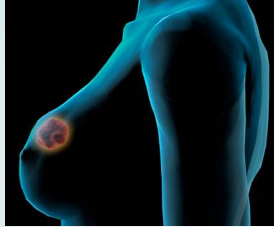


Using Machine Learning to Identify Benign Cases with Non-Definitive Biopsy

Breast Cancer



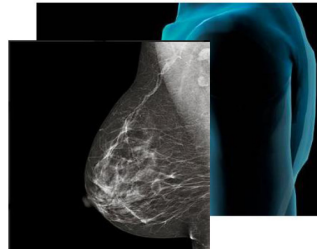
- **USA:**
 - 1 woman dies of breast cancer every 13 minutes
 - In 2011:
 - 230.480 with cancer
 - 39.520 (≈ 17%) died

Source: *U. S. Breast Cancer Statistics* - October 2011

- **Portugal:**
 - Per year:
 - 4500 new cases
 - 1500 deaths (33%)

Source: *Liga Portuguesa Contra o Cancro* - November 2011

Mammography



- **Mammography:**
 - The **cheapest** and most **efficient** method to detect cancer in a preclinical stage

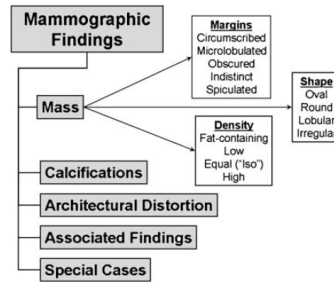


Image-guided Core Needle Biopsy

- 5% to 15% can be non-definitive: there is no medical agreement during a medical conference
- Normal procedure: send all non-definitive biopsy cases to excision
- Result: 15% to 20% only are proved to be malignant findings ☹️

Objective
 Reduce the number of patients that go to excision

Methodology

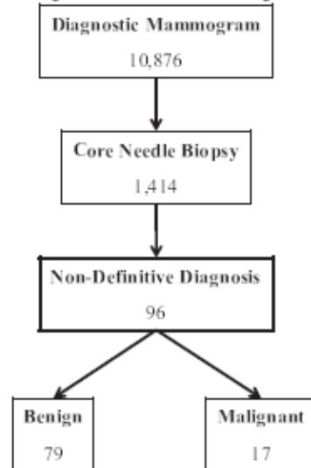
- Learn rules that characterize benign biopsy cases
- Machine learning technique: Inductive Logic Programming (ILP)
- Aleph
- Data represented as Prolog facts
- Data collected between Dec 31 2005 and Dec 31 2009 From UW-Hospital

Conclusions:

ILP can derive rules that accurately predict when a woman may not require excision after a non-definitive core breast biopsy. All five rules predict a substantial number of cases that are benign, and only two miss a single malignancy each.

Data

Fig. 1. Case Inclusion Diagram



Results

17-FOLD CROSS VALIDATION RESULTS

TP	FP	FN	TN	Precision	Recall	$F_{0.1}$
25	2	54	15	0.93	0.32	0.91

- 1) The patient did not have a previous surgery, imaging did not present a spiculated mass margin, the abnormality remained in post-biopsy imaging
- 2) Imaging did not present an indistinct mass margin, imaging did not present a spiculated mass margin, the abnormality remained in post-biopsy imaging
- 3) Imaging did not present a spiculated mass margin, the abnormality remained in post-biopsy imaging
- 4) Imaging did not present an indistinct mass margin, the abnormality remained in post-biopsy imaging
- 5) The patient has no personal history of breast cancer, the abnormality remained in post-biopsy imaging