How to search multimedia information?

- **Richness of multimedia information**
  - Visual and audio information can communicate a wide variety of messages, feelings and emotions
  - Temporal and spatial structure adds organization and usability
Example MRI Scan Reports

This patient had a sudden loss of her motor functions (she wasn’t able to move her right arm and leg) 2 months before the study. She was then a slow recovery with a lot of physical therapy and drugs. She was recovering some of her movements but suddenly all the improvement stop. We performed an MRI that showed the changes expected for a lesion of that time (2 months old) but also showed and increased in the size of the ventricular system (where the Cerebrospinal fluid or CSF flows) that was causing hydrocephalus. Due to this finding, the patient went then another surgery and had a shunt valve installed, the last word we had from one of her relatives is that she is again on recovery.

![MRI Scan](image)

A 30 year old male that after a soccer game came with swelling of the knee. A meniscal tear was suspected. The MRI confirmed the lesion and also showed important swelling within the knee. The appearance of any structure is easily disclosed in MRI. Here you can actually see the bones, ligaments, soft tissues and the fluid collections that appear bright and at surrounds the knee.

The official report included this T2 coronal SE (spin echo) sequence of the knee. The bright (white) rounded images that surround the knee is fluid related to synovitis or inflammation of the bursa of the knee in a patient with a sport-related injury.

![MRI Scan](image)
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- **Expressiveness of the user query**
  - Systems have always forced humans to describe their information need in some query language
  - However, not all information needs are easily expressed
Relevance vs similarity

What is the best [search space + dissimilarity function] to compute the relevance of documents for a given user information need?

The tasks of a search application

- Collect data for storage
  - Crawler
- Analyse collected data and compute the relevant information
  - Information analysis
- Store data in an efficient manner
  - Indexing
- Process user information needs
  - Querying
- Find the documents that best match the user information need
  - Ranking
Putting all together...

What makes a good search application?

- **Efficiency**: application replies to user queries without noticeable delays.
  - 1 sec is the “limit for users feeling that they are freely navigating the command space without having to unduly wait for the computer”

- **Effectiveness**: application replies to user queries with relevant answers.
  - This depends on the interpretation of the user query and the stored information.
Crawler

- Discovers data for storage and indexing
- Applied when data has to be “discovered”
  - i.e., only a sample of the full data can be collected.
- If the sample is unbiased, it is a faithful representation of the real scenario.
- Implements a strategy to collect relevant data
  - e.g. on the Web the crawler needs to decide which links are more fruitful to follow and if a page should be indexed or not (it can be spam or phishing)

Web crawling

Begin with known "seed" URLs
Fetch and parse them
Extract URLs they point to
Place the extracted URLs on a queue
Fetch “robots.txt”
Fetch each URL on the queue and repeat
Data processing

- This stage deals with the extraction of the information to be made searchable
- Extract meaningful words, pairs of words or n-grams
- Extract the images and their main characteristics
- Link visual characteristics and text data

Indexing

- This stage creates an index to quickly locate relevant documents
- An index is an aggregation of several data structures (e.g. several B-trees)
- Index compression is used to reduce the amount of space and the time needed to compute similarities
- The distribution of the index pages across a cluster improves the search engine responsiveness
Querying

- Conversion of the user query into the internal search space
  - Parsing

- Usage history
  - Cookies, profiles, etc.

- User intention
  - What type of task is the user doing?

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Querying

- Process the text query with the same text pre-processing techniques:
  - Stop-words, spelling corrector, stemming, n-grams, etc.

- Allow different types of levels of user expressiveness

- A query is a vector of text terms and n-grams:

  \[ q = (w_1, \ldots, w_M, ng_1, \ldots, ng_N) \]
Ranking

- Once the user query is converted into the internal search space...
  - The ranking function sorts the information according to its relevance to the user query

- Ranking functions should model the human notion of relevance
  - We don’t really know the mathematical form of the human notion of similarity... it is highly subjective. 😊
  - One can only hope for a good approximation:
    - Good heuristics exist but statistical methods together with good data are the most flexible approaches.