MAIA

CAD: Computer Aided Diagnosis

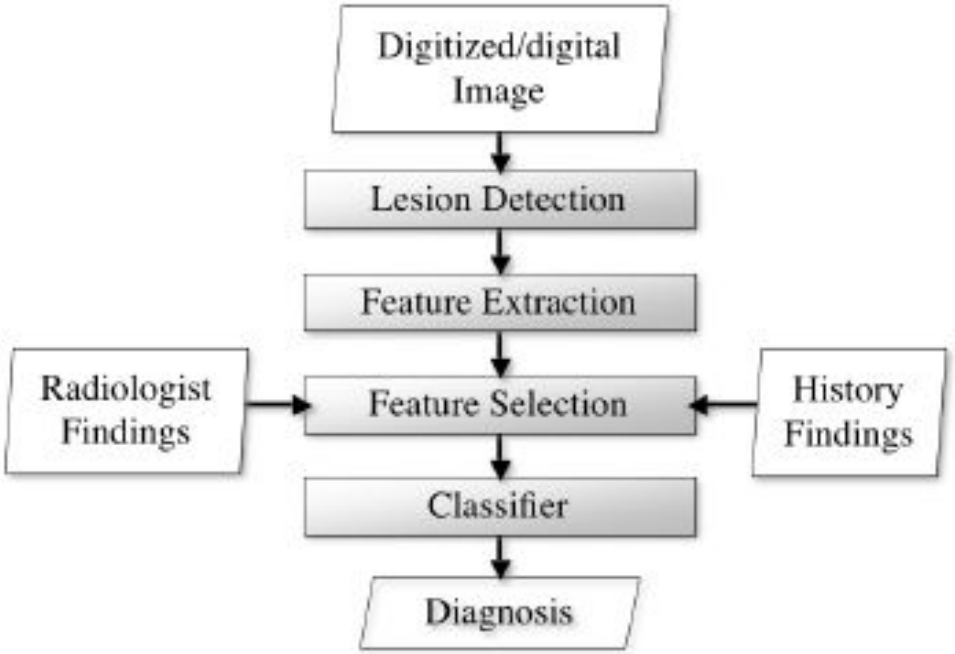
Xavier Lladó, Robert Martí, Kaisar Kushibar

CAD, CADx, CADe

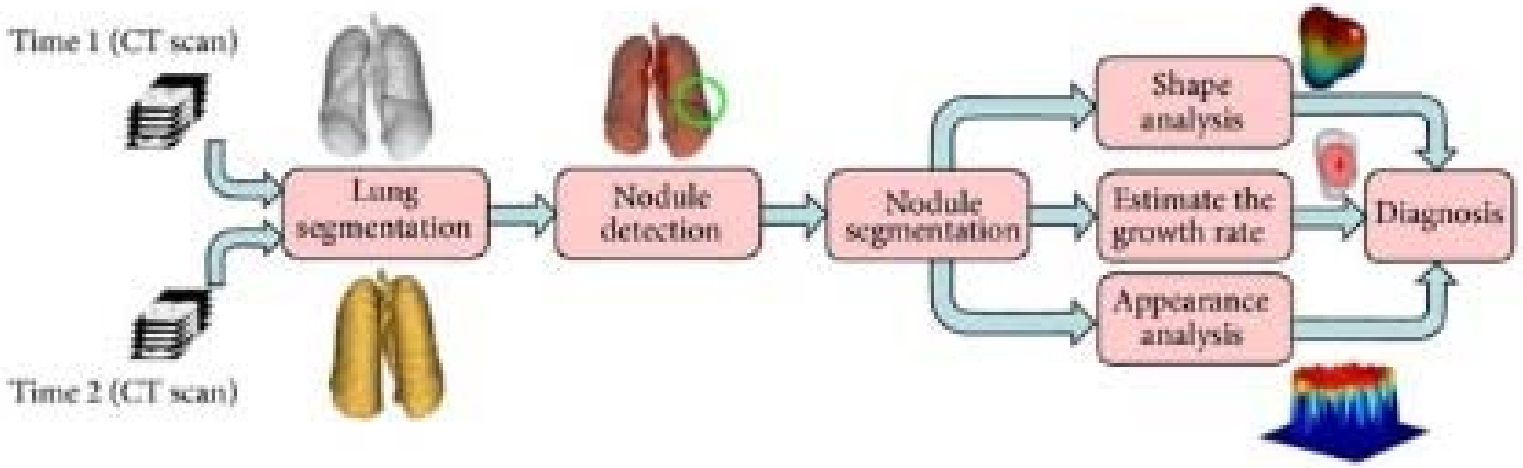
- CAD: computer aided systems to help physicians in issuing a diagnosis. The system can help in multiple ways.
  - CADe: computer aided detection. From a full image (mammogram, MRI, …) detecting lesions, highlighting suspicious areas, …
  - CADx: computer aided diagnosis. Can be a full system, starting from an image, or the starting be just a region of interest (i.e., a part of the image, resulting of the CADx or manually extracted).

- CAD for disease detection, CAD for disease follow-up, …

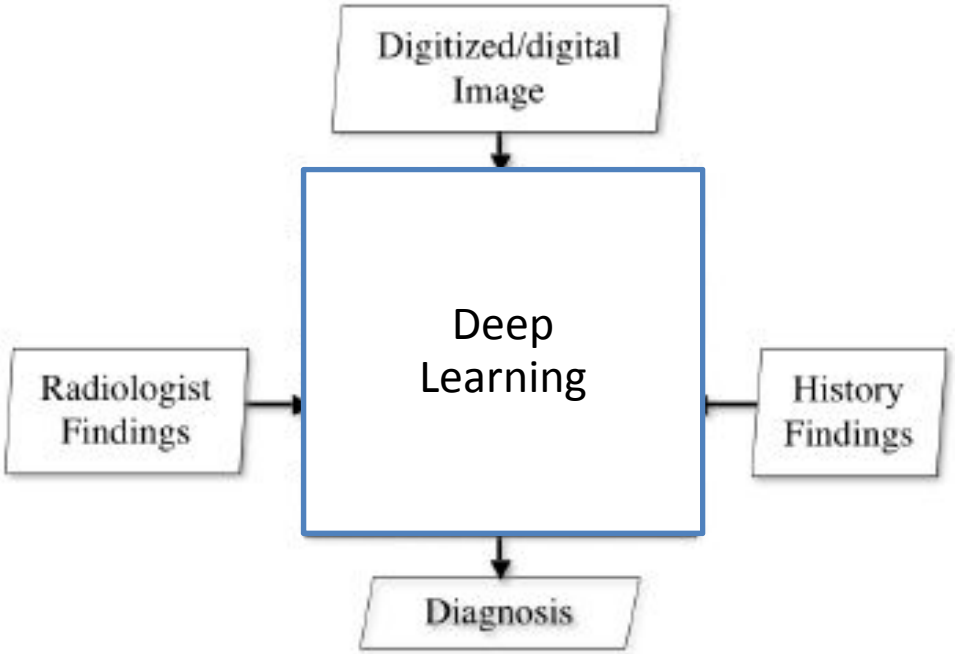
CAD: typical workflow



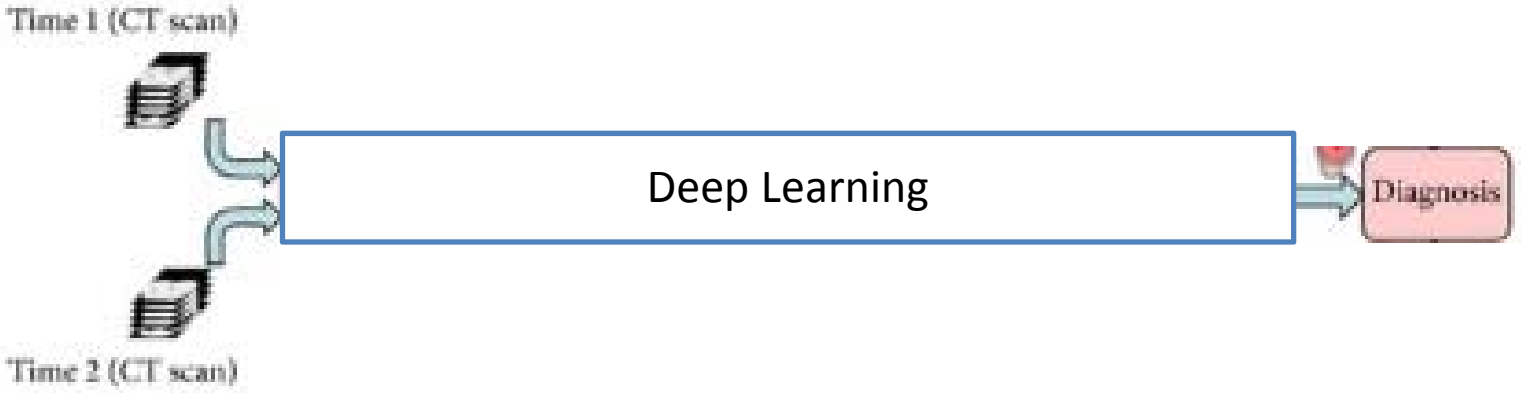
The traditional workflow of a CAD follows the steps that radiologists do when issuing a diagnosis.



CAD: deep learning

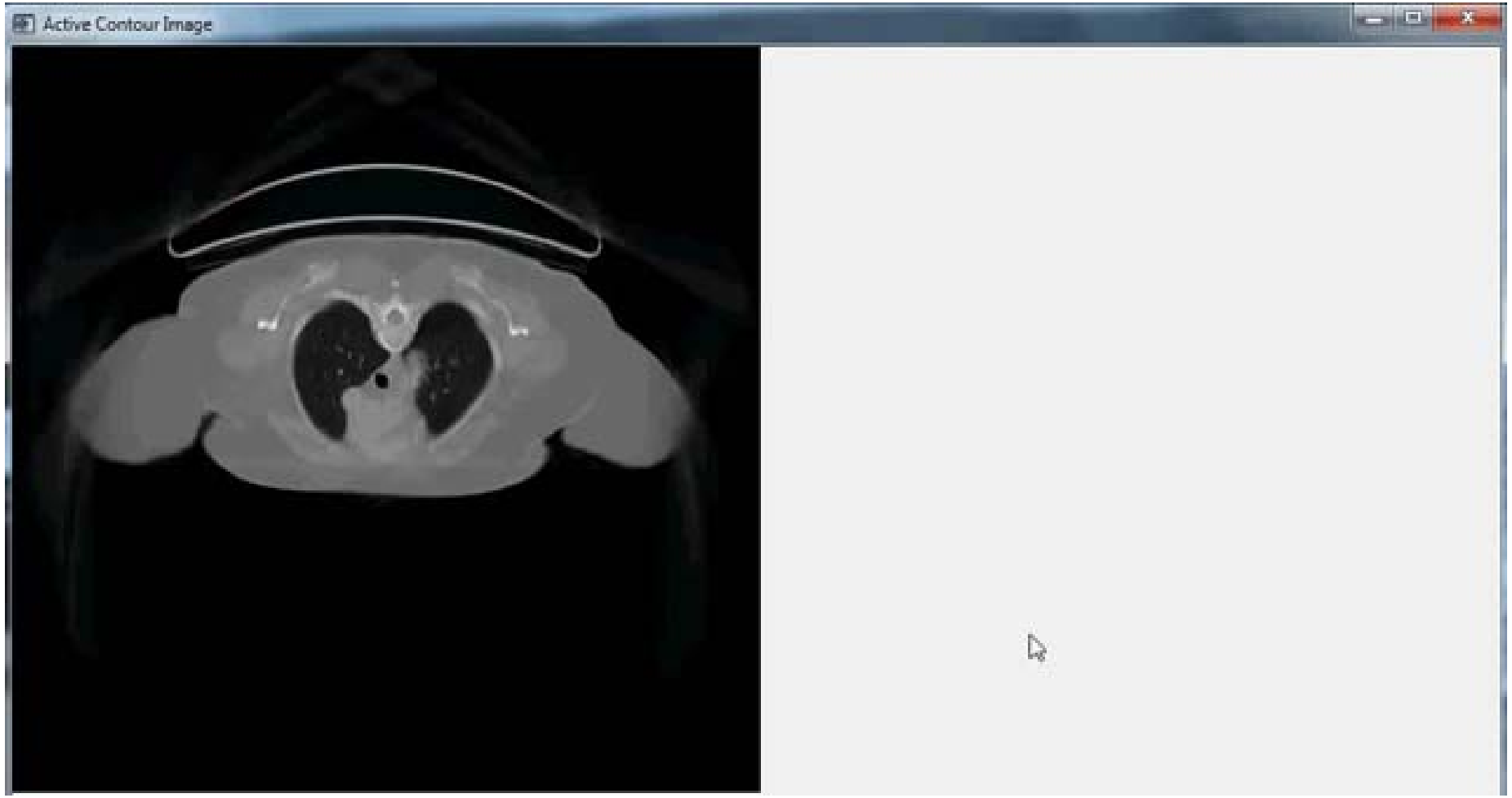


With the advance of hardware (GPUs) the computational power allows to use neural nets with many layers and parameters to optimise.



Lesion detection

- Some algorithms will be seen in MISA
- We will see other algorithms:
  - Deformable algorithms: snakes

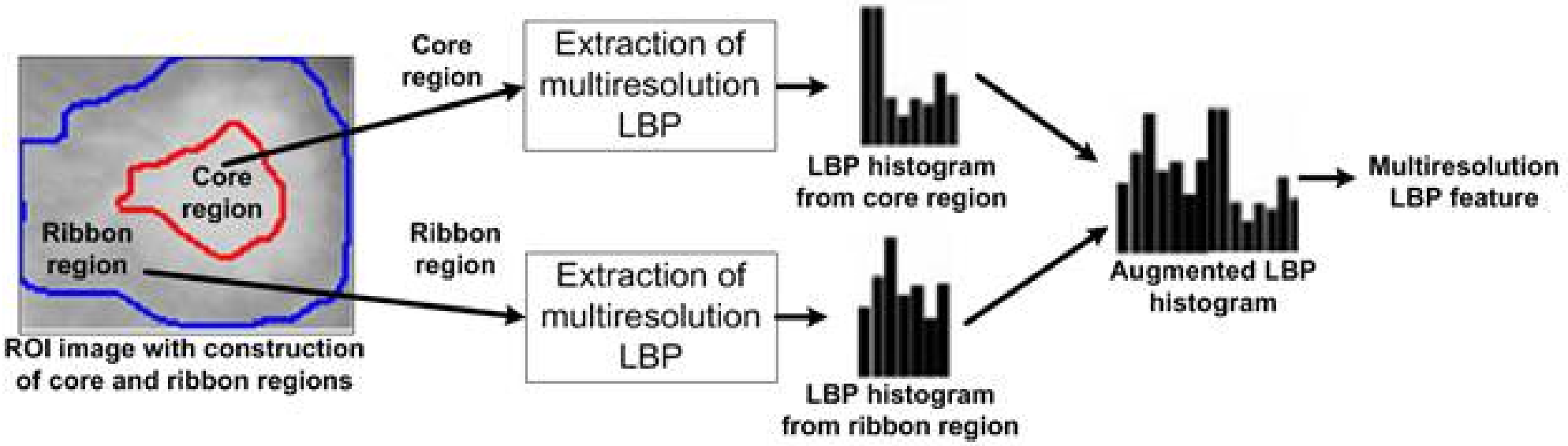


Lesion detection

- Some algorithms will be seen in MISA
- We will see other algorithms:
  - Deformable algorithms: snakes, active shapes

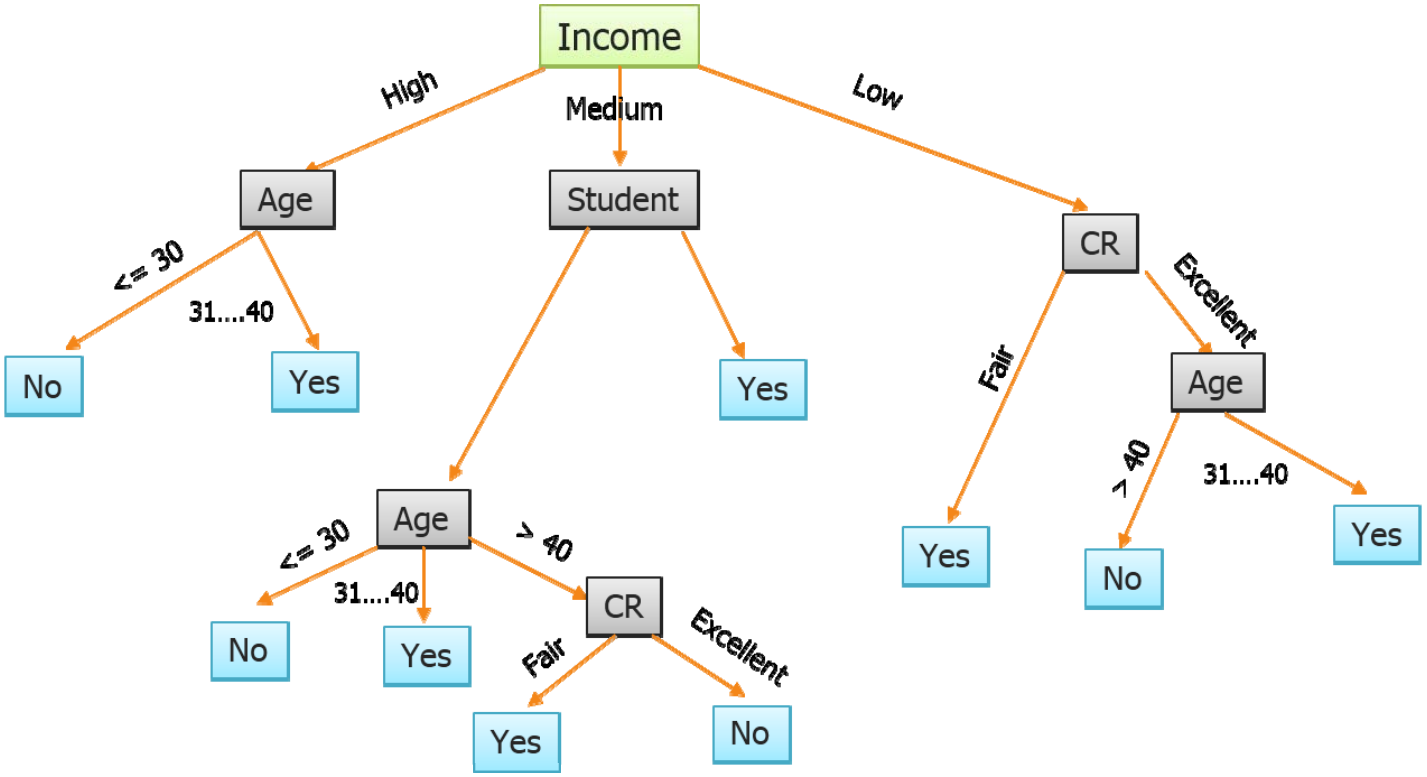
Feature Extraction

- Morphologic/appearance: intensity, texture (co-occurrence matrices, LBP, fractals, …)
- Moments, Shape contexts, …
- Interest keypoints: SIFT, SURF, MSER, …
- Extraction of features from the ribbon!



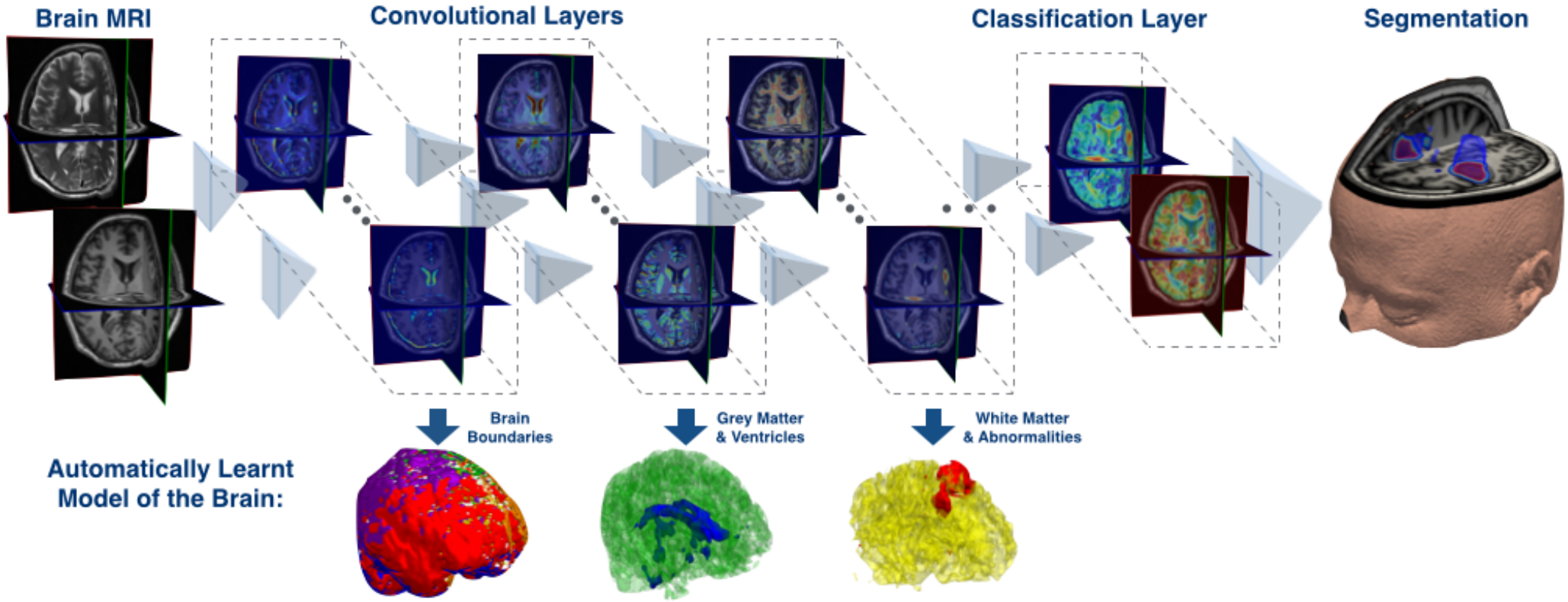
Classification

- kNN, SVM, …
- Decision tree, random forests, …
- Ensemble of classifiers, boosting, …
- Neural nets, …



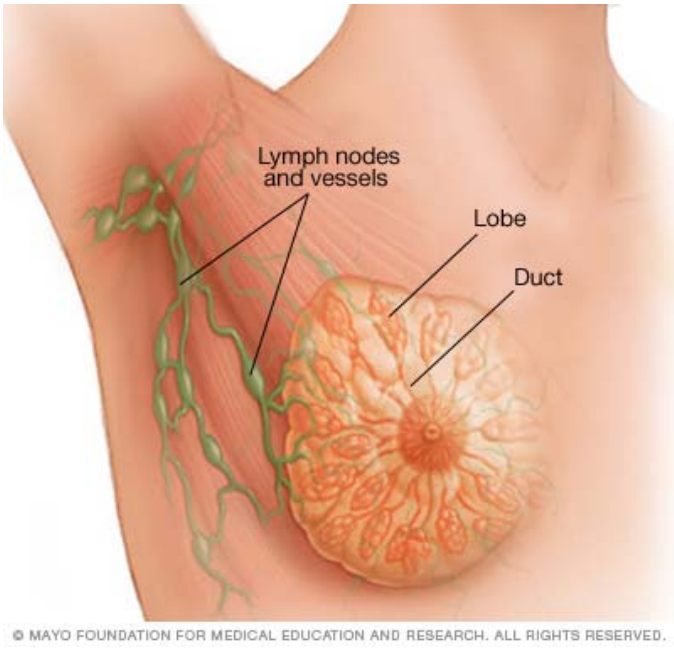
Deep learning

- Images into the net, final result (segmentation / diagnosis)



CADx: breast cancer

Breast cancer is cancer that forms in the cells of the breasts.



Each breast contains 15 to 20 lobes of glandular tissue, arranged like the petals of a daisy.

The lobes are further divided into smaller lobules that produce milk for breast-feeding. Small tubes (ducts) conduct the milk to a reservoir that lies just beneath your nipple.

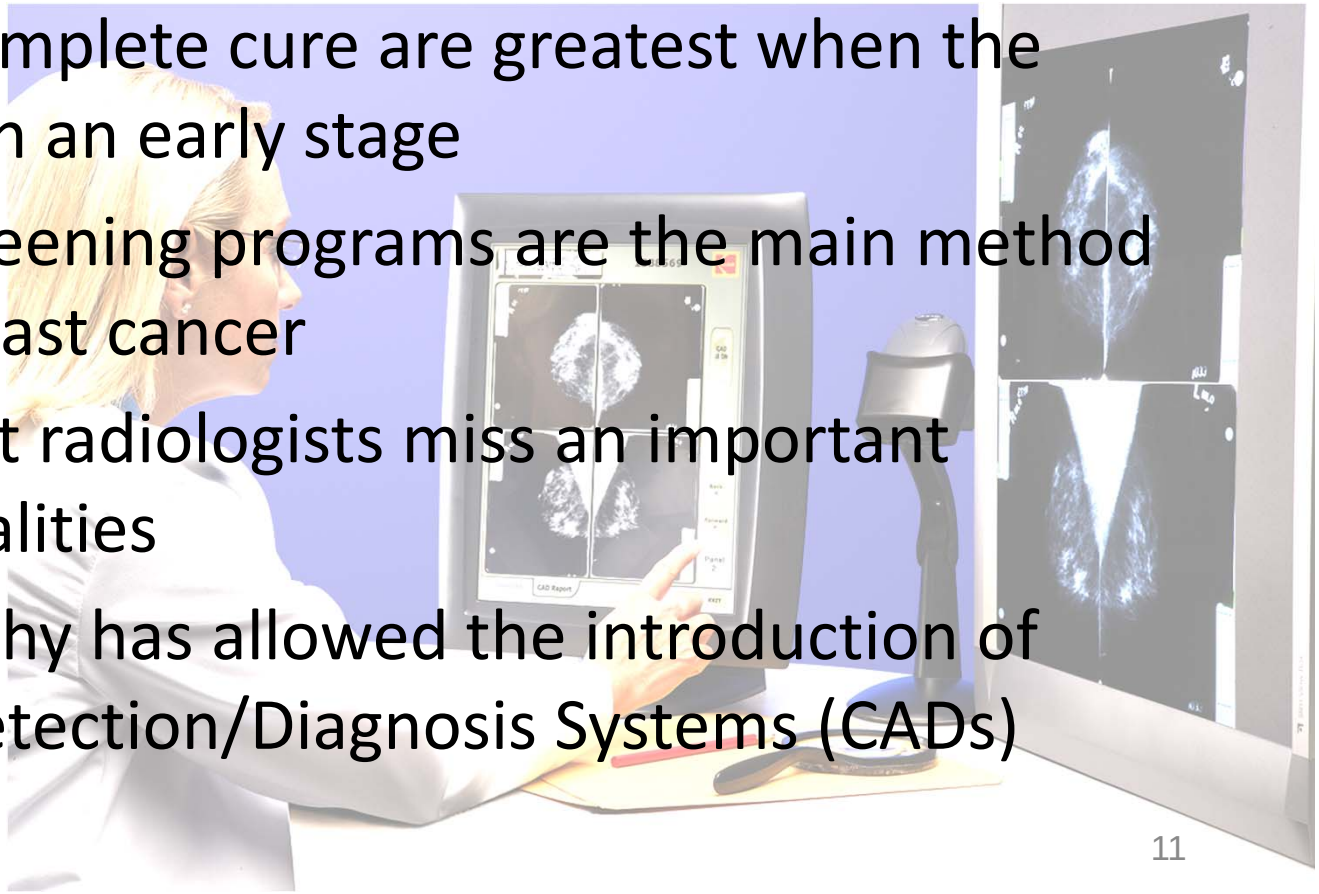
Ductal carcinoma: in the milk ducts. If remain within the ducts is a noninvasive cancer (ductal carcinoma in situ) otherwise, it can break out of the ducts (invasive ductal carcinoma).

Lobular carcinoma: in the milk-producing lobules. When it breaks out of the lobules, it's considered invasive lobular carcinoma.

Connective tissues. Rarely breast càncer.

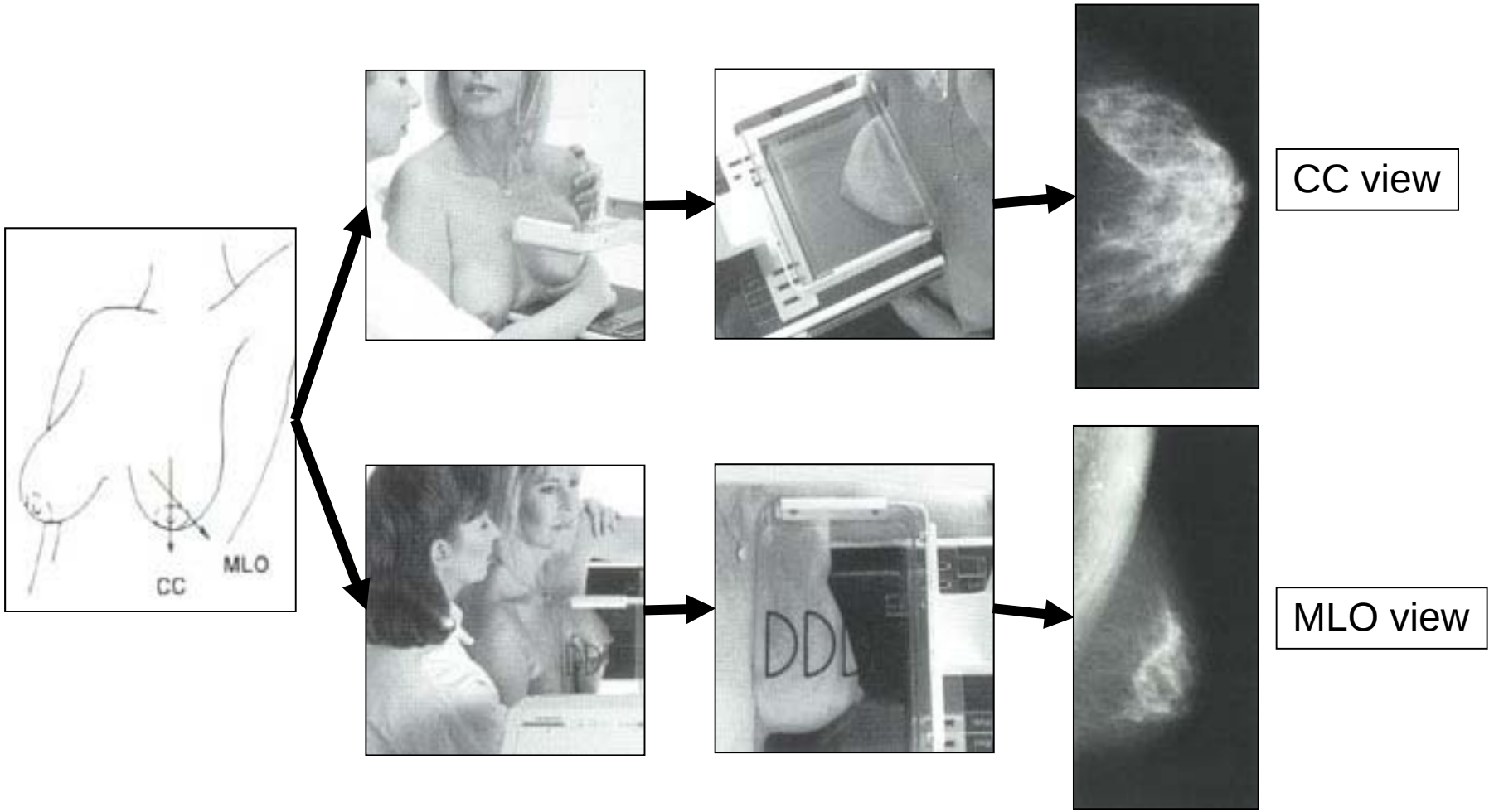
CADx: breast cancer

- Approximately 10% women will develop breast cancer during the course of their lives
- The cause of disease is not understood and there is no immediate hope of prevention
- The chances of a complete cure are greatest when the cancer is detected in an early stage
- Mammographic screening programs are the main method to identify early breast cancer
- It is well-known that radiologists miss an important number of abnormalities
- Digital mammography has allowed the introduction of Computer-Aided Detection/Diagnosis Systems (CADs)



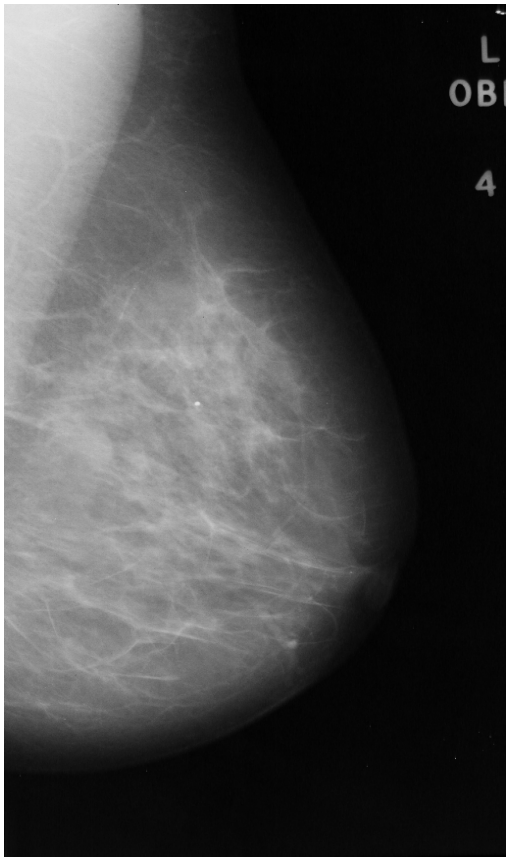
MAMMOGRAPHIC IMAGES

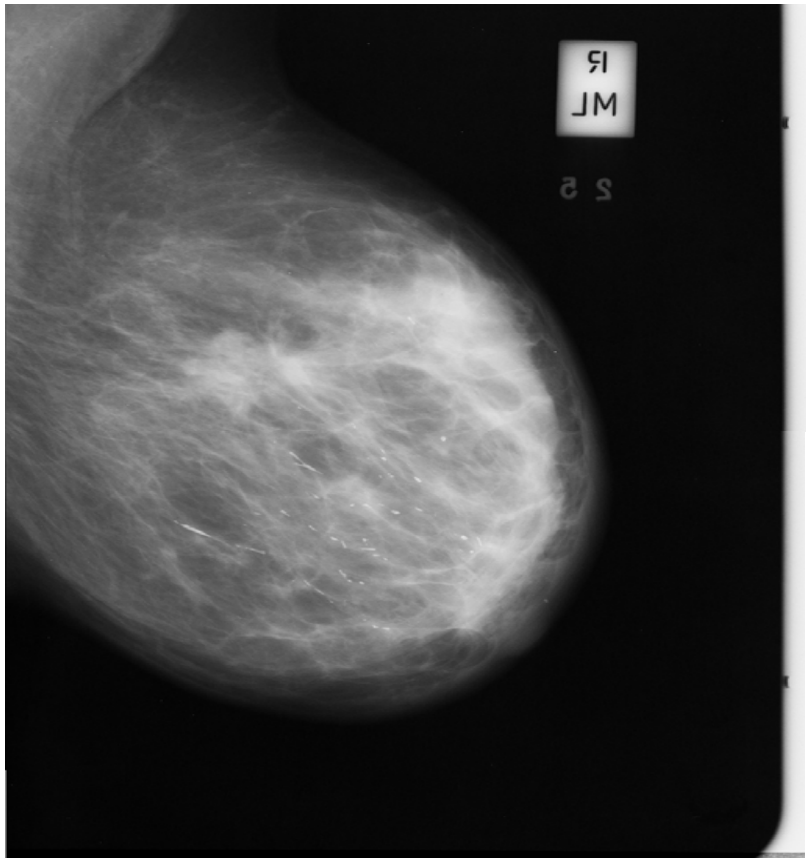
- Mammograms are images coming from the acquisition of low energy X-Rays passing through the breasts



Breast Cancer CADx

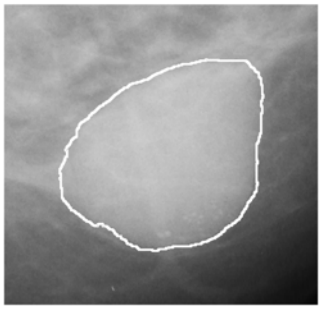
- Mammograms:

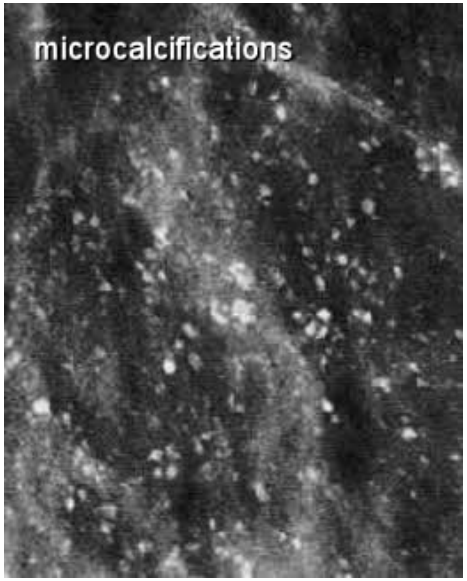




Breast Cancer CADx

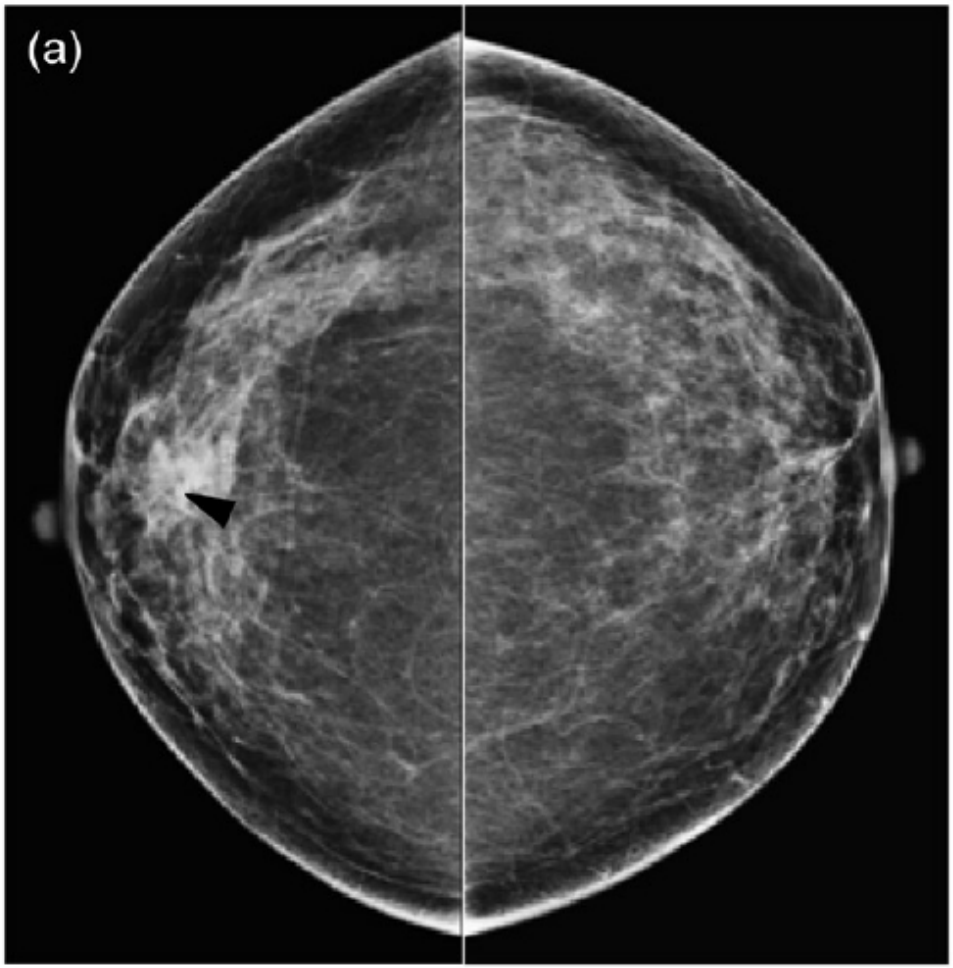
- Different types of abnormalities. Mainly:

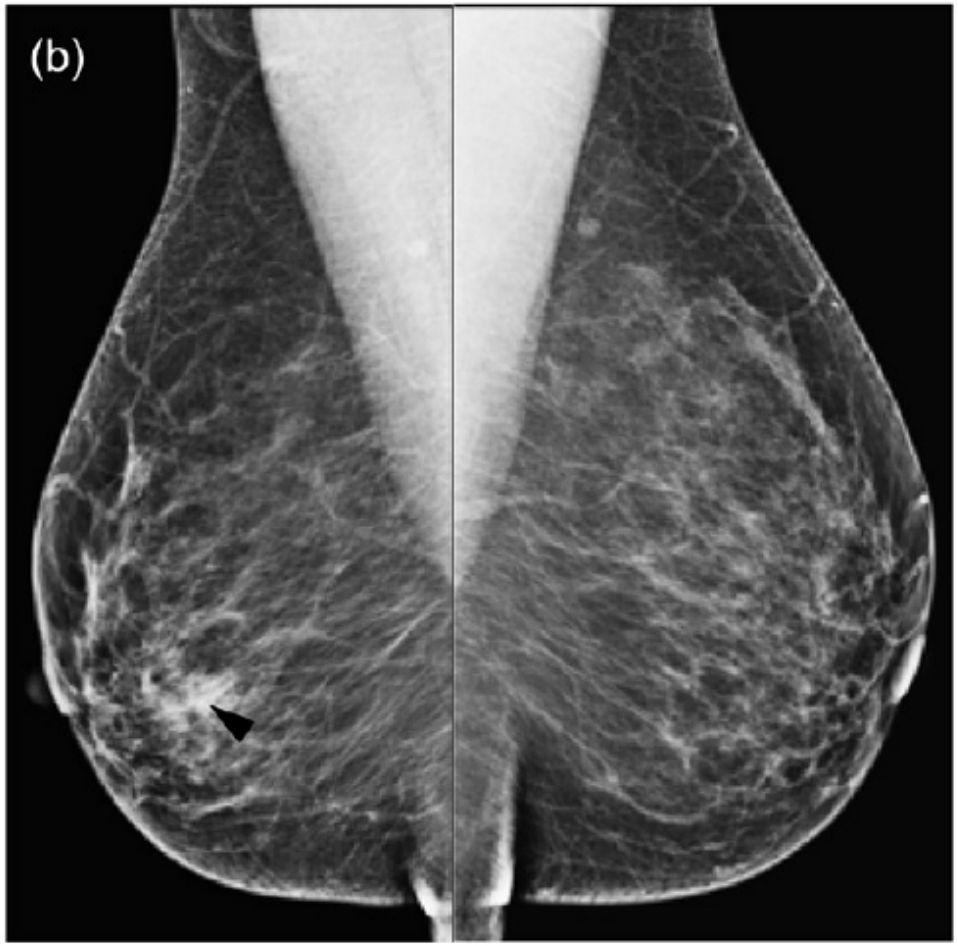




Breast Cancer CADx

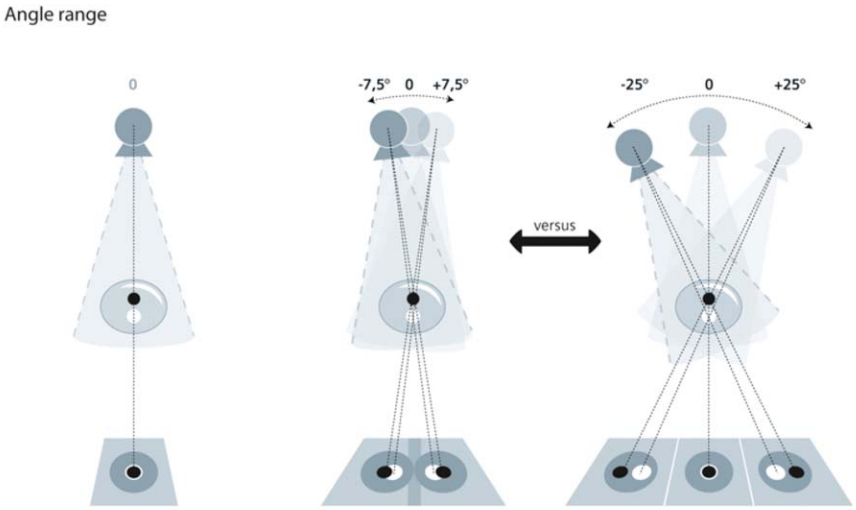
Use of 4 images with different view and also different breast!



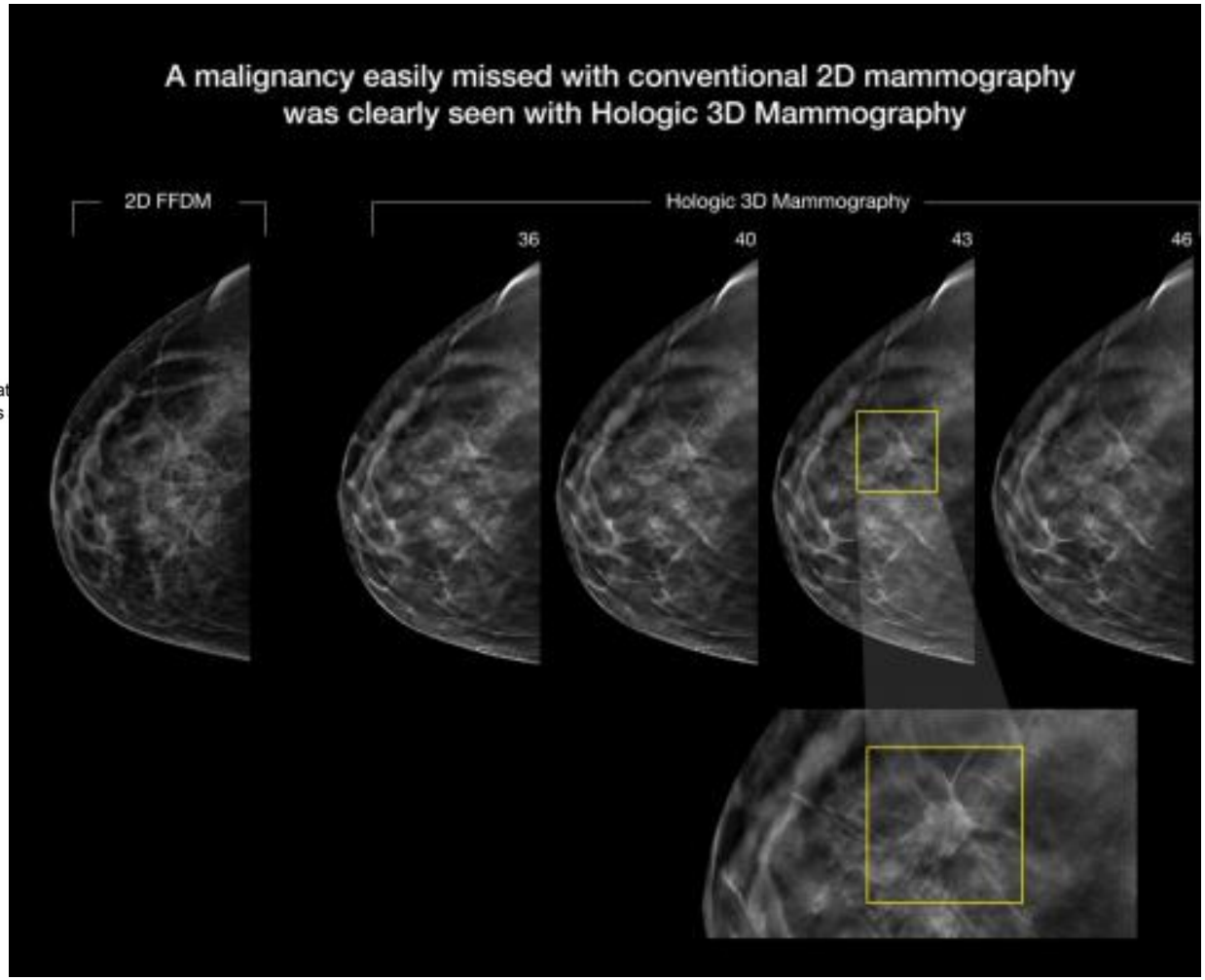


Breast Cancer CADx

- Other modalities: Tomosynthesis



The angular range of the tomosynthesis system will directly affect the depth resolution. Two projections at ±7,5° will not be able to separate the two spheres. Two projections at ±25° can separate the two spheres due to an adequate depth resolution



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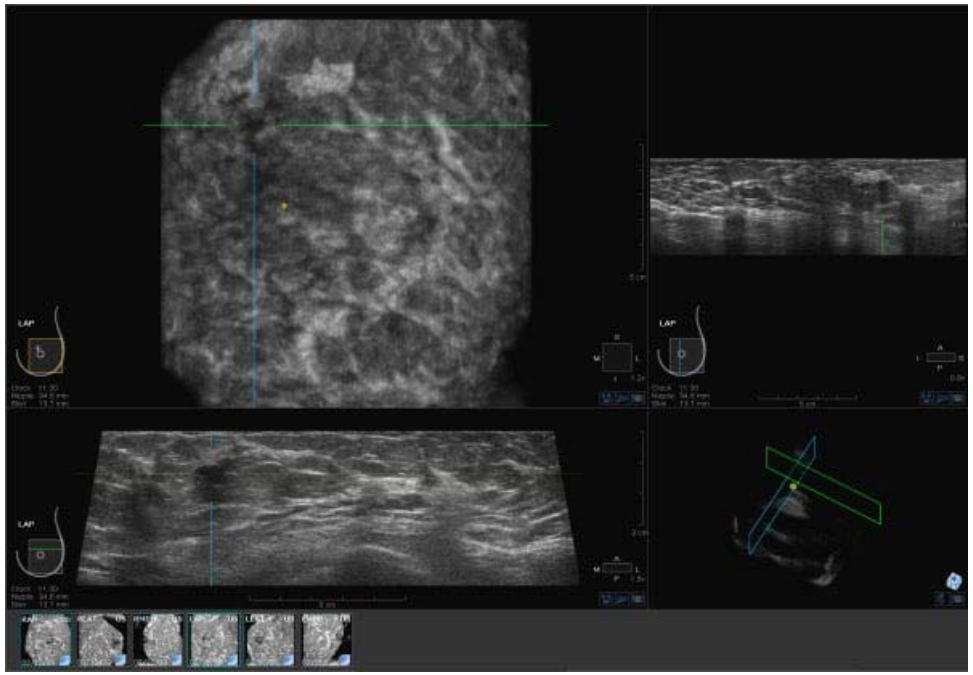
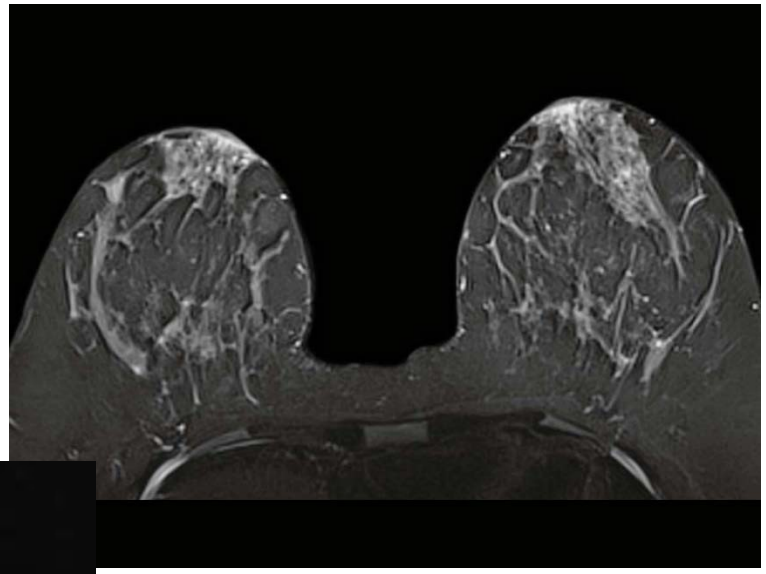
Breast Cancer CADx

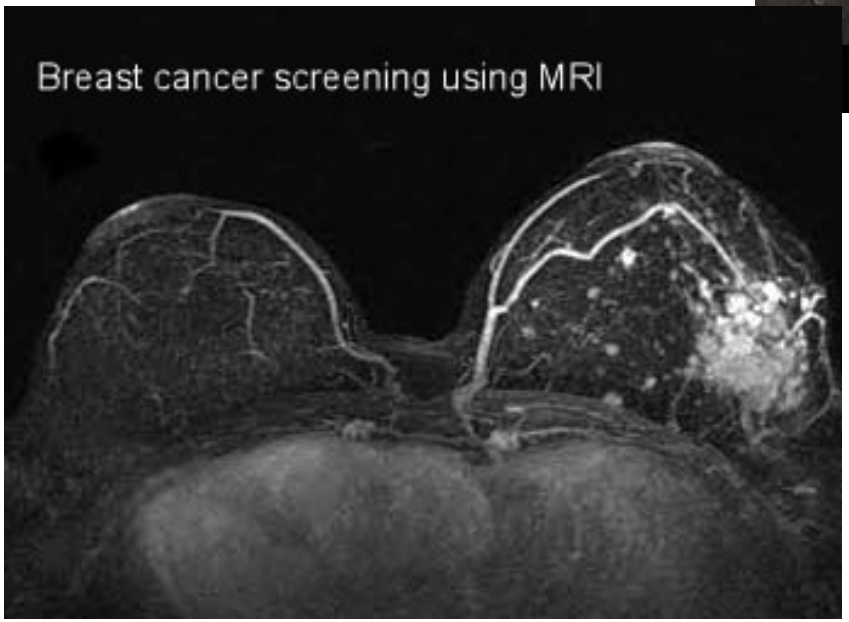
- Other modalities: US



Breast Cancer CADx

- Other modalities: MRI



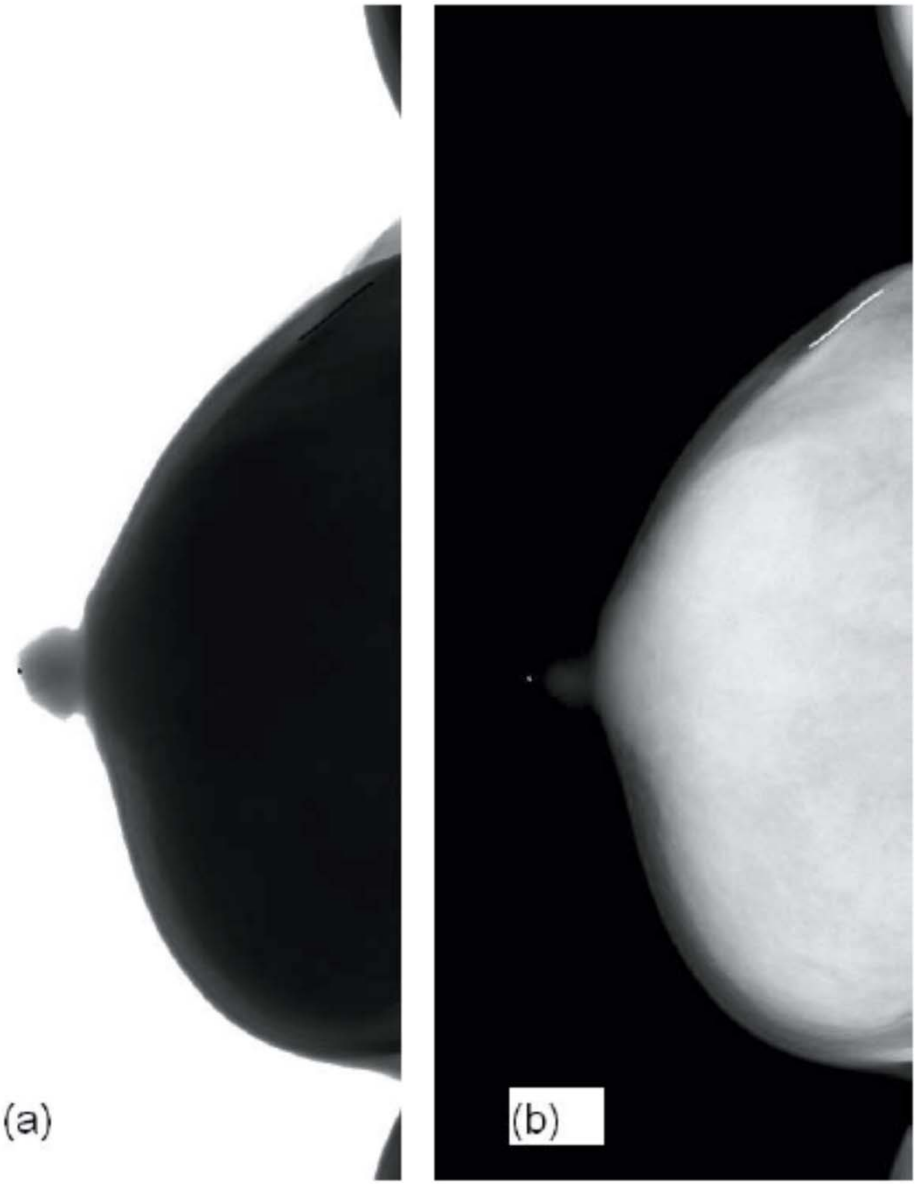


CADx for Breast Cancer

- Problems we have to deal:
  - Pre-processing
  - Breast segmentation
  - Detection of abnormalities (mass / micros)
  - False positive reduction
  - Registration of different views / breasts
  - Registration of different modalities
  - Diagnosis

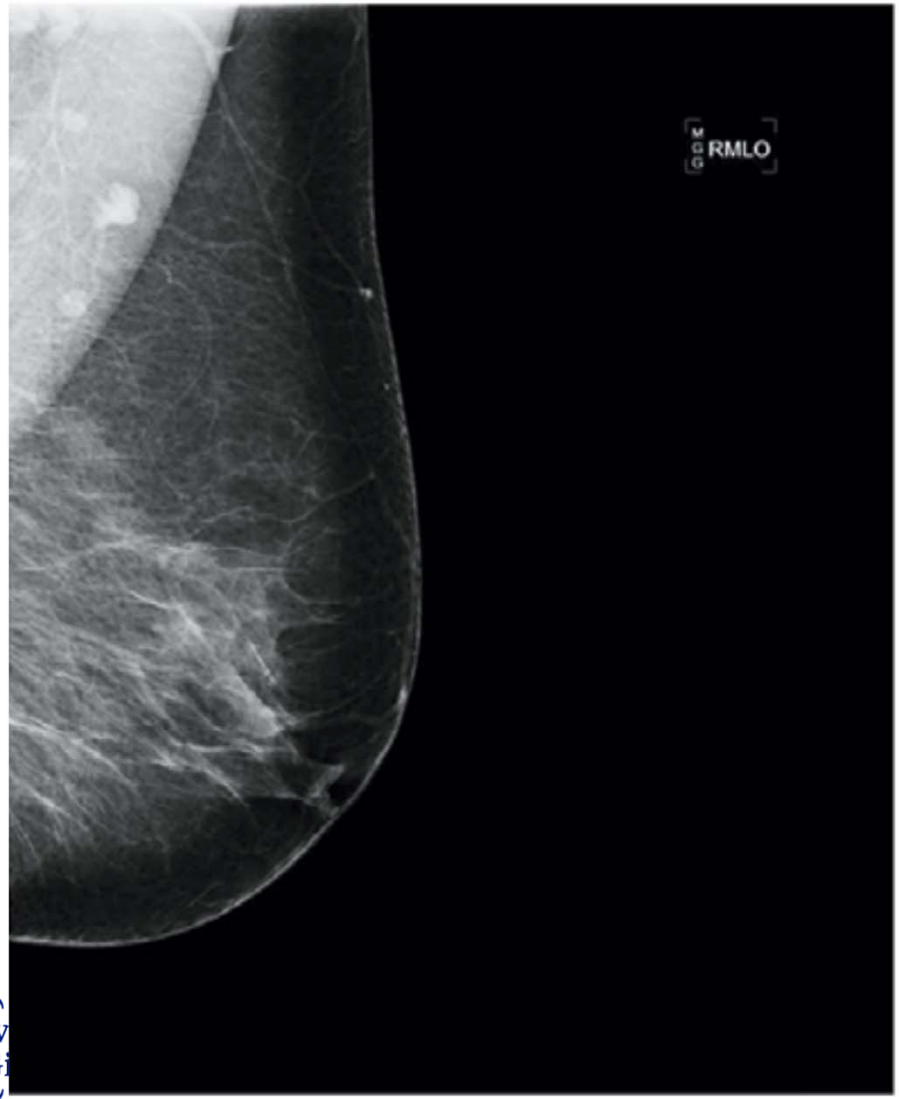
CADx for Breast Cancer

- Pre-processing



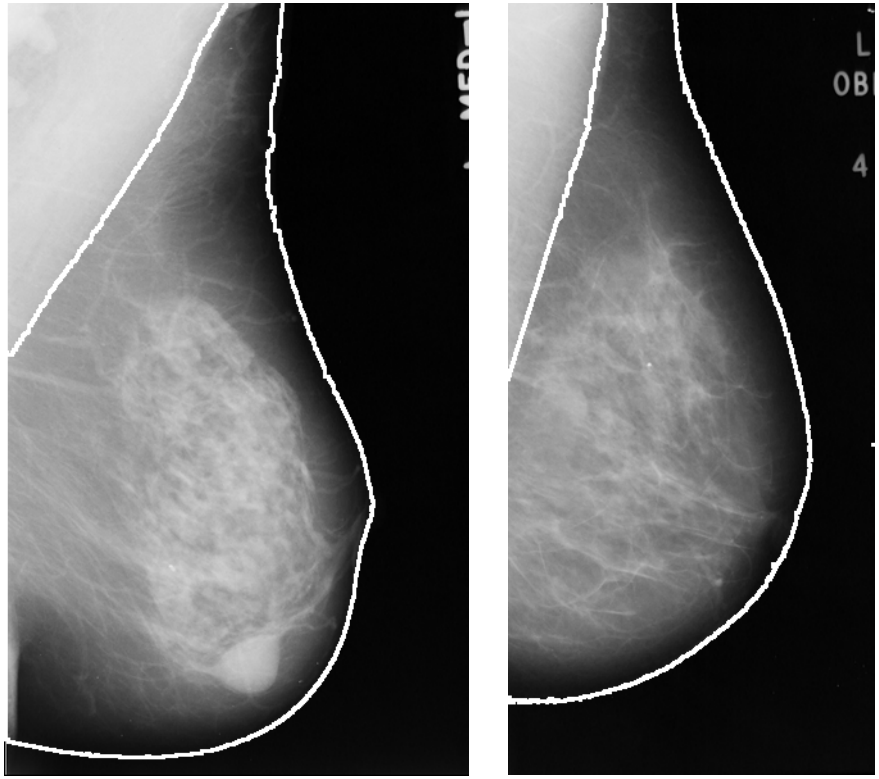
CADx for Breast Cancer

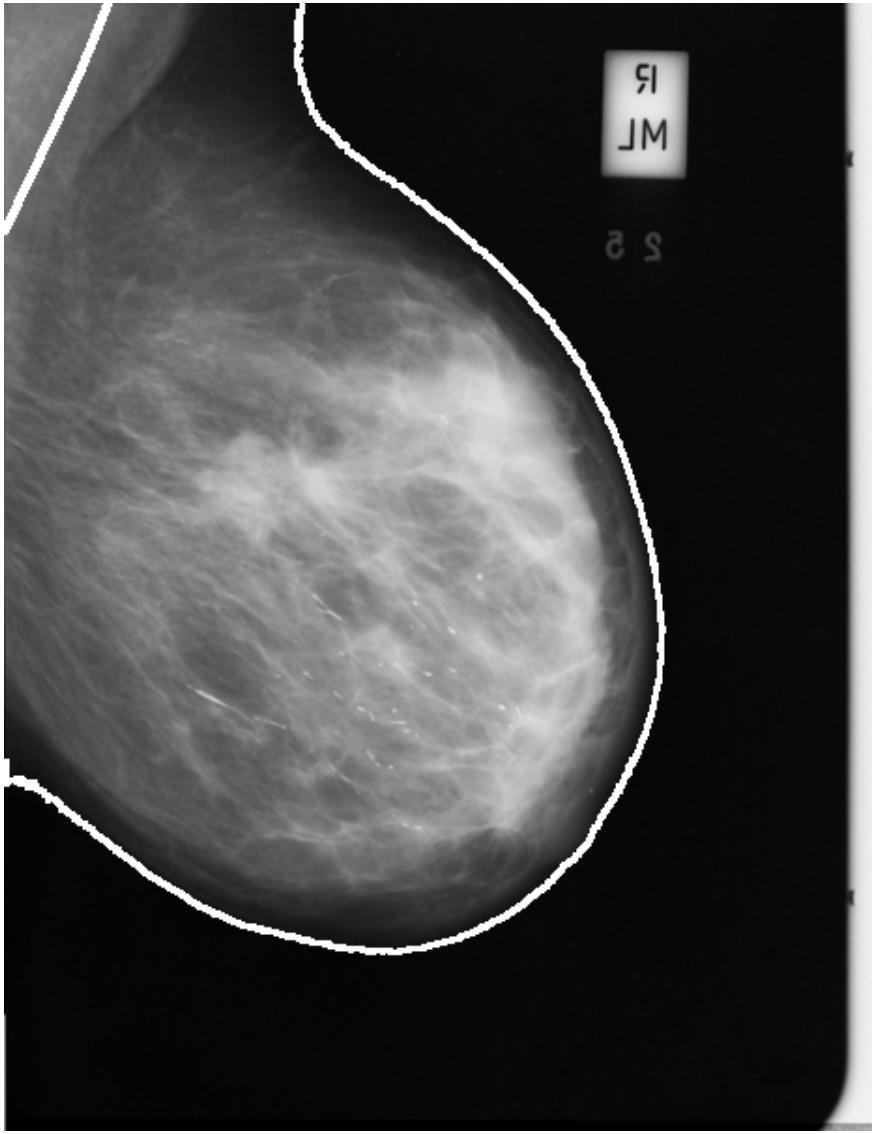
- Pre-processing



Breast Cancer CADx

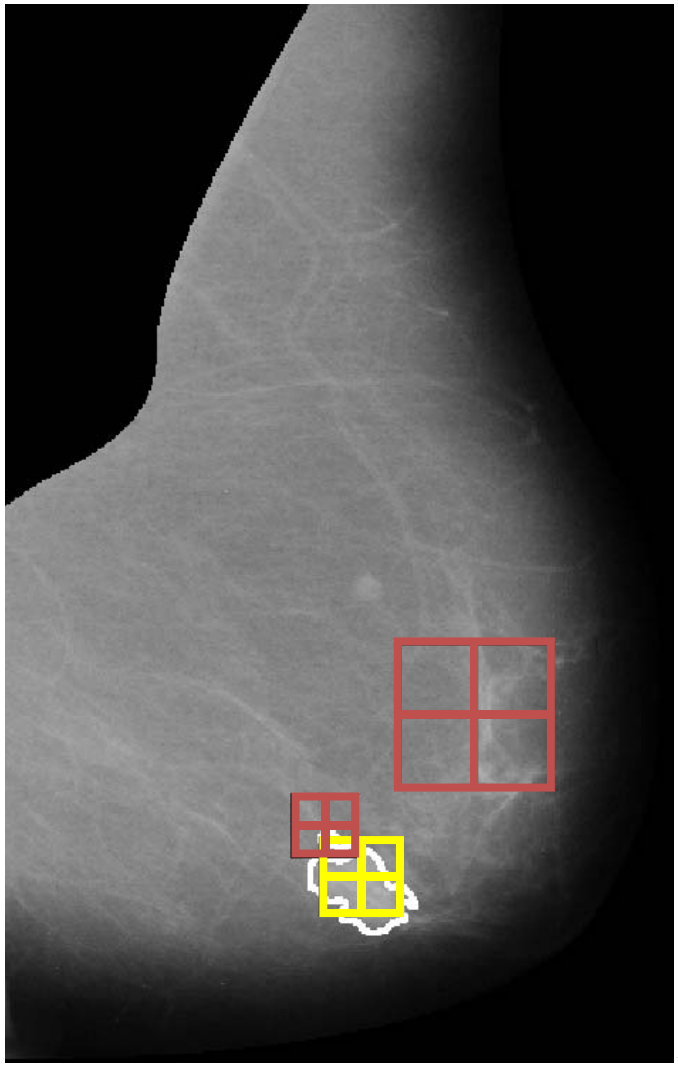
- Breast profile segmentation

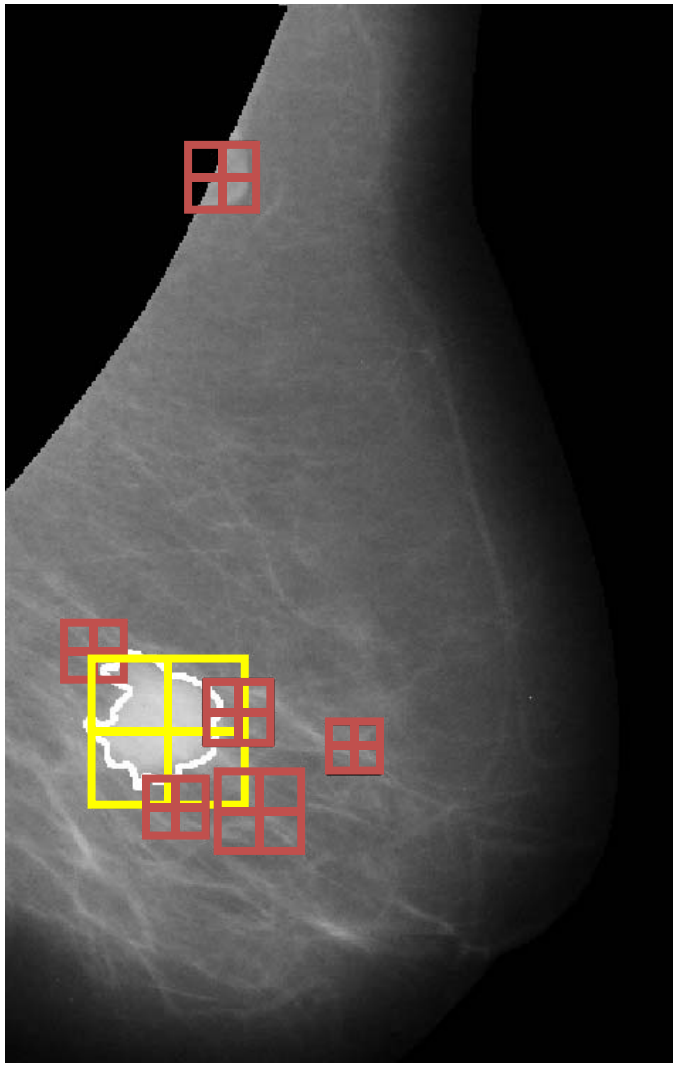




CADx for Breast Cancer

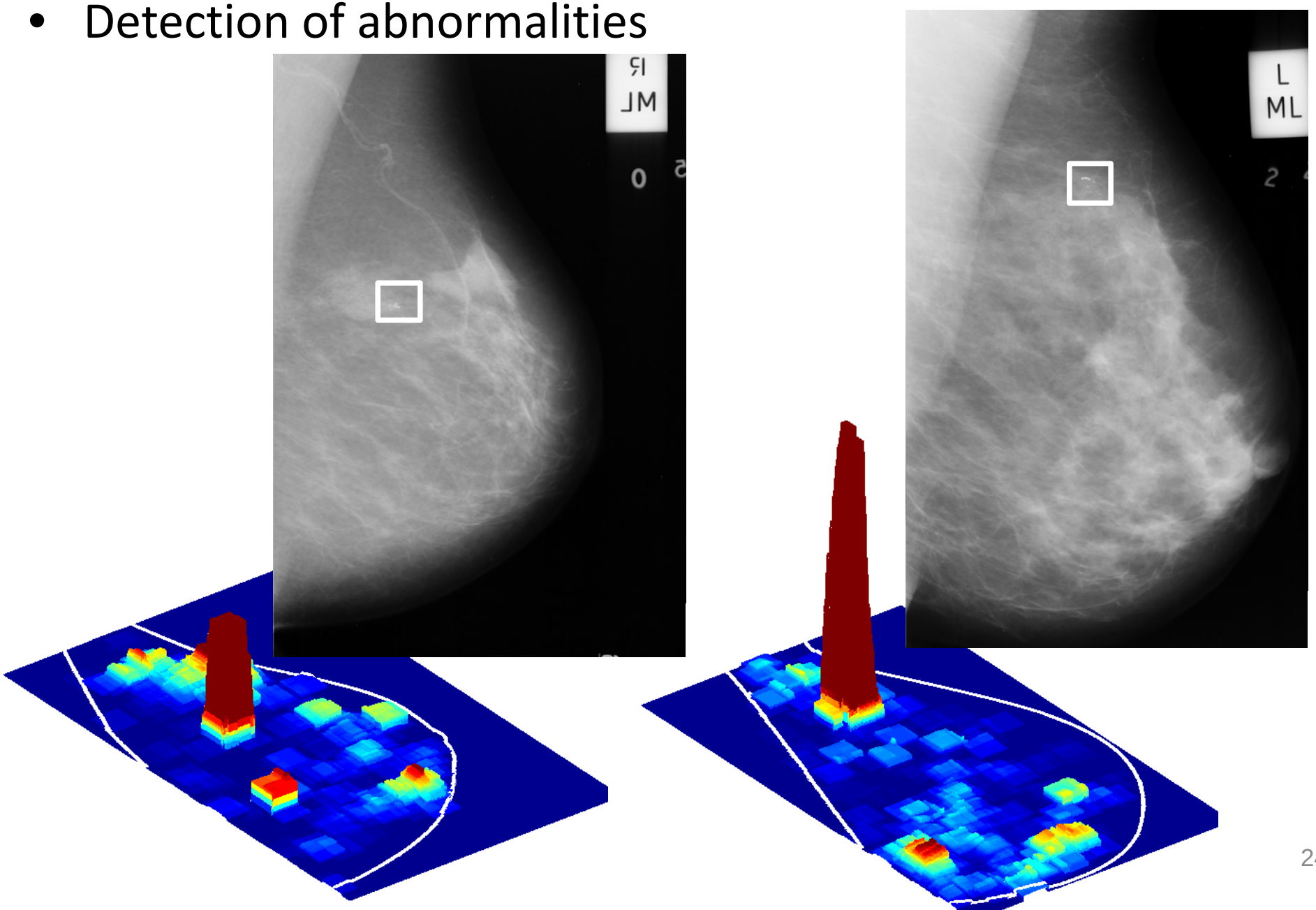
- Detection of abnormalities





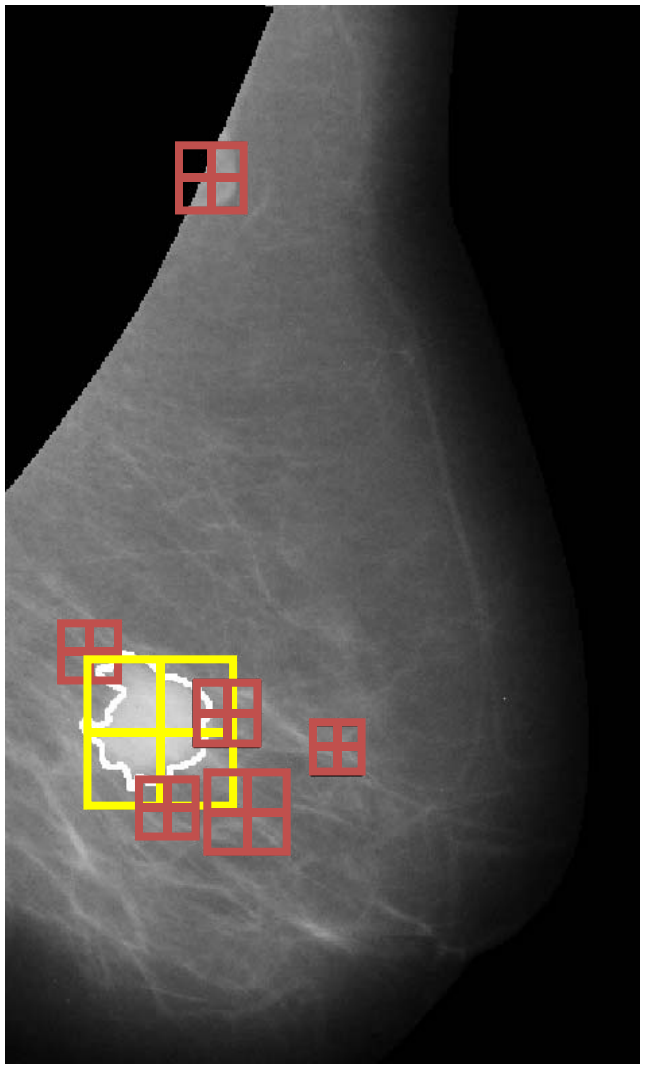
CADx for Breast Cancer

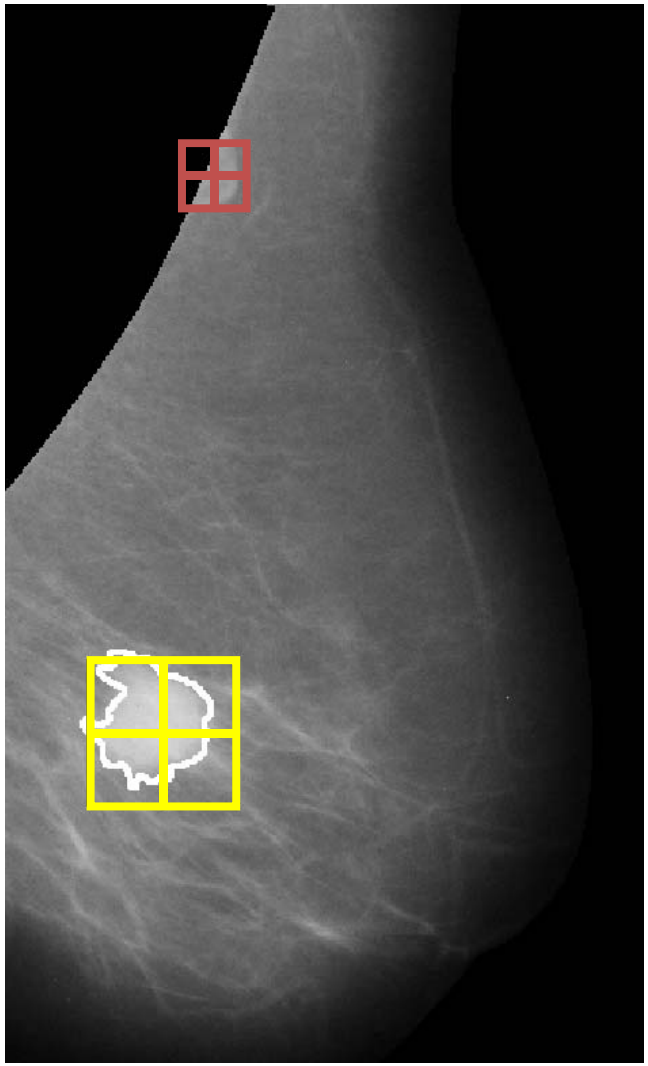
- Detection of abnormalities



CADx for Breast Cancer

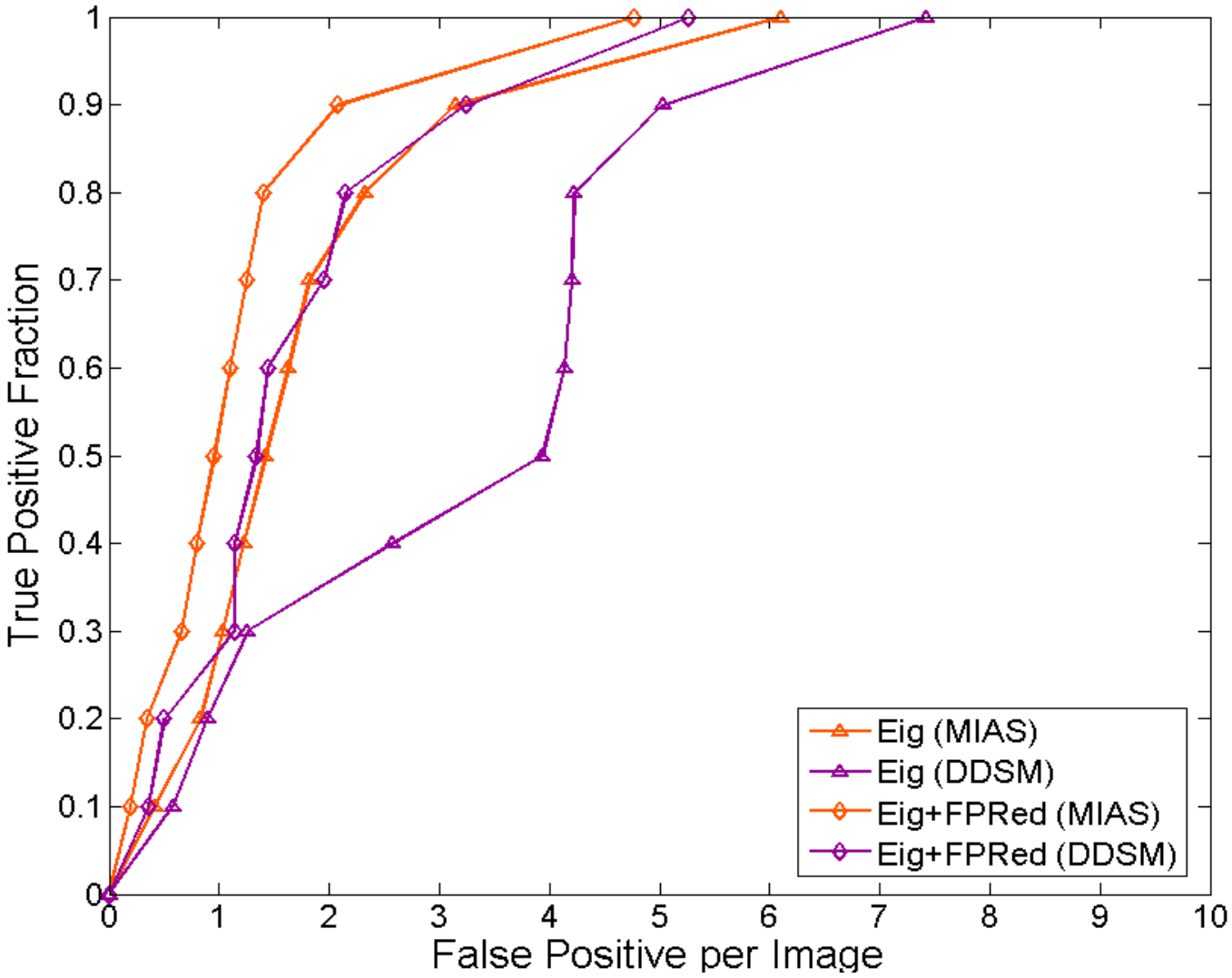
- False positive reduction





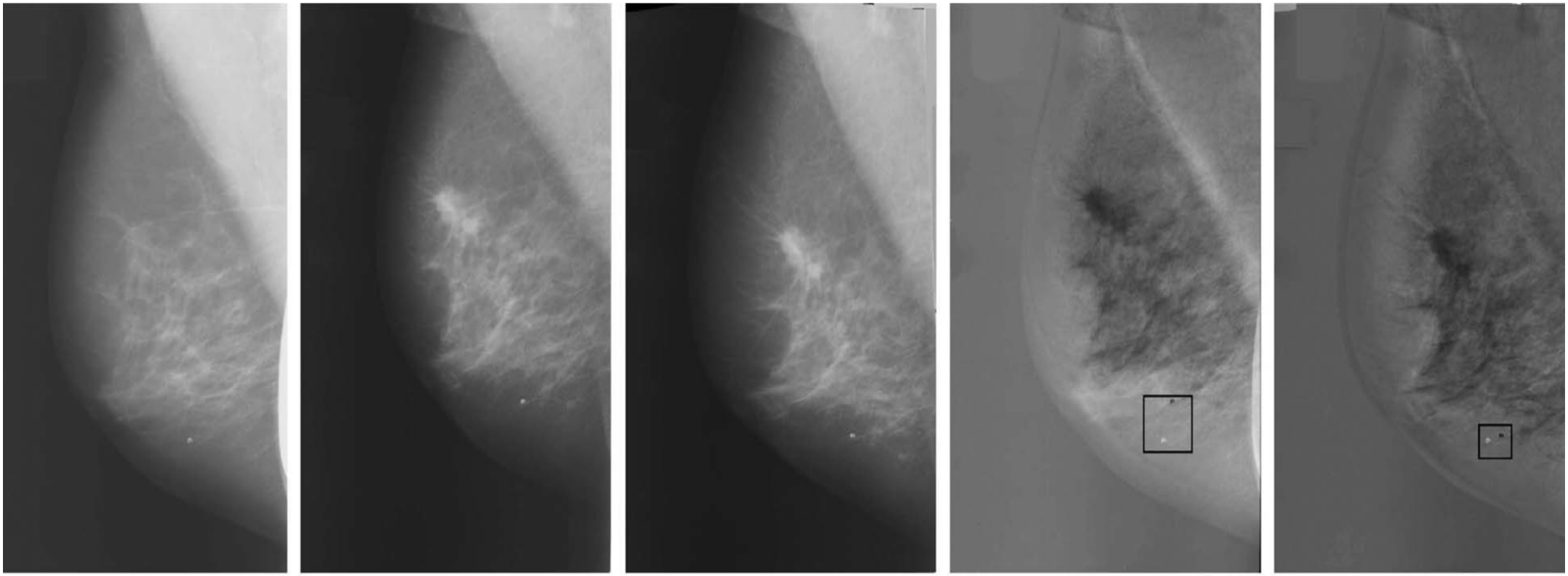
CADx for Breast Cancer

- Evaluation of breast CADx: FROC



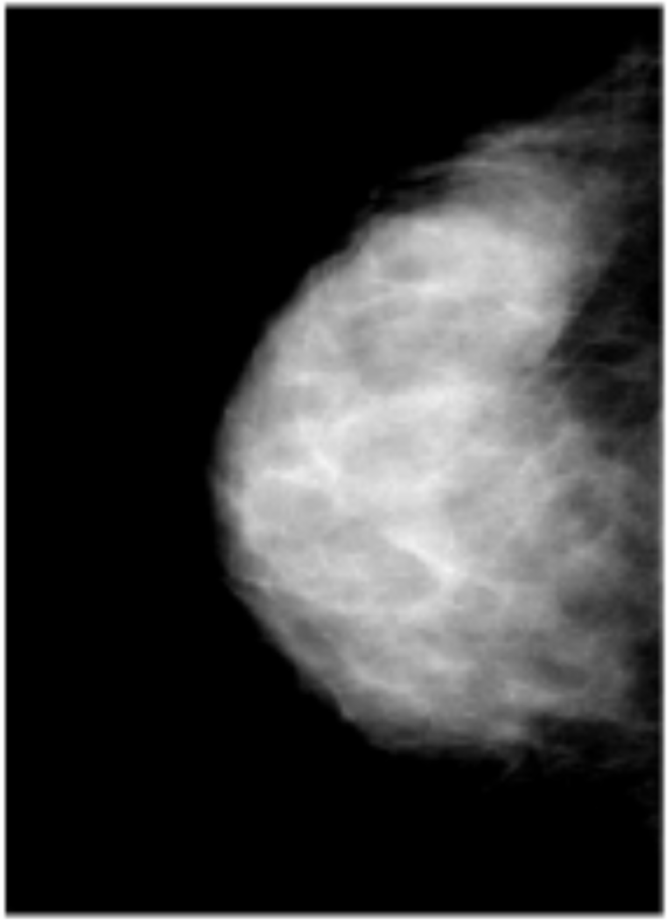
CADx for Breast Cancer

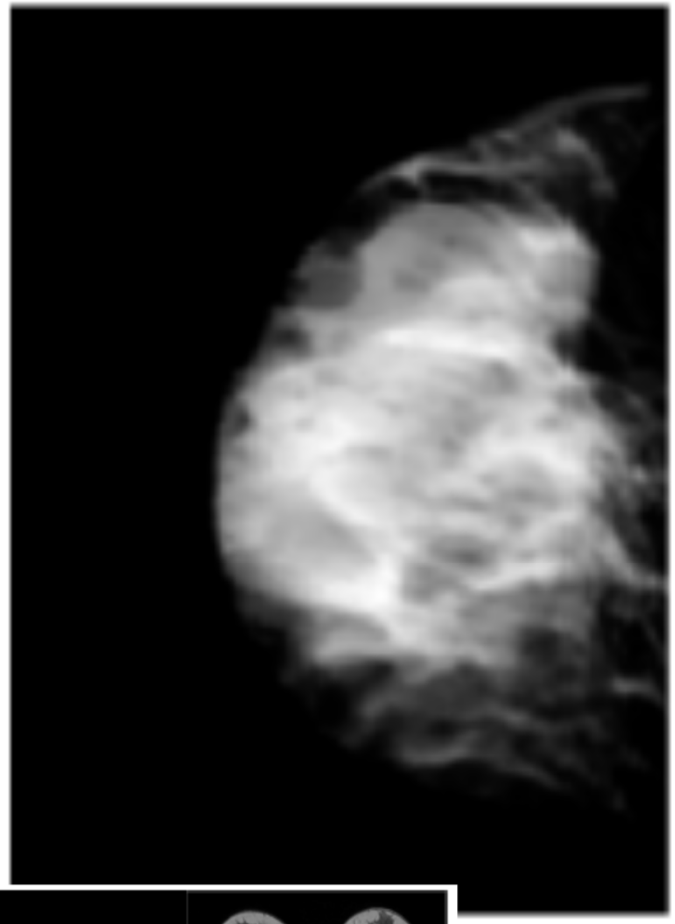
- Registration of different breasts

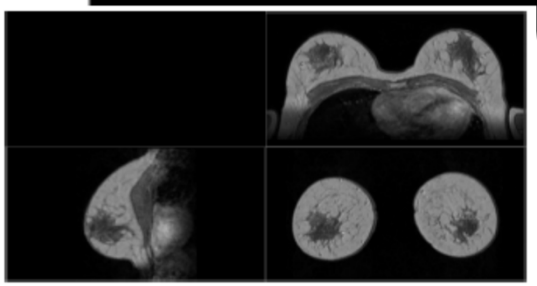


CADx for Breast Cancer

- Intermodality registration

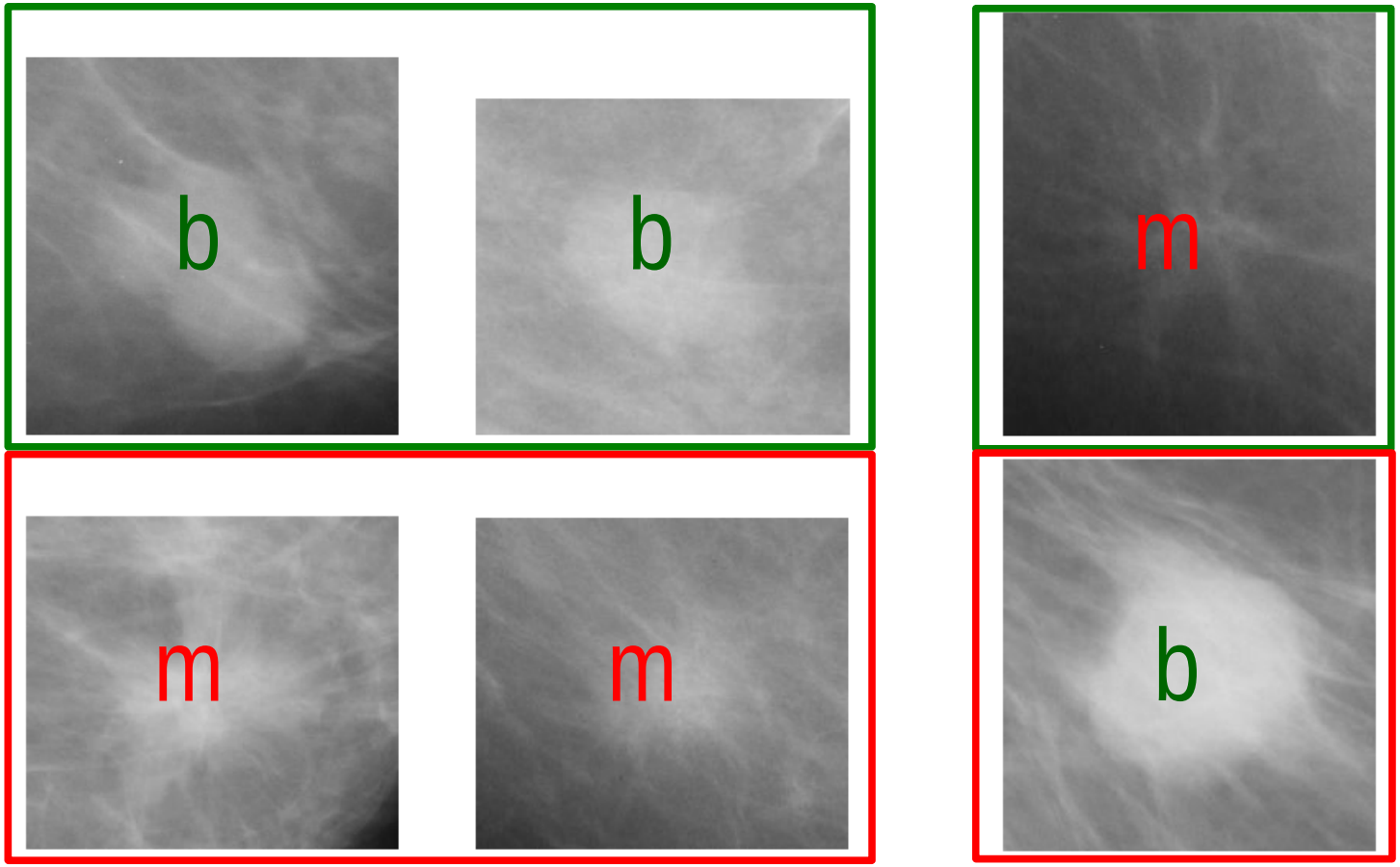






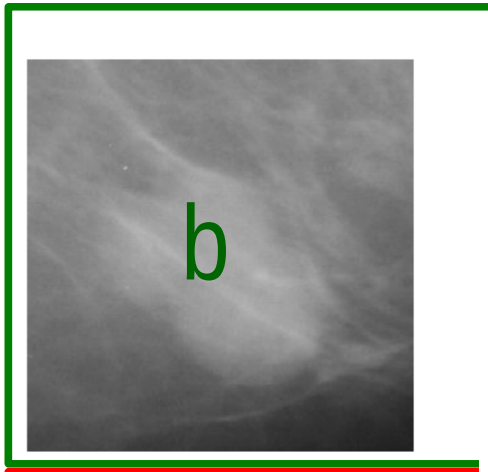
CADx for Breast Cancer

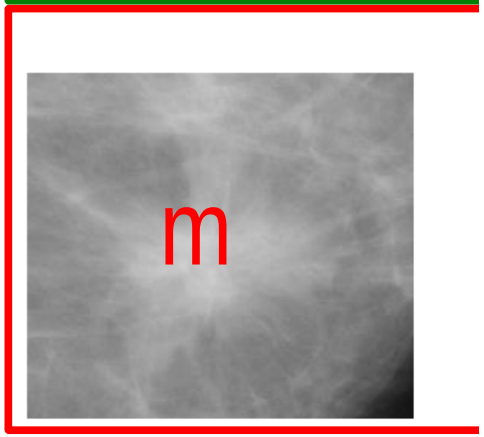
- Final output of the CADx: 2-class problem / 6-class problem

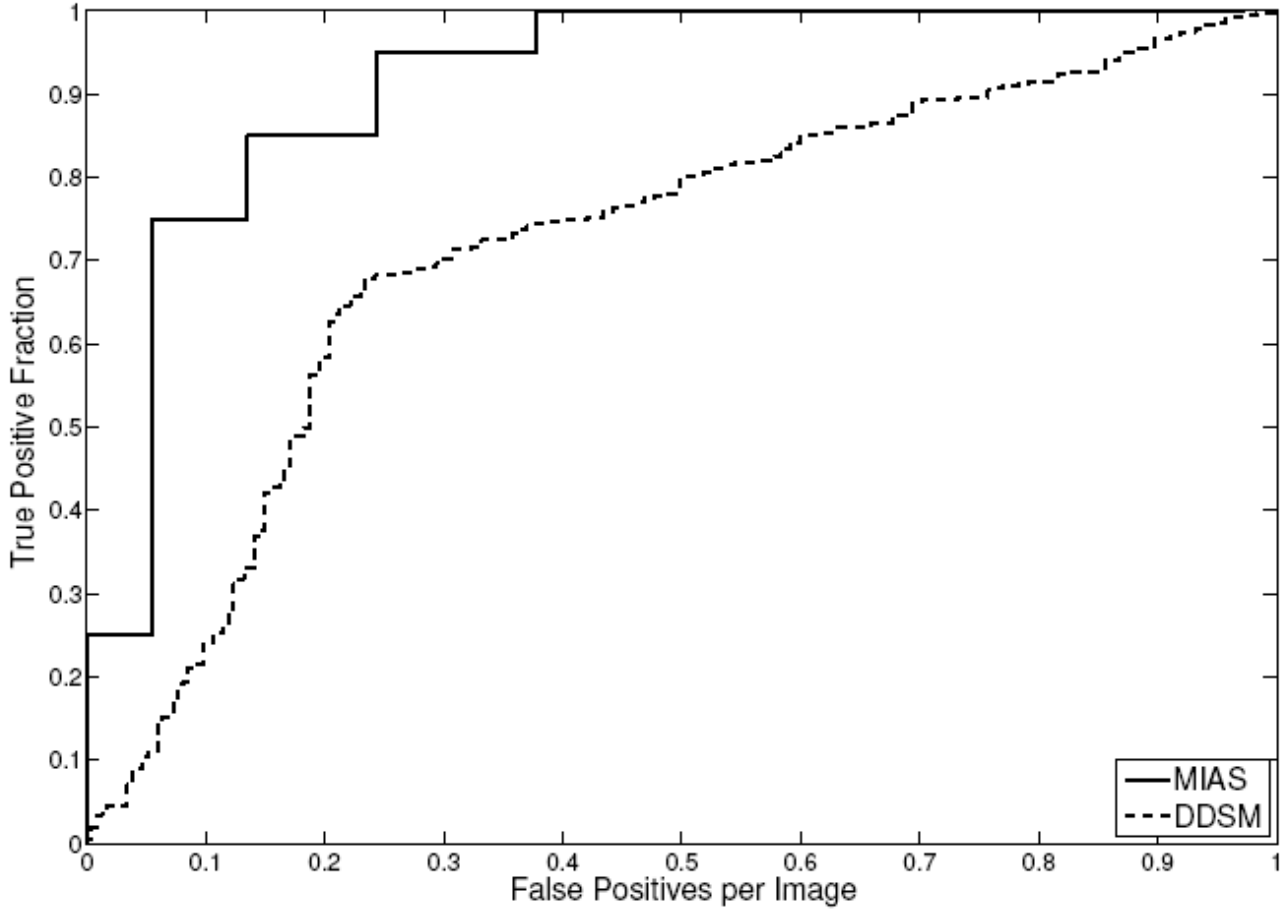


CADx for Breast Cancer

- Final output of the CADx







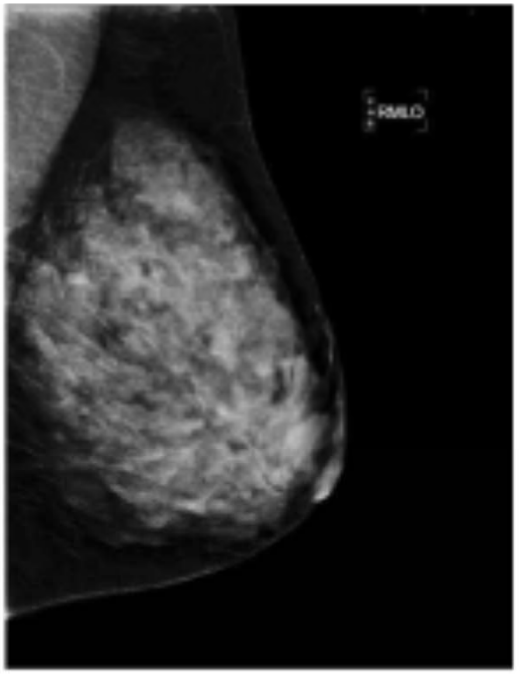
CADx for Breast Cancer

- Other topics: breast density!

(a)

(b)

(c)



(d)

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