



# Tutorial on Medical Image Retrieval - application domains-

Medical Informatics Europe 2005  
28.08.2005

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## Overview

- Current applications
- Tools to manage archives
  - Semi-automatic coding, DICOM header correction, ...
- **Teaching**
  - Access to teaching files for lecturers
  - ... and for students
- **Research**
  - Find good examples, quality control
  - Include visual features into studies
- **Diagnostic aid**
  - Very focused domain, evidence-based medicine, case-based reasoning
  - Example systems and fields
- Others



## Current applications

- This should rather be **empty**
- No programs for visual information retrieval are currently used in clinical routine, at least to my knowledge
  - Assert on lung image retrieval
  - IRMA in image classification and semi-automatic coding
- **Research applications** and large number of projects
  - Melanoma
  - Pathology slides
  - Mammography, lung CTs
  - PACS-like databases



## Tools to manage archives

- **Navigation** in large archives
  - Find lost images (without/with wrong annotations)
  - DICOM is not enough
- Semi-automatic **coding**
  - Propose codes of visually similar images
- Quality control
  - Control the codes and find images with abnormal codes based on visual similarity
  - DICOM headers contain errors (~16% in anatomic region) that can be corrected

# Semi-automatic annotation (IRMA)

**IRMA IMAGECODER**

1. 183296L  
1121-120-920-700  
SELECT

2. 183306L  
1121-120-920-700  
SELECT

3. 172791L  
1121-120-920-700  
SELECT

4. 631681L  
1121-120-920-700  
SELECT

5. 941301L  
1121-120-913-700  
SELECT

6. 777281L  
1121-120-700-000  
SELECT

7. 441281L  
1121-120-320-700  
SELECT

8. 1127381L  
1121-120-310-700  
SELECT

9. 1828901L  
1123-111-500-000  
SELECT

10. 430781L  
1121-120-913-700  
SELECT

Don't check equals

Edit

Delete

Found Items: 3704 (13-13)

TECHNIQUE	DIRECTION	ANATOMY	BIOSYSTEM
1121	120	320	700
1: Röntgen	1: coronar	3: untere Extremität (Bein)	7: Muskuloskeletales System
1: Projektionsradiographie	2: anteroposterior (coronar)	2: Sprunggelenk	0: nicht näher spezifiziert
2: analog	0: nicht näher spezifiziert	0: nicht näher spezifiziert	0: nicht näher spezifiziert
1: Übersichtsaufnahme			

Translate short keys (Alt-t)

Save (Alt-s)

Save the IRMA-Code

Document: Done (2.804 secs)

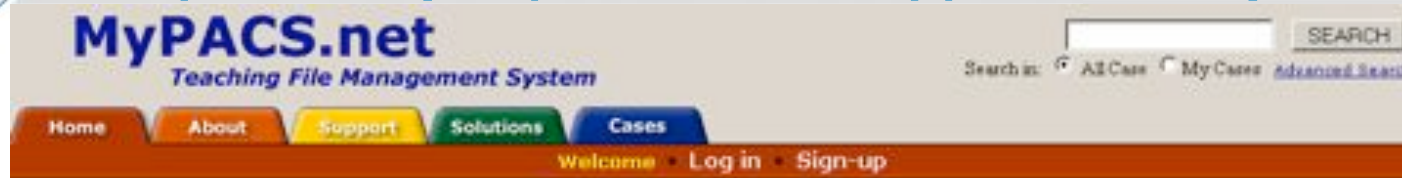


## Teaching

- Manage teaching files
  - myPACS.net, MIRC (Medical Imaging Resource Center, RSNA), HEAL, PathoPic, ...
- Resource for **students** to find and explore databases and cases
  - Casimage (used for exams, teaching CDs, ...)
- Resource for **lecturers** to find optimal images for teaching
  - Share images among lecturers
  - Find visually similar images with varying diagnoses



# myPACS (<http://www.mypacs.net/>)



## MyPACS Log In

Login name:   
Password:   
  
[Sign up for your free account!](#)

## Case of the Week

### APPENDICITIS

by [James Patrick](#), Resident,  
Medical College of Ohio, USA



## Create Your Own Teaching Files

Join radiologists from 400 institutions in 75 countries who are using MyPACS to create their cases online. Users have contributed **5000 radiology teaching files containing 20,000 images**, and new cases are being added every day. All you need is a free account and your web browser, and you can start creating cases right now.



This is a free service to the international community, funded in part by the National Institutes of Health. We also offer custom [enterprise teaching file solutions](#).

## Shared Cases

<a href="#">Cranium and Contents</a>	<a href="#">Heart</a>	<a href="#">Vascular/Lymphatic</a>
<a href="#">Face and Neck</a>	<a href="#">Lung</a>	<a href="#">Breast</a>
<a href="#">Spine and Peripheral Nervous System</a>	<a href="#">Gastrointestinal (GI)</a>	<a href="#">Other</a>
<a href="#">Skeletal System</a>	<a href="#">Genitourinary (GU)</a>	

## Highlighted Features:



## MIRC – Medical Image Resource Center

- <http://mirc.rsna.org/>
- Radiological Society North America
- Ten+ databases are made available for text-based search in database fields or as free text
  - Based on Internet standards
  - Software is open source
- Goal is to create a **worldwide repository** of cases for teaching
- Visual retrieval would be a good complement to the text
  - Multi-lingual retrieval is currently impossible



Teaching Files - Case Viewer - Imagerie Thoracique "Le Discours de la Méthode" - Pneumopathie interstitielle lymphocytaire - Modifs

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop [http://www.casimage.com/40method/ HTML\\_mcase/3168/%25%2795908743.c](http://www.casimage.com/40method/ HTML_mcase/3168/%25%2795908743.c) Search Print

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Digital Imaging Unit  
Geneva University Hospital  
Switzerland

This case is part of [CasImage Web Site](#) from collection: **Imagerie Thoracique "Le Discours de la Méthode"**  
[Don't miss this huge radiology teaching file database!](#)

Pneumopathie interstitielle lymphocytaire

**Chapter:** Pneumopathie interstitielle      **Keywords:** infection; pneumonie interstitielle; lymphome; immunosupprimé      **ID:** 3168

**Diagnosis:** Pneumopathie interstitielle lymphocytaire      **Anatomy:** thorax      **ACR:** 6.21

**Age:** 55      **Sex:** M

**Clinical Presentation:** Etat fébrile chez un patient suivi pour un lymphome non-Hodgkin bas grade stade IVA.

**Description:** Sur la radiographie du thorax de face et profil, présence d'un infiltrat bilatéral, micro-nodulaire diffus, prédominant dans les régions para-hilaires, associé à un élargissement des hiles pulmonaires faisant suspecter la présence d'adénopathies. Sur le CT thoracique, on confirme la présence d'un infiltrat micro-nodulaire diffus avec une distribution sous-pleurale et peribronchovasculaire des micronodules. Présence d'adénopathies sous-carinaires et hilaires bilatérales.

**Commentary:** Le diagnostic a été posé par biopsie chirurgicale. Le lavage bronchio-alvéolaire préalable avait permis d'éliminer une infection.

La pneumopathie interstitielle lymphocytaire est caractérisée par une infiltration interstitielle polymorphe et cytologiquement bénigne de cellules lymphoplasmoctyaires variées. Elle est le plus souvent associée à un syndrome de Sjögren ou une cirrose biliaire primitive et plus rarement à d'autres maladies dysimmunitaires. Chez les enfants, elle est liée au VIH. L'évolution est variable. L'aggravation peut être liée à une fibrose pulmonaire ou un lymphome.

Thorax face      Thorax profil      CT thoracique 1      CT thoracique 2      CT thoracique 3

CT thoracique 4      CT thoracique 5      CT thoracique 6      CT thoracique 7

VIPER ONLINE DEMO - Modifs

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop <http://viper.unige.ch/~mueler/learn/2th/index.php> Search Print

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**Image result**

bilateral basal pneumonia Query Image (1.000000)	Pneumonie basale bilatérale Similarity: 1.000000 [Neutral]	Pneumonie basale bilatérale Similarity: 1.000000 [Neutral]	Pneumopathie interstitielle L... Similarity: 0.497142 [Neutral]	Lymphopathie interstitielle pneu... Similarity: 0.497142 [Neutral]
Extrinsic allergic alveolitis... Similarity: 0.493630 [Neutral]	Alvéolite allergique extrins... Similarity: 0.493630 [Neutral]	Alvéolite allergique extrins... Similarity: 0.493630 [Neutral]	Sarcoidose stade I et II Similarity: 0.492040 [Neutral]	Sarcoidose stages I and II Similarity: 0.492040 [Neutral]
Sarcoidose stade I et II Similarity: 0.492040 [Neutral]	Sarcoidose stade I et II Similarity: 0.492040 [Neutral]	Pneumonia in the left lower l... Similarity: 0.489103 [Neutral]	Pneumonie du lobe inférieur g... Similarity: 0.489103 [Neutral]	Arc aortique droit Similarity: 0.488424 [Neutral]



## Research

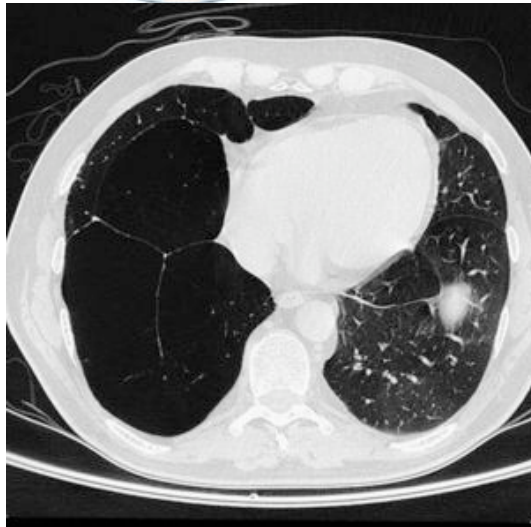
- Optimize the **selection of cases** for research
  - Find visually similar cases
  - Browse databases through example cases
  - Find misclassified cases
- Include **visual features into research studies**
  - Find unknown connections
  - Features need to have a rather high levels
    - Correspond roughly to diseases
  - Visual data mining
  - Visual knowledge management



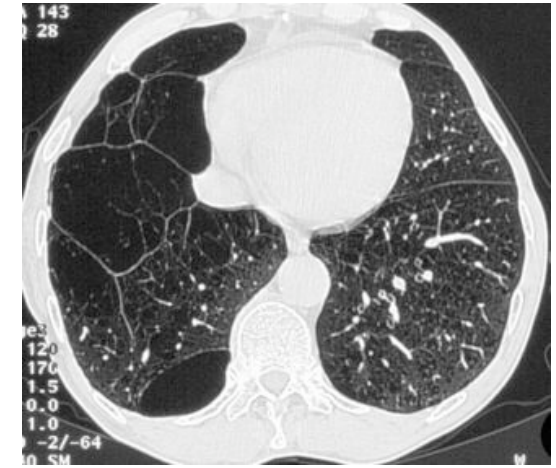
## Diagnostic aid

- Case-based reasoning
- Evidence-based medicine
- Supply **similar cases** as a help for practitioners
  - Has shown to help inexperienced practitioners
  - Aisen et al., *Radiology*
- This is possible in fields where visual low-level similarity is important
  - High resolution lung CT
  - Dermatology, Pathology, Mammography
  - Fractures (treatment planning)
- Problem: Advances in medical imaging equipment

# Example: case-based reasoning



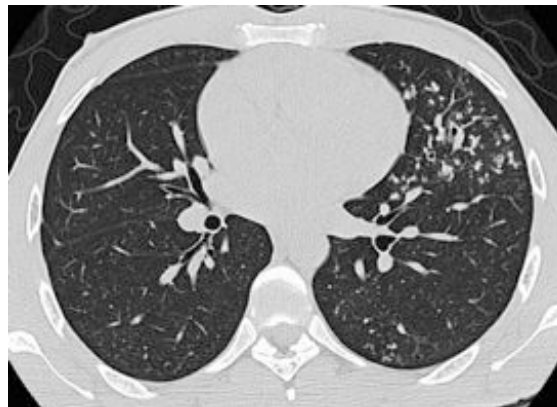
Emphysema



Emphysema



?

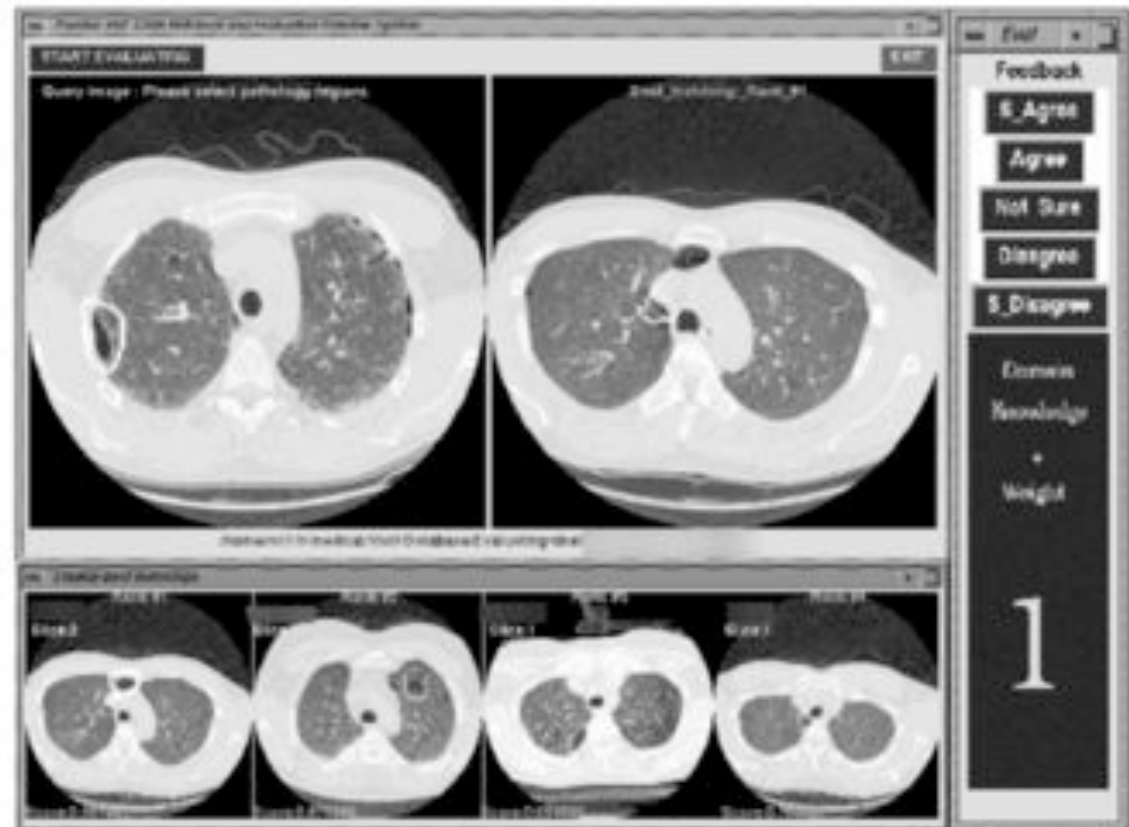


Macro nodules

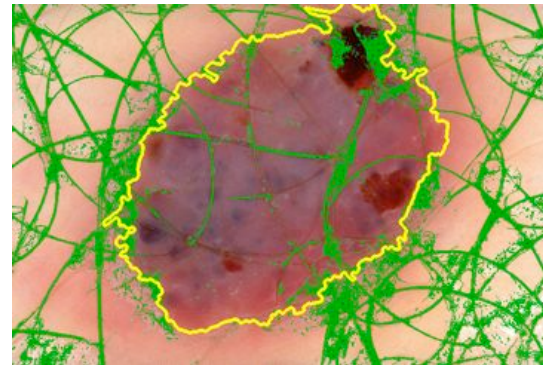
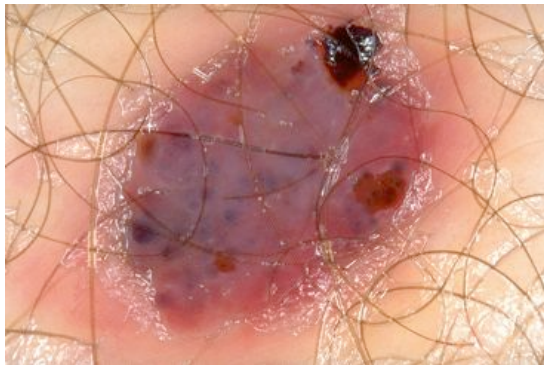


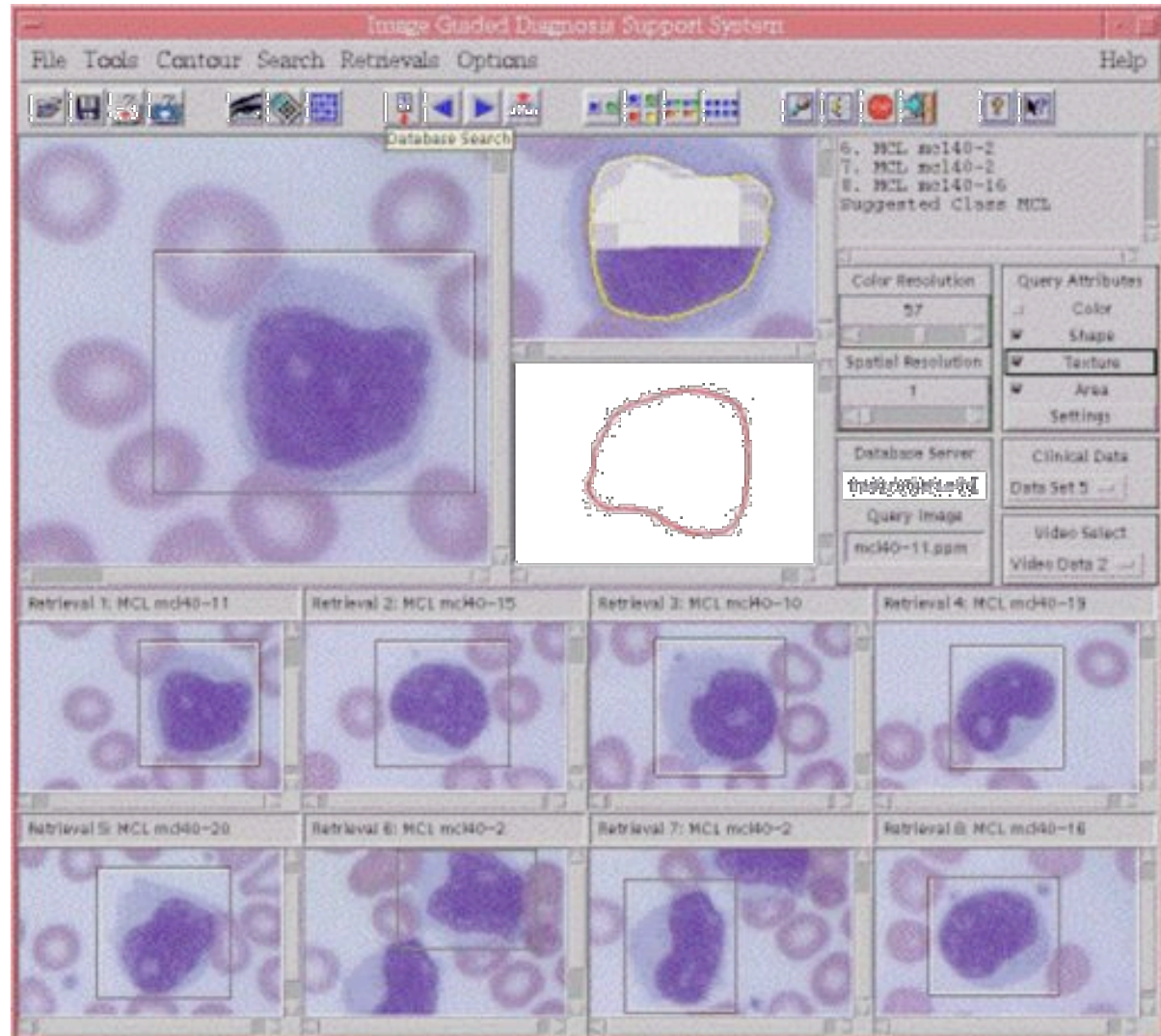
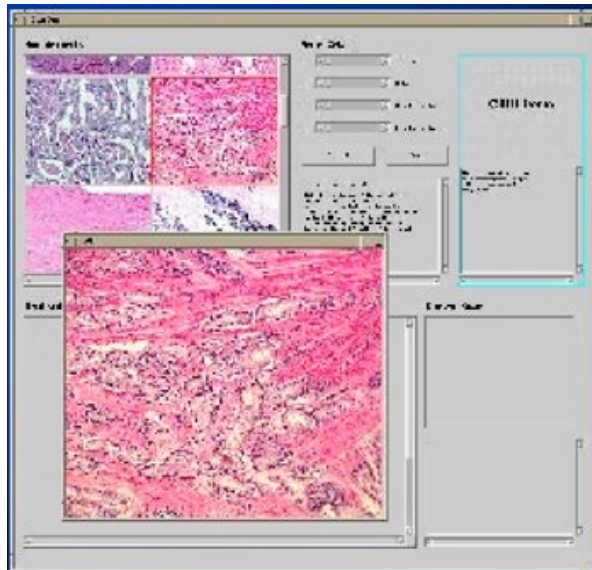
Micro nodules

- Diagnostic aid on lung CTs

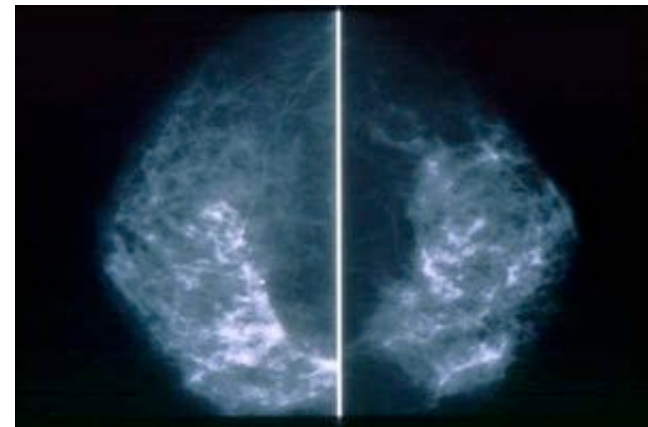


- **ABCD** rule (Asymmetry, Border, Color, Differential structures)
- Hair removal, boundary detection, texture analysis, ...





- Less image retrieval, but rather **detection of regions** with abnormal characteristics
  - micro calcifications
- Local analysis is important
- Large databases with preclassified image regions exist
  - England: Mammogrid







## Case-based rather than image-based retrieval

- Currently the input is mostly one image
- MD might have **several images** (RX, CT, ...) for a same patient
- Cases stored in the patient record also often have more than one image
  - Plus other data: text, numerical values (lab)
- Also, **entire series** (CT, MRI) as an input and not selected images
  - Slice selection based on what a “normal” image would be like



## Other applications

- **Parameter settings** for segmentation, etc.
  - Based on a large number of known, well-segmented cases
- Show me if this case needs further attention, **dissimilarity** retrieval against healthy cases
  - Needs a large number of healthy cases
  - Create a model for a “healthy” image
- ...



## Conclusions

- Image retrieval is at the moment mainly an **academic** problem
- Information explosions is happening in the medical domain (multimedia in digital form)
- We need **tools** and we need to imagine how to use them
- There are **many applications** for image retrieval
- We need to start the clinical **integration**
- Visual systems will not replace text but complement it