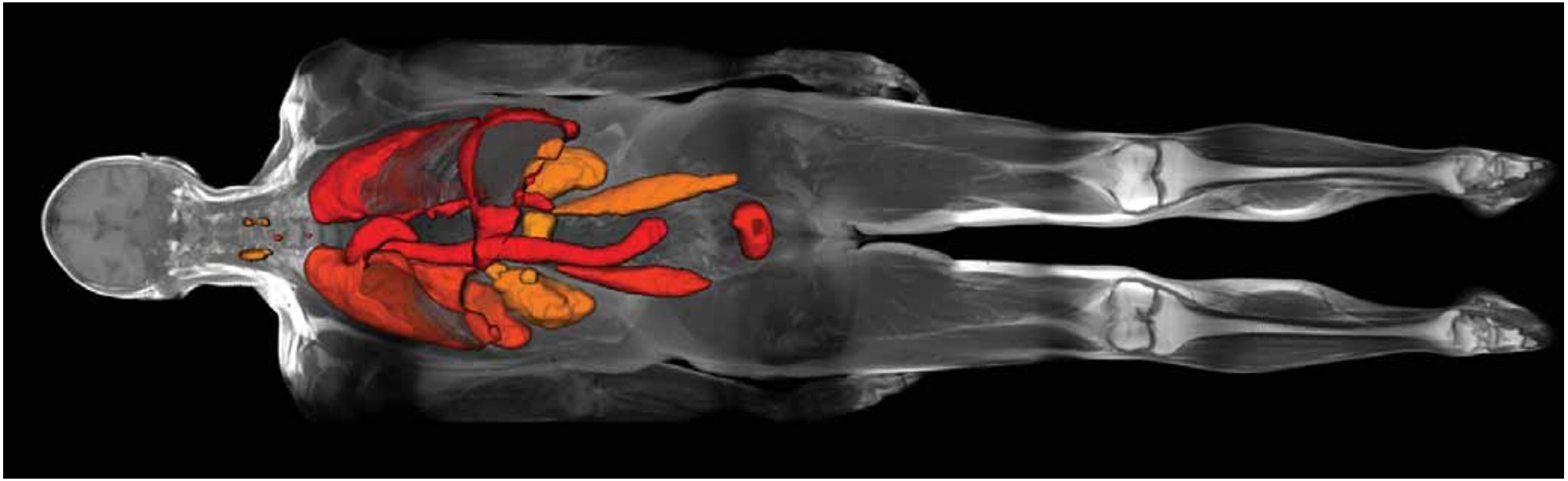
khresmoi
MEDICAL INFORMATION ANALYSIS & RETRIEVAL

Medical 3D data retrieval

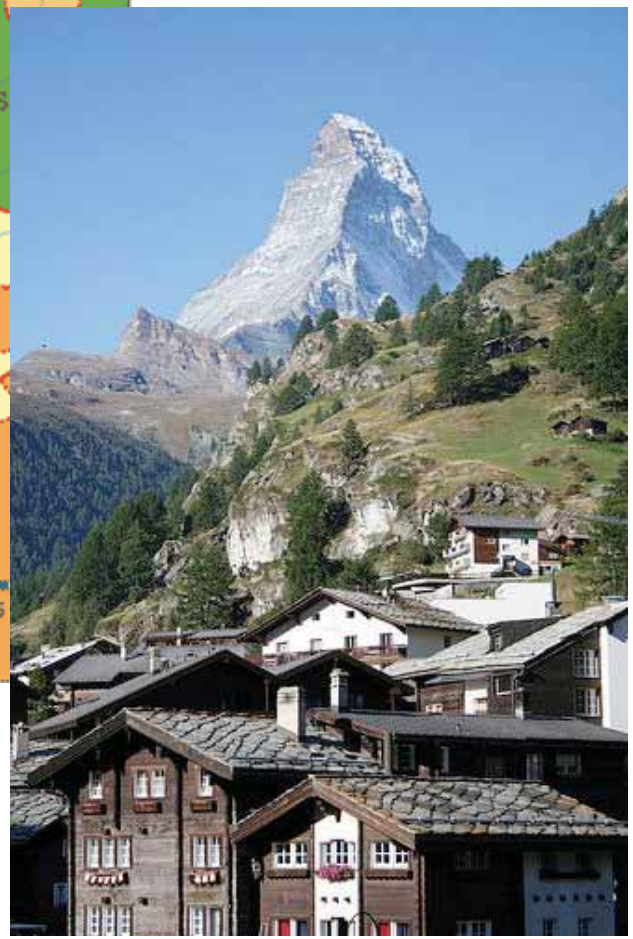


Henning Müller

Hes·so VALAIS WALLIS
Haute Ecole Spécialisée
de Suisse occidentale
Fachhochschule Westschweiz
University of Applied Sciences
Western Switzerland

Where we are

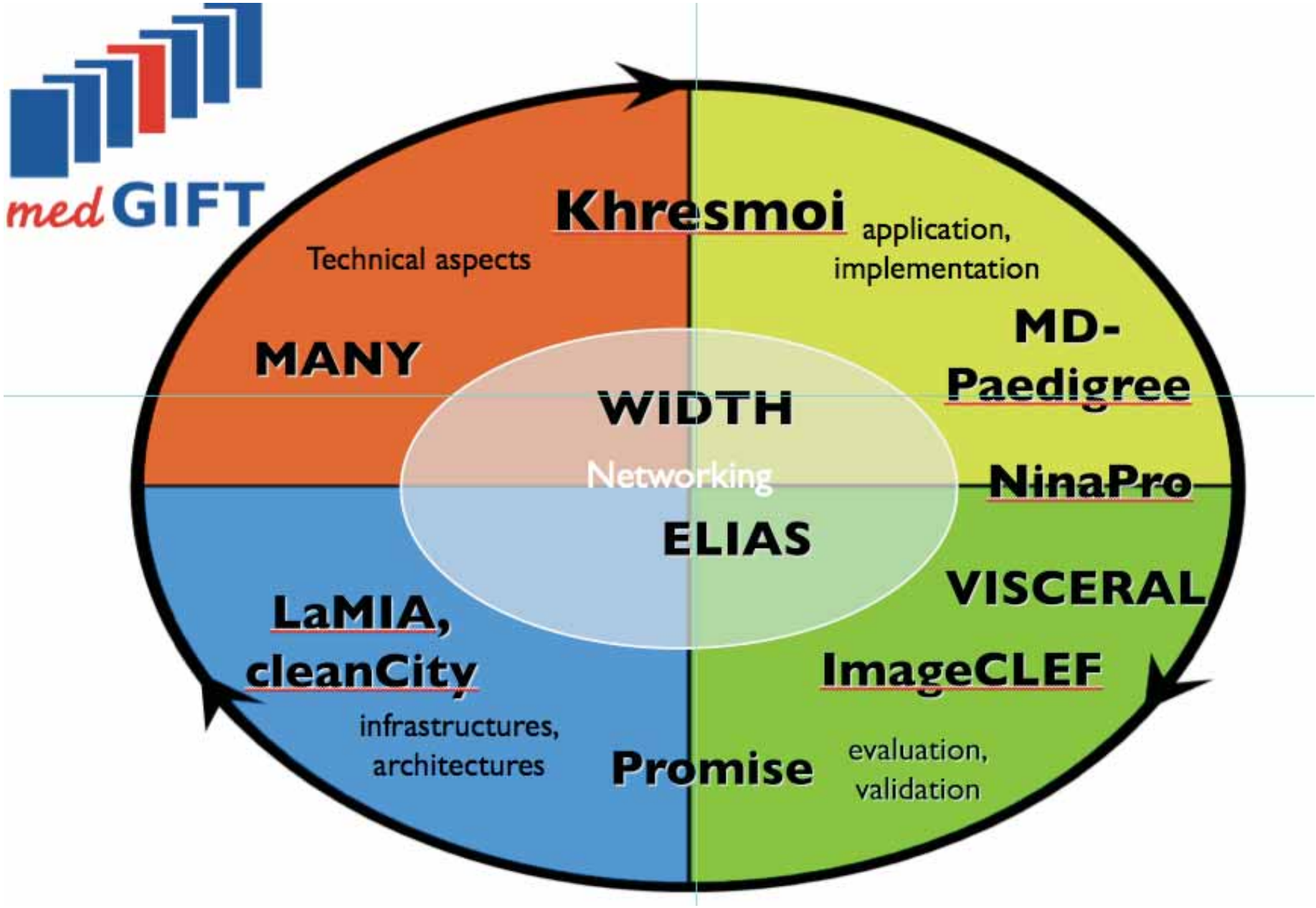

Switzerland
GERMANY
FRANCE
SWITZERLAND
ITALY
LIECH.
Basel
Baden
Winterthur
Zürich
St.Gallen
Horgen
Biel
Lucerne
(Luzern)
Burghdorf
Neuchâtel
Bern
Steffisburg
Fribourg
Thun
Interlaken
Chur
Lausanne
Montreux
Sierre
Geneva
(Genève)
Martigny
Champex
Locarno
©maps.com
8°
10°
0
25



Who I am

- Medical informatics studies in Heidelberg, Germany (1992-1997)
  - Exchange with Daimler Benz research, USA
- PhD in image processing, image retrieval, Geneva, Switzerland (1998-2002)
  - Exchange with Monash University, Melbourne, AUS
- Postdoc, assistant prof. in Geneva University hospitals in medical informatics (2002-)
- Professor in Computer Science at the HES-SO, Sierre, Switzerland (2007-)

What we do


medGIFT
Khresmoi
application, implementation
Technical aspects
MANY
MD-Paedigree
WIDTH
Networking
NinaPro
ELIAS
VISCERAL
LaMIA, cleanCity
ImageCLEF
infrastructures, architectures
Promise
evaluation, validation

Why we are doing this

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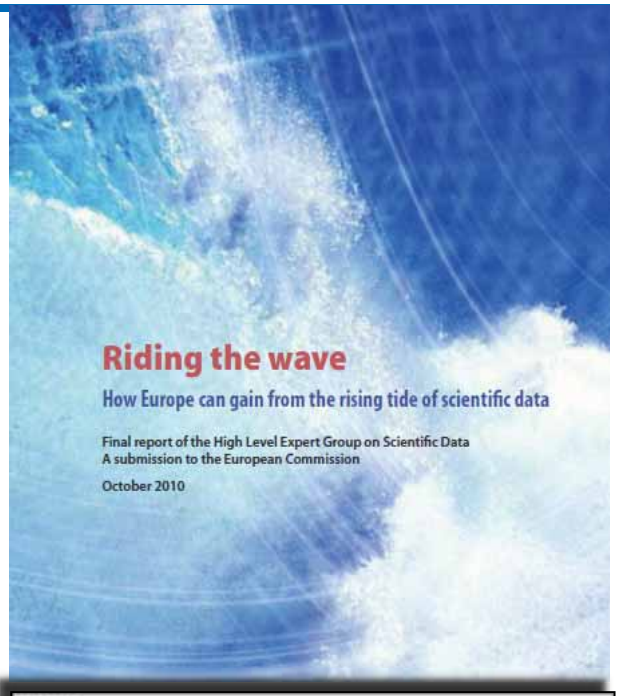
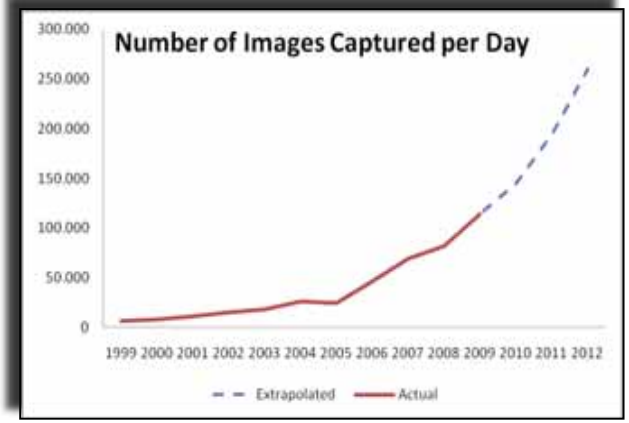
MEDICAL INFORMATION ANALYSIS & RETRIEVAL

- Much imaging data is produced
- Imaging data is very complex
  - And getting more complex
- Imaging is essential in diagnosis and treatment planning
- Images out of their context loose most of their sense
  - Clinical data is necessary
  - Diagnoses are often not precise
- Evidence-based medicine & case-based reasoning





Topics today

3D texture analysis

MANY

GIFTed paraDISE

Radiology image retrieval

3D organ detection & retrieval

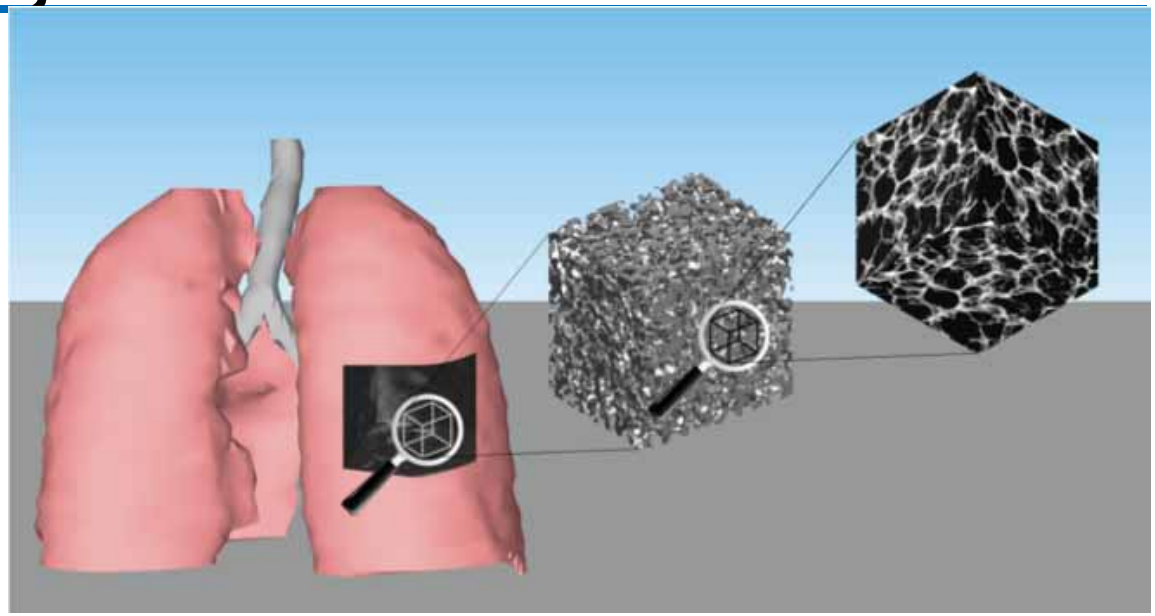
Visceral

Diagnosis aid

© Denis Pessin

3D texture

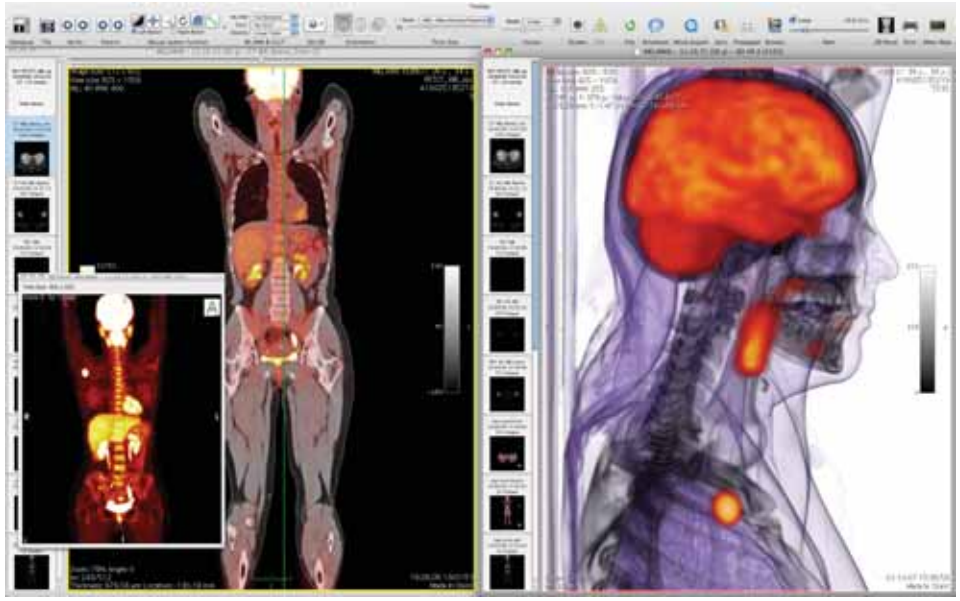
3D texture vs. 3D objects

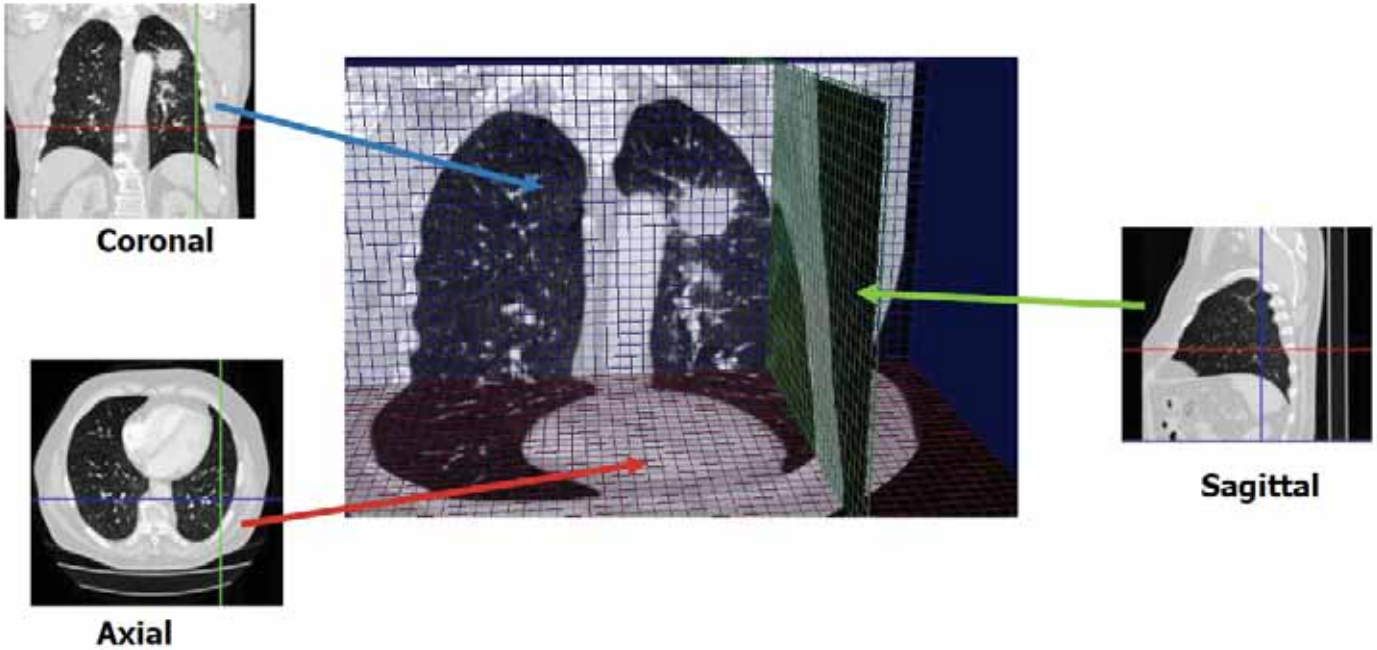


- Not the outer shape of structures but the inner structure
- Hard to visualize, often in several views
- Borders are important because texture needs to be compared inside the same objects
  - Exact place can be important, shape of organs as well
- Variations among subjects are very high
  - Particularly for healthy tissue, linked to other factors

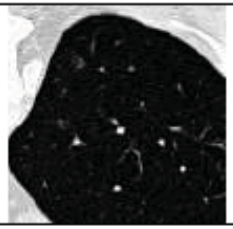
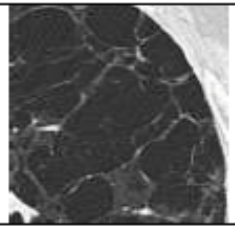
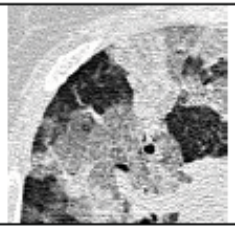
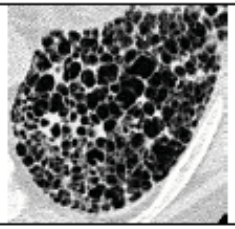
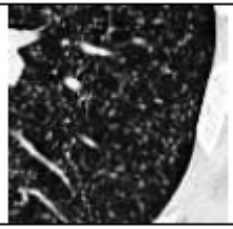
Viewing 3D texture

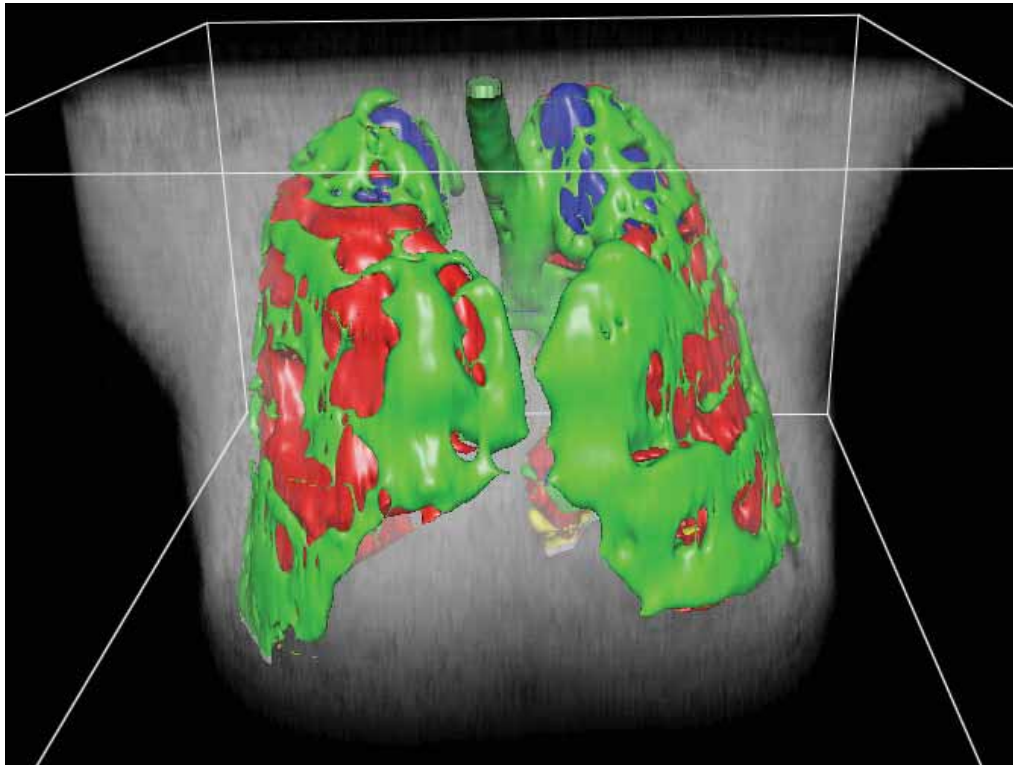
- Multi-planar rendering
- 3D views
  - Semi-transparency
  - MDs need to get used to it

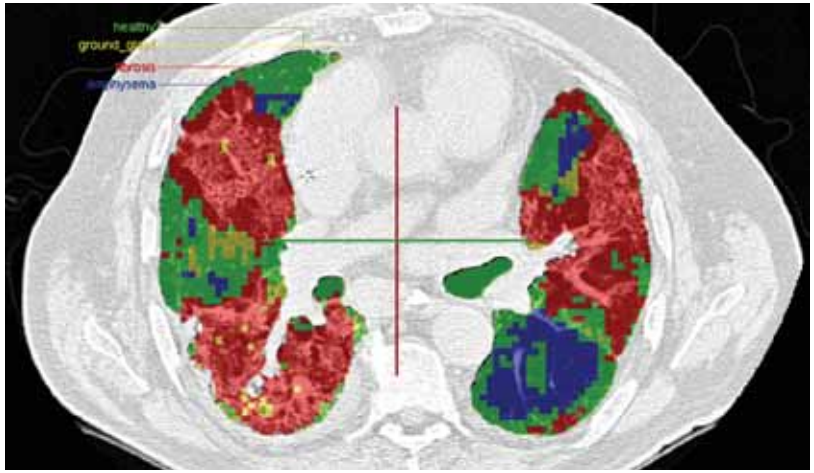




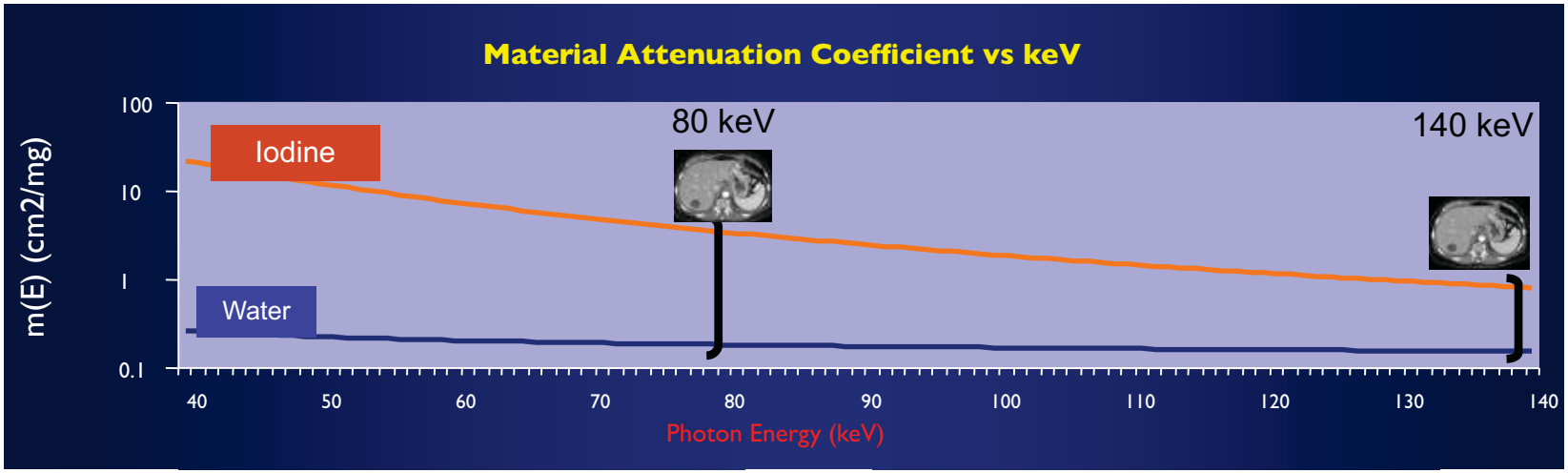
A short video

visual aspect					
class	healthy	emphysema	ground glass	fibrosis	micronodules

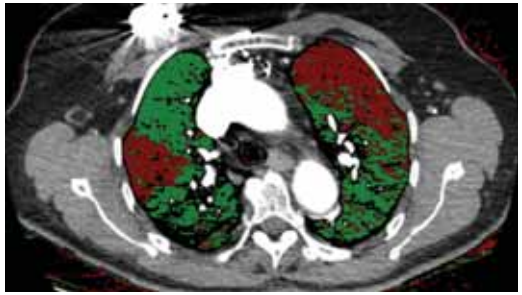




4D texture, pulmonary embolism



- 4D dual energy CT
  - Other 4D data include time components

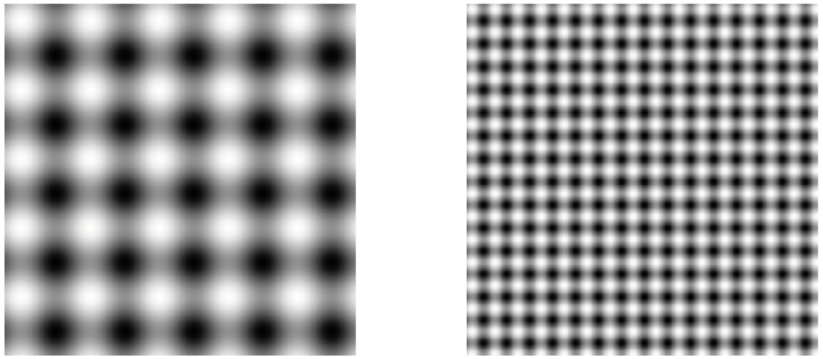


- Goal is to measure tissue perfusion
  - Find whether and which parts of the lung are blocked
  - Emergency radiology has very little time for decisions
- Do things that physicians can not do (quantifying)

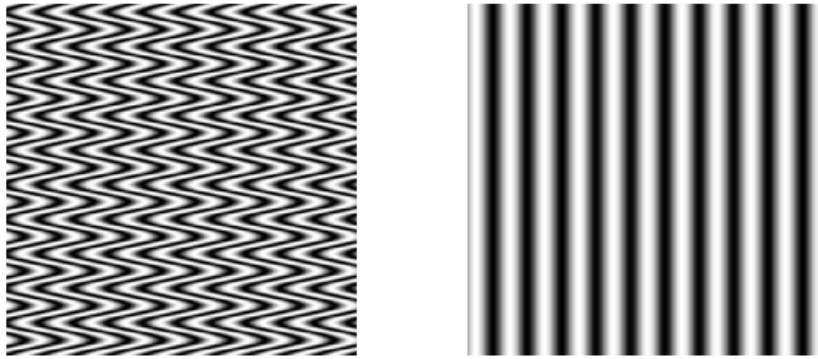
Texture characteristics

- Localized characterizations of scales and local orientations are important for textures
  - Often choices for characterization are arbitrary
  - Riesz transform implements n^{th} order directional derivatives at multiple scales
    - Linear combinations of the filters allows to create texture templates to detect specific textures

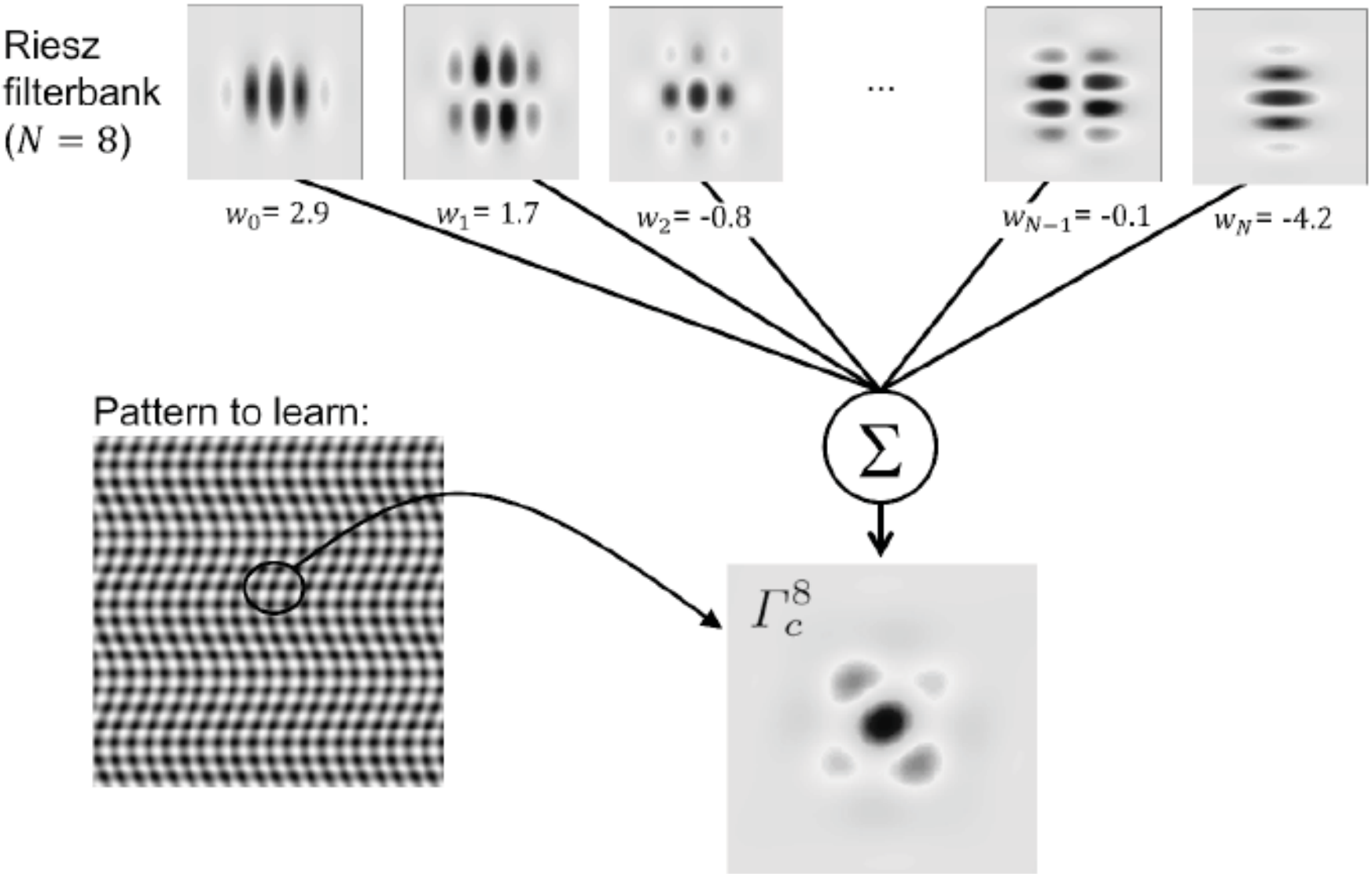
scale



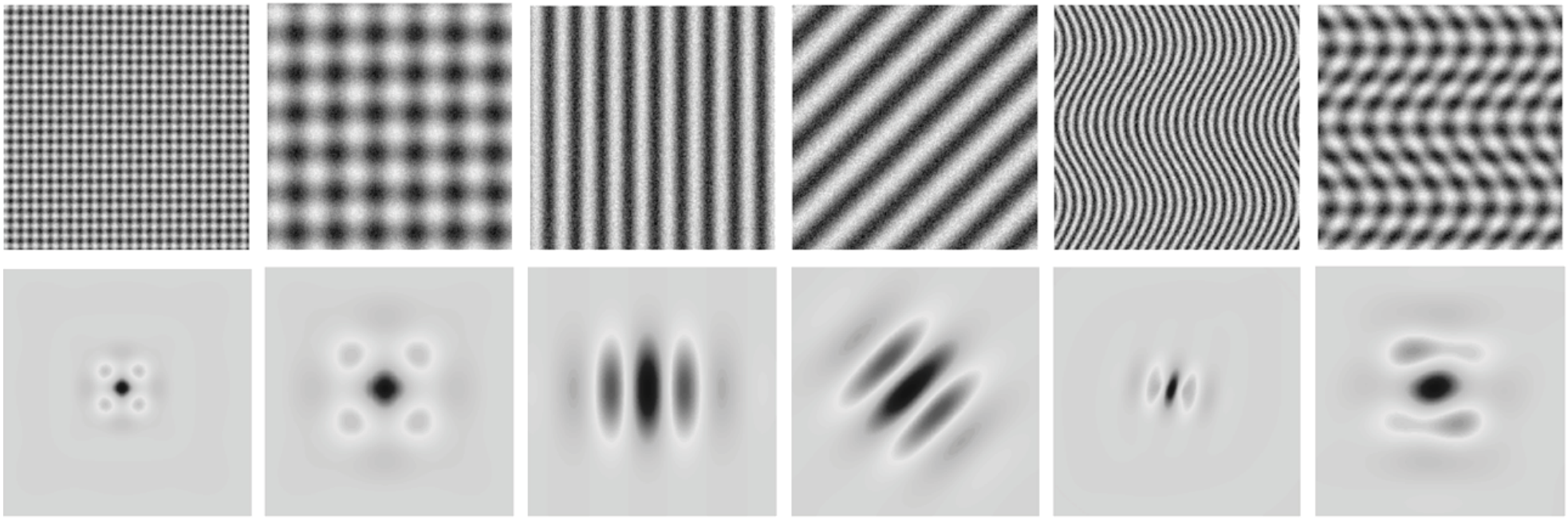
local orientation



Combining filters for detection

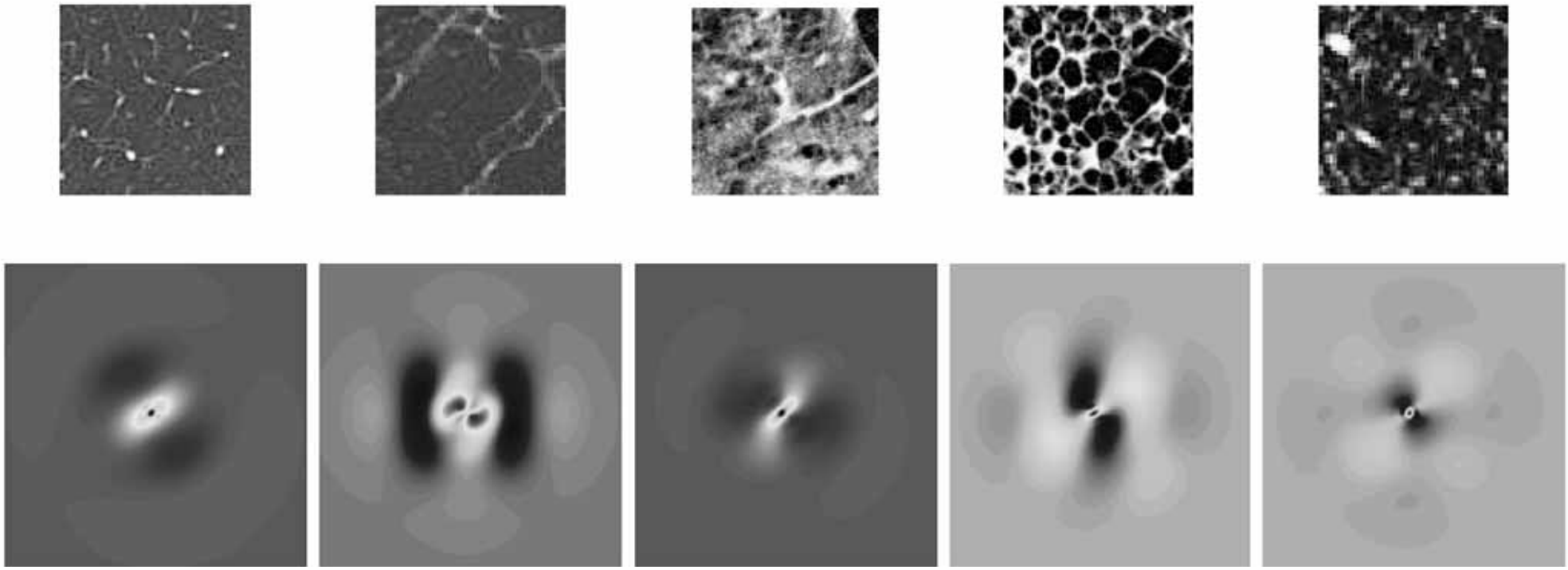


Texture templates



Scale and orientation modeling

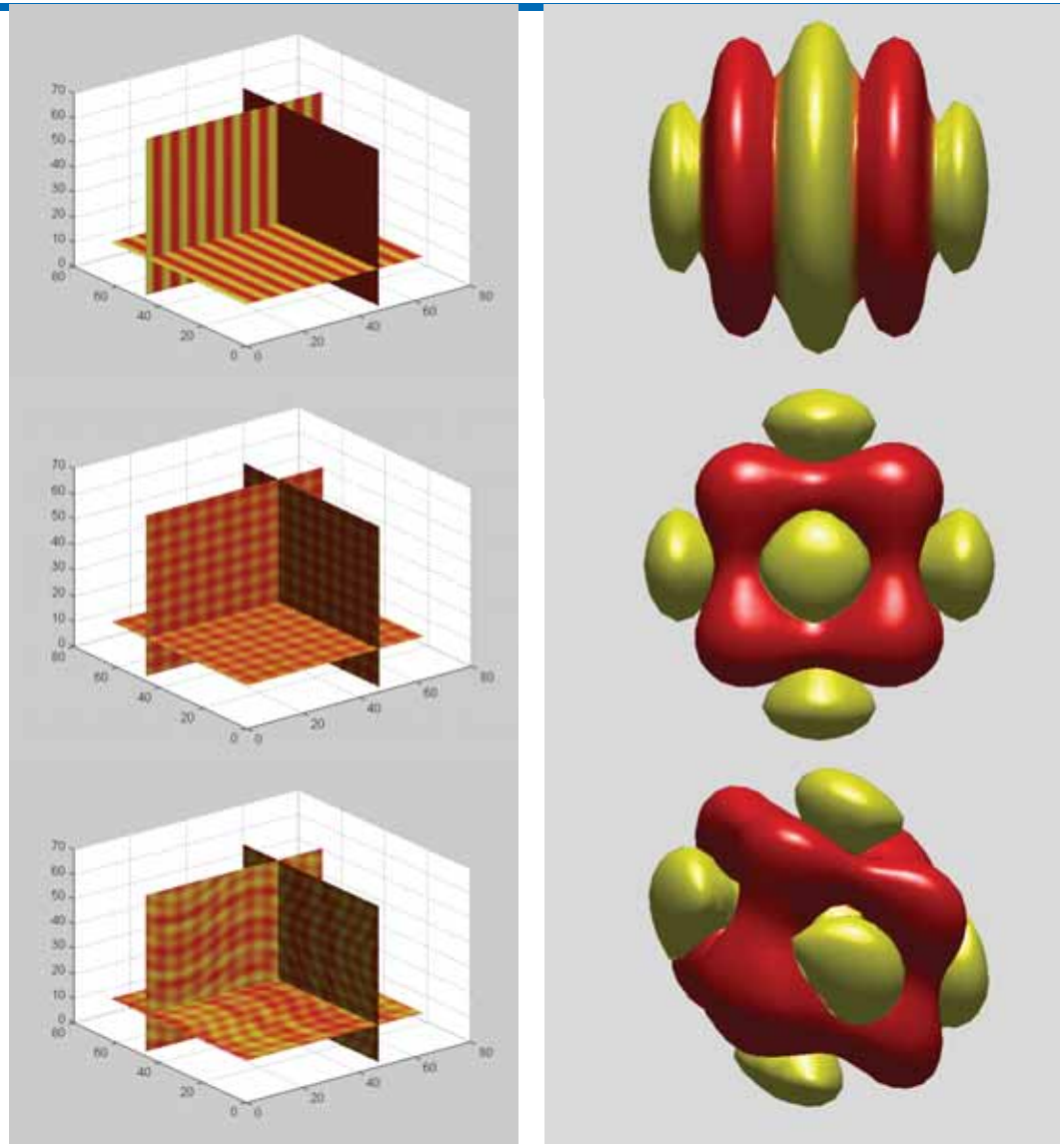
Templates for lung textures



Signatures allow for visually checking the modeled information

3D texture templates

- Vertical planes
- 3D checkerboard
- 3D wiggled checkerboard



Radiology image retrieval

Khresmoi application

- Mixing multilingual data from many resources and semantic information for medical retrieval
  - LinkedLifeData

The informed patient

"I'M SORRY DOCTOR, BUT AGAIN I HAVE TO DISAGREE."

Identifying user requirements

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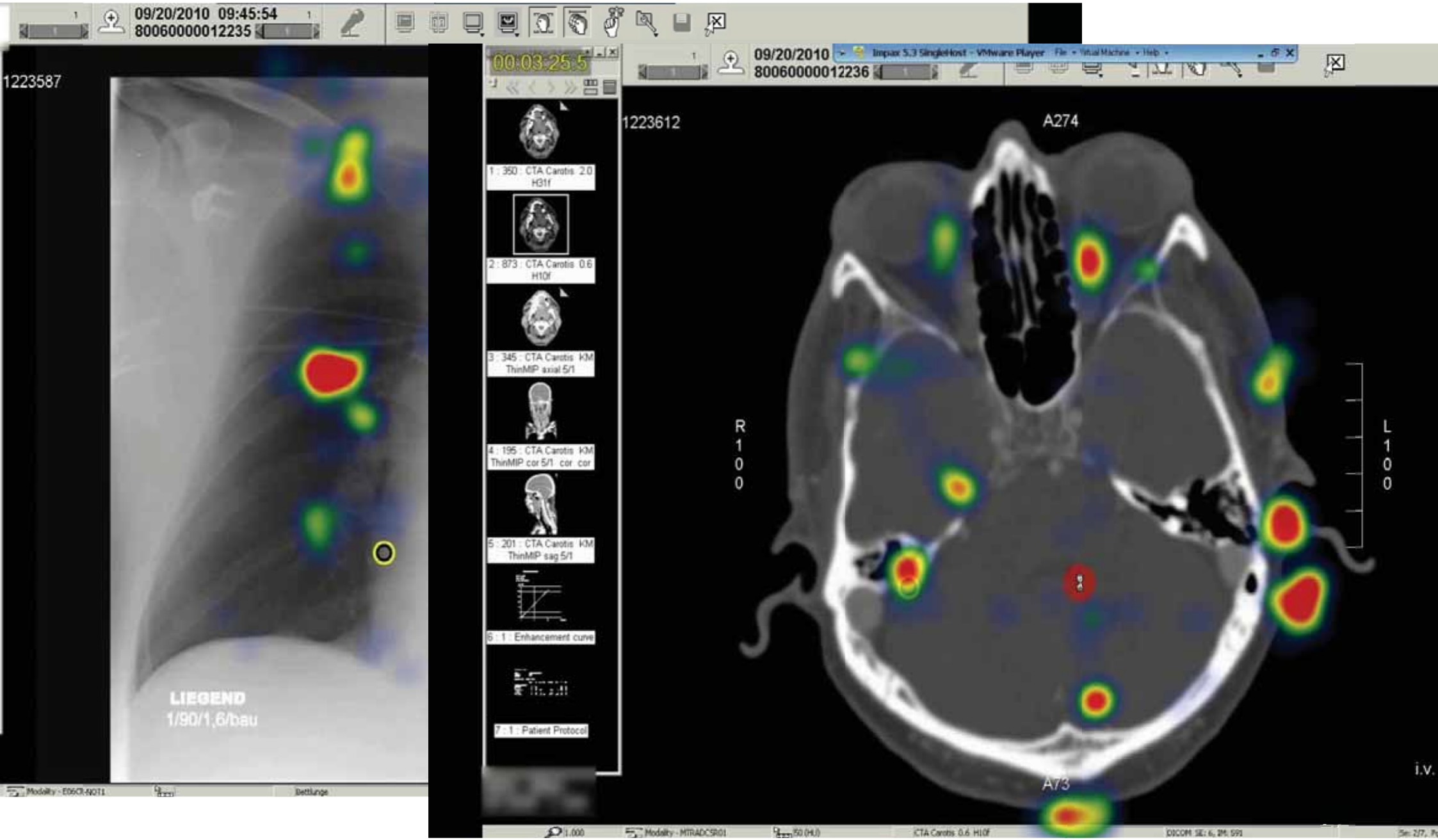
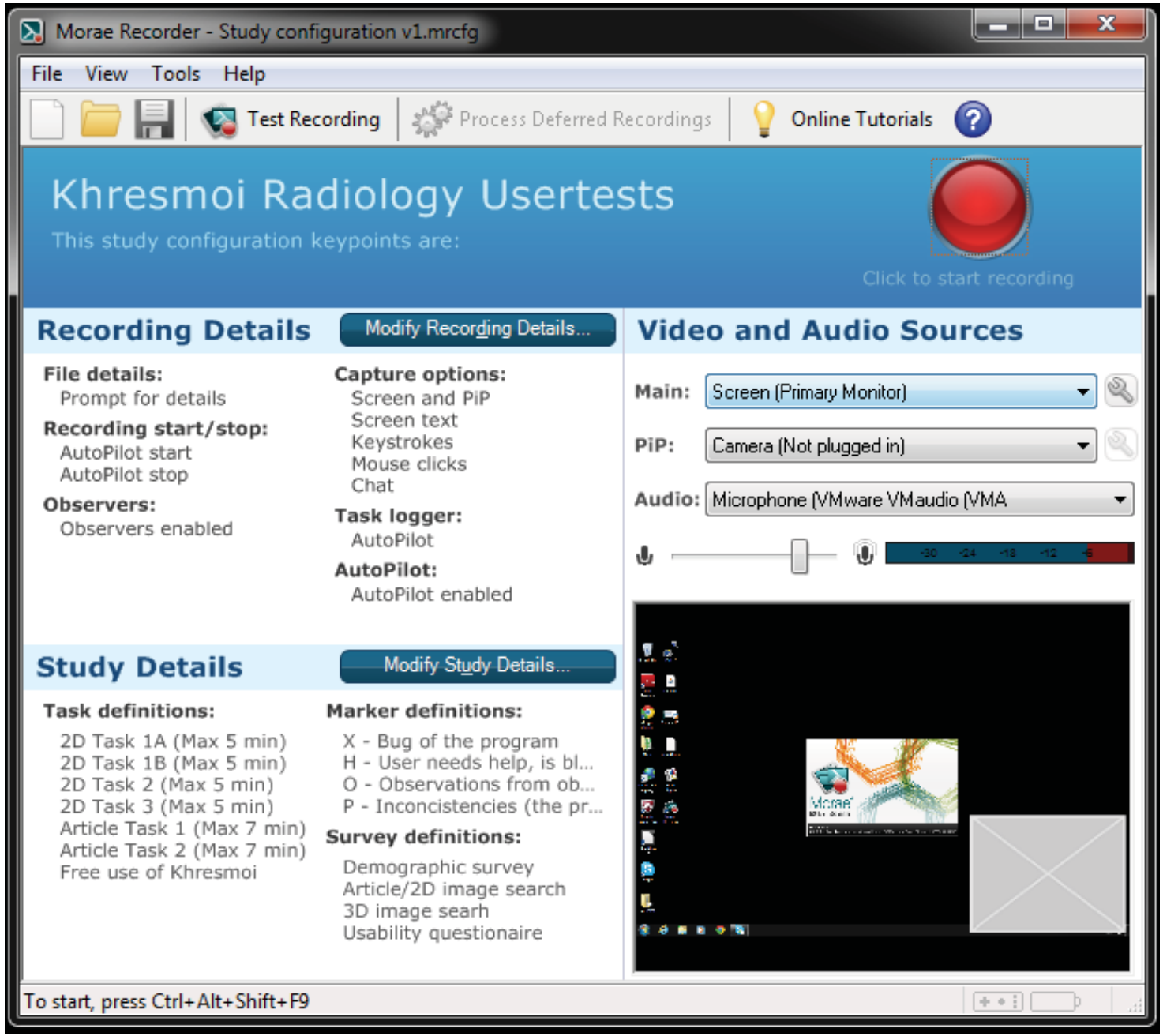
- Surveys among several radiologists
  - Also GPs and patients
- Observing diagnosis processes
  - Analyzing search log files
- Eye tracking on a radiology viewing station
- What are information needs and what are tasks that are hard and where help is needed?
- Test the developed systems in user studies
  - Analyze feedback
  - Record the system use for understanding problems

Eye tracking



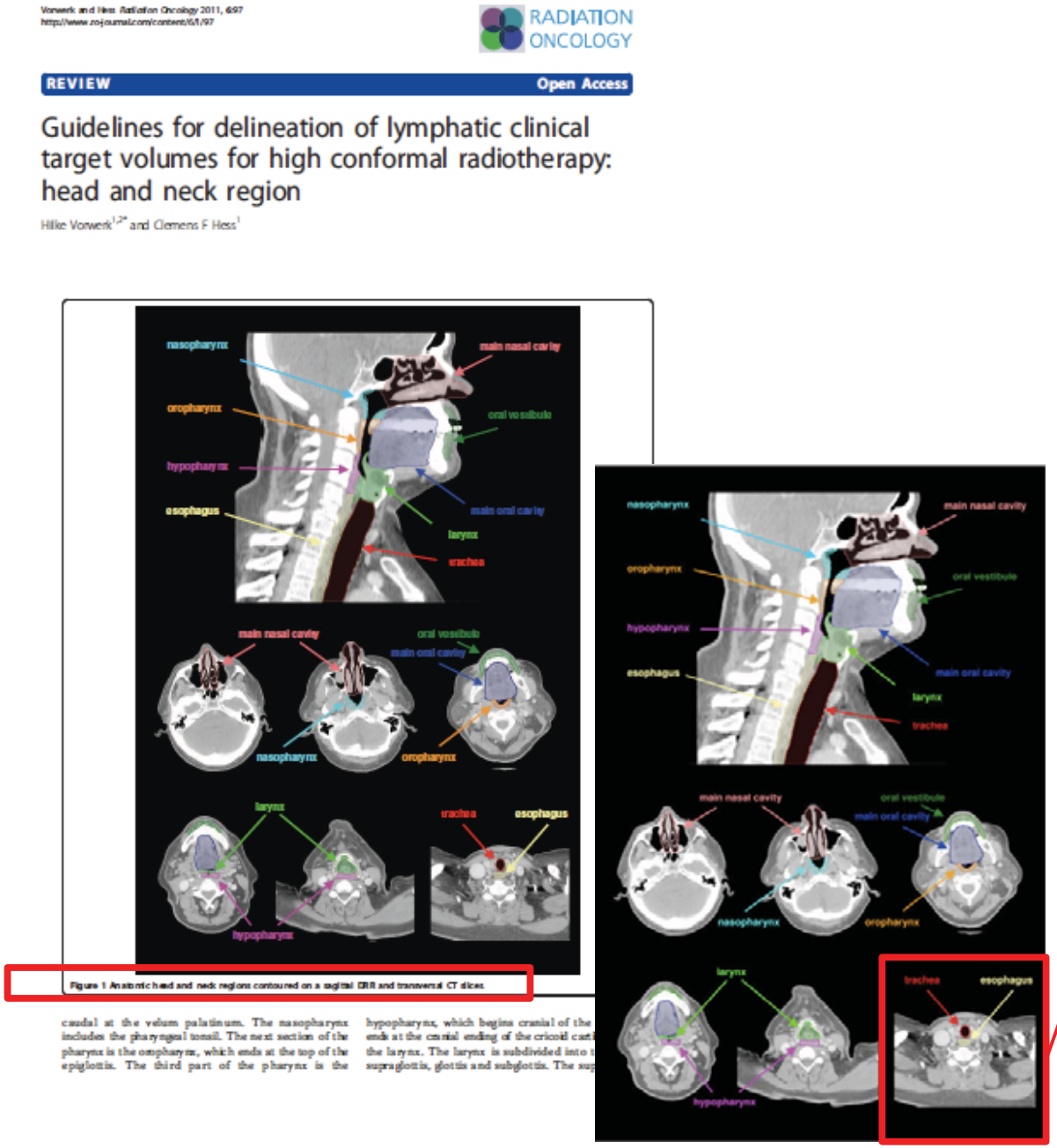
Recording user tests



Data used for ParaDISE

- Scientific data of the biomedical literature
  - 600'000 articles and 1.6 mio figures of the open access literature (>4 mio images if separating compound figures)
  - Public data source but only 2D data
- Clinical data form the Vienna Medical University image archive
  - 5TB of data of two consecutive months
  - Radiology reports for each case
  - Private data source, so access only with password
- Link medical cases with similar cases from the literature based on image data and text

Connecting different data levels


Vorwerk and Hess Radiation Oncology 2011, 6:97
http://www.ro-journal.com/content/6/1/97

RADIATION ONCOLOGY

REVIEW Open Access

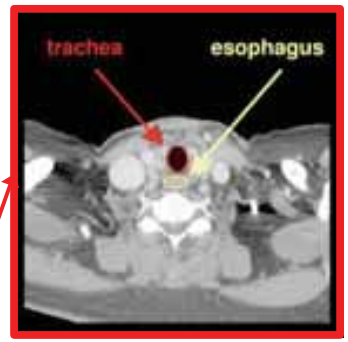
Guidelines for delineation of lymphatic clinical target volumes for high conformal radiotherapy: head and neck region

Hilke Vorwerk[1,2*] and Clemens F Hess[1]

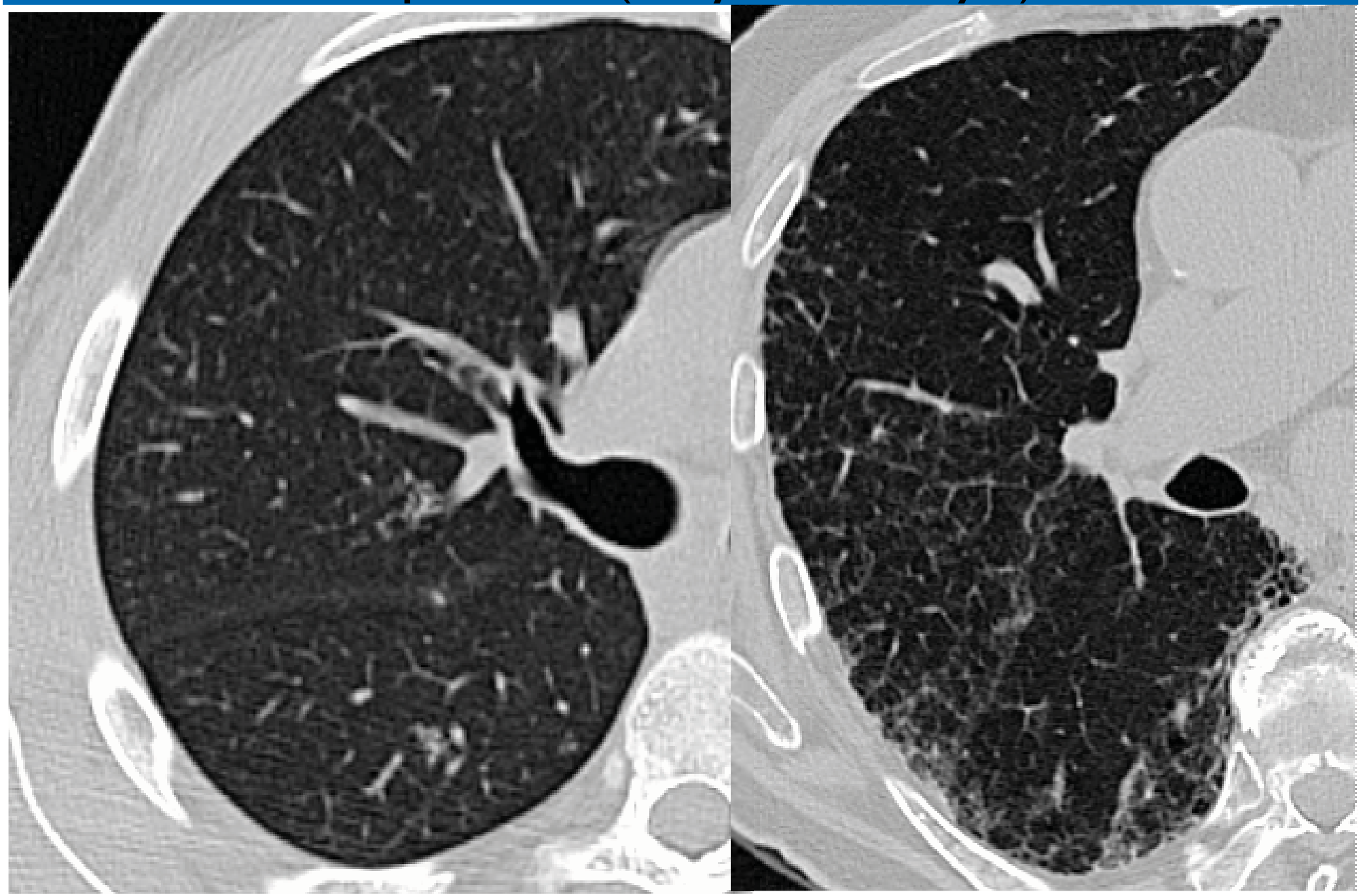
Figure 1 Anatomic head and neck regions contoured on a sagittal CRR and transversal CT slices.

caudal at the velum palatinum. The nasopharynx includes the pharyngeal tonsil. The next section of the pharynx is the oropharynx, which ends at the top of the epiglottis. The third part of the pharynx is the hypopharynx, which begins cranial of the ends at the cranial ending of the cricoid cart the larynx. The larynx is subdivided into supraglottis, glottis and subglottis. The su

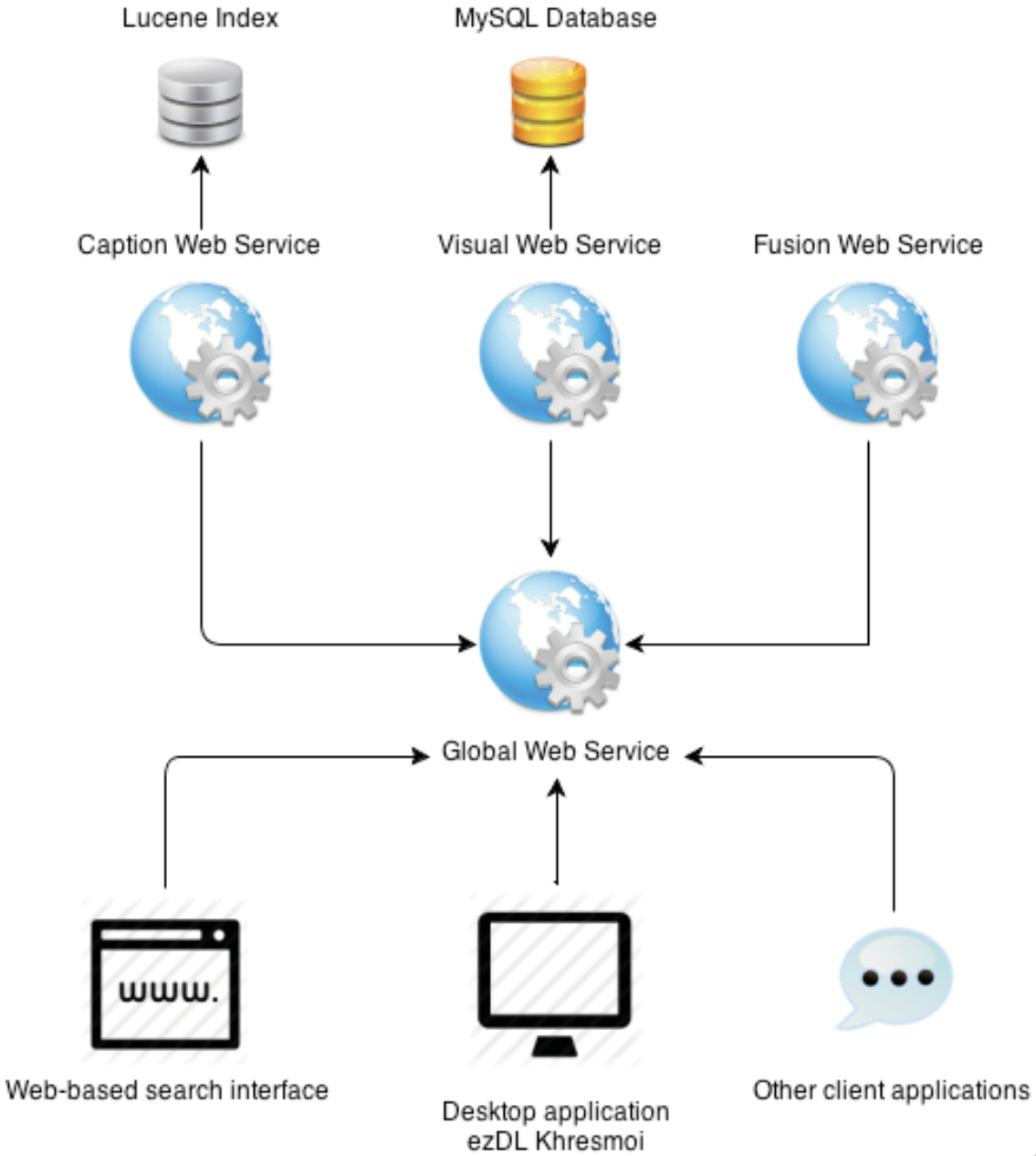
EHR, PACS



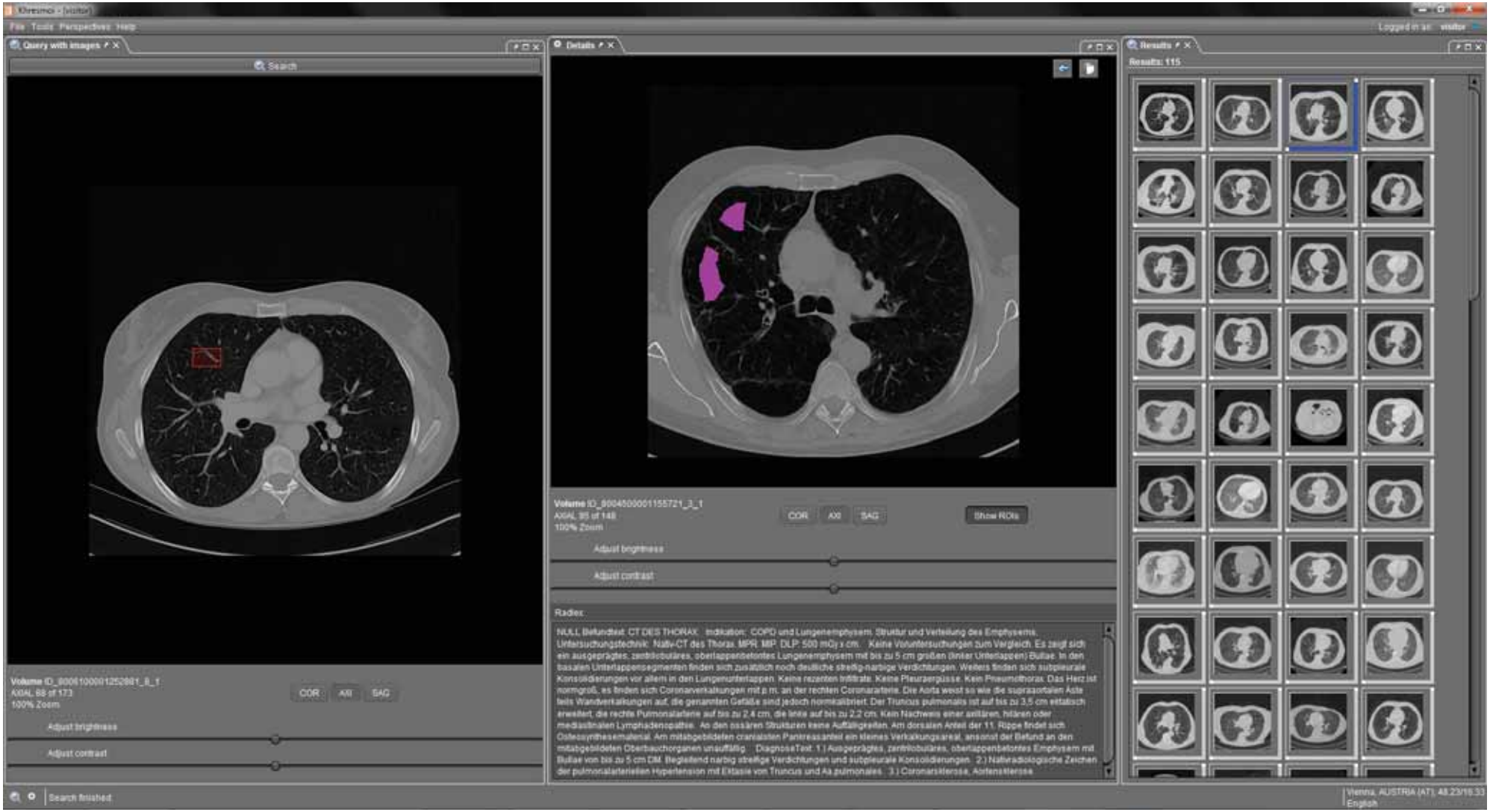
Context is important (25 yo vs. 88 yo)!



ParaDISE architecture



Interfaces for search: radiology



Searching text and images

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Khresmoi - (visitor)

File Tools Perspectives Help

Logged in as: visitor

Search

brain tumor

Results | Source Selection

Results: 200

Relevance

Show all
- Classifications
  - All items (200)
  - Alcohol (1)
  - Babies & Children (1)
  - Blog, Chat or Forum (89)
  - Cancer (14)
  - Cardiovascular disease (2)
  - Clinical Studies, ongoing (89)
  - Day-to-Day Living (89)
  - Drugs & Medical substances (90)
  - Elderly (1)
  - Environmental health (4)
  - For Patients (2)
  - Health Information (89)
  - Health Professionals (89)
  - Hospitals/Clinics/Medical Centers (1)
  - Images (50)
  - News (1)
  - Patient Education (89)
  - Procedures (1)
  - Professional Organizations (89)
  - Research (100)
  - Scientific article (50)
  - Videos (1)
  - Women's Health (1)
  - Work (45)
  - Young people (28)
- Decade
- Source
- Target audience
- Language
- Media type

19. Alterations of BCCIP, a BRCA2 interacting protein, in astrocytomas.
2009 — No snippet available. Click to see a preview.
J. Liu, H. Lu, H. Ohgaki, A. Merlo, Z. Shen
Research • Scientific article

20. Experimental iodine-125 seed irradiation of intracerebral brain tumors in nud...
2007 — No snippet available. Click to see a preview.
J. J. Verhoeff, L. J. Stalpers, A. W. Coumou, K. Koedooder, C. Lavini, C. J. Van...
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21. Genetic alterations and in vivo tumorigenicity of neurospheres derived from a...
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P. Tunici, L. Bissola, E. Lualdi, B. Polto, L. Cajola, G. Broggi, G. Sozzi, G. F...
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22. Sudden deterioration due to intra-tumoral hemorrhage of ependymoma of the fou...
2010 — No snippet available. Click to see a preview.
A. Mahdavi, N. Baradaran, F. Nejat, M. El Khashab, M. Monajemzadeh
Research • Scientific article

23. Clinical significance of Polycomb gene expression in brain tumors.
2010 — No snippet available. Click to see a preview.
F. Crea, E. M. Hurt, W. L. Farrar
Research • Scientific article

24. Correlation between the progressive cytoplasmic expression of a novel small h...
2007 — No snippet available. Click to see a preview.
E. Pozsgai, E. Gomori, A. Szigeti, A. Boronkai, F. jr Gallyas, B. Sumegi, S. Bel...
Research • Scientific article

25. HER3 and downstream pathways are involved in colonization of brain metastases...
2010 — No snippet available. Click to see a preview.
L. Da Silva, P. T. Simpson, C. E. Smart, S. Cocciardi, N. Waddell, A. Lane, B. J...
Research • Scientific article

26. Nano to micro delivery systems: targeting angiogenesis in brain tumors.
2010 — No snippet available. Click to see a preview.
A. Gilert, M. Machluf
Research • Scientific article

27. Metabolic management of glioblastoma multiforme using standard therapy togeth...
2010 — No snippet available. Click to see a preview.
G. Zuccoli, N. Marcello, A. Pisanello, F. Servadei, S. Vaccaro, P. Mukherjee, T....
Research • Scientific article

Details

Nano to micro delivery systems: targeting angiogenesis in brain tumors.

2010 — A. Gilert, M. Machluf — J Angiogenes Res

http://www.jangiogenesis.com/content/.../20

Keywords: Research, Scientific article

Abstract

ABSTRACT: Treating brain tumors using inhibitors of angiogenesis is extensively researched and tested in clinical trials. Although anti-angiogenic treatment holds a great potential for treating primary and secondary brain tumors, no clinical treatment is currently approved for brain tumor patients. One of the main hurdles in treating brain tumors is the blood brain barrier - a protective barrier of the brain, which prevents drugs from entering the brain parenchyma. As most therapeutics are exclu...

Images

Similar Images
Add to query

Frequent terms in this document

abstract angiogenesis anti-angiogenic approved barrier blood brain clinical drugs entering exclu extensively great holds hurdles inhibitors main parenchyma patients potential prevents primary protective researched secondary tested therapeutics treating treatment trials tumor tumors

Detail links

- http://www.jangiogenesis.com/content/.../20

Search finished

Duisburg, GERMANY (DE): 51.42/6.77
English

Playful interfaces

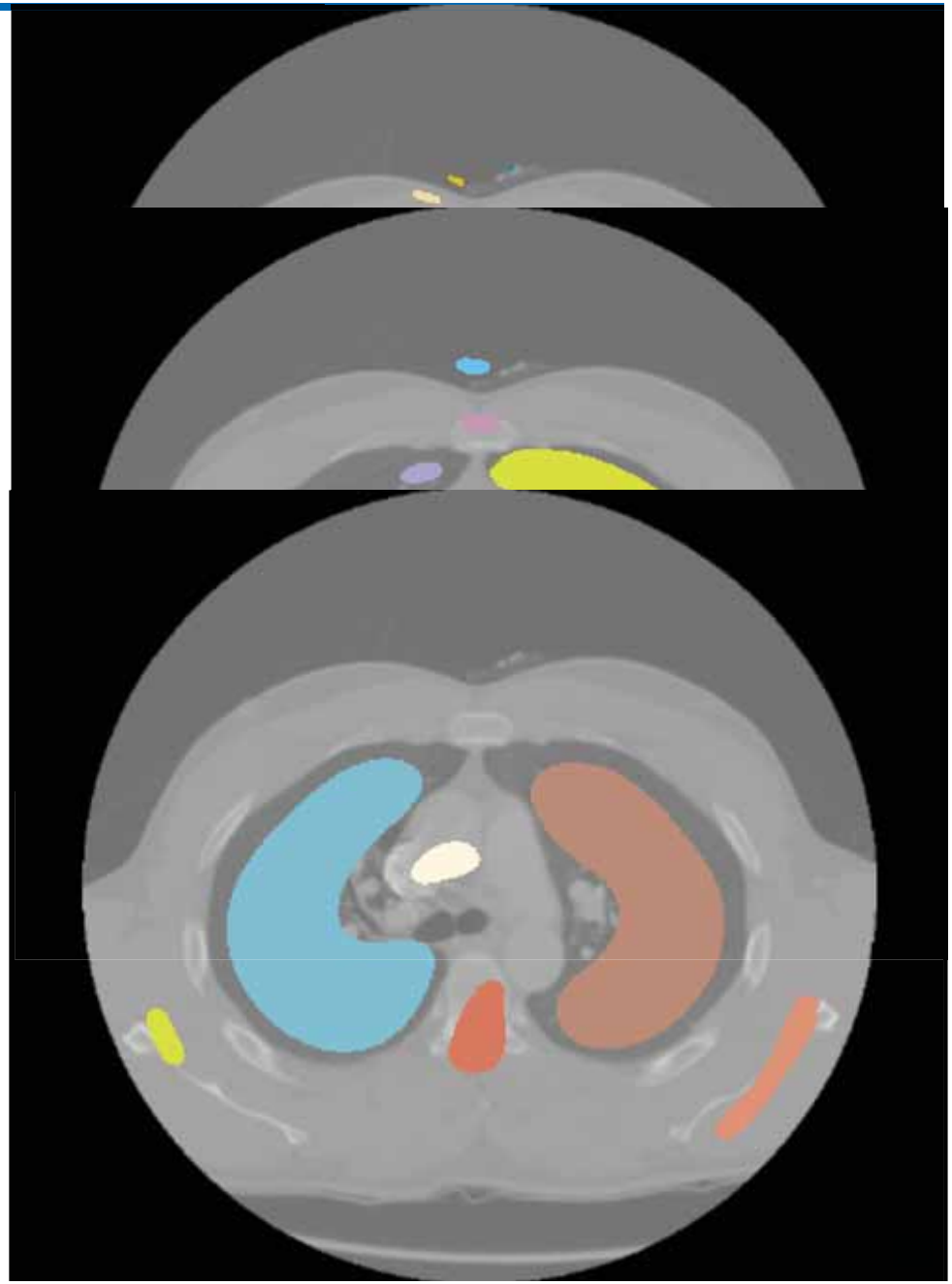
Semantics in radiology

- Map text to ontologies such as RadLex
  - LinkedLifeData is a huge knowledge source
  - Permits synonyms, hypernyms, several languages, etc.
- Use structure and links
  - Anatomic regions are linked with modalities
  - Specific findings (such as fibrosis or micro nodules) are linked with anatomic regions and also with modalities
- Use visual information and semantics to extract information from the images
  - Detecting modality and anatomic region from the images

Visual words in 3D

- Visual features can depend strongly on the application domain
  - Many benchmarks show that using a large feature set and then reducing it is often performing best
  - Early vs. late fusion is not absolutely clear
- Modeling the feature space based on what is actually present in the images
- Use techniques known in text retrieval
  - Removing stop words
  - Latent semantic analysis, synonyms, etc.

Visual words and region detection

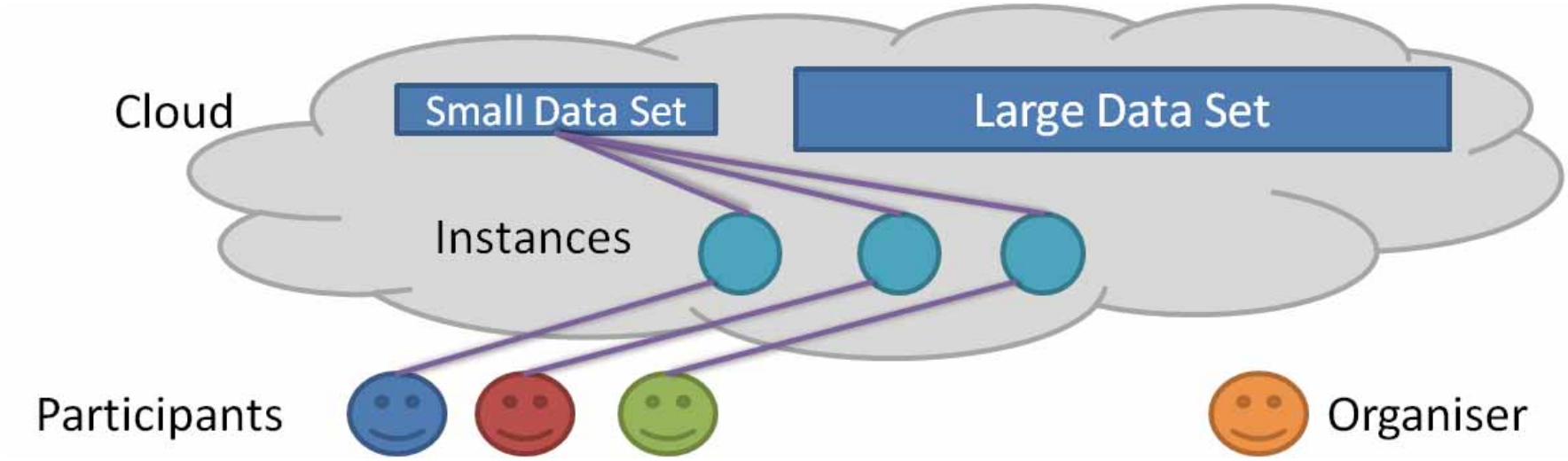


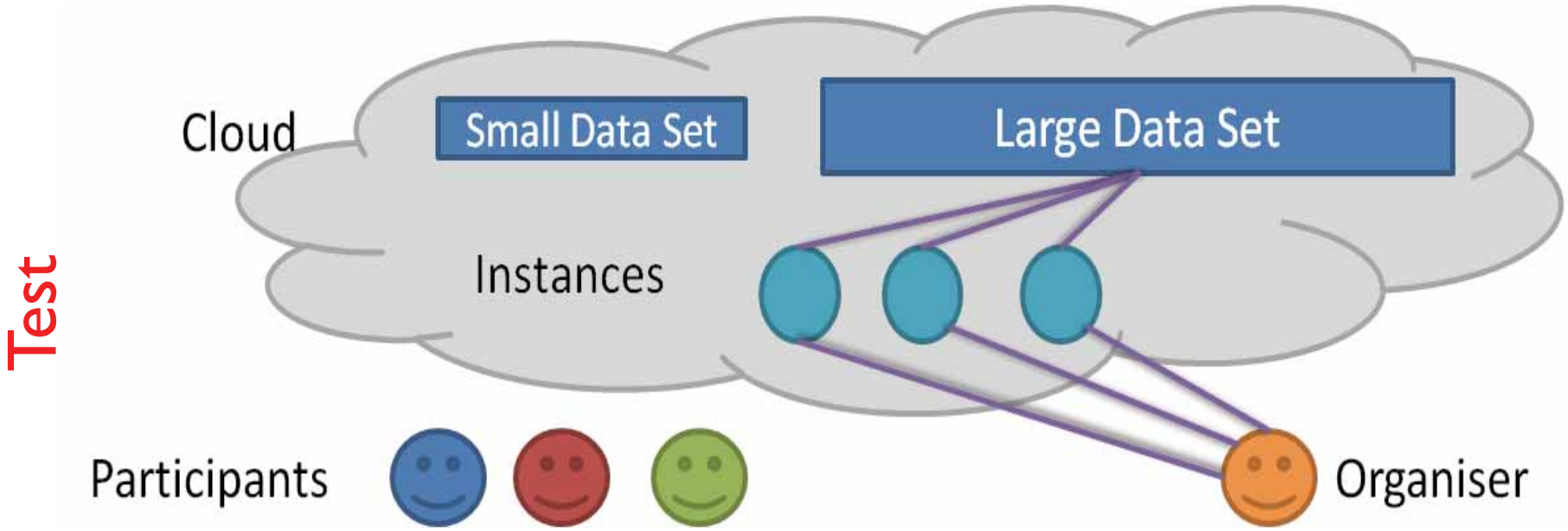
3D organ detection and retrieval

Goals

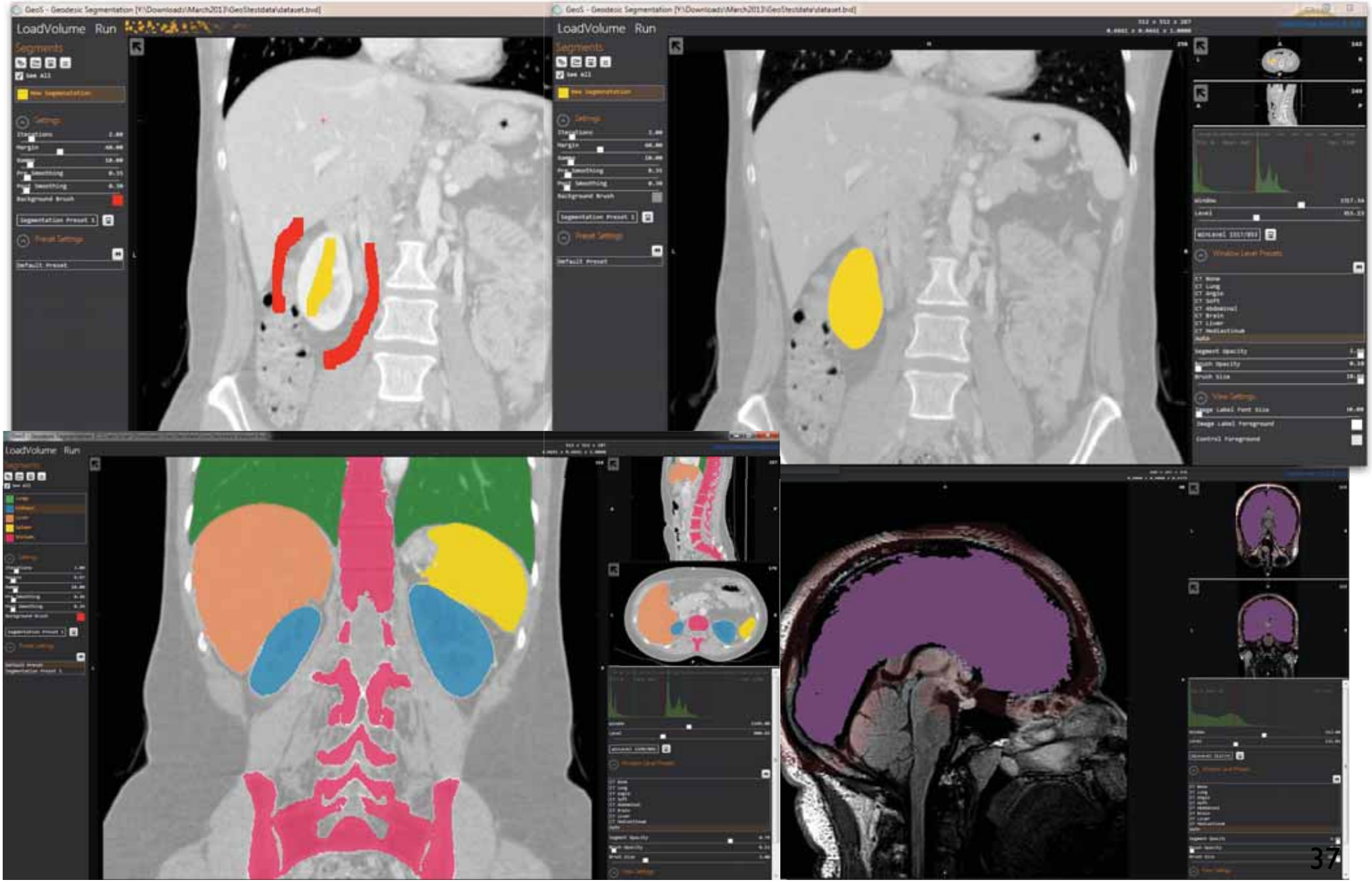
- Organize benchmarks on image analysis in very large data sets >10 TB
  - Identifying anatomic structures
  - Finding similar cases
- Many challenges
  - 10 TB can not be downloaded and also sending hard disks to participants is not easy
  - How can we obtain a solid ground truth to compare algorithms on a large scale
  - Scalability is a major factor, so efficiency of algorithms

Cloud-based benchmarking

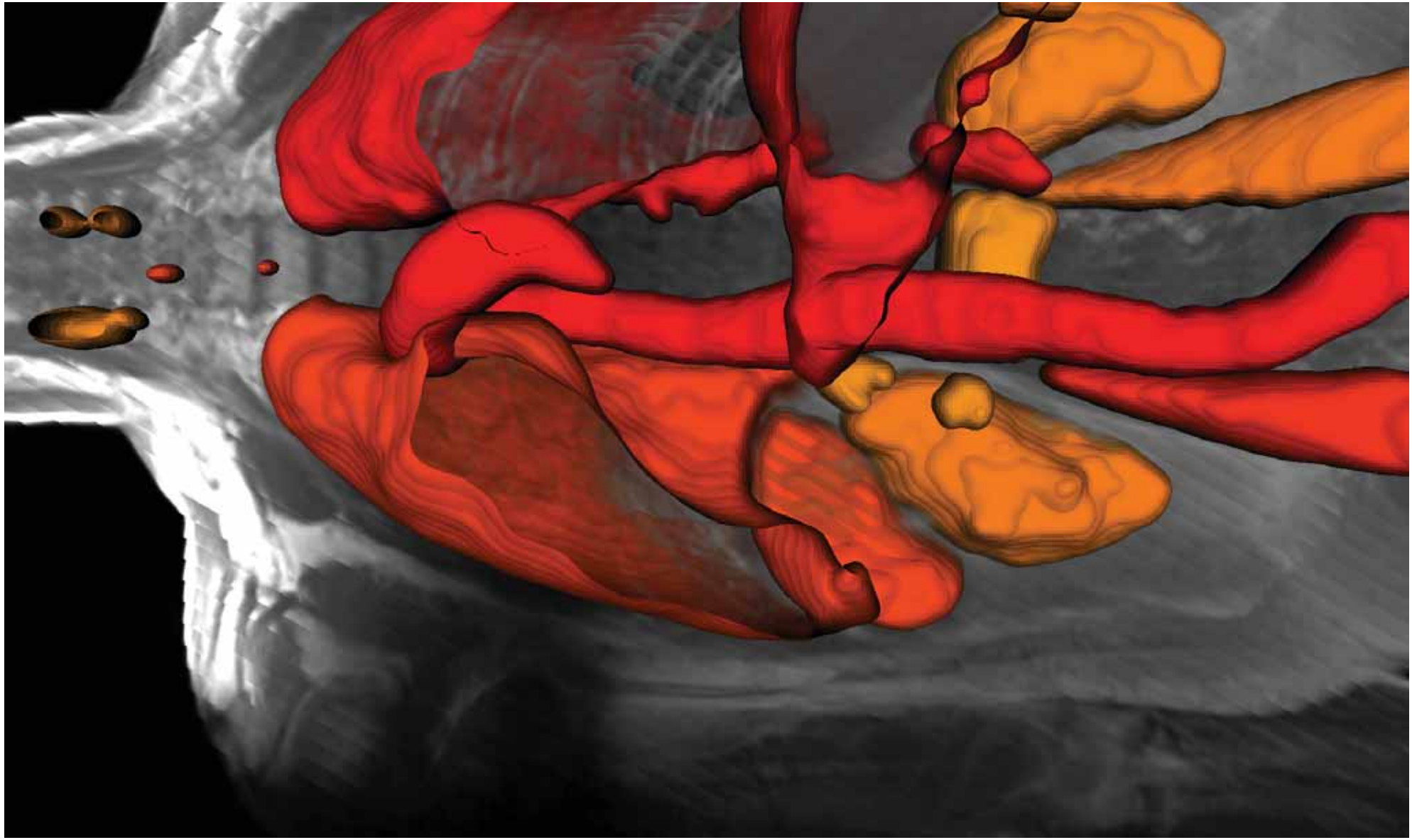




Creation of the database



Annotated data (20-55 organs)



Gold and silver corpus

- Training data will be fully annotated manually
- Part of the test data will also be annotated manually (gold corpus)
  - Does not scale to 10 TB
- Based on results and evaluation a larger silver corpus will be created
  - Based on high quality systems on gold corpus via majority voting
  - Annotate organs where there are strong differences between participating systems
    - Maximize the gain of manual annotation

Participation is open!!

- Data will be released this summer (August 1)
  - http://www.visceral.eu/benchmark-1/
- Registration system is almost finished
- Participants will receive a virtual machine they can configure to their needs in the Azure cloud
  - Linux, Windows, …
- First phase on training data (can be downloaded if really needed), access via Azure API
- Then the organizers will take over the virtual machine and run things on test data
  - Detailed protocol is being defined

MICCAI workshop

MICCAI 2013:
Workshop on Medical
Computer Vision

- http://www.medicalcomputervision.org/
- Linked to the MICCAI conference
  - Medical Image Computing for Computer Assisted Intervention
- Scientific part of the workshop and part related to VISCERAL
  - Big data in medical image analysis
- Discuss the challenges and orient the work of the project towards real challenges
  - Community effort

Conclusions

- Medical imaging offers many interesting opportunities in multidimensional data analysis
- Challenges remain such as data confidentiality, 3D/4D visualization, small regions of interest
  - Images should never be regarded out of their context
- Application-driven approaches can really help physicians and get support from them
- Creating (large) data sets for developing tools requires much effort
  - Open data sets are really important to advance sciece

Contact and more information

- More information can be found at
  - http://khresmoi.eu/
  - http://visceral.eu/
  - http://medgift.hevs.ch/
  - http://publications.hevs.ch/

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