Functionality of MaZda

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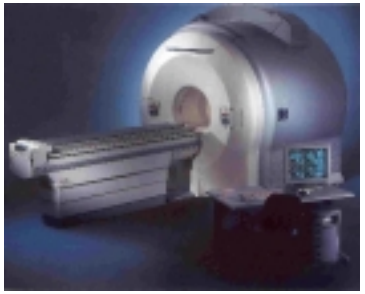
Poland

COST B11 Working Group 1
“Software and Statistics”



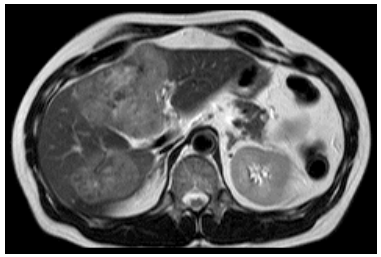
Tasks

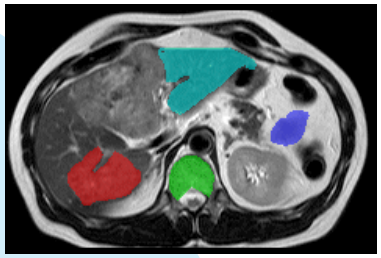
- To develop efficient techniques of image processing and pattern recognition, adequate for MRI quantitative texture analysis.
- To develop MS® Windows® computer program with appropriate GUI and agreed set of functions.

Steps in texture analysis

MaZda

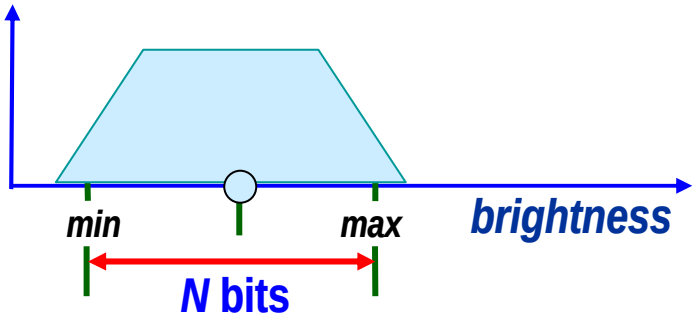
Image acquisition



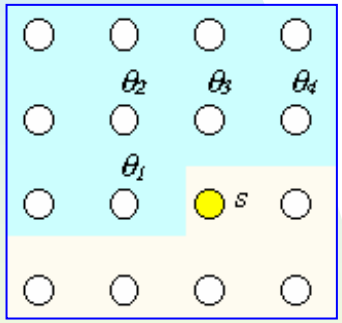


ROI selection

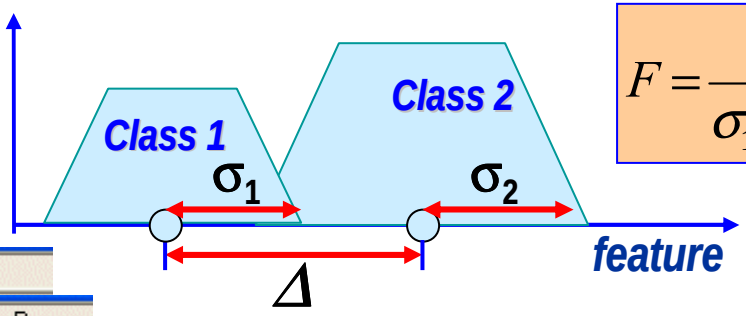
Image normalization



Feature extraction

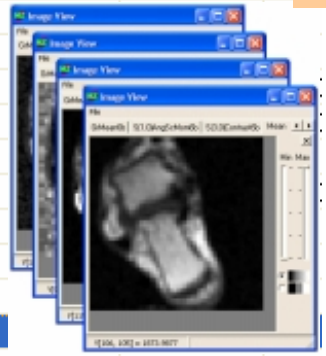


Feature selection & reduction



$$F = \frac{2\Delta^2}{\sigma_1^2 + \sigma_2^2}$$

Feature name	ps1	ps2
GrKurtosis	0.032185	-0.20762
GrNonZeros	0.98765	0.99383
AreaARM		
Teta1		
Teta2		
Teta3		
Teta4		
Sigma		
WavEnLL_s-1		
WavEnLH_s-1		
WavEnHL_s-1		
WavEnHH_s-1		



Feature name	F
S(4,0	
S(2,0	
S(3,0	
S(5,-5	
S(4,-4	
S(1,-1	
S(5,0	
S(3,-3	
S(0,2	
S(4,4	

Feature name	P
Teta3	0.3612
Horzl_RLNonUni	0.3647
S(1,0)Correlat	0.3770
45dgr_GLevNonU	0.3944
Teta1	0.4249
Teta2	0.4389
S(0,3)Correlat	0.4400
Vertl_RLNonUni	
S(1,0)DifVarnc	
S(0,3)DifEntrp	

Steps in texture analysis

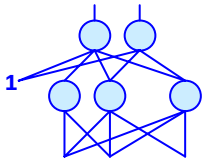
B11

Feature name	ps1	ps2
GrKurtosis	0.032185	-0.20762
GrNonZeros	0.98765	0.99383
AreaARM	1463	1463
Teta1	0.37174	0.30333
Teta2	-0.084613	-0.16263
Teta3	0.24769	0.47548
Teta4	0.067687	-0.099282
Sigma	0.86924	0.85902
WavEnLL_s-1	17106	16196
WavEnLH_s-1	417.31	313.04
WavEnHL_s-1	324.51	442.75
WavEnHH_s-1	222.49	171.27

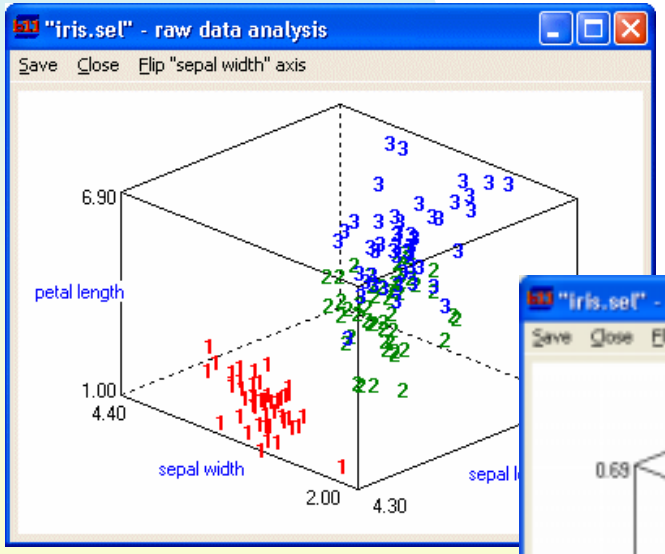
Data transformation (PCA, LDA, NDA)

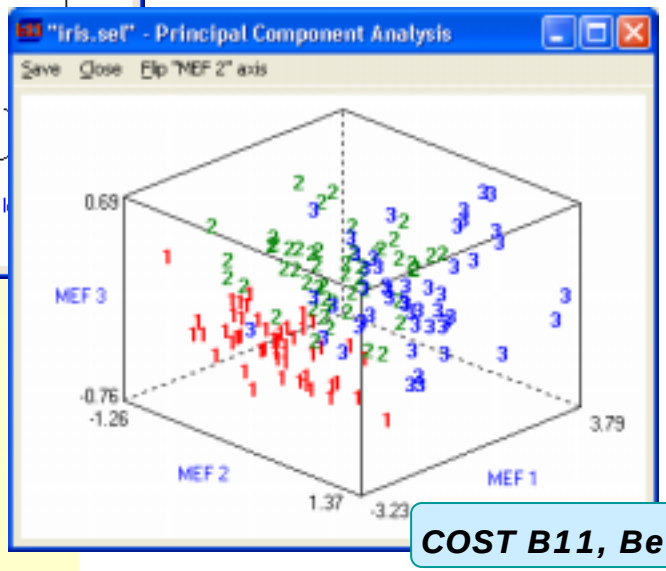
$$\mathbf{p}_i = \Phi^T(\mathbf{x}_i - \boldsymbol{\mu})$$

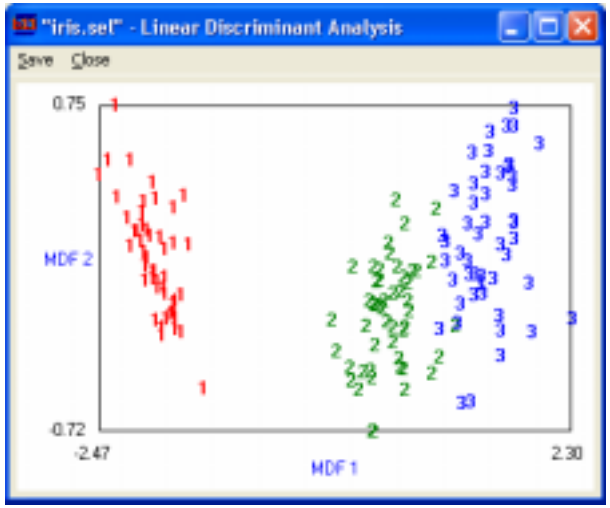
$$\mathbf{q}_i = \Psi^T(\mathbf{x}_i - \boldsymbol{\mu})$$



Texture classification (k-NN, ANN)

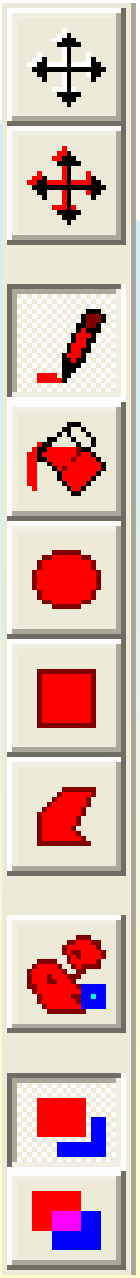






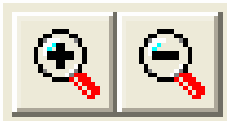
MaZda, ver. 3.08

graphics toolbar



Editing ROI

Zoom-in, zoom-out



grey-scale palette sliders

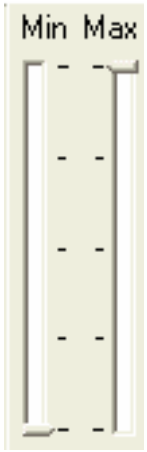
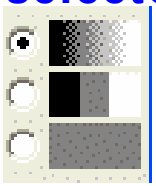


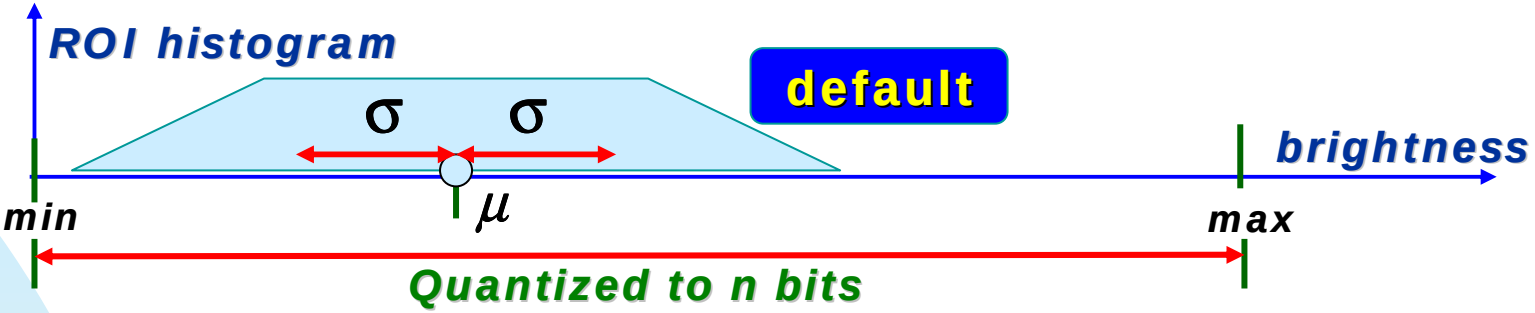
image layer selector

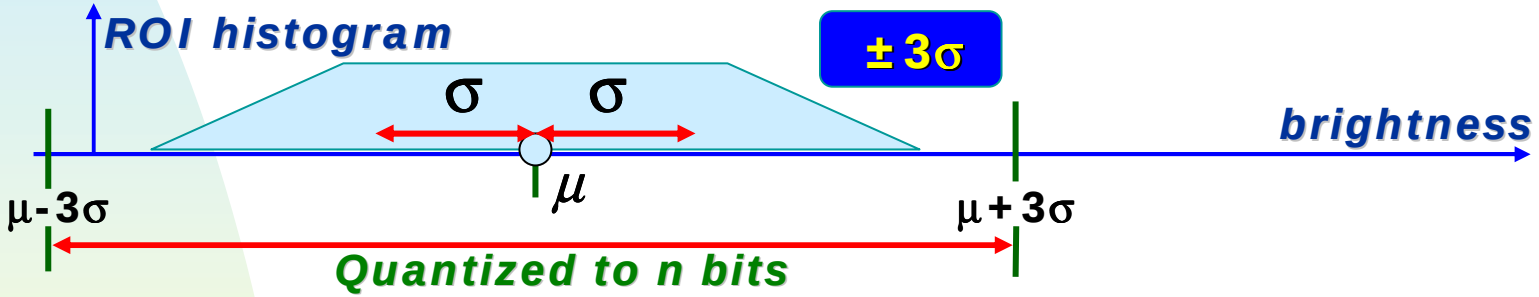


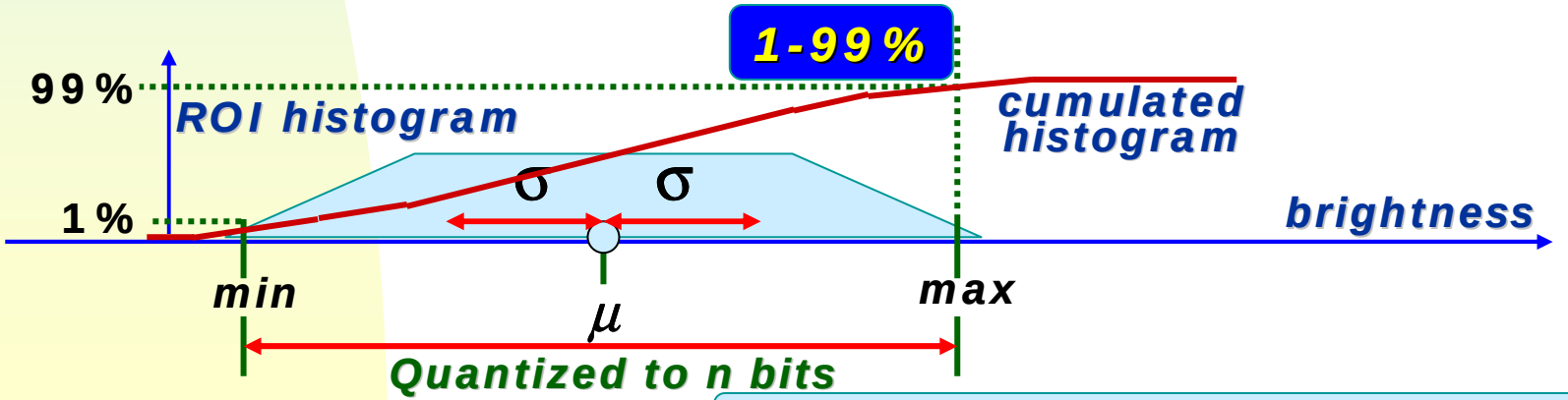
ROI color selector

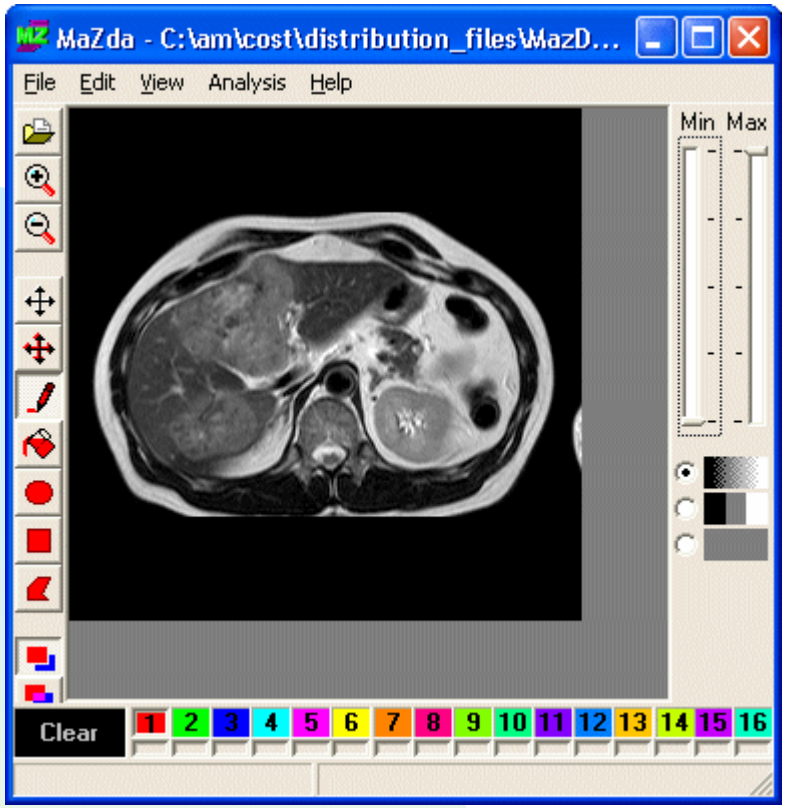
Image normalization

MaZda, ver. 3.08









MaZda, ver. 3.08

Feature extraction

Input

images in 12 file formats

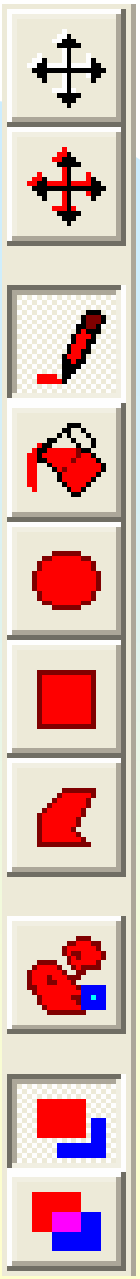
Methods

- histogram
- gradient
- RL matrix
- CO matrix
- AR model
- wavelets

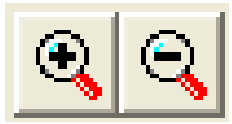
Output

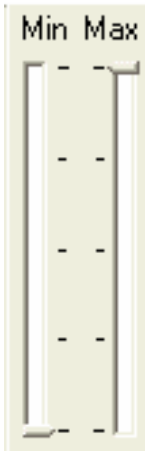
- (*.par, *.sel) text files
- (*.bmp) histograms
- (*.bmp) feature maps

MaZda, ver. 3.08

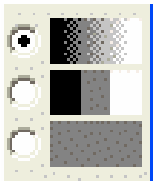


What is new in MaZda 3.08

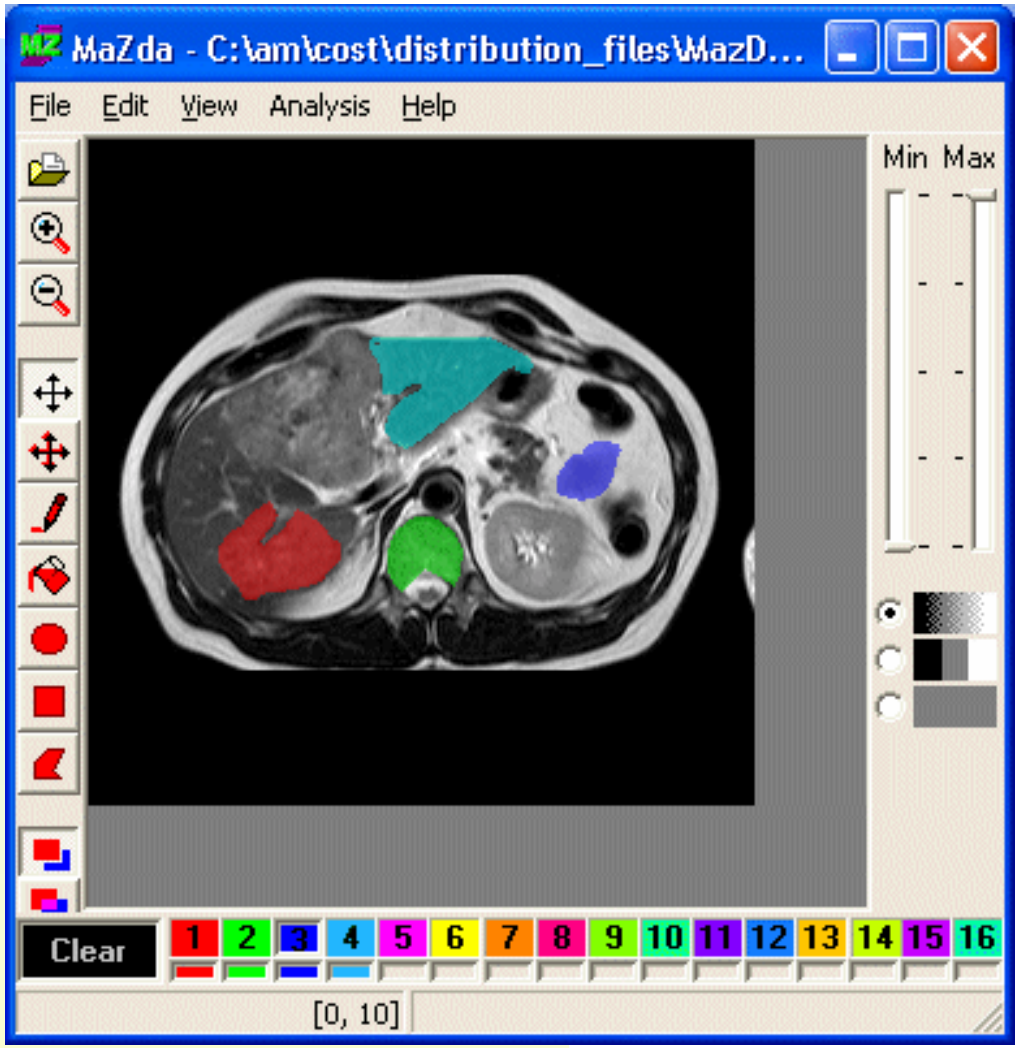




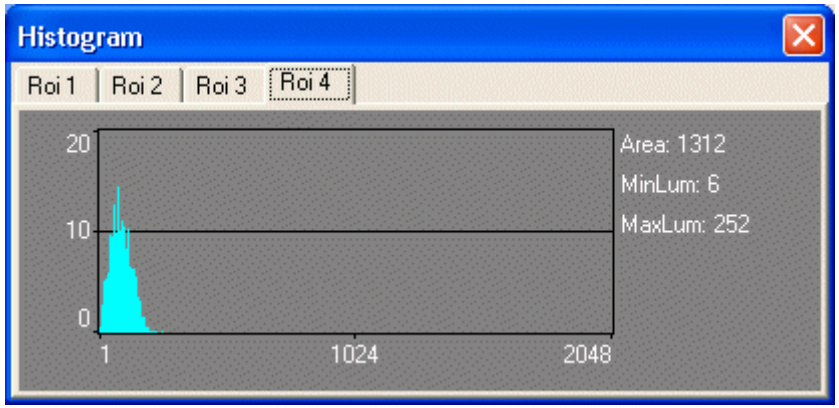
- integration of MaZda, Convert and B11
- wavelet-derived features
- increased number of ROIs (now 16)
- graphical tools for ROI edition
- new multi-report window + tools for parameter selection
- windows for image viewing (with image enhancement sliders)
- image header window
- feature maps in separate windows
- script-driven automated texture analysis
- ANN classifier testing



MaZda 3.08 windows

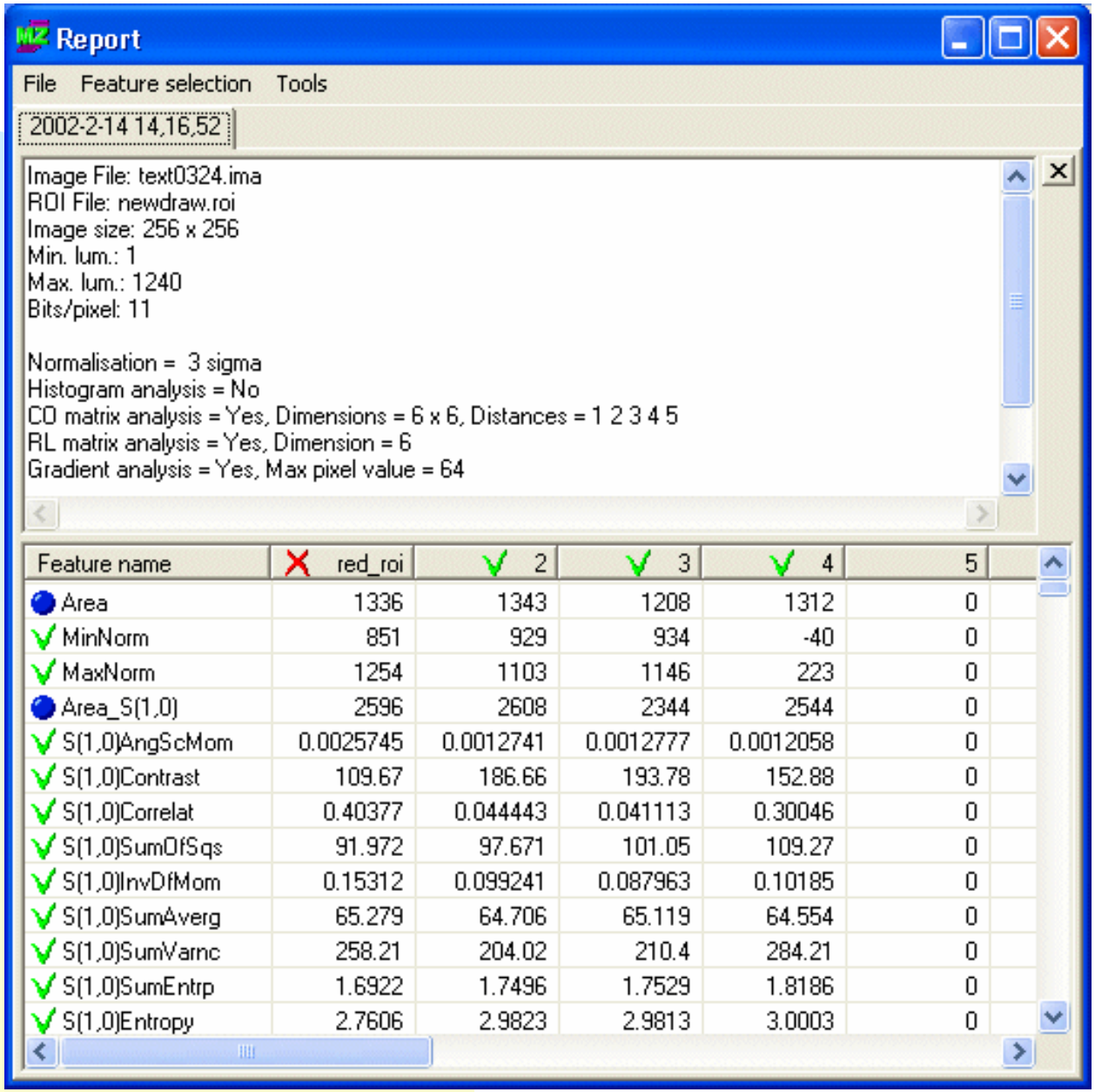


Main window



Histogram window

MaZda 3.08 windows



Feature name	red_roi	2	3	4	5
Area	1336	1343	1208	1312	0
MinNorm	851	929	934	-40	0
MaxNorm	1254	1103	1146	223	0
Area_S(1,0)	2596	2608	2344	2544	0
S(1,0)AngScMom	0.0025745	0.0012741	0.0012777	0.0012058	0
S(1,0)Contrast	109.67	186.66	193.78	152.88	0
S(1,0)Correlat	0.40377	0.044443	0.041113	0.30046	0
S(1,0)SumOfSqs	91.972	97.671	101.05	109.27	0
S(1,0)InvDfMom	0.15312	0.099241	0.087963	0.10185	0
S(1,0)SumAverg	65.279	64.706	65.119	64.554	0
S(1,0)SumVarnc	258.21	204.02	210.4	284.21	0
S(1,0)SumEntrp	1.6922	1.7496	1.7529	1.8186	0
S(1,0)Entropy	2.7606	2.9823	2.9813	3.0003	0

Report window

MaZda 3.08 windows

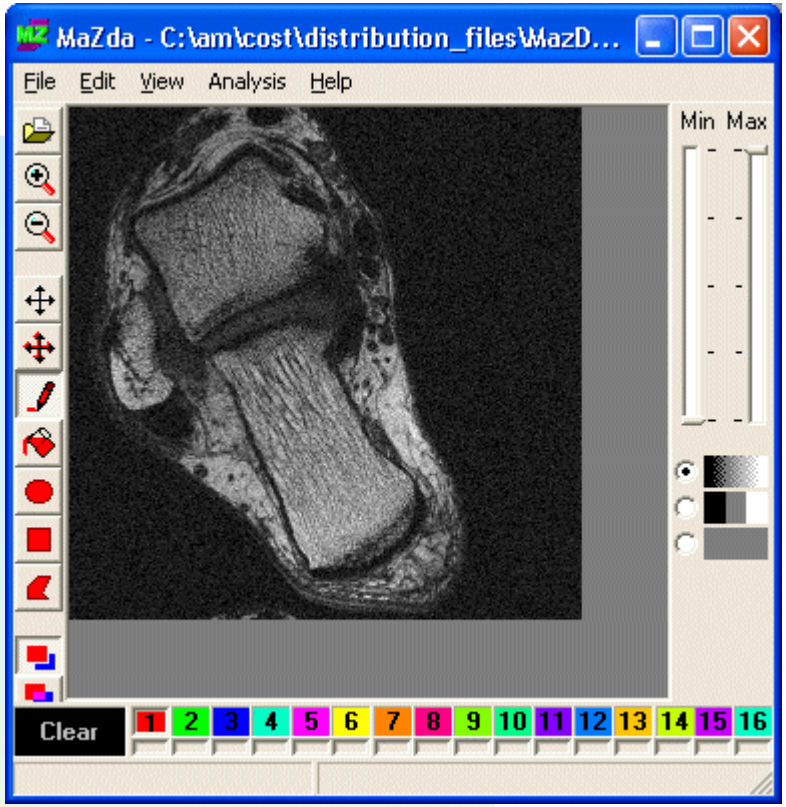
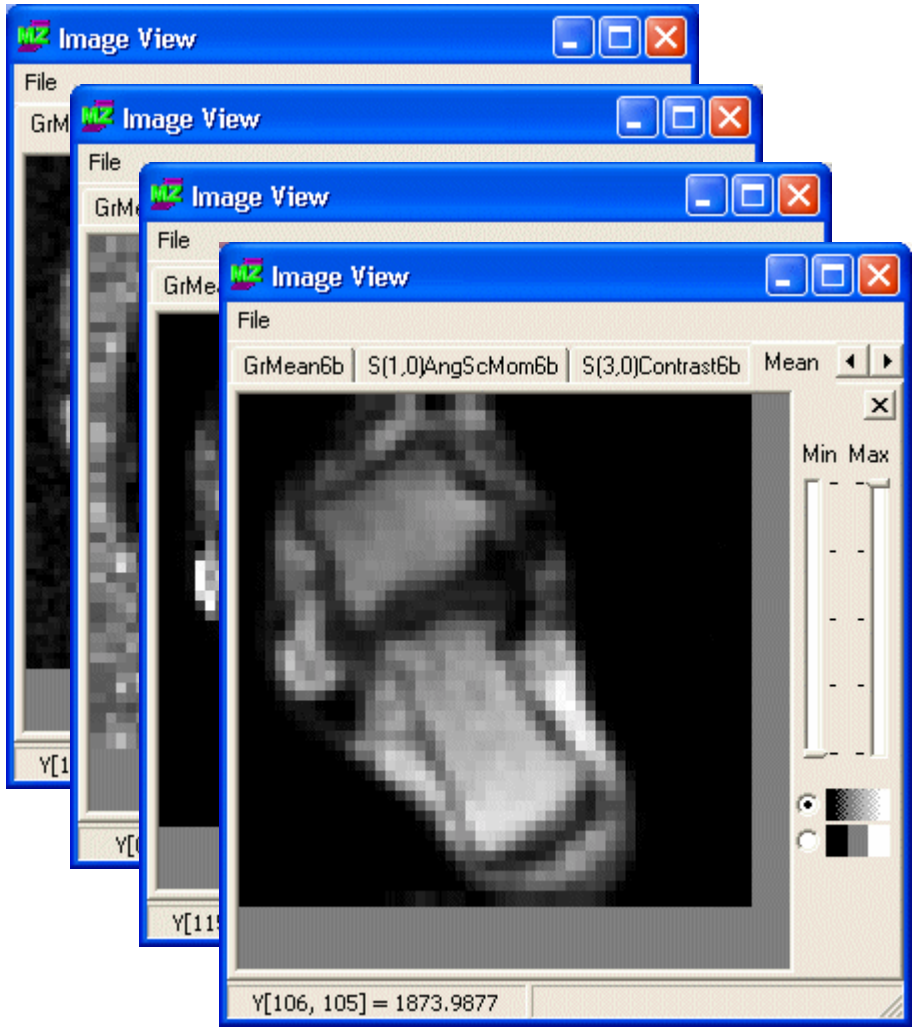


Image View window



MaZda 3.08 windows

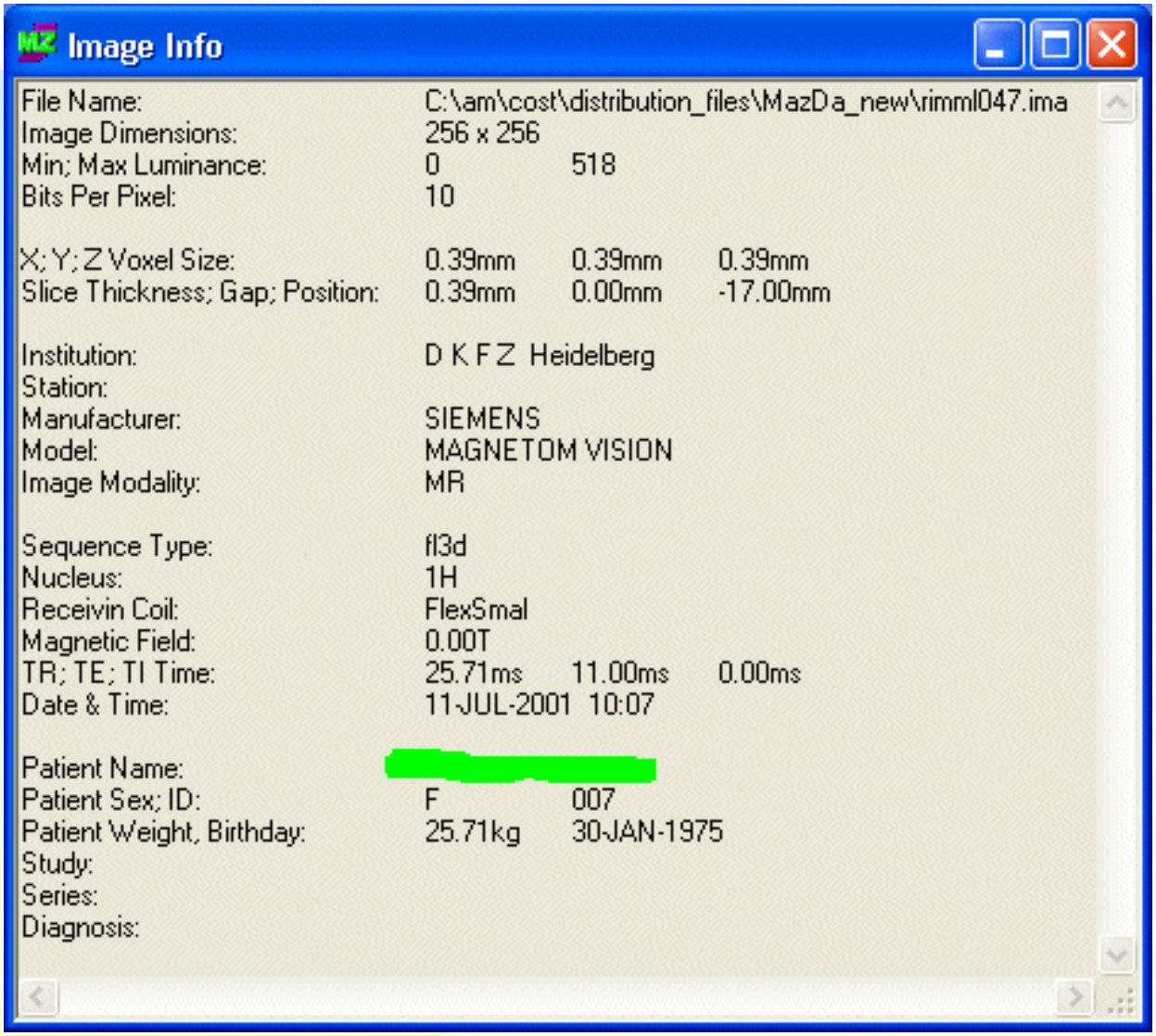
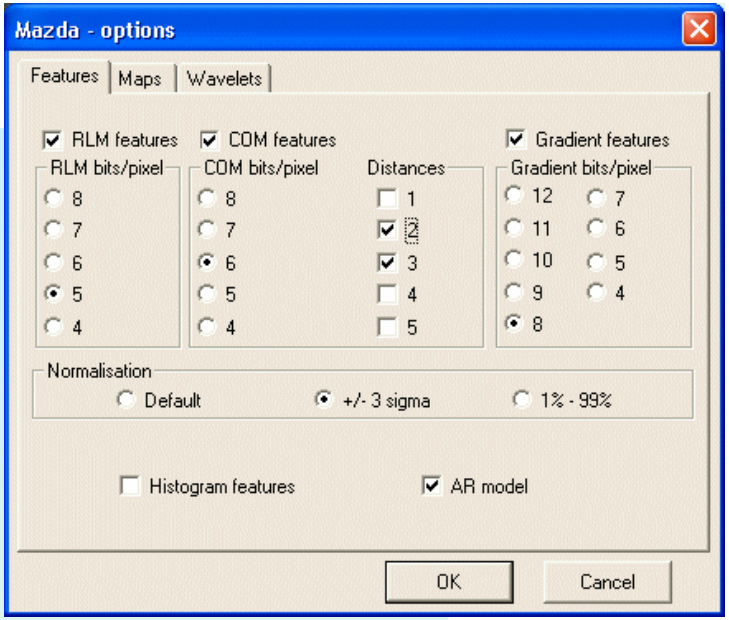
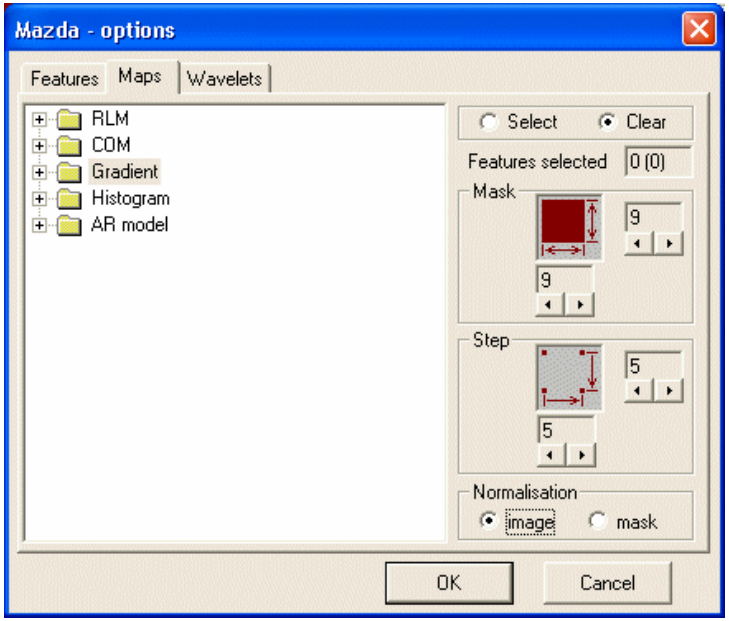
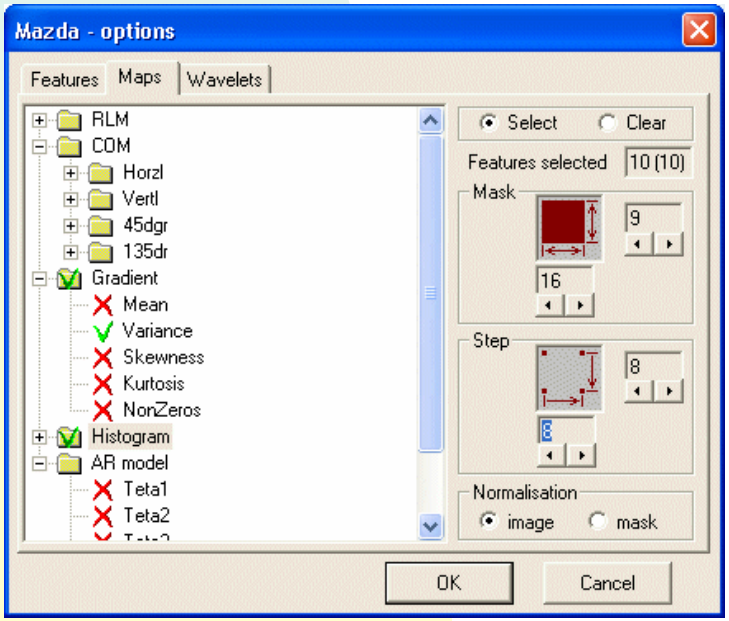


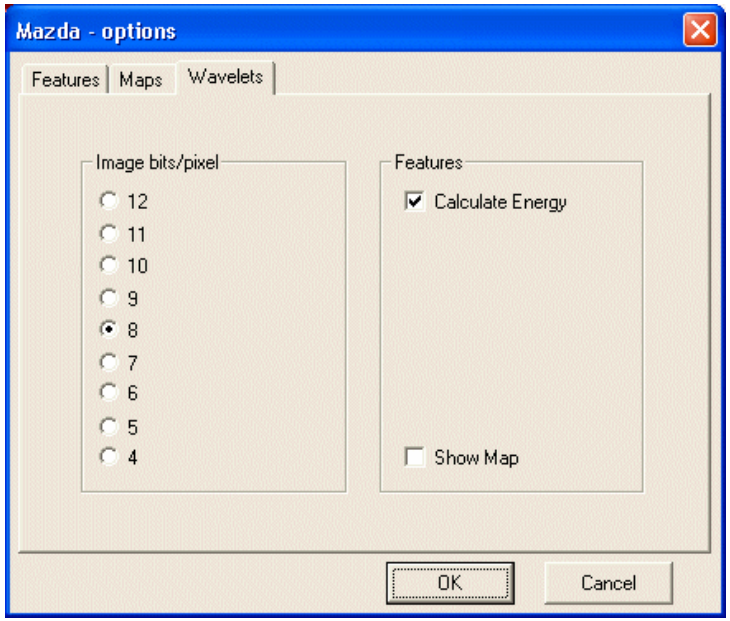
Image header window

MaZda 3.08 windows



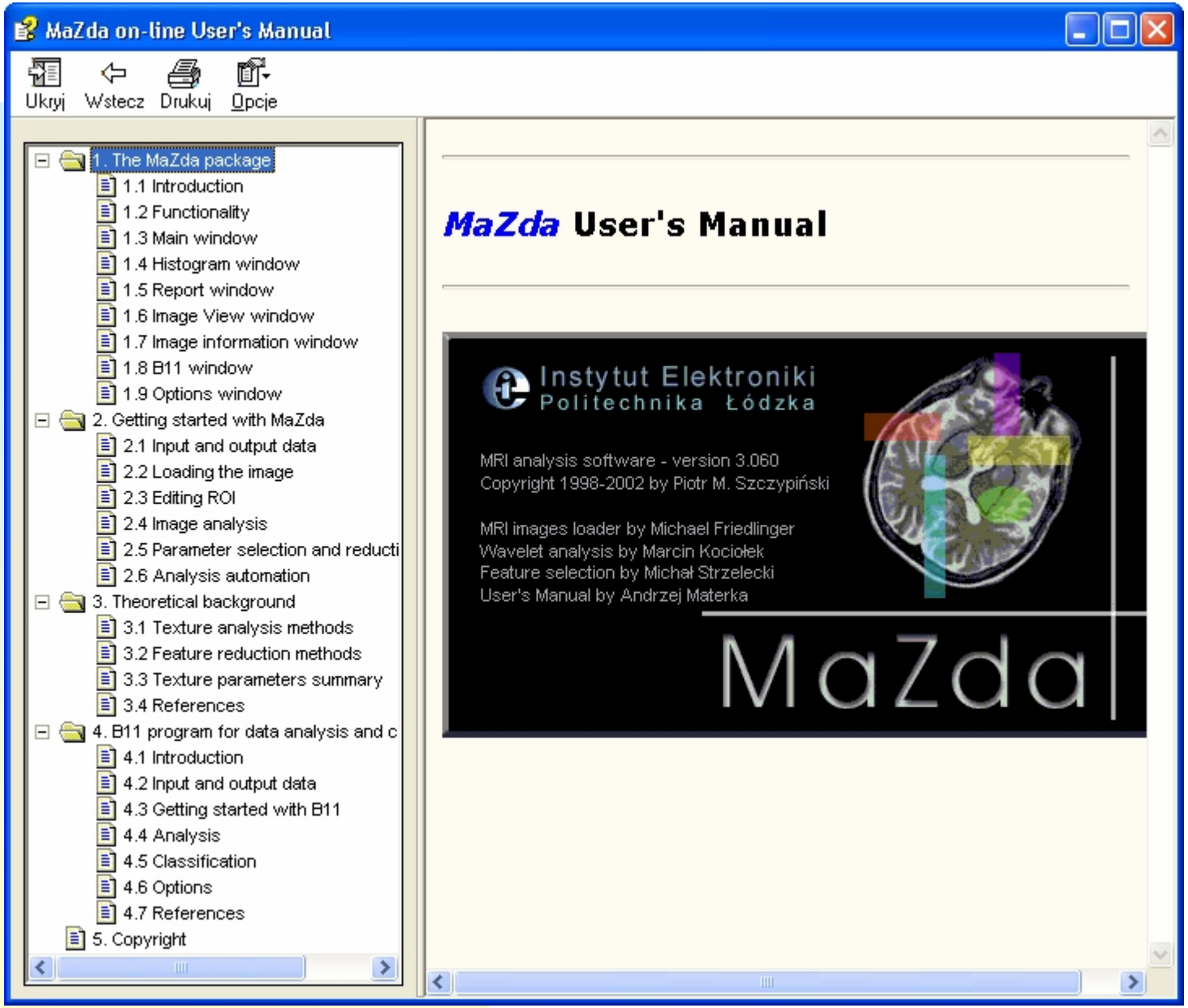


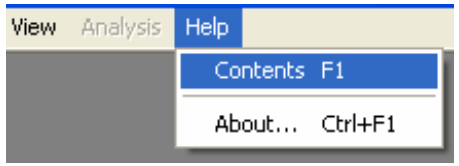




Option windows

MaZda 3.08 windows





On-line help window

MaZda, ver. 3.08

Feature selection

Input

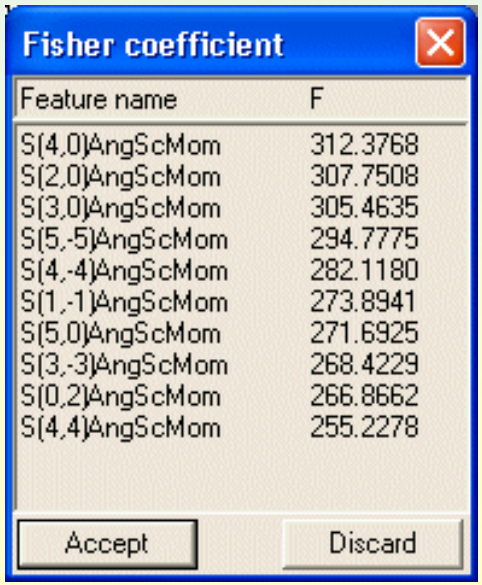
(*.par) files from MaZda

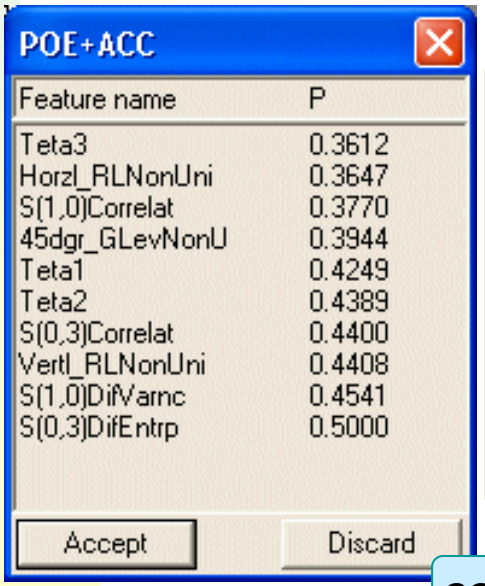
Methods

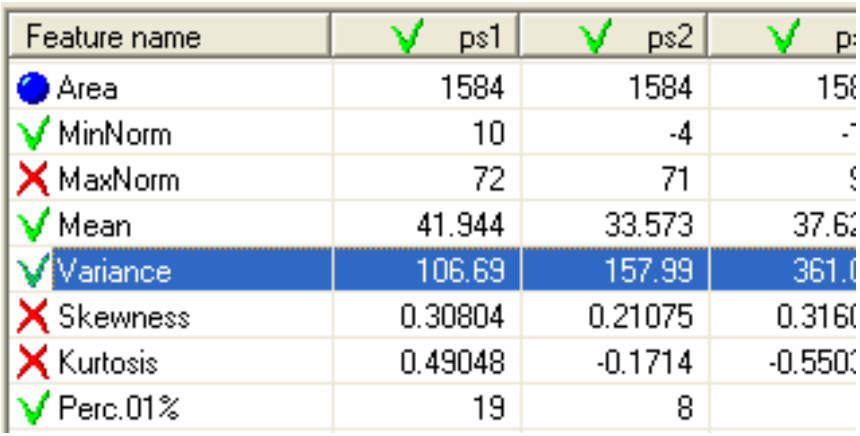
- **Fisher coefficient**
- **POE+ACC**
- **manual choice**

Output

(*.sel) files







Feature name	ps1	ps2	ps
Area	1584	1584	158
MinNorm	10	-4	-7
MaxNorm	72	71	9
Mean	41.944	33.573	37.62
Variance	106.69	157.99	361.0
Skewness	0.30804	0.21075	0.3160
Kurtosis	0.49048	-0.1714	-0.5503
Perc.01%	19	8	

MaZda, ver. 3.08

Automation

Analysis automation

```
// This is an example of macro file for MaZda software

LoadImage siem2.dcm
LoadROI testroi.roi

LoadOptions opcje1.ini
RunAnalysis

SaveReport wynik1.par
SaveMap mapa3.bmf
CloseMap
SaveMap mapa2.bmf
CloseMap
SaveMap mapa1.bmf
CloseMap
```

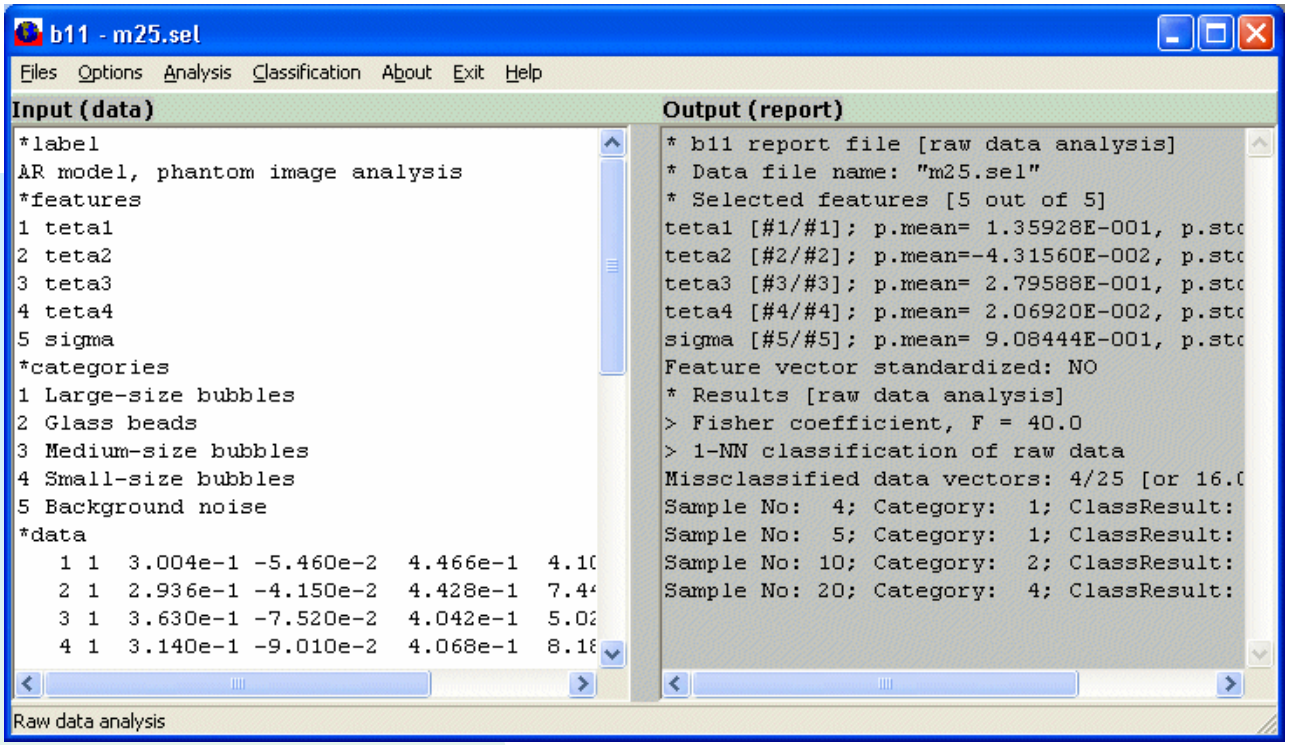
MaZda scripts

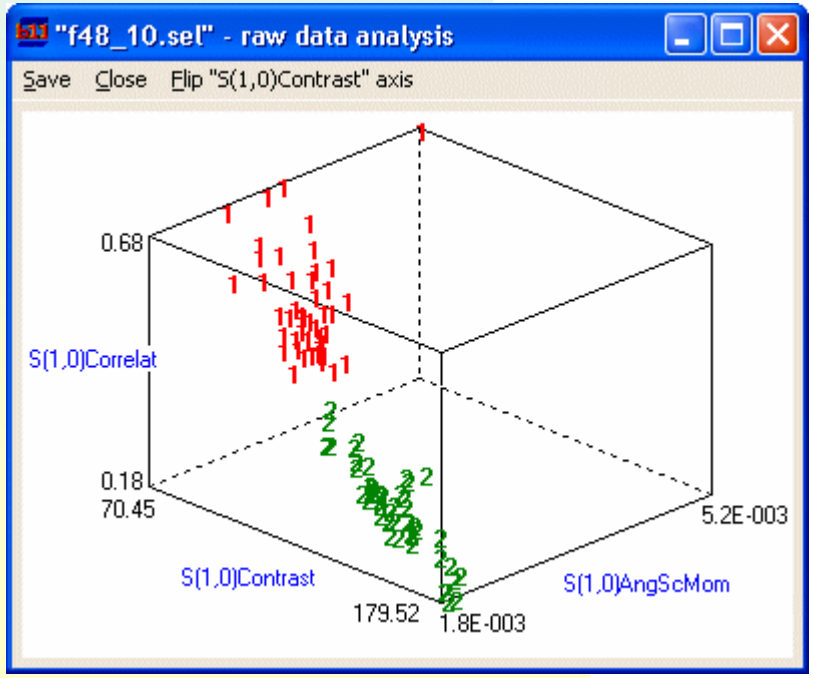
B11

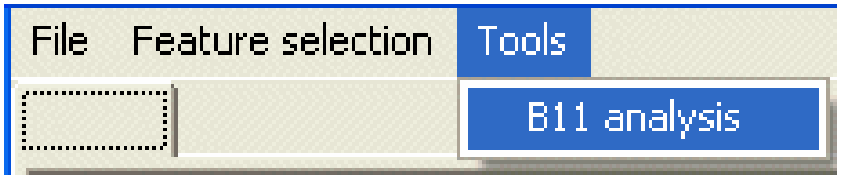
Exploratory data analysis, classification

Input
(*.sel) files

Output
- **text files**
- **BMP graphs**

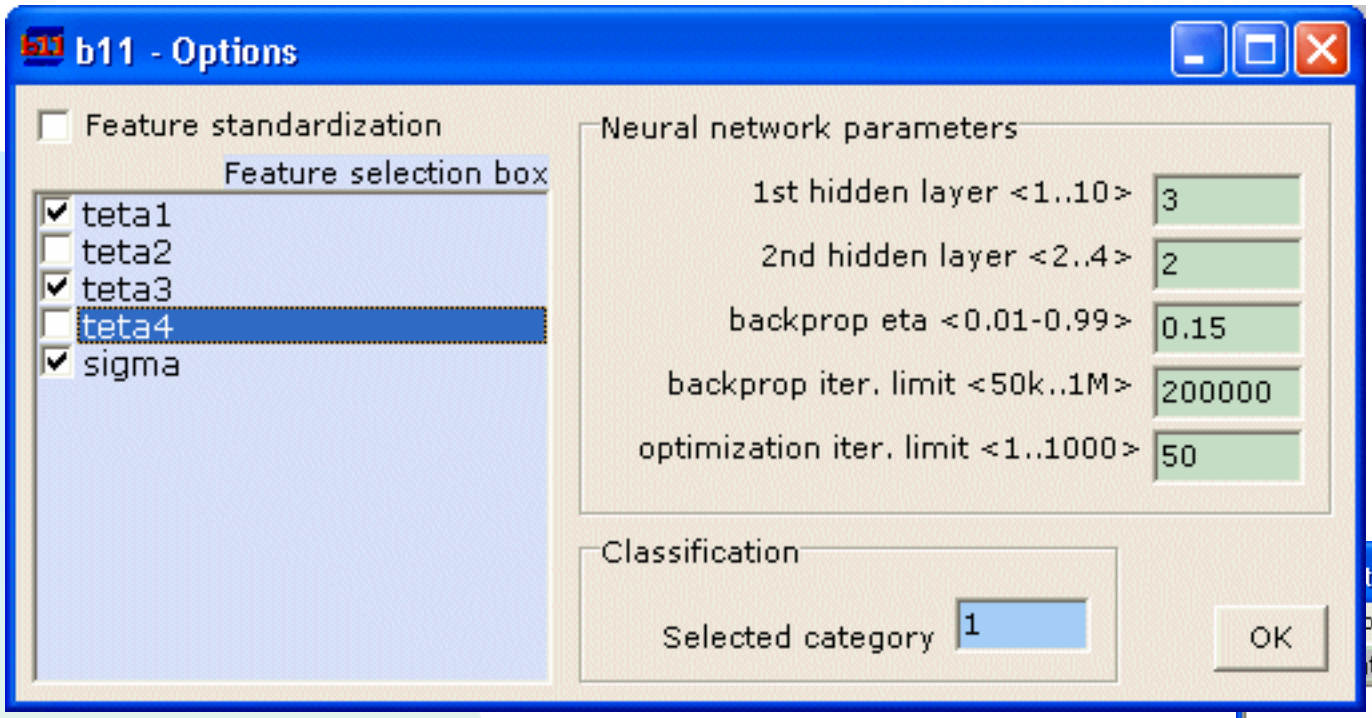




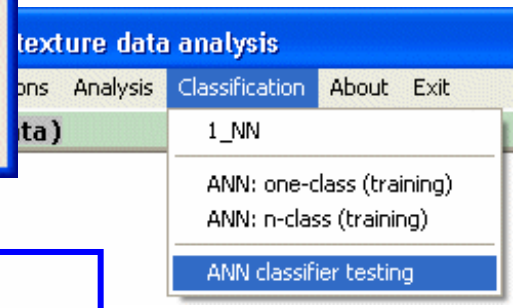


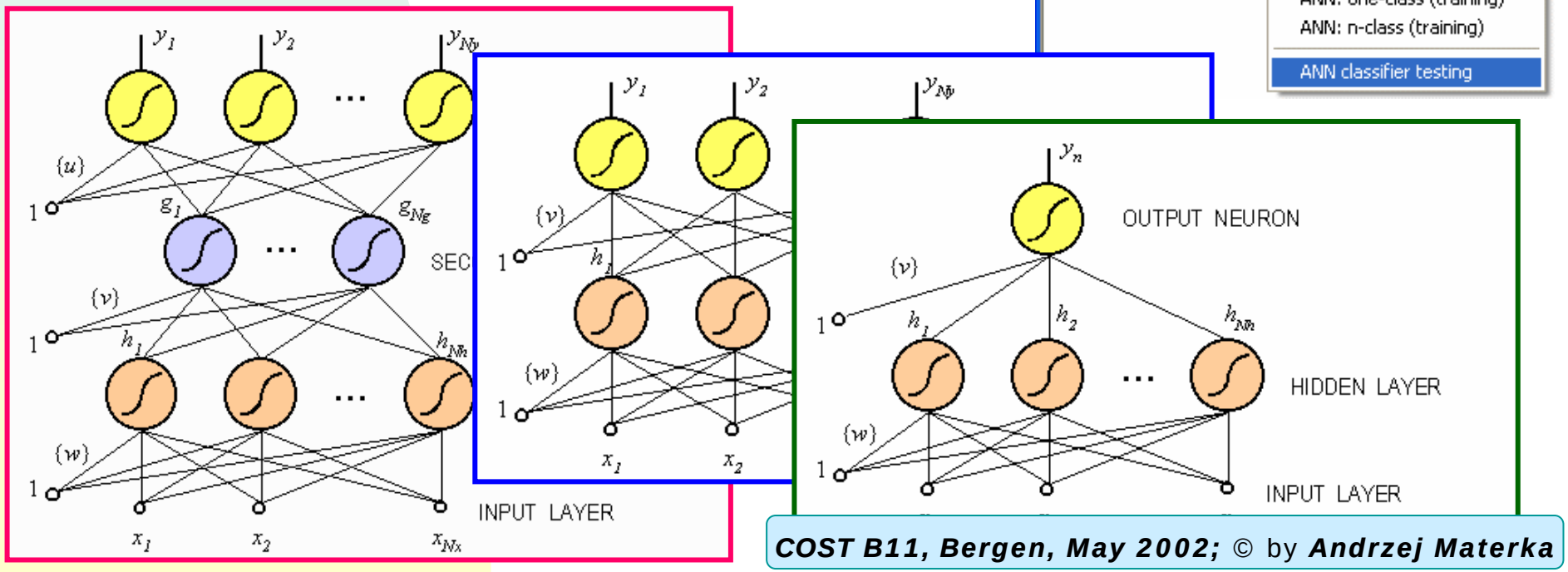
Methods
- **PCA, LDA, NDA**
- **k-NN, ANN**

B11



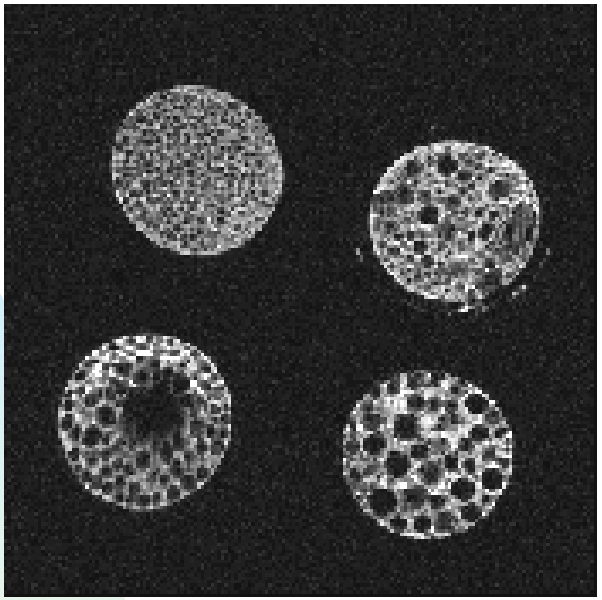
ANN classifier testing

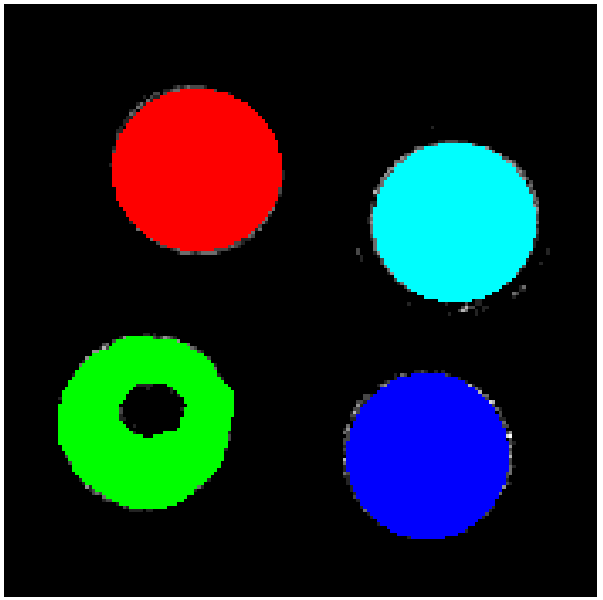




Example - PS phantom image analysis

22 images





class 1
class 2
class 3
class 4

MaZda

22 (*.par) files, ~300 texture parameters

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

b11

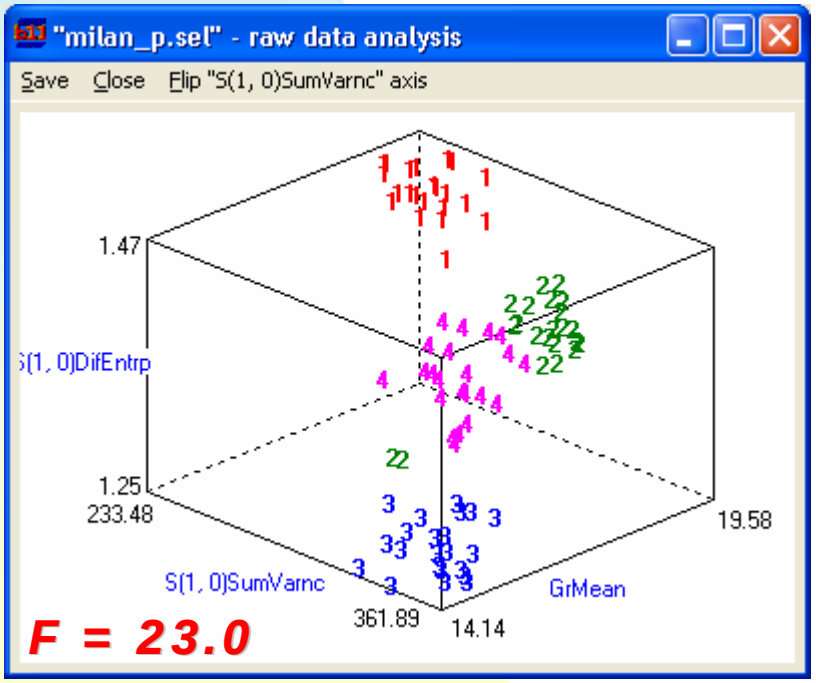
Exploratory data analysis and classification

Example - PS phantom image analysis

b11

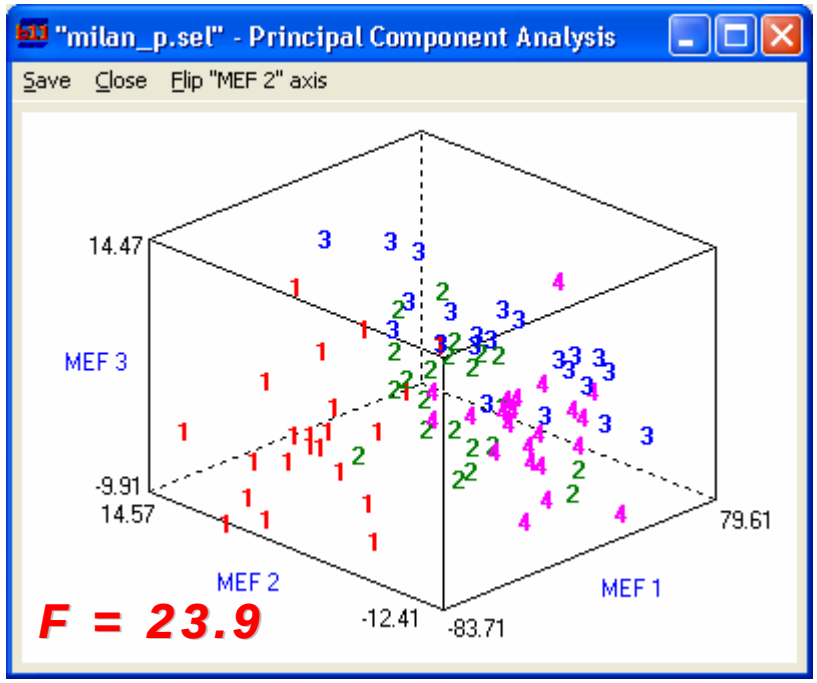
Exploratory data analysis and classification

Raw data



***1-NN*: 8 classification errors**

First 3 PCAs



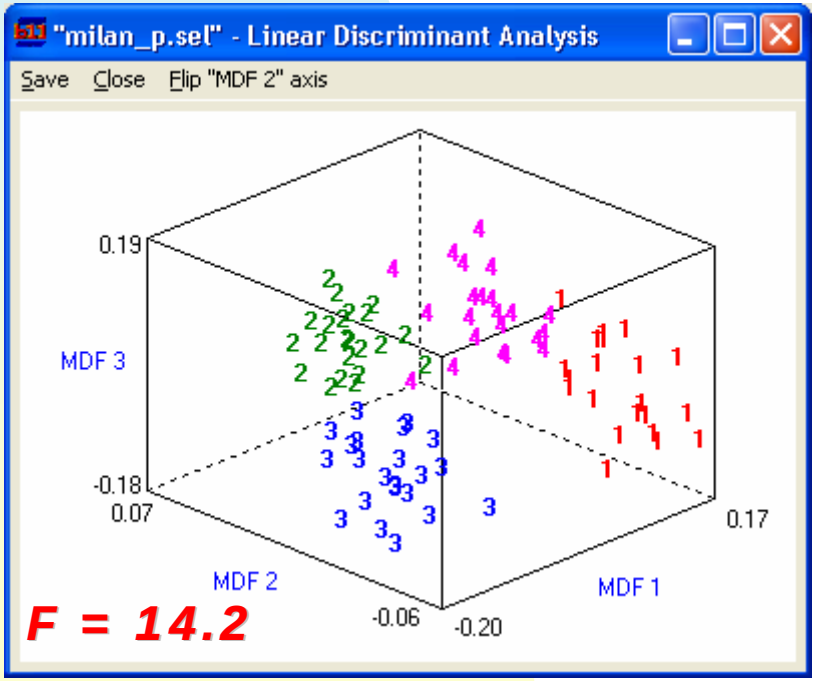
***1-NN*: 10 classification errors**

Example - PS phantom image analysis

b11

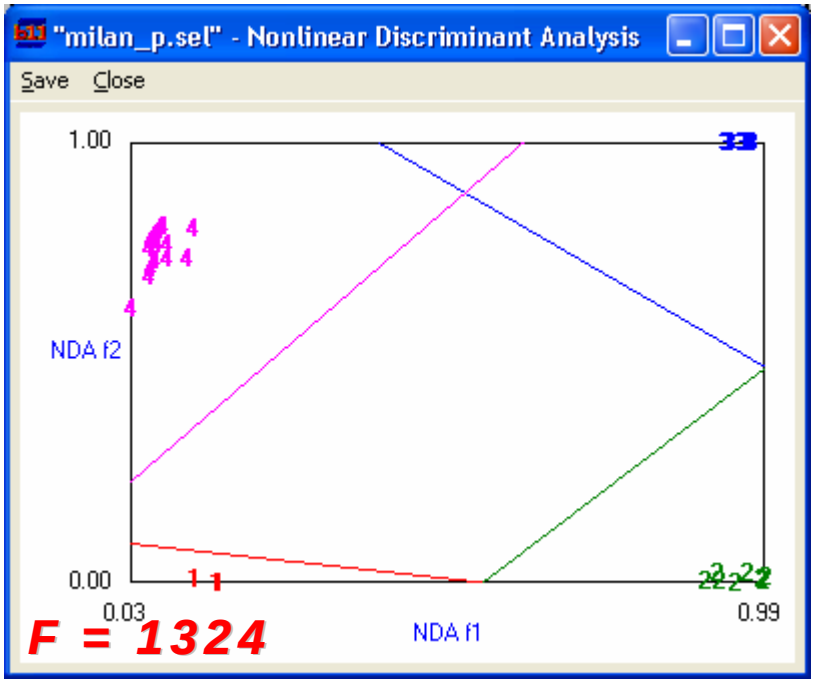
Exploratory data analysis and classification

Linear Discriminant Analysis



***1-NN*: 0 classification errors**

Nonlinear Discriminant Analysis



***1-NN:* 0 classification errors**

Summary

- ***MaZda*** **allows computation of almost all texture parameters known up to date.**
- **It is a unique tool for quantitative analysis of image texture.**
- ***MaZda*** **report files can be further studied using *Matlab*®, *Excel*®, *Statistica*®, etc.**
- **It supports 12 image file formats.**
- **The program is being extensively tested worldwide (> 300 download requests).**
- **Shareware version will be launched soon.**