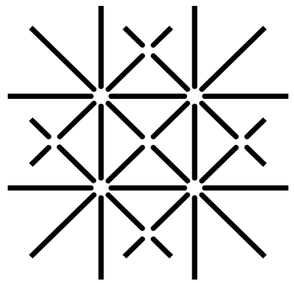

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# Fitting models to images

# Fitting images

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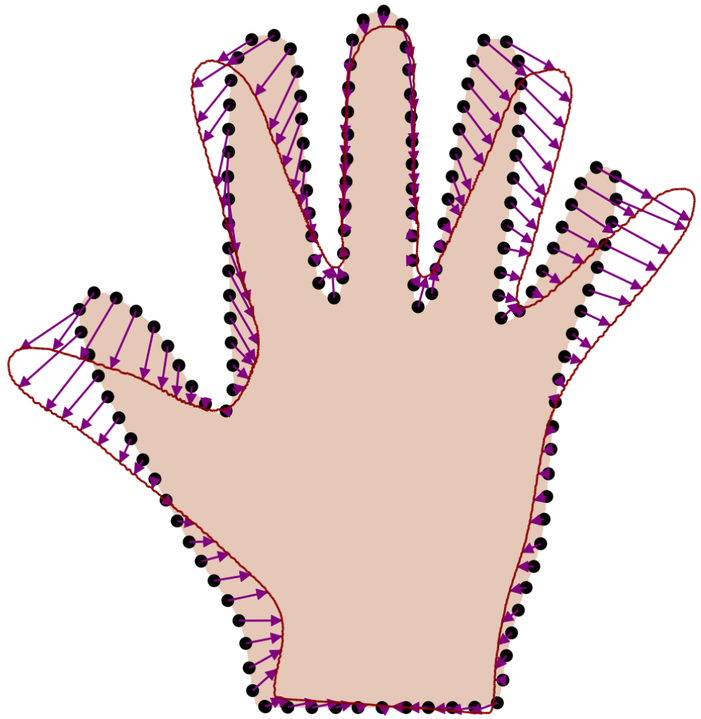
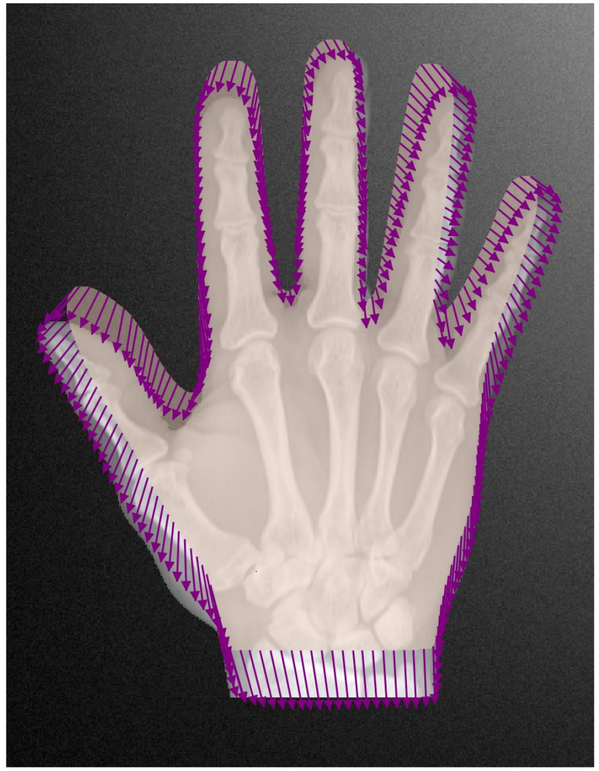


Surfaces / Contour



Images

# Surface vs Image Fitting

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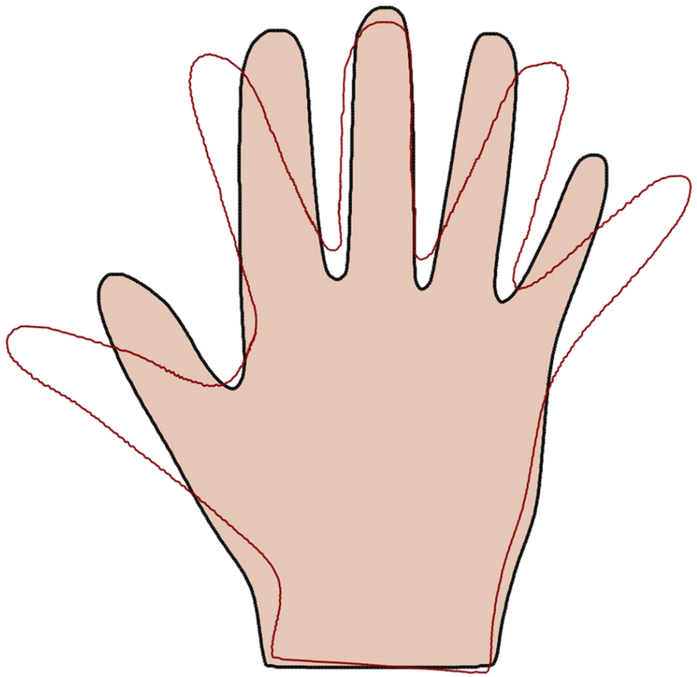

Explicit representation of a shape $\Gamma_T = \{x \,|x \in \mathbb{R}^2\}$

Only intensities given

# The segmentation problem

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- Goal: Partition the image into semantically meaningful regions
  - Very difficult, active research problem
- A successfully fitted model defines a segmentation

Model fitting needs to deal with the segmentation and the correspondence problem.

# Segmentation by model fitting

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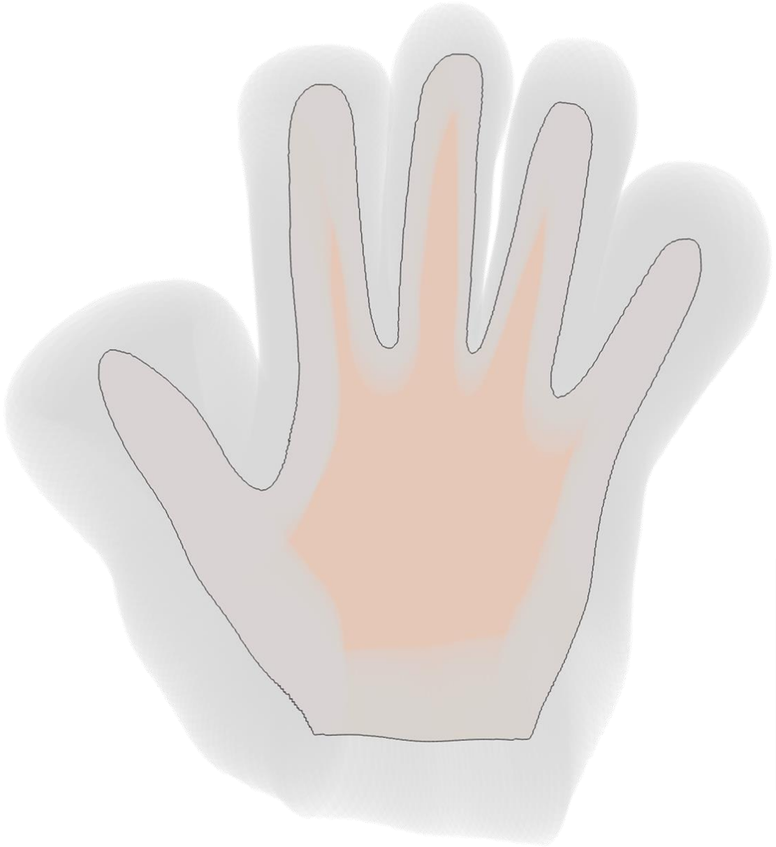

- Shape models encode prior knowledge about
  - which shape we want to find
  - the shape variability.

Image segmentation is the most popular application of shape models

# ICP for image segmentation?

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Iterative Closest Point Algorithm (ICP)

- Classical algorithm for minimizing the distance between two point sets.

Idea:

1. Find closest points between target and reference
2. Estimate transformation based on these corresponding points
3. Transform the reference points using the transformation
4. Iterate

Besl, P. J., & McKay, N. D. (1992, April). Method for registration of 3-D shapes.
In *Robotics-DL tentative* (pp. 586-606). International Society for Optics and Photonics.

# Active Shape Model Fitting

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Active shape model Algorithm (ASM)

- Classical algorithm for fitting a model to an image.

Idea (sketch):

1. Find best matching points between model and target
2. Estimate transformation based on these corresponding points
3. Transform the reference points using the transformation
4. Iterate

Cootes, T. F., Taylor, C. J., Cooper, D. H., & Graham, J. (1995). Active shape models-their training and application. *Computer vision and image understanding*, *61*(1), 38-59.

# Finding matching points

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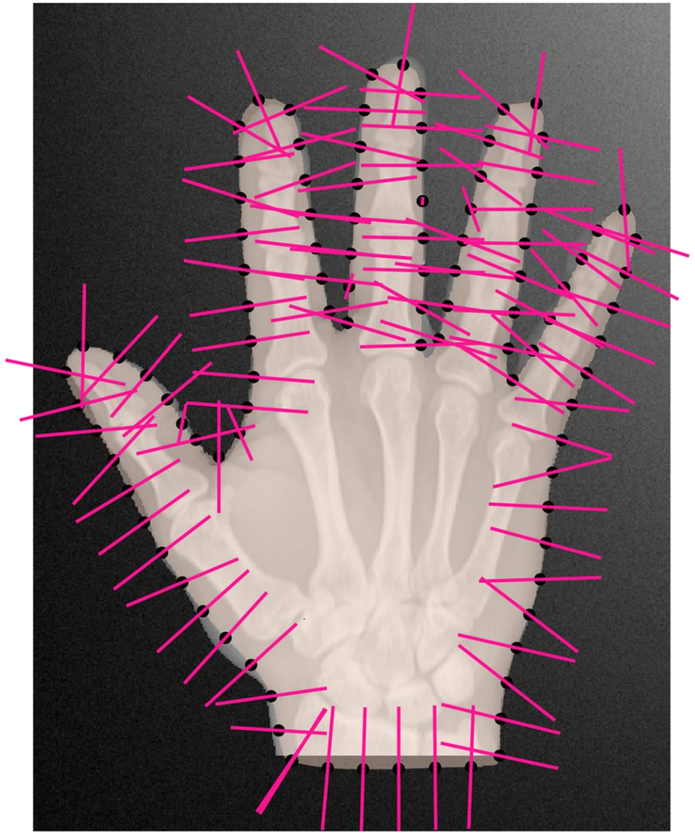

Modelling step:

- Define for each point of the reference an intensity model of a neighbourhood around the point.
  - Neighbourhood usually defined in normal direction.

Search step:

- Choose most probable point in the image as corresponding point.

# Modelling step

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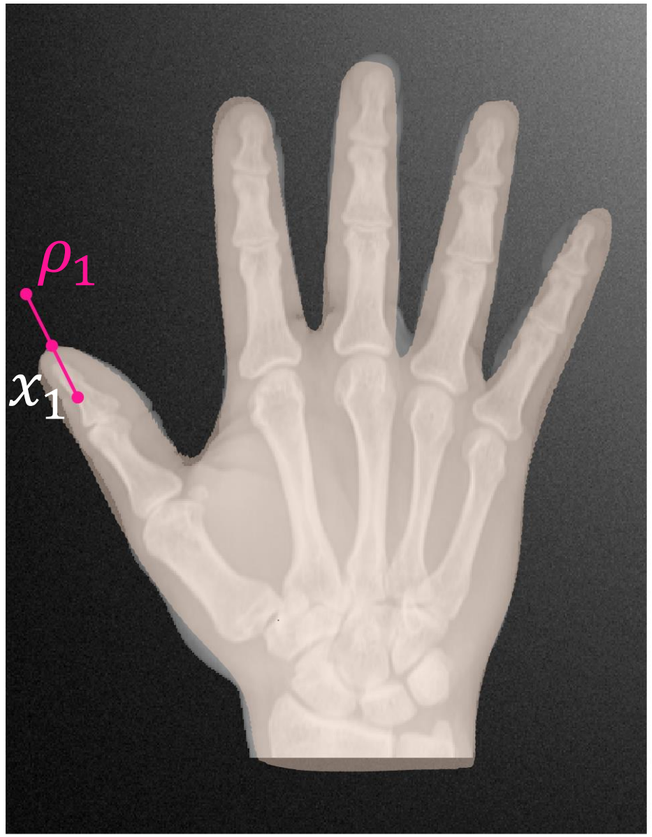


- We model each profile as a normal distribution

$$p(\rho_i) = N(\mu_i, \Sigma_i)$$

- Can be learned from data or «engineered»

Example:

$$p(\rho_1) = N\left(\begin{pmatrix} 20 \\ 100 \\ 700 \end{pmatrix}, \begin{pmatrix} 10 & 0 & 0 \\ 0 & 50 & 0 \\ 0 & 0 & 100 \end{pmatrix}\right)$$

# Search step

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- We choose the most likely candidate within a region $\mathcal{N}(x_1)$

$$\max_{x \in \mathcal{N}(x_1)} p(\rho_1(x))$$

  as the best matching point.

- The maximal size of the neighbourhood to search can be chosen by the shape model.

# Active Shape Model Fitting

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Active shape model Algorithm (ASM)

- Classical algorithm for fitting a model to an image.

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4. Iterate

Cootes, T. F., Taylor, C. J., Cooper, D. H., & Graham, J. (1995). Active shape models-their training and application. *Computer vision and image understanding*, *61*(1), 38-59.

# Summary

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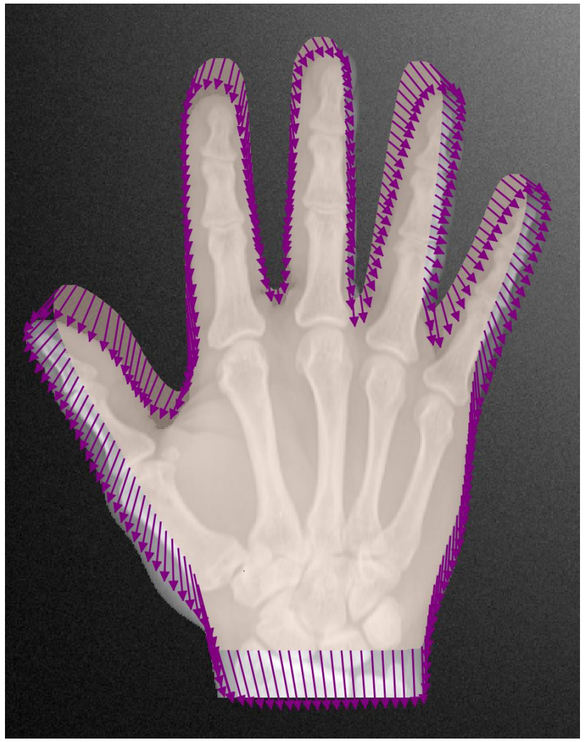

- Fitting shape models to images is difficult
  - finds correspondence
  - implies the segmentation problem
- We need a good model for the shape and a model of the intensities.
  - All concepts for modelling shapes can be transferred to intensities

Makes the automatic analysis of shapes in images possible.