Tutorial on Medical Image Retrieval
- user interaction -

Medical Informatics Europe 2005
28.08.2005

Henning Müller, Thomas Deselaers

Service of Medical Informatics
Geneva University & Hospitals, Switzerland
Aachen Technical University, Germany

Overview

- Usability issues
  - Interfaces, query speed, etc.
- Relevance feedback
  - AND, OR, NOT, XOR
  - Text retrieval
  - Positive and negative
    - Problems
  - Several steps
- Long-term analysis of user behavior
  - Log file analysis
  - Market basket analysis

Usability issues

- Often neglected in research projects
- Several dimensions:
  - Interactivity
  - Interfaces
    - Explain the output to the user
    - Different interfaces for novice, expert users
  - Standards for system use

- Nielsen: Usability Engineering

Usability: Query speed (Nielsen)

- 10 s: maximum to keep the attention focused on the dialogue
- 1 s: maximum for interactive working
- 0.1 s: instantaneous response

- We need to aim for 1 s
- Often systems state >3 minutes

- Features etc. can be precalculated
  - Much literature on optimizing the query speed

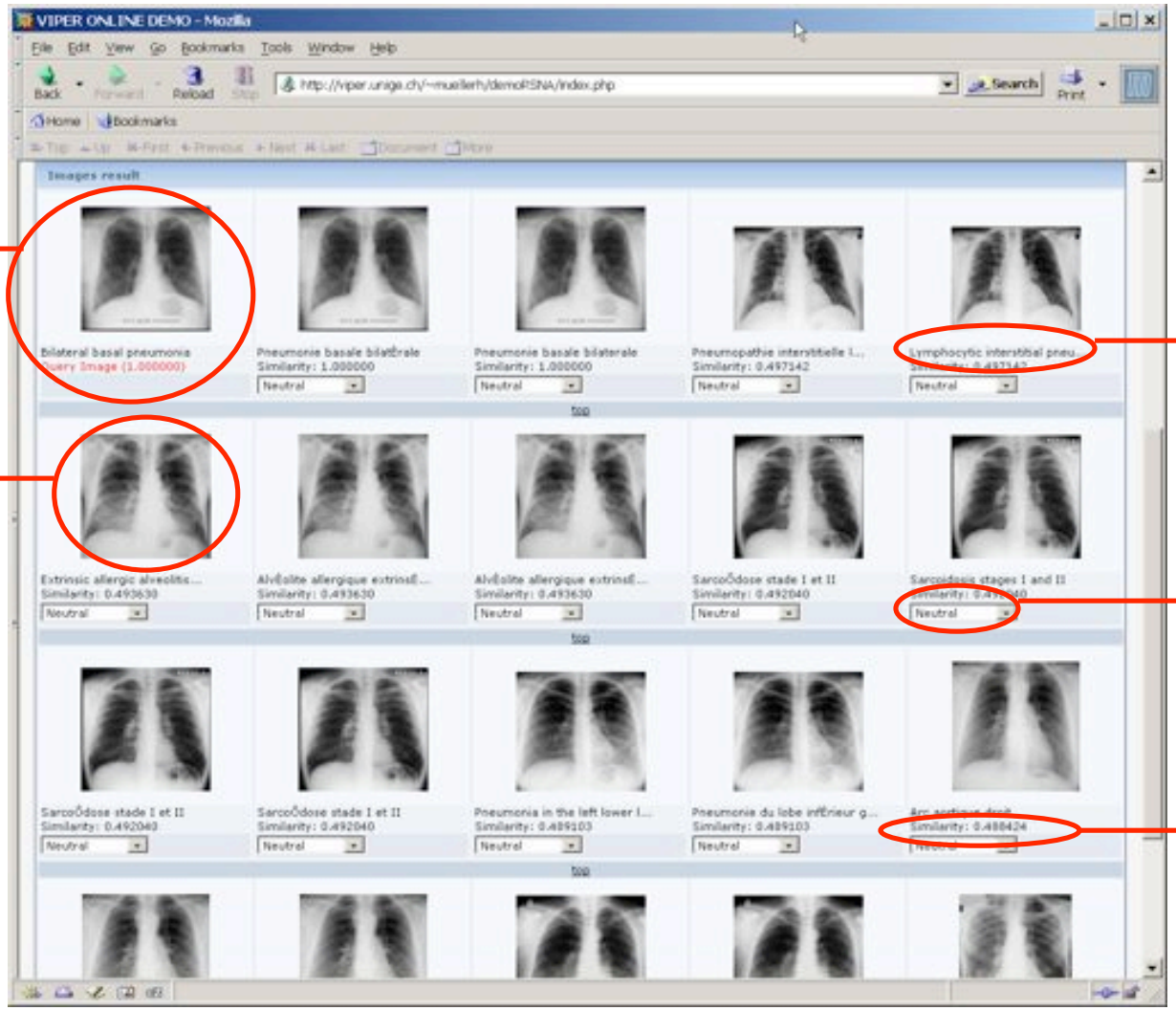
Query starting point

- Example image(s)
  - Internal images (precalculated features)
  - External images
- Sketch
- Marking of regions in images
- Selection of pre-segmented regions
- Text
  - Free text
  - Database fields

User interfaces

- Standards are evolving, similar to web-based navigation (google for images)
- Many of the shown interfaces were similar
  - N=20-50 images on screen
  - Marking of images/regions for feedback
  - Function for random images
- Innovative interfaces:
  - 3D interfaces
  - Interaction with a data glove
    - Basically for sketching
  - Manual grouping of images to define a distance measure

Example interface: medGIFT



Relevance feedback

- Query refinement of a query with new and/or more example images from the result set
- Sometimes clearer formulation possible, of what the user wants
  - AND, OR, NOT, XOR
- Most often: images marked as relevant or non-relevant
  - Sometimes more gradual
- Two ways of calculating this
  - Separate queries for every image (~or)
  - Creation of a «pseudo-image» and one query (~and)

Positive and negative feedback

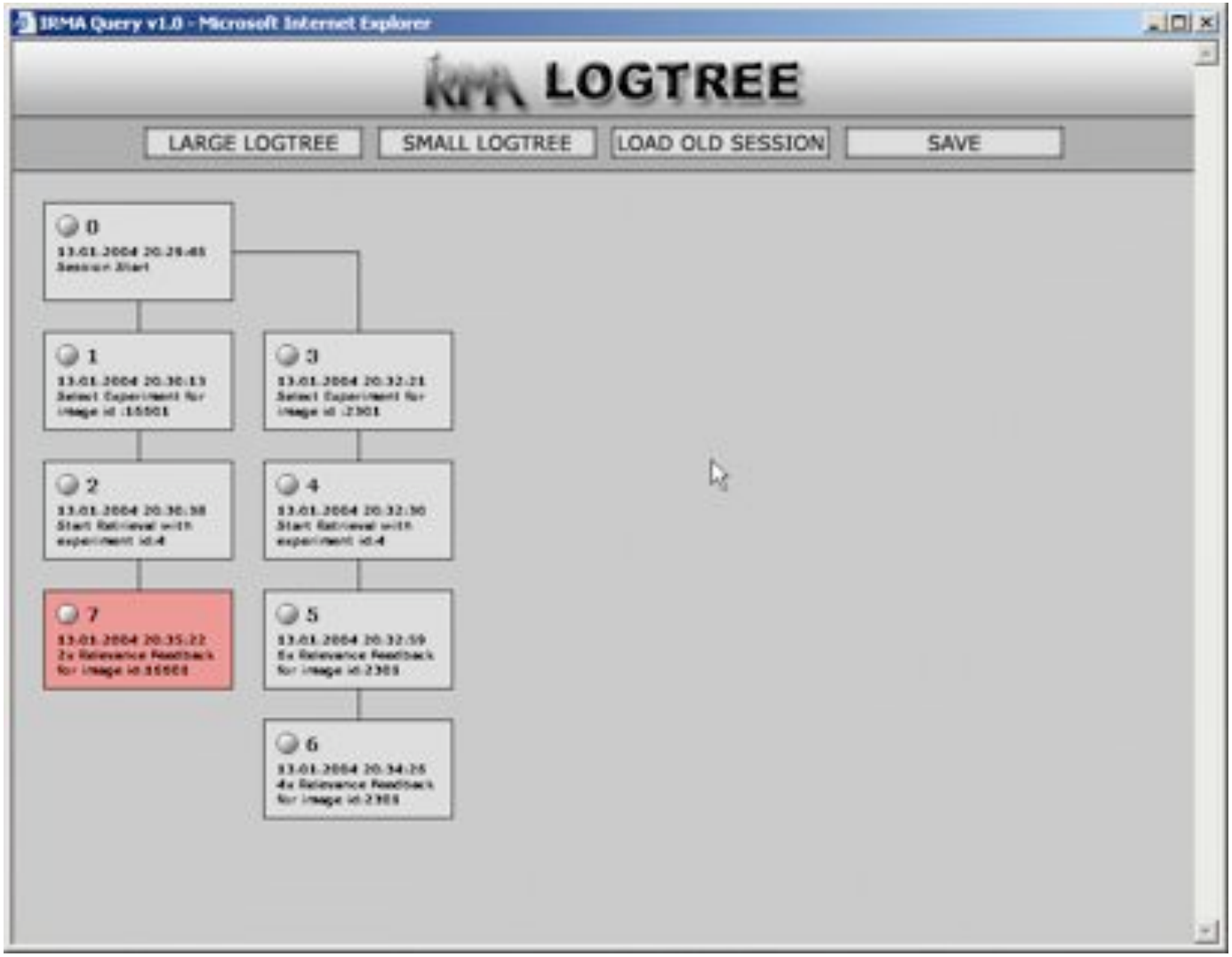
- Studies on strategies for relevance feedback
  - Positive feedback often a reordering of top results or one new query with a single image
    - Images already have much in common
  - Negative feedback is key to good results
    - Really new images are retrieved
    - Much more information is supplied
  - Problem with two much negative feedback!
    - Images with small number of features are returned
  - As much feedback as possible delivers best results

Rocchio Feedback (1960s)

- Problem with too much negative feedback also in text retrieval
- Solution: Separately weighting positive and negative parts of feedback
  - Often positive=0.65, negative=0.35

$$tf_j = \frac{\alpha}{n_1}\sum_{i=1}^{n_1} \mathrm{Rel}_i \cdot tf_{ij} - \frac{\beta}{n_2}\sum_{i=1}^{n_2} \mathrm{Rel}_\mathrm{i} \cdot tf_{ij}$$

Storage of an interaction tree

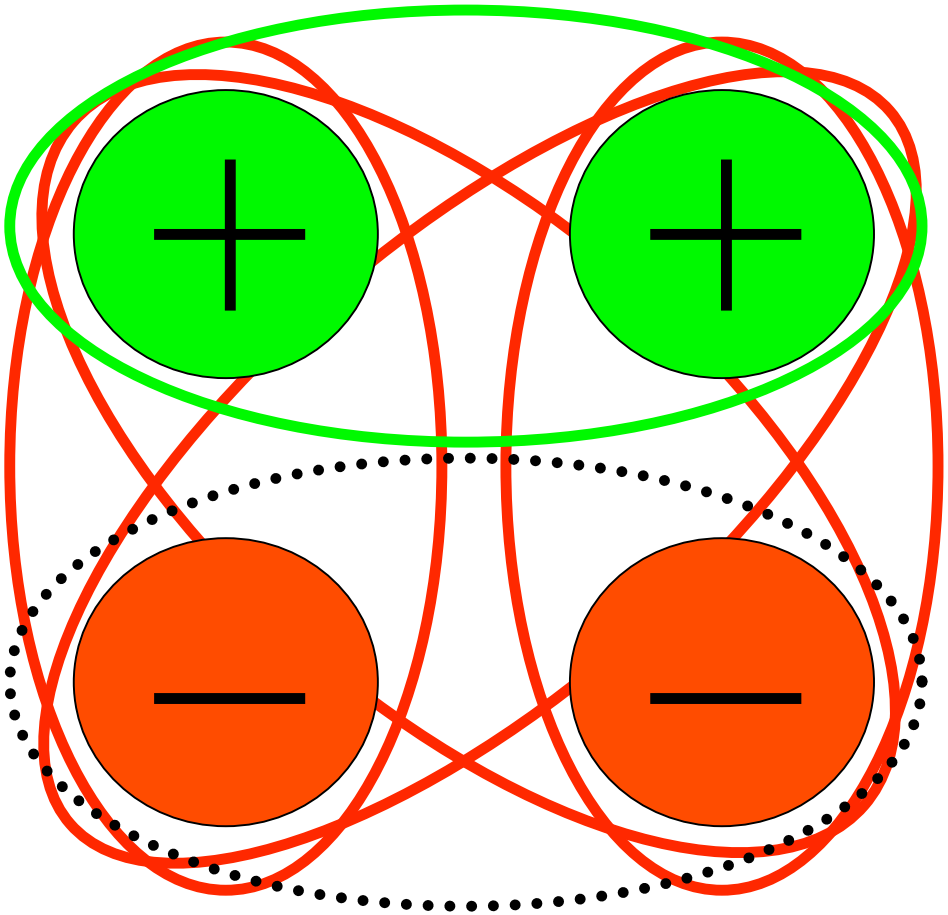


Market basket analysis

- Artificial intelligence problem
- Articles bought together by consumers in a supermarket
  - Extremely large data sets exist
  - Efficient calculation is the main goal
- How does a change in layout change what the consumers buy, what is bought together anyways

- Some similarities with image retrieval
  - Which features perform well based on what the users do

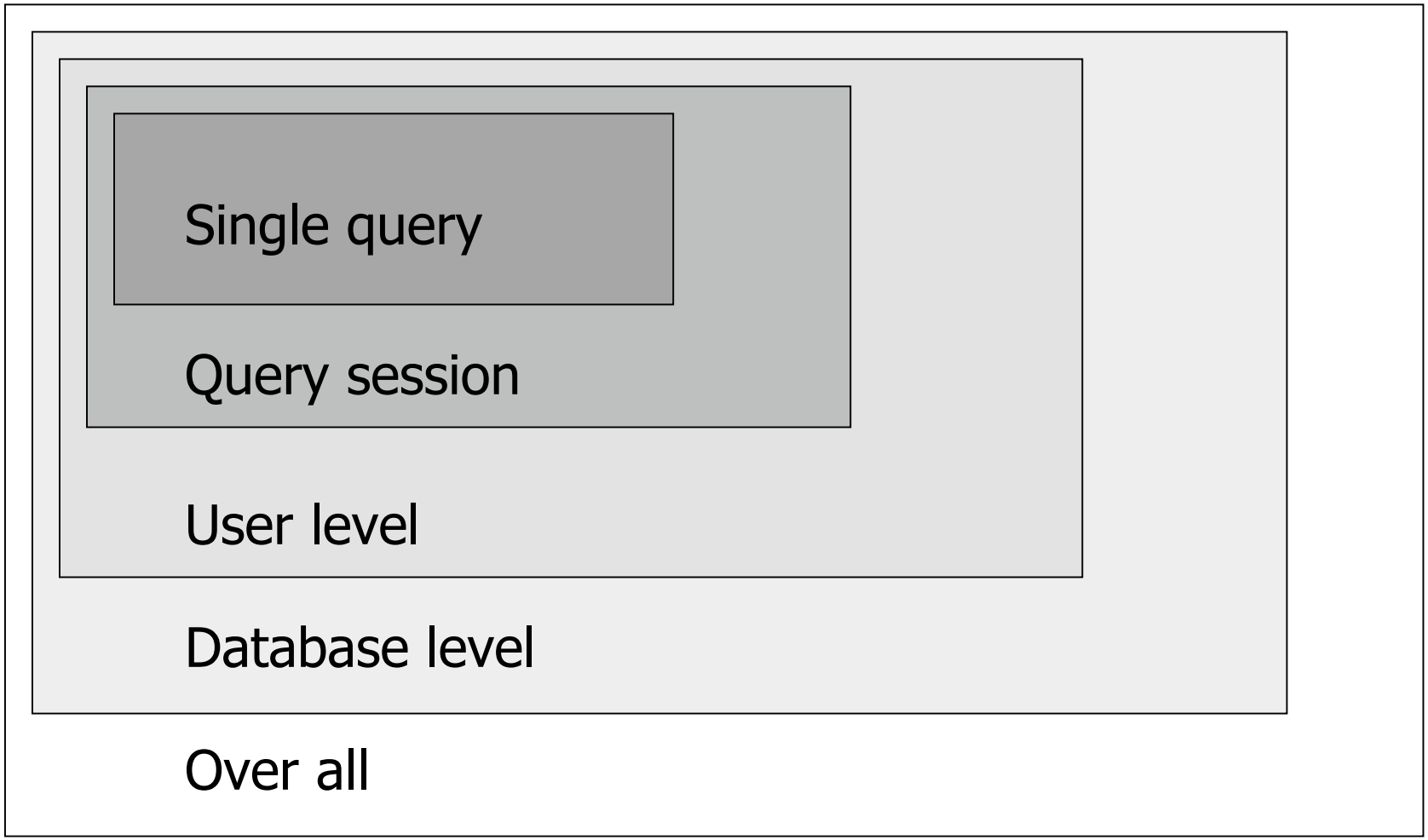
Combination of images from usage log files



Learning from log files

- Large log files of user interaction exist from web demos
- Find out the images marked together
  - To return them for a similar query
- Better: Find out which features these images have in common
  - Calculate the important for each feature
    - Include it into the distance measure
    - Include it into the feature weighting
    - Can be an additional factor
- Goal: system gets better over time the more it is used
- Learning over several databases does not work too well

Learning over several scales



Conclusion

- Interaction is the key for information retrieval success
  - Interfaces, speed, …
- System needs to be able to get as much information as possible on user goals
- When logging the user behavior and using this information, important improvements can be obtained in the long term