

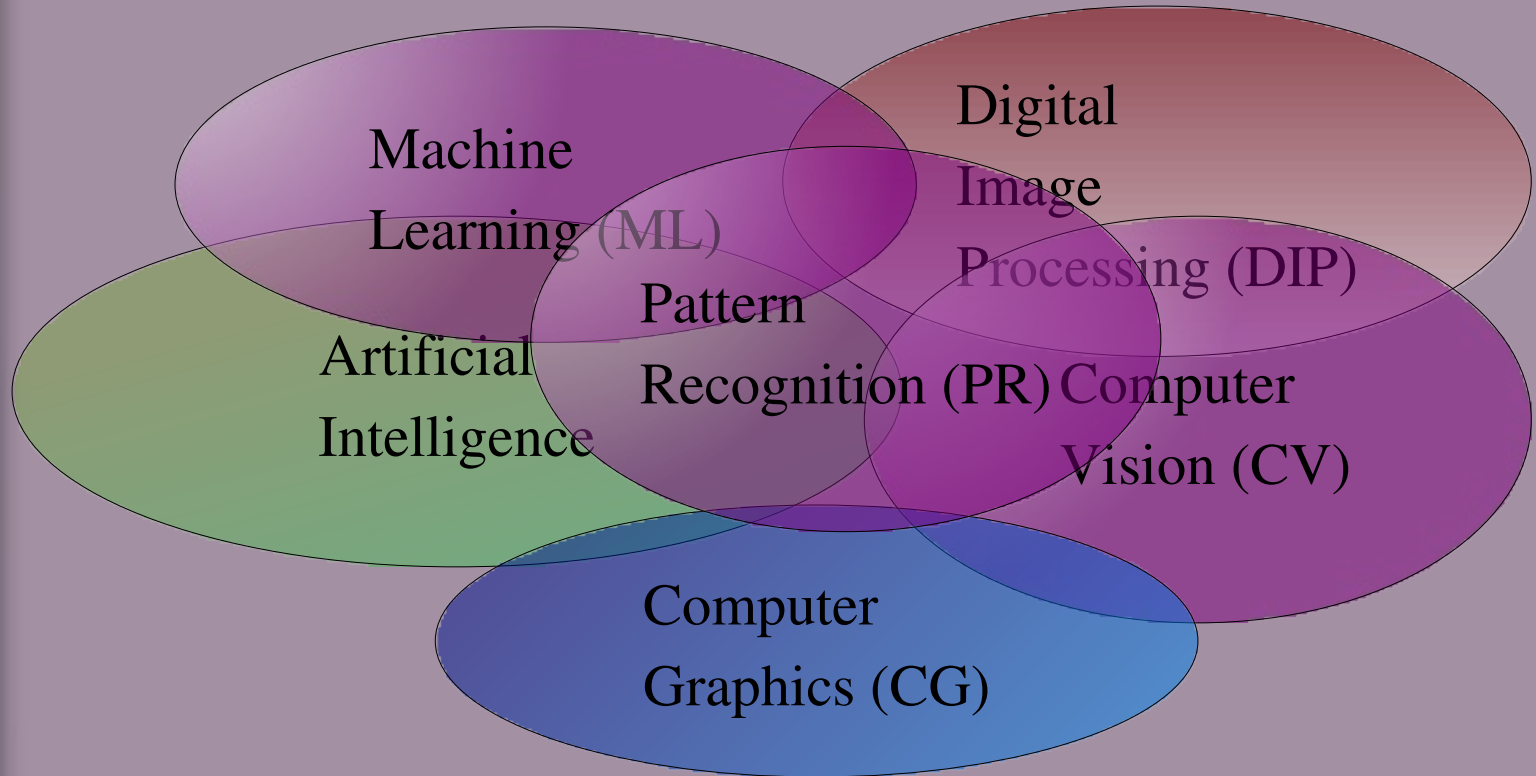
Introduction to Pattern Recognition with Applications in Computer Vision

Hemerson Pistori (UCDB)

Summary

- Pattern Recognition - overview and relations
- Computer vision – applications and topics
- General PR/CV system architecture
- Classification problems – statistical learning approach
- Learning Gaussian Models – Maximum Likelihood estimation (MLE)
- Parametric X Non-parametric models
- Gaussian Mixture Models – Incomplete Information
- Iterative methods for MLE – the EM
- Dimensionality Reduction – PCA and FLDA

Pattern Recognition - overview and relations



P.R.: Automatic identification or classification of “things”
(e.g. A face, a voice, a genome, a behavior, a word, etc)

C.V.: Automatic interpretation and reaction to images
(e.g. Photo, movie, satellite image, MRI, X-Ray, etc)

Leather Classification

www.gpec.ucdb.br/dtcouro



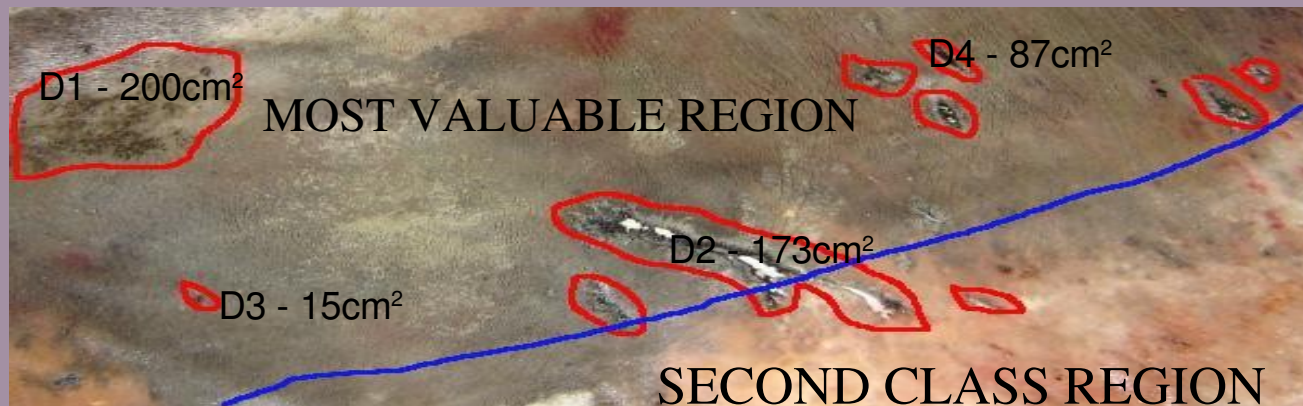
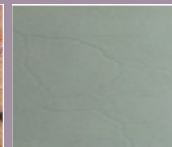
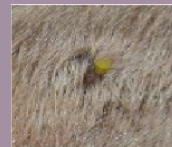
Alive cow



Just after flay

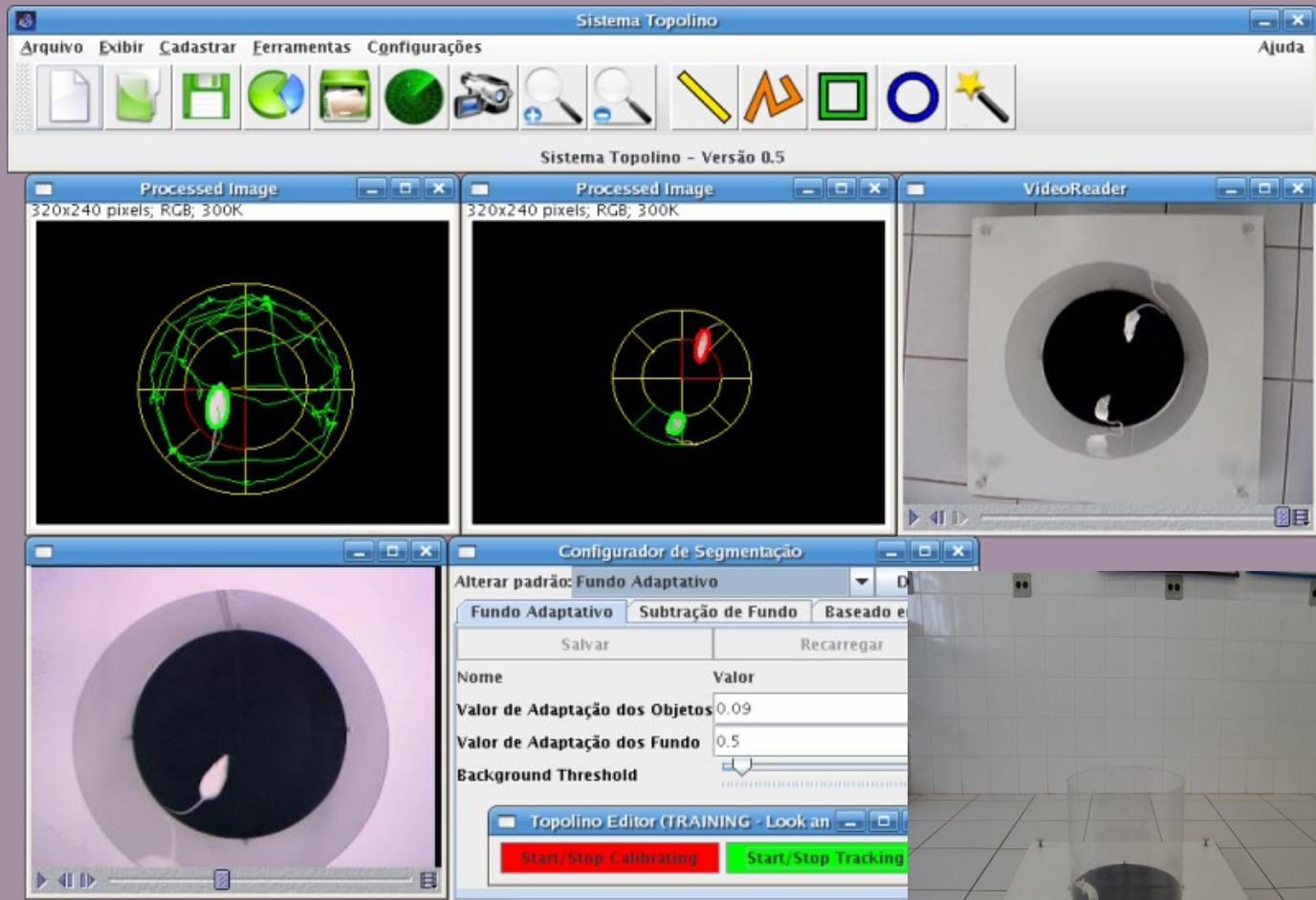


Wet Blue (Tanned)



Animal Behaviour Identification

www.gpec.ucdb.br/topolino



Visual Sign HMI

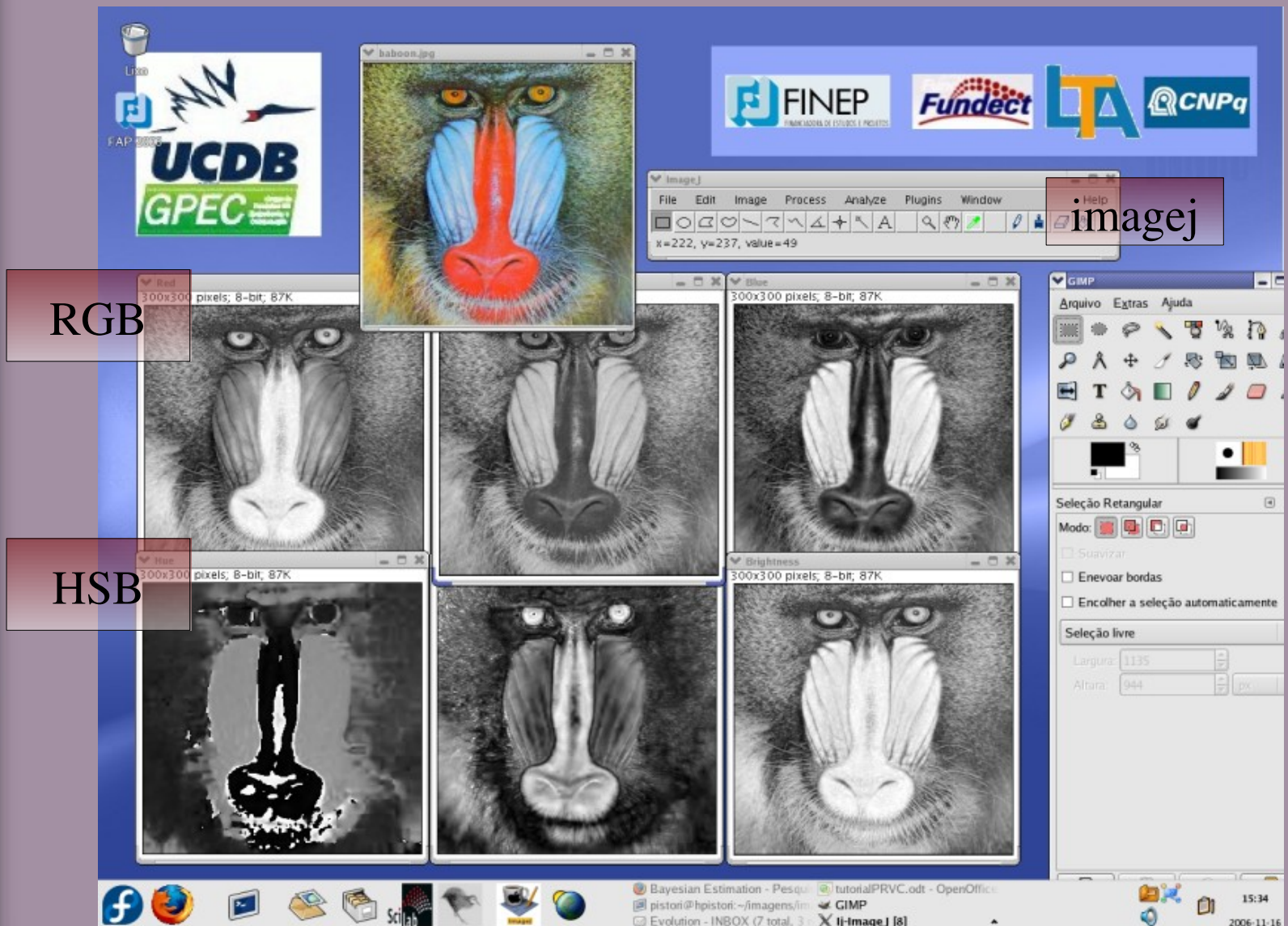
www.gpec.ucdb.br/sigus



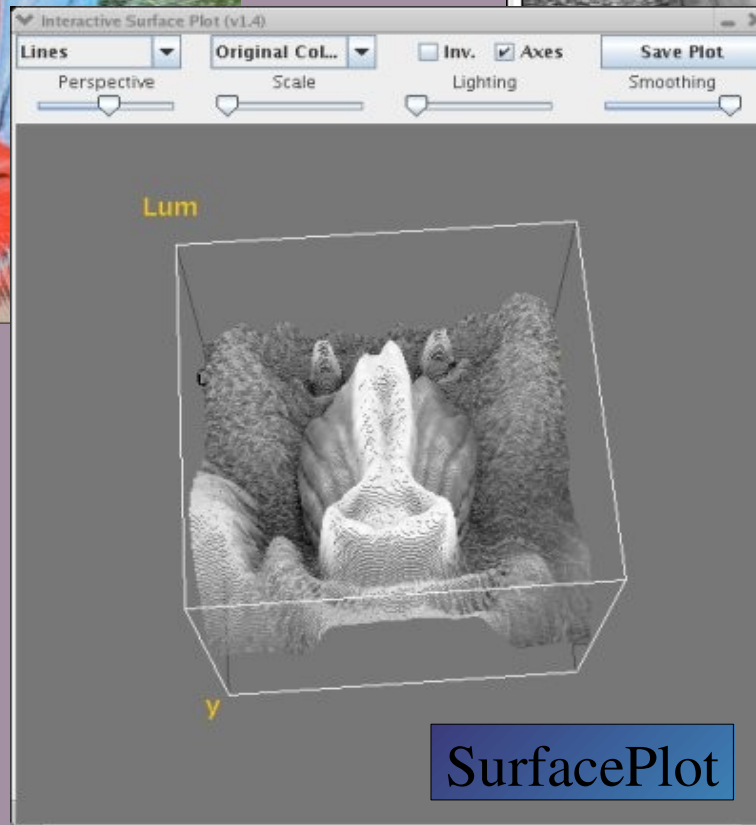
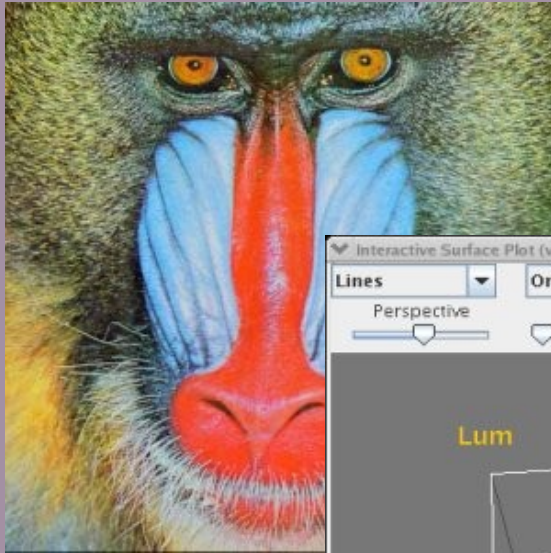
Computer Vision – Some Topics

- Colored images, color spaces and histograms
- Image enhancement (preprocessing)
- Segmentation
- Texture features
- Shape features
- Feature Vectors and Vector Spaces

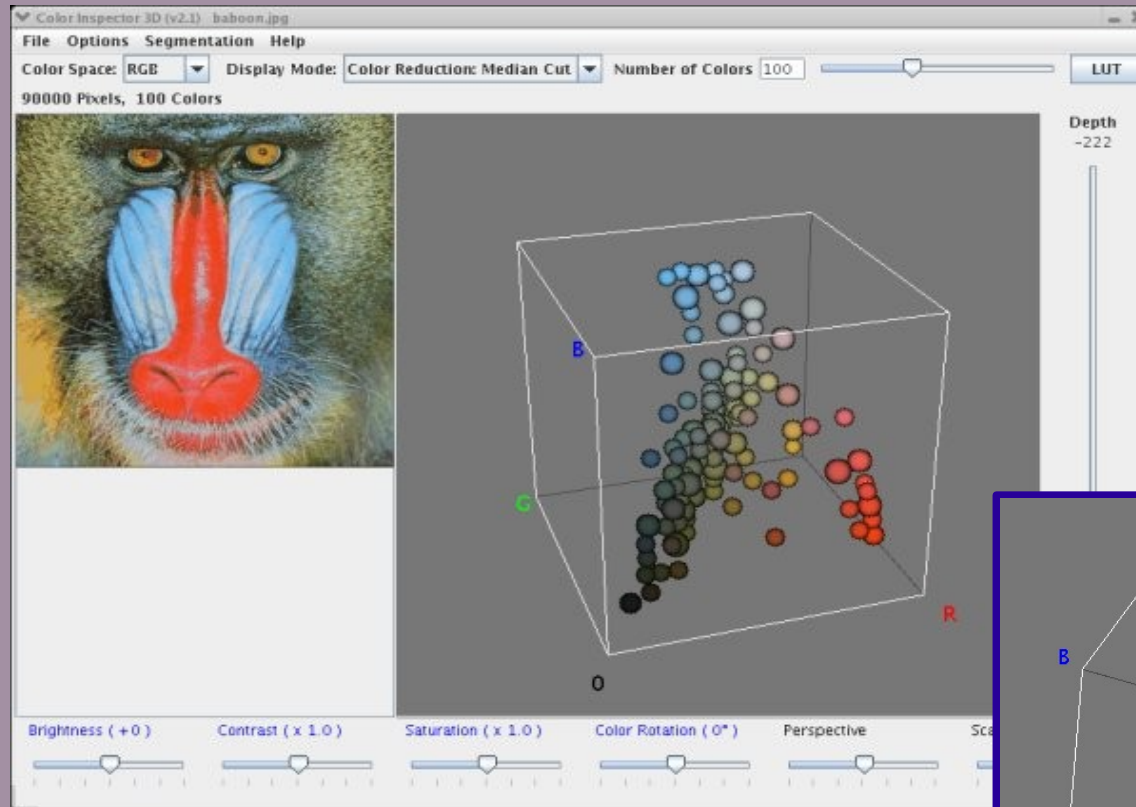
Colored Images and Color Spaces



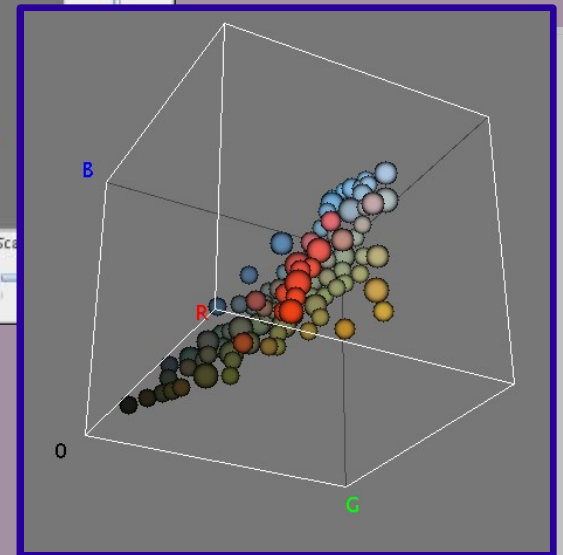
Colored Images and Color Spaces



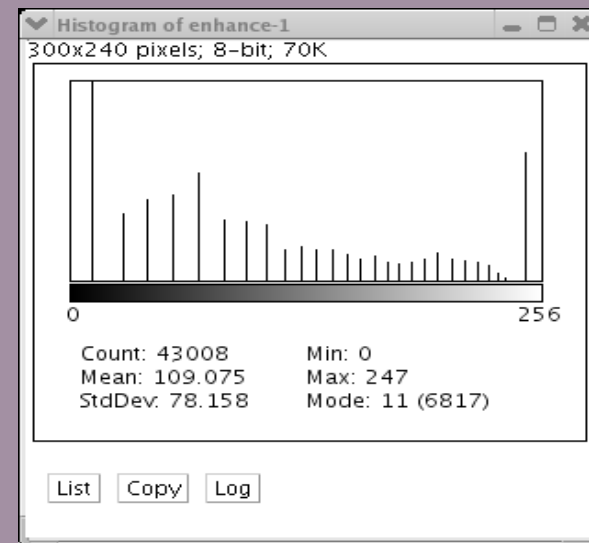
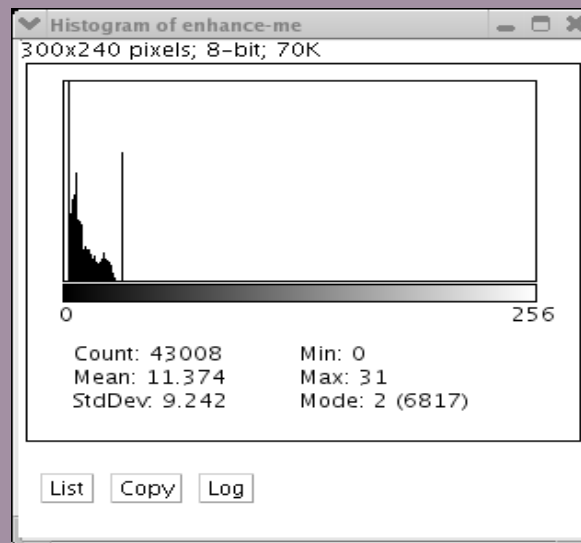
Color Histograms



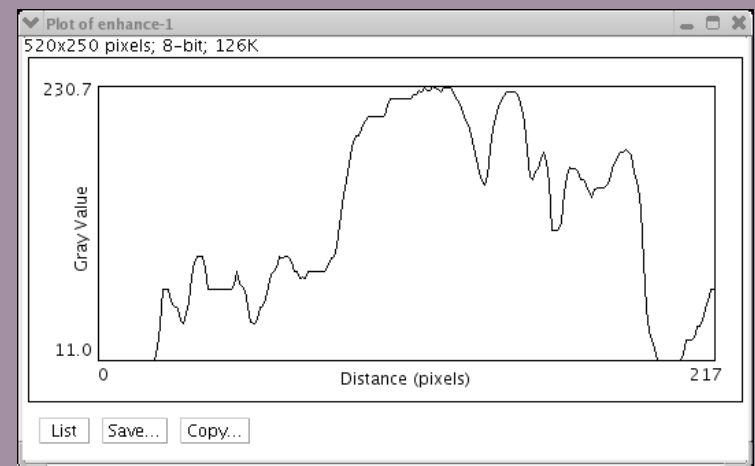
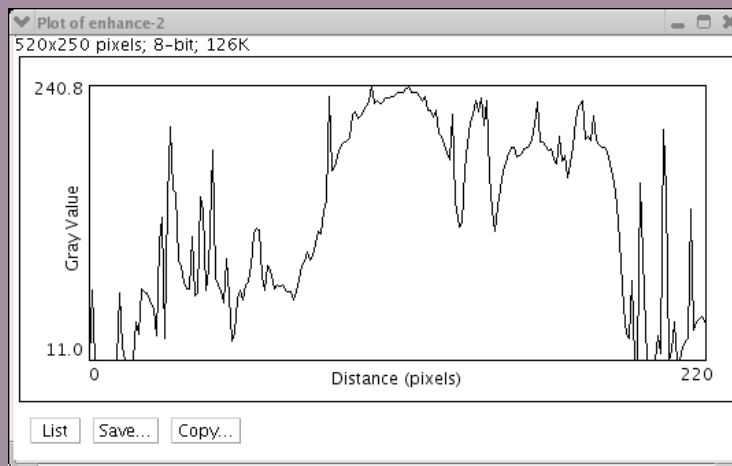
Color Inspector 3D



Preprocessing – Image Enhancement



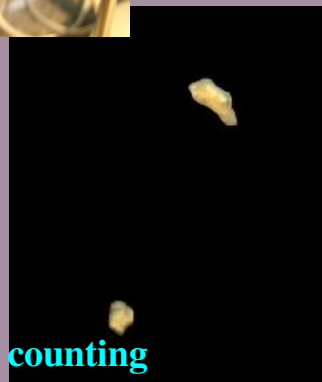
Preprocessing – Image Enhancement



Segmentation



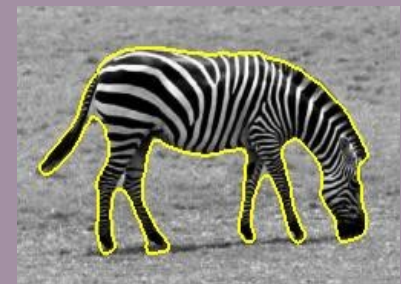
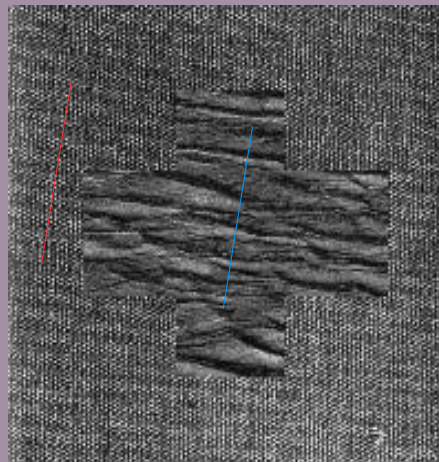
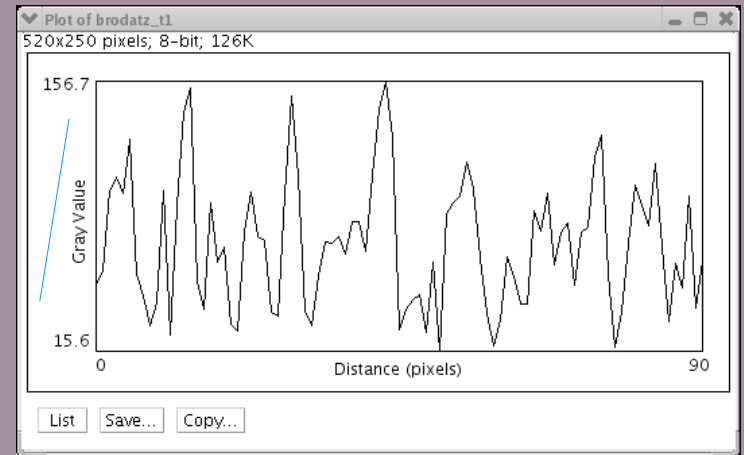
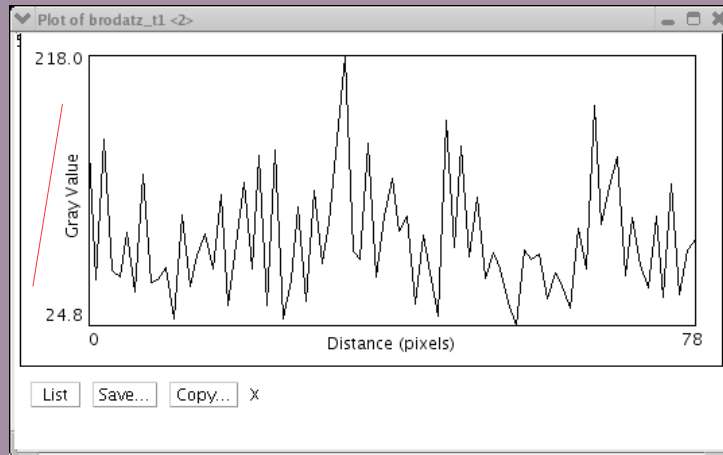
Artemis counting



Wetblue leather defects

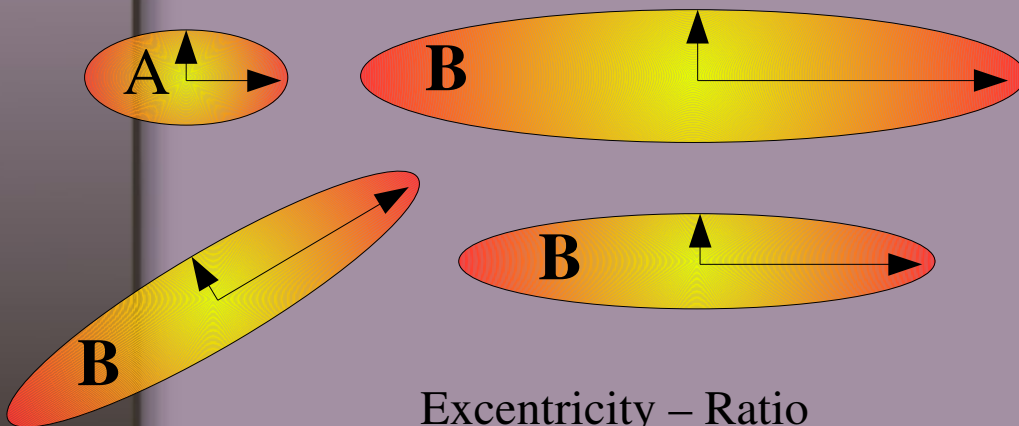
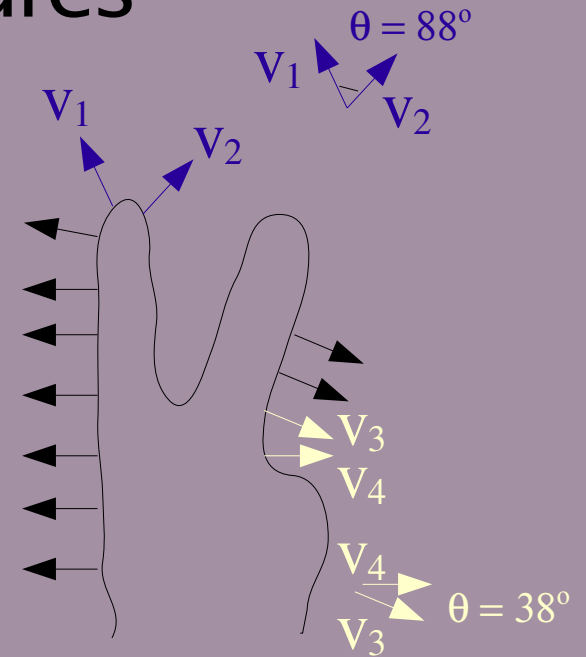
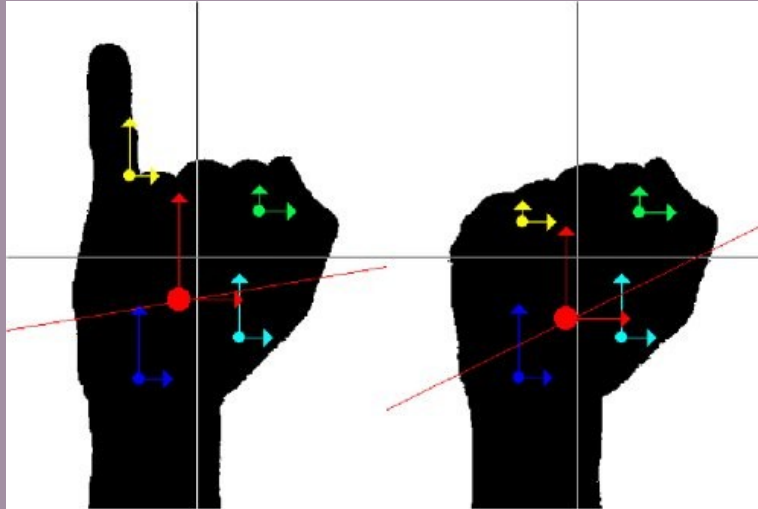


Texture Features



Shape Features

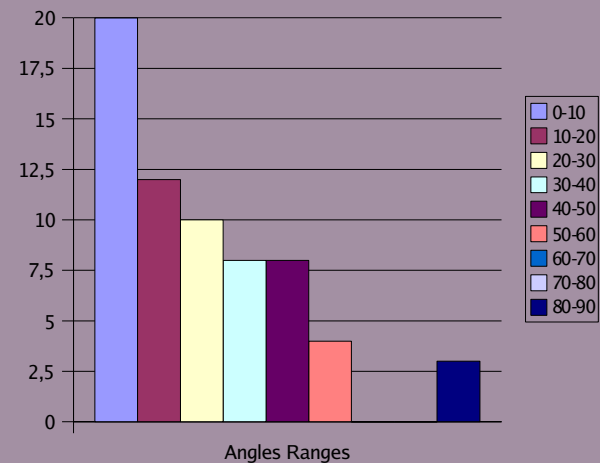
Image Moments



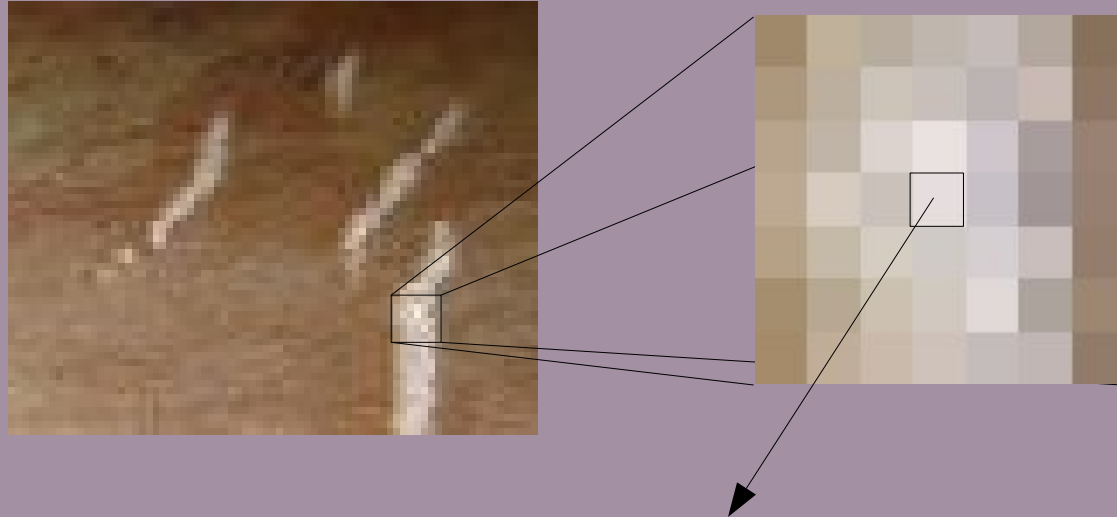
Excentricity – Ratio

Rotation, Translation and Scaling Invariance

Curvatures Histogram

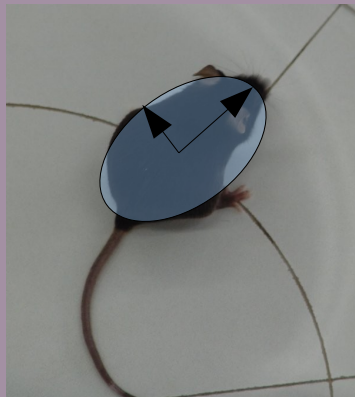


Feature Vectors and Vector Spaces



$$\mathbf{x} = [230 \quad 221 \quad 222 \quad 353 \quad 4 \quad 90 \quad 0.12 \quad 0.5]'$$

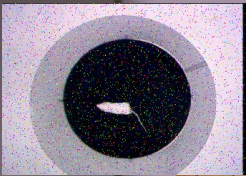
Red Green Blue Hue Sat. Value Freq.45° Freq.90°



$$\mathbf{x} = [0.2 \quad 430 \quad 0.4 \quad 0.2 \dots]'$$

Excen. Perimeter Curv.Hist.0-10 Curv.Hist.40-50. ...

Pattern Recognition System Architecture (Applied to VC problems)



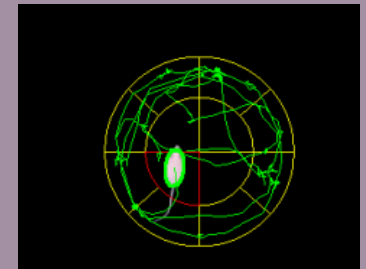
Capture



Enhancement



Segmentation

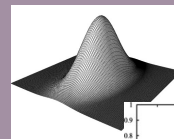


Tracking

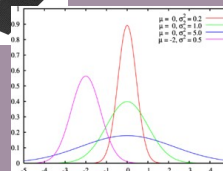


[0.2 0.1 40 30 0.2]
↓
Vertical

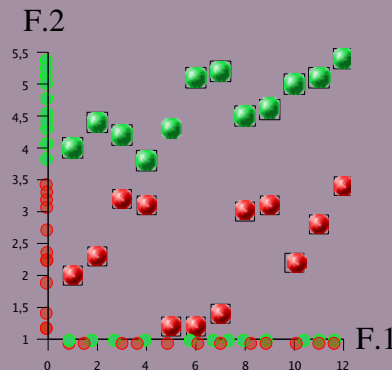
Inference
Classification



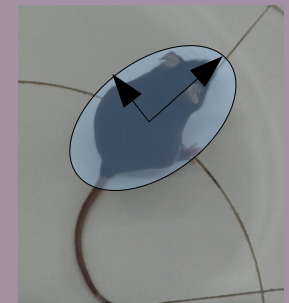
$F.2 > 3.6$



Parameter Estimation
or Learning

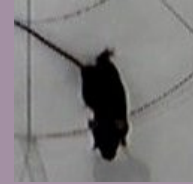


Feature Selection



Feature Extraction

Statistical Learning



ω_1 : Ticks

ω_2 : Wrinkles

ω_3 : Bot fly

3-Class Classification Problem

ω_1 : Horiz.

ω_2 : Vert.

2-Class Classification Problem

$$P(\omega_j | x) = P(x | \omega_j) \cdot P(\omega_j) / P(x)$$

ω_j : Class j

x : Feature vector

$P(\omega_j | x)$: A posteriori prob. of ω_j

$P(x | \omega_j)$: Likelihood of ω_j

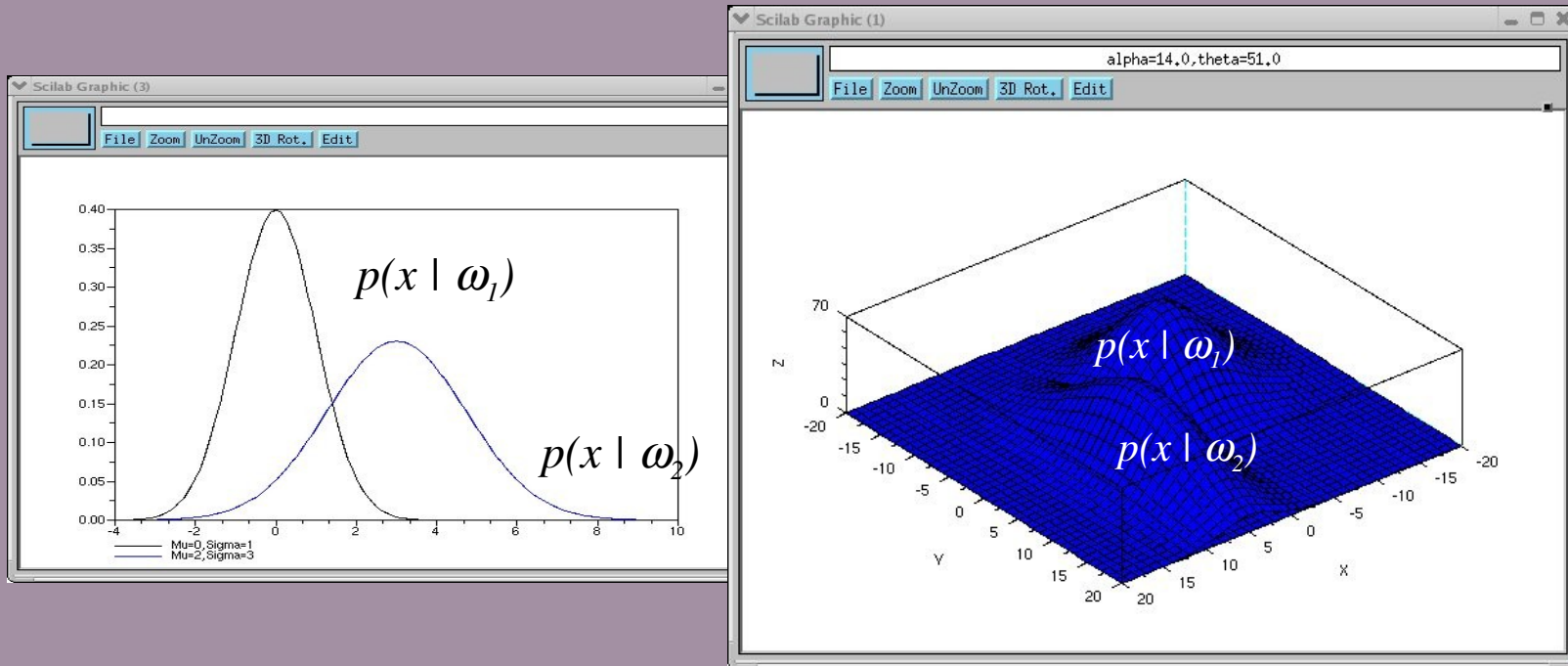
$P(\omega_j)$: A priori prob. of ω_j

$P(x)$: Prob. of x (evidence)

Bayes Decision

$$\arg \max_j P(\omega_j | x)$$

Learning Gaussian Models

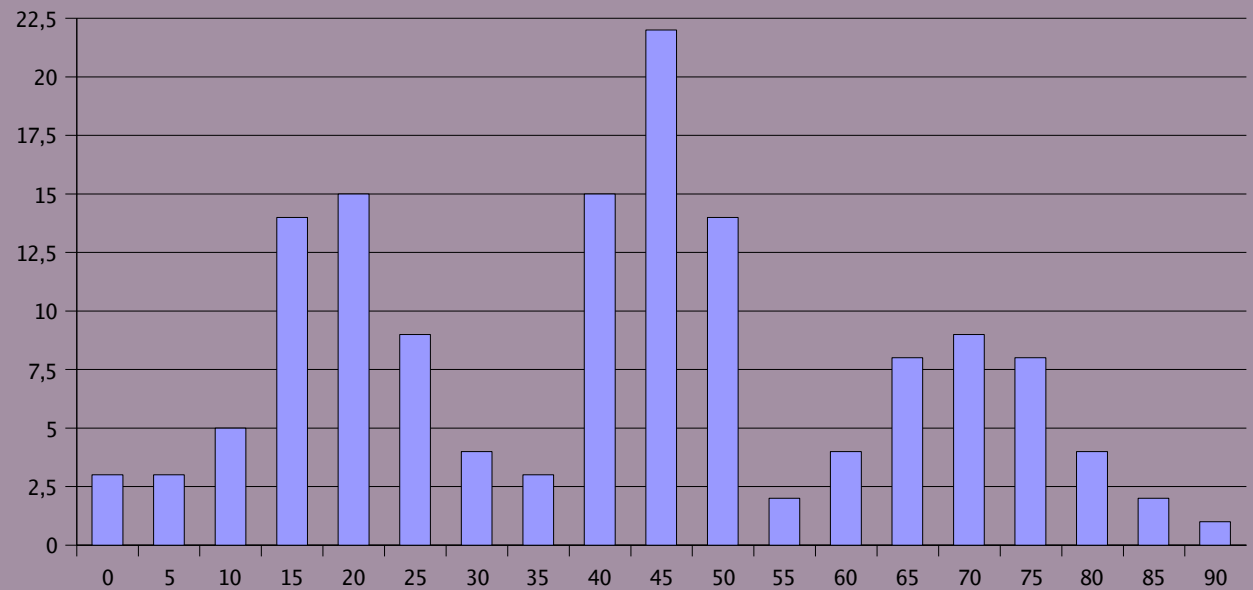
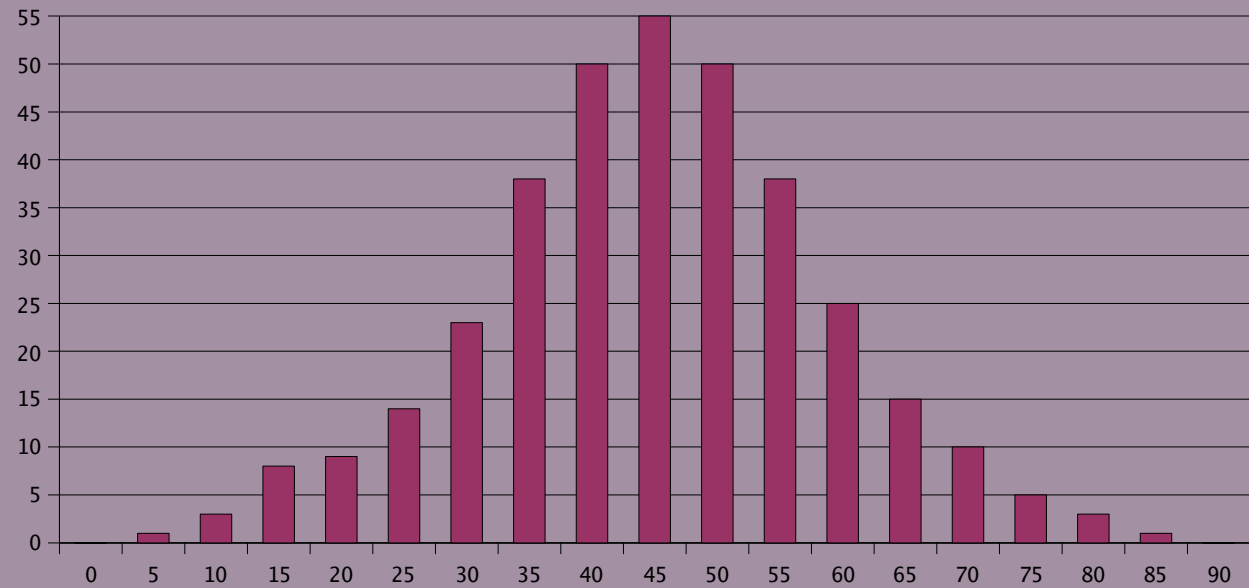


$$P(x | \omega_j) : \frac{1}{(2\pi)^{N/2} |\Sigma|^{1/2}} \exp \left(-\frac{1}{2} (x - \mu)^\top \Sigma^{-1} (x - \mu) \right)$$

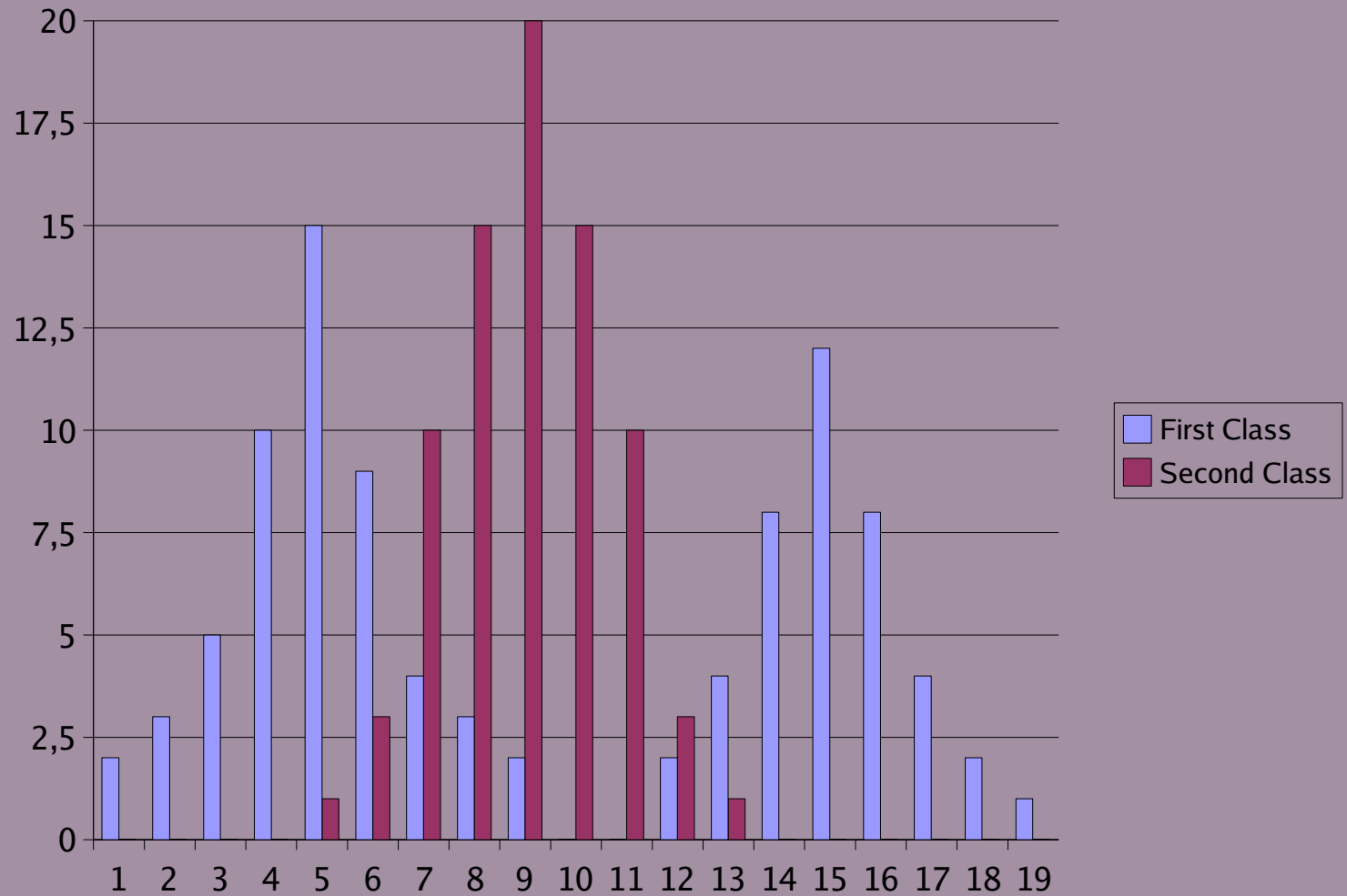
Maximum Likelihood Estimation

First Partial Derivative relative to μ_i and Σ equals zero

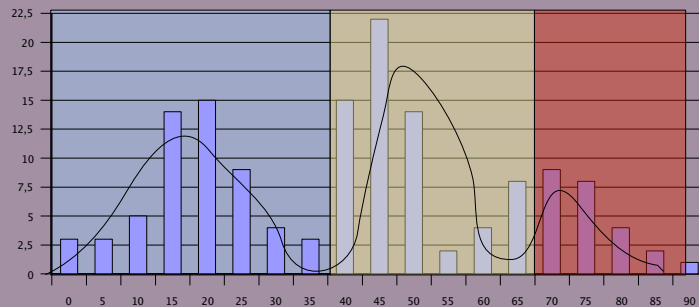
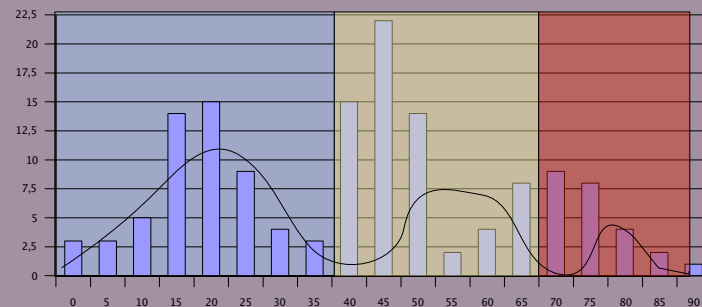
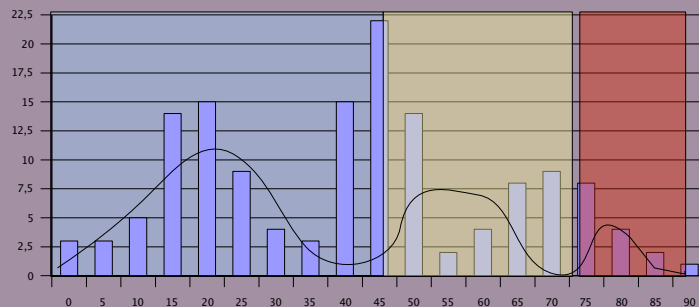
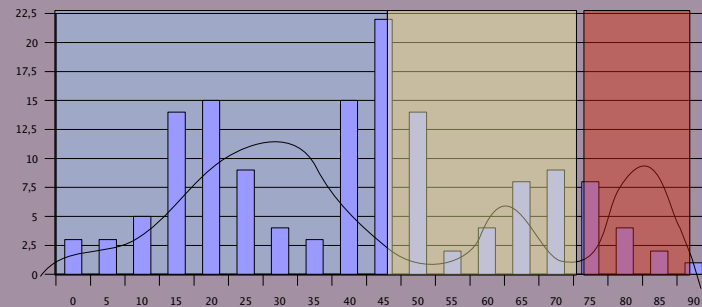
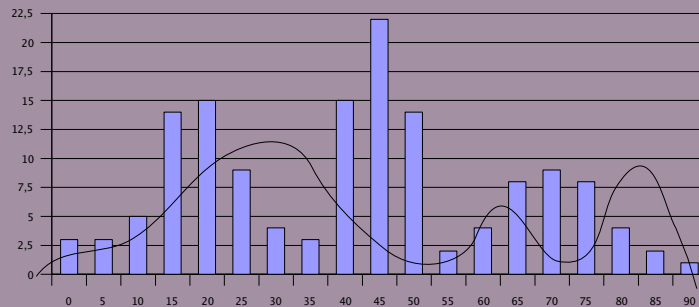
Parametric X Non-Parametric Models



Gaussian Mixture Models

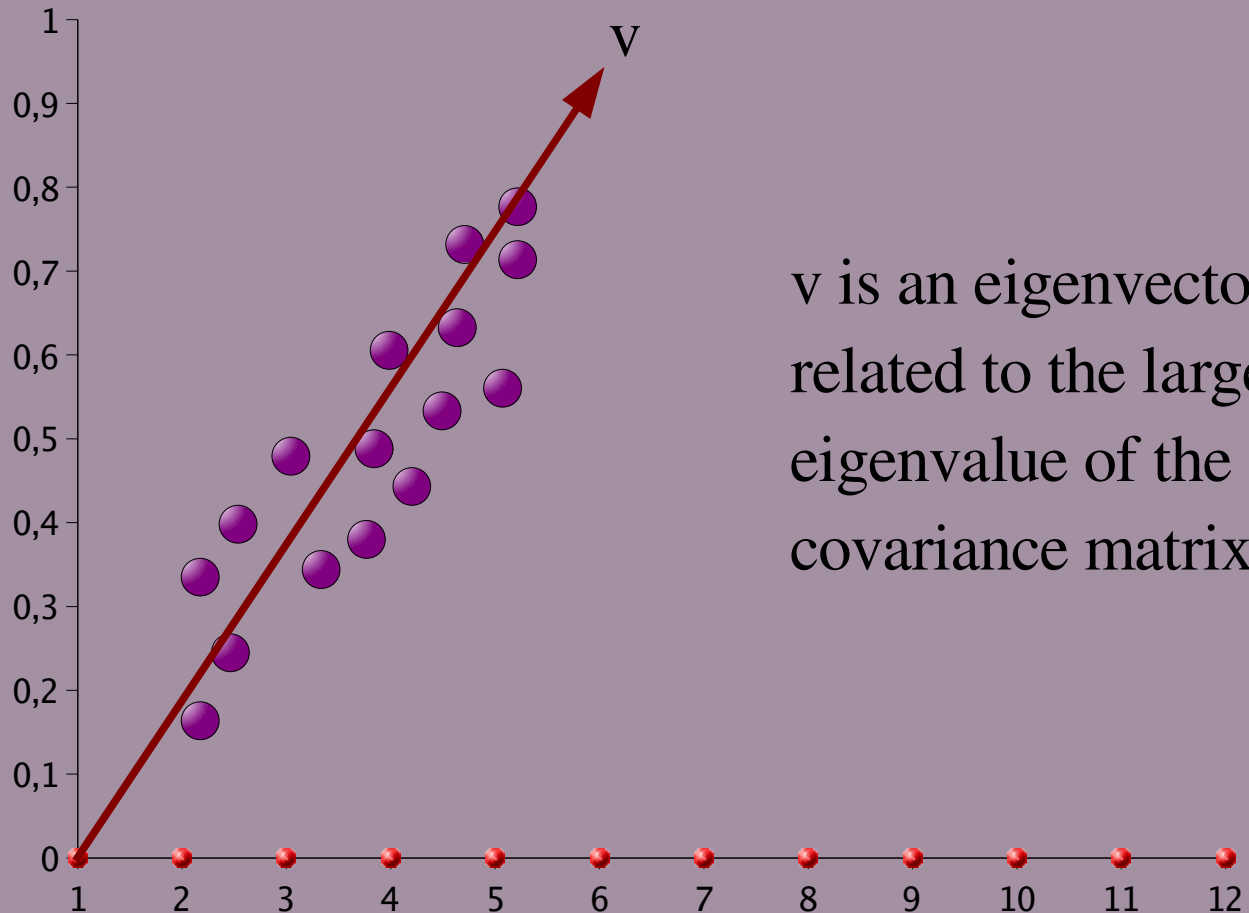


Iterative Methods for MLE



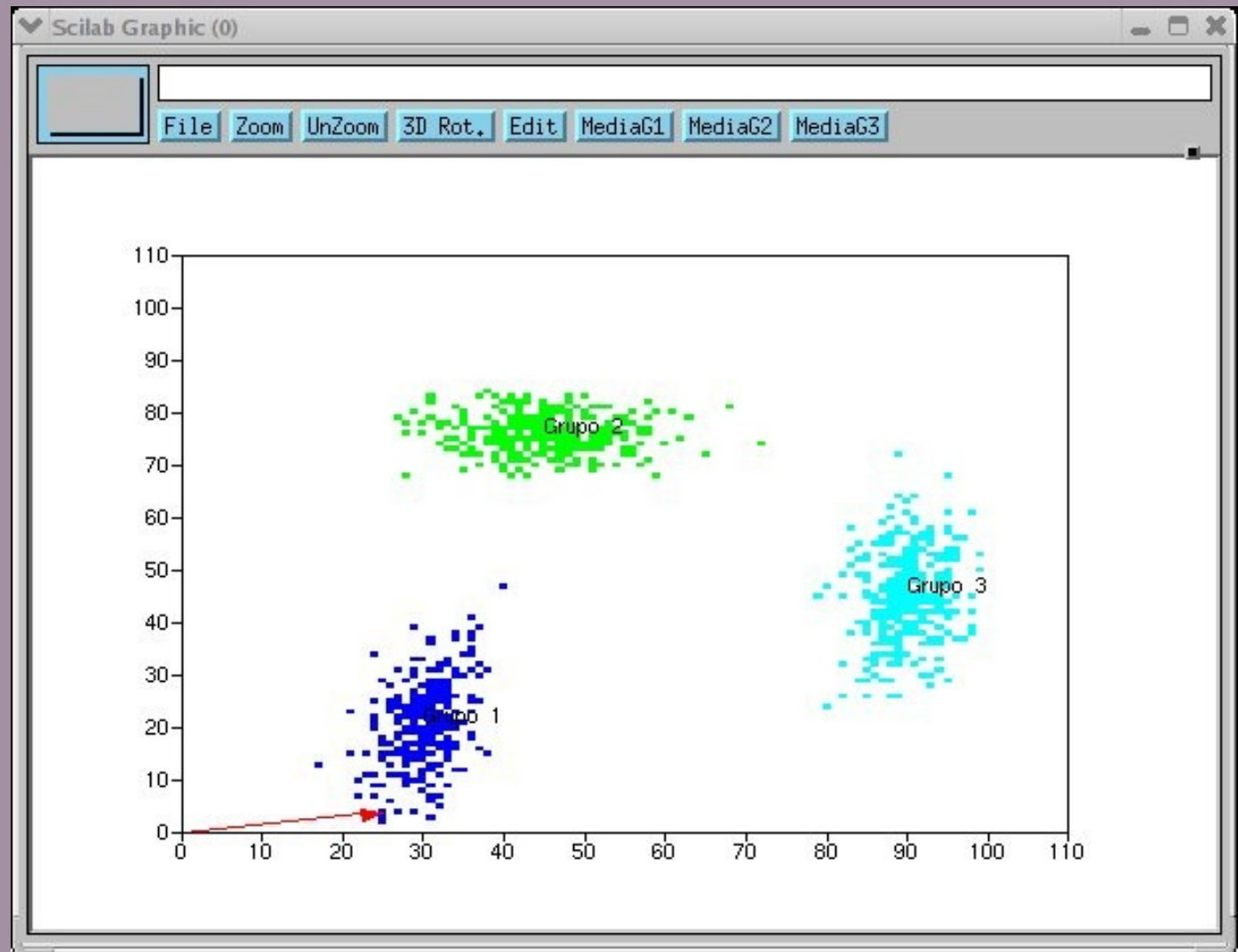
E.M. - Expectation-Maximization

Dimensionality Reduction - PCA

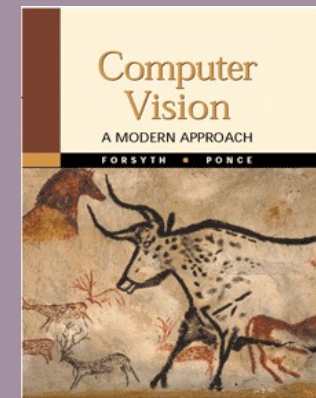
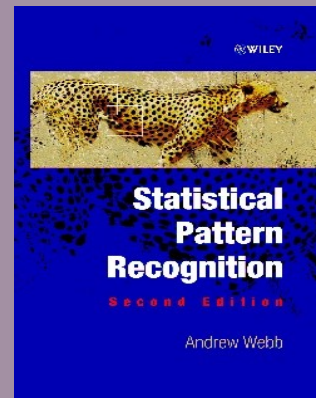


v is an eigenvector
related to the largest
eigenvalue of the
covariance matrix

Dimensionality Reduction - FLDA



More Information



www.ec.ucdb.br/~pistori

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Concluido



Dr. Hemerson Pistori

[Research Group in Engineering and Computing - GPEC](#)
[Dom Bosco Catholic University - UCDB](#)
[Salesians Institutions for Higher Education - IUS](#)

Resume

Hemerson Pistori received his doctorate in 2003 from the [University of São Paulo](#), USP, at the Computer Engineering Department, and his M.Sc. degree in Computer Science from [State University of Campinas](#), UNICAMP, in 1998. Currently, he is working as a professor of Discrete Mathematics and of Computer Vision at [Catholic University of Dom Bosco](#), UCDB. He is also a member of the [UCDB Scientific Committee](#) and of the [Colabora's](#) editorial board. Recently, he joined the IUS Engineering Group, an international board of [Salesians Institutes of Higher Education](#), as the UCDB's representative. Since February of 2004, he leads the Research Group in Engineering and Computing. His current research interests include statistical learning, stochastic modeling, adaptive devices, dissimilarity measures, predictive filters, graphical models and texture analysis. Professor Pistori coordinates

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