ETH

Eidgenössische Technische Hochschule Zürich

Swiss Federal Institute of Technology Zurich

Shape Context and Shape Matching

Computer Vision

Exercise session 8

Shape Matching Objectives

1. Compute shape context descriptors
2. Match a template shape to a target set of points using shape contexts

Overview of Algorithm

Given a set of template and target points:

a. Compute shape context descriptors for both sets of points

b. Estimate cost matrix between two sets of descriptors

c. Use cost matrix to solve the correspondence problem between two sets of descriptors (e.g. with Hungarian algorithm)

d. From the correspondence, estimate a transformation from template to target points (e.g. with Thin Plate Splines) and perform this transformation on the template points

e. Iterate steps a-d.

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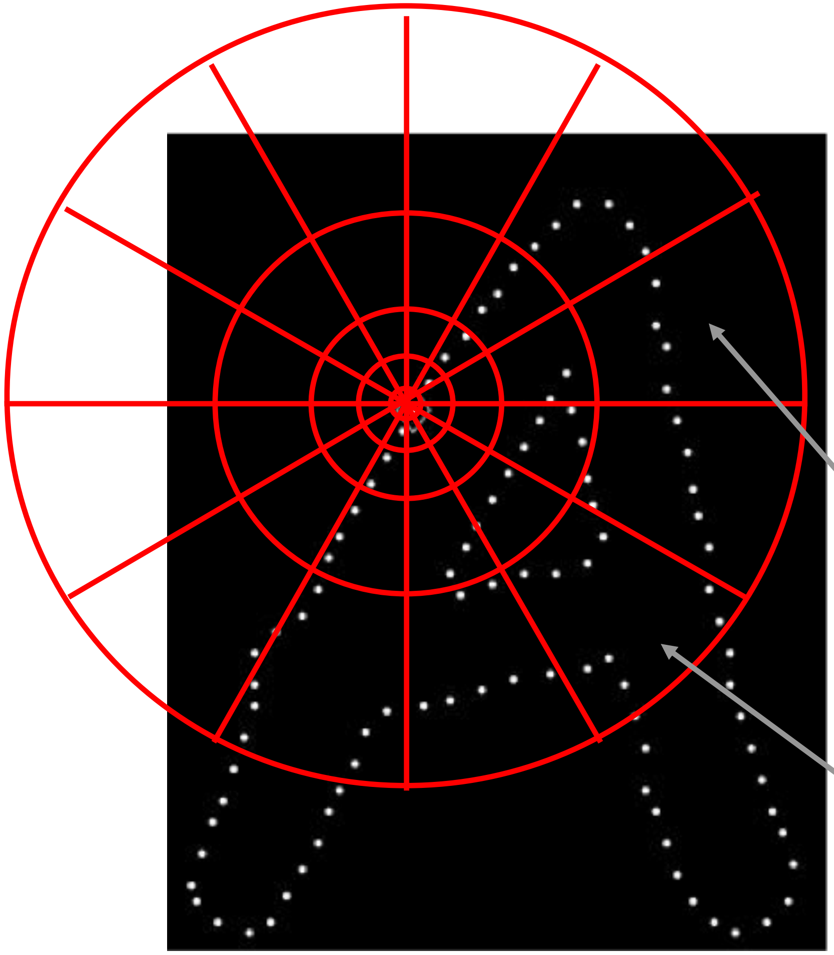
Shape Context Descriptor



- For each point: define a log-polar coordinate system with this point as origin
  - Count number of points inside each bin
  - Compact representation of distribution of points relative to each point

Count = 4

Count = 12

N_bins=4*12=48

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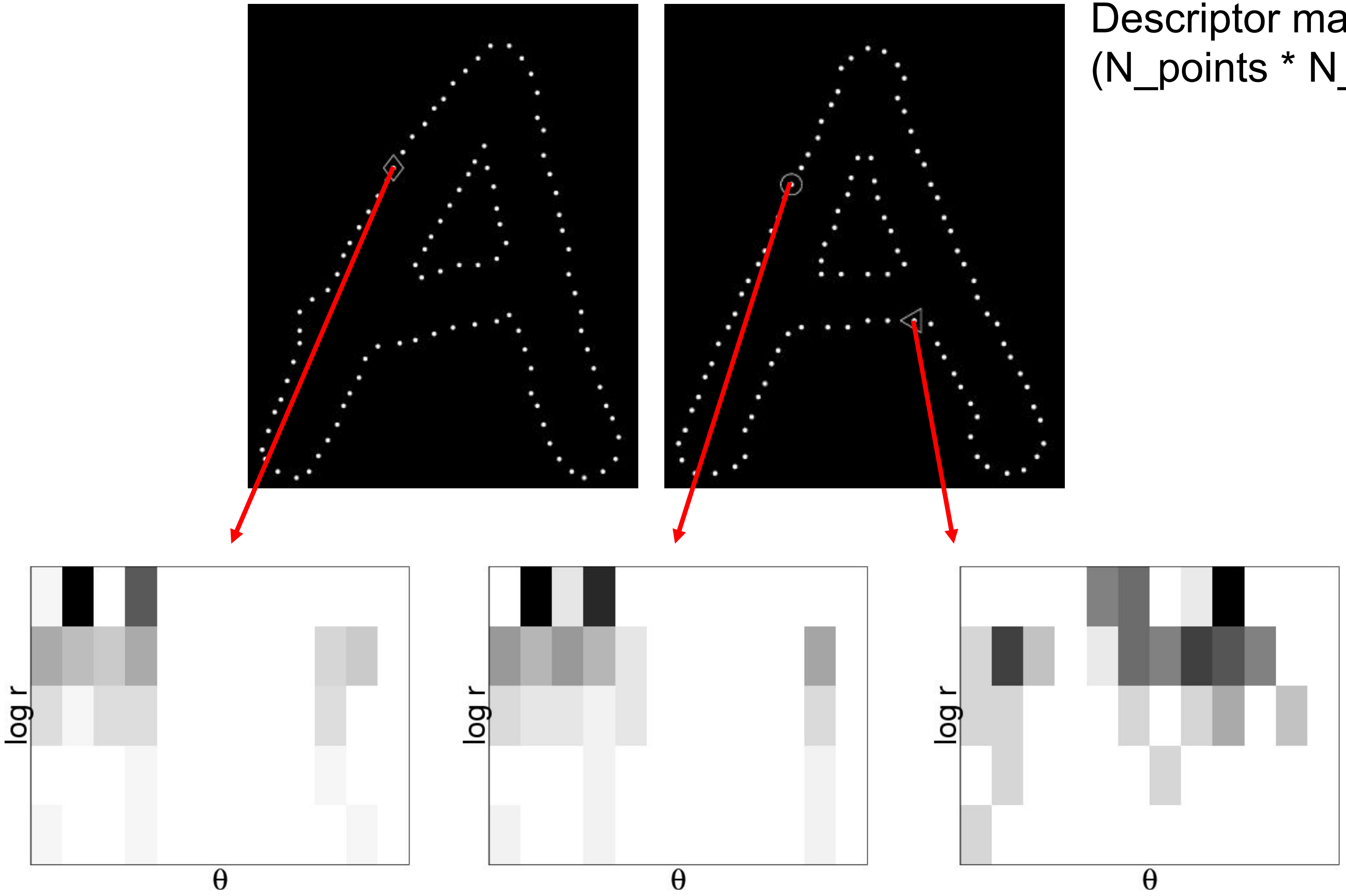
Shape Context Descriptor (2)

Descriptor matrix:
(N_points * N_bins)



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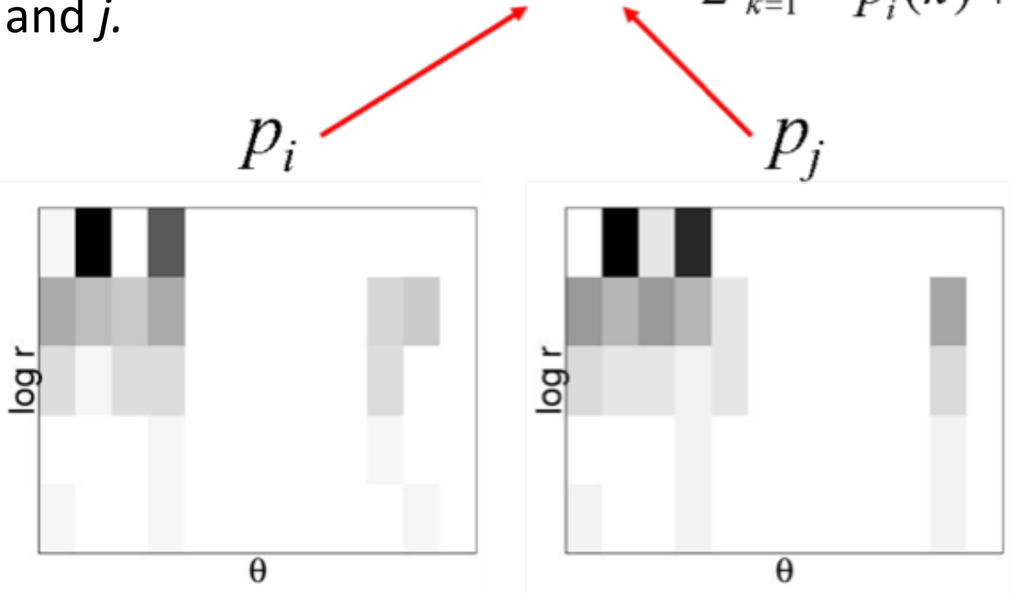
Matching Costs

Chi-squared distance between descriptors *i* and *j.*

$$C_{ij} \equiv C(p_i, p_j) = \frac{1}{2}\sum_{k=1}^{K}\frac{\left[p_i(k) - p_j(k)\right]^2}{p_i(k) + p_j(k)}$$



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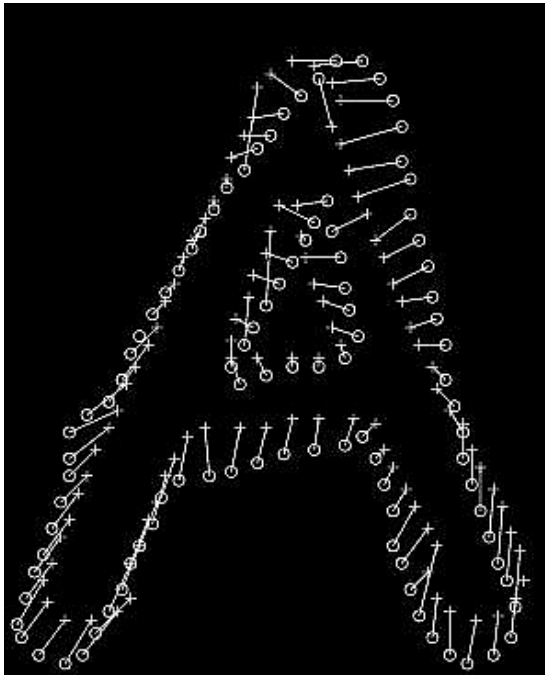
Correspondence Problem



- Minimize total cost of matching such that matching is one-to-one
- E.g. with Hungarian algorithm
- Code provided in hungarian.m

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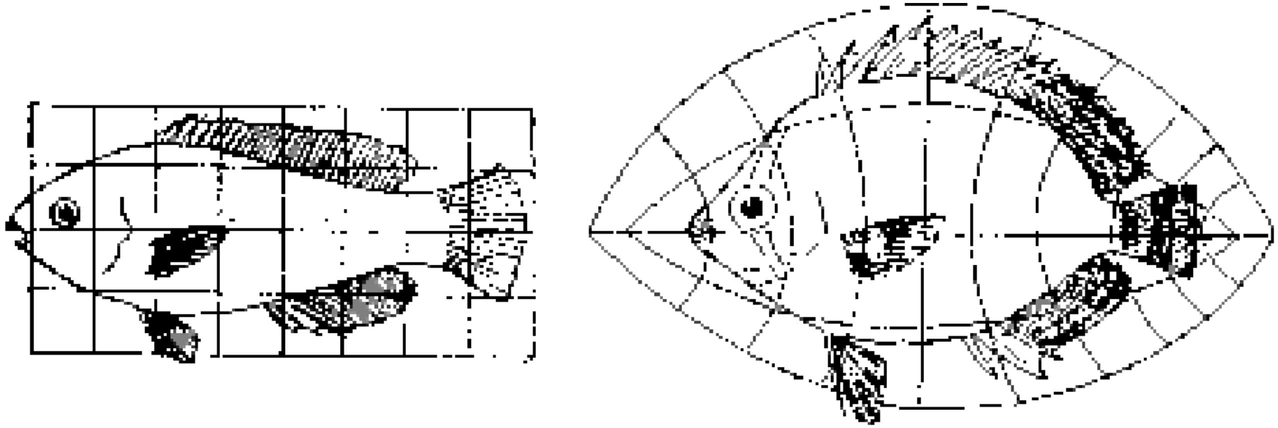
Transformation



Model

Target

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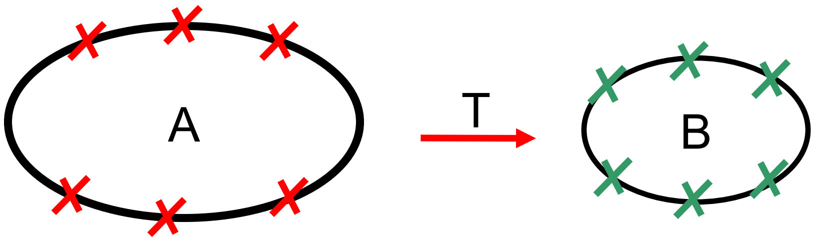
Thin Plate Splines(1)



- We are given a set of correspondences

- We want to estimate the function T: $R^2 \rightarrow R^2$ that transforms A into B

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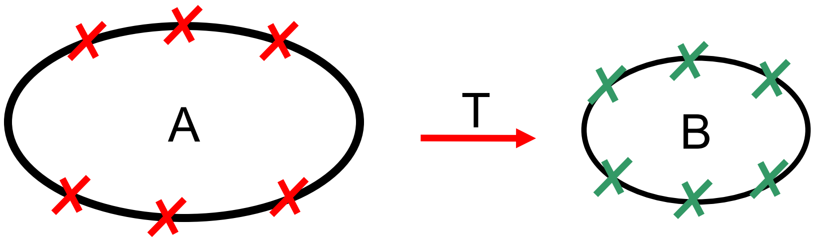
Thin Plate Splines(1)



$$f(x,y) = a_1 + a_x x + a_y y + \sum_{i=1}^{n} \omega_i U(\| (x_i, y_i) - (x,y) \|)$$

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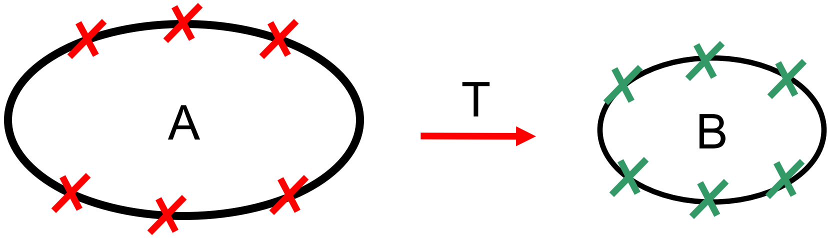
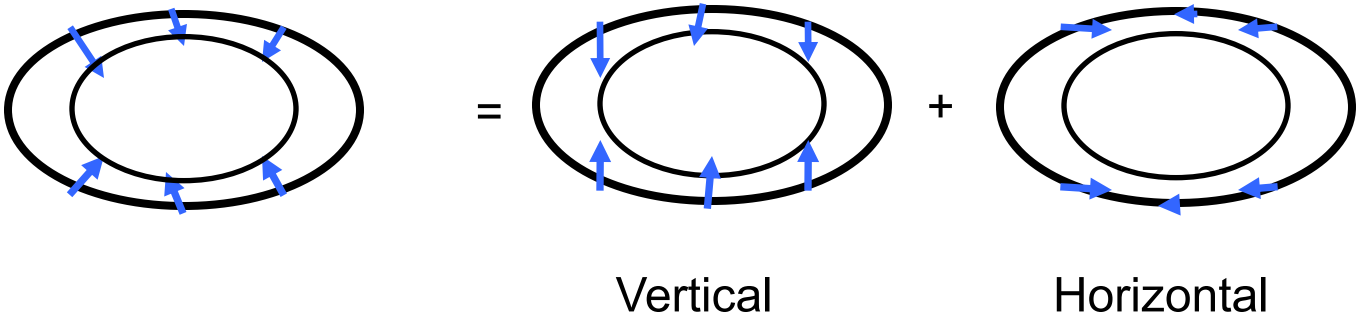
Thin Plate Splines(2)



- From the correspondences, we get a displacement:



- Each component (vertical and horizontal) is a single function that we want to interpolate with a TPS.

$$T(x,y) = (f_x(x,y), f_y(x,y))$$

Overview of Algorithm

Given a set of template and target points:

a. Compute shape context descriptors for both sets of points

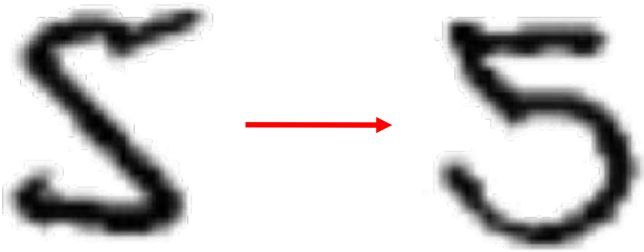
b. Estimate cost matrix between two sets of descriptors

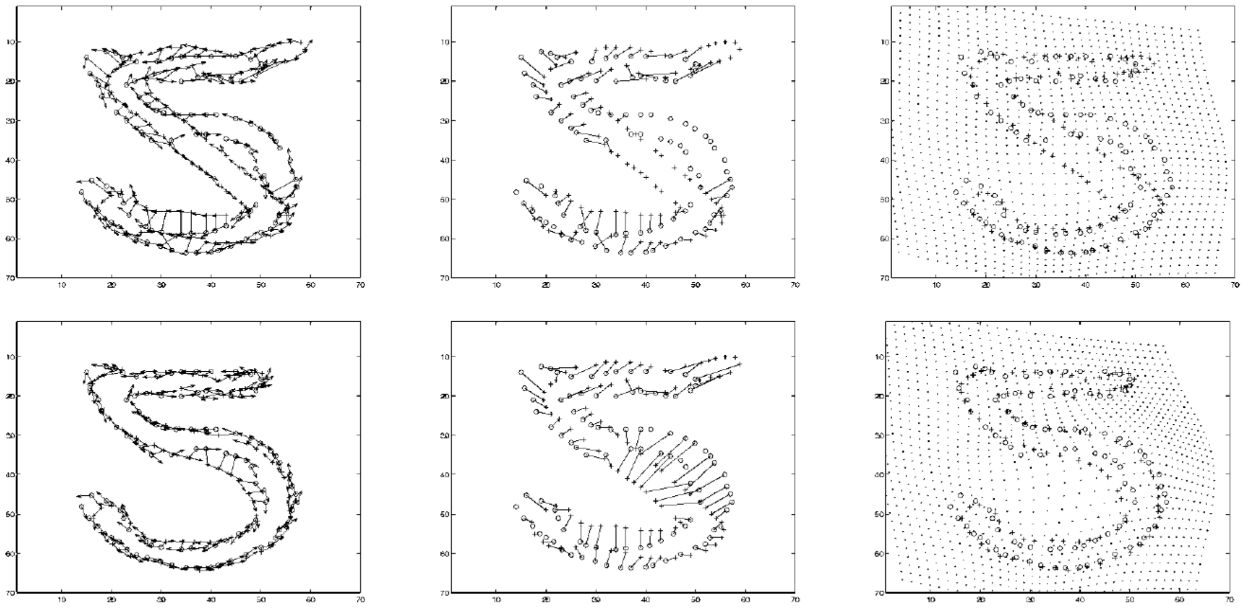
c. Use cost matrix to solve assignment problem between two sets of descriptors (e.g. with Hungarian algorithm)

d. From the assignment, estimate a transformation from template to target points (e.g. with Thin Plate Splines)

e. Iterate steps a-d.

Example 1 - Numbers





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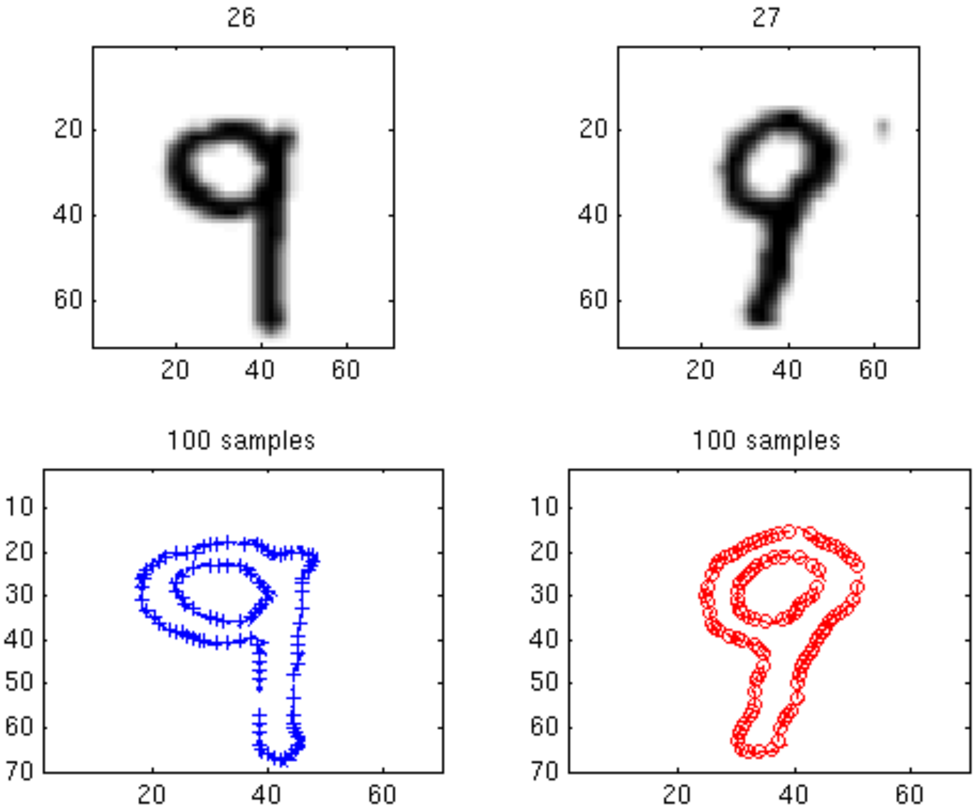
Example 2 - Numbers



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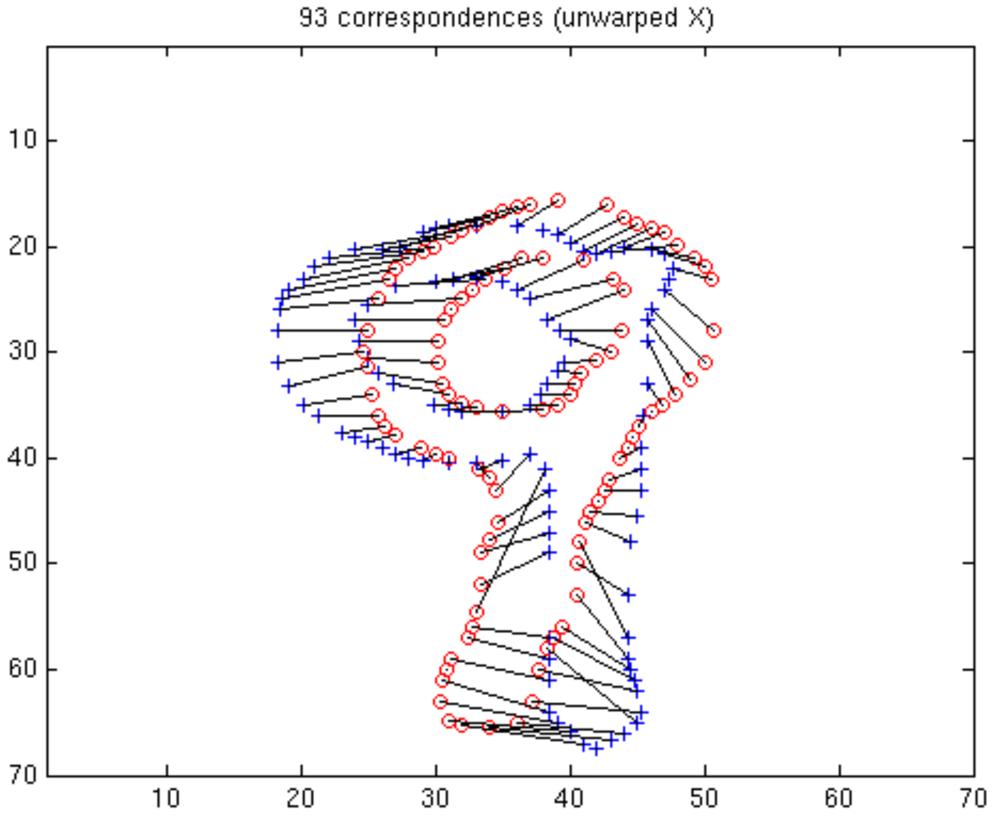

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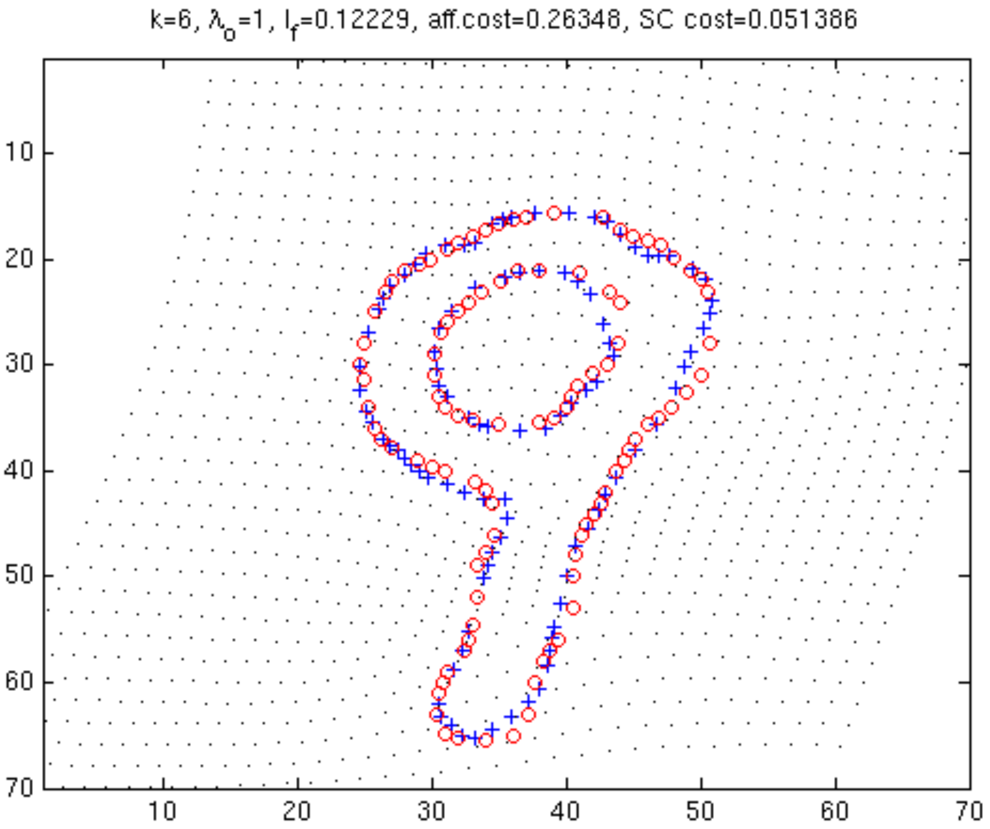

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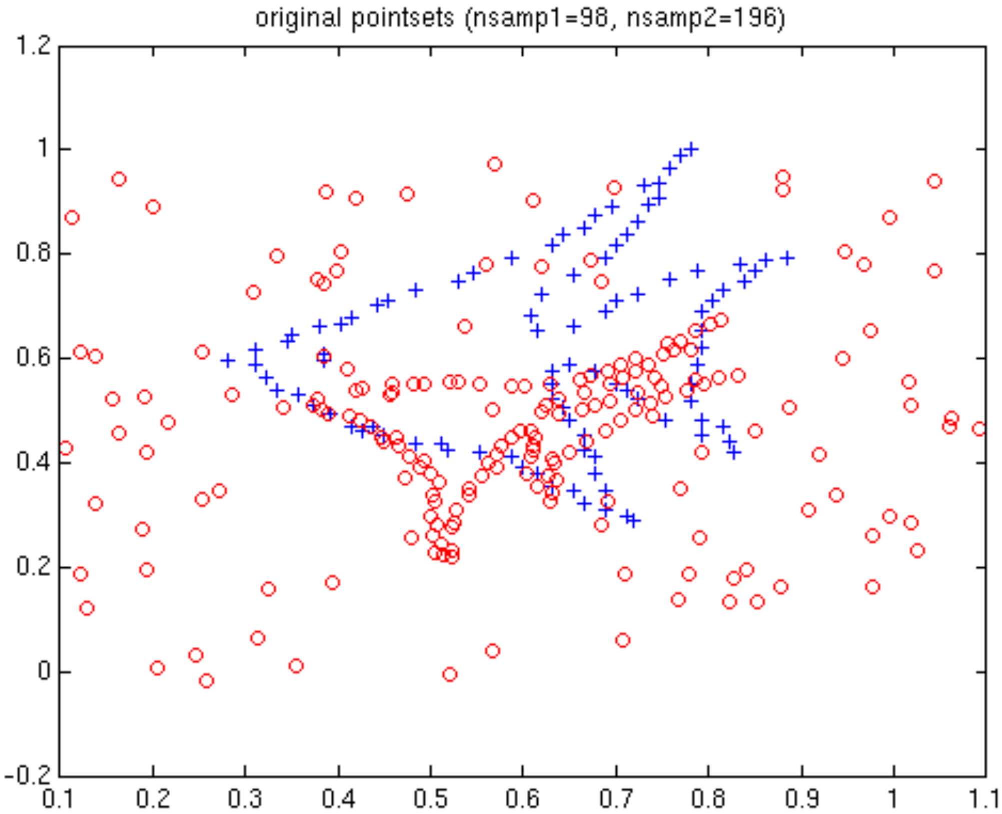
Example 3 - Fish



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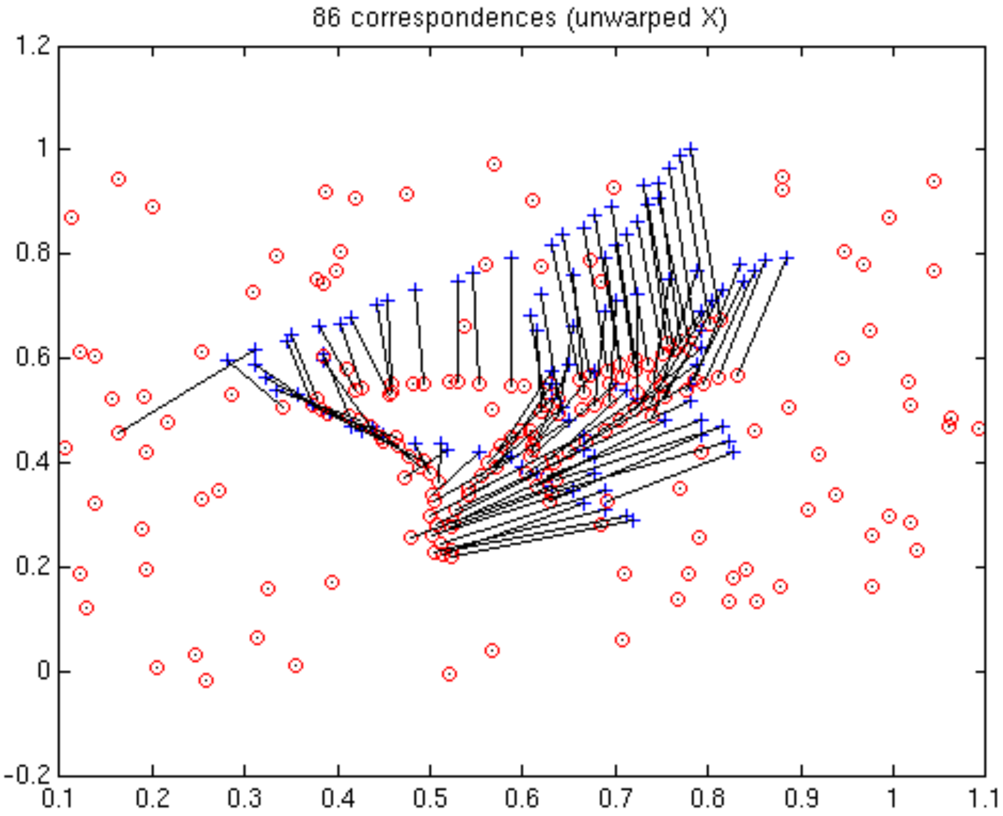

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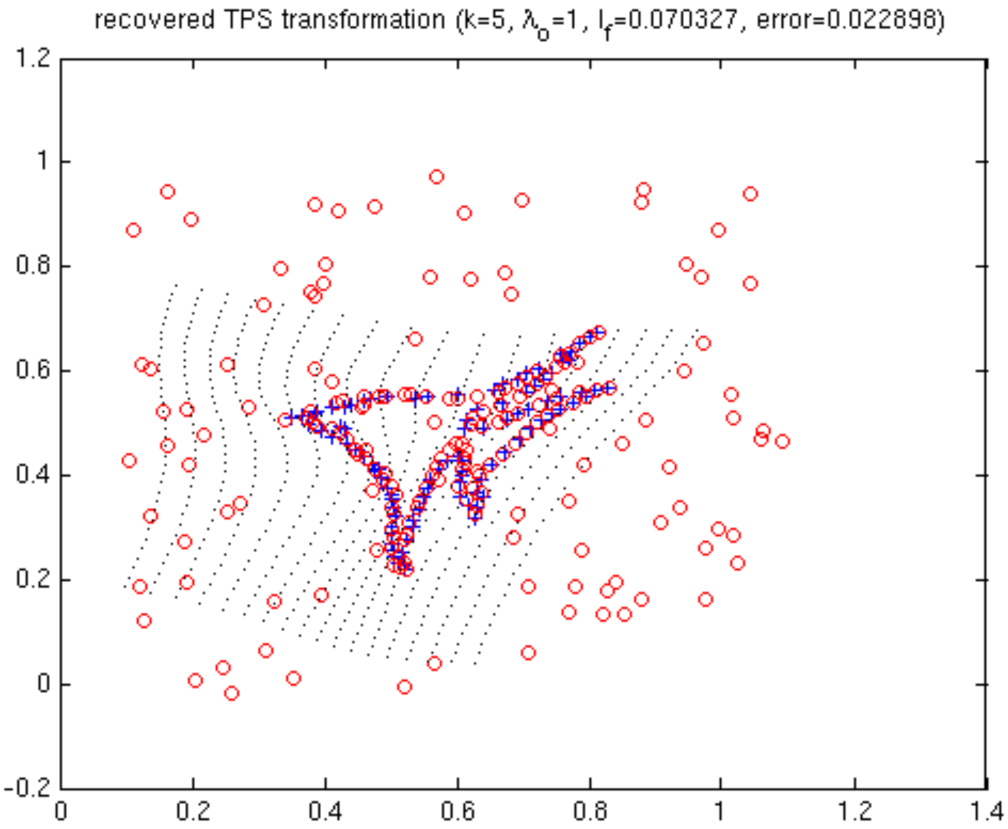

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- implement required functions
  - set lamba in shape_matching.m
  - sc_compute(), chi2_cost(), tps_model()
- include a main.m to run the code
  - load shapes dataset.mat to test your code
  - Use get_samples.m to sample points
- write your report
  - explain main steps of your implementation
  - include images, comment the results
  - answer the questions in the hand-out paper