An Interactive Region-Of-interest (ROI)-Based Image Retrieval Approach of Biomedical Articles in a Local Concept-Based Feature Space

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Introduction

❑ Authors of biomedical publications frequently use images to illustrate various medical concepts.

❑ Use annotation markers: arrows, letters, or symbols overlaid on figures to highlight ROIs.

❑ Annotations are then referenced and correlated with concepts in the caption text.

❑ Users often seeking images similar with respect to ROI, but are limited to similarity of the entire image.

Figure 23. Pulmonary fibrosis: High-resolution CT scan shows rounded, well-defined cysts in the right lung (black arrow) in a patient with traction bronchiectasis (white arrow) and bilateral basal subpleural honeycombing (arrowheads)

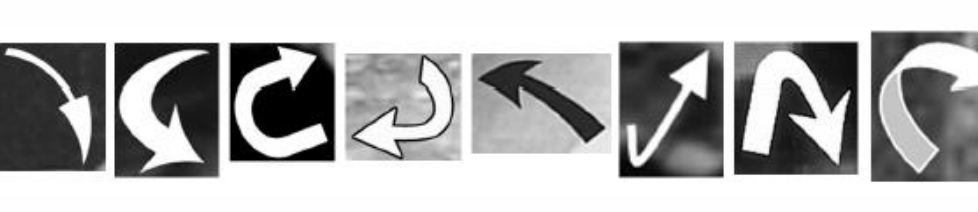*Example chest CT image with associated caption and different arrows*

Objectives:

❑ Perform semantic search without knowing the concept keyword or the specific name of the visual pattern.

❑ Involve Users in the Retrieval Loop (RF).

❑ Cross-Modal Image Search.

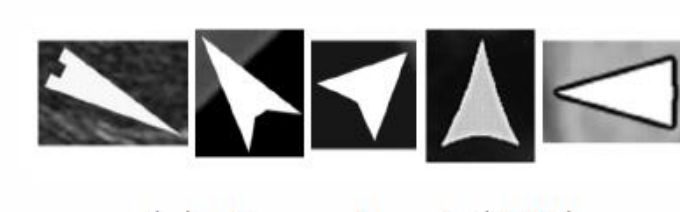❑ Use Spatial Information in Images.

Pointer Recognition

❖ Utilized a combination of rule-based and statistical image processing techniques.

❖ Represents shapes with both Markov Random Field (MRF) and Hidden Markov Model (HMM).

(a) Straight arrow (SA)

(b) Curved arrow (CA)

(c) Arrowhead (AH)

(d) Asterisk (AR)

Various shapes of pointers

Input → Edge detection → Edge image binarization → Contour detection → Line segment (polygon) approximation → MRF line segment labeling → HMM shape classification
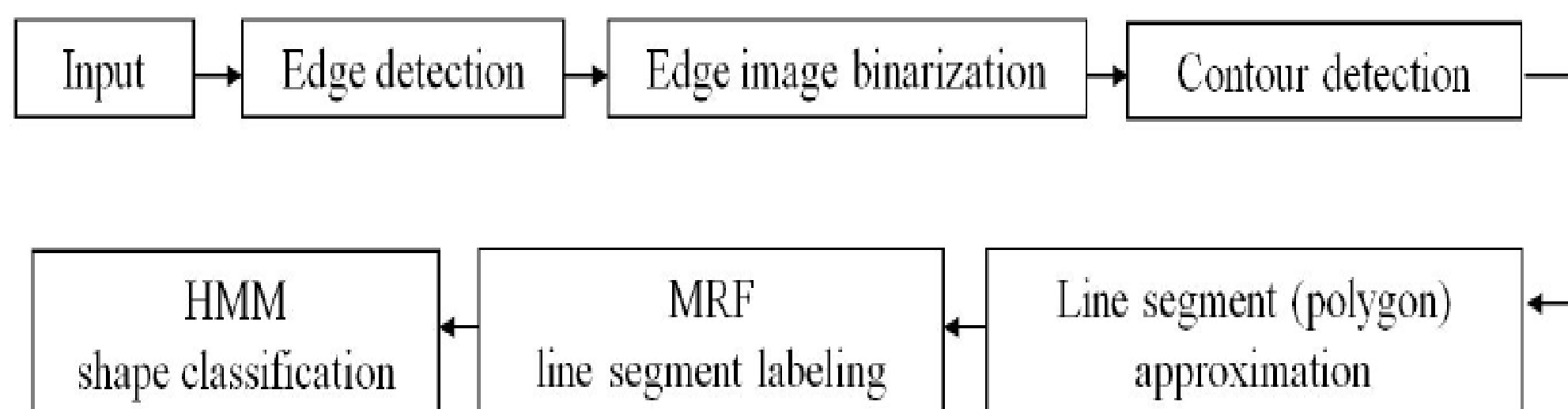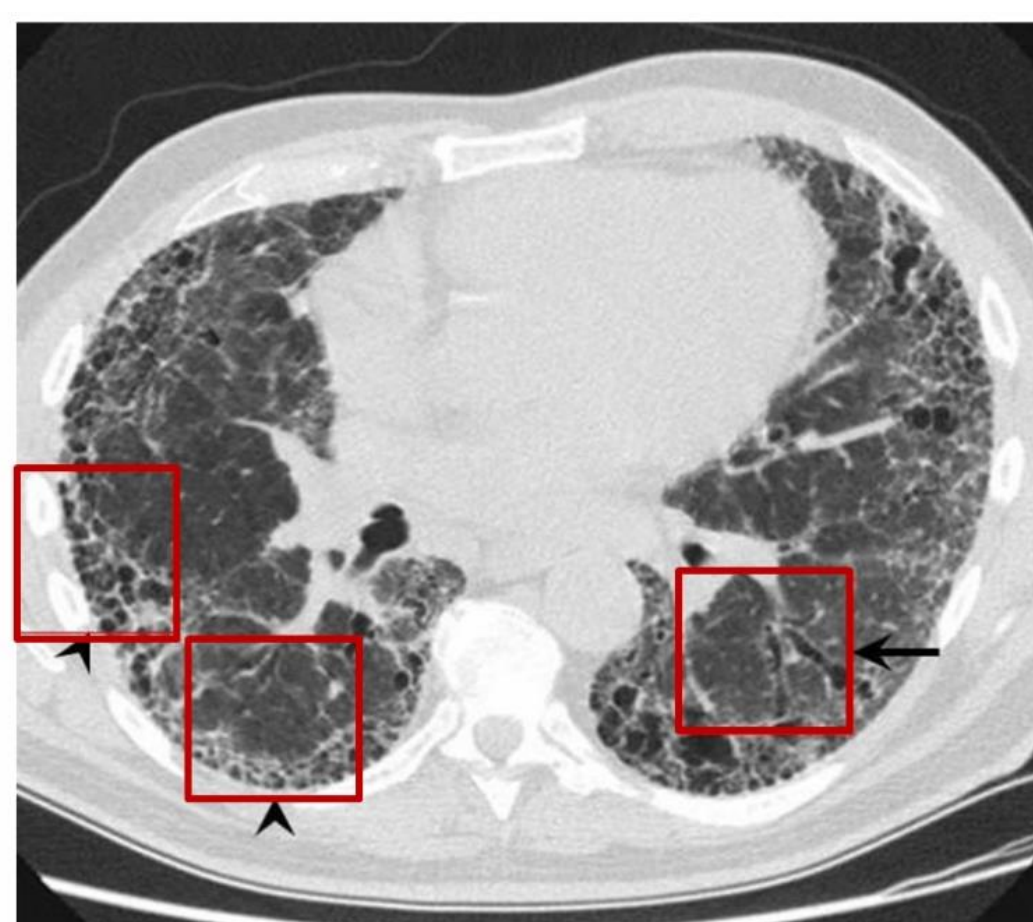
*Schematic of the pointer recognition algorithm*

ROI Identification

Extracted local patches within an image: (80x80, 100x100 pixels).

Example of automatic arrow and visual ROI detection

Concept Classification

"Concept" refers to perceptually distinguishable image patches.

Ground Glass, Bronchi, Honey Comb, Cyst, Consolidation, Fibrosis, Mosaic, Crazy paving, Nodule
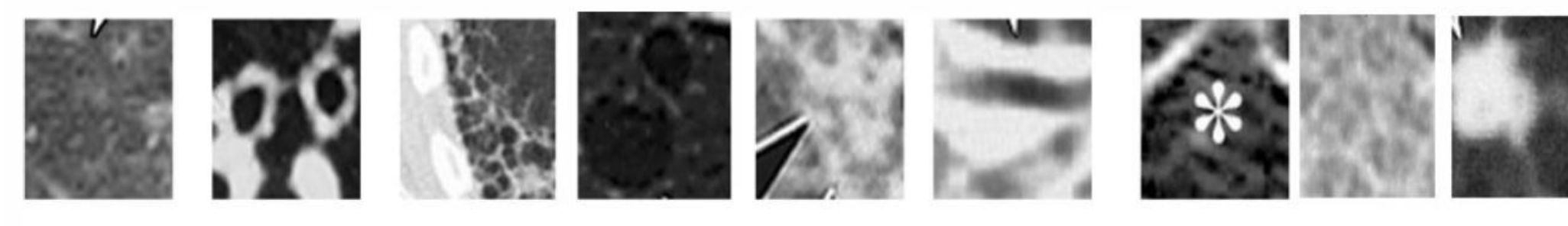
Example ROIs with Concepts in the Thoracic Imaging Glossary

Visual ROI Feature Extraction:

Feature	Dimensionality
Image moments	3
GLCM moments	10
Autocorrelation Coefficients (AC)	25
Edge Frequency (EF)	25
Gabor Filter descriptor	60
Tamura descriptor	18
CEDD	144
FCTH	192
Combined Texture Feature	487

Pattern	No. of ROI	No. of Images
Ground Glass	178	128
Bronchi	206	98
Cyst	72	47
Honey Comb	40	27
Fibrosis	15	10
Consolidation	60	34
Mosaic	42	23
Nodule	215	100
Crazy paving	14	8

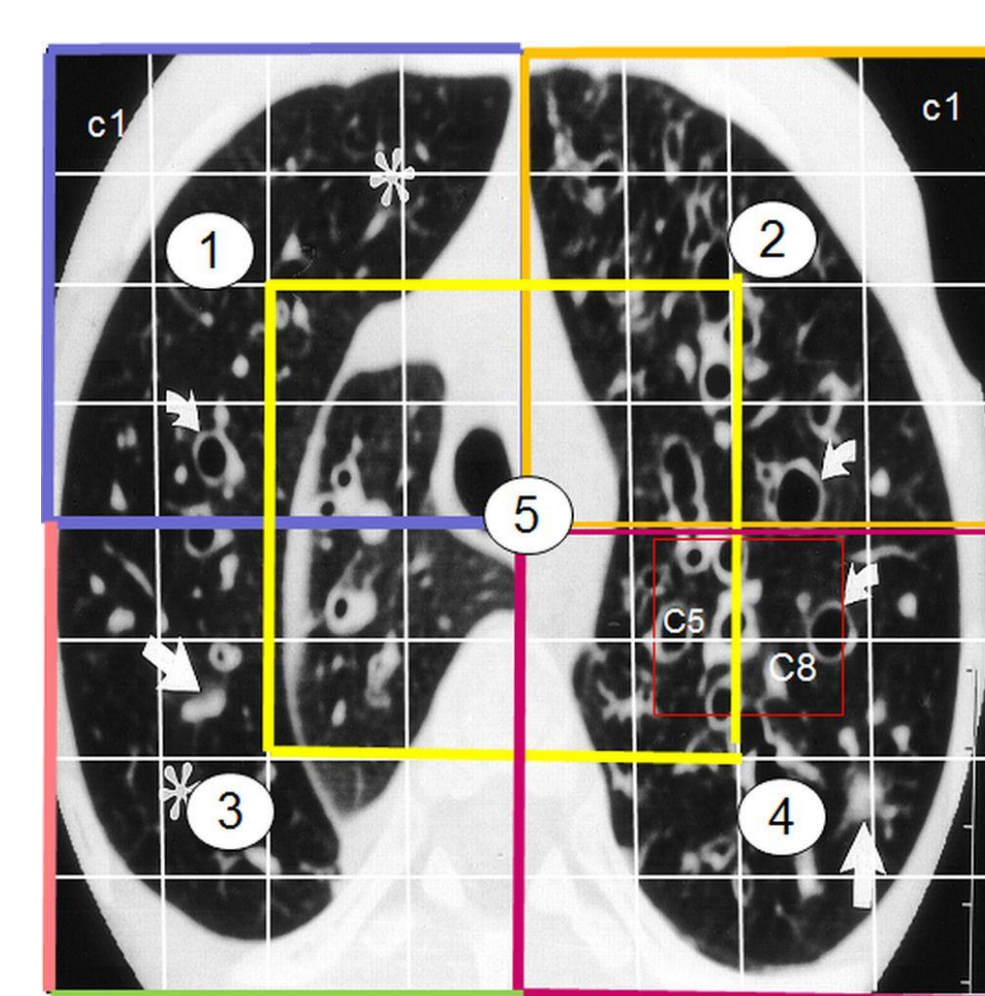*Patches for SVM training*

Multi-Class SVM:
Automatically mapping the appearance of visual entities within the selected query image ROI those in the codebook.

Retrieval Process Diagram

Spatial Layout

Patch Category	Visual Example	# Patches	Avg. Entropy
background_black		169	3.554
groundglass		257	6.401
honeycomb		174	6.777
cyst		270	6.500
bronchi		263	6.750
background_white		272	0.771
nodule_micro		230	6.258
nodule_macro		259	6.325
corner_black_grey		287	5.158
fat_lung_tissue		279	6.033
fat_grey		283	3.500
tissue_normal		275	4.989
tissue_heart		182	4.671
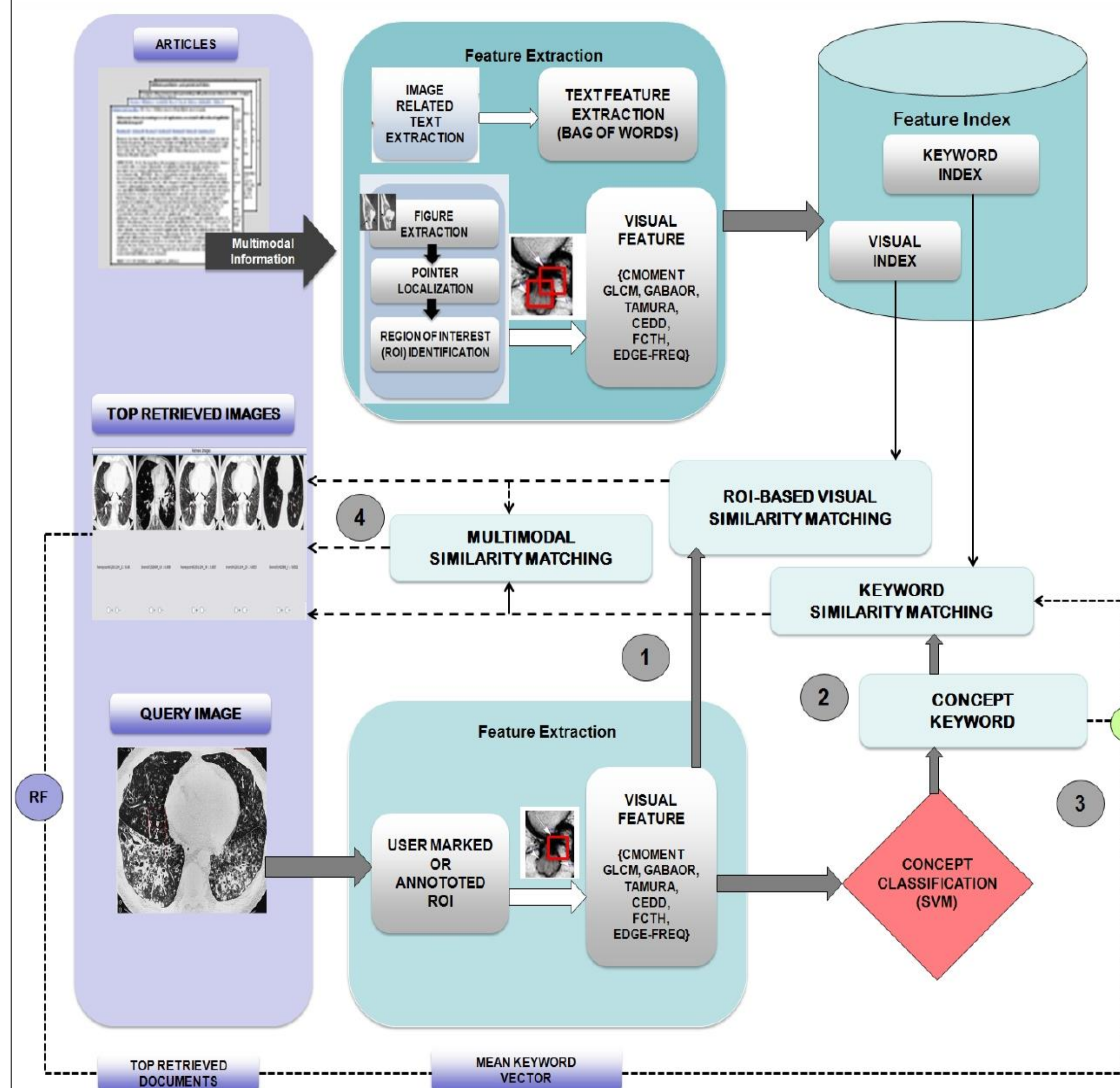
• Post-processing step to re-rank the retrieved images.
• Consider five overlapping regions.

Concept Entropy

Experiments & Results

❖ **Dataset:** 346 lung CT images appeared in journal articles from four different collections.

❖ Manually annotated a total of 1201 ROIs with different concept categories.

❖ **Classification:** Created a dataset of 842 ROIs of nine different concepts.

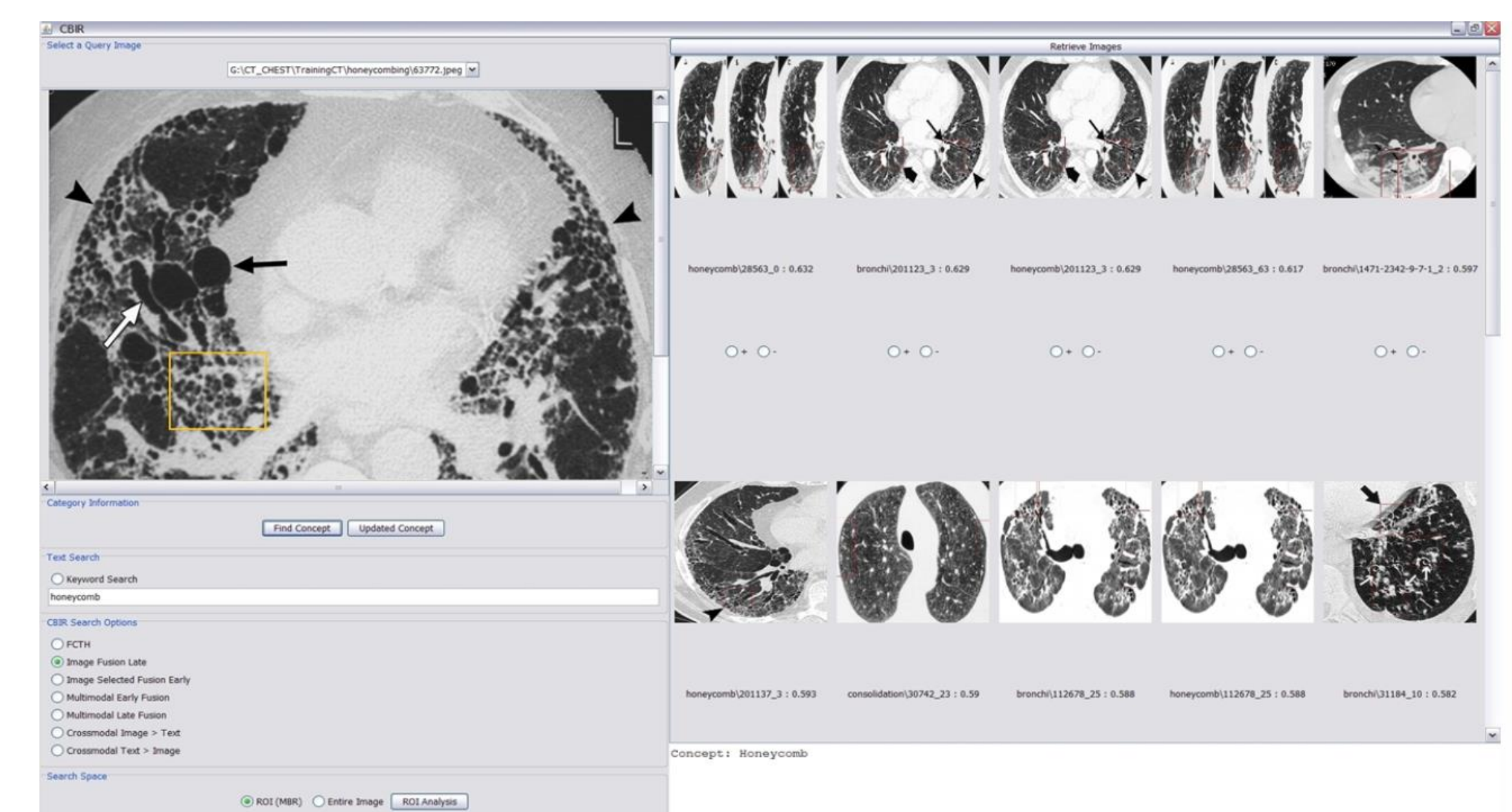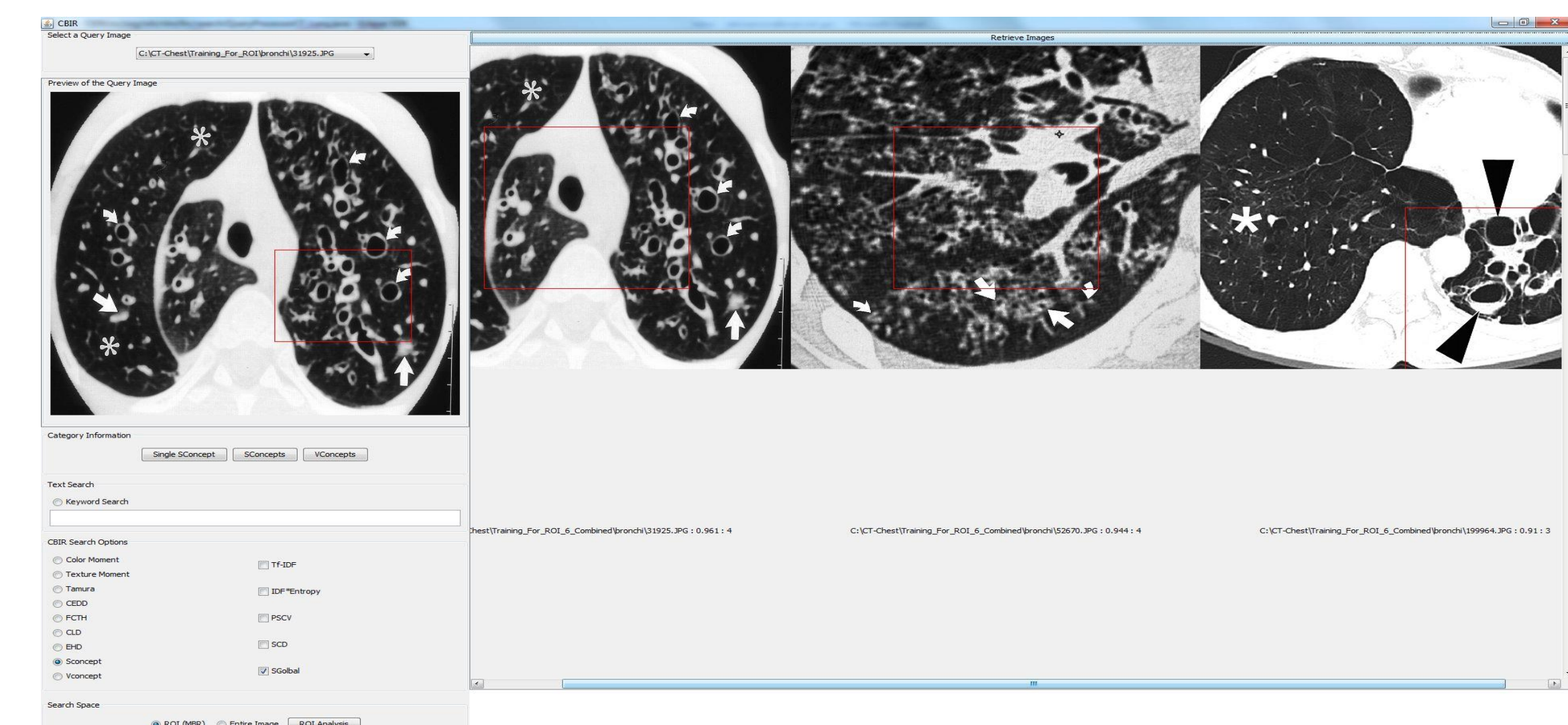|	Ground truth	Total detected	Detected true	Precision (%)	Recall (%)
#	1201	1146	974	85.0	81.1

Pointer Recognition Result
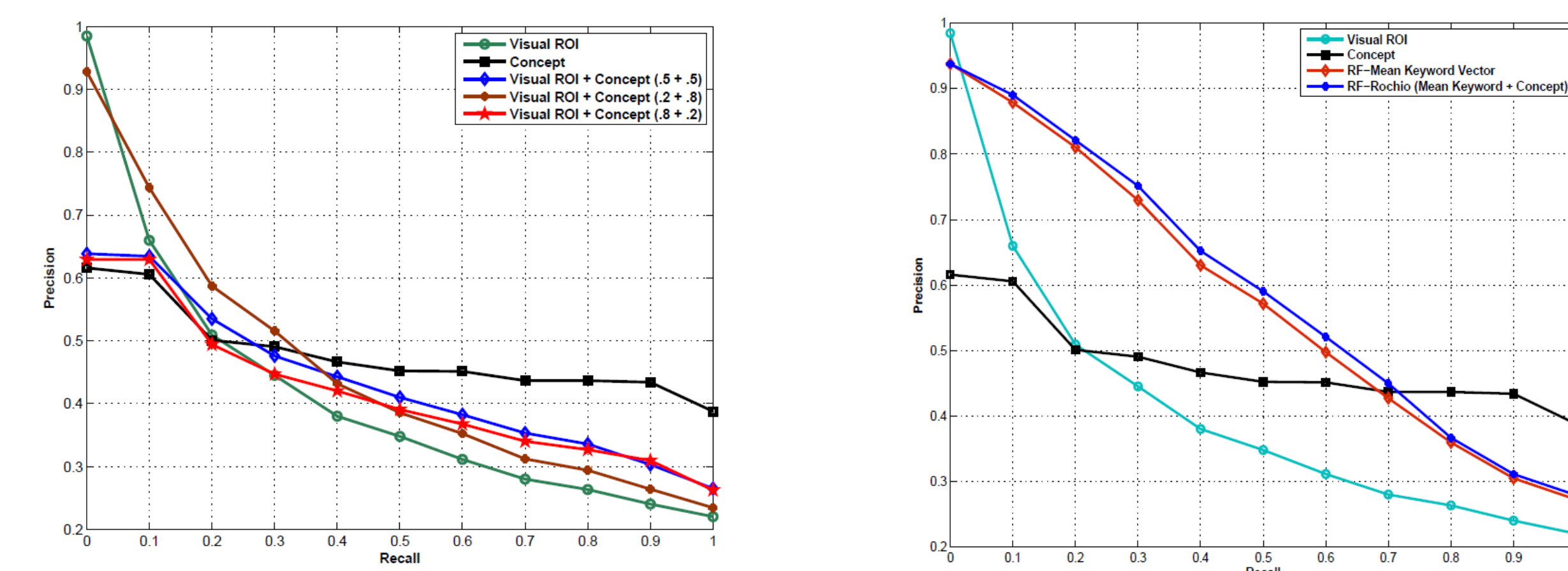
PR graphs for different image retrieval approaches

PR graphs for different image retrieval approaches based on RF

Retrieval Snapshots

Concept-Based Search

Concept Search Based on Spatial Layout

Summary

• Propose an Interactive Biomedical Image Retrieval approach.
• Focused on thoracic CT scans and their captions.
• Preliminary retrieval results show effectiveness of the proposed retrieval approach.
• Current results are promising toward our larger goal of creating a visual ontology of biomedical imaging entities.

Acknowledgement