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Learning shape variations from data

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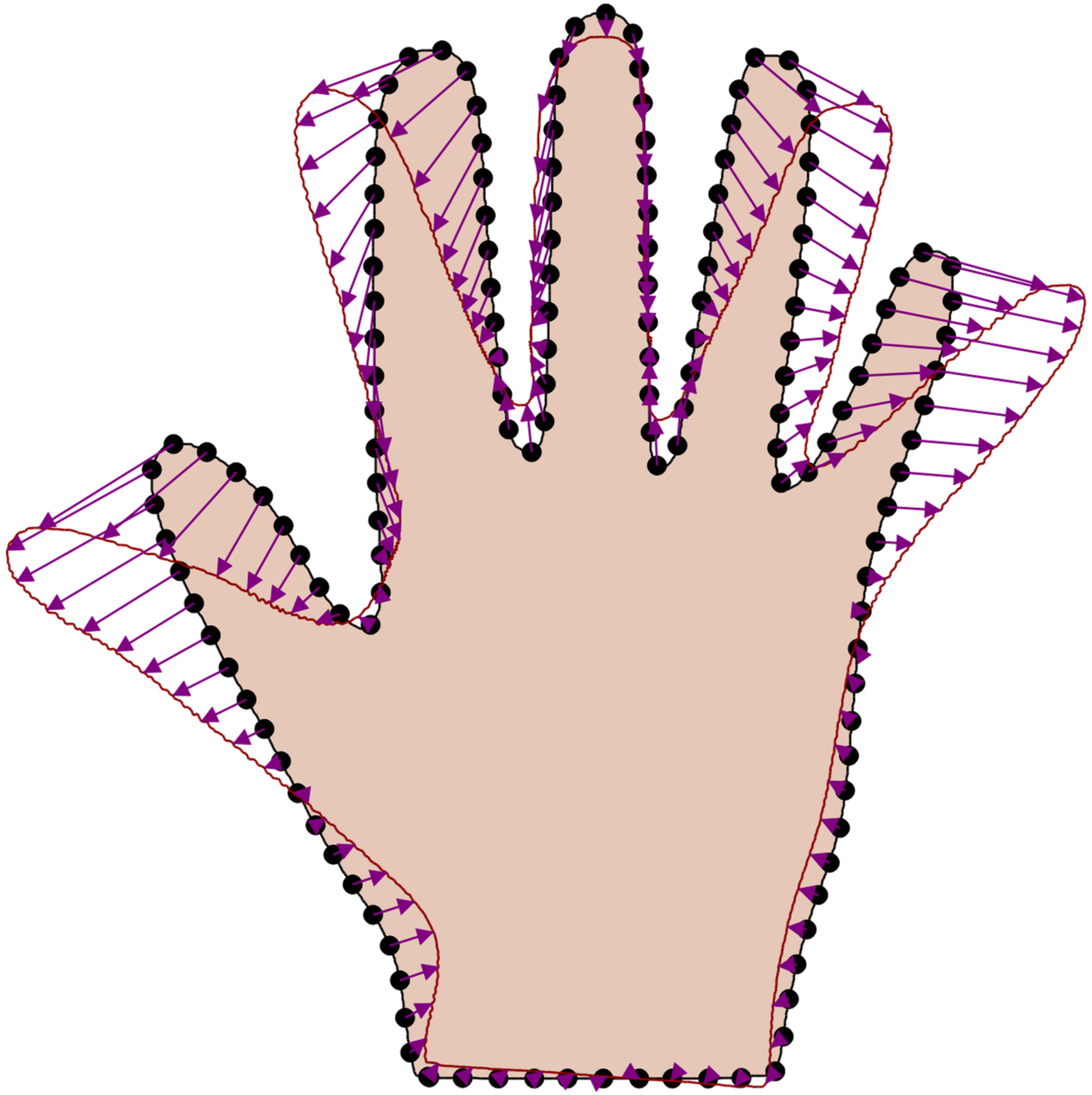

We can describe a shape as

$$\Gamma = \{x + u(x) | x \in \Gamma_R\}$$

for some $u : \Gamma_R \to \mathbb{R}^2$.

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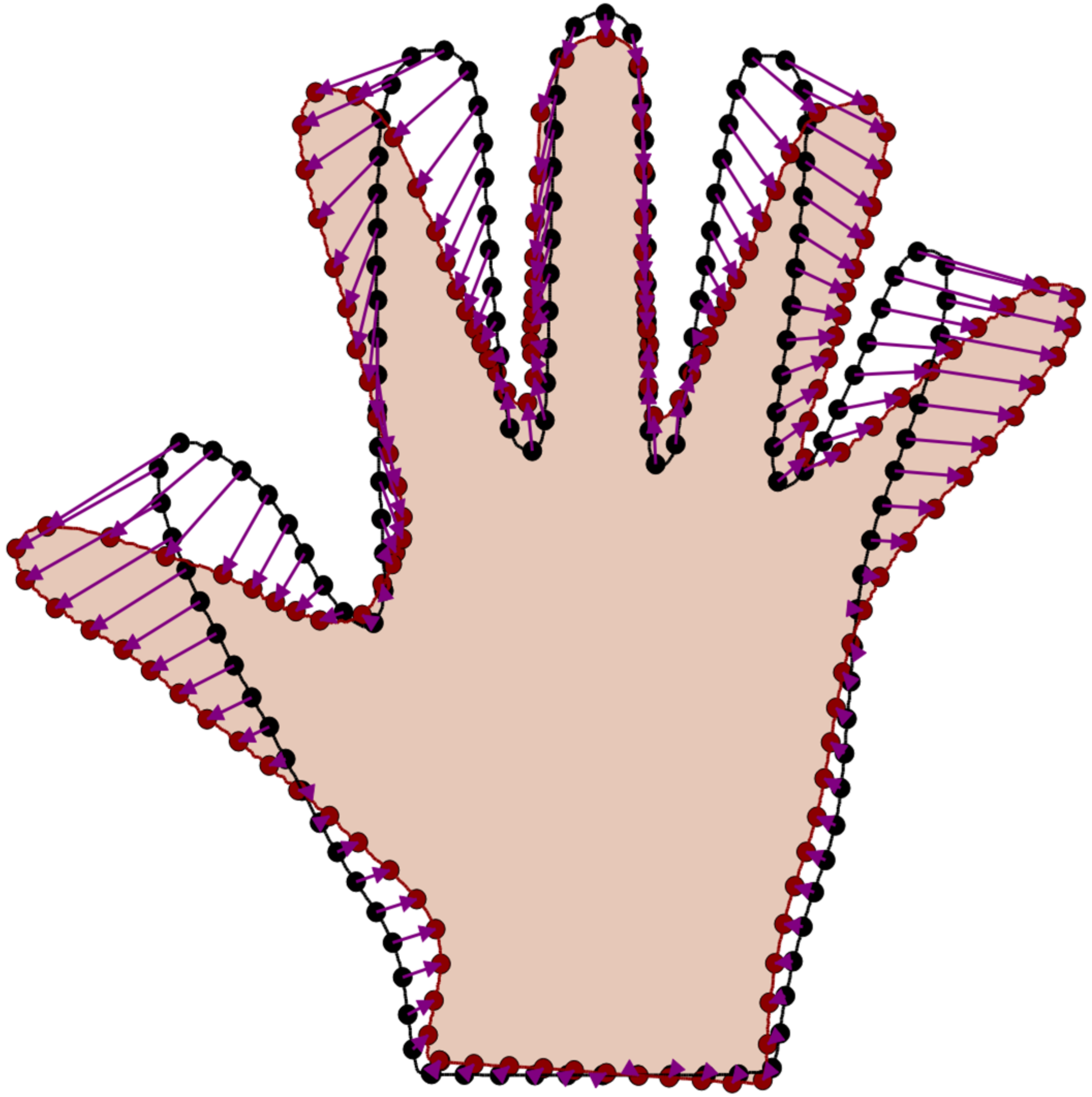

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$$\Gamma = \{x + u(x) | x \in \Gamma_R\}$$

for some $u : \Gamma_R \to \mathbb{R}^2$.

u establishes correspondence between the points of the shapes.

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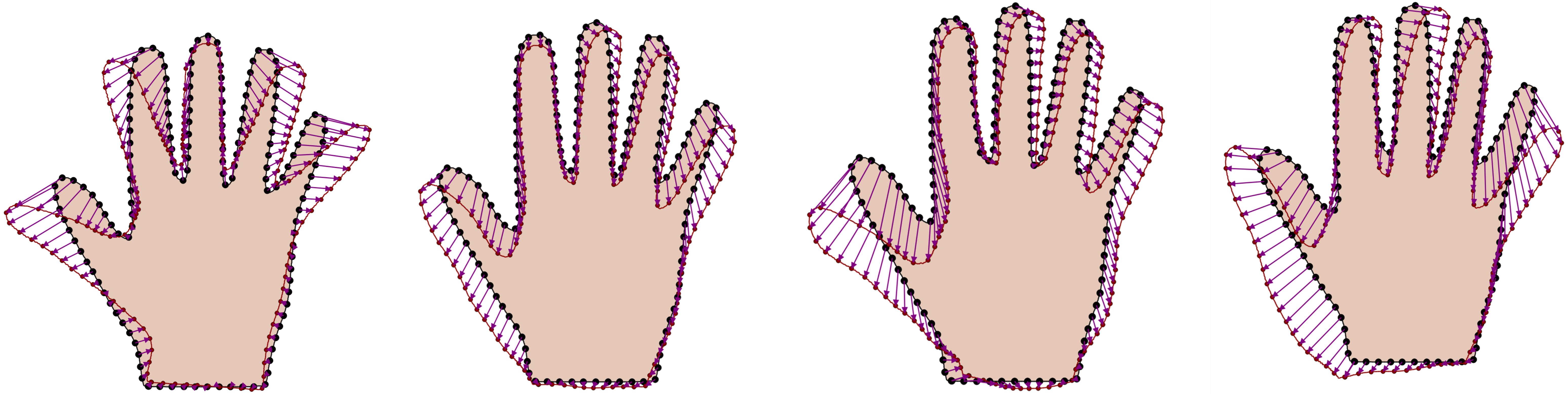
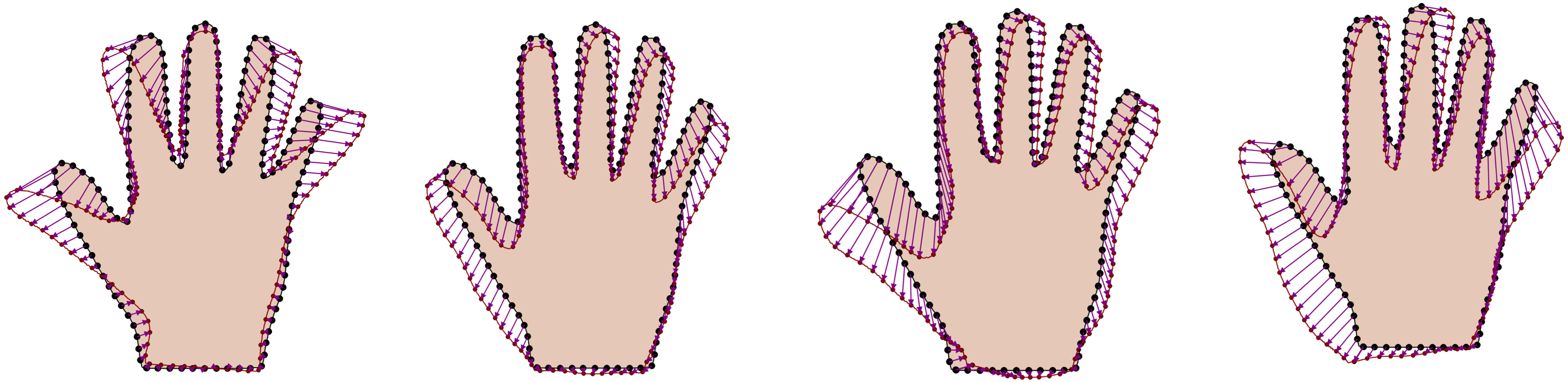
Correspondence makes shapes comparable

- We can measure differences and compute statistics



$u^1 : \Gamma_R \to \mathbb{R}^2$ $u^2 : \Gamma_R \to \mathbb{R}^2$ … $u^n : \Gamma_R \to \mathbb{R}^2$

Learning shape variability



$u^1 : \Gamma_\mathrm{R} \rightarrow \mathbb{R}^2$ $u^2 : \Gamma_\mathrm{R} \rightarrow \mathbb{R}^2$ … $u^n : \Gamma_\mathrm{R} \rightarrow \mathbb{R}^2$

$$\mu(x) = \overline{u}(x) = \frac{1}{n}\sum_{i-1}^{n} u^i\,(x)$$

$$k(x, x') = \frac{1}{n-1}\sum_{i}^{n}\left(u^i(x) - \overline{u}(x)\right)\left(u^i(x') - \overline{u}(x')\right)^T$$

Building statistical shape models

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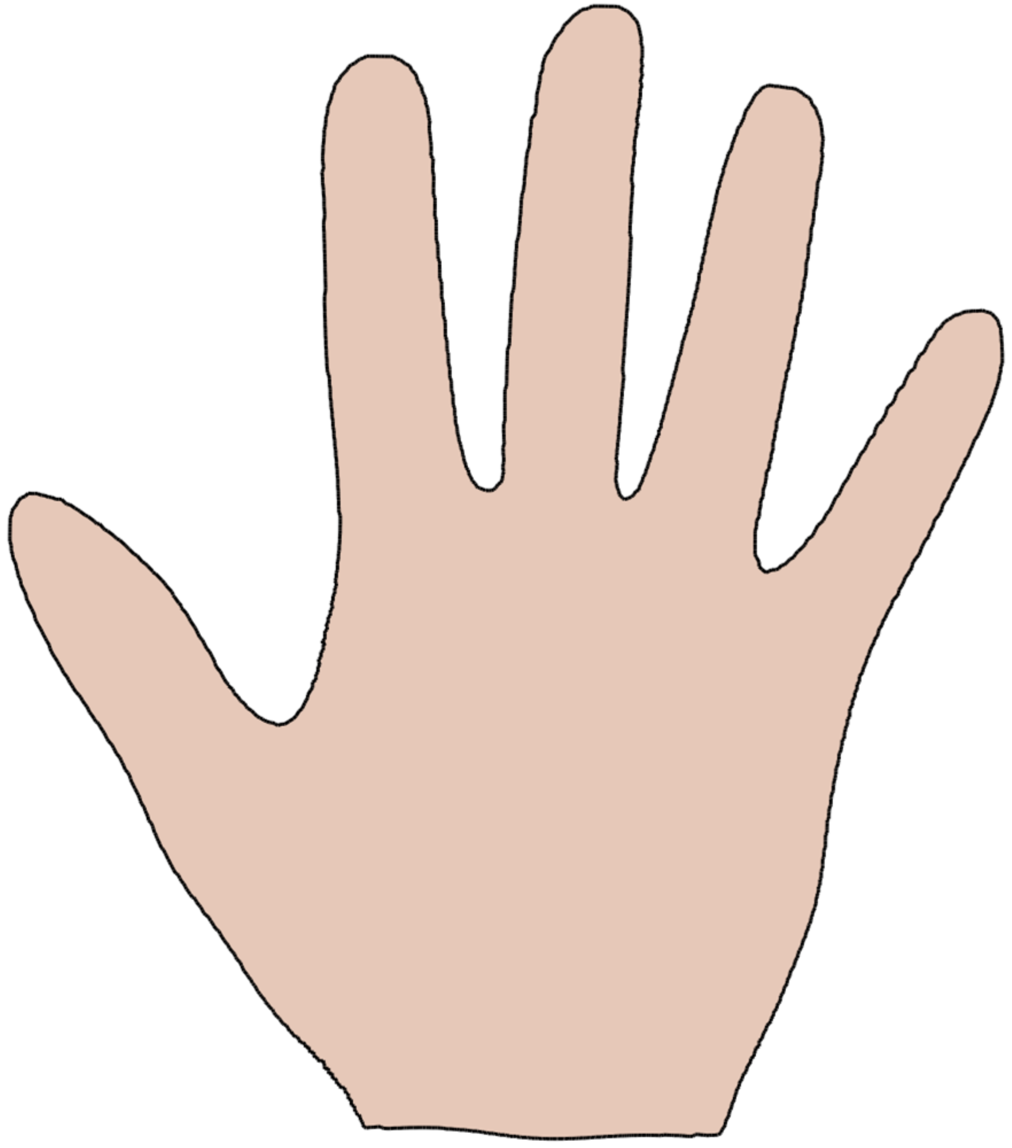
1. Define a reference shape
2. Find deformations $\{u^1, \dots, u^n\}$ from example data
3. Estimate mean μ and covariance function k from $\{u^1, \dots, u^n\}$
4. Define $u \sim GP(\mu, k)$
5. Final shape model:

$$\Gamma = \{x + u(x) | \mathrm{x} \in \Gamma_R\}$$

Open problem: How do we find the deformations?



Mean hand shape