Shape Signatures

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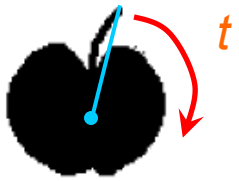
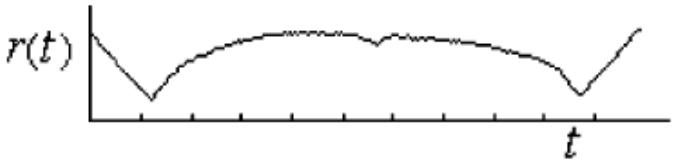
Slides credit:Bob Fisher & Vittorio Ferrari

Shape signatures

Idea
represent shape by a 1D function derived from boundary points

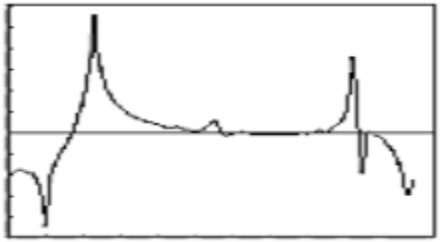
Centroid distance





Curvature

$\kappa(t) = d\theta / dt$



Area, cumulative angles, …

Similarity between two shapes: difference integrated over *t*

Images: A. Zweng; Zhang and Lu

Shape signatures

Cope with challenges

+ invariance to translation

+ invariance to scale (if normalize shape beforehand)

+ invariance to rotation (for tangent angle need orientation normalization)

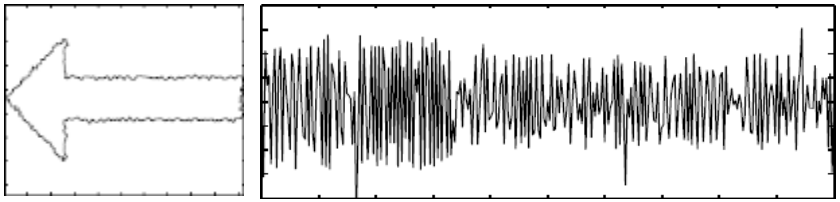
+ point correspondences (if solve for alignment)

* handles shape deformations to some degree

Advantages

+ quite informative

+ deformations affect signature locally



Disadvantages

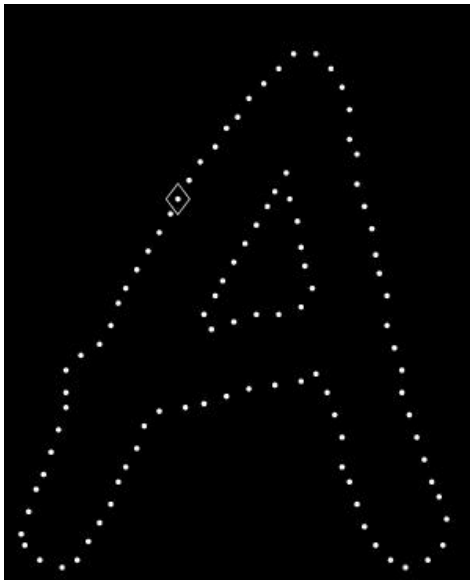
- where to start ? → high matching cost (e.g. DTW)

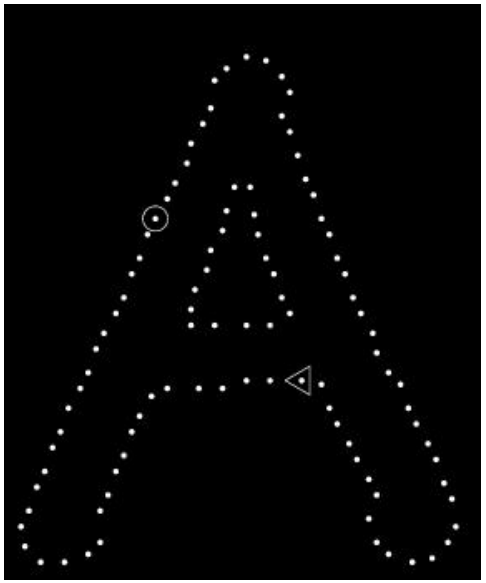
- sensitive to noise (especially when derivatives involved)

Images: S. Manay

Shape Contexts

Belongie et al. PAMI 2002

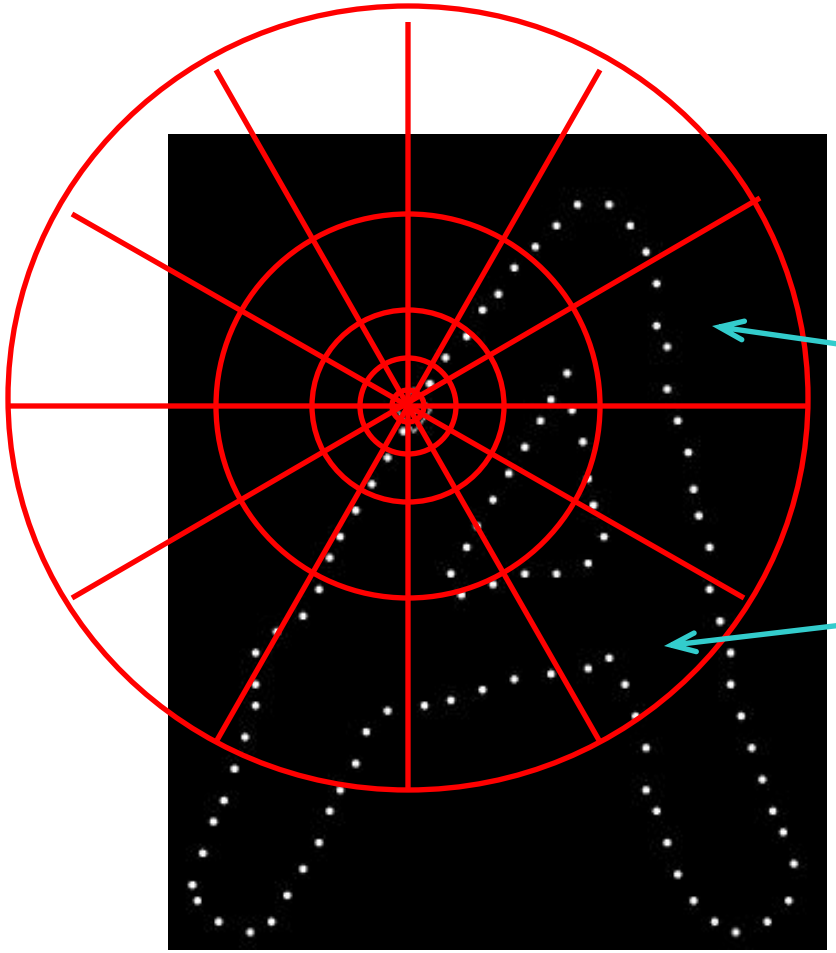




What points on these two sampled contours are most similar? How do you know?

Slide: K. Grauman

Shape context descriptor



Count the number of points inside each bin, e.g.:

Count = 4

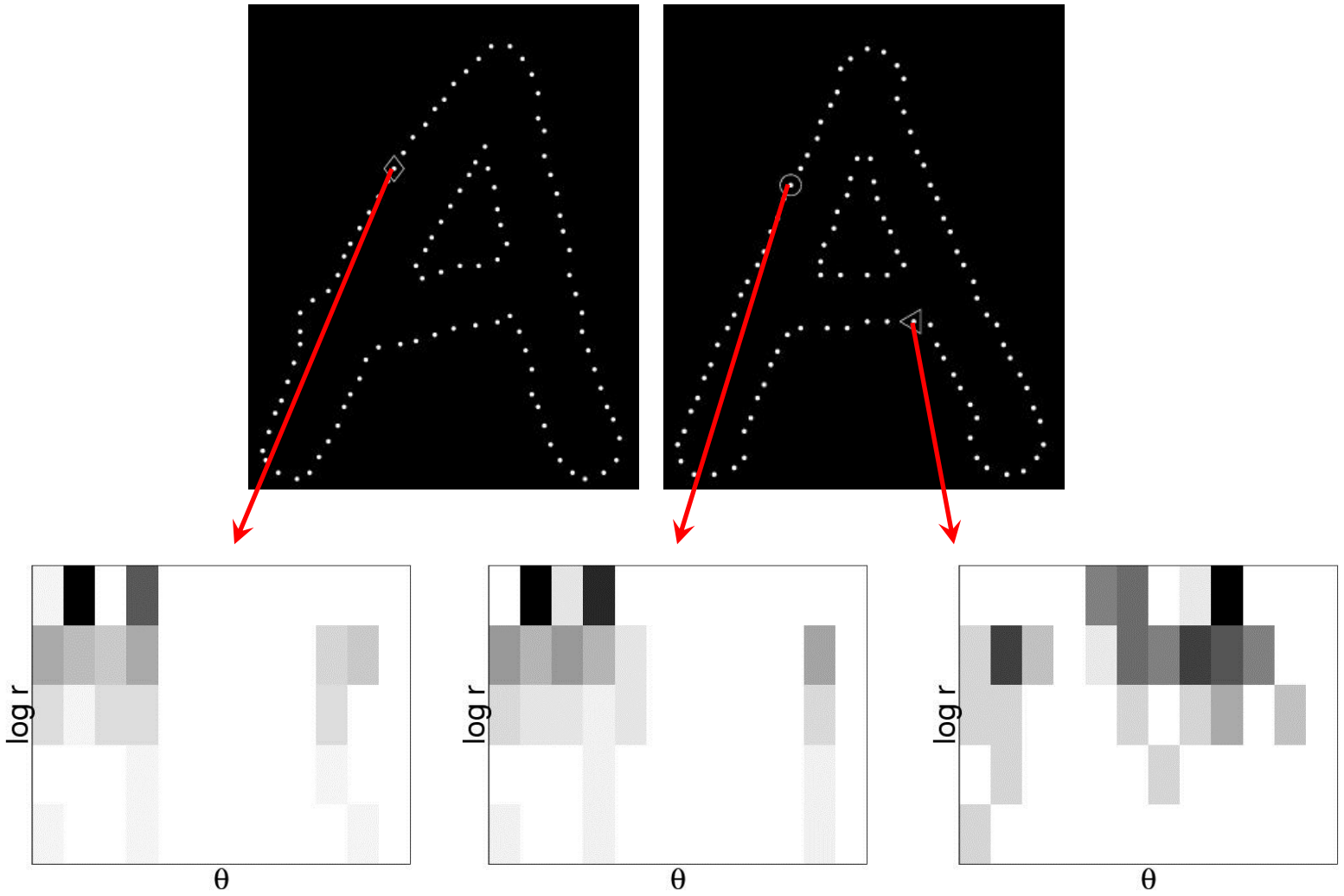
⋮

Count = 10

Compact representation of distribution of points relative to each point

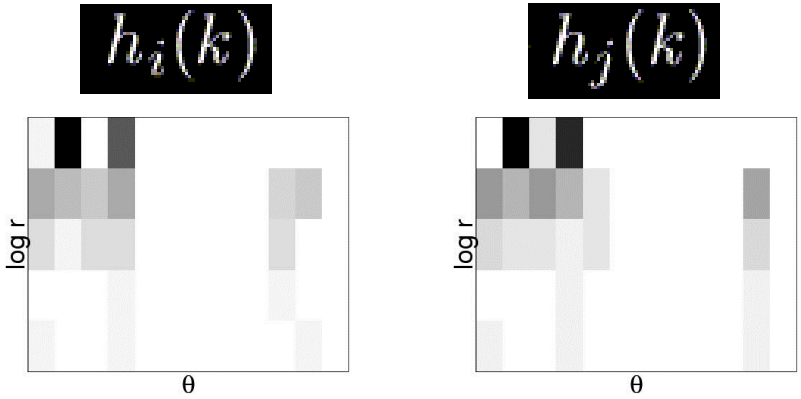
Slide: Grauman / Belongie

Shape context descriptor

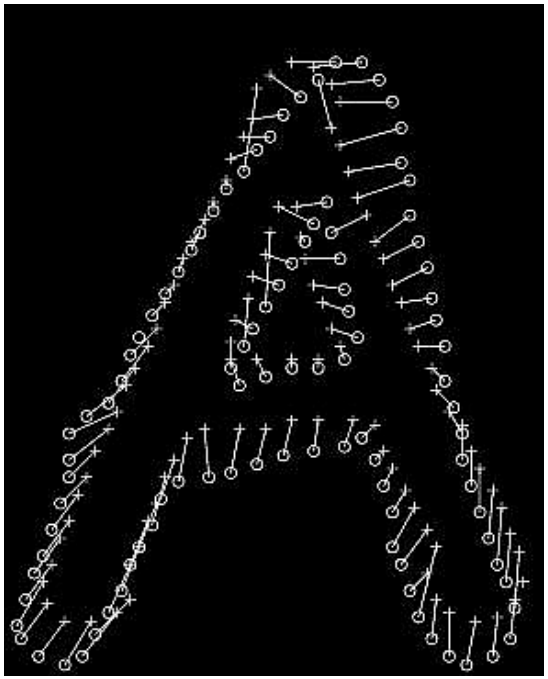


Slide: Grauman / Belongie

Comparing shape contexts



$$C_{ij} = \frac{1}{2}\sum_{k=1}^{K}\frac{[h_i(k) - h_j(k)]^2}{h_i(k) + h_j(k)}$$



Recover correspondences by solving for least cost assignment, using costs C_{ij} (e.g. by the Hungarian algorithm)

Slide edited from: Grauman / Belongie

Shape Signature Discussion

Shape Signatures cope with challenges

+ invariance to translation

+ invariance to scale (if normalize shape beforehand)

- no invariance to rotation (but could be added)

+ some point correspondences

+ handles some shape deformations

Advantages

+ informative: describe points in the context of overall shape

+ deformations handled well: descriptor more sensitive near a point than far from it

Disadvantages

- many parameters (# and size of bins, # iterations, etc.)

- computationally expensive (especially with iterations)

Lecture Overview

+ Method for describing and matching complex shapes
+ Doesn’t need segmentation
+ Based on local point distributions
- Computationally expensive

Further readings

Rothwell et al. ECCV 1992, Canonical frames
(+ historical relevance)

Manay and Soatto ECCV 2004, Integral Signatures
(+ avoid derivative noise)

Ling and Jacobs PAMI 2007, Inner distance
(+ articulations)

Felzenszwalb and Schwartz CVPR 2007, Hierarchical shape models
(+ excellent on the MPEG-7)