

ImageCLEF 2013 overview & Techniques of MedGIFT in 2013



Overview

- **ImageCLEF 2013**

- Data set
- Tasks
- Outcomes

- **MedGIFT 2013**

- Approaches
 - Each of the tasks
- Lessons learned

Image
CLEF
med



ImageCLEF history

- CLEF started as part of TREC until 1999
- ImageCLEF started as part of CLEF in 2003
 - 4 participants
- Medical task started in 2004
 - 12 participants
- 2013 with four tasks in ImageCLEF
 - Medical, photo, plant, robot vision
 - Over 240 research groups registered

ImageCLEF objectives

- Explore various techniques for **cross-language** image retrieval
 - First year included only textual approaches
- Concentration on **multimodal** retrieval
 - Combine visual retrieval with text retrieval
 - Including semantic retrieval and combinations with it
 - Potentially other modalities
 - Depth sensor, several images of a plant (flower, leave, full plant, ...), GPS, data, time of when a picture was taken
- Explore **machine learning** approaches

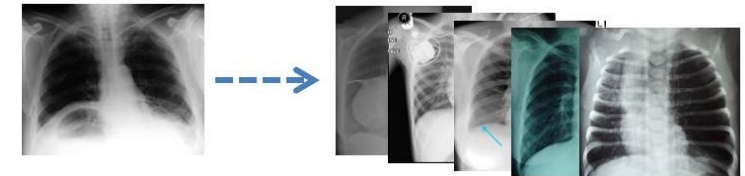
Medical data set used in 2013

- PubMed Central data set
 - Only articles allowing redistribution
 - Downloadable at the NLM
- 300'000 images of 75'000 articles were chosen
- Many challenges
 - Large number of compound figures (around 30%)
 - Small number of clinical images (around 20%)
 - Extremely large variety of images
 - Definition of 38 image types does not allow classifying all
- Full text, caption text, and also MeSH terms



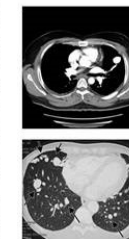
Tasks

- Image-based retrieval task



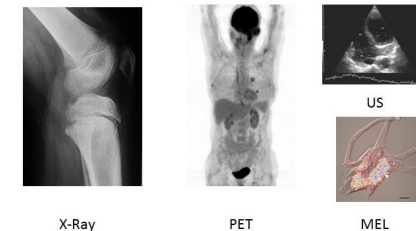
- Case-based retrieval task

A woman in her mid-30s presented with dyspnea and hemoptysis. CT scan revealed a cystic mass in the right lower lobe. Before she received treatment, she developed right arm weakness and aphasia. She was treated, but four years later suffered another stroke. Follow-up CT scan showed multiple new cystic lesions.



[Cystic nephroma: a case report and review of the literature](#)
2008 Case 1
ABSTRACT: Cardiovascular magnetic resonance diagnosis
cystic renal 2009 J Cardiovasc Magn Reson
RESULTS: Late gadolinium enhancement of the lung as a
nature of can
Article in J
Authors: T
http://www.jc
Article in PDF-Version
Authors: T
http://www.jc
View all images
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- Modality classification task

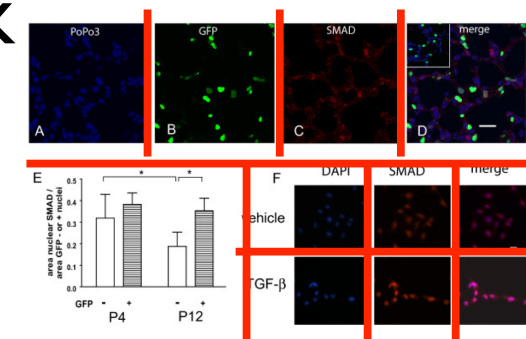


X-Ray

PET

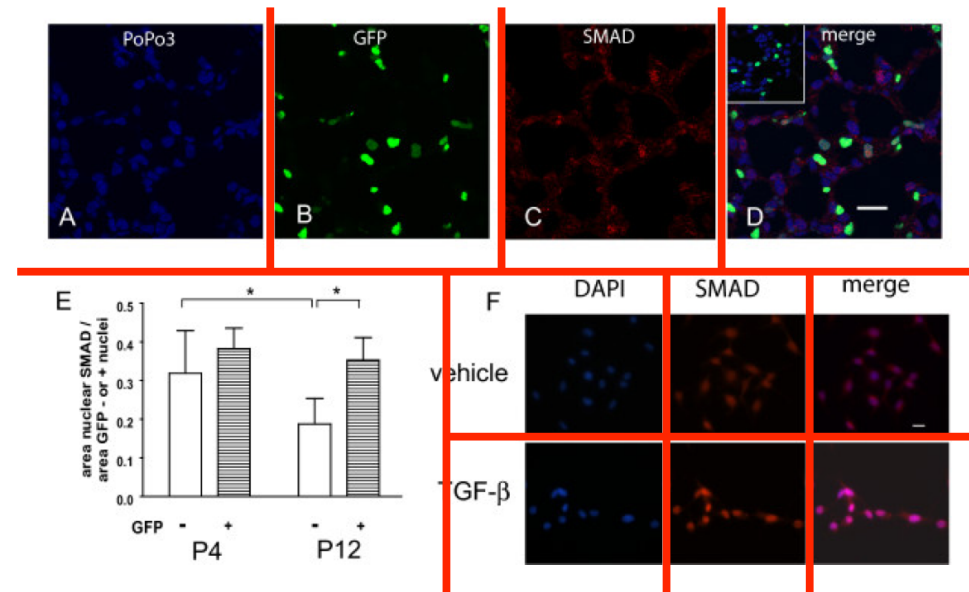
MEL

- Compound figure separation task



Compound figure separation

- Large **proportion** of images are compounds
- Each subfigure carries meaning
 - But context of the subfigures has to be kept
 - Link to an article and figure caption
 - Visual and textual information can be used



Modality classification

- **Image type** is extremely important for retrieval
 - Filtering irrelevant results
 - On several levels
- Compound figures are apart
- **Diagnostic** or not is important
- **Radiology** or not is important

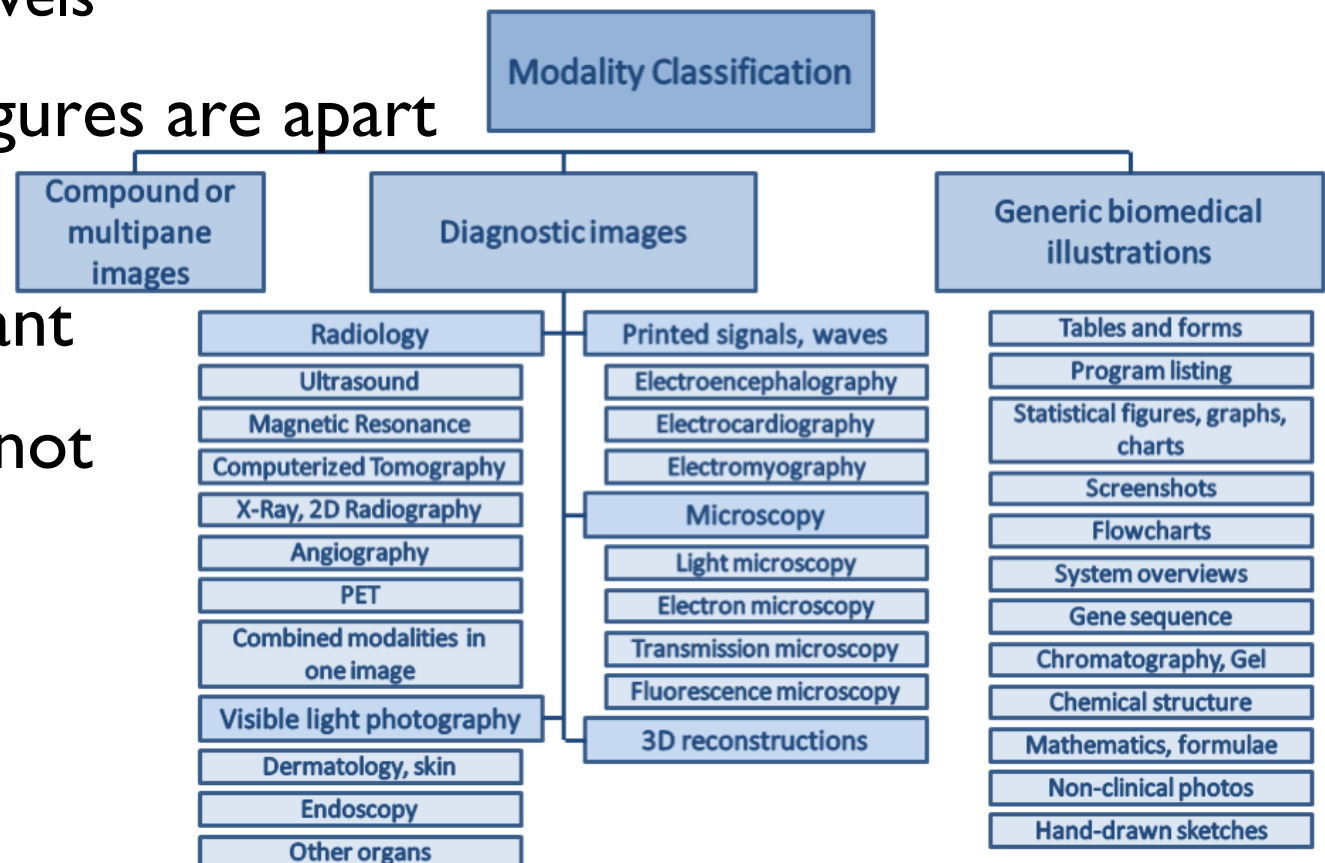


Image-based retrieval

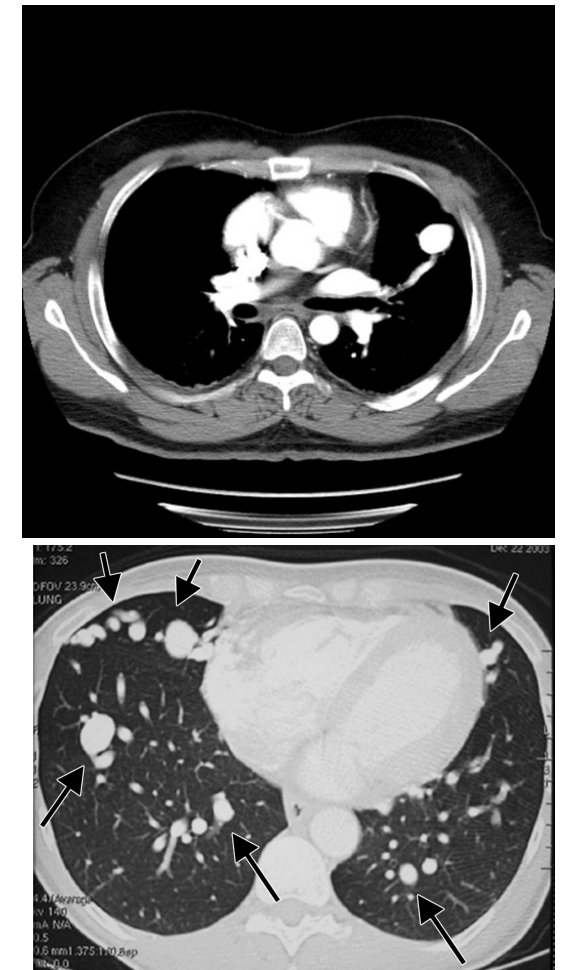
- Targets are **images** of a specific kind
- Show me x-ray images of a tibia with a fracture.
- Zeige mir Röntgenbilder einer gebrochenen Tibia.
- Montre-moi des radiographies du tibia avec fracture.



Case-based retrieval

- 35 case descriptions
 - Patient demographics, limited symptoms, test results,
 - NOT the final diagnosis

A woman in her mid-30s presented with dyspnea and hemoptysis. CT scan revealed a cystic mass in the right lower lobe. Before she received treatment, she developed right arm weakness and aphasia. She was treated, but four years later suffered another stroke. Follow-up CT scan showed multiple new cystic lesions.



Lessons learned

- **Multiple-feature** approaches can improve performance, particularly for visual approaches
- **Text** is better in the retrieval tasks whereas for compound figure separation and modality detection **visual** approaches work best
 - Visual is good for early precision
- **Fusion** can improve results over single modalities
 - Not always
 - Sometimes early and sometimes late fusion works best

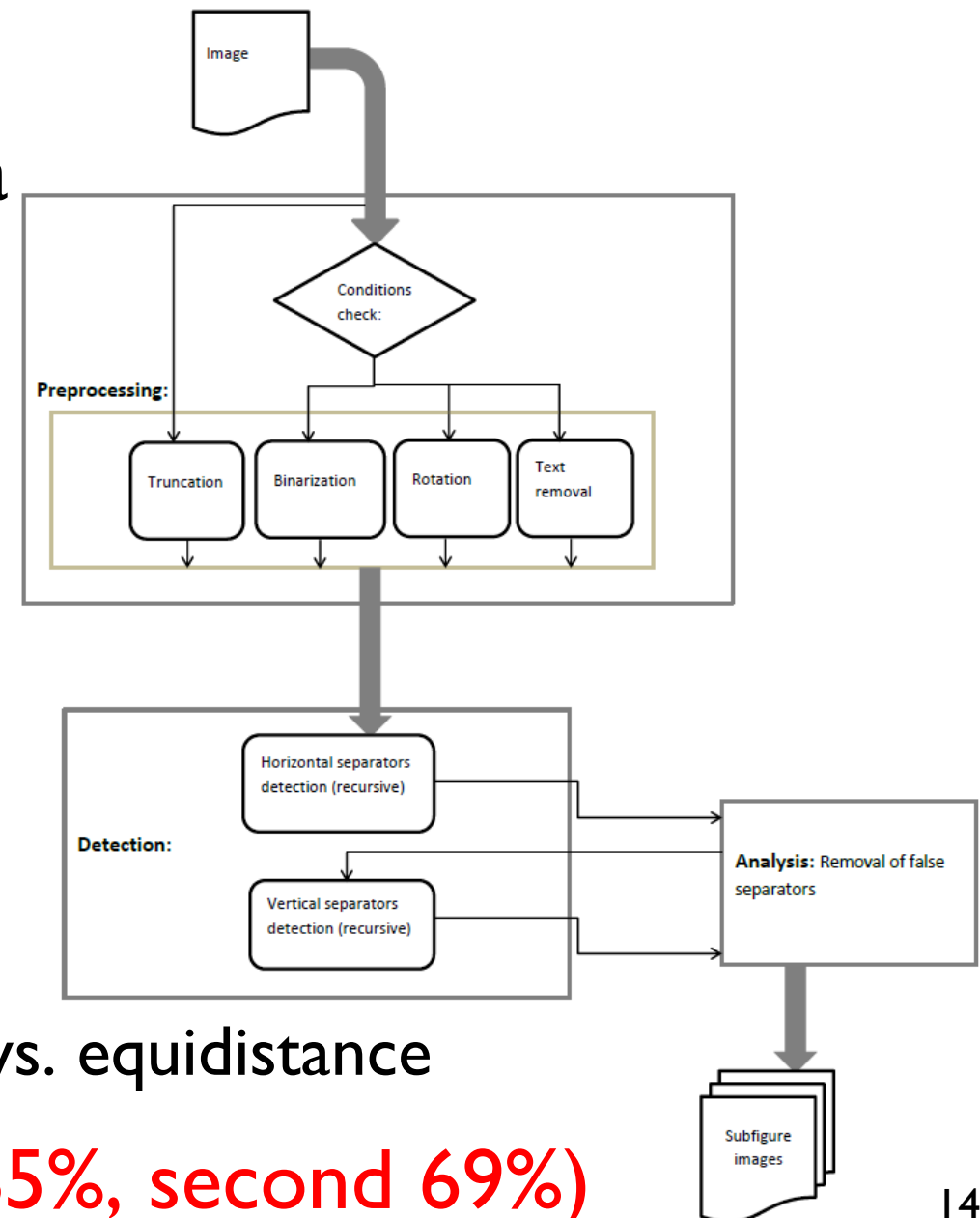
ImageCLEFmed 2014

- No medical retrieval task
- Semantic liver annotation task
 - Given a liver volume, mark tissue with semantic labels
- Annotated database exists
 - Currently being packaged
- First real 3D task in ImageCLEF



Compound figure separation

- Development of **rules** based on training data
- Lines across image in a single color
- Lines across image with **no variance**
- **Iterative** approach
- Consistency check in the end
- Proximity of separators vs. equidistance
- **Best overall results (85%, second 69%)**



Text-based retrieval

- Text retrieval is using **Lucene** in standard setting as a strong baseline
 - Indexing of full text
 - Indexing of captions
- Extraction of **RadLex** terms from the figure captions
 - Mainly for the modality classification





Visual retrieval

- Using the **ParaDISE** system
 - Parallel Distributed Image Search Engine
 - Outcome of the Khresmoi project
- Multitude of **visual descriptors**
 - CEDD + BoVW + FCTH + BoC + FCH
 - SIFT in the bag of visual words

Other strategies

- Extending the **training data** set for modality classification automatically
 - Finding terms in the captions for modalities
 - Not optimal strategy, we found out, ...
- Using various **filtering** strategies
 - Only radiology images, only diagnostic images, ...
- Using **semantic** links in RadLex for modality classification
 - Better for radiology modalities, otherwise no change

Modality classification

- **Error** in compound figure separation reduces overall results (70% instead of 79%)
- **Extended training data** did not help
 - Not using text queries for extension
- **Semantics** only helps for radiology modalities
- Results:
 - Visual: 64%, best 81%, 10th position of 19
 - Text: 62%, best 64%, 6th position of 10
 - Mixed: 70%, best 82%, 5th of 22

Image- & case-based tasks

- **Image-based**

- Visual: MAP 1.3%, best 1.8%, 2nd of 28
- Textual: 25%, best 31%, 5th of 27
- Mixed: 25%, best 32%, 5th of 12

- **Case-based**

- Visual: 0.3%, best 2.8%, 2nd of 5
- Textual: 18%, best 24%, 11th of 33
- Mixed: 15%, best 16%, 2nd of 5

Lessons learned

- Mistakes in a new system are not easy to find
 - Mistake in feature extraction
 - Wrong training set expansion
 - Mistake linked to image that could not be read
- **Image-based** tasks
 - Several features fused lead to better results
 - For us with late fusion but early fusion results need to be explored in a better way
- **Case-based** tasks
 - More complex matching and filtering is needed, particularly for the visual retrieval

Conclusions

- **ImageCLEFmed** has provided resources for evaluation over ten years
 - Important creation of databases for various tasks
 - Increasingly complex and realistic scenarios
 - Many papers published on the data (impact analysis)
- **MedGIFT** group has provided GIFT system as a baseline for many years
 - Clear performance gain can be shown over the years!
 - Visual-word based approaches lead to better results
 - Lucene is good but terminologies can do better
- **Fusion** is the key to success