

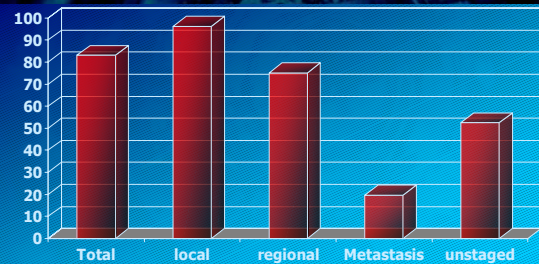
Breast Cancer - FACTS:

- ☑ Breast carcinoma leading cause of cancer death in women
- ☑ Every 8-10th woman affected during lifetime
- ☑ About 4000 new cases/a in Austria
- ☑ Clustered microcalcifications one of early signs



Breast Cancer - FACTS:

SURVIVAL vs TUMORS SPREAD

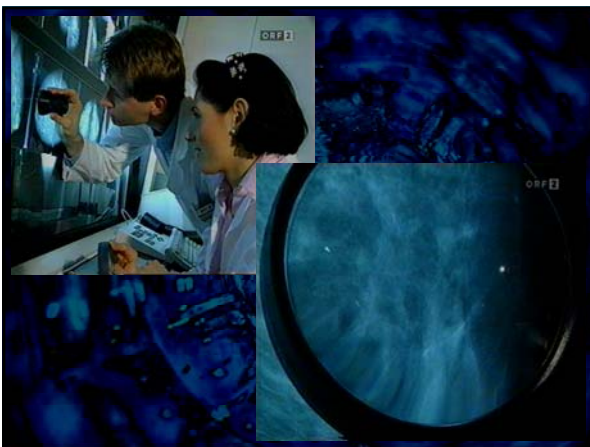


Mammography - TECHNIQUE:



Mammography - REPORTING:

- ☑ Clustered Microcalcifications are early signs of breast cancer (bright spots)
 - Size: 0.2-0.5 mm - search with a magnifying glass
 - Difficult perception in low contrast areas
 - Differentiate: cancerous vs non cancerous



Mammography - DILEMMA:

- ☑ Special training of radiologists necessary
- ☑ Positive predictive value of radiologists: 20%
- ☑ „Double Reading“ (independent reporting by 2 radiologists): improves accuracy by 5 - 15%

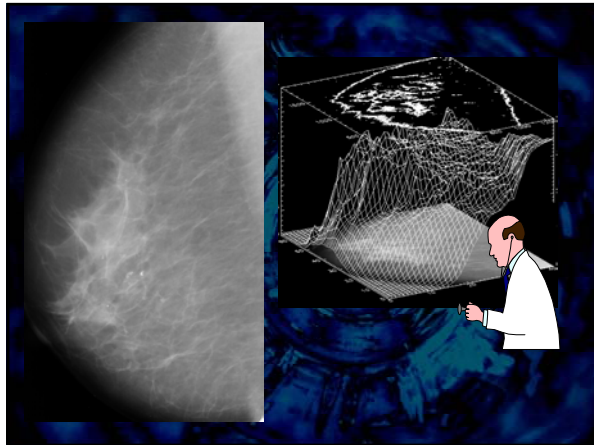
Artificial Intelligence in Mammography - HYPOTHESIS:

- ☑ Clustered microcalcifications be found reliably found by a computer application
- ☑ and a discrimination between cancerous and non cancerous microcalcifications be done using neuronal nets



Mammography - VISION

- ☑ CAD System (Computer Aided Diagnosis) can act as "never tired, second reader"

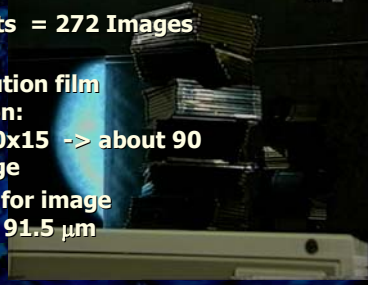


Variance of female FEATURES



ANN & Mammography - PATIENTS:

- ☑ Patient Database:
 - 100 patients = 272 Images with Mc's
 - High resolution film digitalization: 8000x6000x15 -> about 90 Mbyte/image
 - Resolution for image processing: 91.5 μ m



ANN & Mammography - GROUNDTRUTH:

- ☑ All patients operated and biopsy reports available:
 - 54 malignant, 46 benign
- ☑ All patients rated to be
 - benign, indeterminate, malignant
- ☑ Manual marking of
 - 828 indiv. microcalcifications
 - 735 artifacts



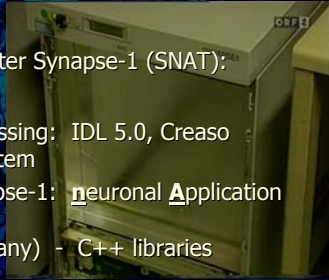
ANN & Mammography - HARD & SOFT:

Hardware:

- SunSparc20
- Neurocomputer Synapse-1 (SNAT):

Software:

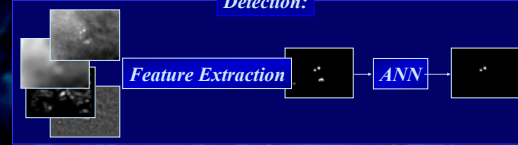
- Image Processing: IDL 5.0, Creaso Research System
- ANN - Synapse-1: neuronal Application Language (SNAT, Germany) - C++ libraries



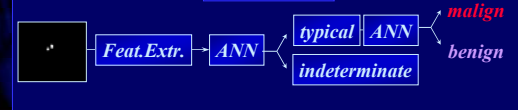
ANN & Mammo - WORKFLOW

Background correction

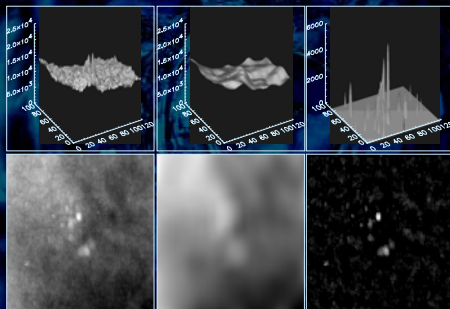
Detection:



Classification:



ANN & Mammography - BACKGROUNDKORREKTION



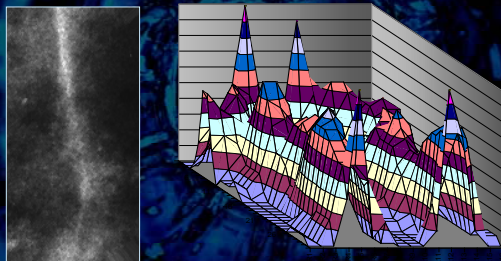
ANN & Mammography - FEATURES FOR DETECTION:

Line feature:

- Calculate Sobel Gradients
- map to 16 directions
- make histogramm 9x9
- if difference between 2 peaks $> 6/16$ and $< 10/16$
 - multiply both peaks = line feature for a point

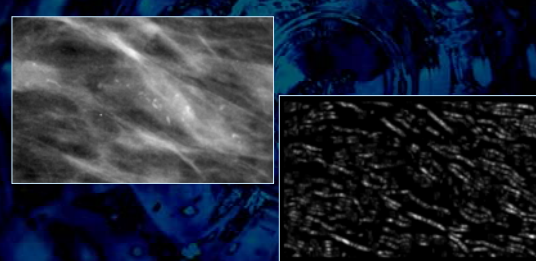
ANN & Mammography - FEATURES FOR DETECTION:

Linefeatures:



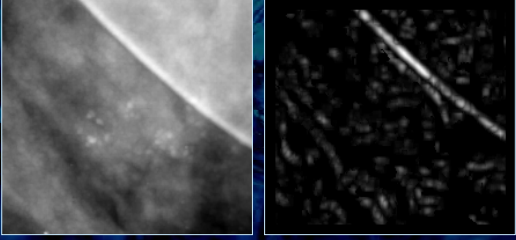
ANN & Mammography - FEATURES FOR DETECTION:

Linefeatures:



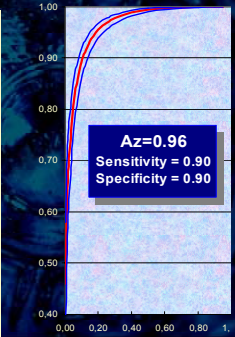
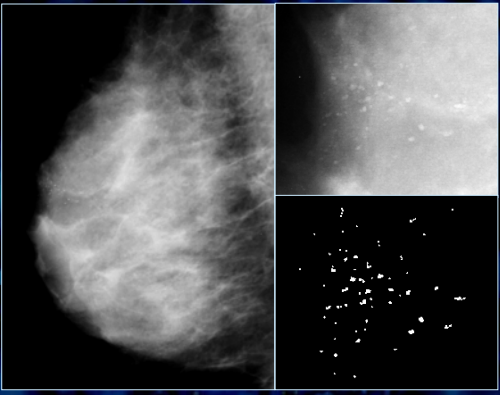
ANN & Mammography - FEATURES FOR DETECTION:

☑ **Linefeatures:**




ANN & Mammography - RESULTS DETECTION:

FEAT URE	Az
graylevel	min 0.769
	max 0.836
	mean 0.808
	var 0.875
edge gradients	min 0.817
	max 0.895
	mean 0.920
	var 0.755
line feature	min 0.651
	max 0.698
	mean 0.636
	var 0.557
local contrast (object)	0.930


ANN & Mammography - FEATURES FOR CLASSIFICATION

- ☑ Mean vector of population: $\mathbf{m}_x = E\{\mathbf{x}\}$
- ☑ Covariance matrix: $\mathbf{C}_x = E\{(\mathbf{x} - \mathbf{m}_x)(\mathbf{x} - \mathbf{m}_x)^T\}$
- ☑ Calculate eigenvectors of \mathbf{C}_x , and transformationmatrix \mathbf{A}
- ☑ Transform image: $\mathbf{y} = \mathbf{A}(\mathbf{x} - \mathbf{m}_x)$ - Hotelling Transformation



ANN & Mammography - FEATURES FOR CLASSIFICATIONS

- ☑ **Extension in 8 directions**
- ☑ „Minimum Enclosing Rectangle“:
 - Center of gravity, excentricity, aspect-ratio
 -

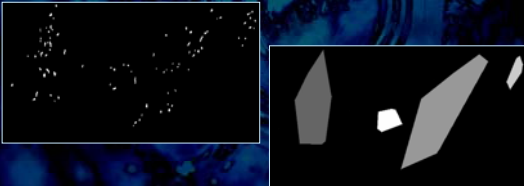


ANN & Mammography - FEATURES FOR CLASSIFICATIONS

- ☑ **Features of individual microcalcifications:**
 - Meanvalue of greylevels of pixels within one mc
 - Local contrast of one mc
 - Border gradients
 - Area, perimeter and compactness (P^2/A)

ANN & Mammography - FEATURES FOR CLASSIFICATIONS

- ☑ Clustering - recursive algorithm
- ☑ Area of the cluster - Convex Hull Procedure



ANN & Mammography - FEATURES FOR CLASSIFICATIONS

- ☑ Features from „Convex Hull“:
 - Number of mc's
 - Area, perimeter and compactness of cluster
 - Density (number of mc's/A)
 - Inter mc - distances
 - descriptive statistics of individual mc features

ANN & Mammography - FEATURES FOR CLASSIFICATIONS

- ☑ Total features: n=73
- ☑ Automatic selection process: patient based
- „Leave-one-out“
- every feature

10 suited for differentiation typical - indeterminate

12 suited for differentiation benign - malignant

