

Medical image analysis and retrieval

Henning Müller

Hes·SO VALAIS WALLIS

 Haute Ecole Spécialisée

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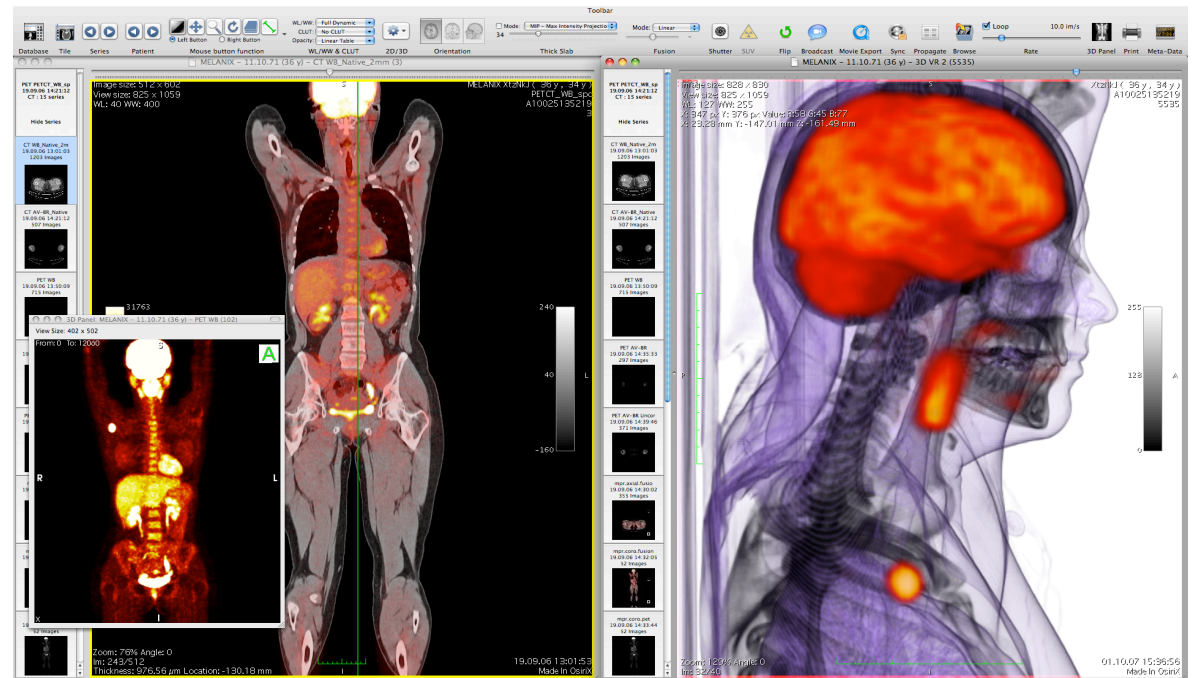
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UNIVERSITÉ DE GENÈVE



Overview

- My background
- Our laboratory
- Current projects
 - Khresmoi, MANY, Promise, Chorus+, NinaPro
- Challenges
- **Demonstration**
- Conclusions

Personal background

- Studies of medical informatics in Heidelberg, Germany (1992-97)
- Work at Daimler-Benz research, USA (1997-98)
- PhD in **image processing**, University of Geneva, Switzerland (1998-2002)
- Work on artificial intelligence at Monash University, Melbourne, Australia (2001)
- Medical Informatics Service, University and **Hospitals of Geneva** (2002-)
- HES-SO, Business information system, Sierre (2007-)

Sierre, Switzerland



HES-SO Sierre (part of HES-SO)

- 1'500 students
 - Economy, tourism, business informatics
- Institute of business **information systems**
- Research in focused domains
 - Internet of things, RFID
 - Mobile applications
 - Energy, Green ICT
 - SAP Center
 - **eHealth**
 - **Information retrieval and management**



Research team

Henning Müller

Professor

Adrien Depeursinge

Postdoc

Theodora Tsikrika

Postdoc

Manfredo Atzori

Postdoc

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Medical Doctor

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Ph.D. student

Dimitris Markonis

Ph.D. student

Alba Garcia

Ph.D. student

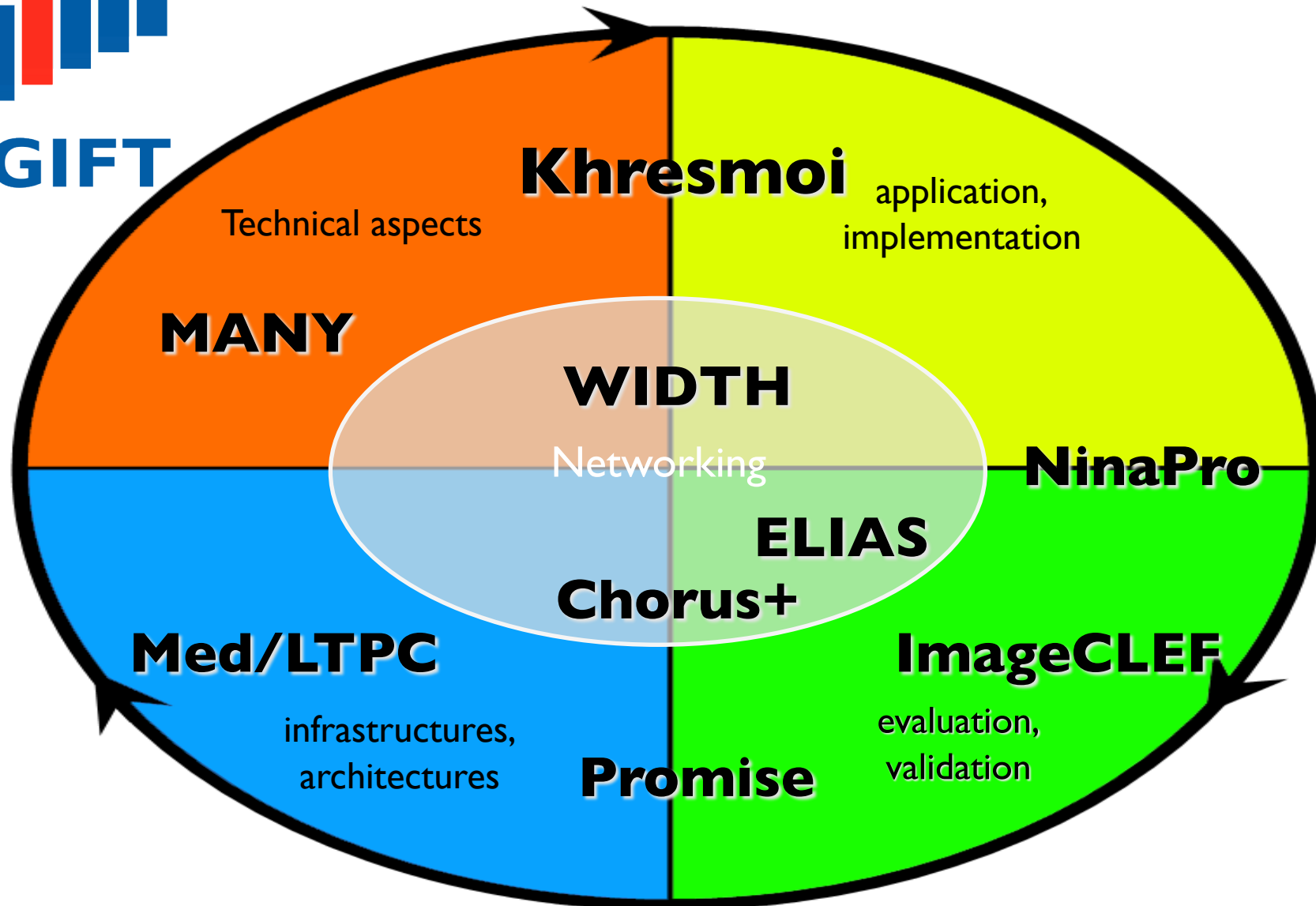
Xin Zhou (GE)

Ph.D. student

Ivan Eggel

Developer

Current projects



Introduction to medical image retrieval

Retrieval vs. classification

- **Classification**

- Fixed, often limited number of well defined classes
- Training and test data
- Examples: modality classification, anatomy, ...

- **Retrieval**

- No fixed set of classes in the data base, rather similarity
 - Information need of user may be subjective, vary over time, based on concept of “relevance”
 - Browsing in information, then judging if relevant
 - Retrieval and classification can be used together
- 9

Example interface

Query image

Diagnosis

Link to Teaching file

Similarity score

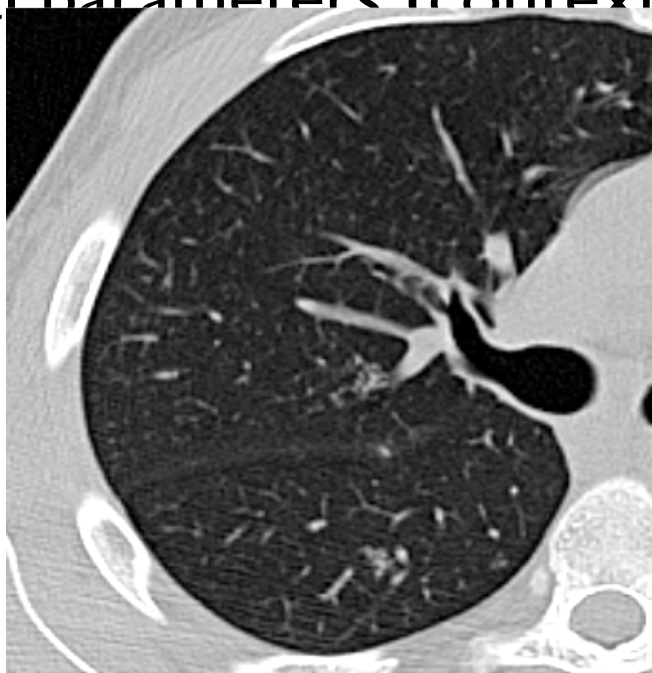
The screenshot displays the 'VIPER ONLINE DEMO - Mozilla' web application. The browser window shows the URL 'http://vipер.unige.ch/~muellerh/demoRSNA/index.php'. The main content area is titled 'Images result' and contains a grid of chest X-ray images. Each image is accompanied by a diagnosis and a similarity score. The first image in the top row is circled in red and labeled 'Query image'. The fifth image in the top row is circled in red and labeled 'Diagnosis'. The similarity score for the fifth image in the top row is circled in red and labeled 'Similarity score'. The interface includes a search bar, navigation buttons (Back, Forward, Reload, Stop), and a 'Search' button. The bottom of the browser window shows the Mozilla status bar.

Image	Diagnosis	Similarity
	Bilateral basal pneumonia	Similarity: 1.000000
	Pneumonie basale bilatérale	Similarity: 1.000000
	Pneumonie basale bilatérale	Similarity: 1.000000
	Pneumopathie interstitielle I...	Similarity: 0.497142
	Lymphocytic interstitial pneu...	Similarity: 0.497142
	Extrinsic allergic alveolitis...	Similarity: 0.493630
	Alvéolite allergique extrinsÈ...	Similarity: 0.493630
	Alvéolite allergique extrinsÈ...	Similarity: 0.493630
	Sarcoïdose stade I et II	Similarity: 0.492040
	Sarcoïdose stages I and II	Similarity: 0.492040
	Sarcoïdose stade I et II	Similarity: 0.492040
	Sarcoïdose stade I et II	Similarity: 0.492040
	Pneumonia in the left lower l...	Similarity: 0.489103
	Pneumonie du lobe inférieur g...	Similarity: 0.489103
	Arc aortique droit	Similarity: 0.488424

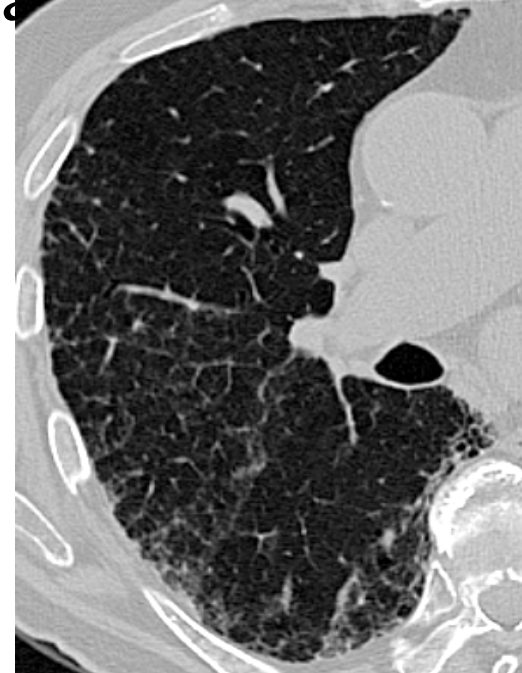
Problems with image retrieval

- Visual retrieval **performance** is fairly low
 - Visual features only work when in a specific domain
 - Text works generally much better, in a different way
- Images alone are **not enough** for a diagnosis
 - Clinical parameters (context) play an important role

25 yo



88 yo



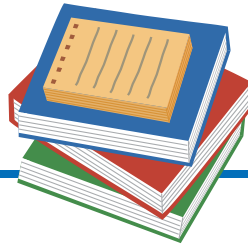
Challenges in radiology

- Little standardization in image use
 - Personal image collections (not legal), restrictive access rights of image archives, Internet (Google)
- Usefulness of results is not always clear
 - Different diagnoses retrieved can help in differential diagnosis or teaching, to explain (dis)similarities
 - Experienced and non-experienced need different results
- Replace search in standard books
 - Context needs to be given and image quality has to be high (confidence in the explication, quality)
- Visually, irrelevance can quickly be determined

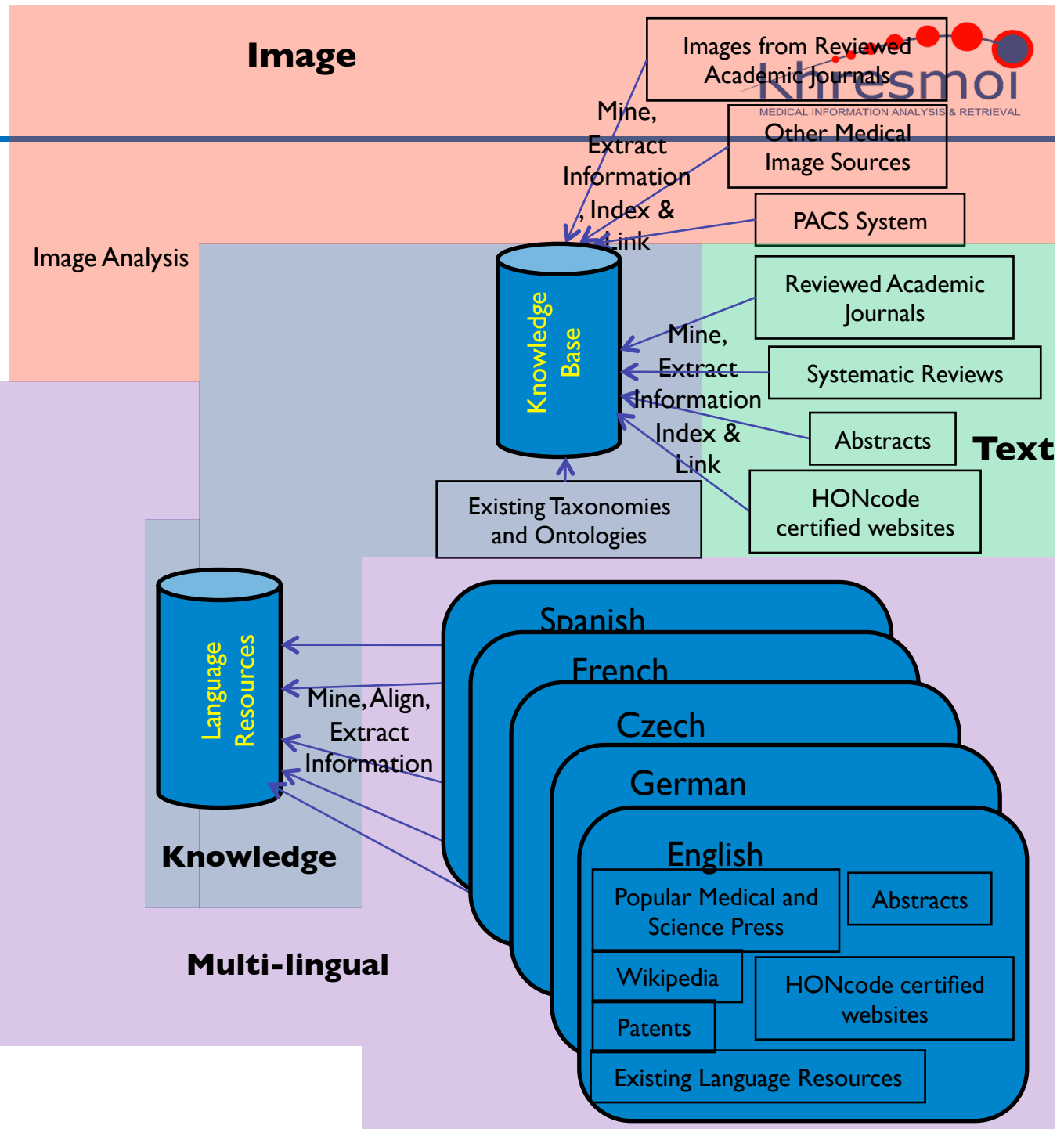
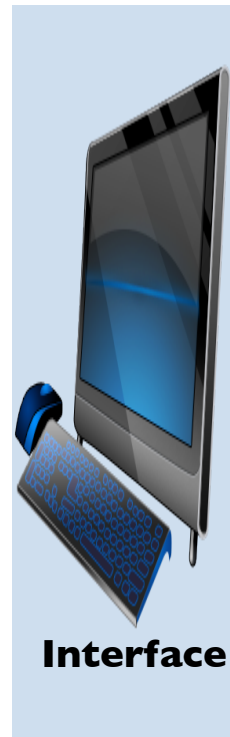
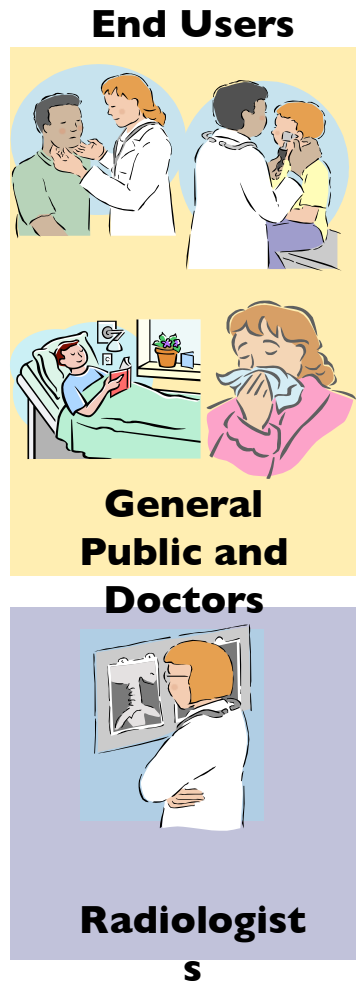
Khresmoi – Knowledge Helper for Medical and Other Information users

The Khresmoi project

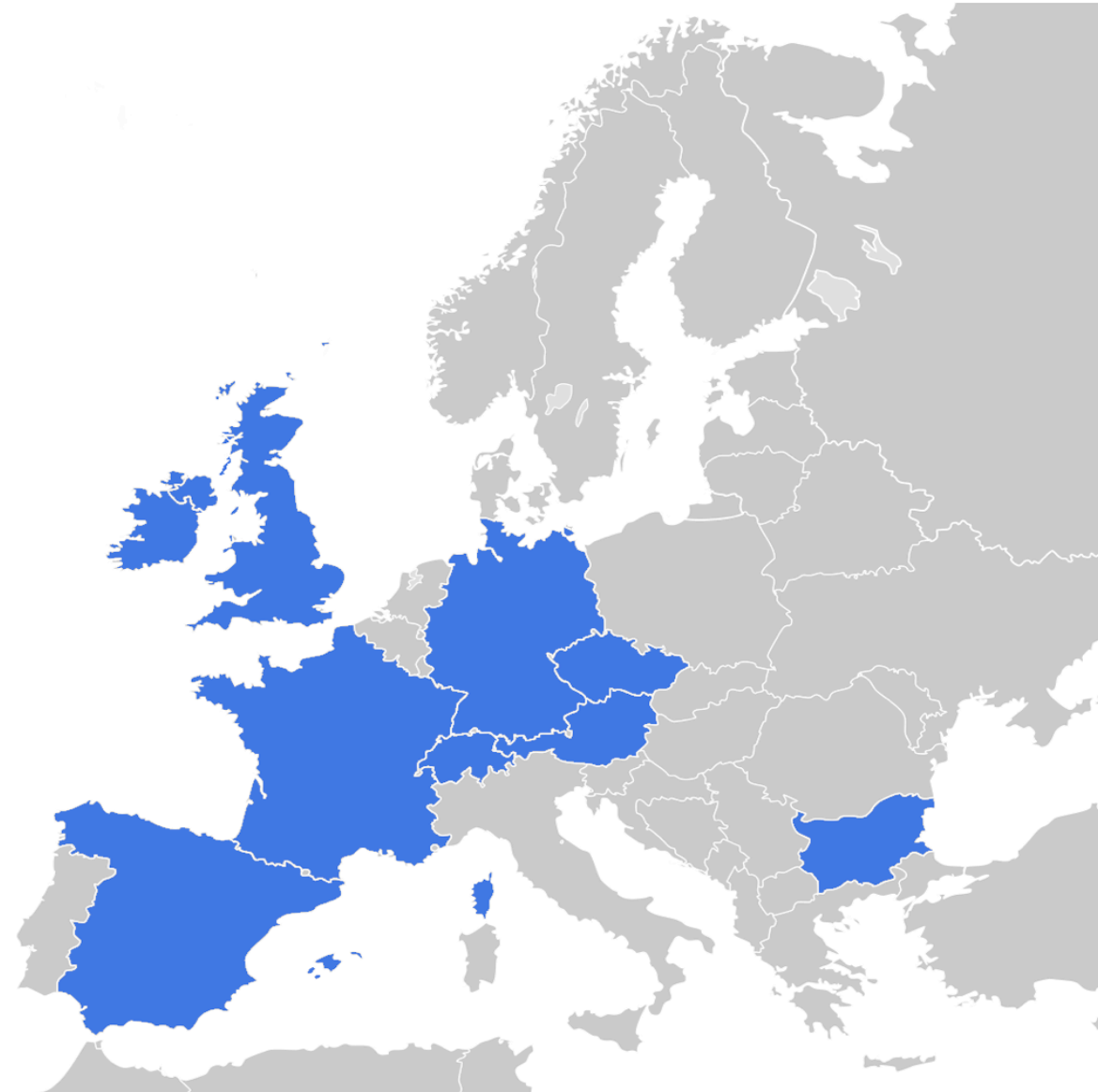
- A **multi-lingual, multi-modal** search and access system for biomedical information and documents
- Data from **many sources**
- **Multi-dimensional** medical images (2D, 3D, 4D)
- Improved search capabilities through
 - Natural language processing, information extraction
 - Supervised and unsupervised categorization,
 - Linking text to knowledge base facts, ...
- **Trustable** results at a **level of understanding** adapted to the users
 - Health on the Net search system



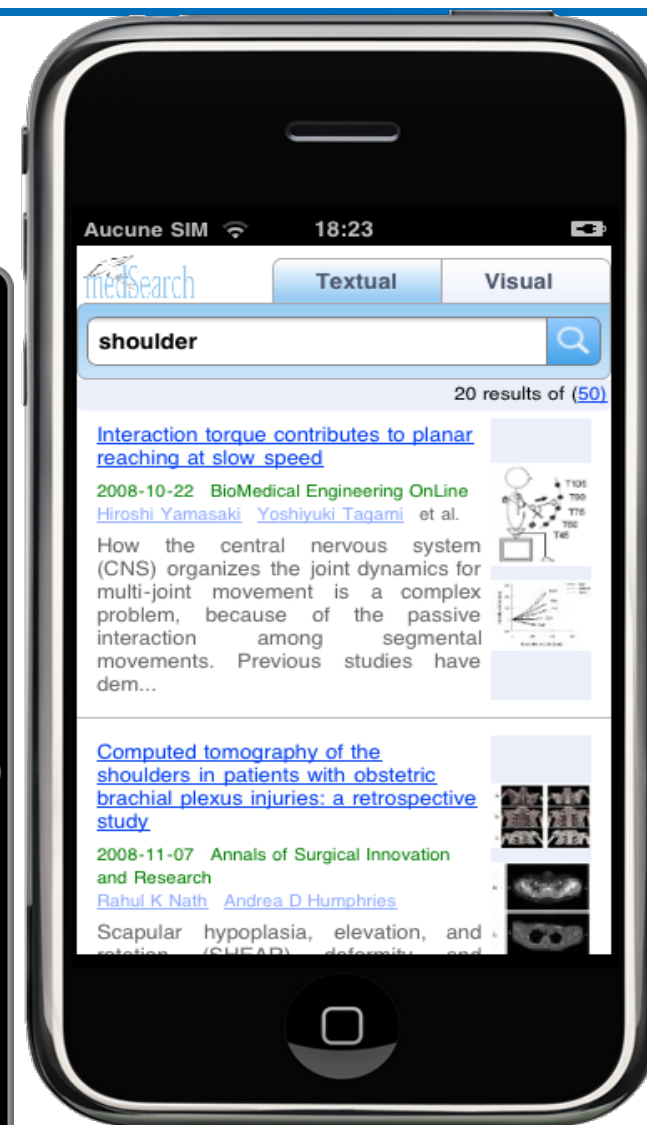
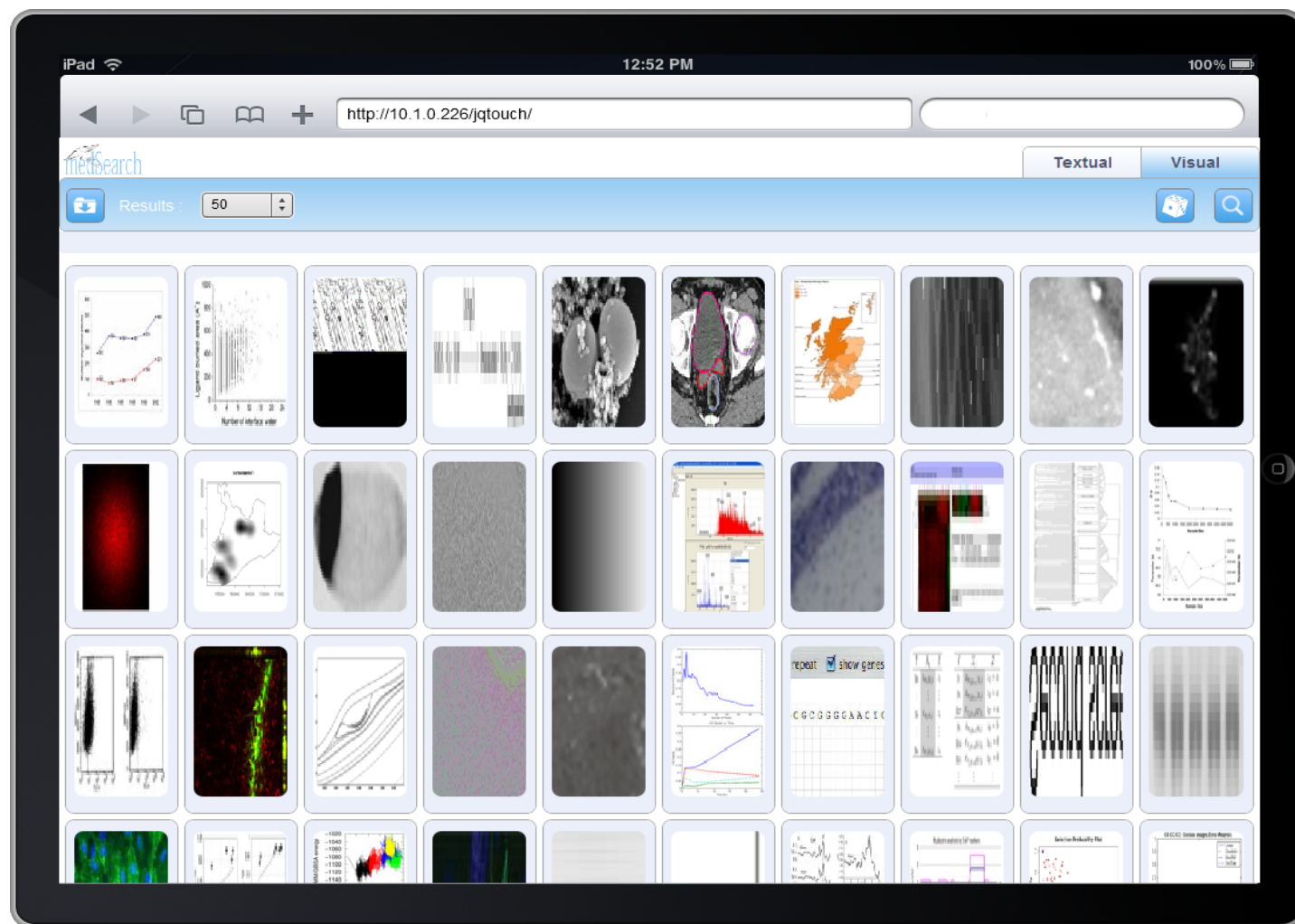
How?



Khresmoi Consortium



Many New Ideas ...

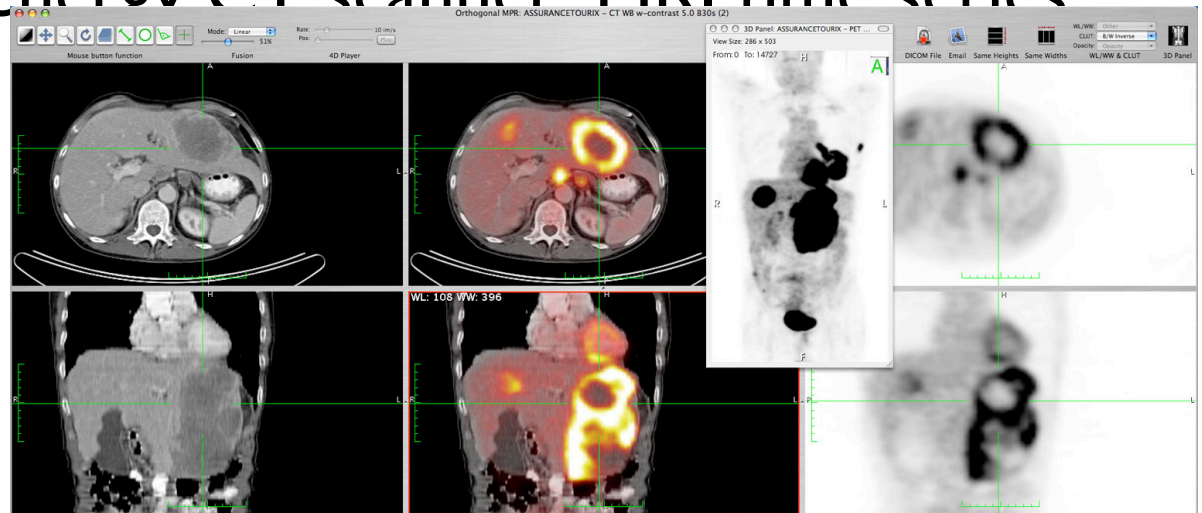


MANY – Medical image retrieval in mANY dimensions



MANY

- Follow up of **Talisman** project on lung images
- Work closely with emergency radiology
 - Quick response is required, not specialized in one image type or anatomic region
- 3D texture analysis > **4D** analysis as well
 - PET/CT data, dual energy CT scanner MRI time series
- 3D visual words
- Not surface-based



Talisman interface

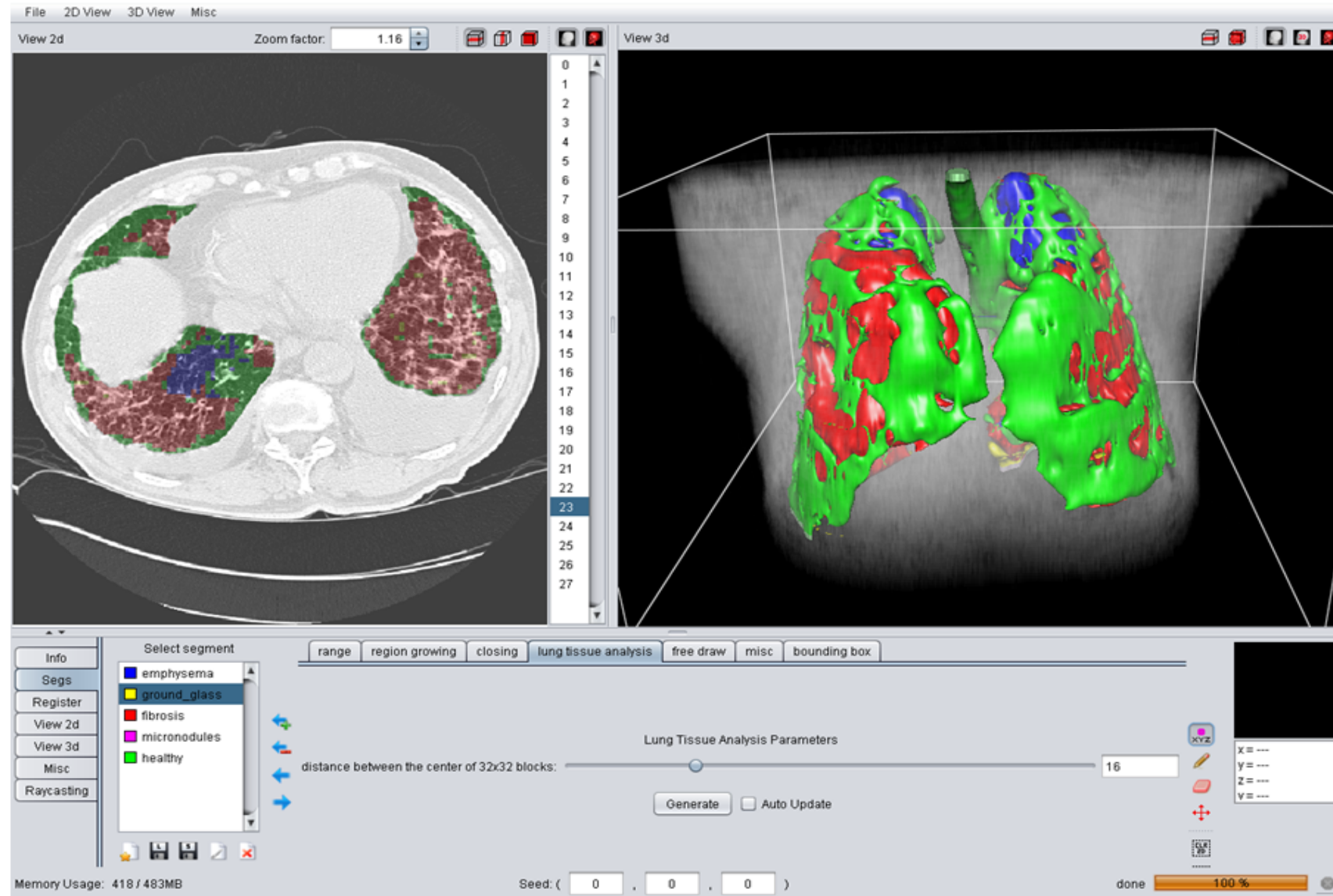


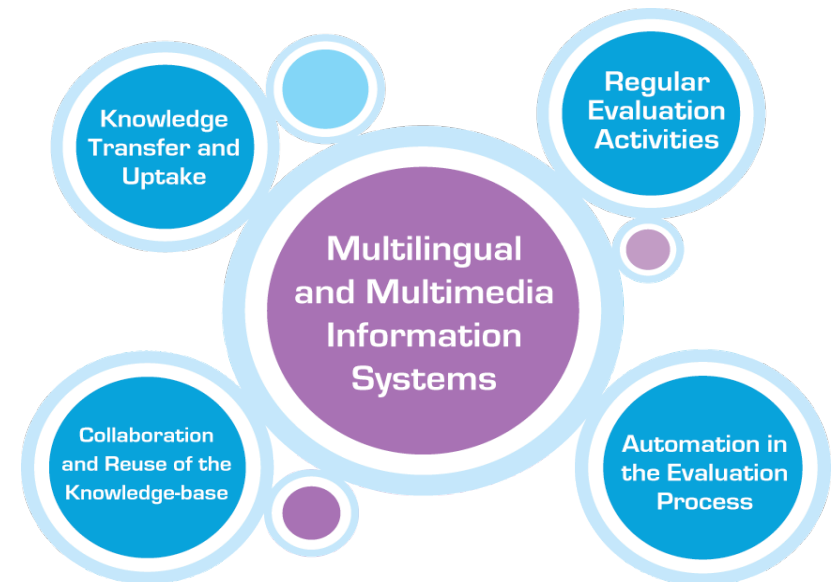
Image retrieval evaluation – ImageCLEF, Promise, Chorus+

- **Coordination** of European activities in networked media, i.e. multimedia retrieval
 - Wiki to exchange data etc.
- Organization of workshops, cluster meeting, ICT events
- Application areas
 - Enterprise search
 - Mobile search
- Policy making





- **Evaluation** of multilingual and multimedia retrieval systems
- Based on the CLEF benchmark and its partners
- Use cases
 - Patent retrieval
 - Unlocking culture
 - **Medical decision support**
- **Visualization** and user interfaces



- **Voluntary** effort to organize an image retrieval benchmark
 - Multi-lingual, multi-modal and language-independent
 - **Little funding**, so not always professional
- Started in 2003
- Medical task since 2004
- Registration rose from 4 to 110
 - About 60 groups submitted results in 2010
- **Tasks in 2011**
 - Medical, Wikipedia, Plant classification, photo annotation

Medical task: evolution

- **Topics**

- First only images, then image search tasks, now also case-based topics and modality classification
- Tasks are based on surveys, analysis of log files (MedLine, Health on the net, ...)
- Currently a larger scale survey is under way

- **Data bases**

- Started with a 8,700 image teaching file, then several teaching files, radiology journals, now Open Access publishers (BioMedCentral, 240,000 images)

Example topics

Show me x-ray images of a tibia with a fracture.

Zeige mir Röntgenbilder einer gebrochenen Tibia.

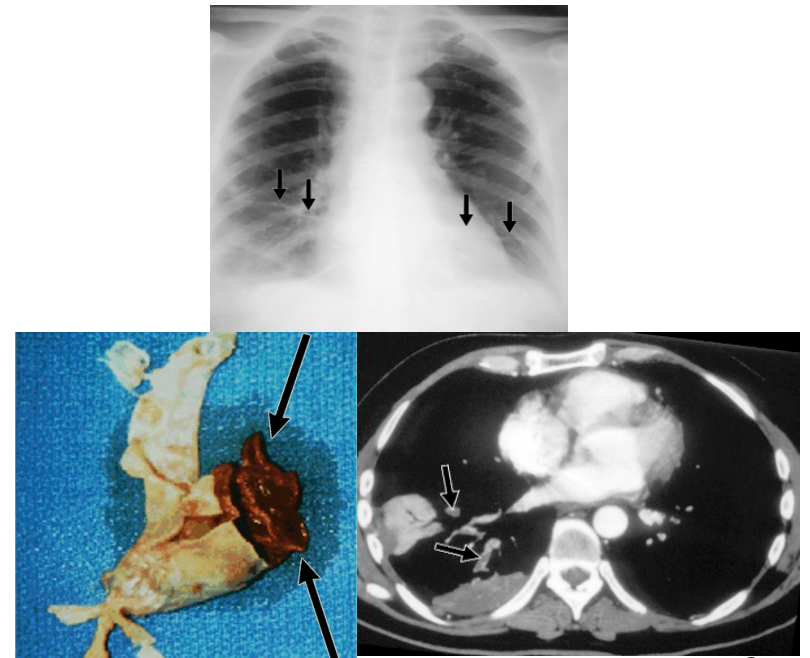
Montre-moi des radiographies du tibia avec fracture.



pulmonary embolism all modalities

Lungenembolie alle Modalitäten

Embolie pulmonaire, toutes les formes



Some lessons learned

- Image retrieval alone has **low** performance
 - Image retrieval can **increase** results, particularly **early precision**
 - **Classification** can be used for filtering and increase results (modality)
- Groups do not like user studies or **interactive** retrieval
 - Could be key to better results
- Combing all results usually is best ... **fusion!**

Upcoming challenges

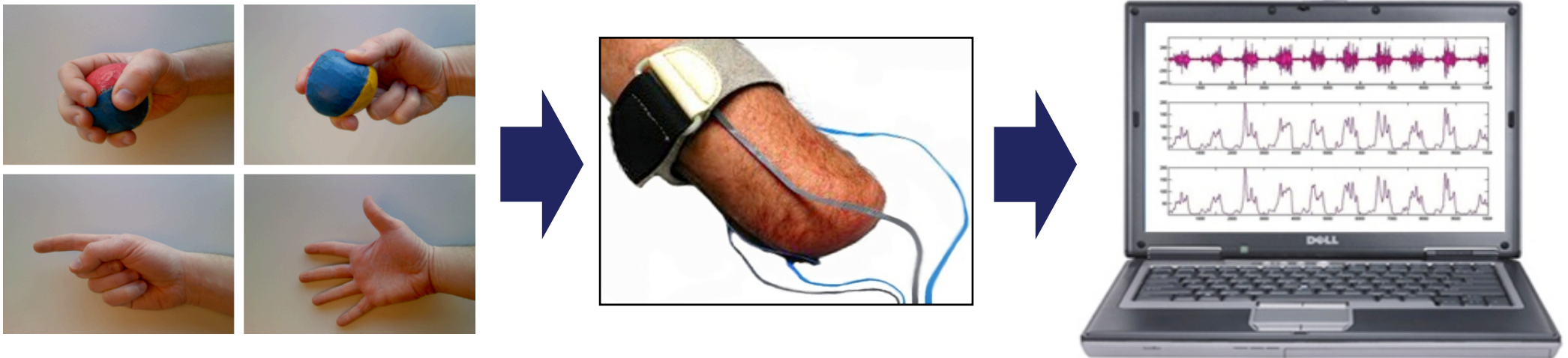
- Very **large scale** retrieval
 - Millions of images
 - PubMed Central has 1 million images, is increasing ...
- Limiting **noise** in retrieval
 - Classification and retrieval combined to have semantic information with a probability score
- **Combinations** of text (multilingual), semantics and visual features
 - Still a lot to learn
 - Confidence scores for combinations need to be better

NinaPro



Non Invasive Adaptive Hand Prosthesis

Step I: NinaPro electromyography database - including clinical data

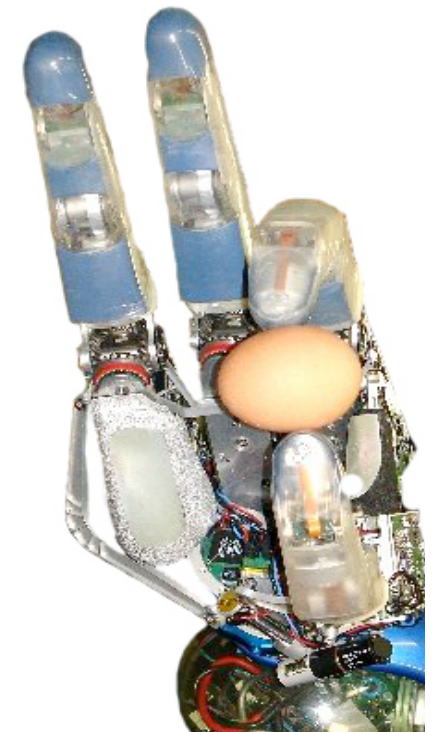


Project overview

- Step 2: posture classification
- Step 3: natural control
- Step 4: adaptive learning



- Results:
 - Augment dexterity of the sEMG prosthesis
 - Reduce training time for amputated persons



Demonstrations

Demonstration: MedSearch

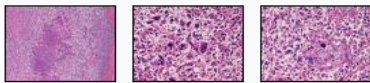
'carcinoma' returned

[+ Options](#)

[Urinary bladder carcinoma with triplicate differentiations into giant cell sarcomatoid carcinoma, squamous cell carcinoma, and papillary urothelial transitional cell carcinoma: a case report](#)

2009-11-30 [Cases Journal](#)

The author reports a very rare and very unique urinary bladder carcinoma. This carcinoma occurred in a 68-year-old Japanese patient who underwent cystectomy for bladder tumor. The tumor was large polypoid and ulcerated one. Histologically, the tumor consisted of the following three elements: giant cell sarcomatoid carcinoma (70% in area), squamous cell carcinoma (20% in area), and papillary urothelial transitional cell carcinoma (10% in area). The former two elements were invasive into the perib...



[View full abstract](#) [Article in PDF-Version](#) [View all images / Visual search](#) [Similar articles](#)

Authors:
<http://www.casesjournal.com>

[Simultaneous Chromophobe renal cell carcinoma and squamous renal cell carcinoma](#)

2007-8-21 [Diagnostic Pathology](#)

Chromophobe renal cell carcinoma (CHRC) is a neoplasm of the kidney with clinicopathologic peculiarities. Classical and eosinophilic types are the two histological variants recorded. Also, it has been described in carcinoma and sarcomatoid renal cell carcinoma. Squamous renal carcinoma is a very rare neoplasm with



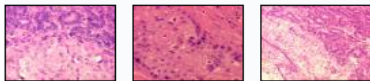
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Authors: [Teresa Pereda](#) [Luis Robles](#)
<http://www.diagnosticpathology.org>

[Collision tumor of the thyroid: follicular variant of papillary carcinoma and squamous carcinoma](#)

2006-9-19 [World Journal of Surgical Oncology](#)

Collision tumors of the thyroid gland are a rare entity. We present a case of a follicular variant of papillary carcinoma and a squamous carcinoma. To our knowledge, this is the first documentation of a collision tumor with a papillary carcinoma and a squamous carcinoma. The theories of origin, epidemiology and management are discussed.



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Authors: [Subhadra Kane](#)
<http://www.wjso.com>

GIFT content-based visual search

Query

Query image

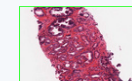
Number of results

Fetch a random set of images

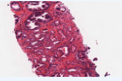
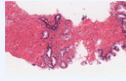
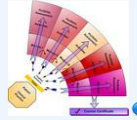
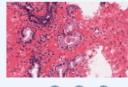
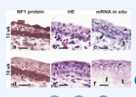

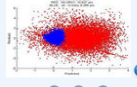
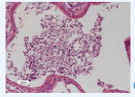
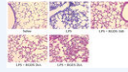
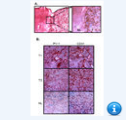
Launch the query

Clear the query

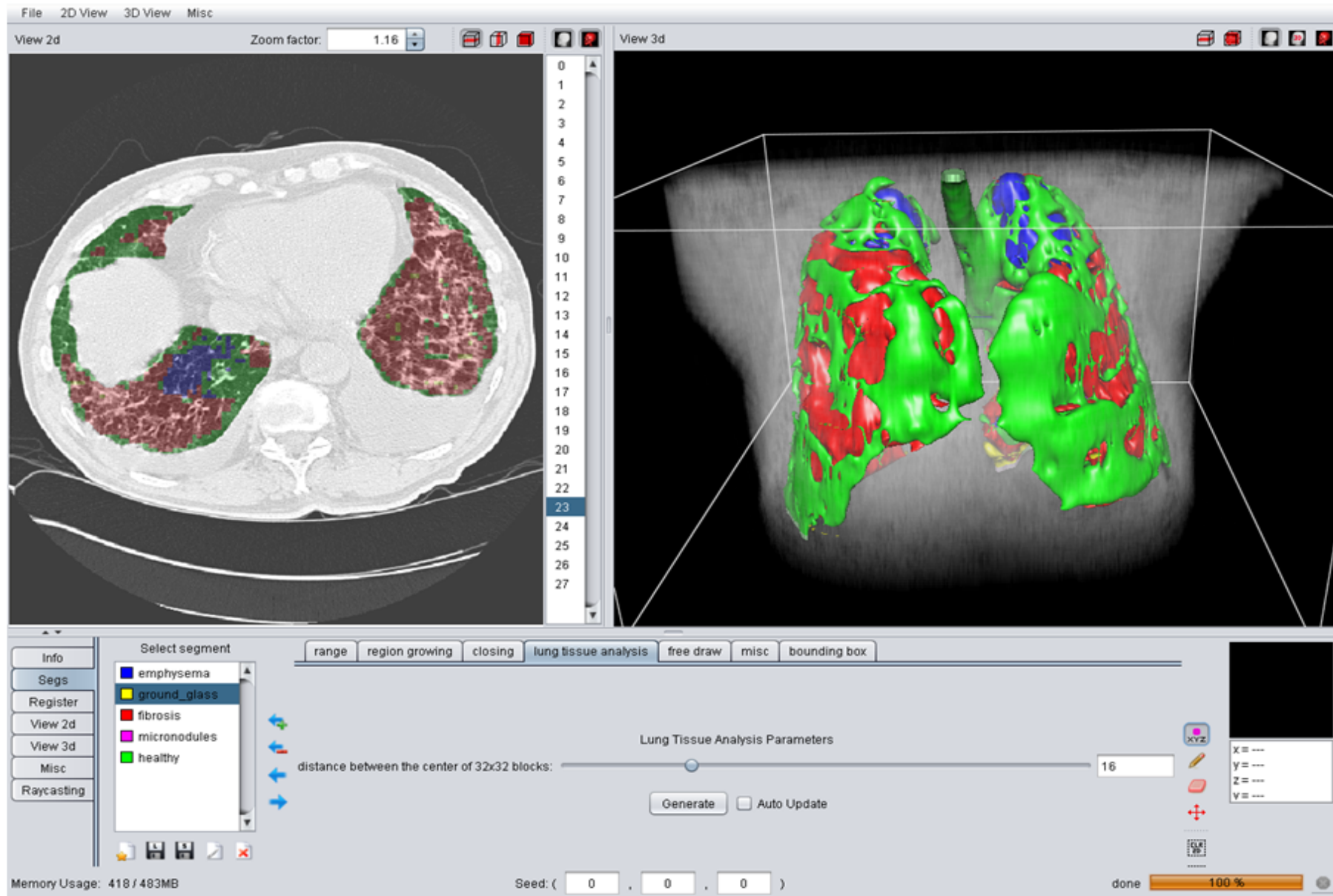
Queried images(s)



Results

top				
 Query image Similarity: 1.0 Show dedicated Article	 Similarity: 0.390065 Show dedicated Article	 Similarity: 0.395567 Show dedicated Article	 Similarity: 0.385454 Show dedicated Article	 Similarity: 0.380981 Show dedicated Article
top				
 Similarity: 0.372831 Show dedicated Article	 Similarity: 0.366244 Show dedicated Article	 Similarity: 0.36288 Show dedicated Article	 Similarity: 0.361117 Show dedicated Article	 Similarity: 0.358835 Show dedicated Article
top				
 Similarity: 0.355477	 Similarity: 0.355417	 Similarity: 0.353589	 Similarity: 0.348512	 Similarity: 0.348744

Video: MANY



Conclusions

- Images supply much information in diagnosis and treatment planning
 - **Extraction** of relevant features is not always easy
 - **Combination** with clinical data/knowledge is needed
 - Integration with clinical feedback is essential
 - 3D/4D data are now the largest volumes produced
- Visual information can be helpful in information search on several levels
 - Information search in the literature and databases
 - **Learning from the past** in clinical records

Questions?

- More information can be found at
 - <http://www.khresmoi.eu/>
 - <http://medgift.hevs.ch/>
- Contact:
 - Henning.mueller@hevs.ch

