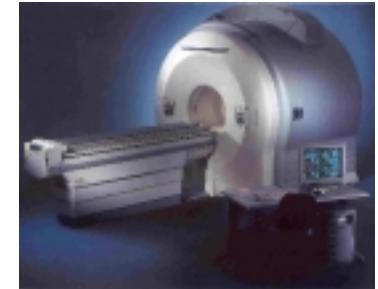


# WG1 - Report on Software

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Andrzej MATERKA,  
Technical University of Lodz, Poland

# COST B11: “Software and Statistics” Working Group



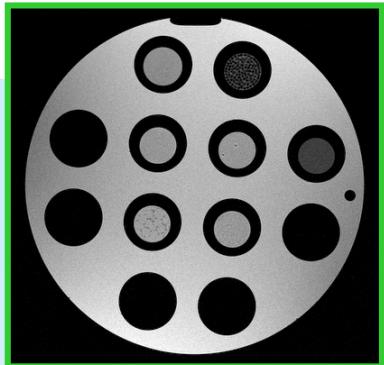
## Context (activity in general)

- Development of software tools for all Working Groups of COST B11 action.
- Stimulation of discussion of the functionality of the software.
- Searching for image processing and pattern recognition techniques adequate for MRI texture analysis

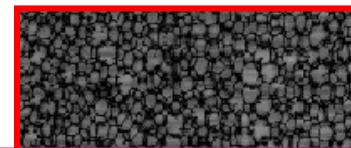
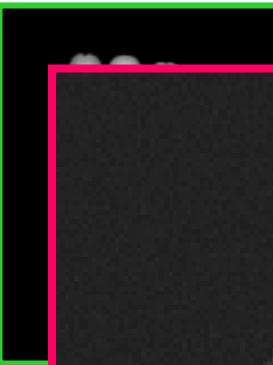
## Goals

- To develop PC MS Windows computer programs with appropriate GUI and agreed set of functions.
- To develop efficient techniques of quantitative texture analysis in magnetic resonance images.

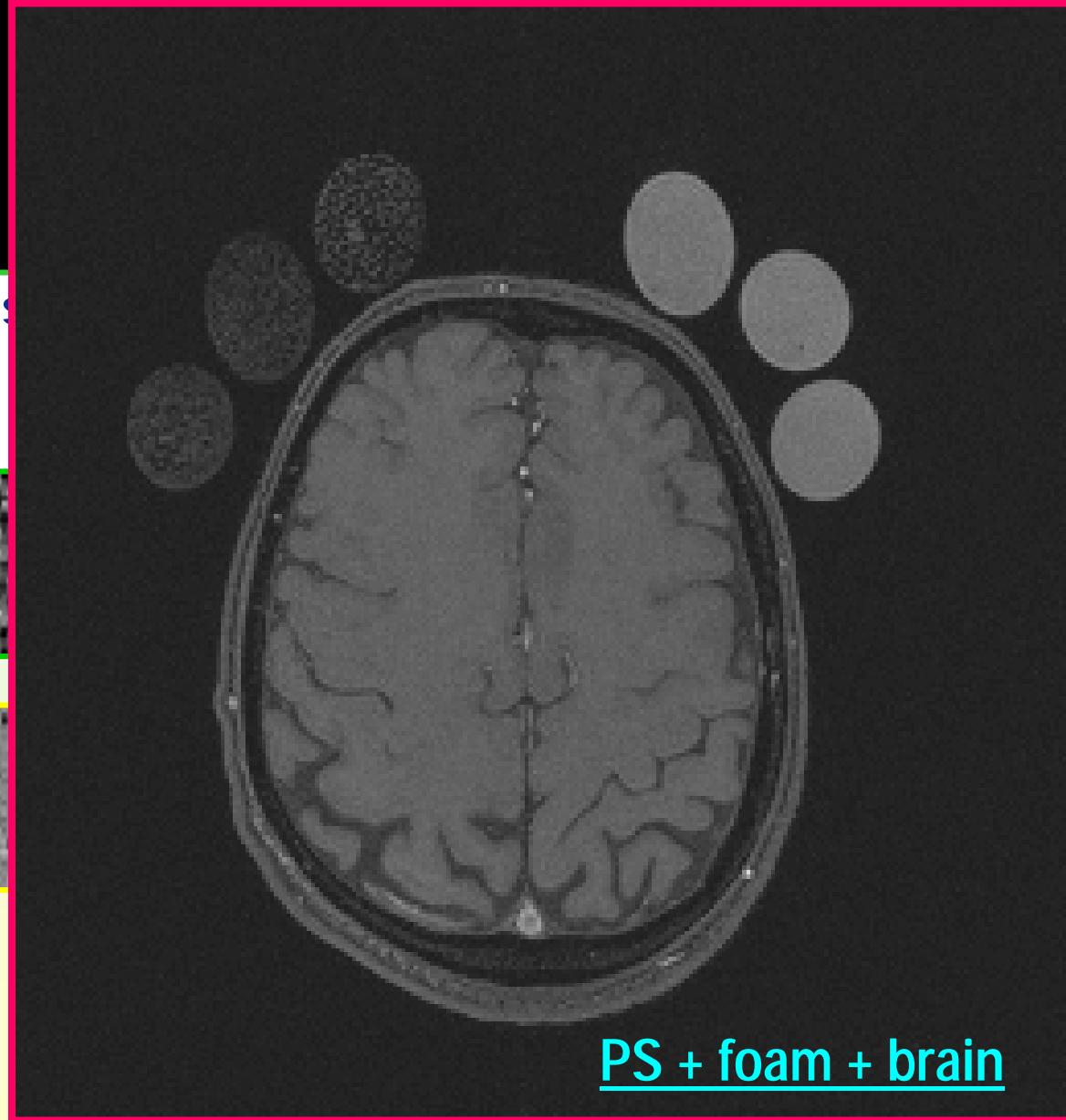
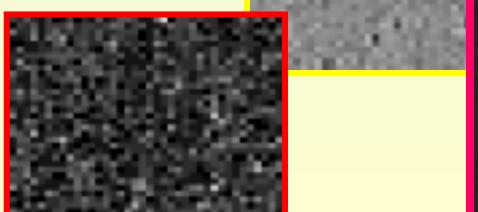
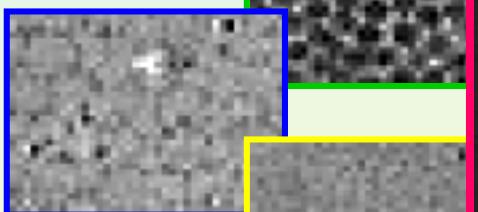
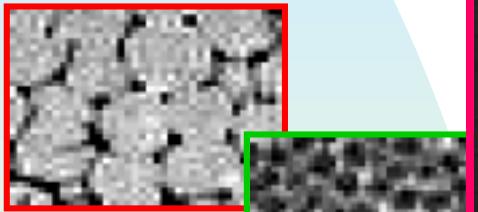
# Material



Foam phantoms

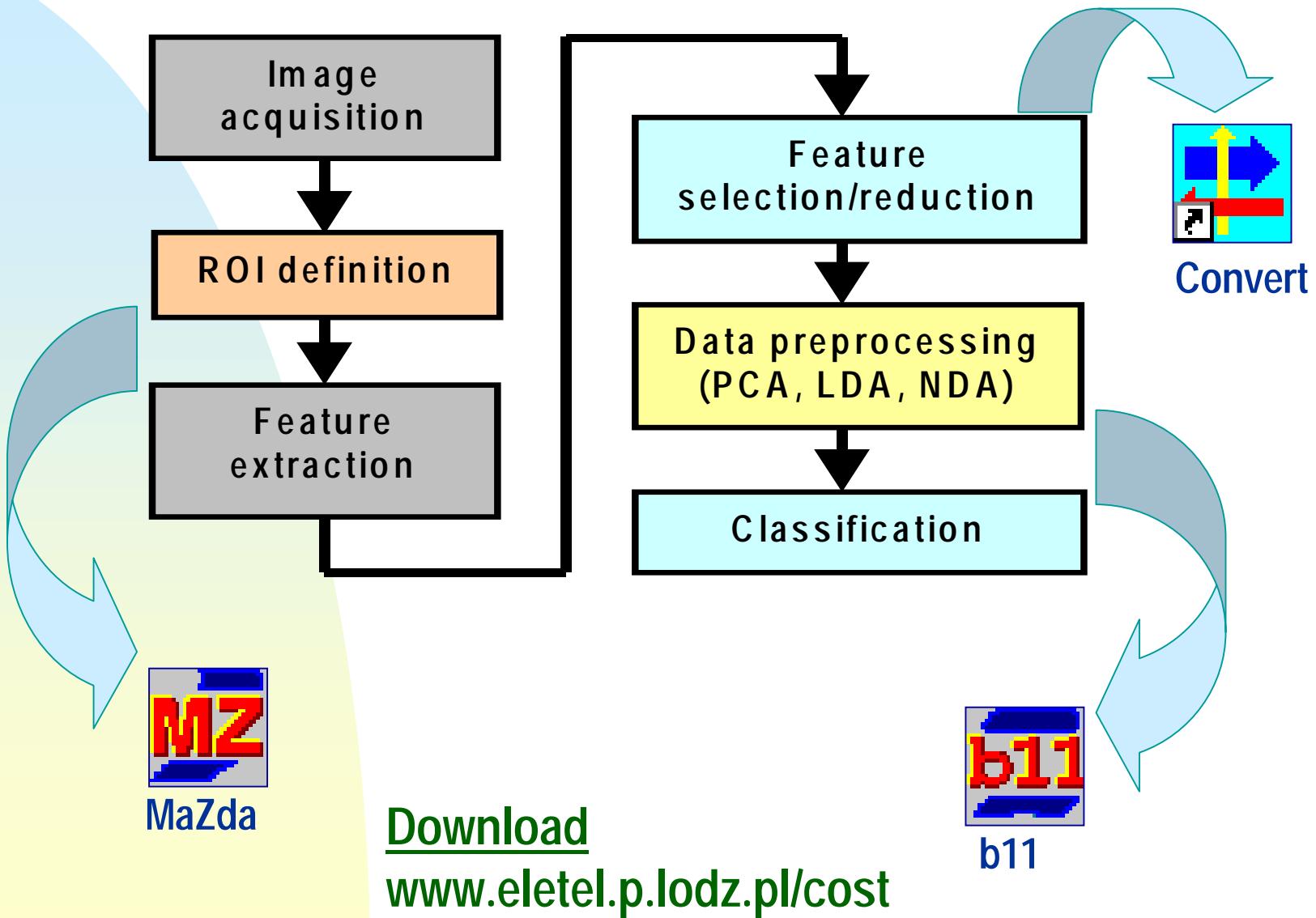


Image



PS + foam + brain

## Methods





# Mazda, ver. 2.21

Input: images in 11 file formats

## Methods

histogram, gradient, CO matrix,  
AR model (total of 259 features)

**MZ Mazda - Image: 399-6-107.ima ROI: r6\_106.bmp**

File ROI Analysis Help

Area =	1(red)	2(green)	3(blue)
Min_norm =	.51	251	197
Max_norm =	209	337	262
Area =	422	392	367

Image File: 399-6-107.ima  
 ROI File: r6\_106.bmp  
 Image size: 256 x 256  
 Min. lum.: 1  
 Max. lum.: 667  
 Bits/pixel: 10

Histogram analysis = No  
 Normalisation = 3 sigma  
 Gradient analysis = Yes, Max pixel value = 64  
 RIL matrix analysis = Yes, Dimension = 64  
 CO matrix analysis = Yes, Dimensions = 64 x 64, Distances =  
 AR model analysis = Yes  
 Histogram data = No

Width: 256  
 Height: 256  
 Min. lum.: 1  
 Max. lum.: 667  
 Bits/pixel: 10

## Output:

- (\*.par) text file,
- (\*.bmp) histograms
- (\*.bmp) feature maps



# MZ Mazda - Image: 399-6-107 ima ROI: r6\_106.bmp

File ROI Analysis



Mazda



Mazda



Mazda



Mazda



Mazda



Mazda



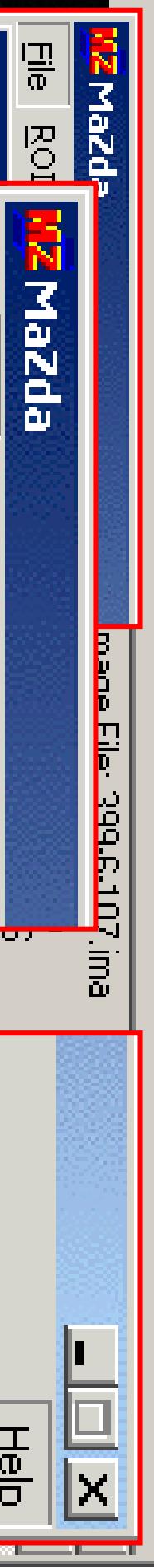
Mazda



Mazda



Mazda



Area	1(red)	2(green)	3(blk)
Area =	492	458	431
Min_norm =	.51	251	197
Max_norm =	209	337	262
Area =	422	392	367

## Mazda - options

## Mazda - options

## Mazda - options

Features Maps

BLM

 Horz

✓ RLNonUni

 GleyNord

LogBErank

 EngenHEMpi  
SLA/PE

ShirtREm  
T

 Vert

45dgr

135dr

COM

A small icon representing a gradient, consisting of a yellow square with a diagonal black line and a grey square with a diagonal black line.

...  Mean

## ... ✓ Variance

## ... Skewness

## ... X Kurtosis

Page 1

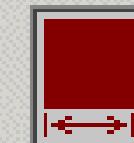
Select

 Clear

### Features selected

2

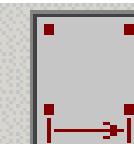
└ Mask



9

9

## Step

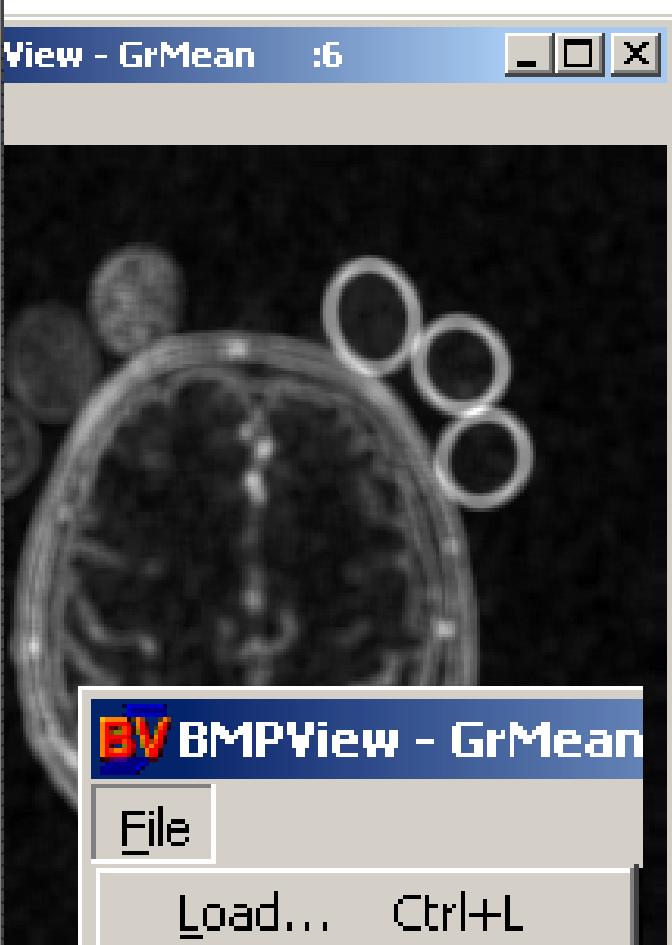
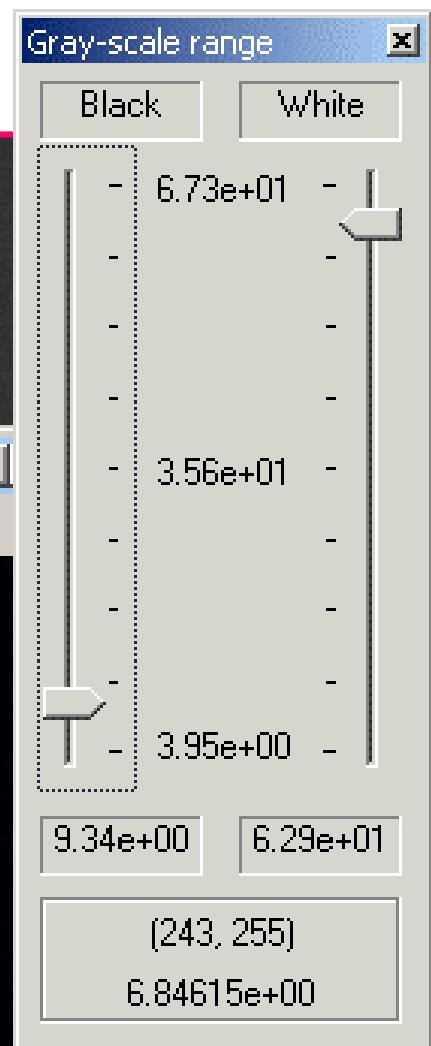


7

0

Cancer

# MaZda - feature maps



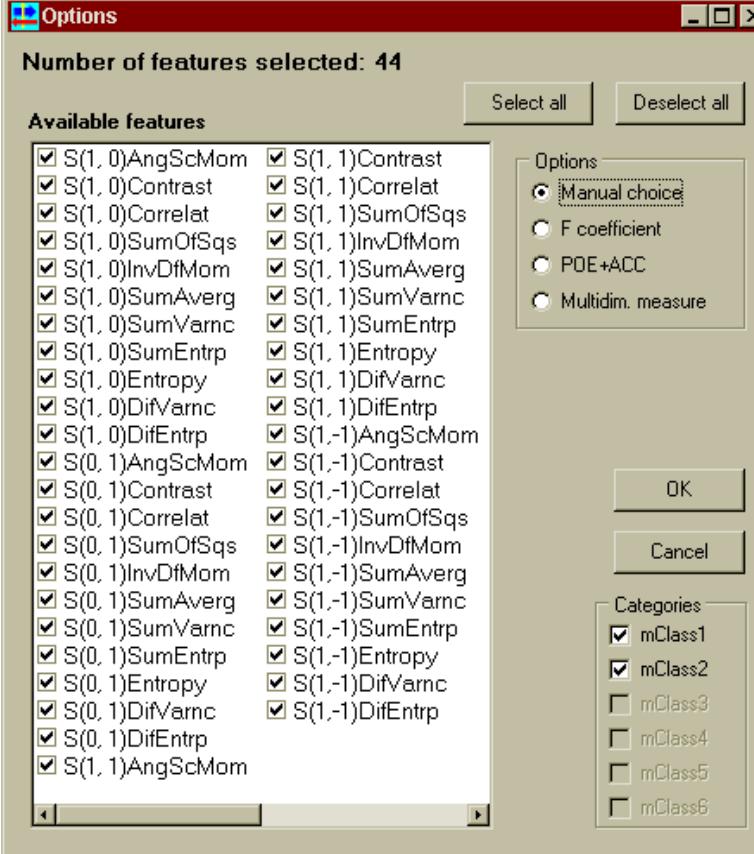
# Convert



Input: (\*.par) files from MaZda

Methods: Fisher coefficient, POE+ACC,  
multidimesional analysis of variance, manual choice

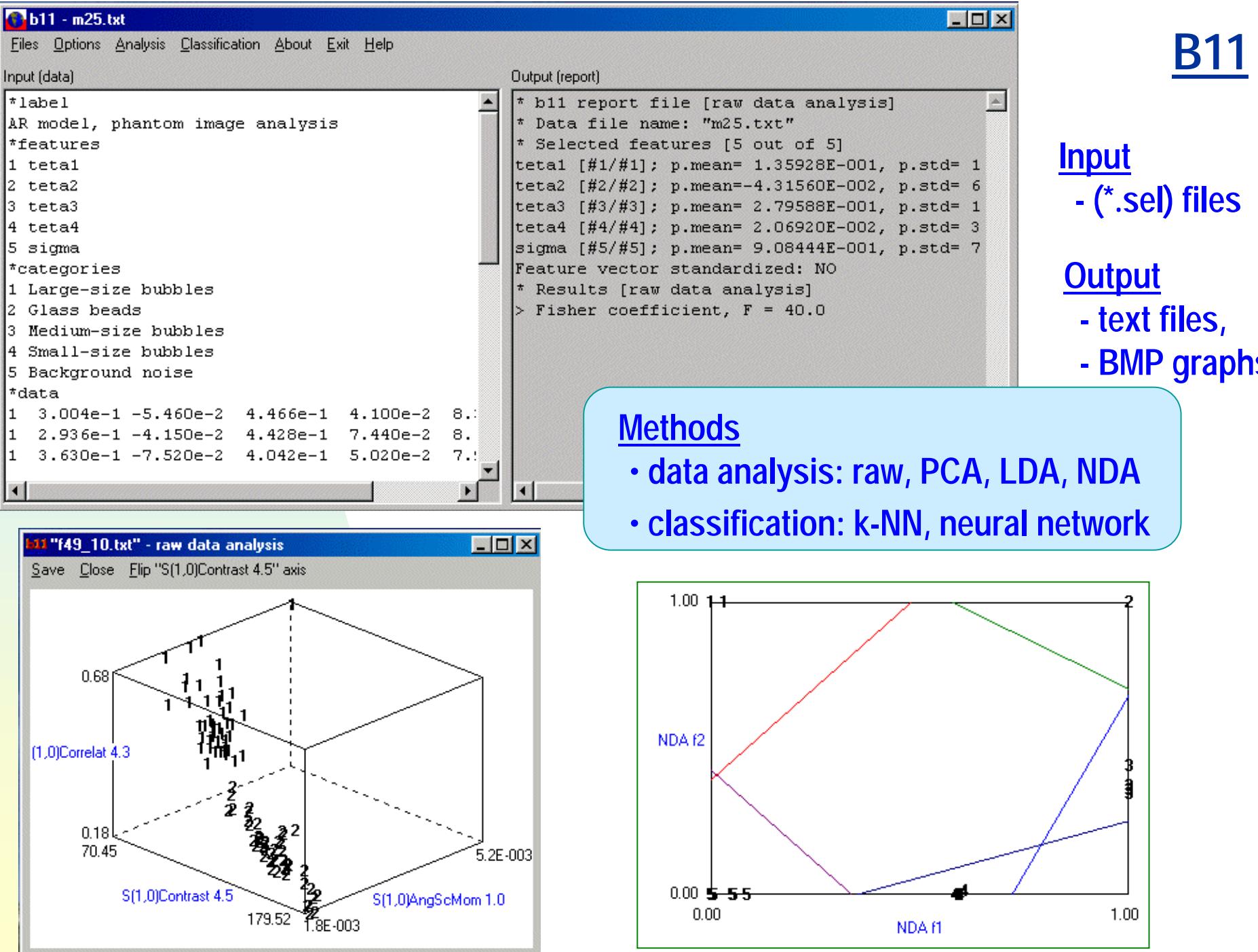
Output: (\*.sel) files



Fisher coefficient	F
S(1, 1)Correlat	44.00
S(0, 1)Correlat	43.52
S(1, 0)Correlat	37.59
S(1, 1)SumVarnc	36.19
S(0, 1)Contrast	35.72
S(1, 0)Contrast	33.66
S(1, 1)Contrast	33.01
S(1, 0)DifEntrp	31.47
Sigma	29.65
S(1,-1)Correlat	27.96

POE+ACC	POE+ACC
GrMean	0.00
S(0, 1)SumVarnc	0.02
S(4, 4)DifVarnc	0.06
Teta4	0.10
S(0, 5)Correlat	0.10
S(4,-4)SumAverg	0.10
S(5, 0)DifVarnc	0.11
S(1, 0)DifEntrp	0.10
S(1, 0)SumVarnc	0.12
S(1,-1)InvDfMom	0.12

Multidimensional Measure	U
S(0, 1)SumEntrp	8.11E16
S(0, 4)AngScMom	1.28E16
45dgr_ShrtREmp	1.21E16
S(4,-4)Correlat	8.73E15
S(4, 0)Entropy	6.63E15
S(0, 4)DifEntrp	6.42E15
S(5,-5)InvDfMom	4.63E15
S(0, 4)InvDfMom	3.43E15
S(4, 0)AngScMom	3.38E15
S(1,-1)SumEntrp	3.24E15

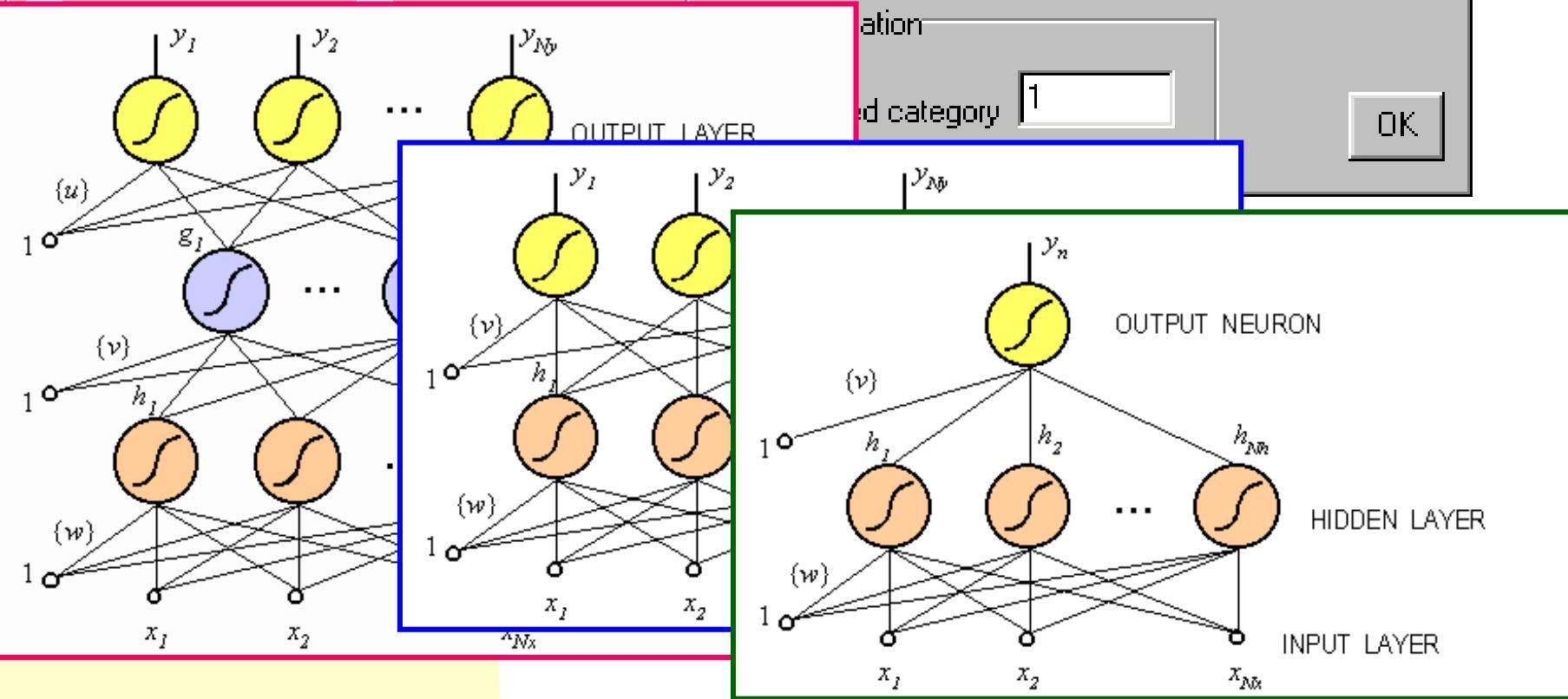


## Feature selection box

- GrMean
- S(1, 0)SumVarnc
- S(1, 0)DiffEntrp
- S(0, 1)SumVarnc
- S(1,-1)InvDfMom
- S(4, 4)DiffVarnc
- S(4,-4)SumAverg
- S(5, 0)DiffVarnc
- S(0, 5)Correlat

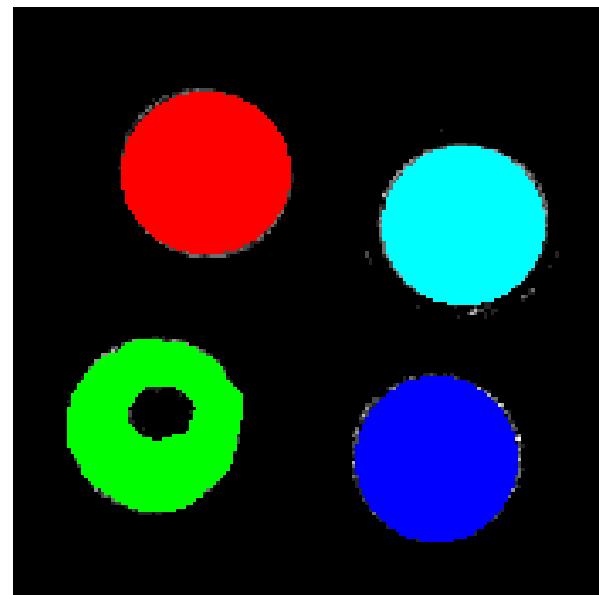
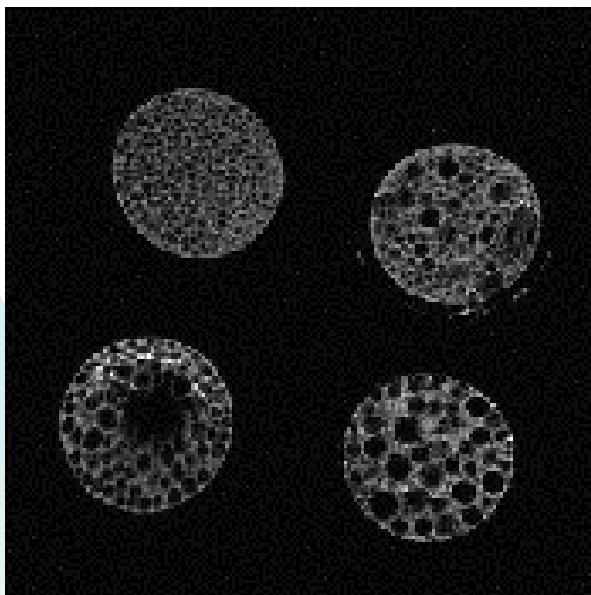
## Neural network parameters

- 1st hidden layer <1..10> 2
- 2nd hidden layer <2..4> 2
- backprop eta <0.01-0.99> 0.15
- backprop iter.limit <50000..1000000> 300000
- optimization iter. limit <1..1000> 50



# Example - PS phantom image analysis

22 images



- class 1
- class 2
- class 2
- class 2



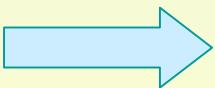
MaZda



22 (\*.par) files, each contains 259 texture parameters



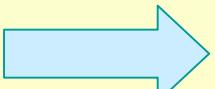
Convert



2 (\*.sel) files, each of 10 parameters (F, POE)



b11



Exploratory data analysis and classification

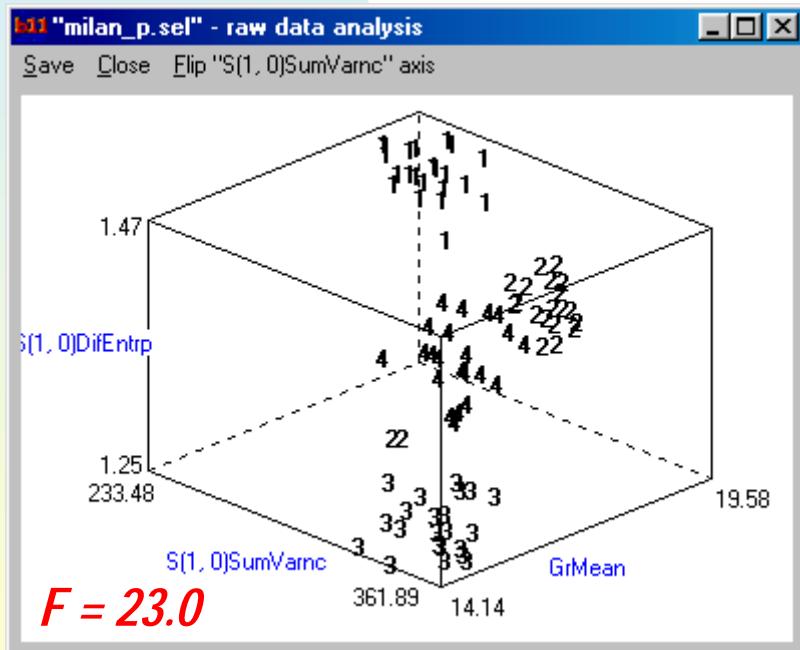
# Example - PS phantom image analysis



b11

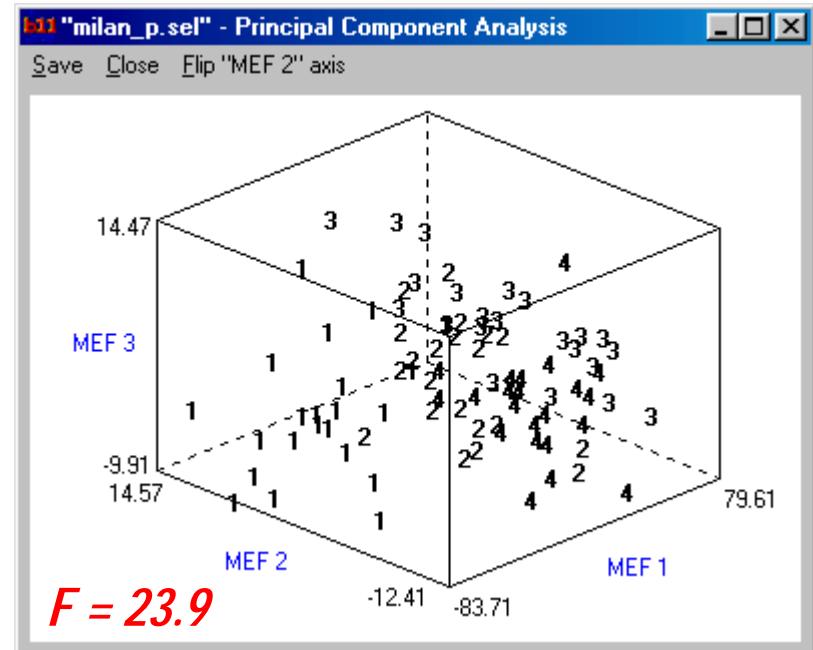
Exploratory data analysis and classification

Raw data



1-NN: 8 classification errors

First 3 PCAs



1-NN: 10 classification errors

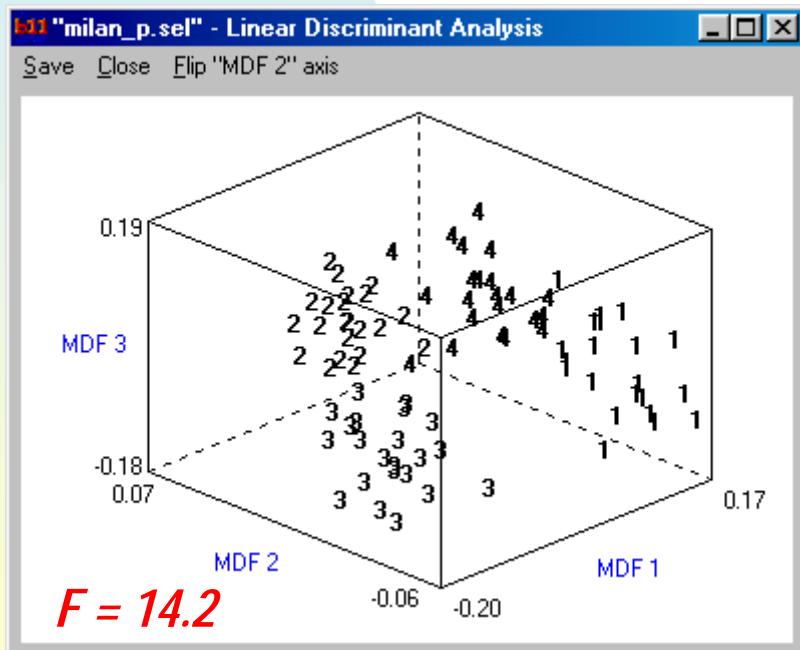
# Example - PS phantom image analysis



b11

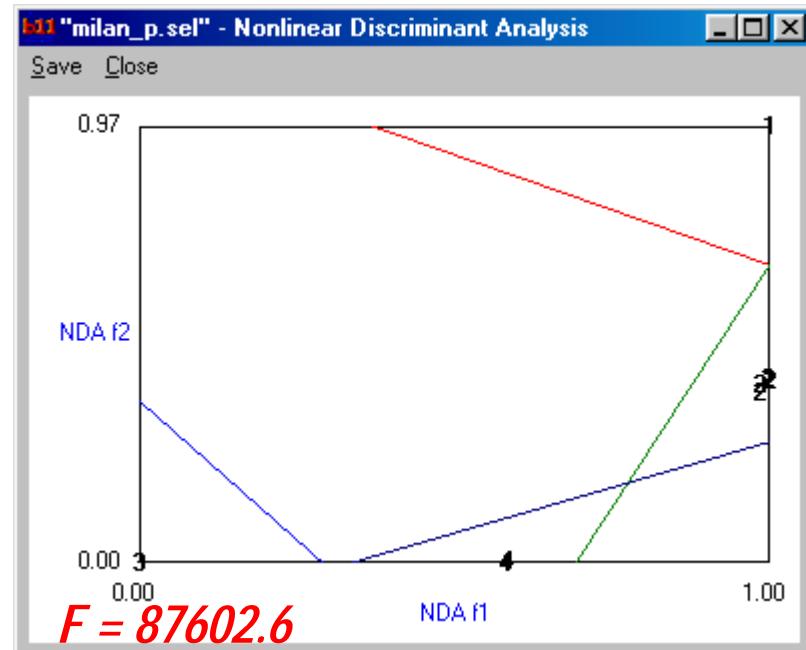
Exploratory data analysis and classification

## Linear Discriminant Analysis



1-NN: 0 classification errors

## Nonlinear Discriminant Analysis



0 classification errors

## Projects under way

- MaZda: ROI editor (to replace MS Paint)
- MaZda: new texture features (wavelets and mathematical morphology).
- Convert: feature reduction and selection techniques.
- B11: ANN classifier testing (expansion of B11)
- Methods for texture segmentation.
- Extensive experiments using test object and biological MRI.