question Answering

- **Question Answering:** Here, the system is designed to provide a full answer to a question, e.g.:
  - Question: What is the capital city of France?
  - Answer: Paris is the capital city of France.
- Many mainstream search engines include some element of question answering as well as their Information Retrieval system.
- Over time, as search engines have gained more functionality, the distinction between IR and related tasks has become much more unclear.
- Many Large Language Models (e.g. ChatGPT) attempt to do Question Answering (i.e. giving answers directly).

Question Answering



Information Extraction

- An **Information Extraction** system is designed to take unstructured text and try to create structured data from it.
- **Input:**
  - "Kate Hudson was born in Los Angeles, California, the daughter of Academy Award-winning actress Goldie Hawn and Bill Hudson, an actor, comedian, and musician. Her parents divorced eighteen months after her birth; she and her brother, actor Oliver Hudson, were raised in Colorado by her mother and her mother's long-time boyfriend, actor Kurt Russell."
- **Output (examples):** mother(Kate Hudson, Goldie Hawn), brother(Kate Hudson, Oliver Hudson), gender(Kate Hudson, female)

Summary

- We have seen:
  - What is Information Retrieval (definition)?
    - Information Items (unstructured: representation, storage, organization and access)
    - Information Need (expressed as queries of various types)
    - Relevance
  - What is not Information Retrieval?
    - Question Answering
    - Information Extraction