ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

BIWI Computer Vision

Shape Context, Shape Matching, and Shape classification

Computer Vision

Exercise session 8

Teaching assistant:

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Assignment Tasks:

1. Shape Matching

1. Shape based Image Classification

Hand-out: 22-11-2018
Hand-in: 06-12-2018 23:00

Task 1: 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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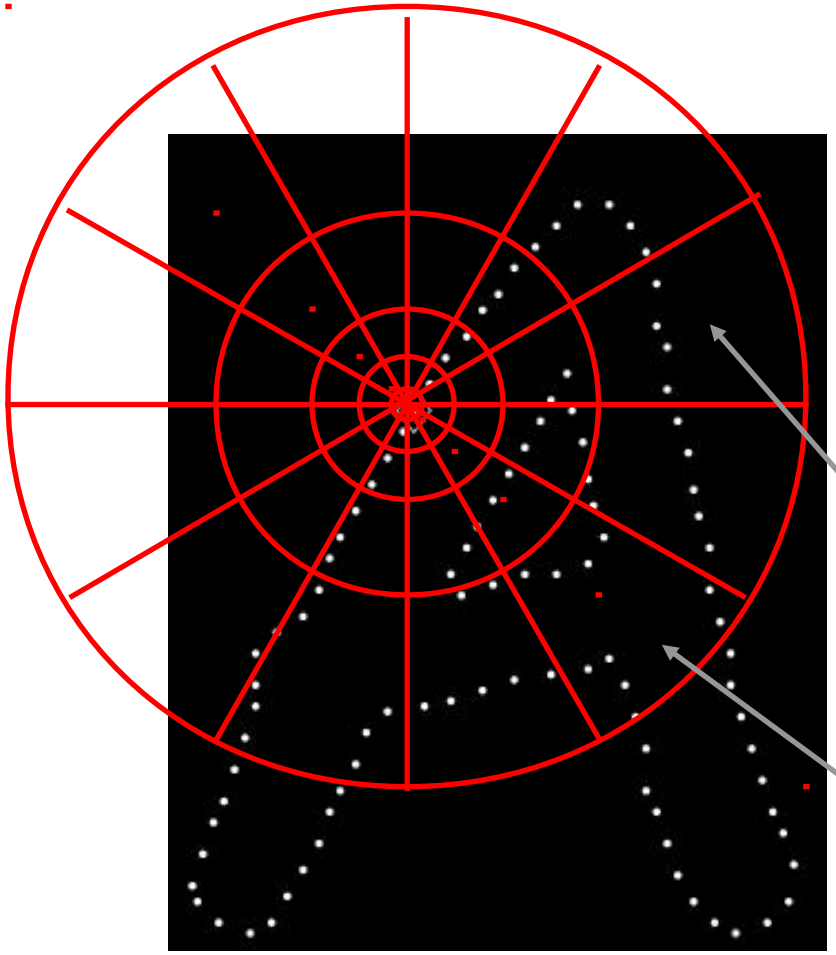
Shape Context Descriptor



- Count number of points inside each bin
- Compact representation of distribution of points relative to each point

Count = 4

Count = 10

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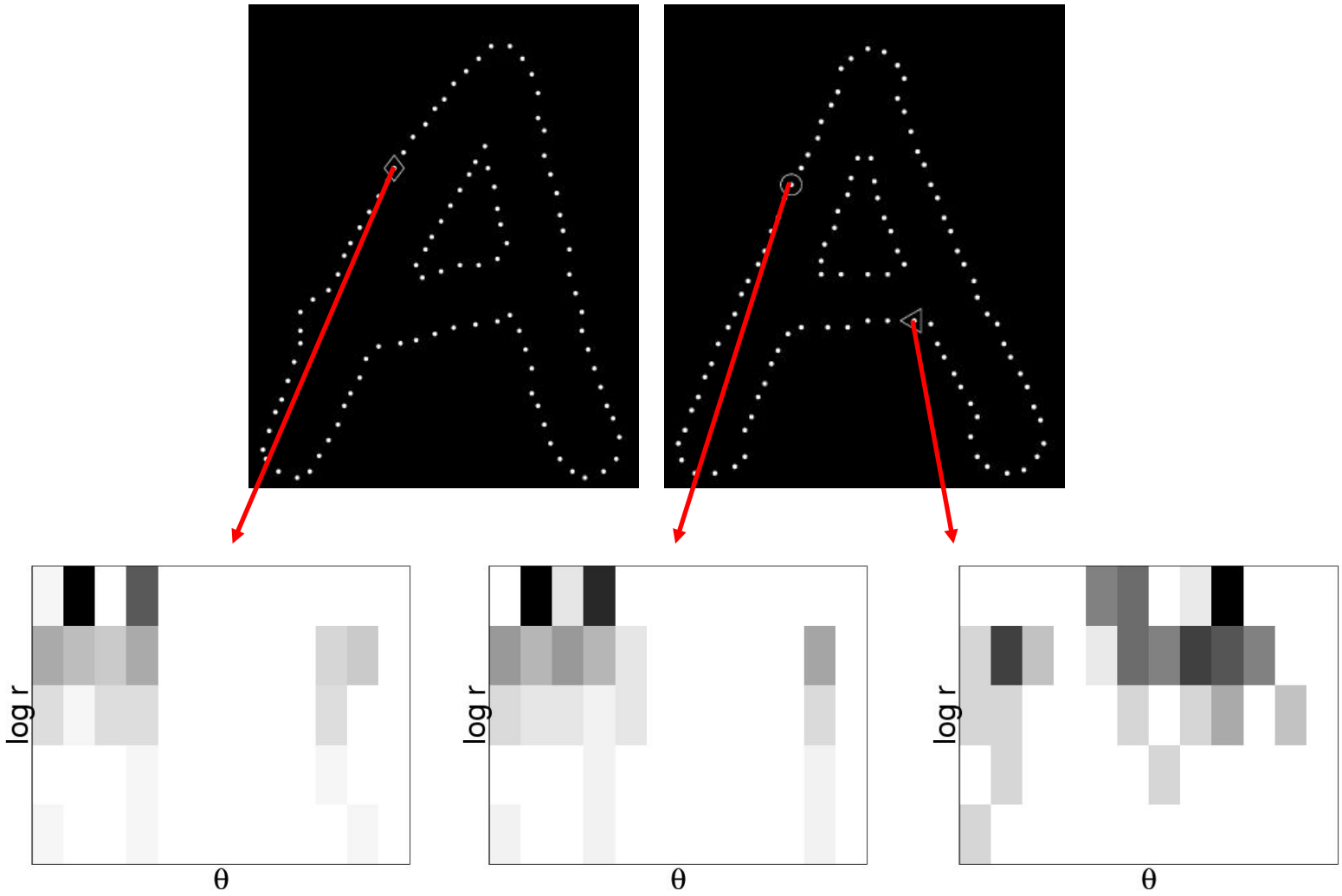
Shape Context Descriptor (2)



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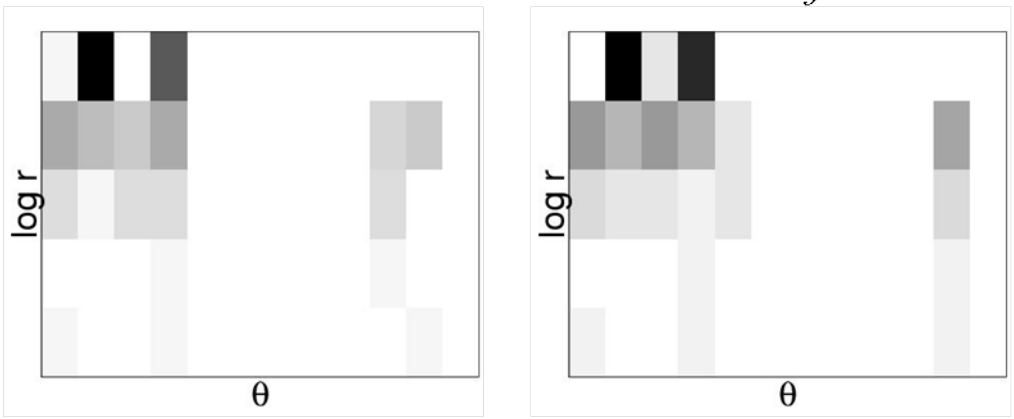
Matching Costs

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

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

p_i p_j



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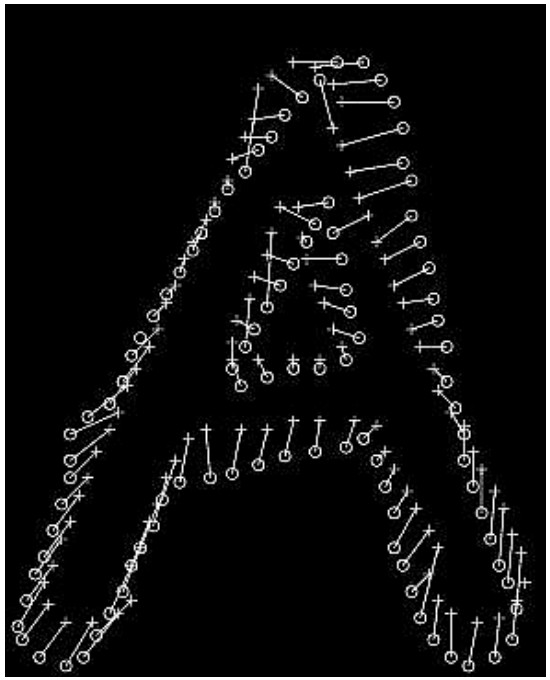
Correspondence Problem



- Minimize total cost of matching such that matching is one-to-one
- E.g. with Hungarian algorithm

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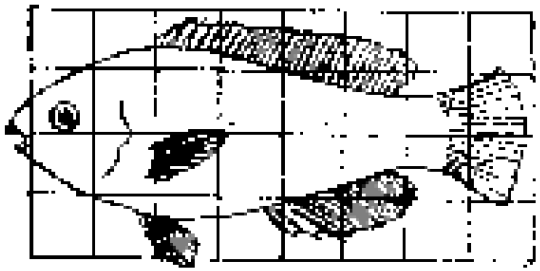
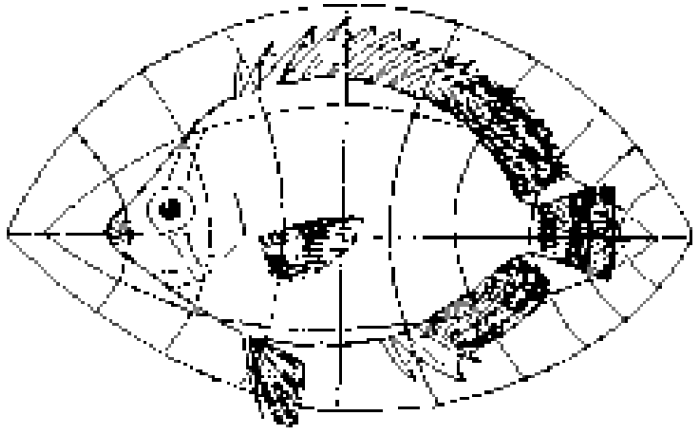
Transformation



Model



Target

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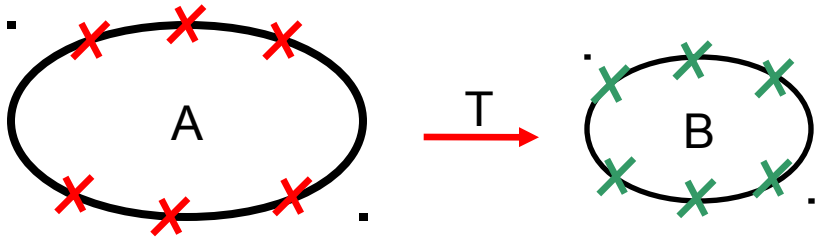
Thin Plate Splines(1)



- 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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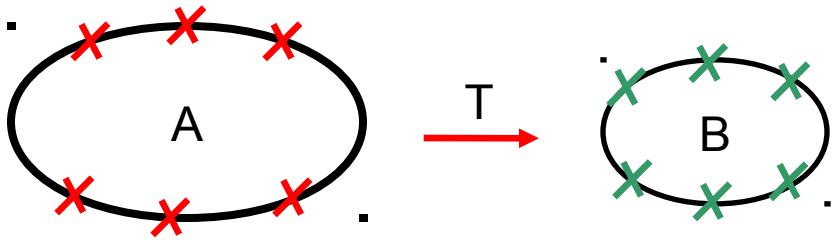
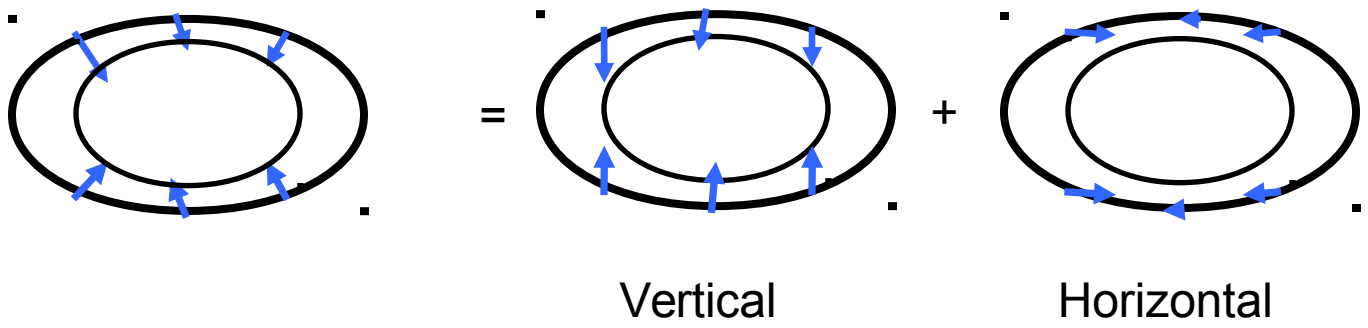
Thin Plate Splines(2)

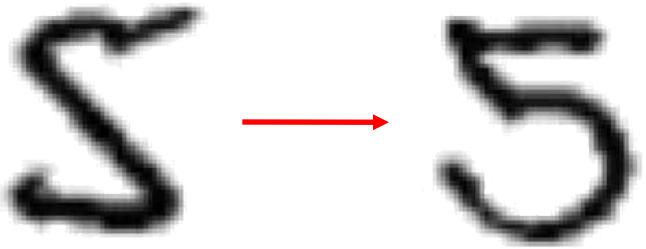


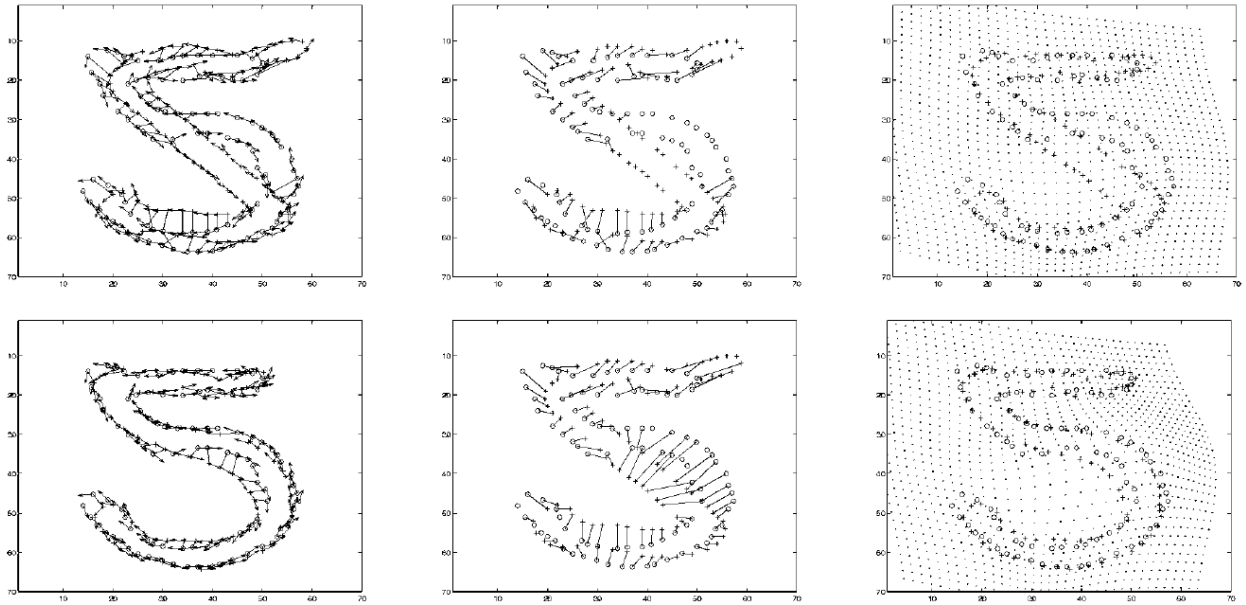
•From the correspondences, we get a displacement:



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

Thin Plate Splines(3)





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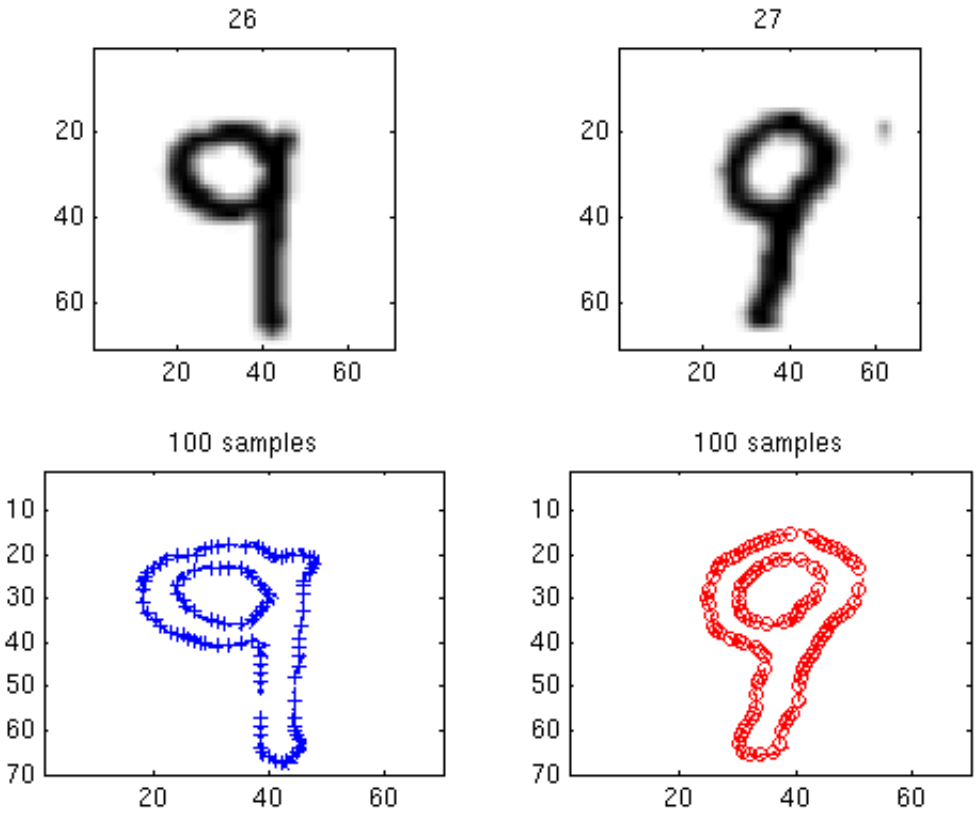
Example 1 - Numbers



Task 1

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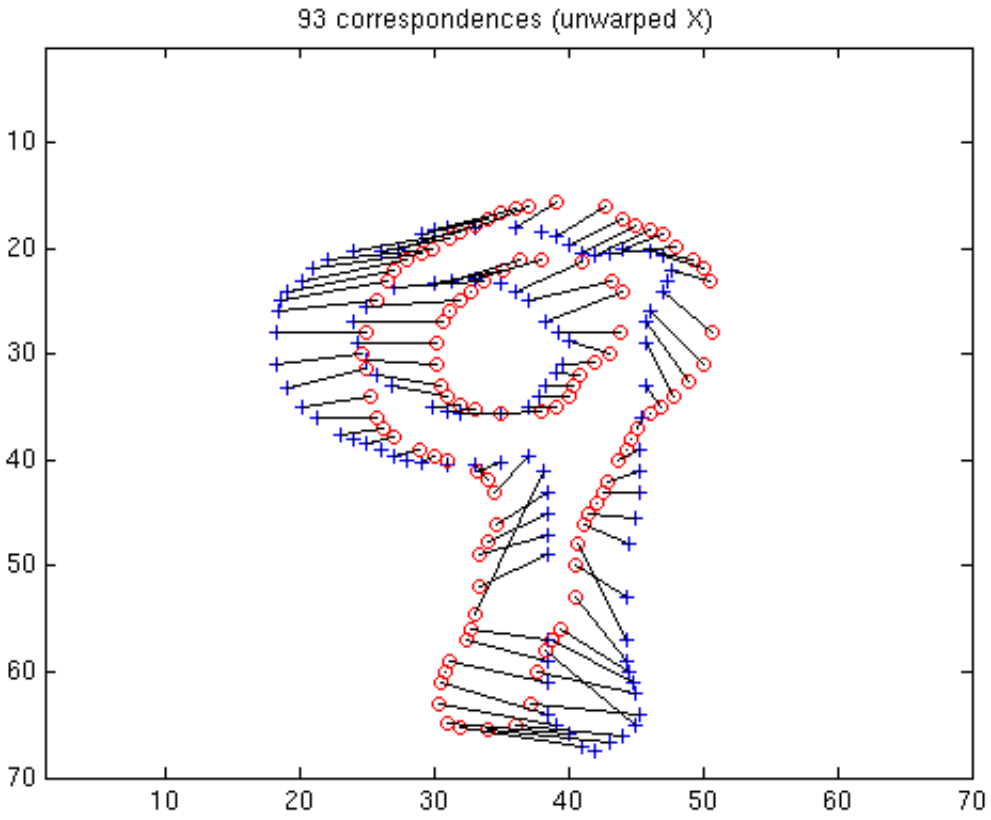
Example 1 - Numbers



Task 1

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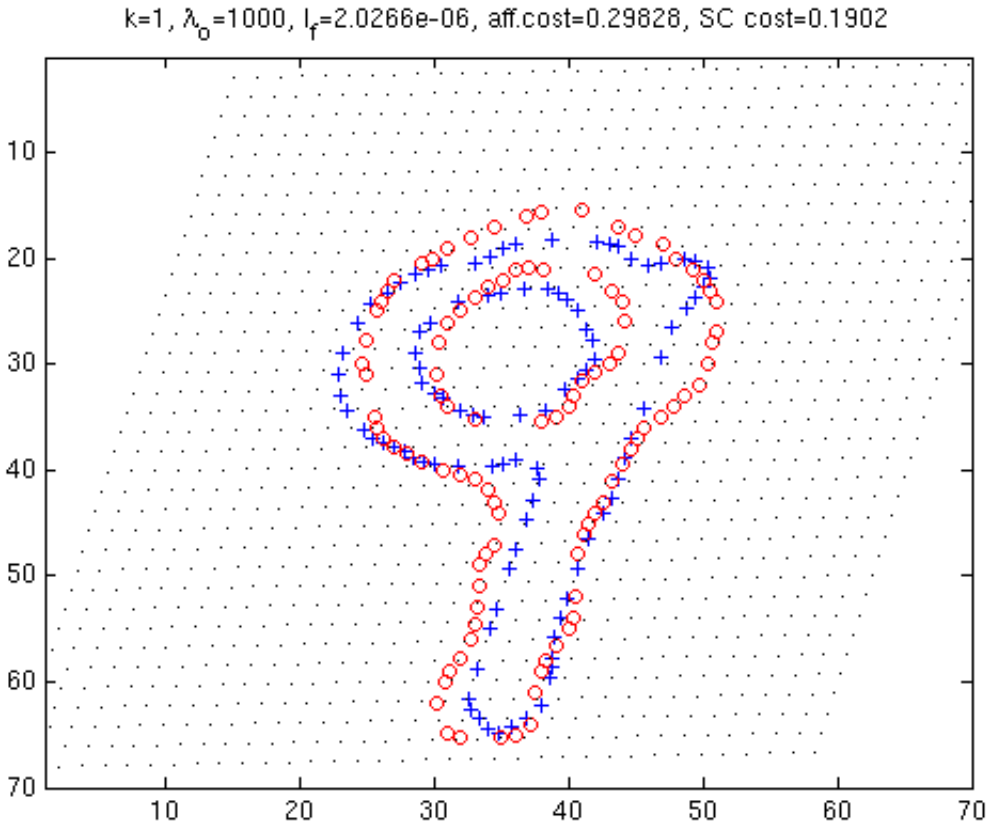

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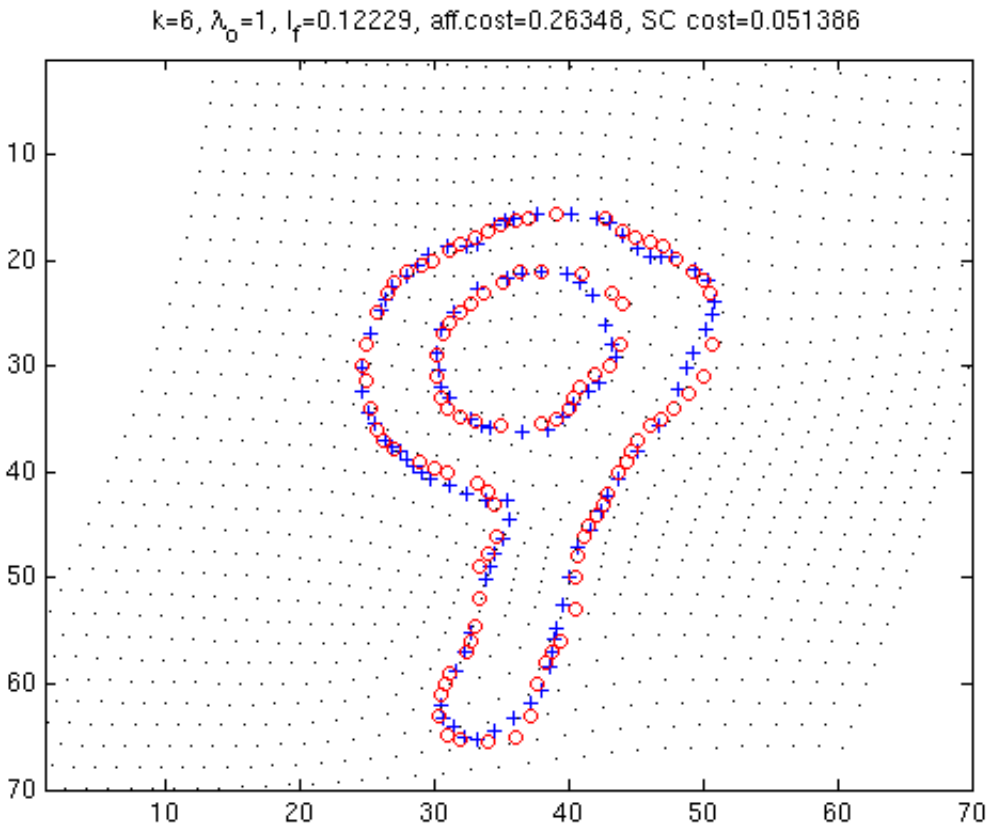

Task 1

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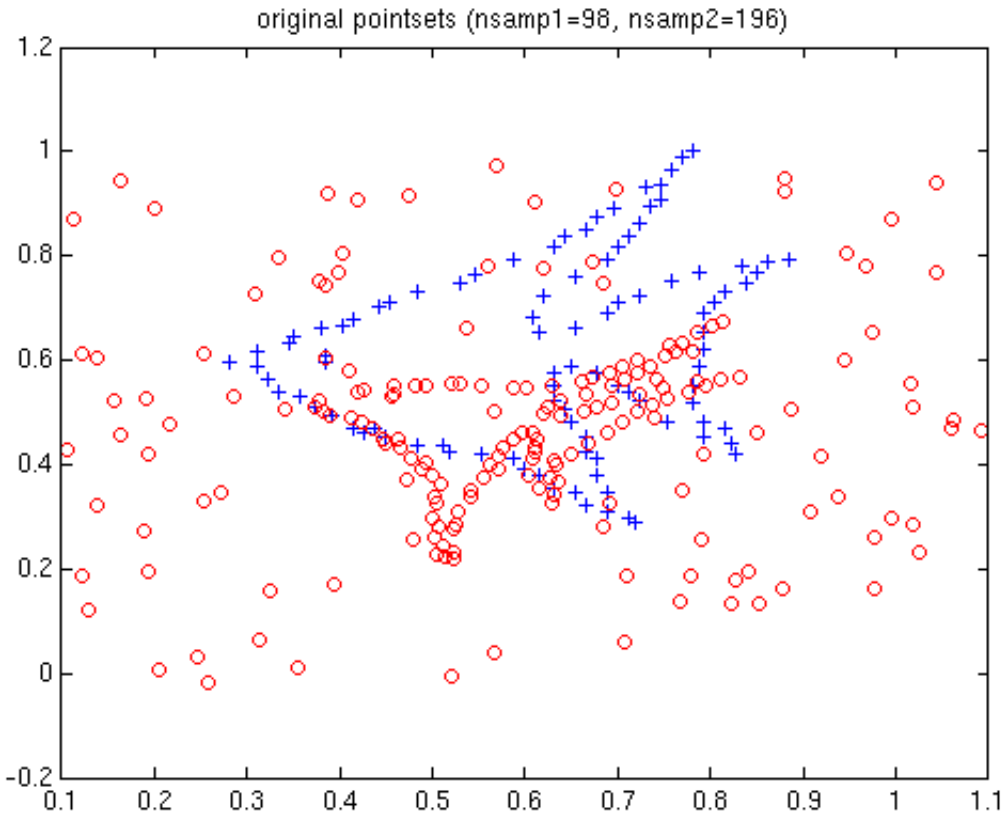
Example 2 - Fish



Task 1

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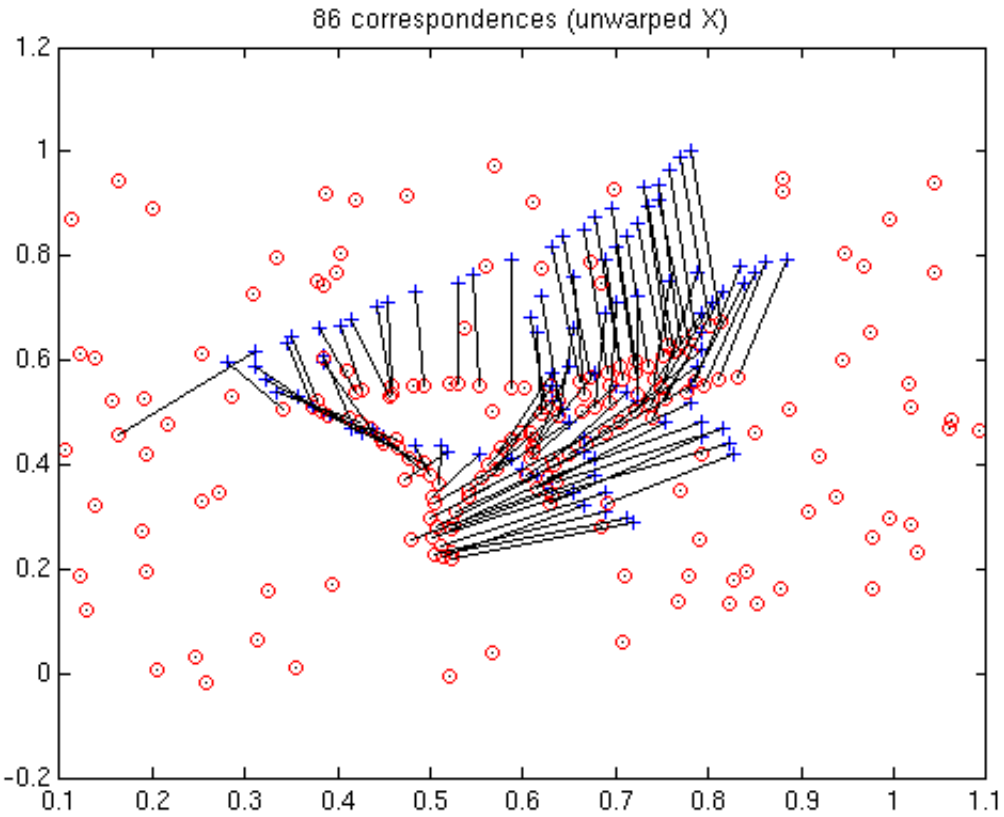

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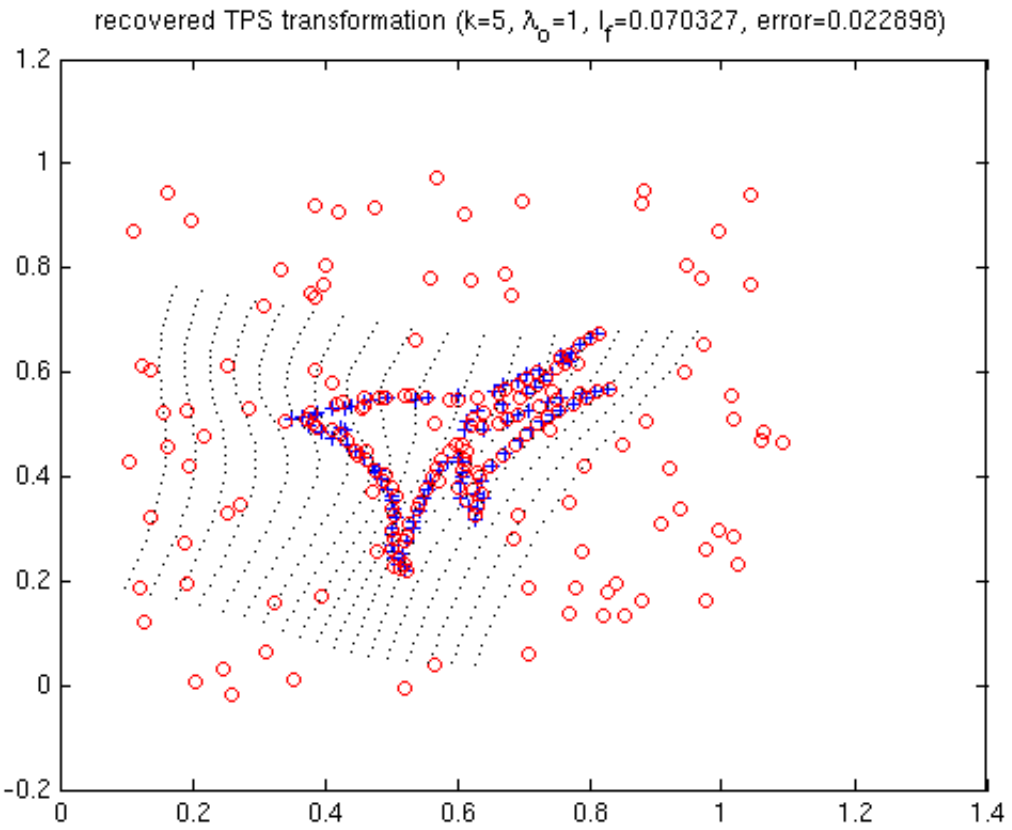
Example 2 - Fish



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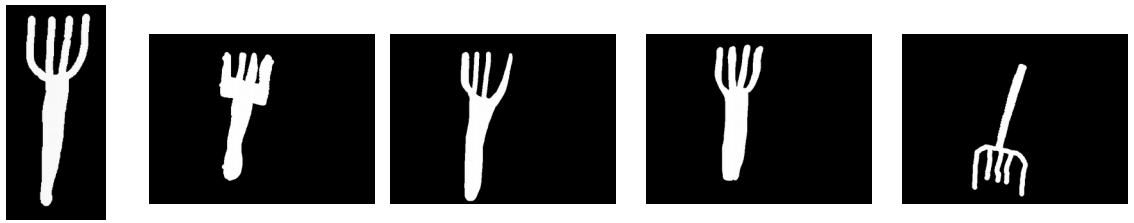
Task 2: Shape based Image Classification Objectives

1. Design a k-nearest-neighbour classifier
2. Perform shape based image classification
   - using the k-nearest-neighbour classifier
   - leave-one-out cross validation scheme

Dataset

- 15 images containing instances of 3 classes:
  - heart,
  - fork
  - watch



Design a k-nearest-neighbour classifier

- 2D shape matching for a considered image shape with all the other 14 image shapes
- compute the bending energies E_1, ..., E_{14}
- define the k-nearest-neighbours of the image shape based on E_1, ..., E_{14}
- classify the considered image using the labels of the k-nearest-neighbours

Shape based Image Classification

- for every image in the dataset (15 images)
  - k-nearest-neigbour classifier using the other 14 images (labels are known)
  - classification performance:

    inferred label = ground truth label?

- Send your reports and your implementation of the required Matlab functions
  - explain main steps of your implementation
  - comment the results
  - answer the questions in the hand-out paper
- Ask questions: email to yawei.li@vision.ee.ethz.ch