Tutorial on Medical Image Retrieval
- application domains-

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Overview

- Current applications
- Tools to manage archives
  - Semi-automatic coding
- 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
• 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
  • 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
Semi-automatic annotation (IRMA)
Slice finder

- Tool to manage patients with a large number of series (oncology patients)
  - Several series every few months
- When navigating in one dataset, find the corresponding slices in other datasets
  - Various numbers of slices
  - Various devices
  - Varying slice thickness and slice distances
  - Different body area can be captured
  - Different modalities (CT, MRI)
Teaching

- Manage teaching files
  - myPACS, MIRC (Medical Imaging Resource Center, RSNA), ...

- 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
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

<table>
<thead>
<tr>
<th>Cranium and Contents</th>
<th>Heart</th>
<th>Vascular/Lymphatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face and Neck</td>
<td>Lung</td>
<td>Breast</td>
</tr>
<tr>
<td>Spine and Peripheral</td>
<td>Gastrointestinal</td>
<td>Other</td>
</tr>
<tr>
<td>Nervous System</td>
<td>(GI)</td>
<td></td>
</tr>
<tr>
<td>Skeletal System</td>
<td>Genitourinary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(GU)</td>
<td></td>
</tr>
</tbody>
</table>

Highlighted Features:
• 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
### Clinical Presentation:

<table>
<thead>
<tr>
<th>Chapter:</th>
<th>Hematopathie interstitielle</th>
</tr>
</thead>
</table>

| Diagnosis: | Hematopathie interstitielle lymphoïdème |

| Sex: | M |

| Age: | 66 |

| History: | 1er traitement chémid d'intérêt pour un lymphome non-léukémique haut grade stade IV A. |


| Commentary: | Le diagnostic a été posé par imagerie thoracique. Le lavage bronchique-avancé n'avait pas permis d'éliminer une infection. Le diagnostic a été posé par imagerie thoracique. Une infiltration interstitielle polyclonale et un élargissement des lobes supérieurs étaient présents. Il n'y avait pas d'association à un syndrome auto-immune ou une maladie immunodéficitaire. Un traitement par corticostéroïdes a été instauré. L'évolution est favorable. L'imagerie thoracique a été réalisée à deux reprises pendant ou après le traitement. |

### Images:

- 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
• 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
• 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
• Problem: Advances in medical imaging equipment
Example: case-based reasoning

Emphysema

Macro nodules

Micro nodules
• Diagnostic aid on lung CTs
• **ABCD** rule (Asymmetry, Border, Color, Differential structures)

• Hair removal, boundary detection, texture analysis, ...
Mammography

- 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 patient
- Cases stored in the patient record also often have more than one image
- 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
- ...

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Conclusions

- Image retrieval is at the moment mainly an academic problem
- Information explosions is happening in the medical domain (multimedia)
- 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