A Web-Based System for Biomedical Image Storage, Annotation, Content-Based Retrieval and Exploration

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Outline

1. The Problem
2. What For?
3. The System
4. Ongoing Work

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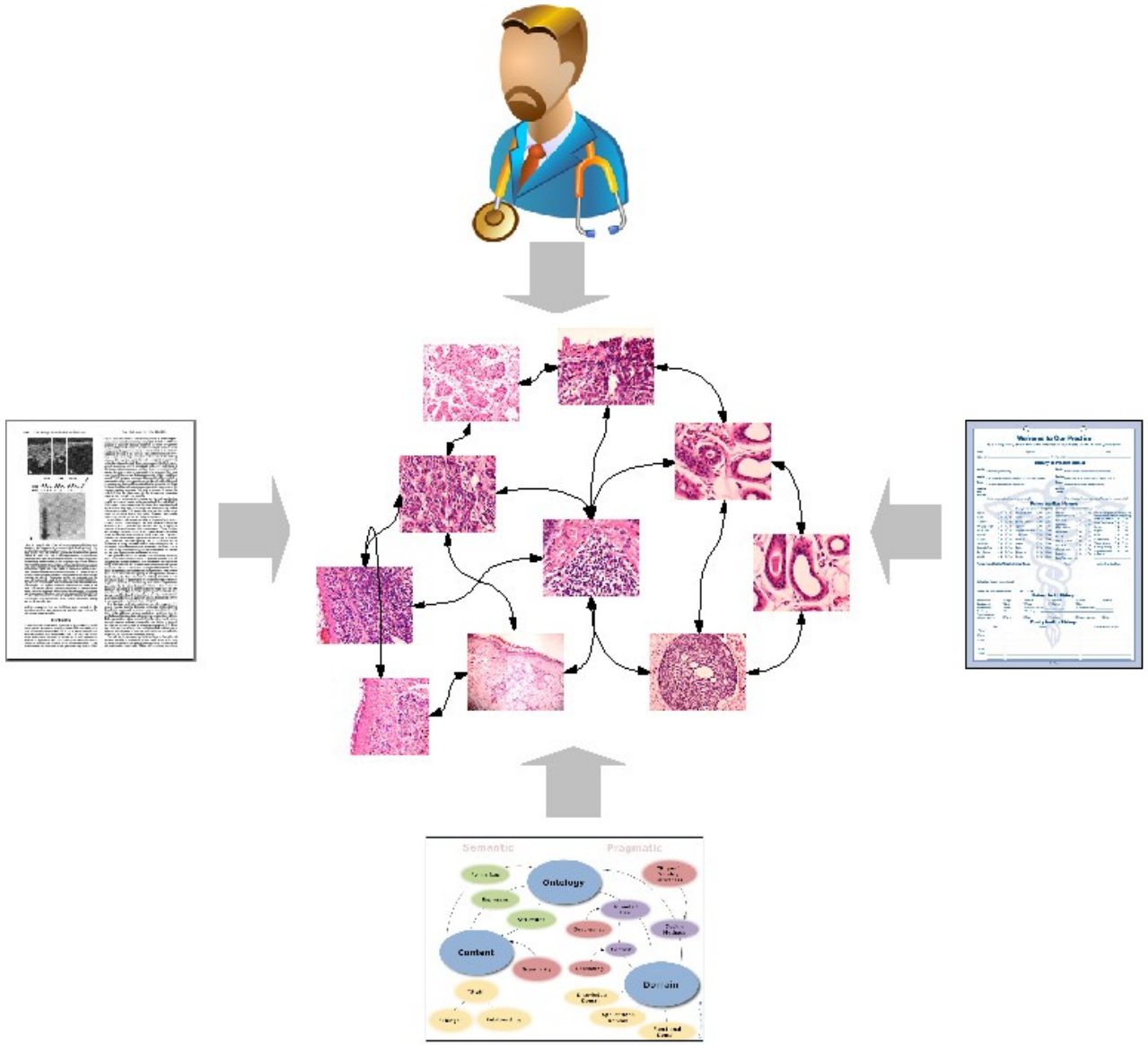
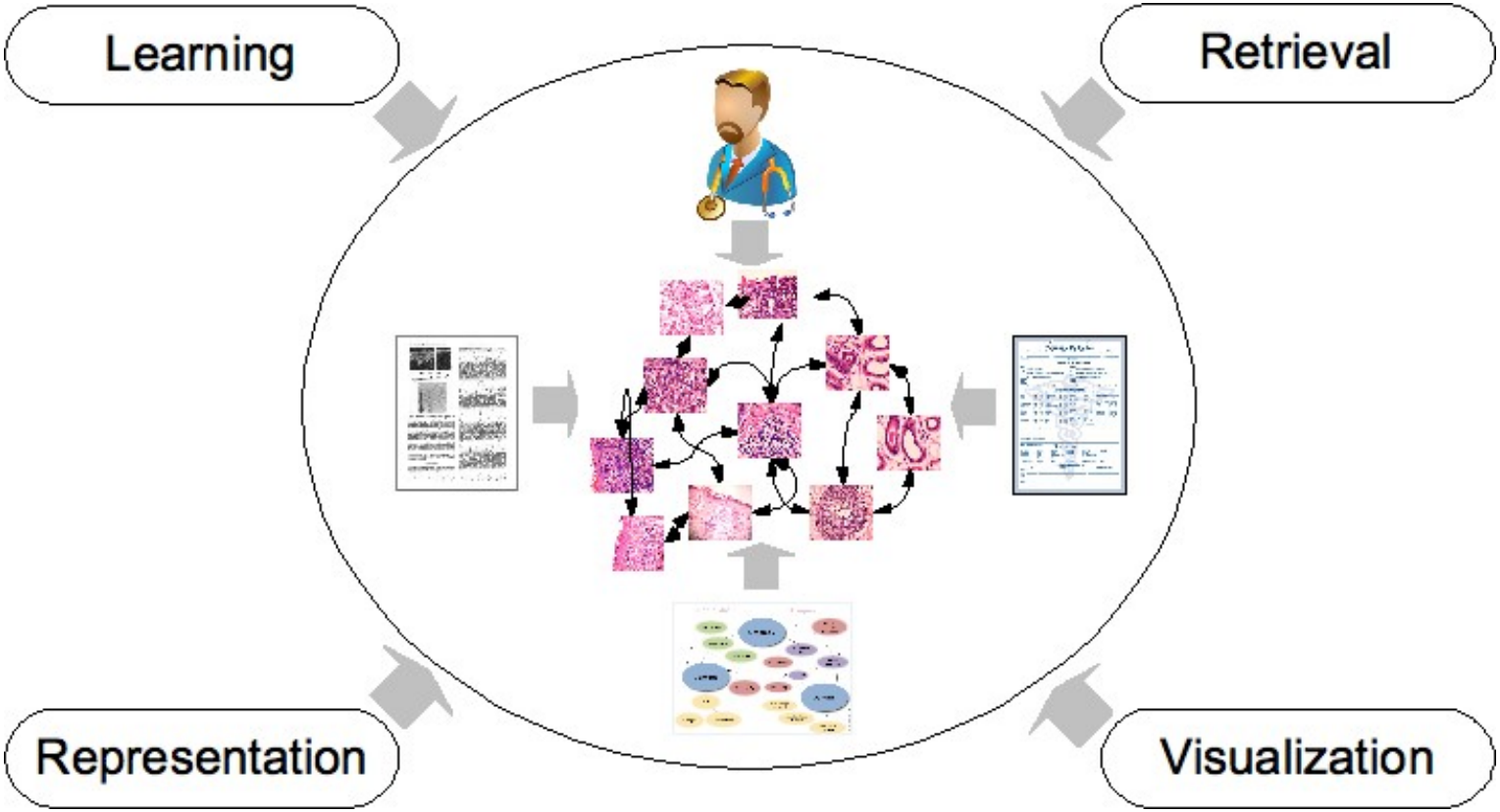
Biomedical Information

- Huge volume of different types of data
- It is difficult to find specific information
- Complex objects comprising visual and non-visual information
- Important resource for diagnosis support, teaching and research

Biomedical Image Collections



Computational Problems



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Supporting Research (1)

Cell Biology Center (biophysics and biology of membrane), National University of Colombia, CIF

- Nerve regeneration: In vitro culture of peripheral nerve component cells
- Thyroid function: Functional thyroid follicles
- Parasite-host cell relationship: Impact of Leishmania infection on the three membrane system found between the parasite and its host cell, the macrophage

Supporting Research (2)

- Digital images are an important asset for this kind of research
- Advantages of an image management system:
  - material reuse
  - collaborative work
  - information integration
  - knowledge dissemination
  - teaching support

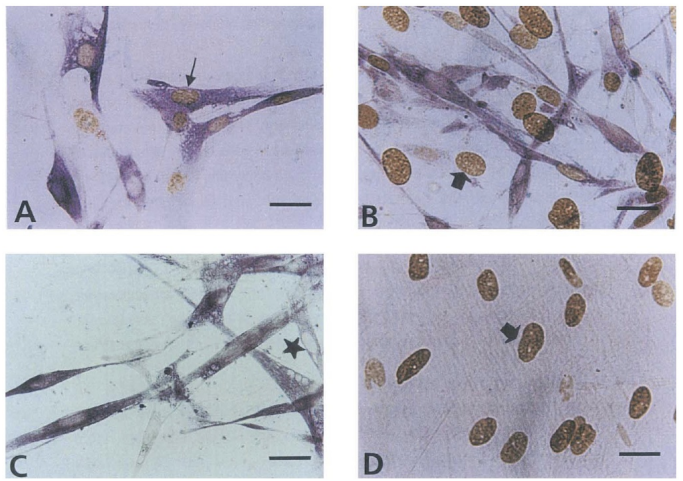


Fig. 4. Action of Ara-C on adult human peripheral nerve cultures. Double immunolabeling technique was used for both S-100 (cytoplasm labeling of Schwann cells (star)) and BrdU (nuclear labeling of cells in S phase (filled arrow)). (A) Corresponds to primary culture in the presence of one (24 h) pulse of Ara-C, double inmunolabeling cells is observed (arrow head); (B) corresponds to primary culture in the absence of Ara-C at the same time. A large number of fibroblasts incorporating BrdU are observed; (C) represents, wells of primary cultures of adult human peripheral nerve, in absence of Anti-BrdU (nuclear labeling of cells in S phase); and (D) represents wells in absence of antibody against S-100 protein (cytoplasm labeling of Schwann cells). Scale bar = 20 μm.

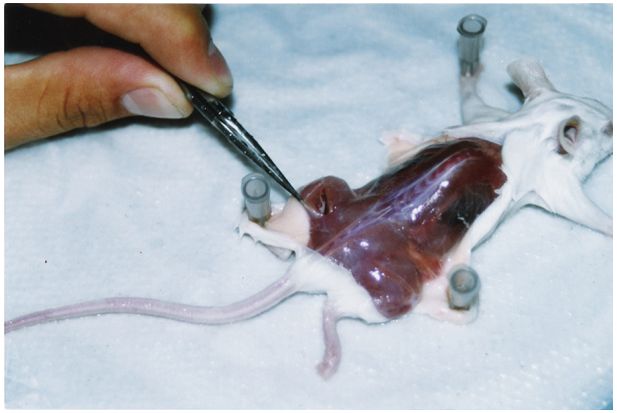
In the case of fibroblasts incorporating BrdU (Fig. 3B) we observed a significant difference when comparing initial values and values after first pulse of Ara-C (24 h pulse), 40 and 12% (Fig. 4A), respectively ($P < 0.05$). During the application of the second pulse this percentage remained constant (no differences between first and second pulse). Between the third and fourth Ara-C pulses, the percentage quickly decreased to values less than 5%. In the absence of Ara-C (Fig. 4B)

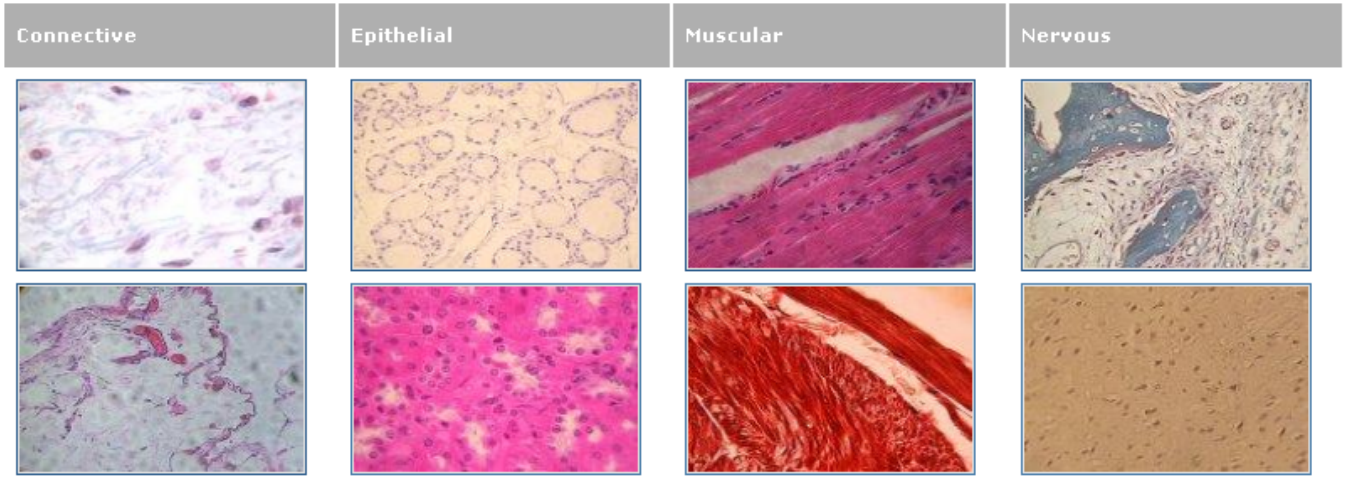
ences were not found among samples in respect to the cell number obtained, viability cell percentage, as well as difficulties during the culture process. However, an influence of donor age on cultured cells can not be discarded.

In terms of viability, using the same in vitro Wallerian degeneration process, but a different enzymatic dissociation protocol (dissociation time and enzyme concentration), we observed that the viability level ob-

Supporting Research (3)

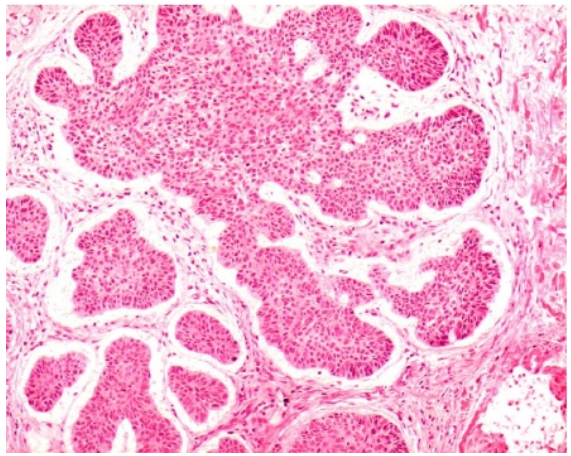
- Data:
  - Different tissues extracted from mice
  - 20,000 histological images collected
  - 9,000+ images annotated





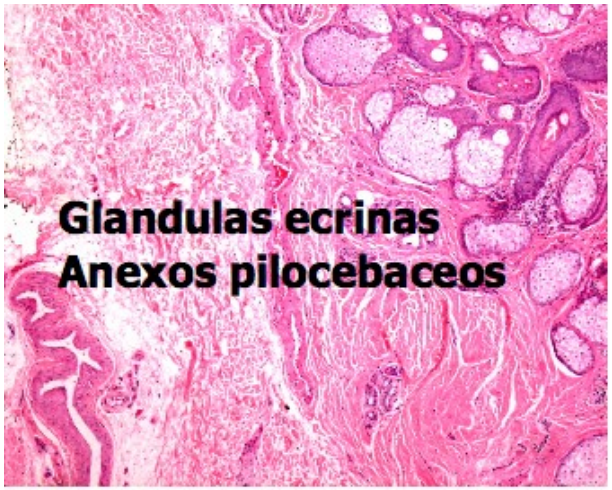
Supporting Medical Diagnosis (1)

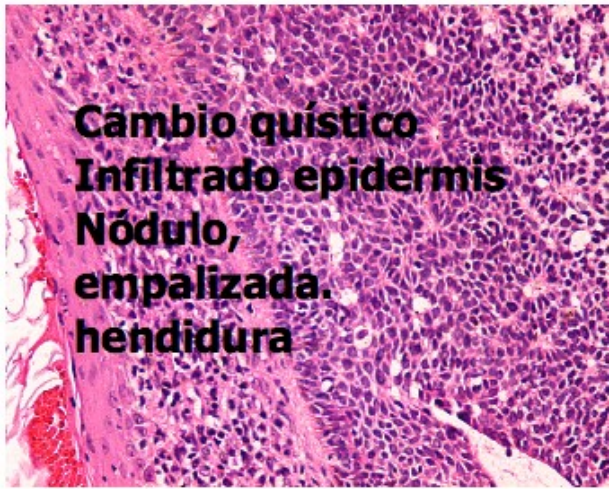
- Pathology Lab at the National University of Colombia:
  - Histopathology, cytopathology, immunopathology
  - Relies heavily in microscopical imaging
- Advantages of an image management system:
  - evidence-based medicine
  - collaborative and remote work
  - support to clinical studies and trials
  - physician training



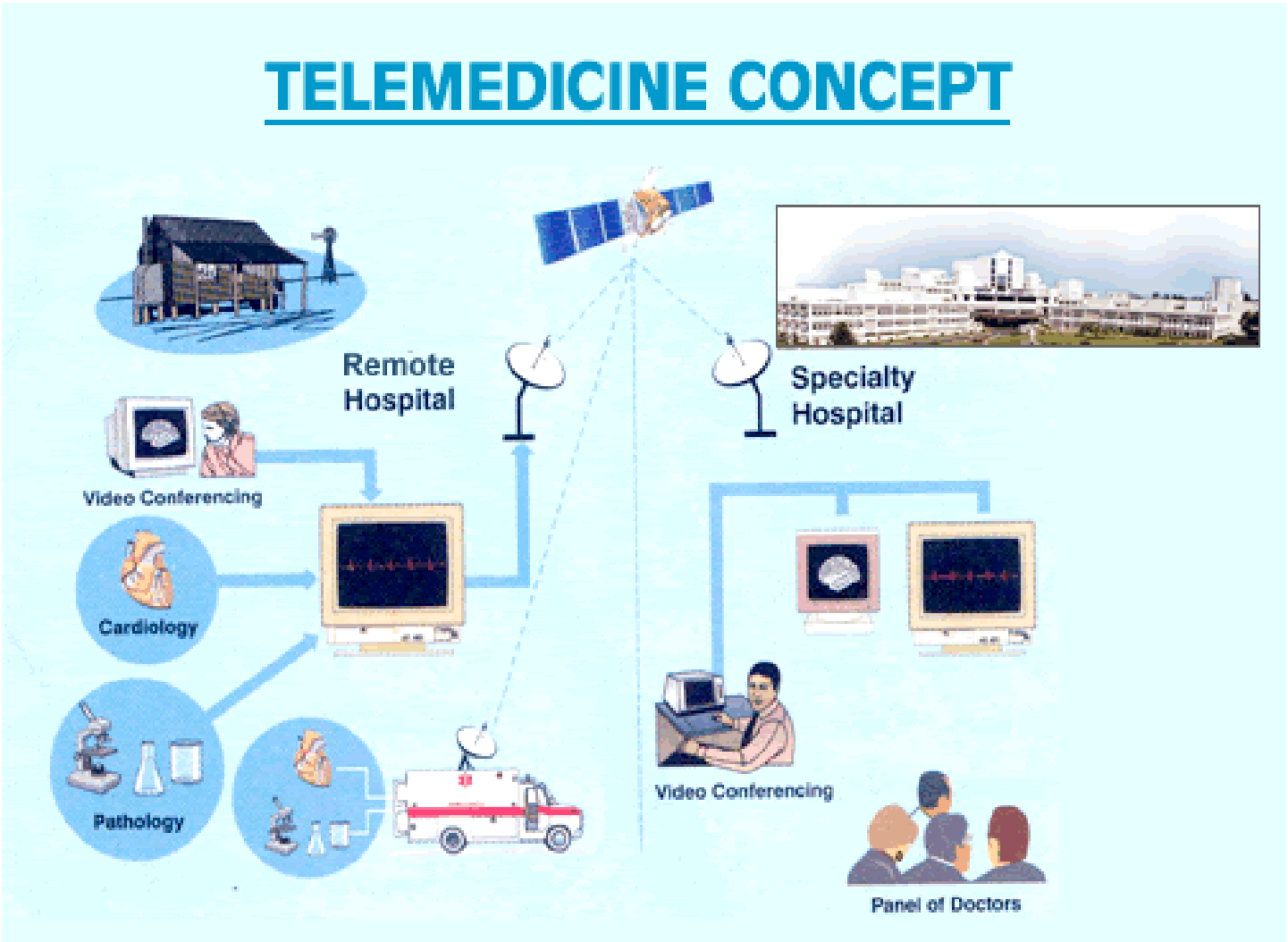
Supporting Medical Diagnosis (2)

- Real samples for diagnosing bassal-cell carcinoma
- 5,995 images at 1,280×1,024 pixels, acquired under a Nikon microscope at the Pathology Lab
- A subset of 1,502 images was studied and annotated by a pathologist
- 30 visual structures associated to tissue and cell properties identified and grouped in 18 concepts





Telemedicine



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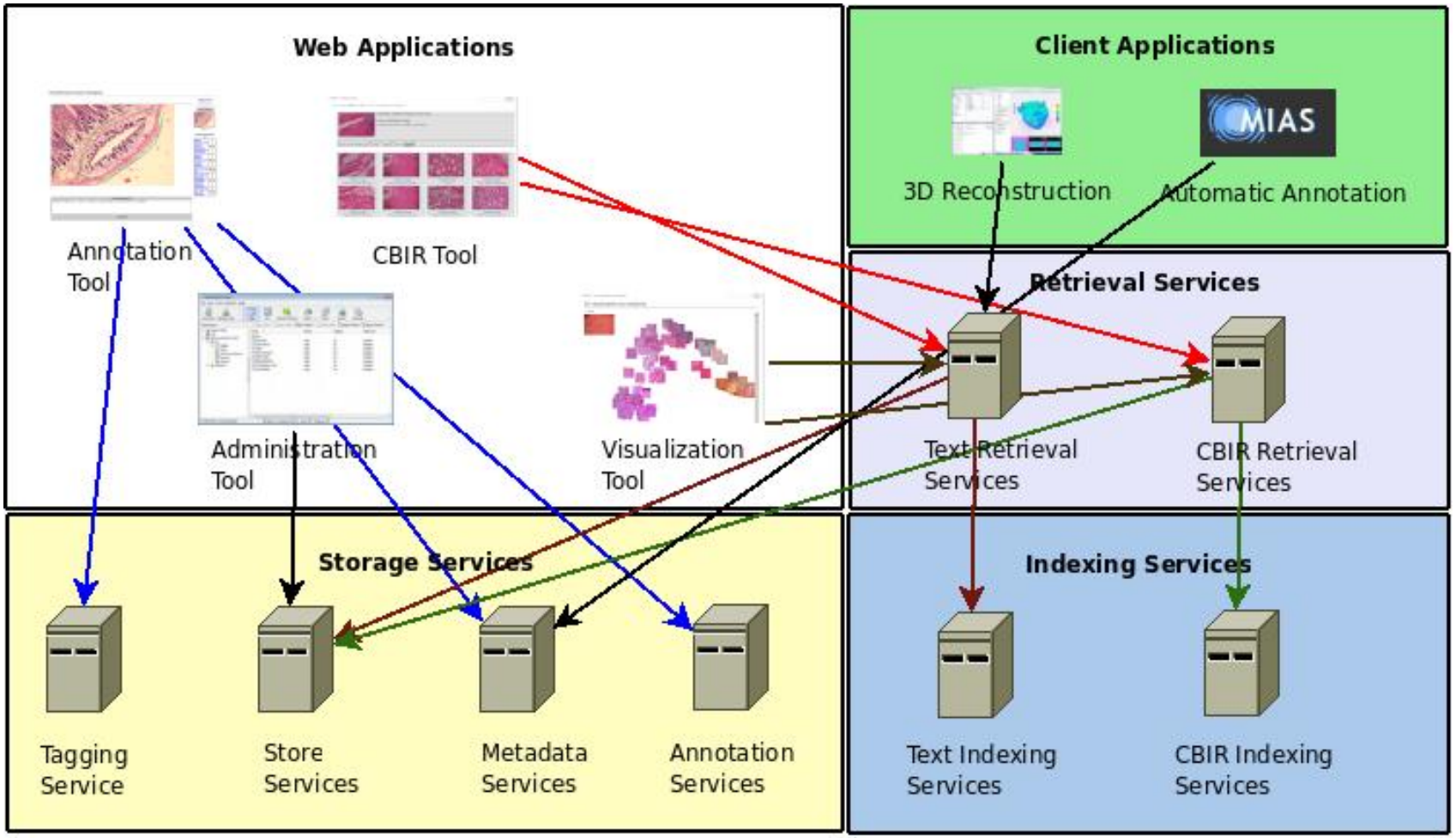
Requirements

- Image management:
  - addition, deletion, updating
- Image annotation:
  - global annotation, region annotation
- Image search:
  - text keywords, query by example
- Collection exploration:
  - visualization, summarization, interaction

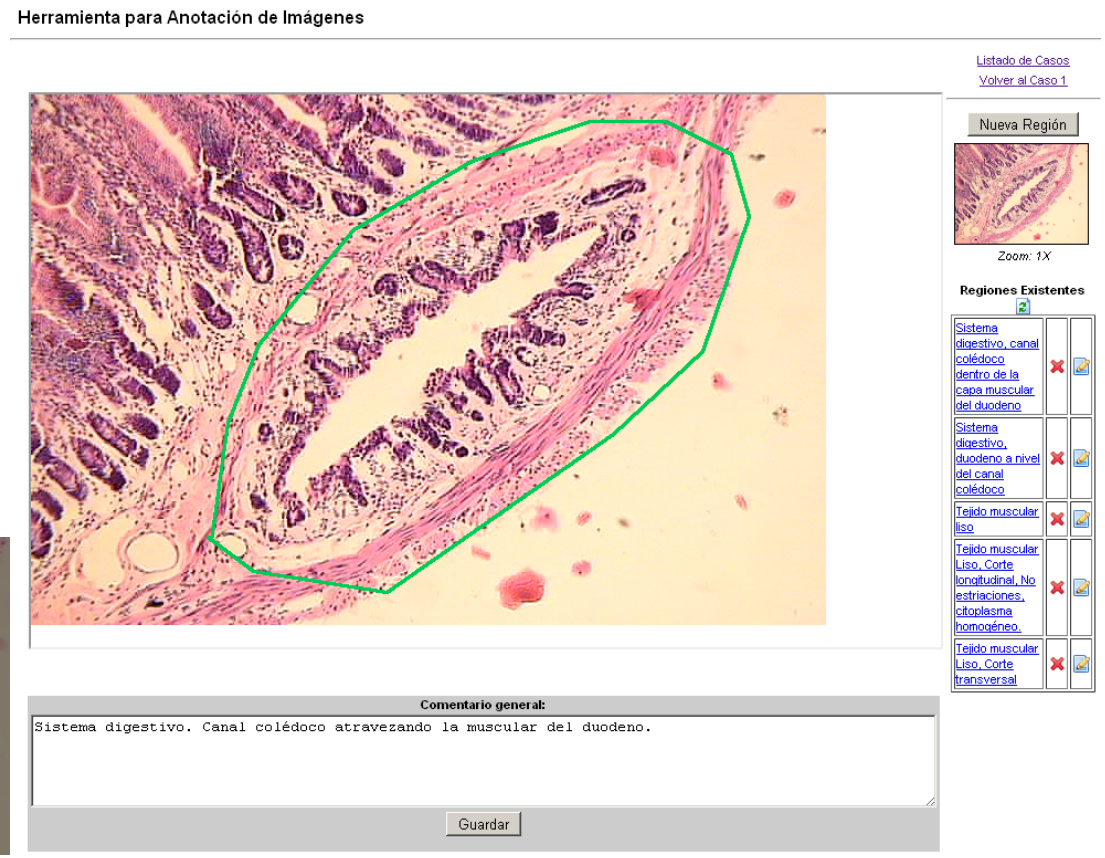
System Architecture



Supporting Technology

- Architecture: SoA, XML/SOAP standard
- Application Server: Java EE, JBoss, GlassFish
- Software components: Apache Solr/Lucene (text indexing and search), ImageJ (image edition), Colt (linear algebra library)
- DB server: MySQL
- Languages: Java, PHP, Python

Image Annotation



Text search


tejido epitelial
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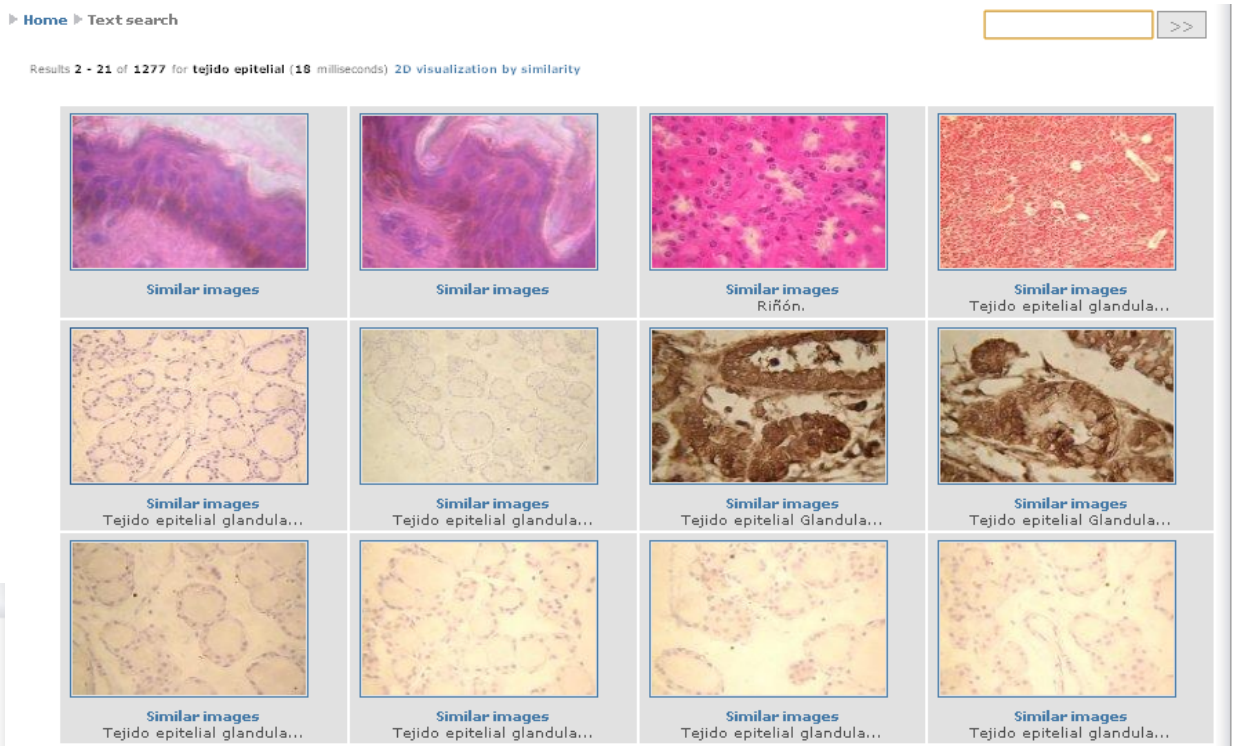
Home Text search
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Results 2 - 21 of 1277 for tejido epitelial (18 milliseconds) 2D visualization by similarity
Similar images
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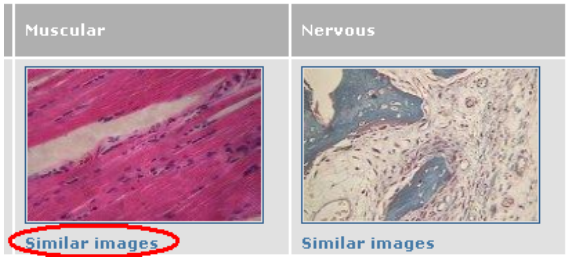
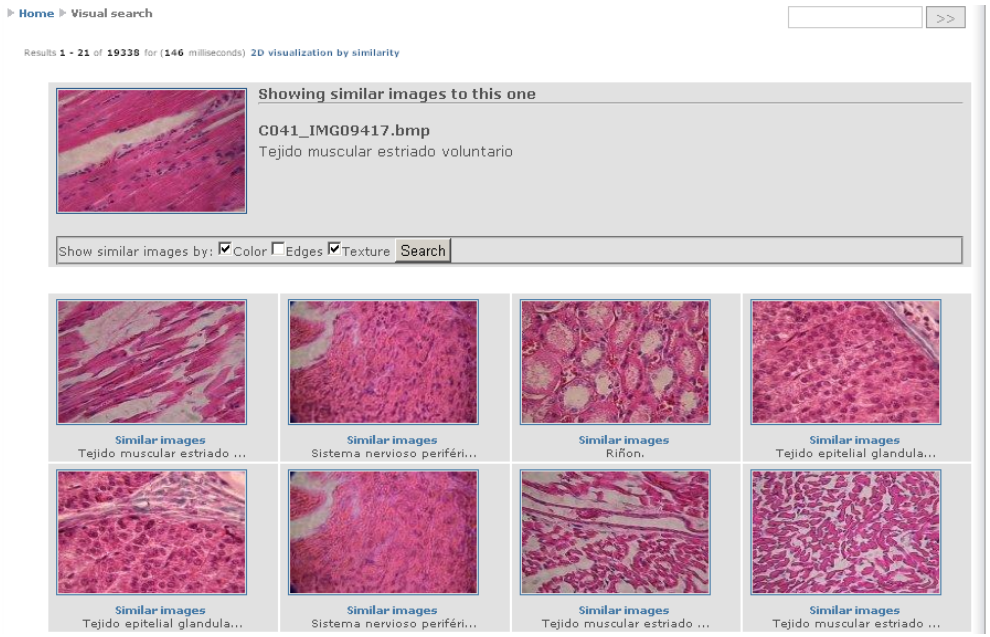
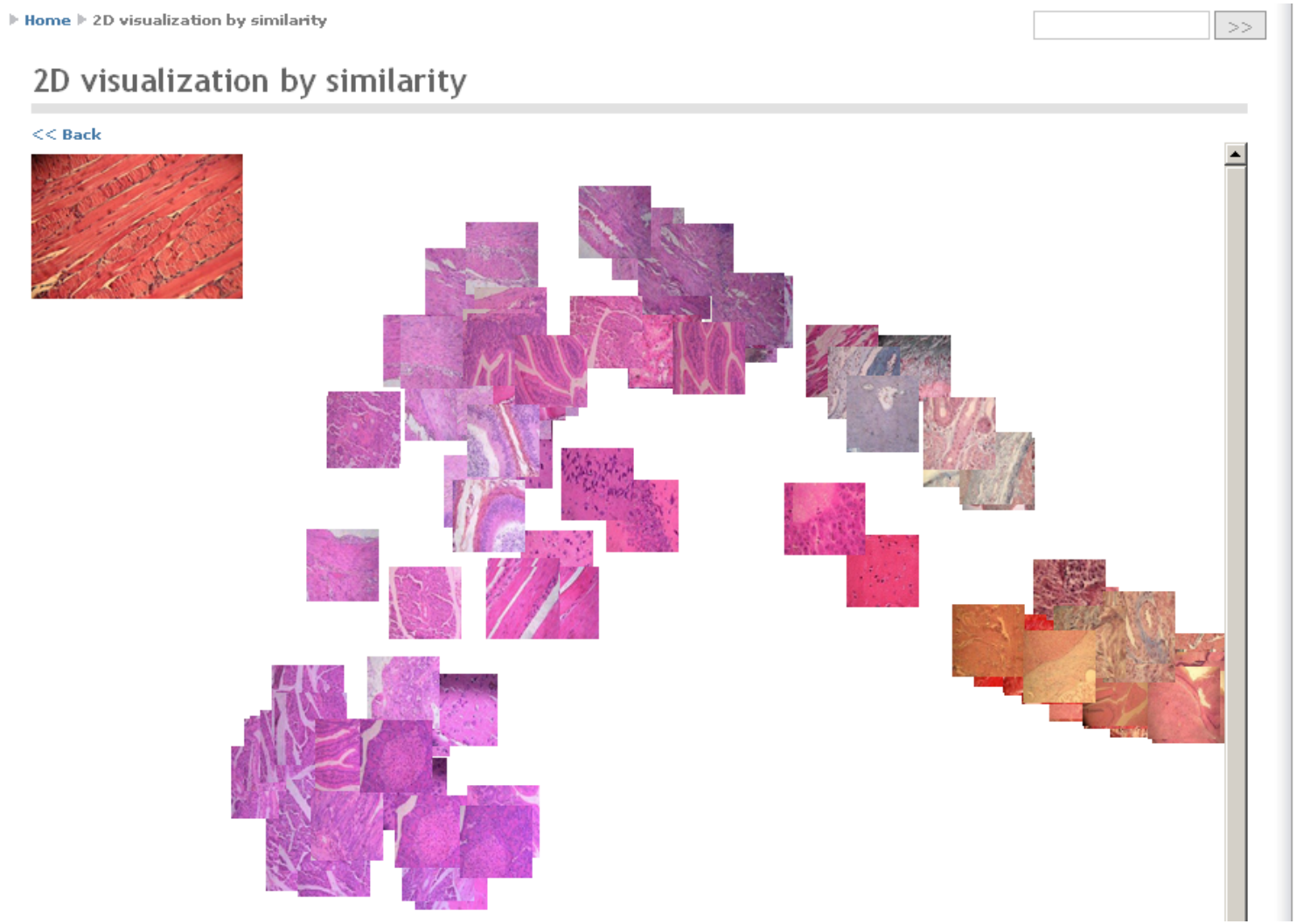
Content-Based Image Search





2D Visualization of Image Collection



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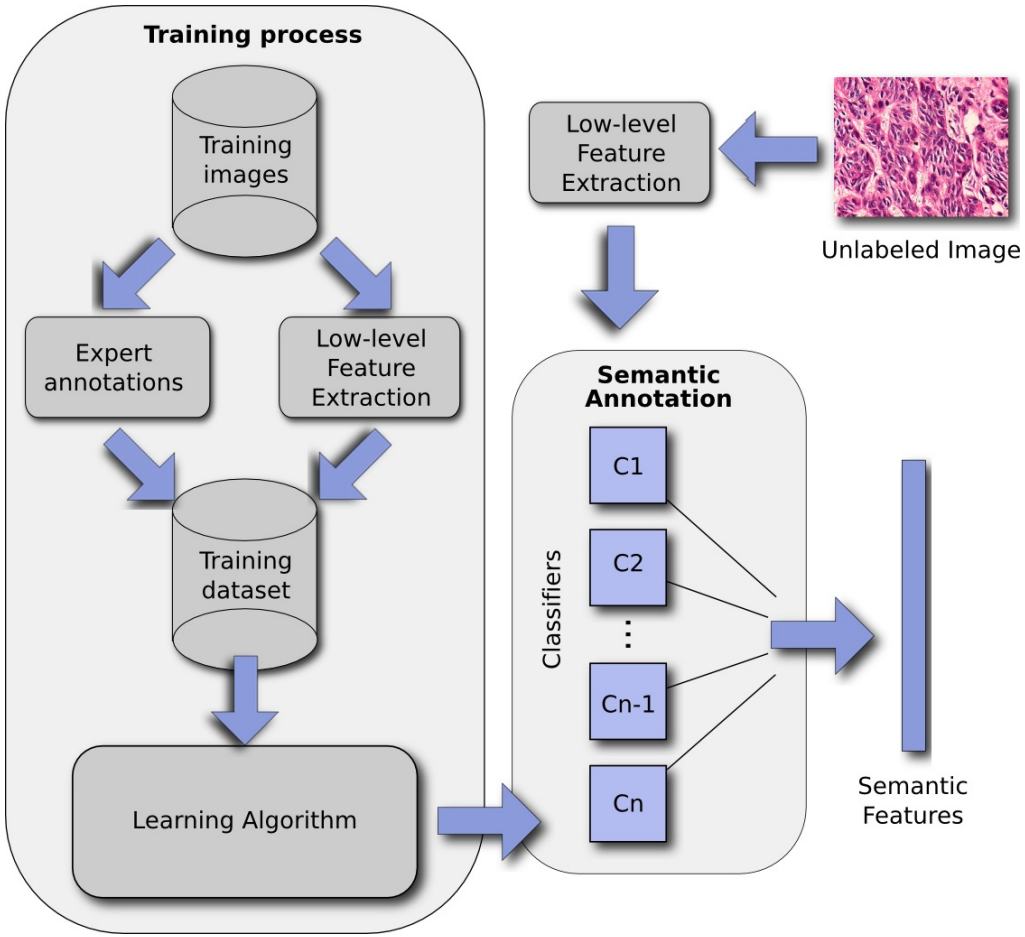
Semantic Content-Based Image Retrieval



Semantic Image Retrieval Performance

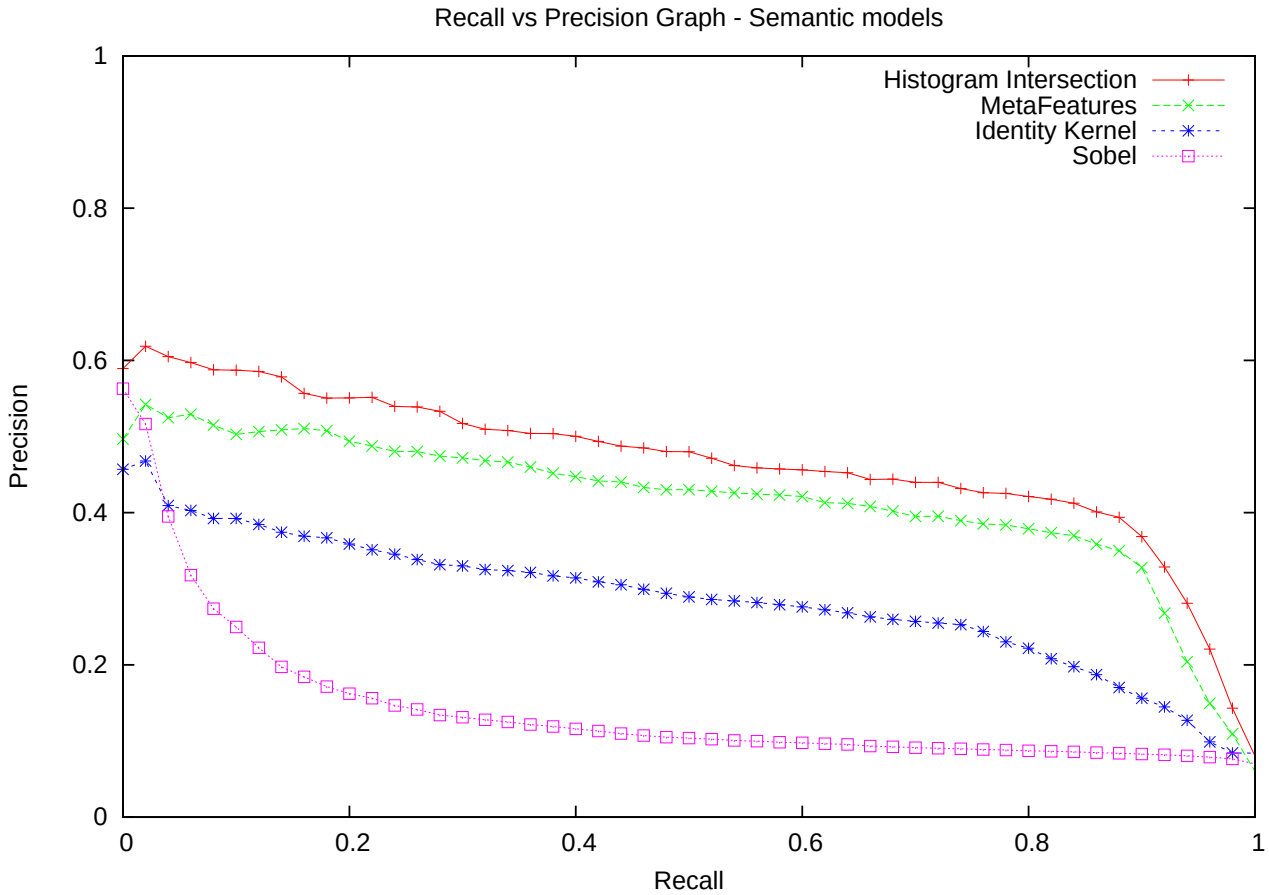
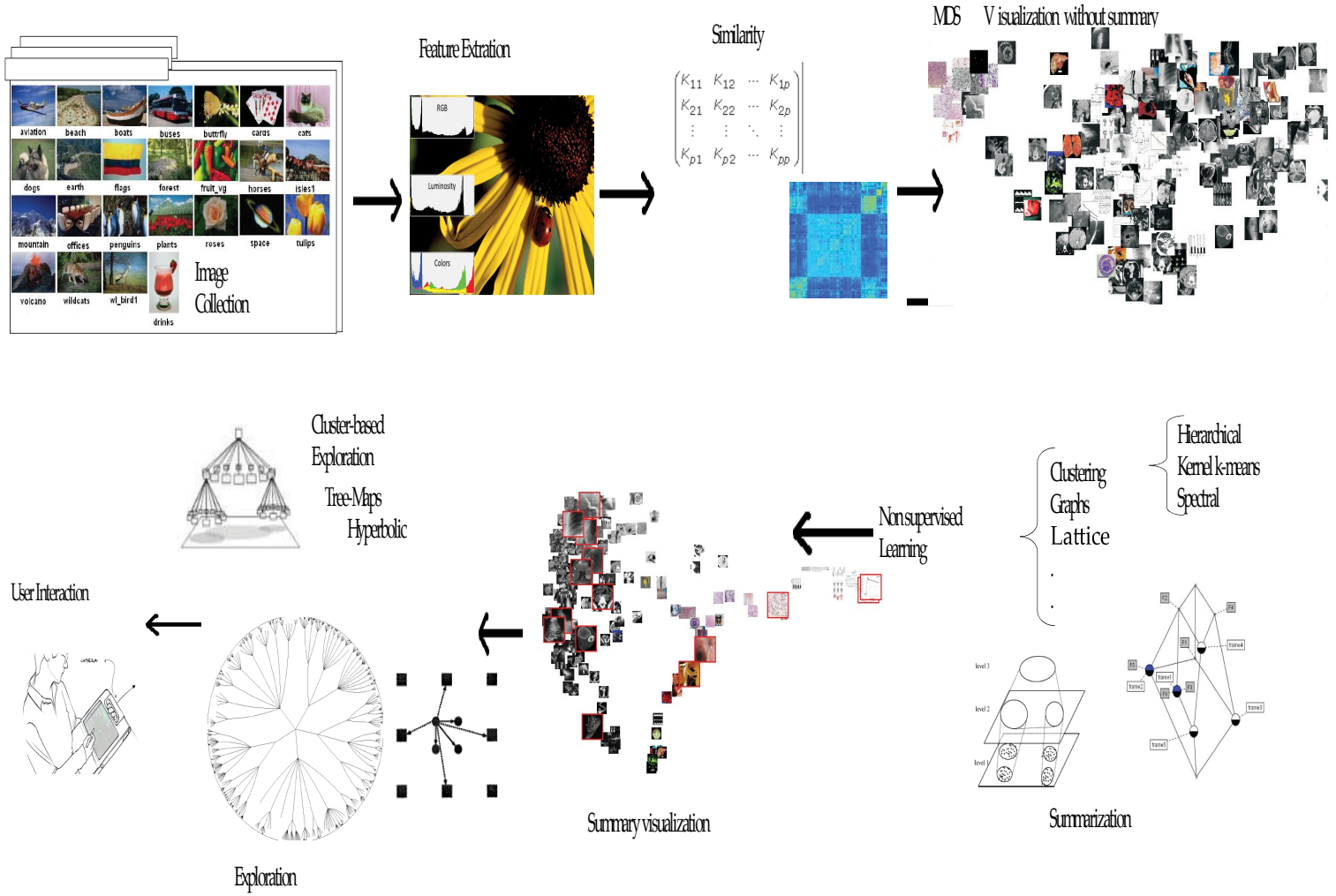


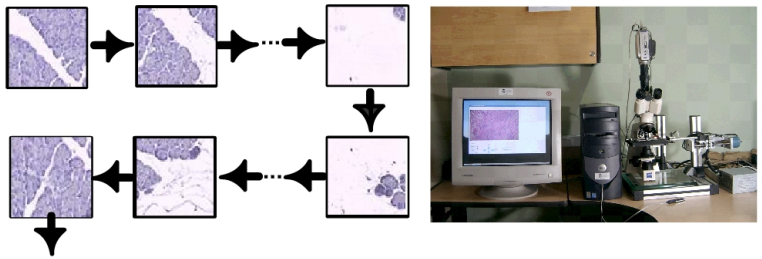
Image Collection Summarization and Visualization



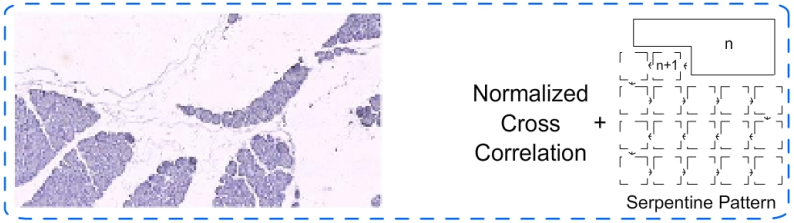
Interactive Machine learning

Virtual Microscope

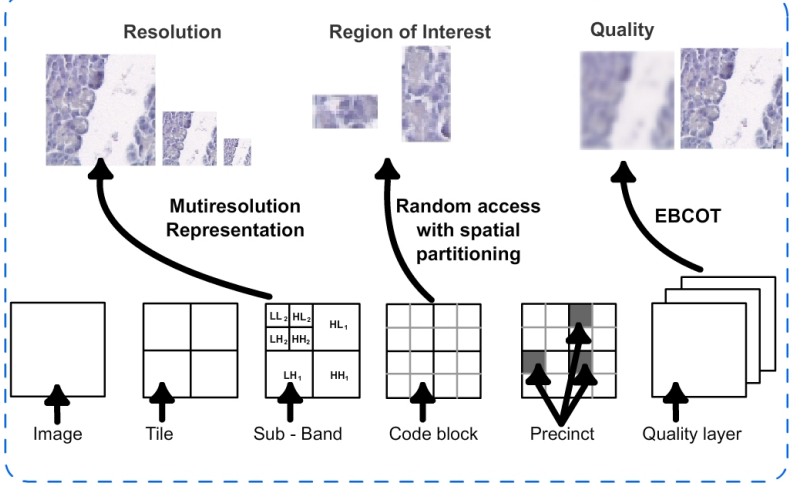
(1) Acquisition



(2) Reconstruction



(3) JPEG2000 Storage



(4) Navigation

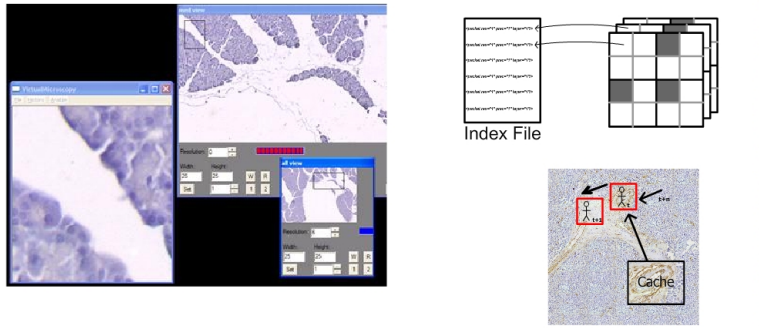
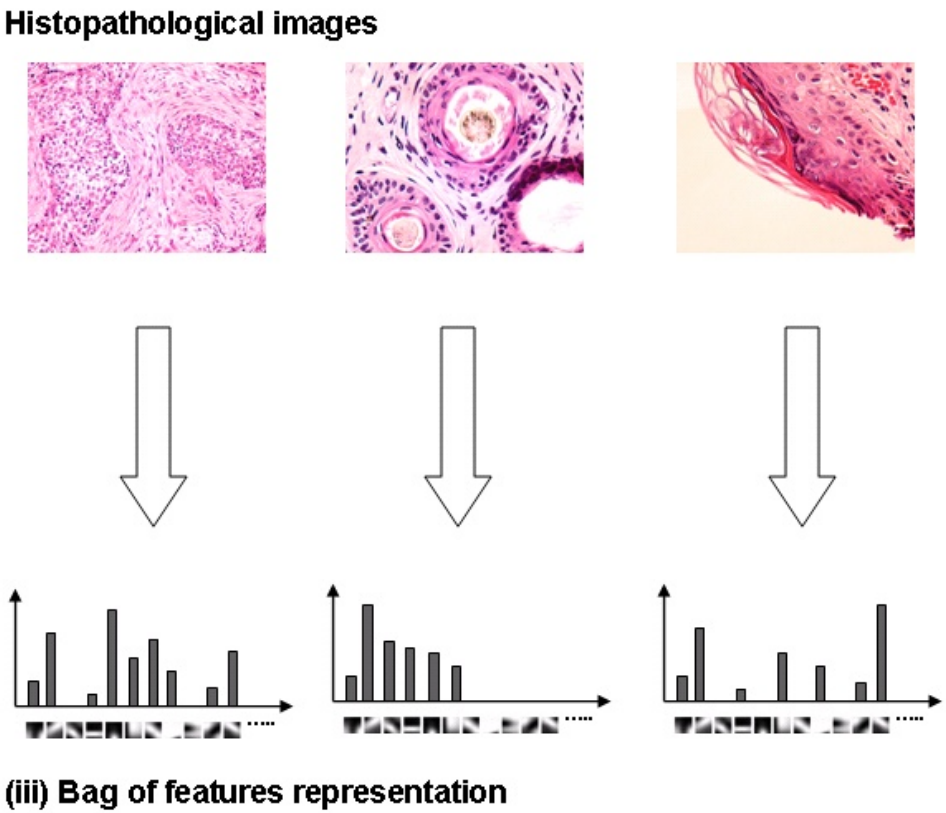
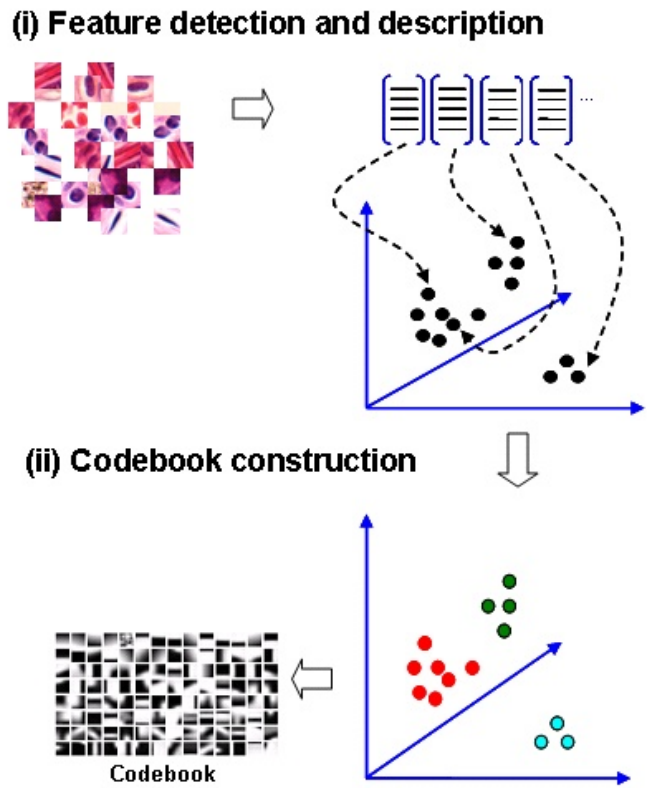


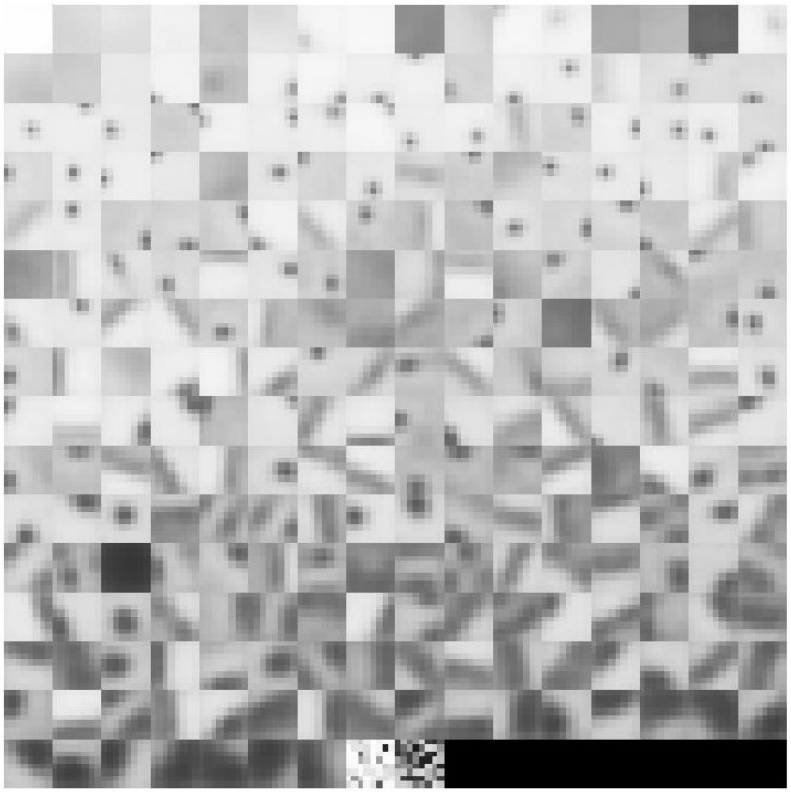
Image Pattern Analysis Tools

Using Bag of Features for Histology Image Analysis

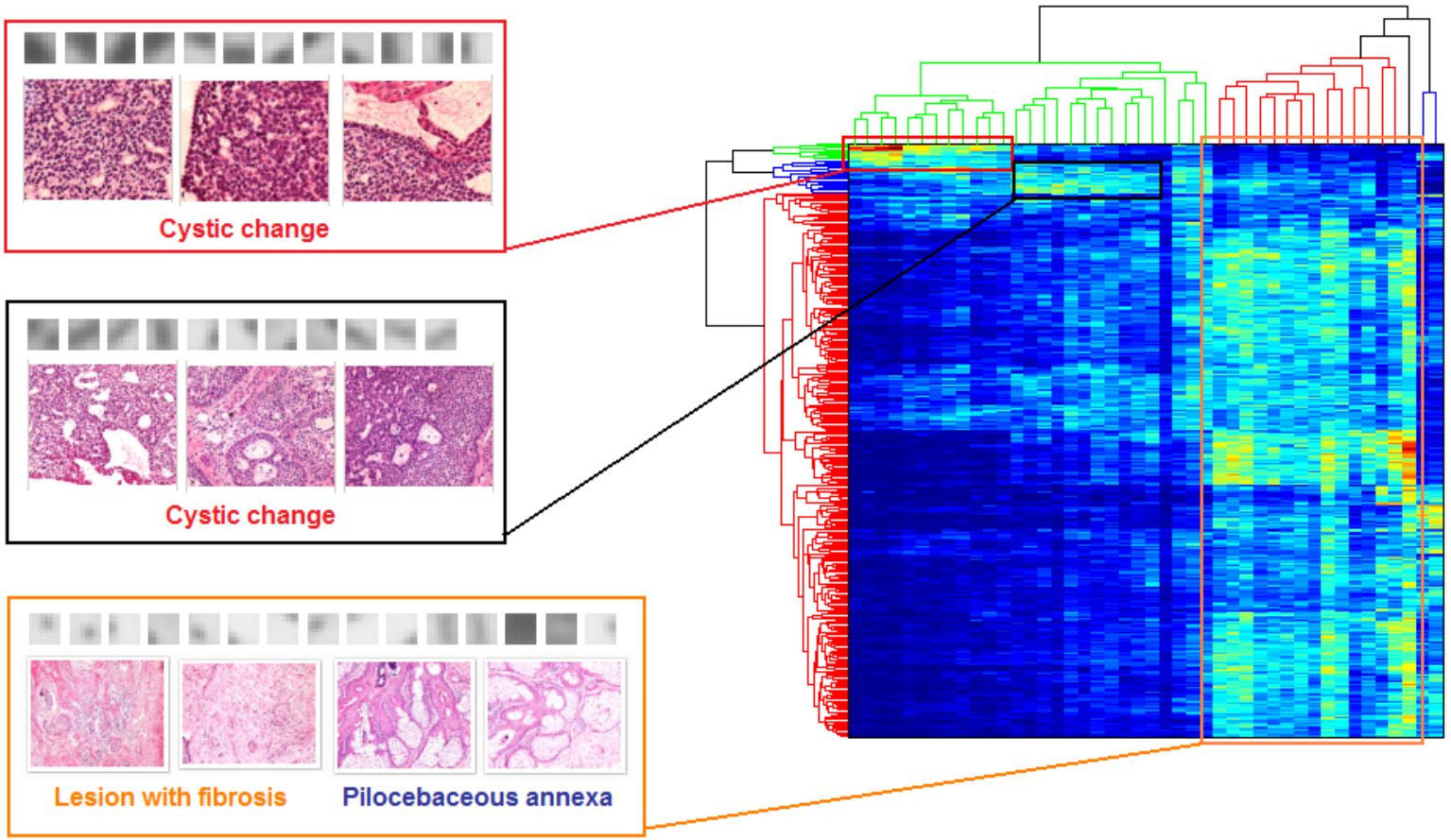




The Codebook



Visual Words vs. Concepts



Summary

- A web-based application for biomedical image management
- Enhanced functionality for collection search and exploration
- Easily extensible to support new functionalities and underlying technologies
- A testbed for novel image-collection-management technologies
- Big question: what is the real impact of this type of technologies on research and clinical tasks?

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