國立高雄應用科技大學

100-101年度獎勵科技大學及技術學院
教學卓越計畫
產學及研究成果轉課程製作教材

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A study of Computer-Aided Detection on digital chest radiographs

Outline

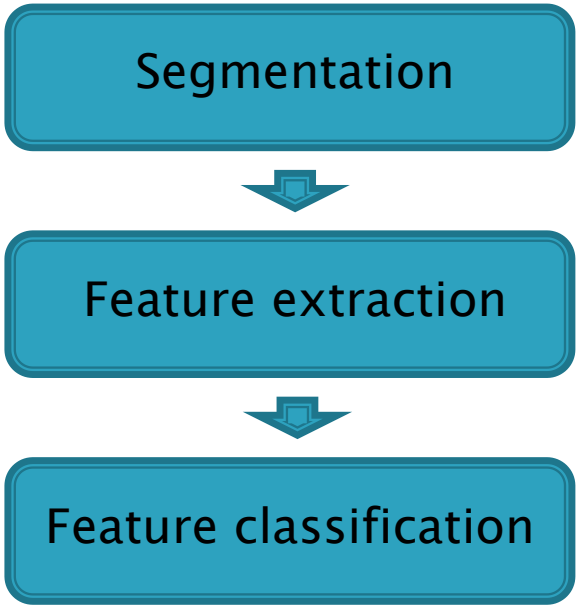
- Goal
- Introduction
- Methods
  - Segmentation
    - The ASM algorithm
  - Feature extraction
    - Gabor
  - Feature classification
    - SVM
- Experiment
- Test result

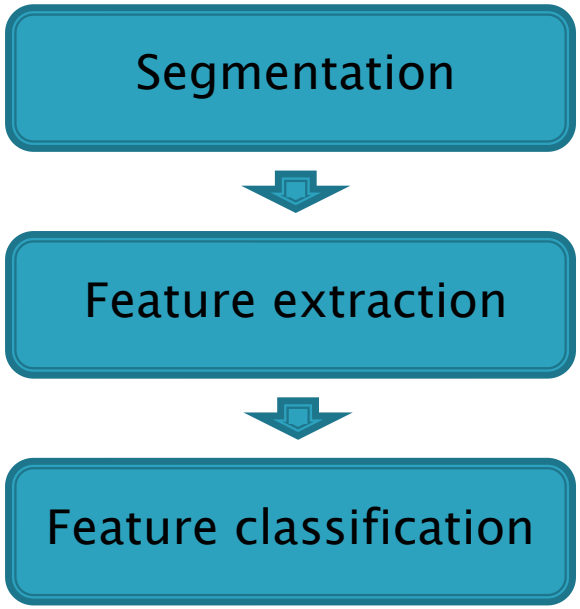
Goal

- This paper presents an automatic computer-aided detection scheme on digital chest radiographs to detect disease.

Introduction

- Computer-Aided Detection (CAD)
  - Generally, a complete CAD scheme for chest consists of three main steps:





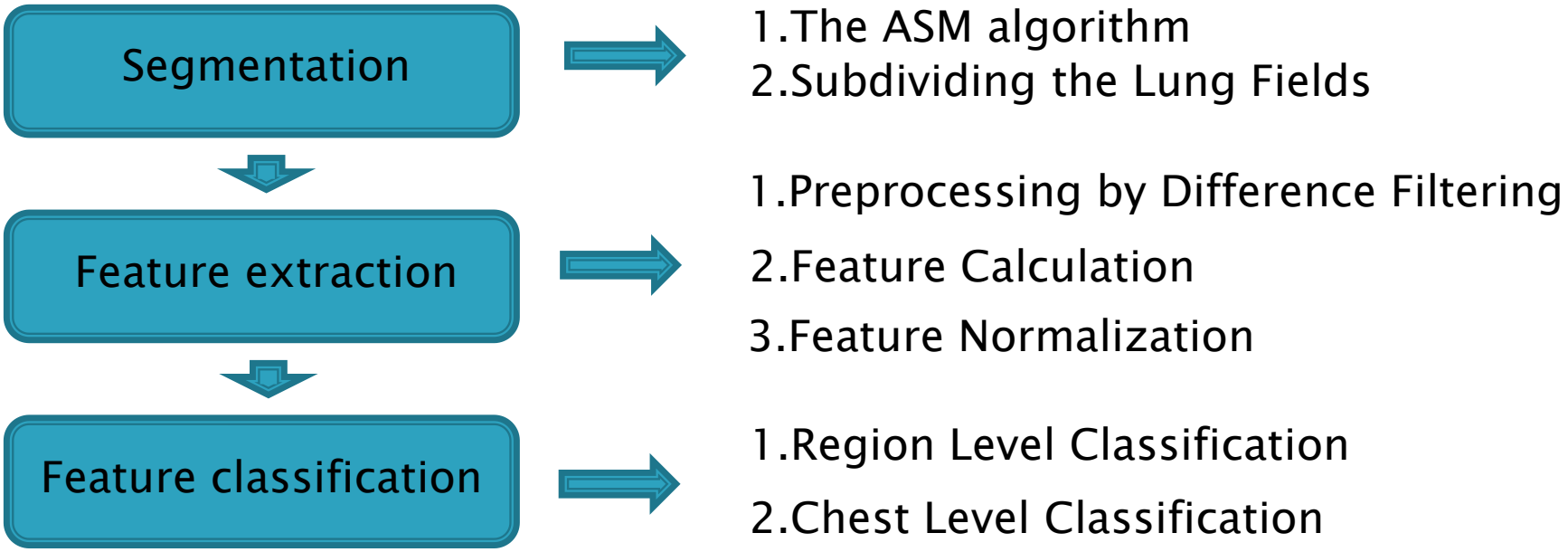
Segmentation is a necessary prerequisite process for quantitative analysis applications.

Describing the image feature using geometrical feature, texture feature

Could be employed to discriminate normal samples from abnormal.

Methods

In this paper, each main step have independent algorithm in block.



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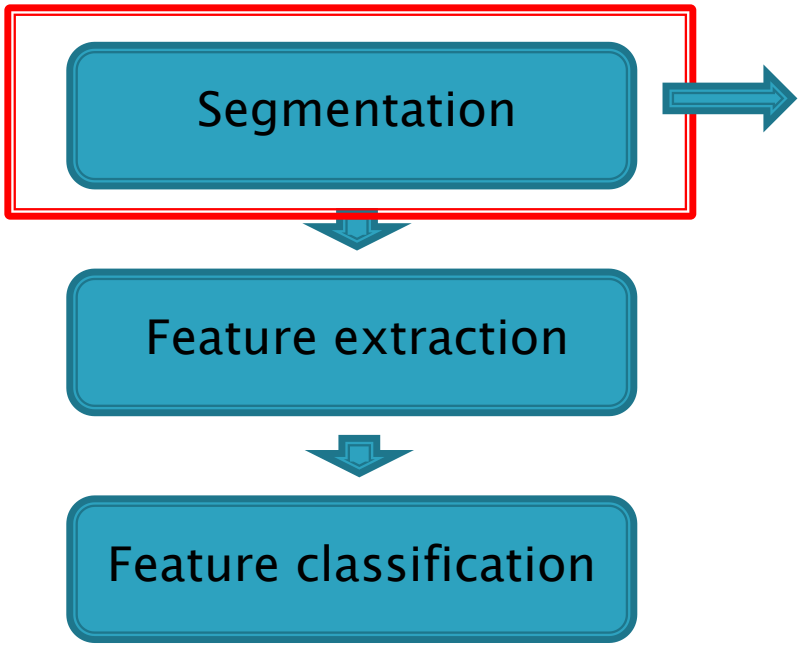
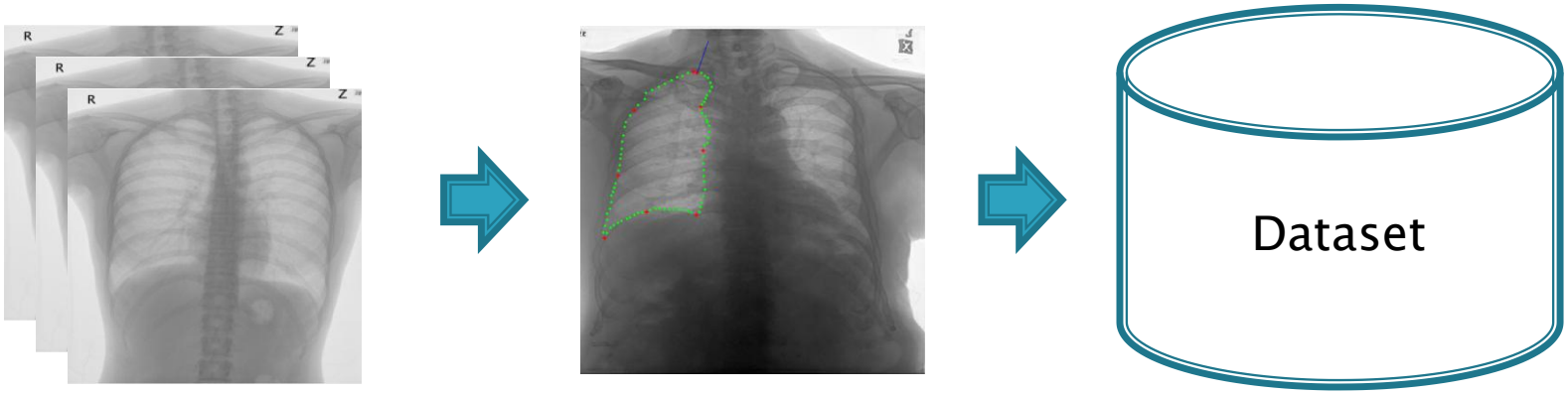


1.The ASM algorithm
2.Subdividing the Lung Fields

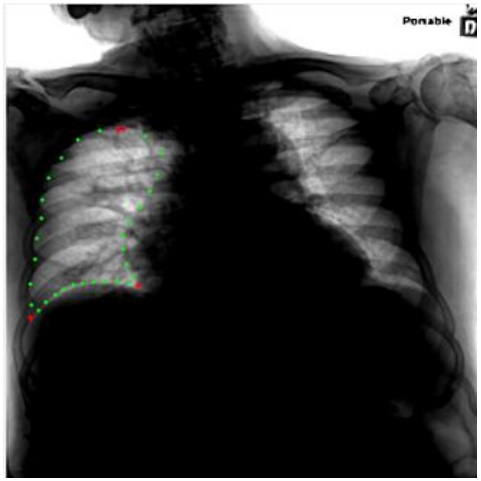
- The ASM algorithm could be mainly divided into two steps, training and segmentation.

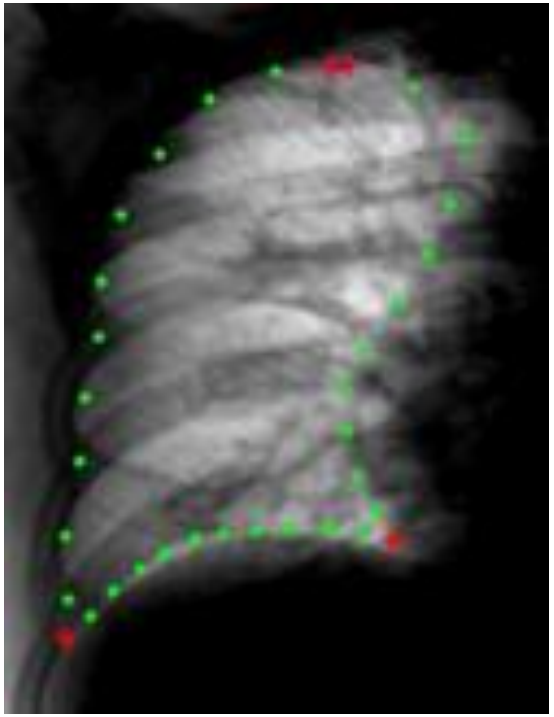
Training phase



Label the lung contour landmarks on the training image

Example1 training

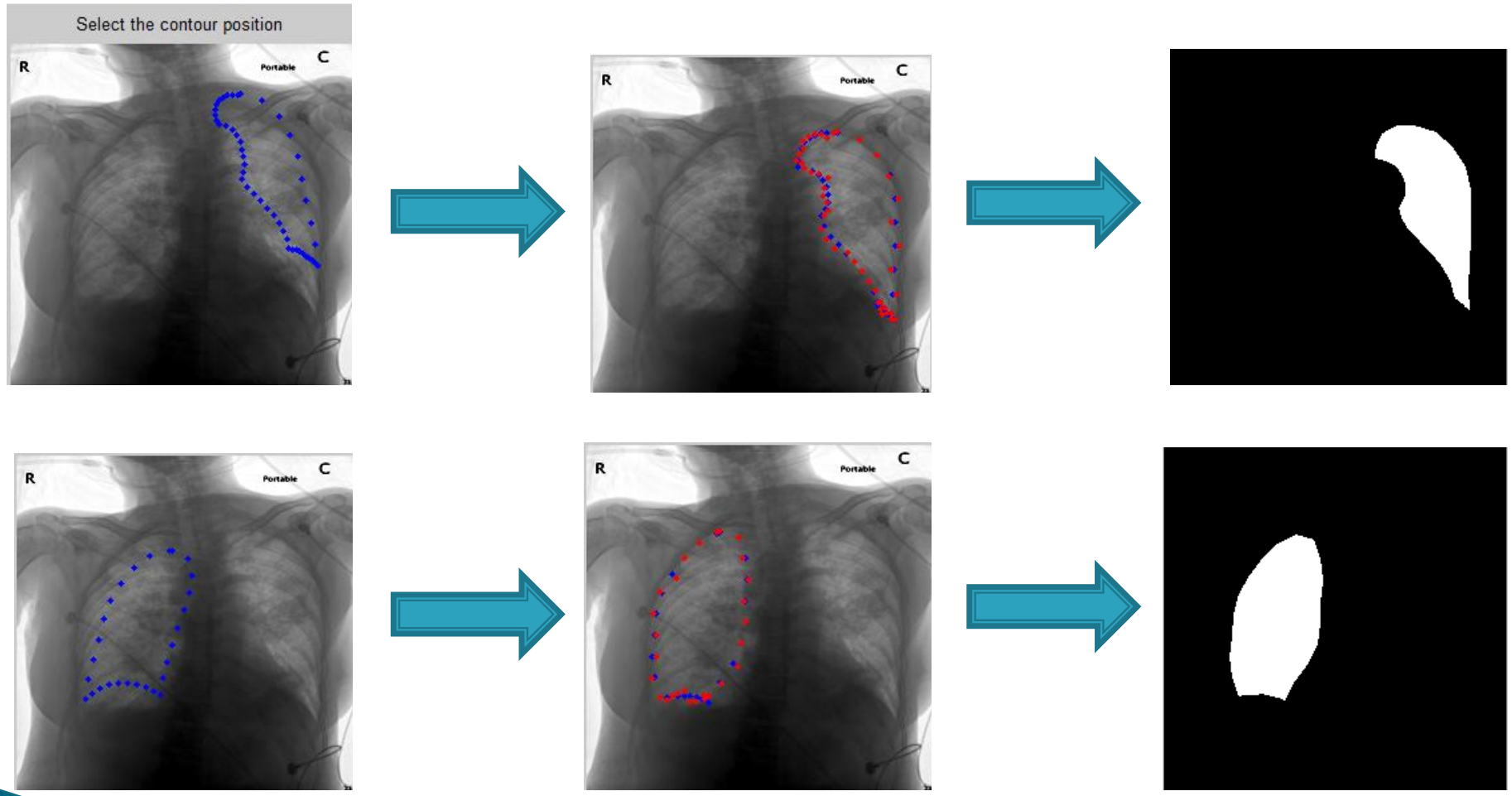




Right Lung

left Lung

Example2 testing



Finding the best position to recognition lung region.

- Computer-Aided Detection (CAD)
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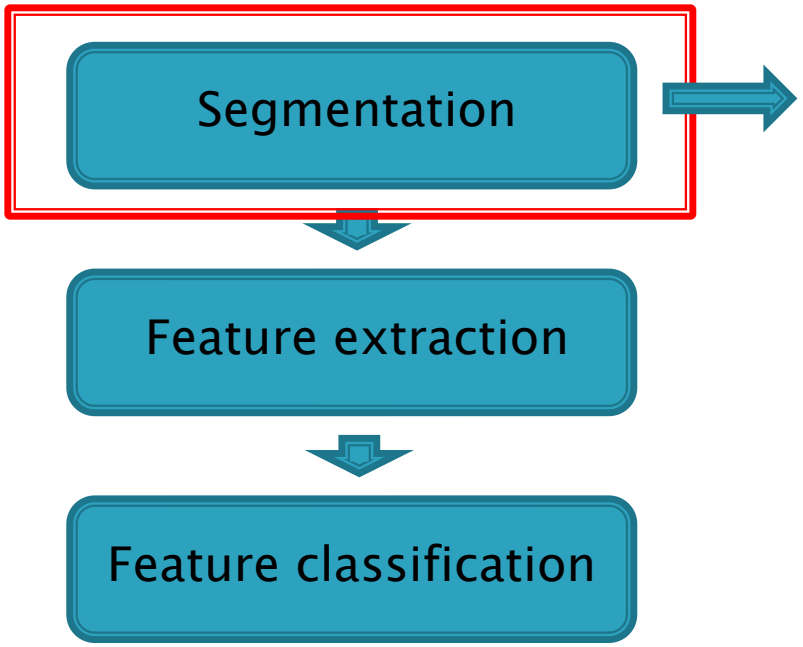
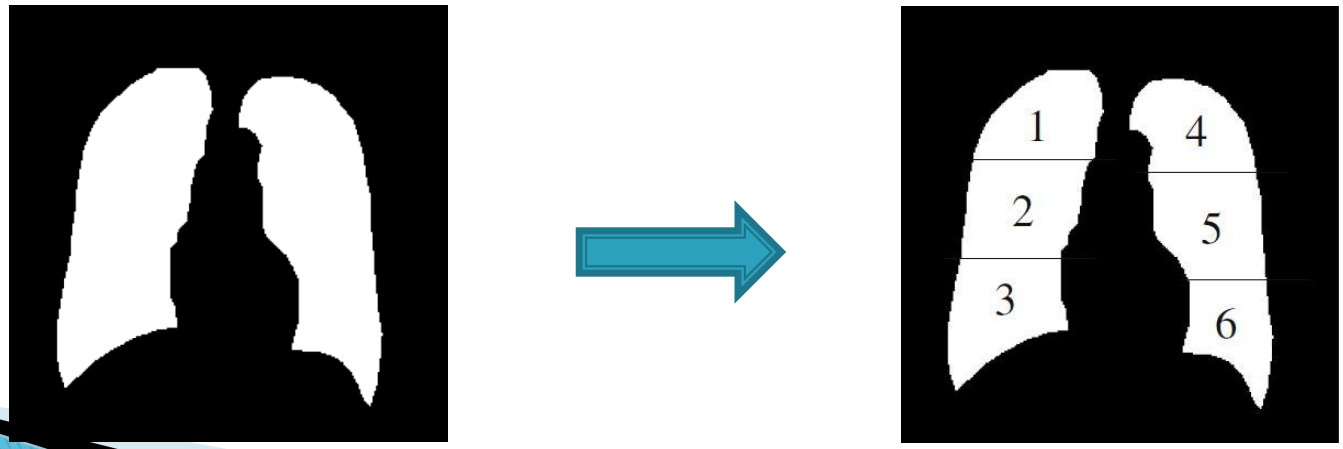
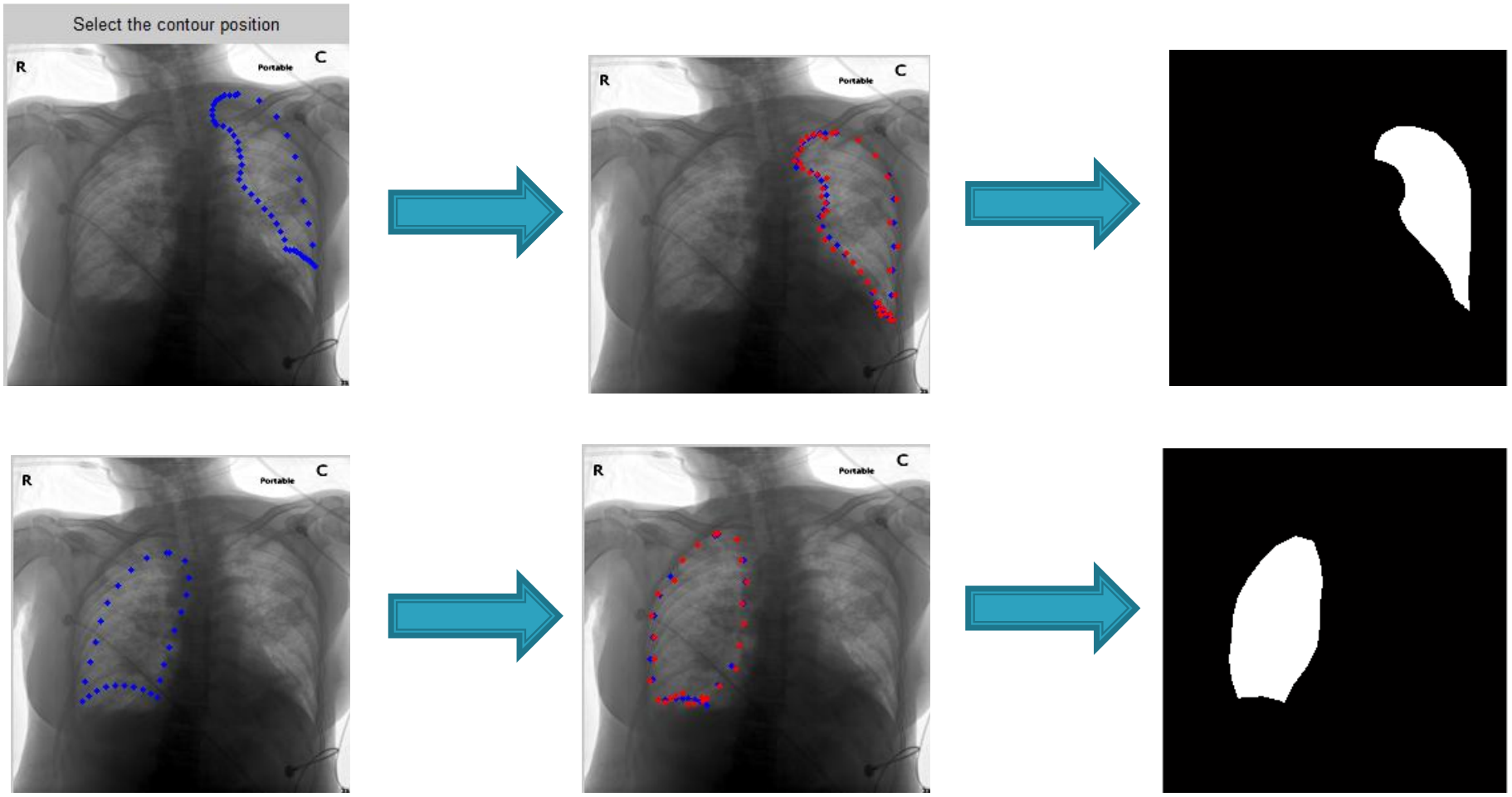


1.The ASM algorithm
2.Subdividing the Lung Fields

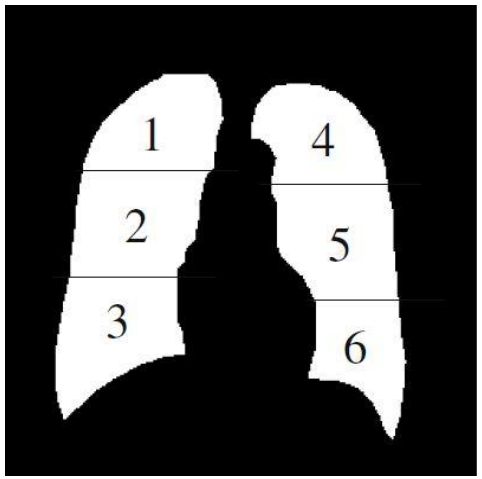
- Subdividing the Lung Fields into Six Zones
  - Algorithm:
    - 1. Computing lung area.
    - 2. Subdividing the Lung Fields

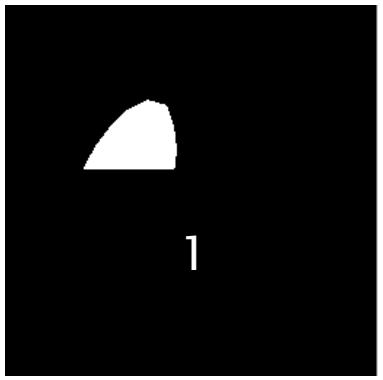
left lung	right lung
apex and bottom position	apex and diaphragm position
horizontal lines	horizontal lines





Finding the best position to recognition lung region.


1
4
2
5
3
6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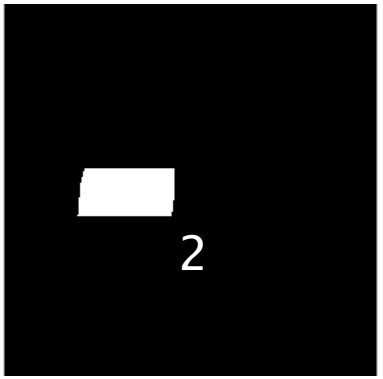
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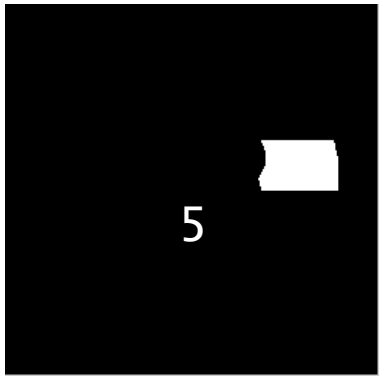
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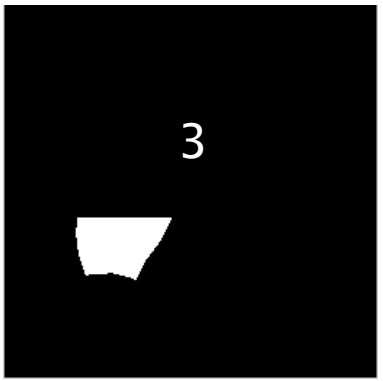
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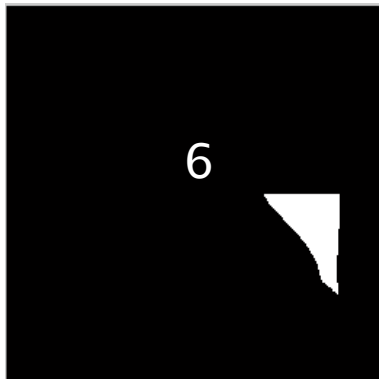
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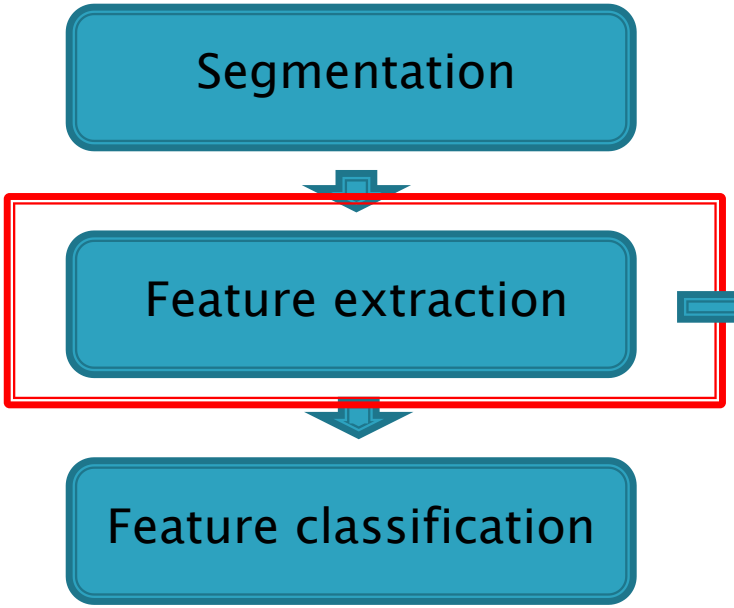
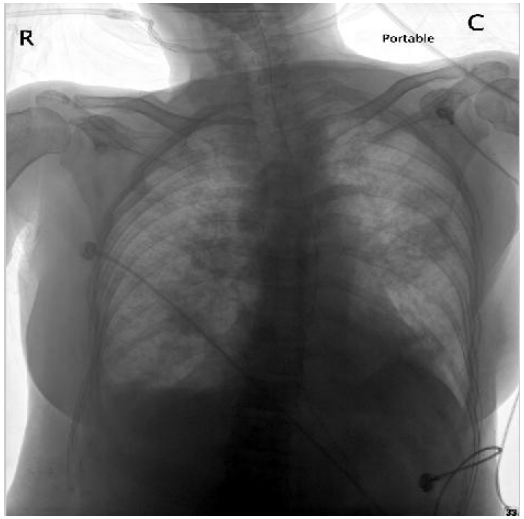


1.Preprocessing by Difference Filtering

2.Feature Calculation

3.Feature Normalization

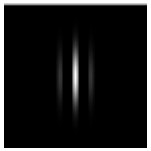
Preprocessing

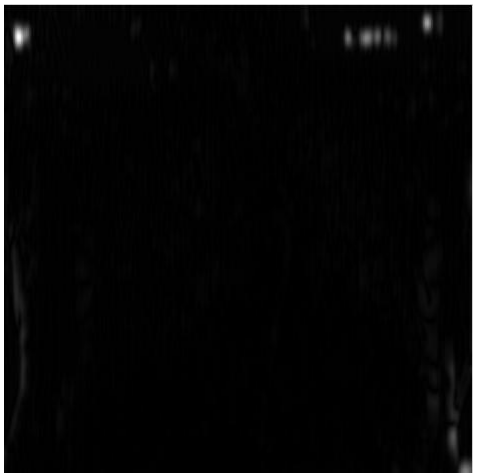
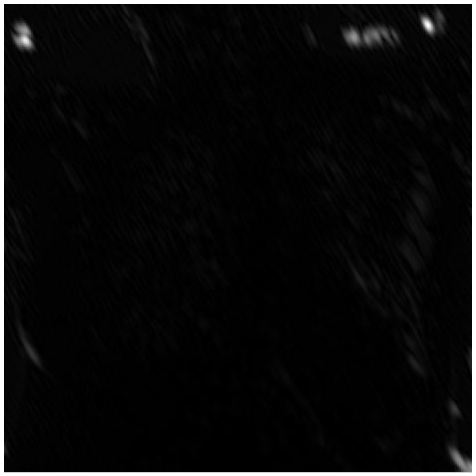
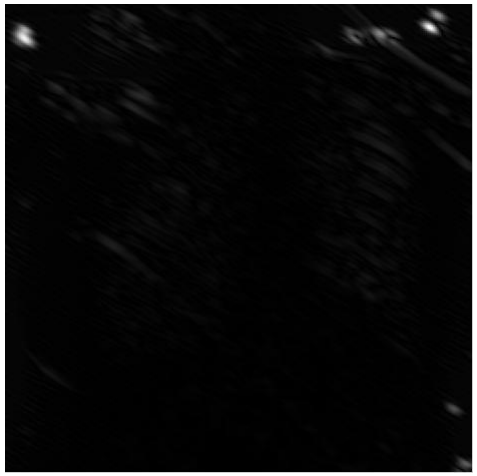
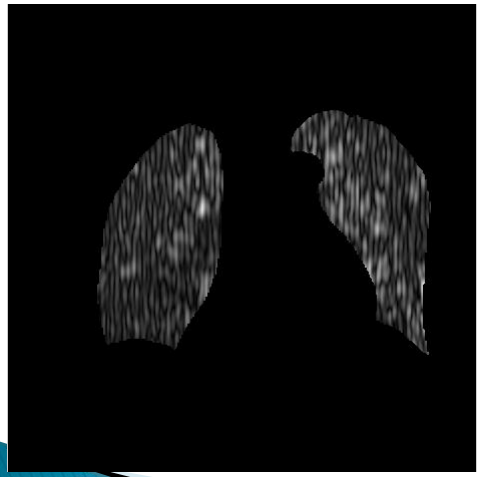
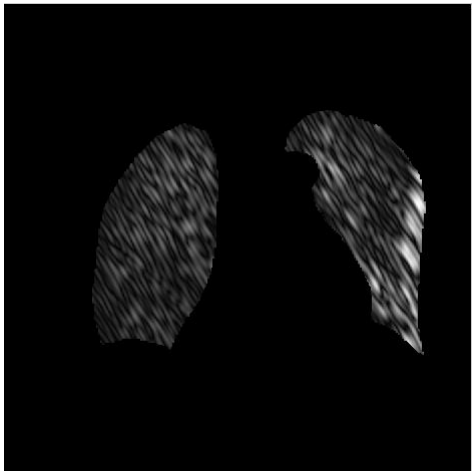
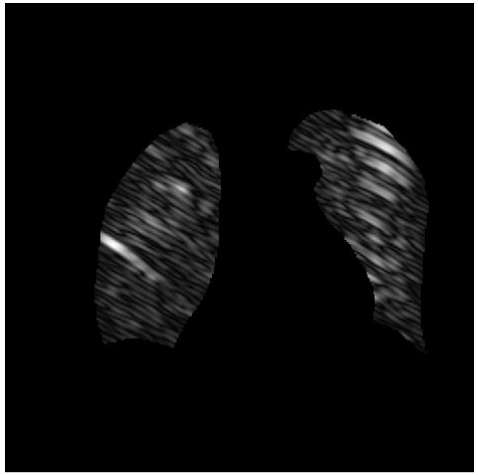


- Size normalization
  - 700*700

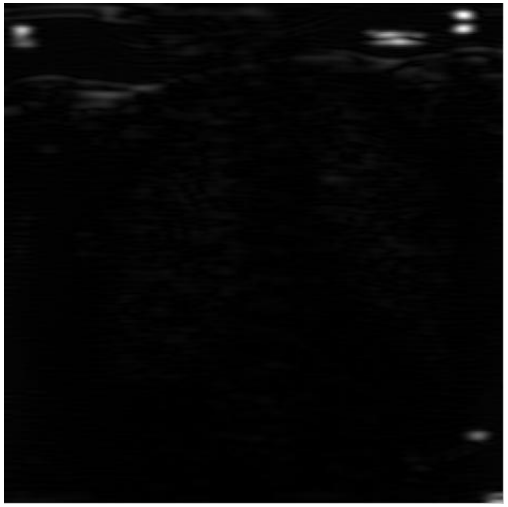
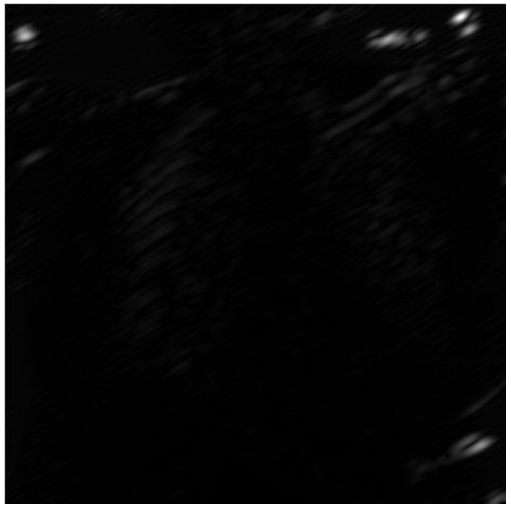
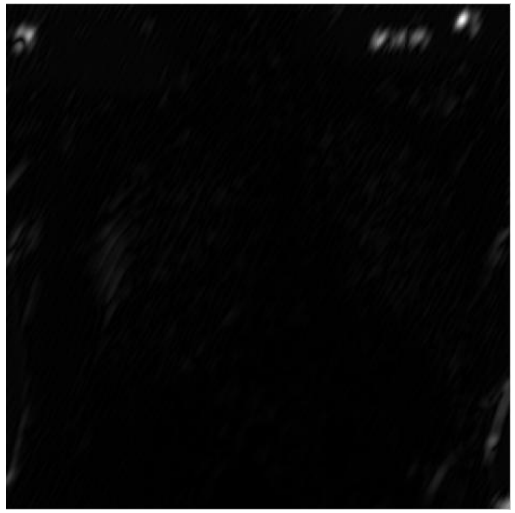
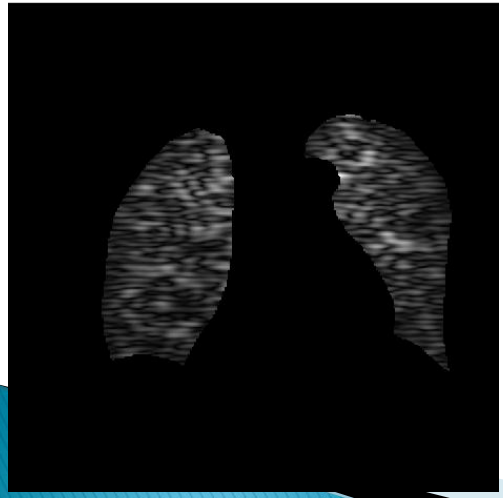
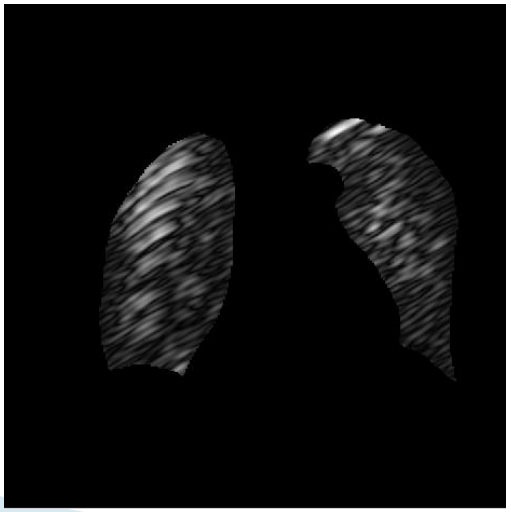
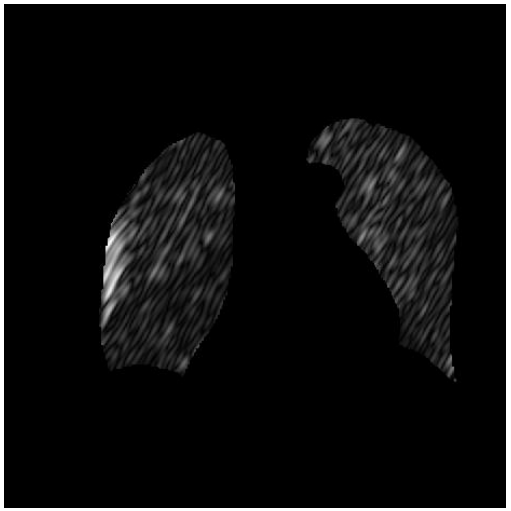
- Gabor filter bank
  - Six kernel:
    - Theta = 0, pi/6, pi/3, 3*pi/2, 2*pi/3, 5*pi/6
    - Lambda = 8

Kernel





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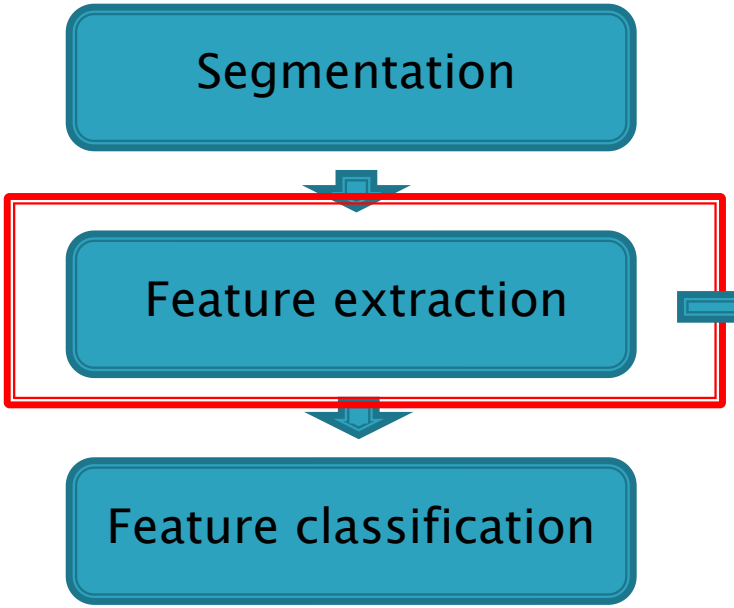


1.Preprocessing by Difference Filtering

2.Feature Calculation

3.Feature Normalization

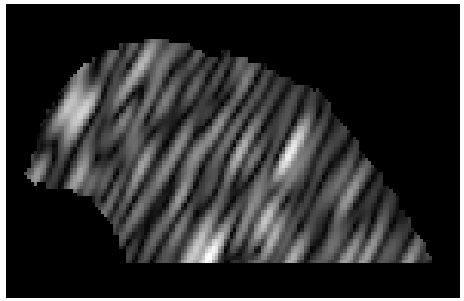
Feature Calculation

- Moment:
  - MEAN, Standard deviation, Variance, Skewness

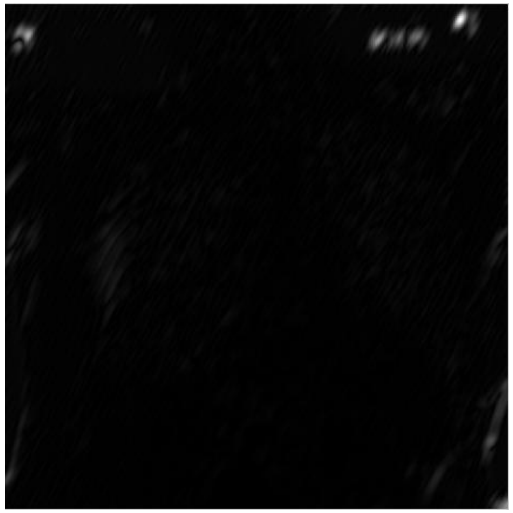
Feature	Equation
Mean	$M_1 = \sum i \cdot h(i)$
Standard deviation	$M_2 = \sqrt{\sum (i - M_1)^2 \cdot h(i)}$
Skewness	$M_3 = \frac{1}{M_2{}^3} \sum (i - M_1)^3 \cdot h(i)$
Kurtosis	$M_4 = \frac{1}{M_2{}^4} \sum (i - M_1)^4 \cdot h(i) - 3$

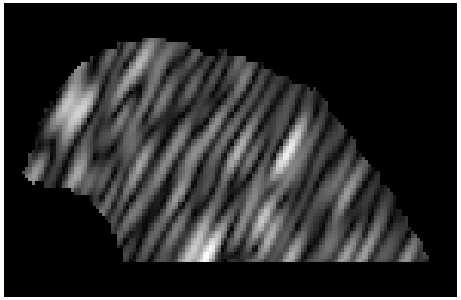
Mean for each regions

- Feature 1:



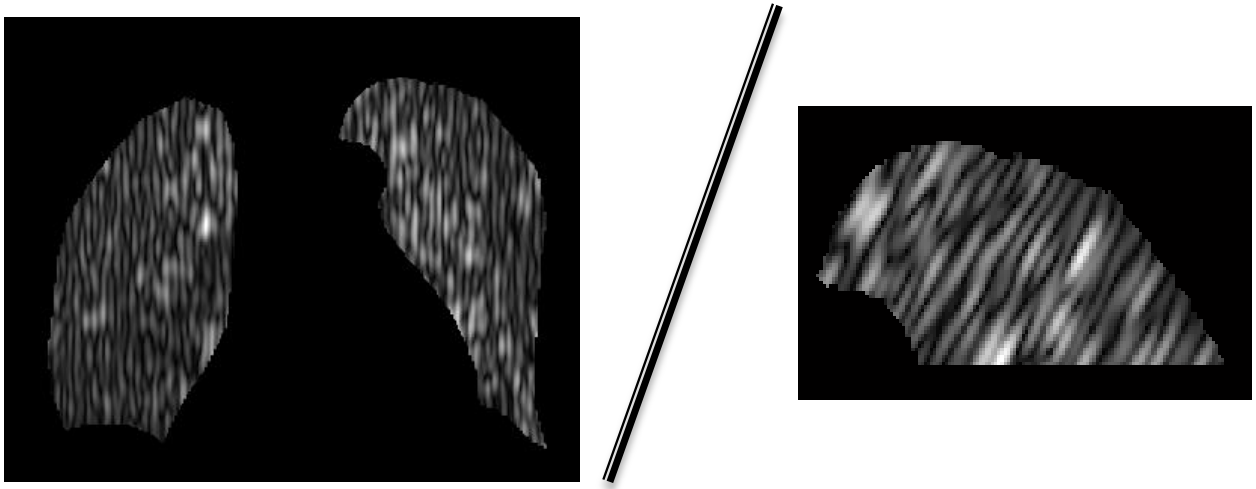
- Feature 2:



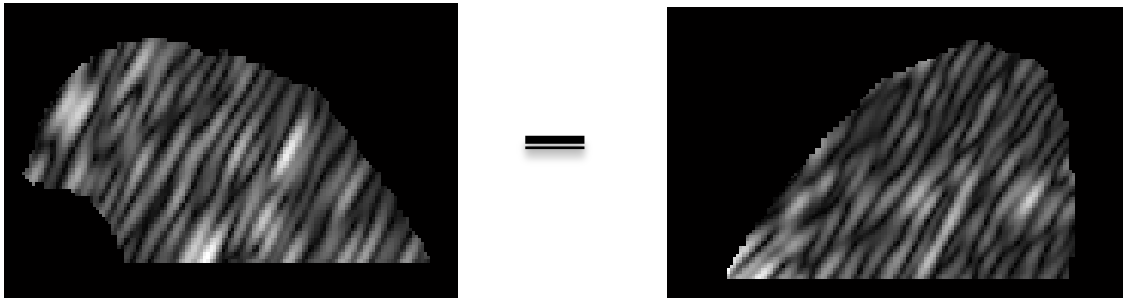


Mean for each regions

- Feature 3:



- Feature 4:

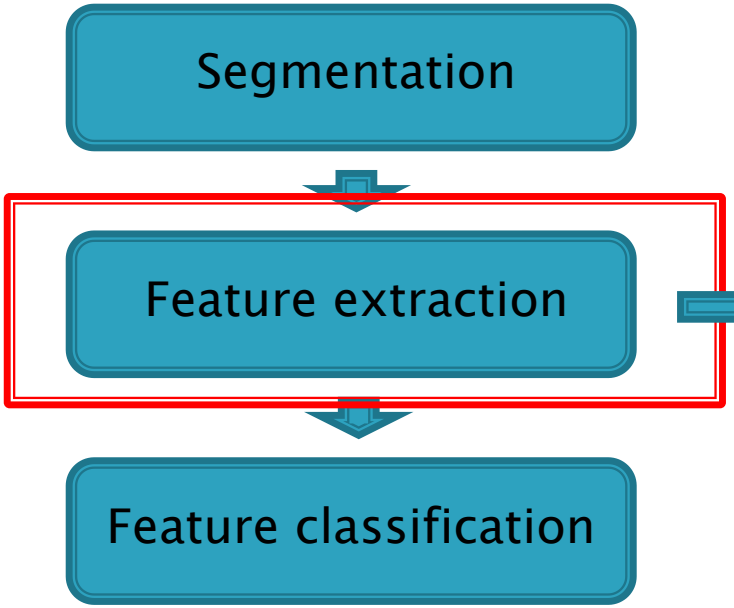


Data saving

Each region field of lung

	moment1	moment2	moment3	moment4
kernel1	Feature 1	Feature 2	Feature 3	Feature 4
kernel2	Feature 1	Feature 2	Feature 3	Feature 4
kernel3	Feature 1	Feature 2	Feature 3	Feature 4
kernel4	Feature 1	Feature 2	Feature 3	Feature 4
kernel5	Feature 1	Feature 2	Feature 3	Feature 4
kernel6	Feature 1	Feature 2	Feature 3	Feature 4

- Computer-Aided Detection (CAD)
  - Generally, a complete CAD scheme for chest consists of three main steps:



1.Preprocessing by Difference Filtering

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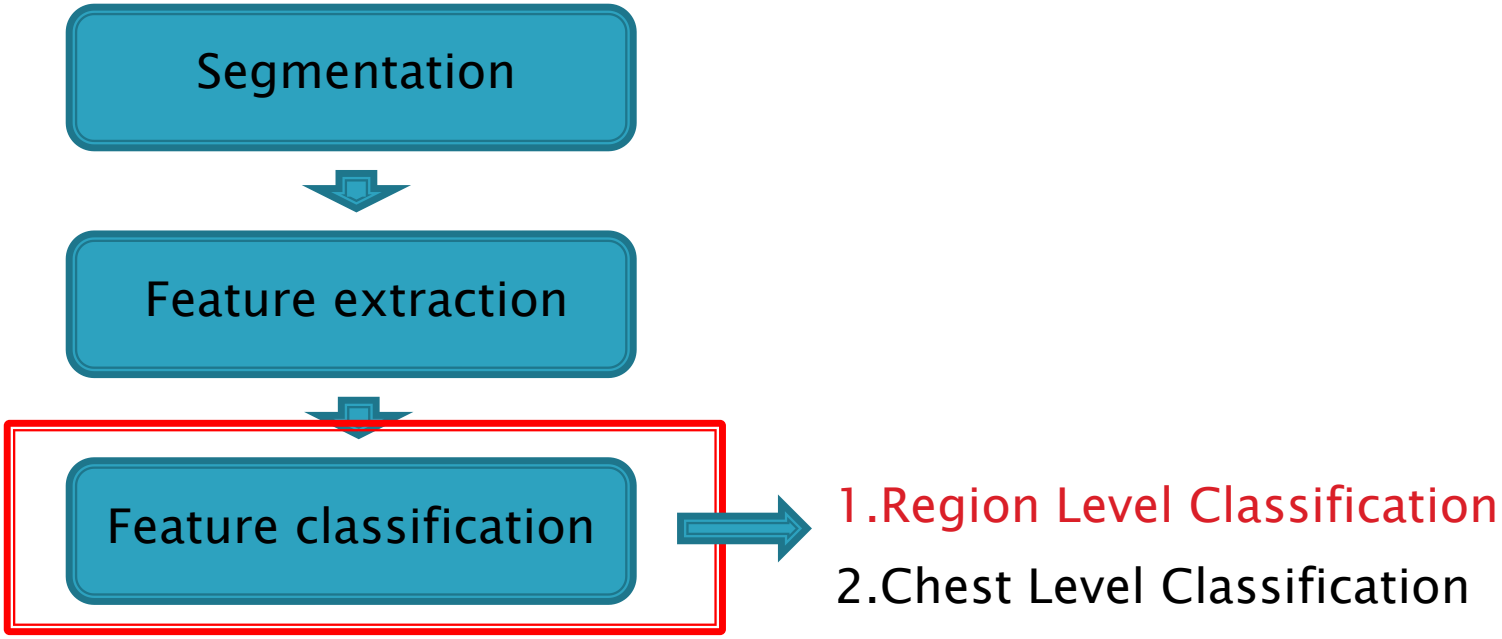
3.Feature Normalization

Feature Normalization

- Feature Normalization
  - Equation:

$$X_{normal} = \frac{2X - (X_{\max} + X_{\min})}{X_{\max} - X_{\min}}$$

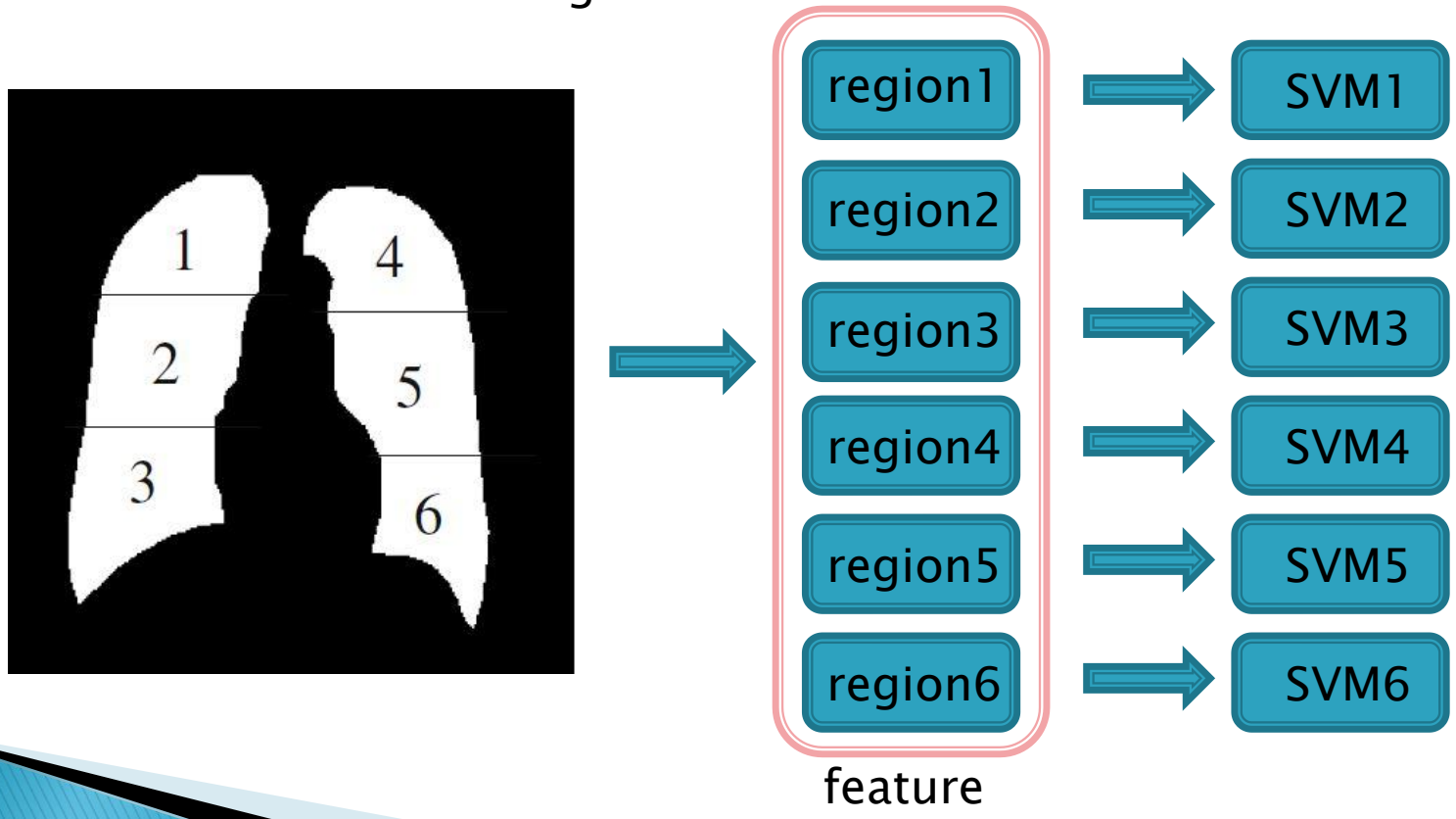
- Computer-Aided Detection (CAD)
  - Generally, a complete CAD scheme for chest consists of three main steps:



Feature classification

- Region Level Classification

These feature vectors are used by the classifier to estimate the abnormalities of each region.



Feature classification

- Chest Level Classification
  - A chest level classifier is employed to integrate the probabilities of the six regions to obtain the classification result for the whole image.

Methods	Weighted	Probability
The weighted voting	$W_i = \frac{A_{v_i}}{\sum_{i=1}^{N} A_{v_i}}$	$\Pr = \sum_{i=1}^{N} W_i P_i$
The weighted multiplying	$f_i = MAX(\frac{A_{v_i} - T_{Av}}{1 - T_{Av}}, 0)$	$\Pr = 1 - \prod_{i=1}^{N} (1 - f_i P_i)$

SYMBOL

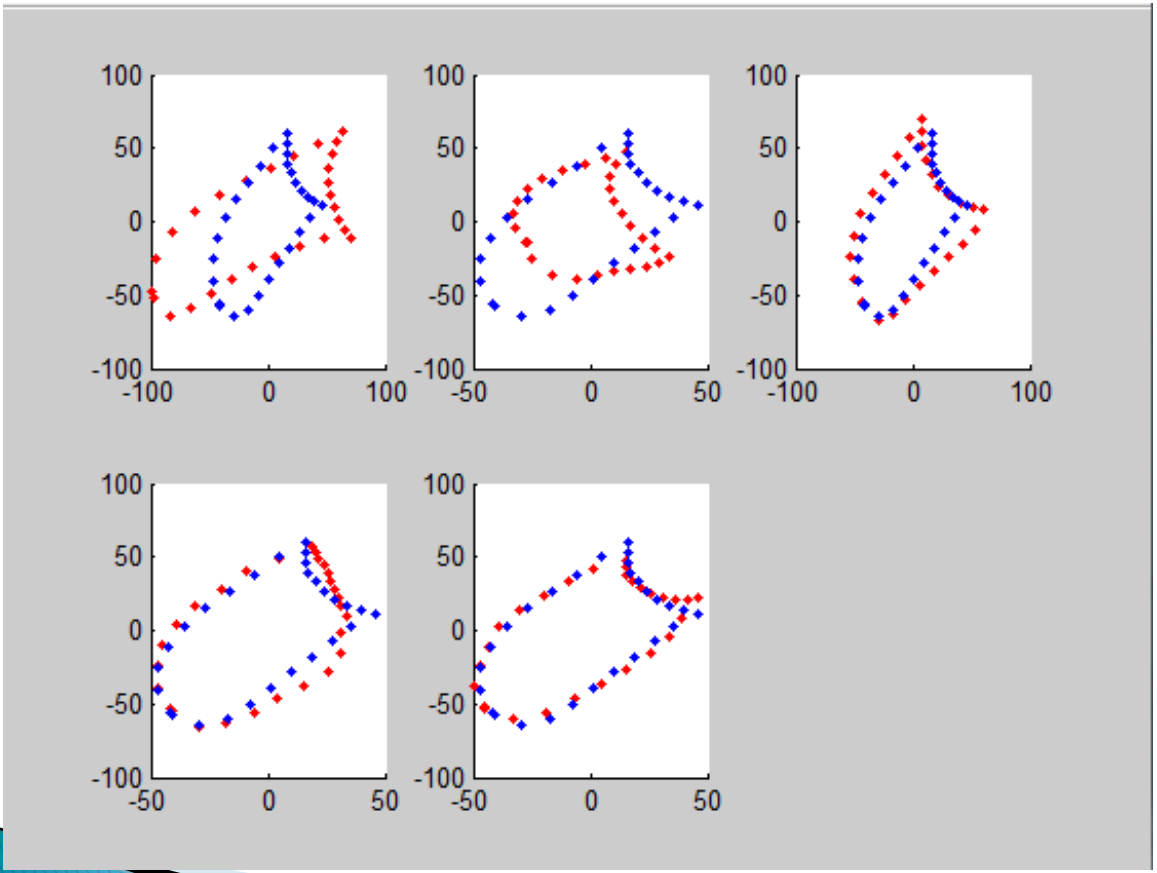
The area under the ROC curve (AUC) value is denoted as Av.(range from 0 to 1)

T_{Av} denote the threshold to determines the minimum value A_{v_i}.

Methods	Weighted & Weighted factor	Probability
The weighted voting	$W_i = \frac{A_{v_i}}{\sum_{i=1}^{N} A_{v_i}}$	$\Pr = \sum_{i=1}^{N} W_i P_i$
The weighted multiplying	$f_i = MAX(\frac{A_{v_i} - T_{Av}}{1 - T_{Av}}, 0)$	$\Pr = 1 - \prod_{i=1}^{N} (1 - f_i P_i)$

Experiment

- ASM Right Lung



Red : shape model
Blue : mean model

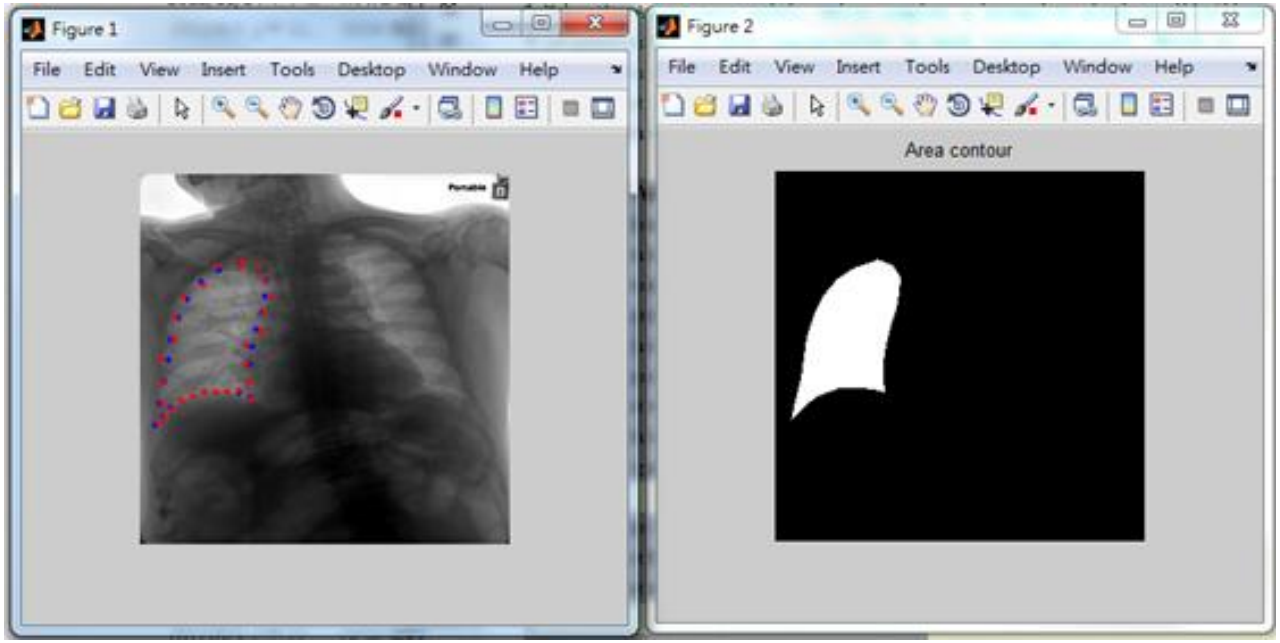
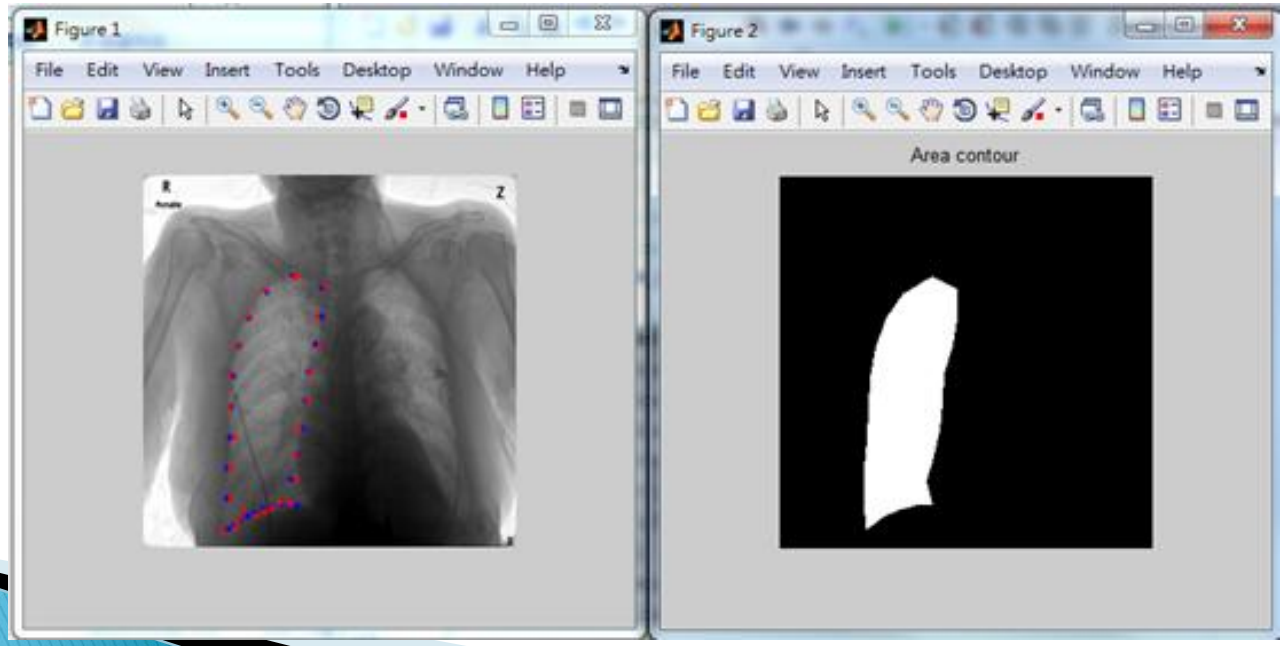


Figure 1
File Edit View Insert Tools Desktop Window Help
Figure 2
File Edit View Insert Tools Desktop Window Help
Area contour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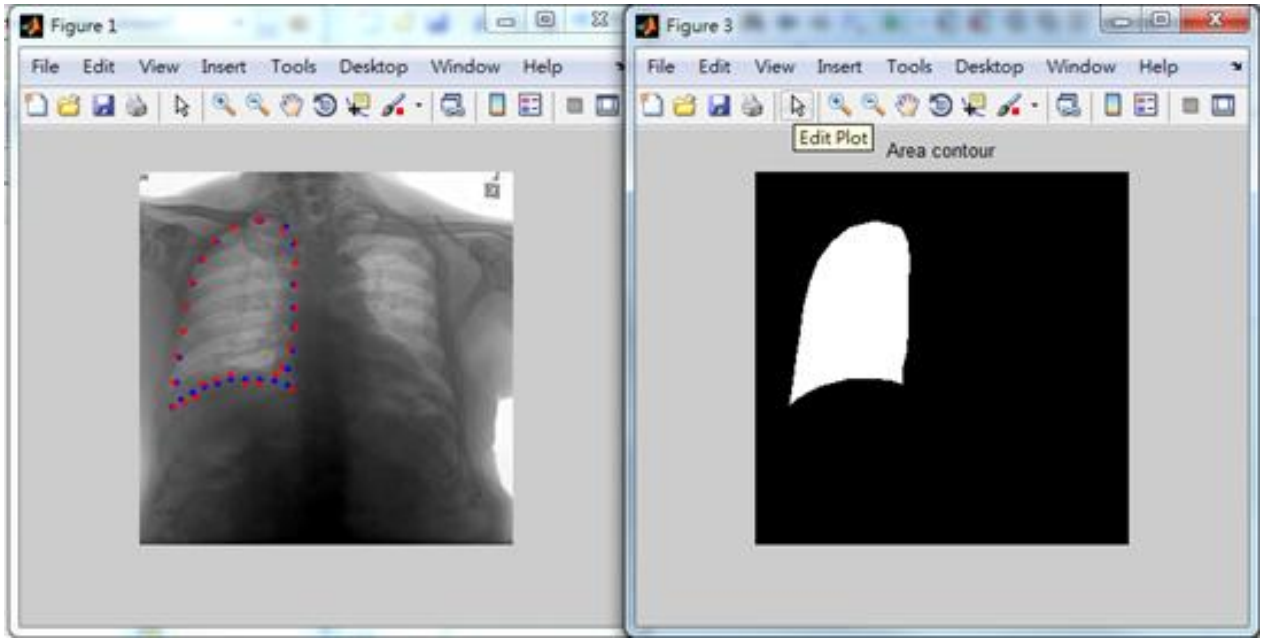
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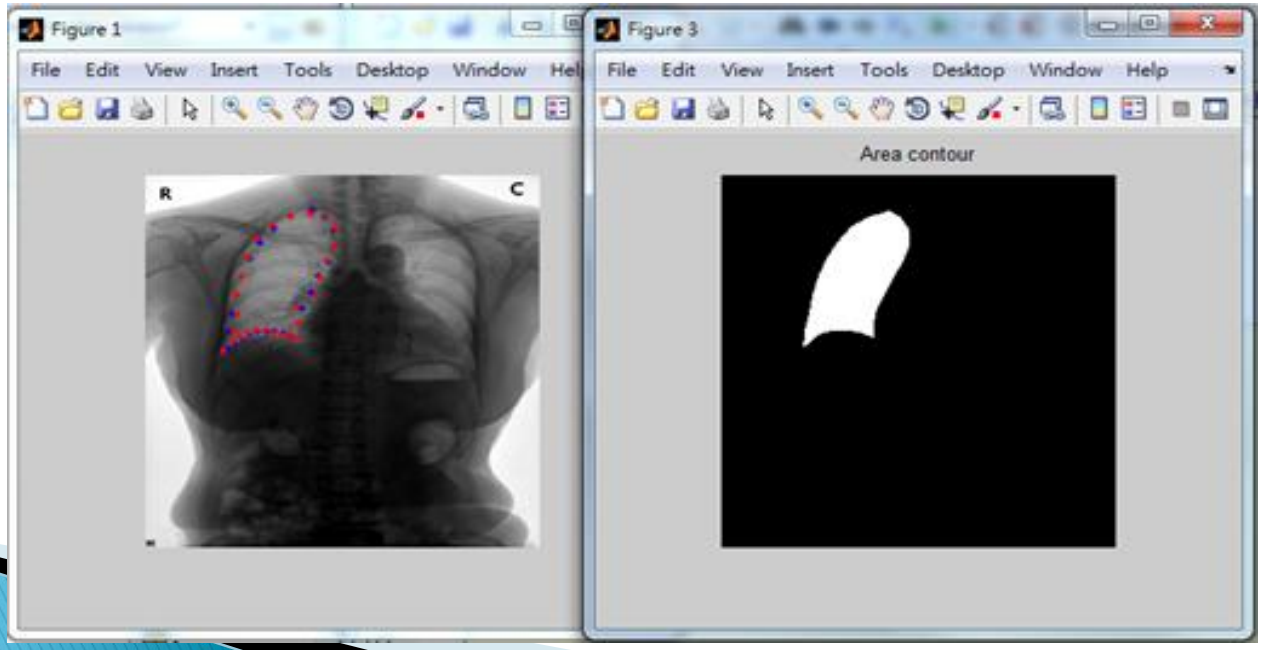
File Edit View Insert Tools Desktop Window Help
Figure 3
File Edit View Insert Tools Desktop Window Help
Edit Plot
Area contour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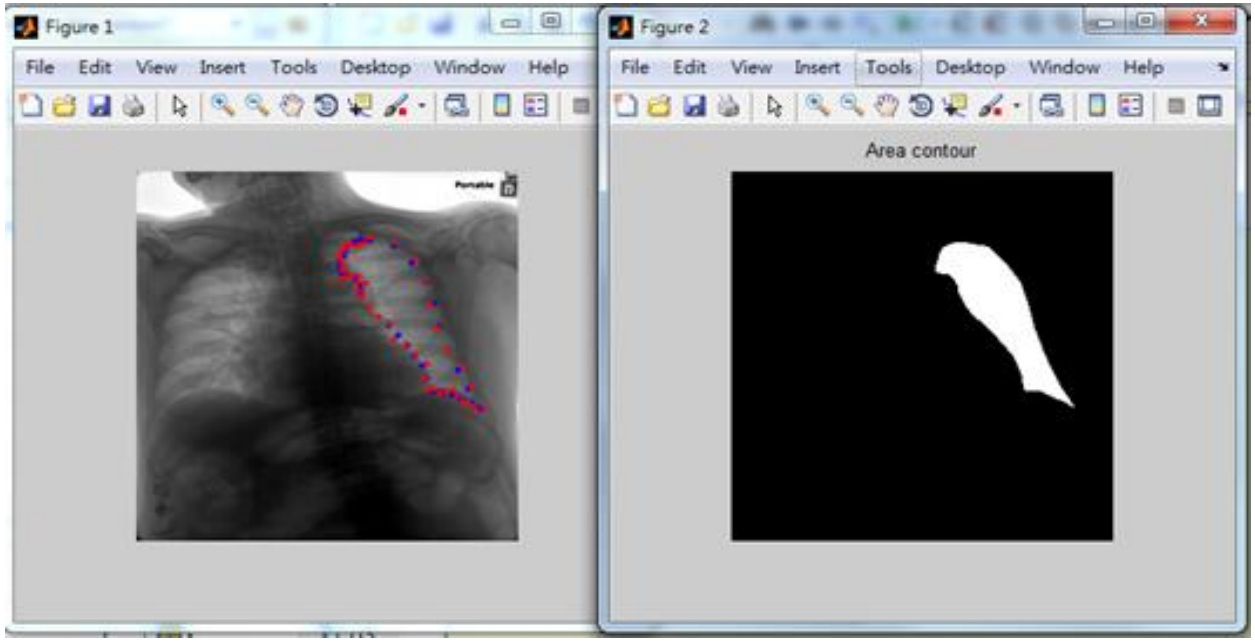
Area contour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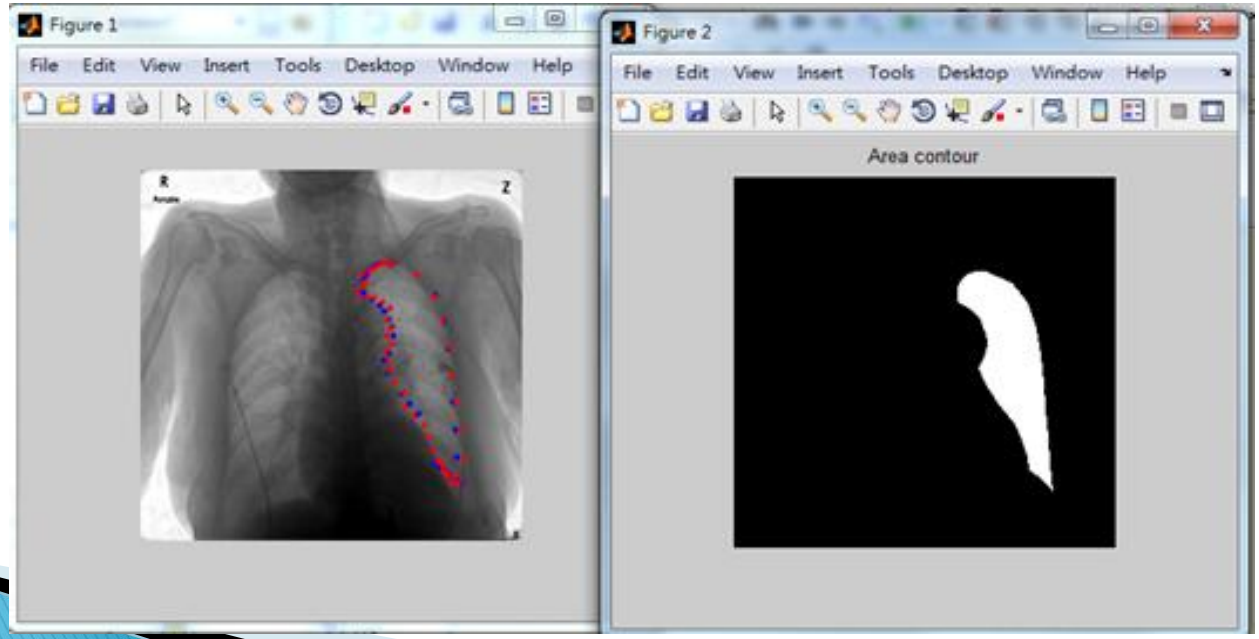
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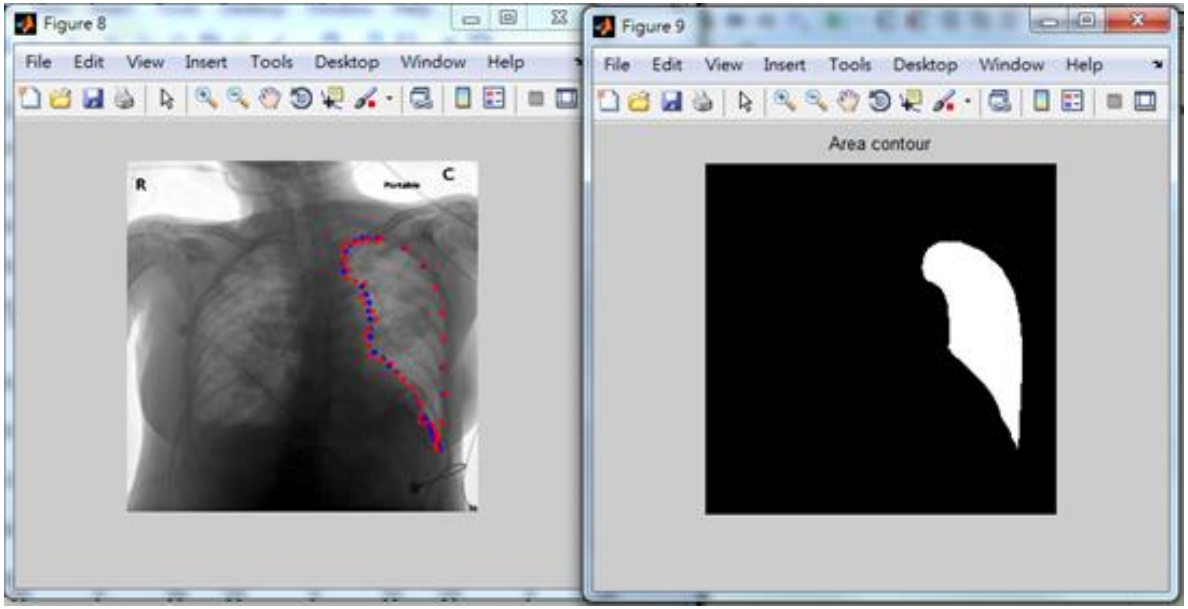


Figure 8
File Edit View Insert Tools Desktop Window Help
R
C
Figure 9
File Edit View Insert Tools Desktop Window Help
Area contour

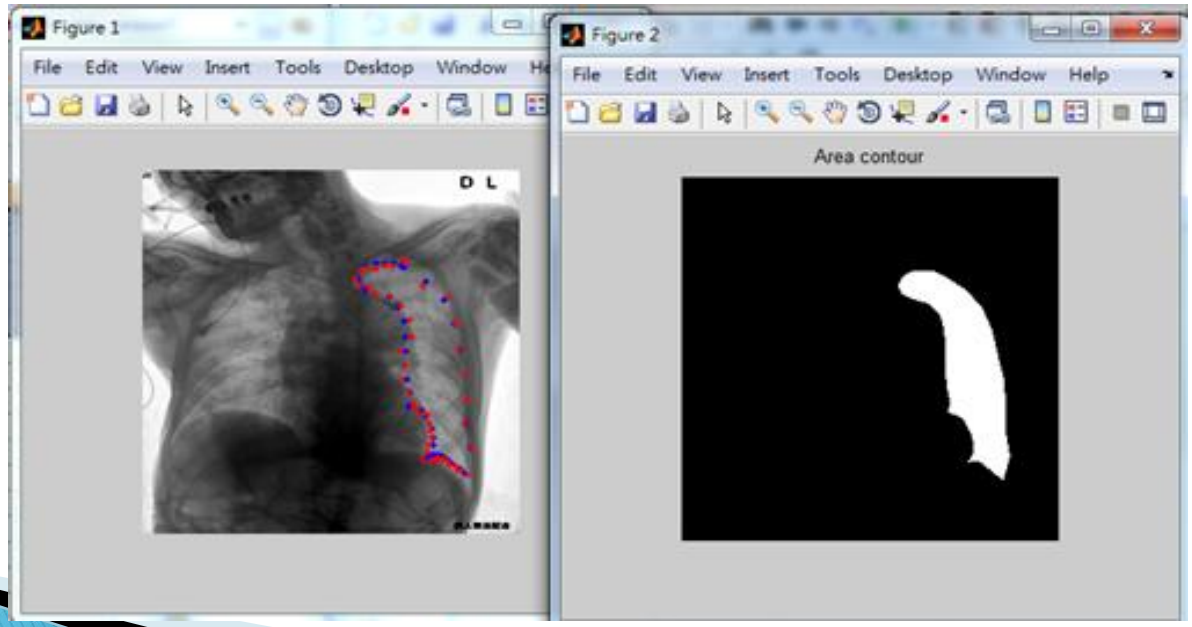


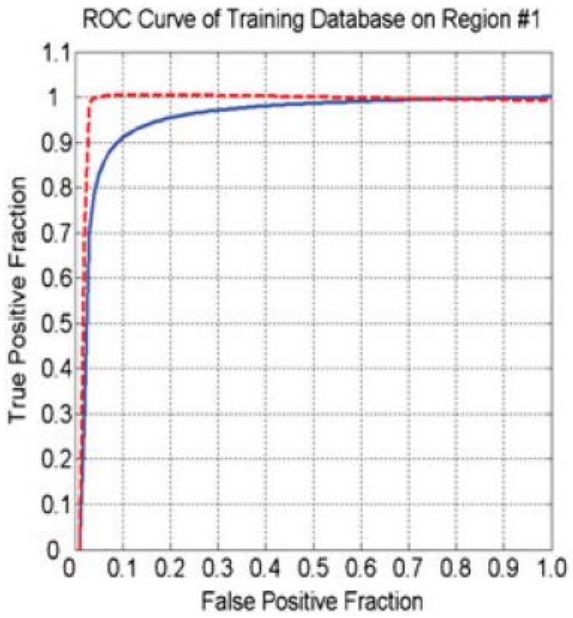
Figure 1
File Edit View Insert Tools Desktop Window
D L
Figure 2
File Edit View Insert Tools Desktop Window Help
Area contour

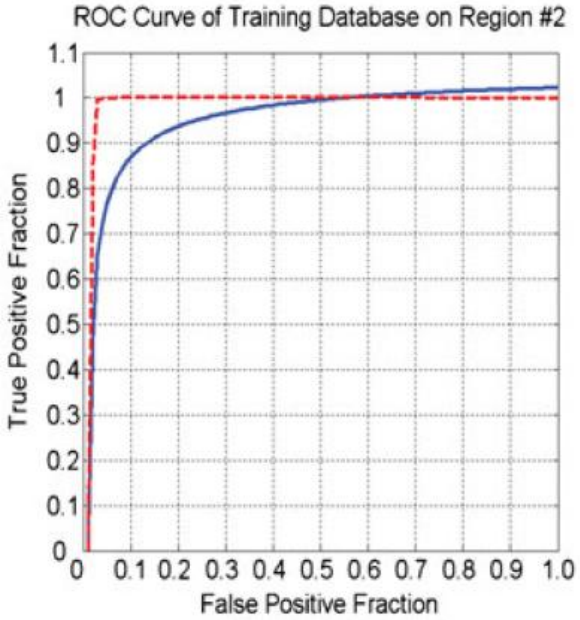
Test result

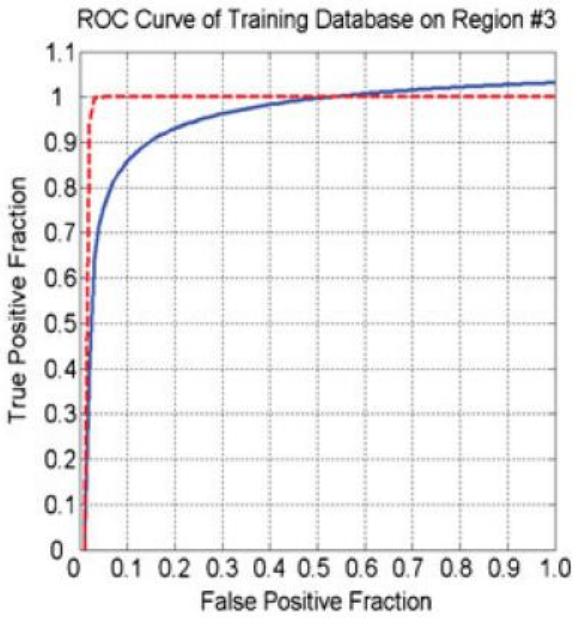
Feature Vector	Region #	lg$C$	lg Γ	SSAve	Acc	Ses	Spe	AUC value
Full	R1	9	−11	0.912	0.908	0.920	0.903	0.998
Selected	R1	11	5	0.878	0.882	0.862	0.894	0.968
Full	R2	7	−9	0.923	0.925	0.920	0.926	0.999
Selected	R2	11	−7	0.879	0.889	0.851	0.907	0.970
Full	R3	9	−9	0.928	0.922	0.944	0.913	0.999
Selected	R3	7	−5	0.884	0.892	0.862	0.905	0.971
Full	R4	7	−9	0.895	0.892	0.904	0.887	0.998
Selected	R4	11	−5	0.873	0.875	0.866	0.879	0.988
Full	R5	11	−11	0.924	0.924	0.921	0.927	0.998
Selected	R5	11	−3	0.889	0.880	0.911	0.867	0.998
Full	R6	9	−11	0.896	0.892	0.905	0.885	0.993
Selected	R6	11	−5	0.878	0.875	0.886	0.870	0.979

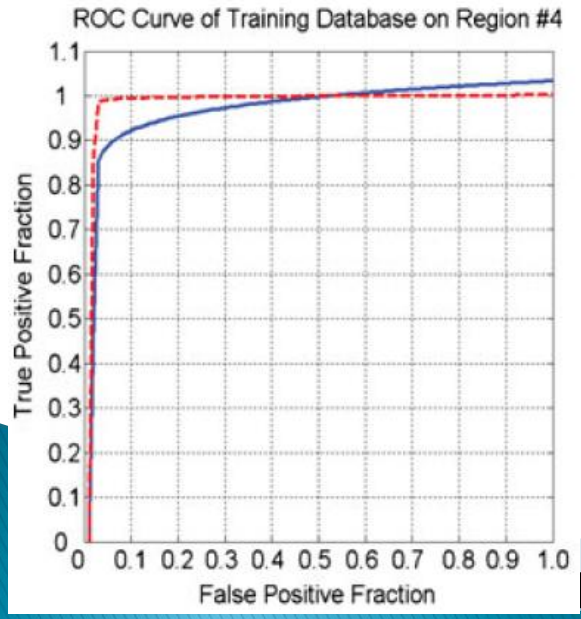
Classification Results of Training Set on Feature Vectors for Each Region Using Leave-One-Out Cross-Validation Method.

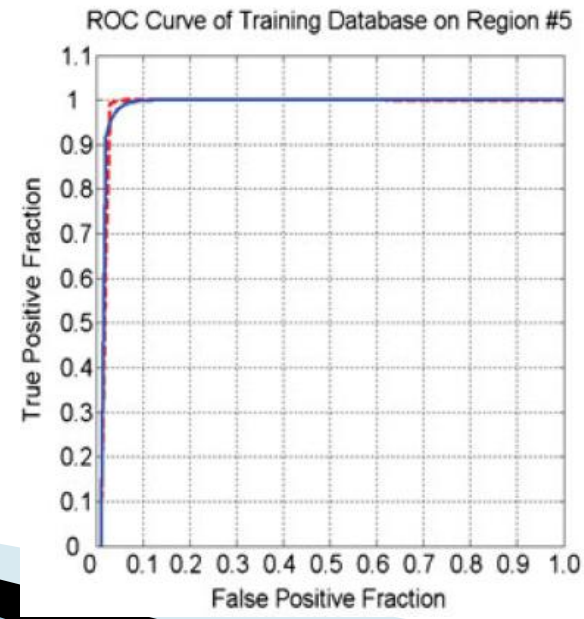
ROC curves for the training set for the six regions on feature vectors.

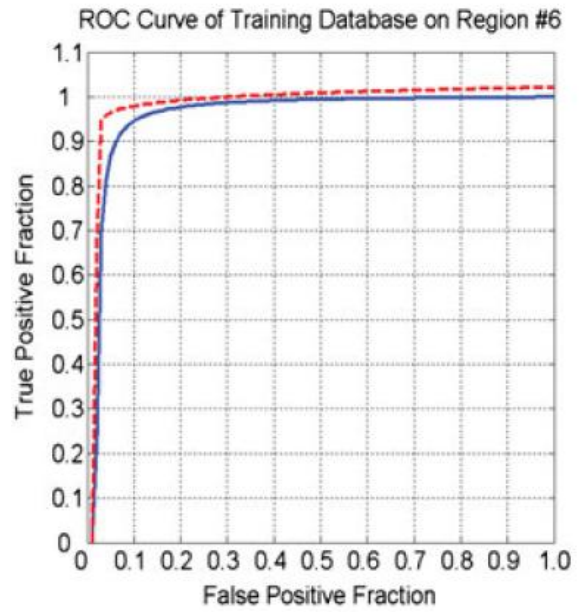












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