JHU vision lab

Generalized Principal Component Analysis

Tutorial @ CVPR 2007

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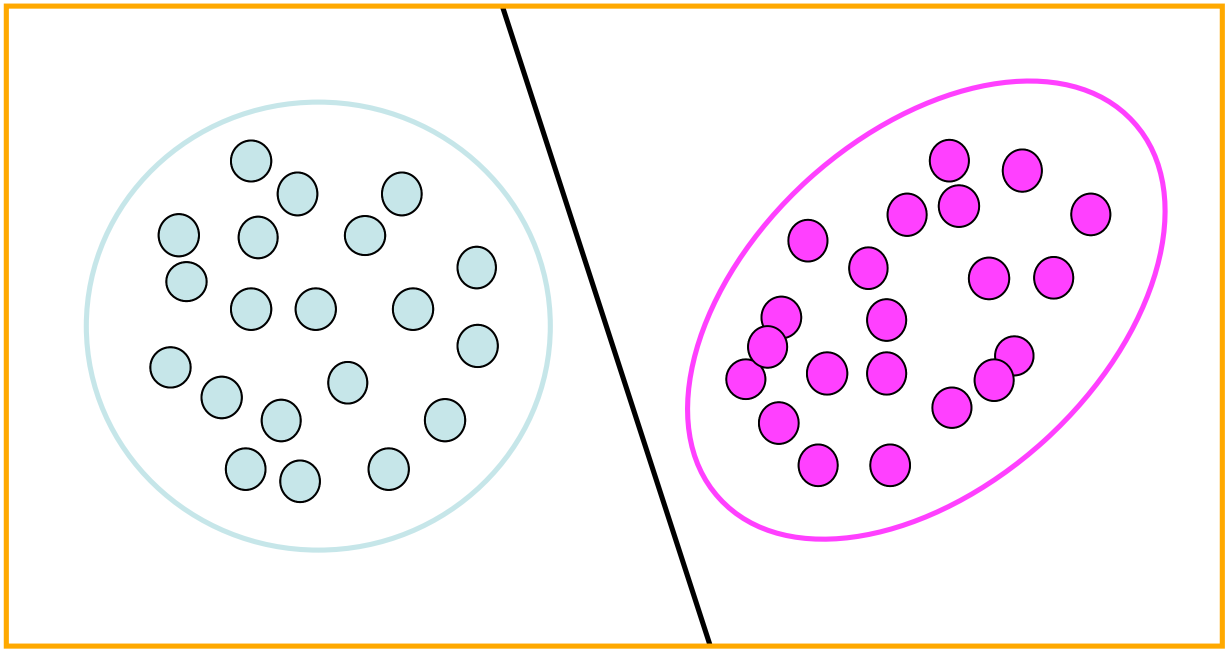
Data segmentation and clustering

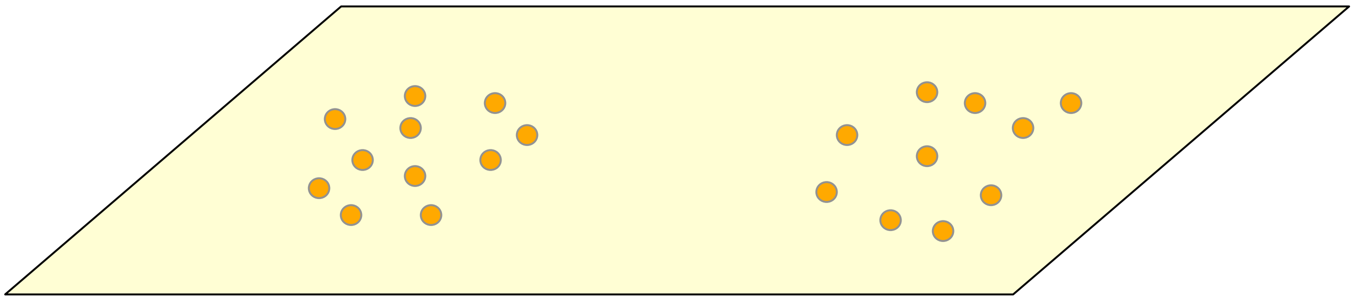
- Given a set of points, separate them into multiple groups



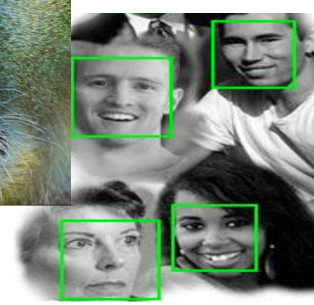
- Discriminative methods: learn boundary
- Generative methods: learn mixture model, using, e.g. Expectation Maximization

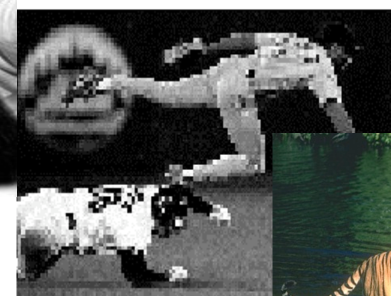
Dimensionality reduction and clustering

- In many problems data is high-dimensional: can reduce dimensionality using, e.g. Principal Component Analysis



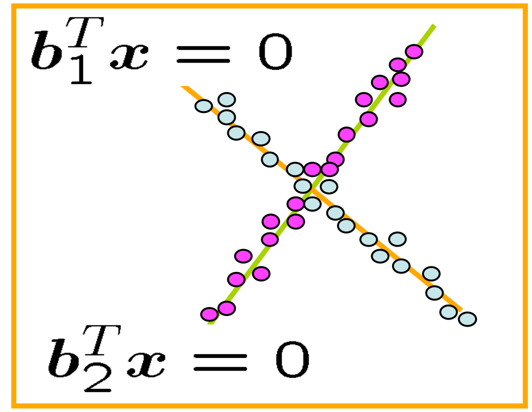
- Image compression
- Recognition
  - Faces (Eigenfaces)
- Image segmentation
  - Intensity (black-white)
  - Texture



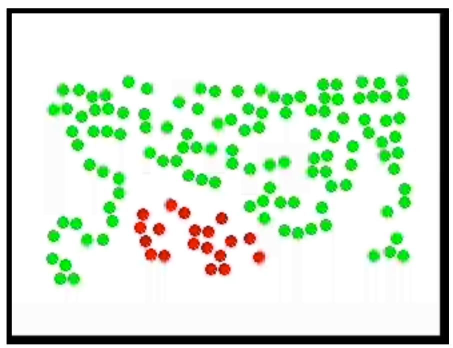


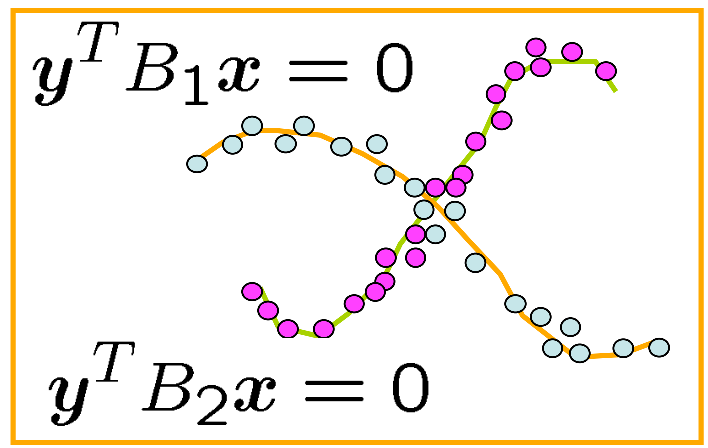
Segmentation problems in dynamic vision

- Segmentation of video and dynamic textures



- Segmentation of rigid-body motions



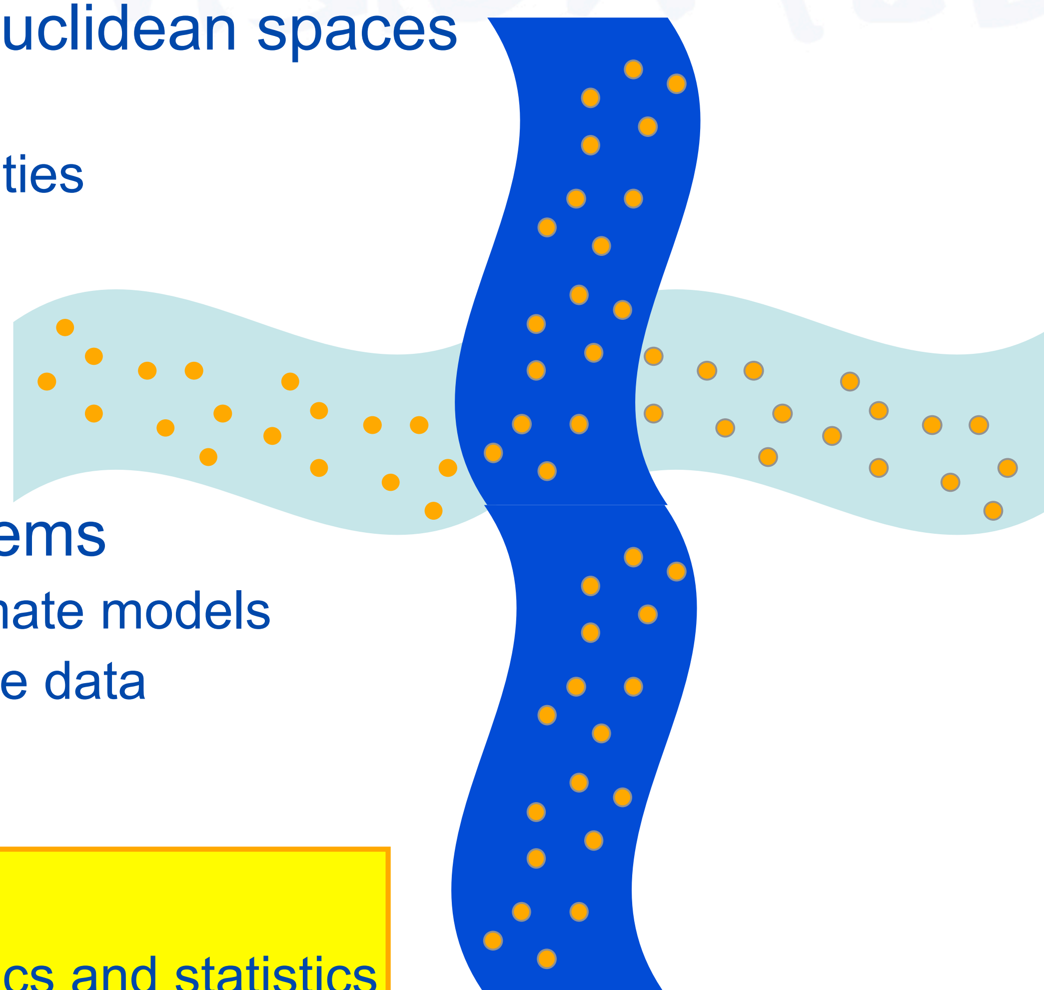


Segmentation problems in dynamic vision

- Segmentation of rigid-body motions from dynamic textures

Clustering data on non Euclidean spaces

- Clustering data on non Euclidean spaces
  - Mixtures of linear spaces
  - Mixtures of algebraic varieties
  - Mixtures of Lie groups
- “Chicken-and-egg” problems
  - Given segmentation, estimate models
  - Given models, segment the data
  - Initialization?
- Need to combine
  - Algebra/geometry, dynamics and statistics



Outline of the tutorial

- Part I: Theory (8.30-10.00)
  - Introduction to GPCA (8.30-8.40)
  - Basic GPCA theory and algorithms (8.40-9.20)
  - Advanced statistical and algebraic methods for GPCA (9.30-10.20)
- Break (10.00-10.30)
- Part II: Applications (10.30-12.10)
  - Applications to motion and video segmentation (10.30-11.20)
  - Applications to image representation & segmentation (11.20-12.10)
- Questions (12.10-12.30)

Part I: Theory

- Introduction to GPCA (8.30-8.40)

- Basic GPCA theory and algorithms (8.40-9.20)
  - Review of PCA and extensions
  - Introductory cases: line, plane and hyperplane segmentation
  - Segmentation of a known number of subspaces
  - Segmentation of an unknown number of subspaces

- Advanced statistical and algebraic methods for GPCA (9.20-10.00)
  - Model selection for subspace arrangements
  - Robust sampling techniques for subspace segmentation
  - Voting techniques for subspace segmentation

Part II: Applications in computer vision

- Applications to motion & video segmentation (10.30-11.20)
  - 2-D and 3-D motion segmentation
  - Temporal video segmentation
  - Dynamic texture segmentation

- Applications to image representation and segmentation (11.20-12.10)
  - Multi-scale hybrid linear models for sparse image representation
  - Hybrid linear models for image segmentation

References: Springer-Verlag 1998

Generalized Principal Component Analysis

Estimation & Segmentation of Geometric Models

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Slides, MATLAB code, papers

http://perception.csl.uiuc.edu/gpca