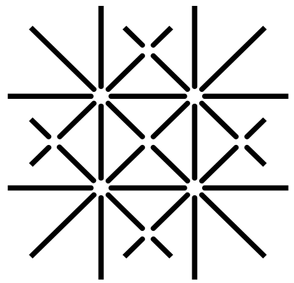

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Model fitting and correspondence

Model-based shape analysis

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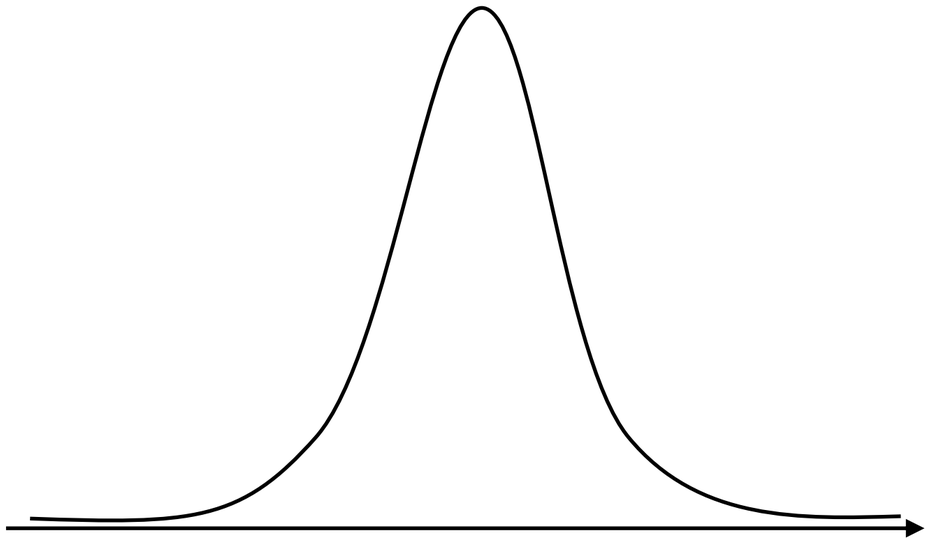
- Is this shape normal?
- Does it show pathologies?
- How would it look without the pathologies?



Comparing the model with the data

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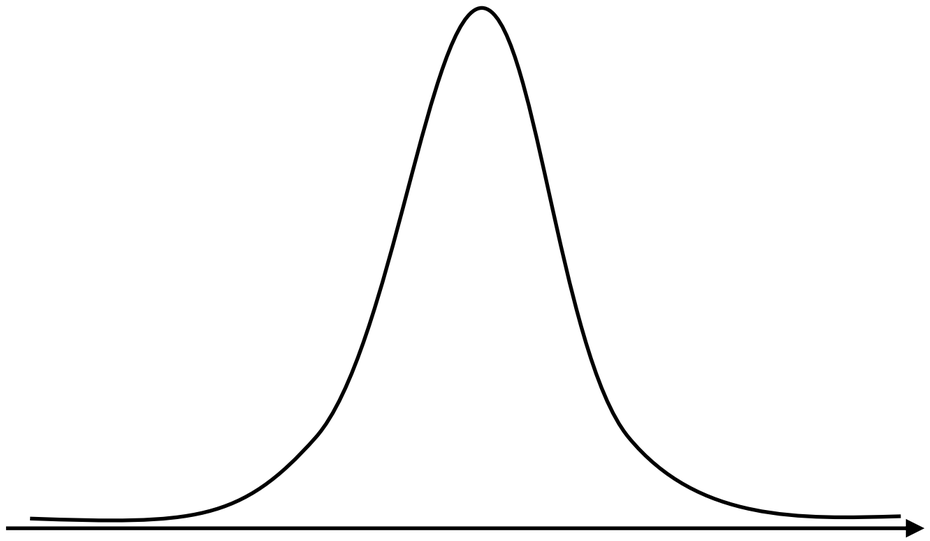
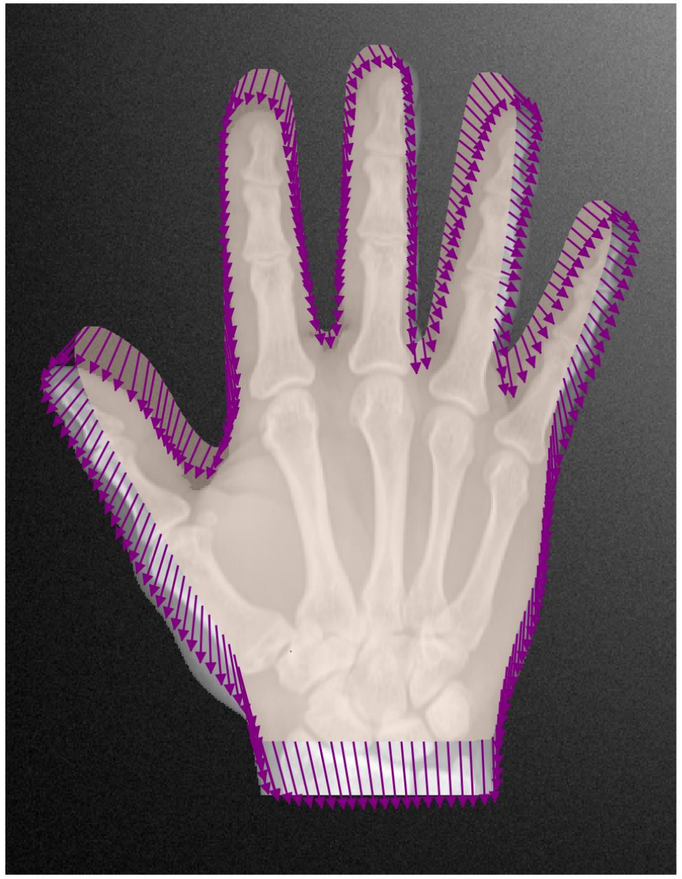
- Is this shape normal?
- Does it show pathologies?
- How would it look without the pathologies?





Shape representations

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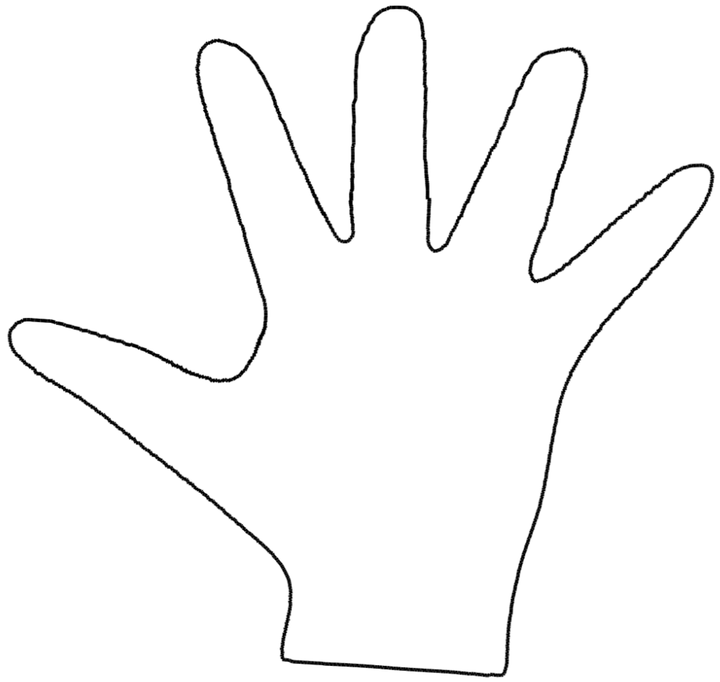

Surface / Contour

Image

Deformations from closest point

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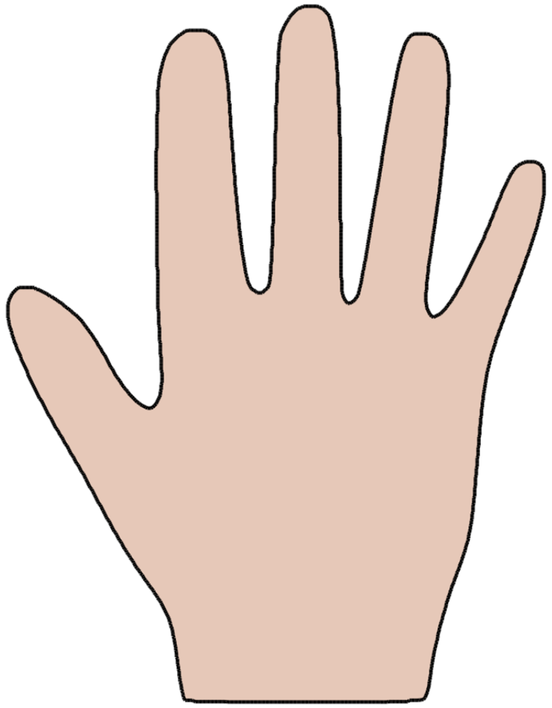
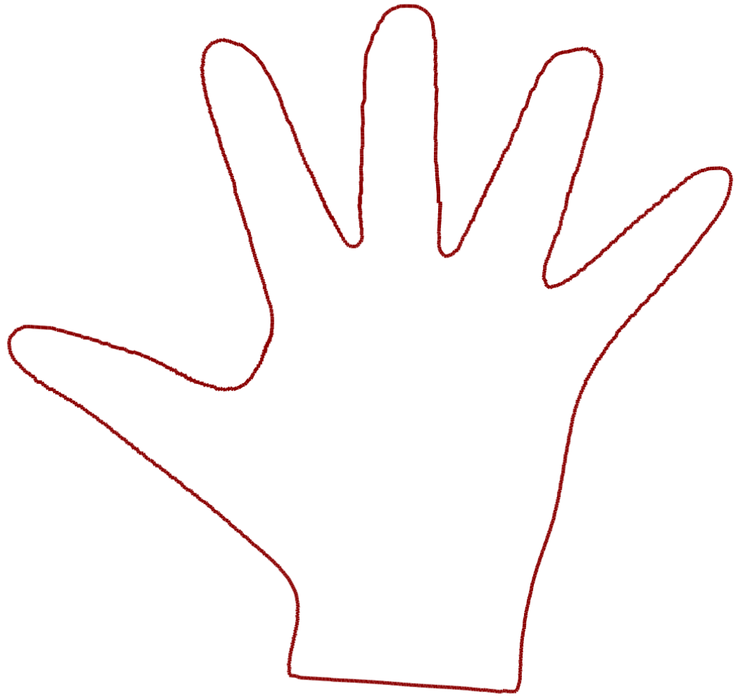


Reference shape

Γ_R



Target shape

Γ_T

Deformations from closest point

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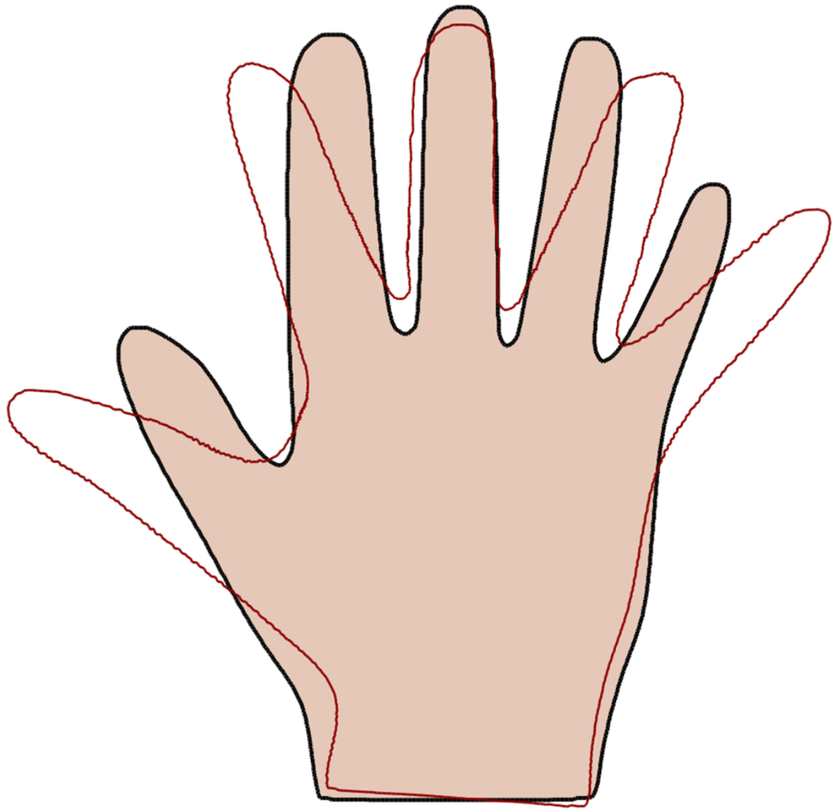

Deformations from closest points

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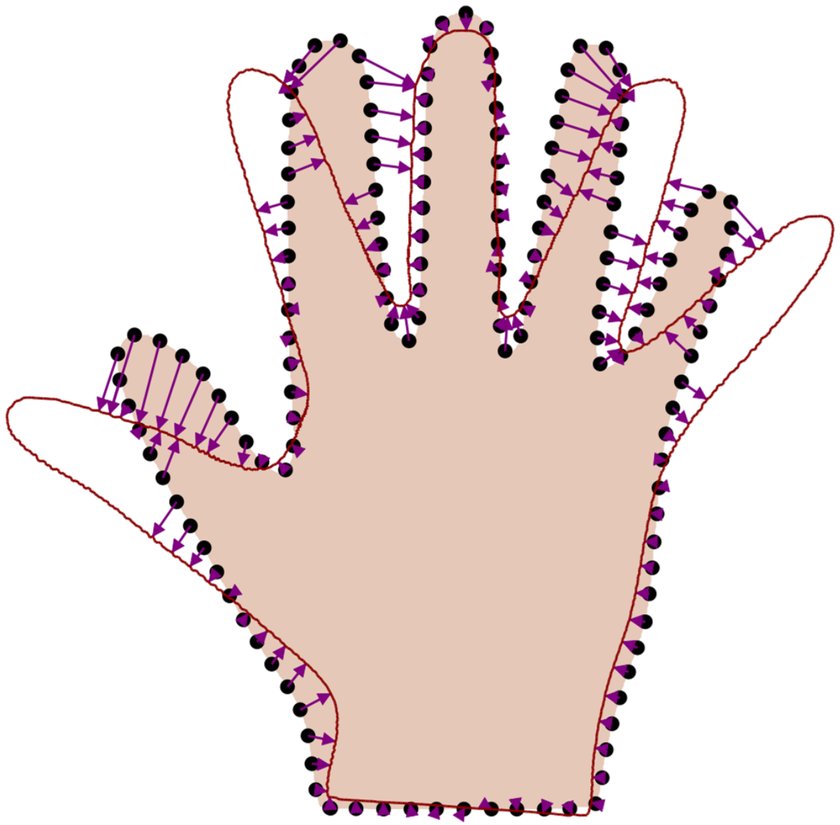

First idea:

- Define deformation by closest point

Defines deformation but not correspondence.

Adding prior knowledge

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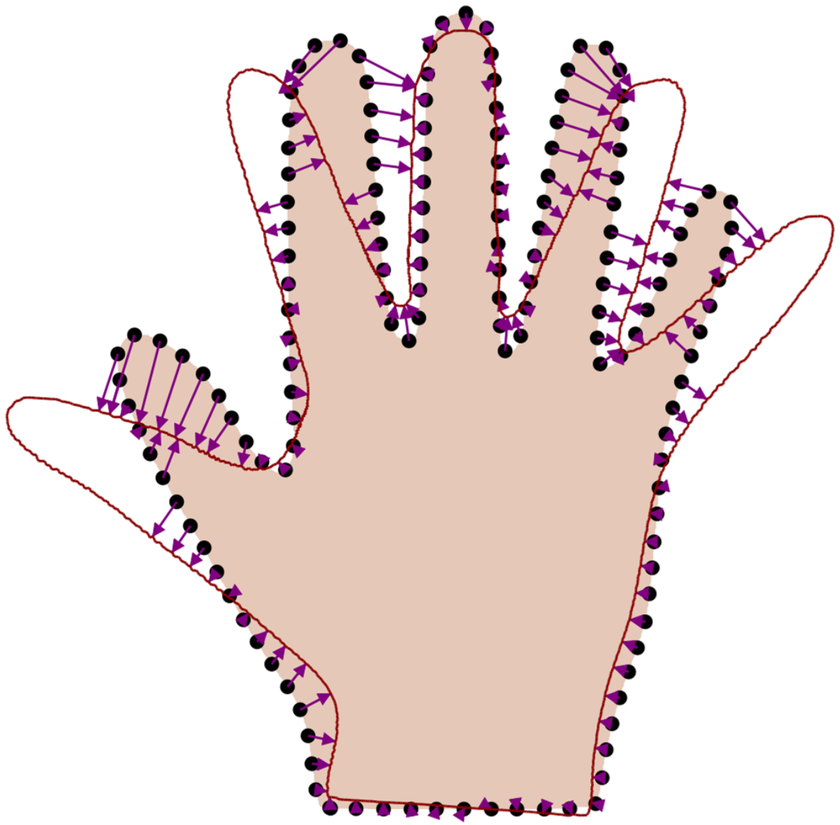

- Closest point strategy makes too weak assumptions
- We need prior assumptions about possible deformations:
  - Smoothness
  - Result should be a hand?

Adding prior knowledge

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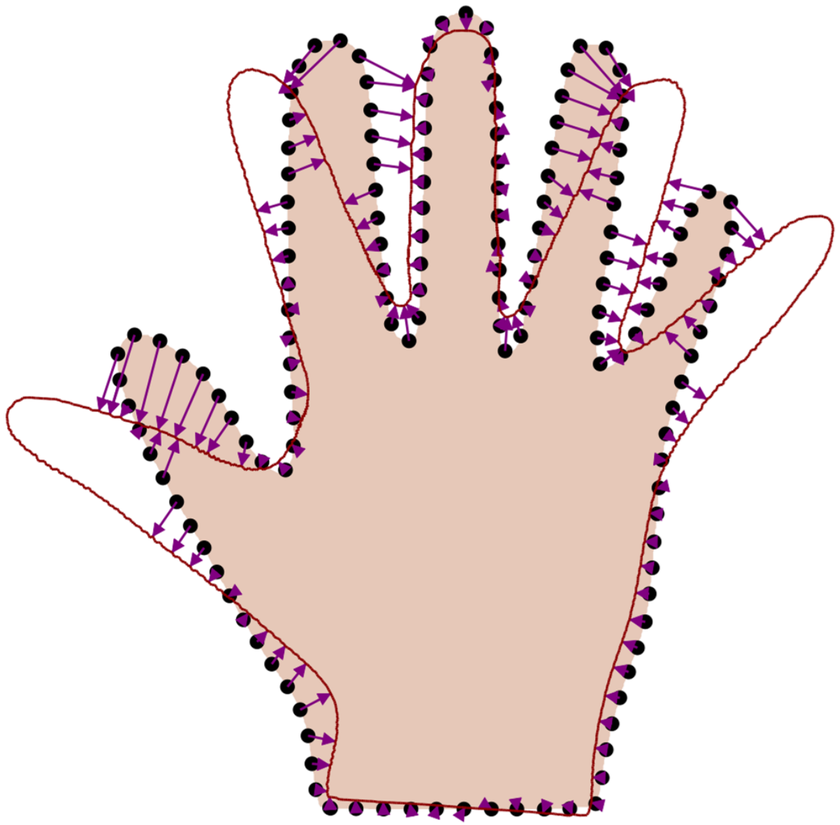

- Closest point strategy makes too weak assumptions
- We need prior assumptions about possible deformations:
  - Smoothness
  - Result should be a hand?

Idea: Use hand model as prior knowledge

Model fitting (Principled way)

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Bayes theorem:

$$p(u|\Gamma_T) = \frac{p(u)p(\Gamma_T|u)}{p(\Gamma_T)}$$

Prior knowledge $p(u)$:

- The shape model

Likelihood function $p(\Gamma_T|u)$

- Distance measure that determines how well the solution u explains the data.

This requires a course on its own.

We use instead a popular heuristic.

Model fitting using ICP

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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 using the transformation
4. Iterate

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

Iterative closest points

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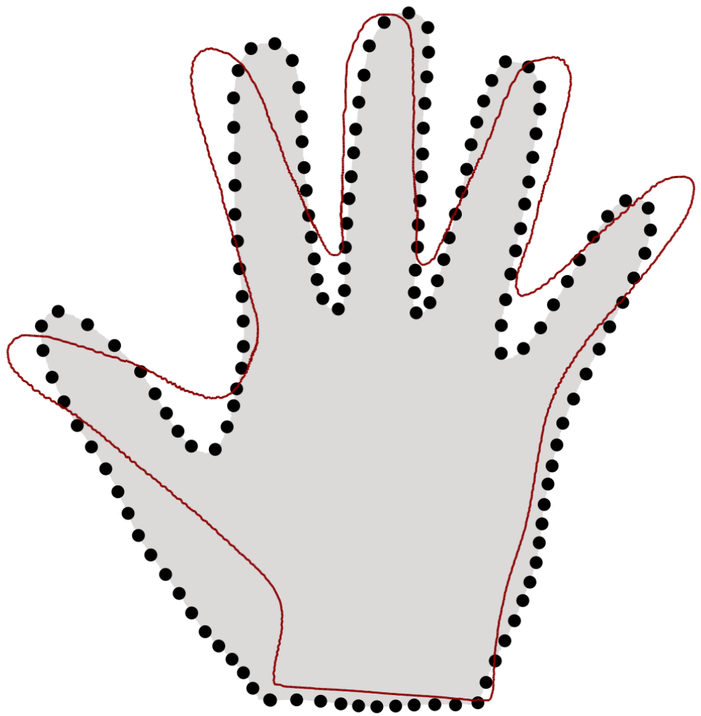

Iteration 1: Mean shape

Step:

- Find closest points to target

Iterative closest points

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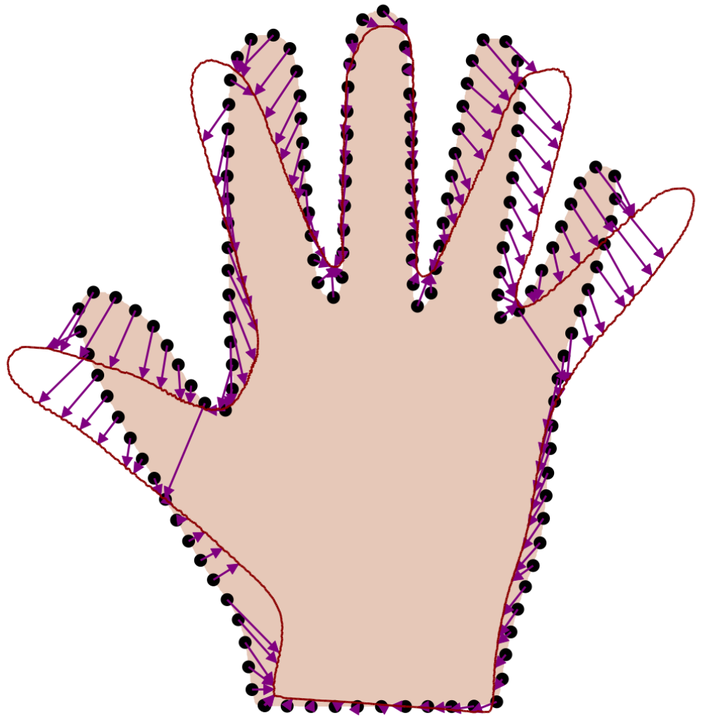

Iteration 1: Deformation field

Step:

- Perform Gaussian process regression using deformations as noisy observations

Iterative closest points

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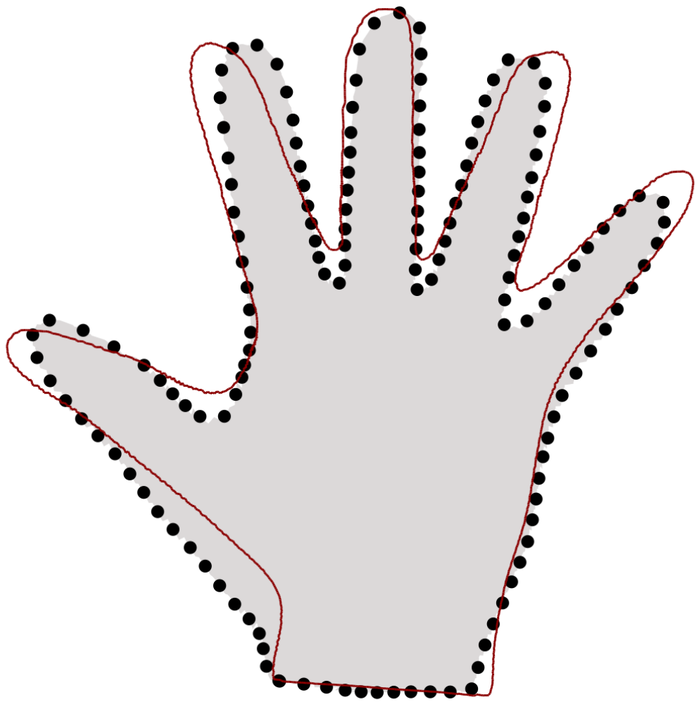

Iteration 2: Mean shape

Step:

- Find closest points to target

Iterative closest points

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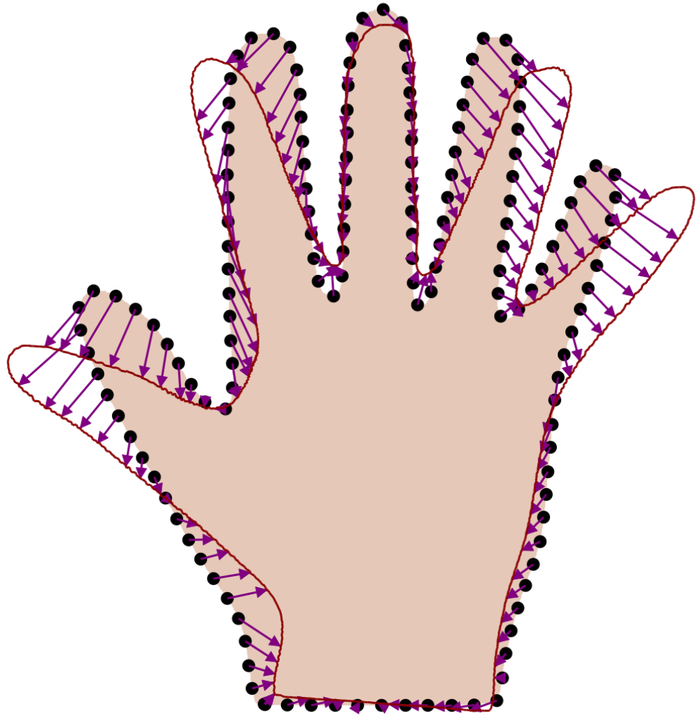

Iteration 2: Deformation field

Step:

- Perform Gaussian process regression using deformations as noisy observations

Iterative closest points

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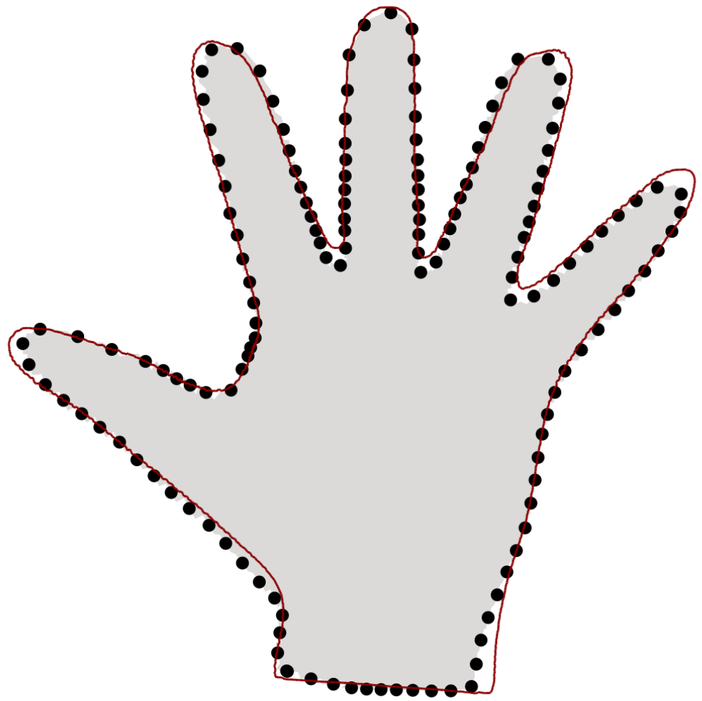

Iteration 20: Mean shape

Step:

- Find closest points to target

Iterative closest points

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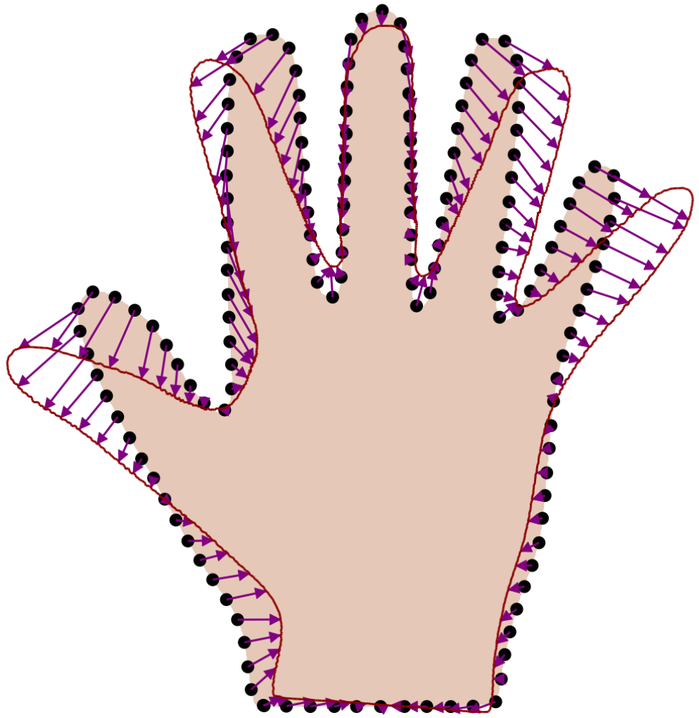

Iteration 20: Deformation field

We have established correspondence.

- We can use all model information to analyze the shape.