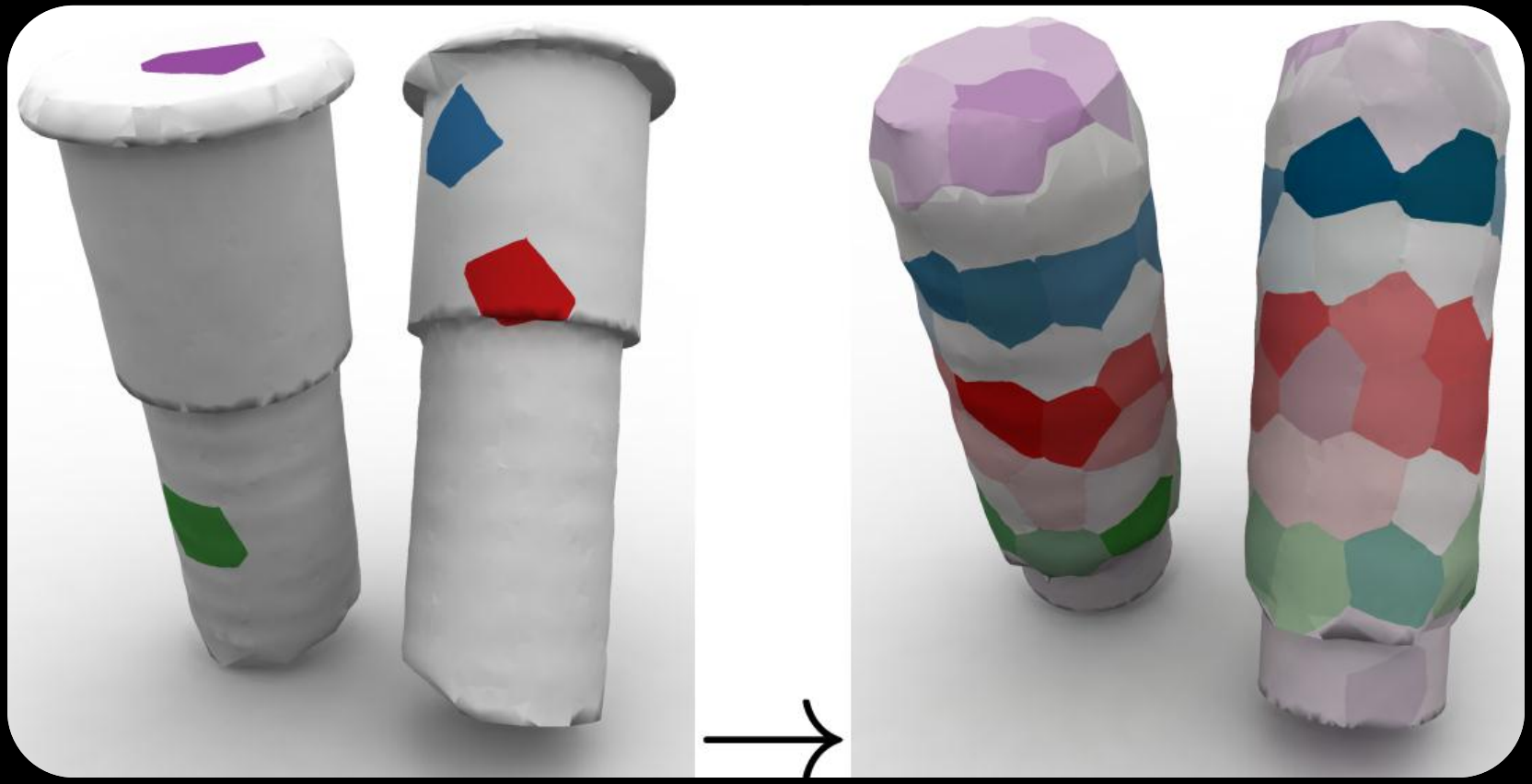
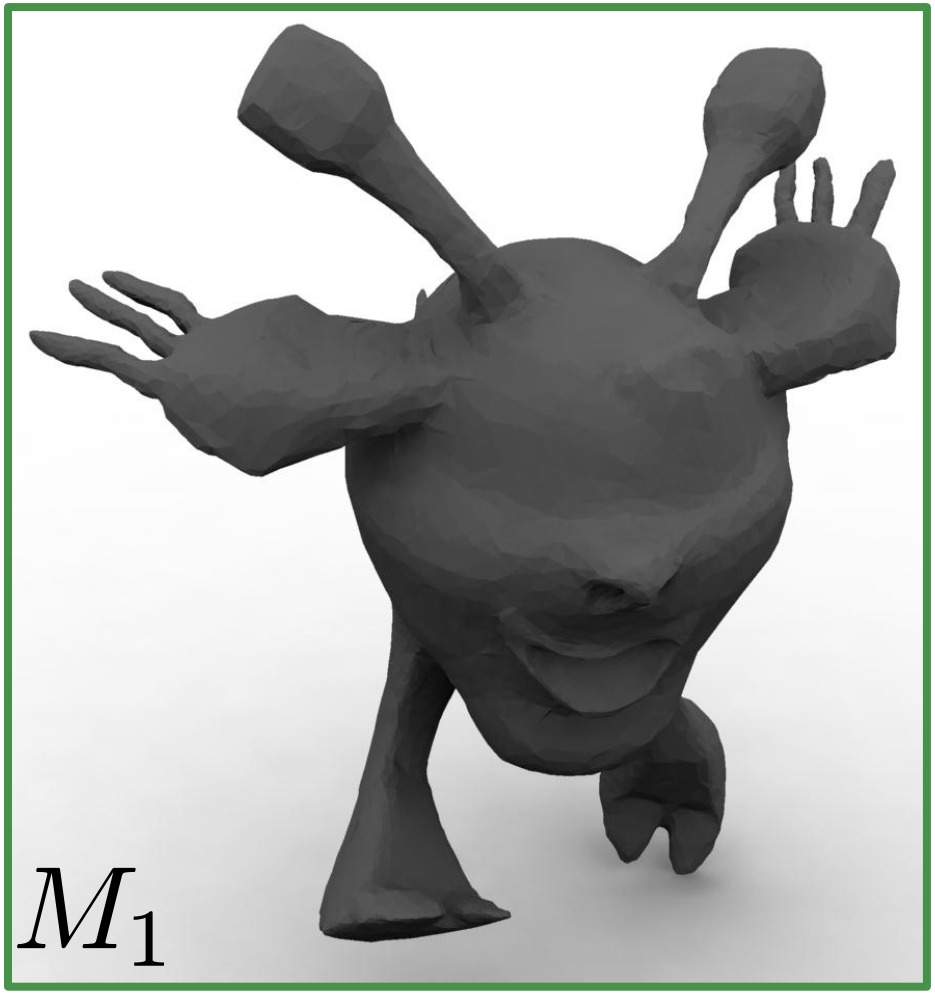


Soft Maps Between Surfaces

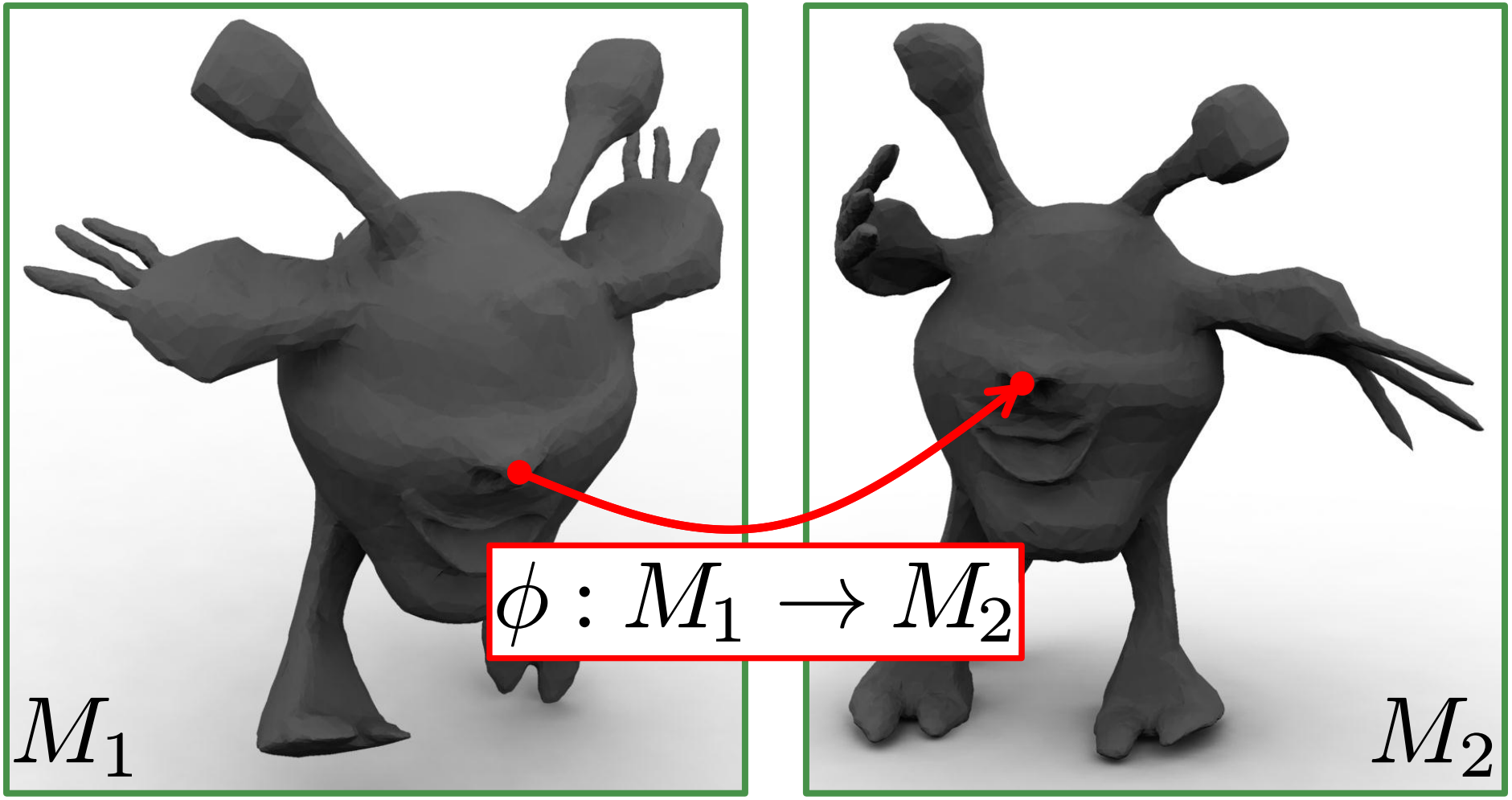
Justin Solomon* Andy Nguyen*
Adrian Butscher Mirela Ben-Chen Leonidas Guibas

Stanford University

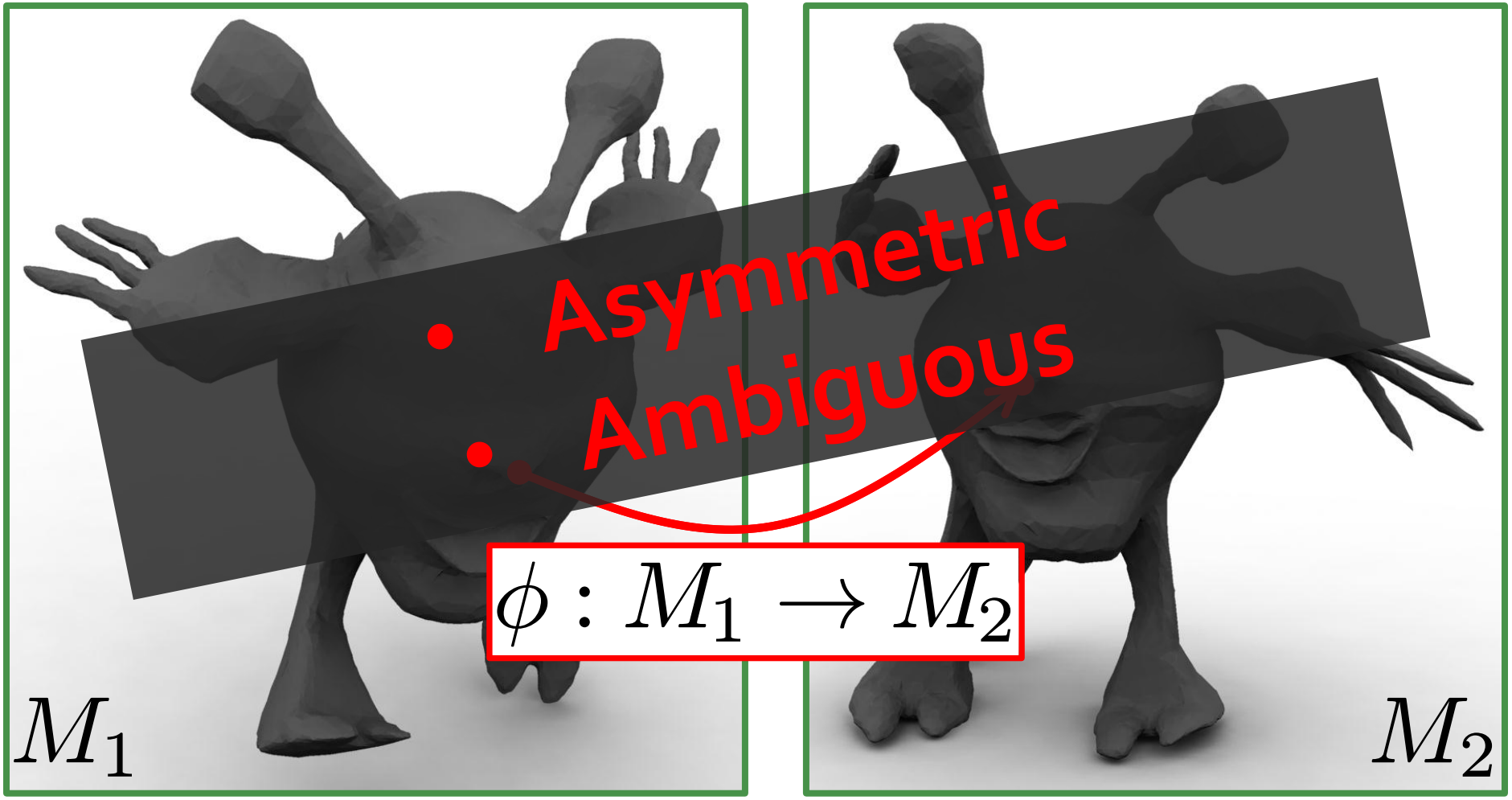
"Traditional" Mapping



"Traditional" Mapping



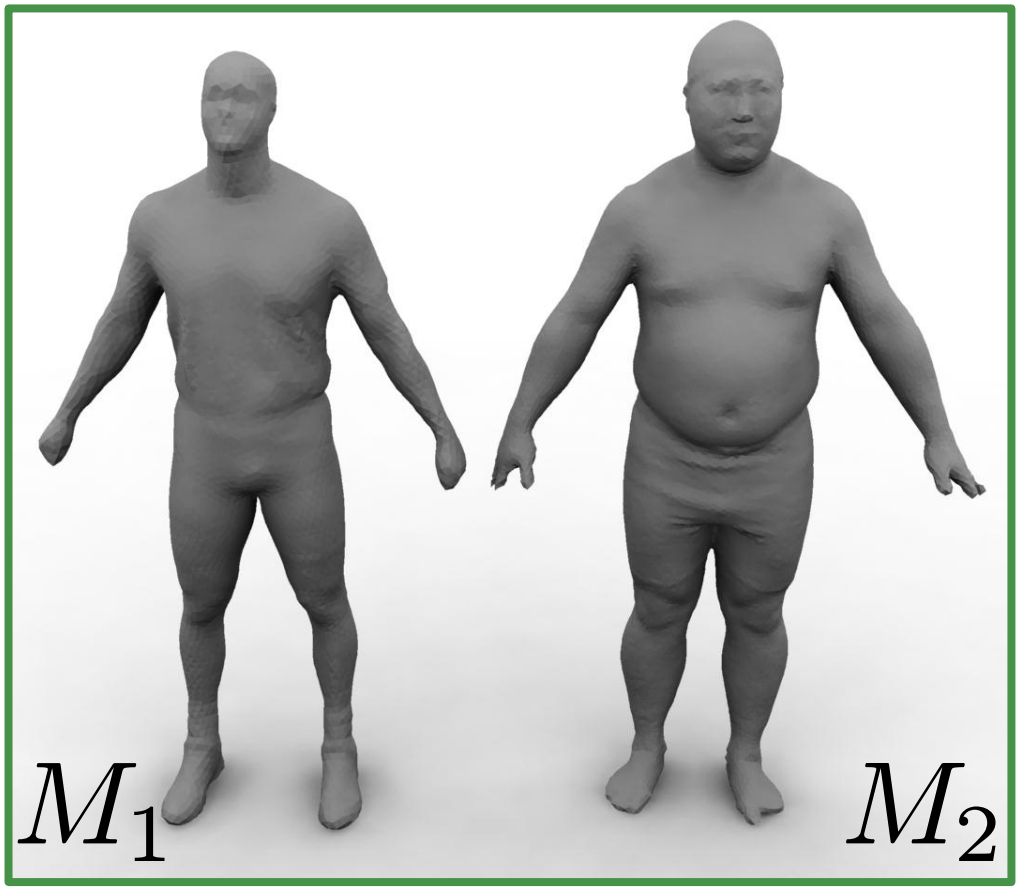
"Traditional" Mapping



Mapping Ambiguities

Global Ambiguity

Mapping Ambiguities

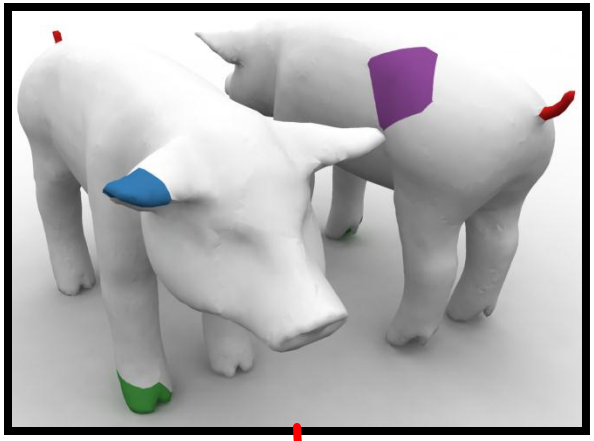


Local Ambiguity

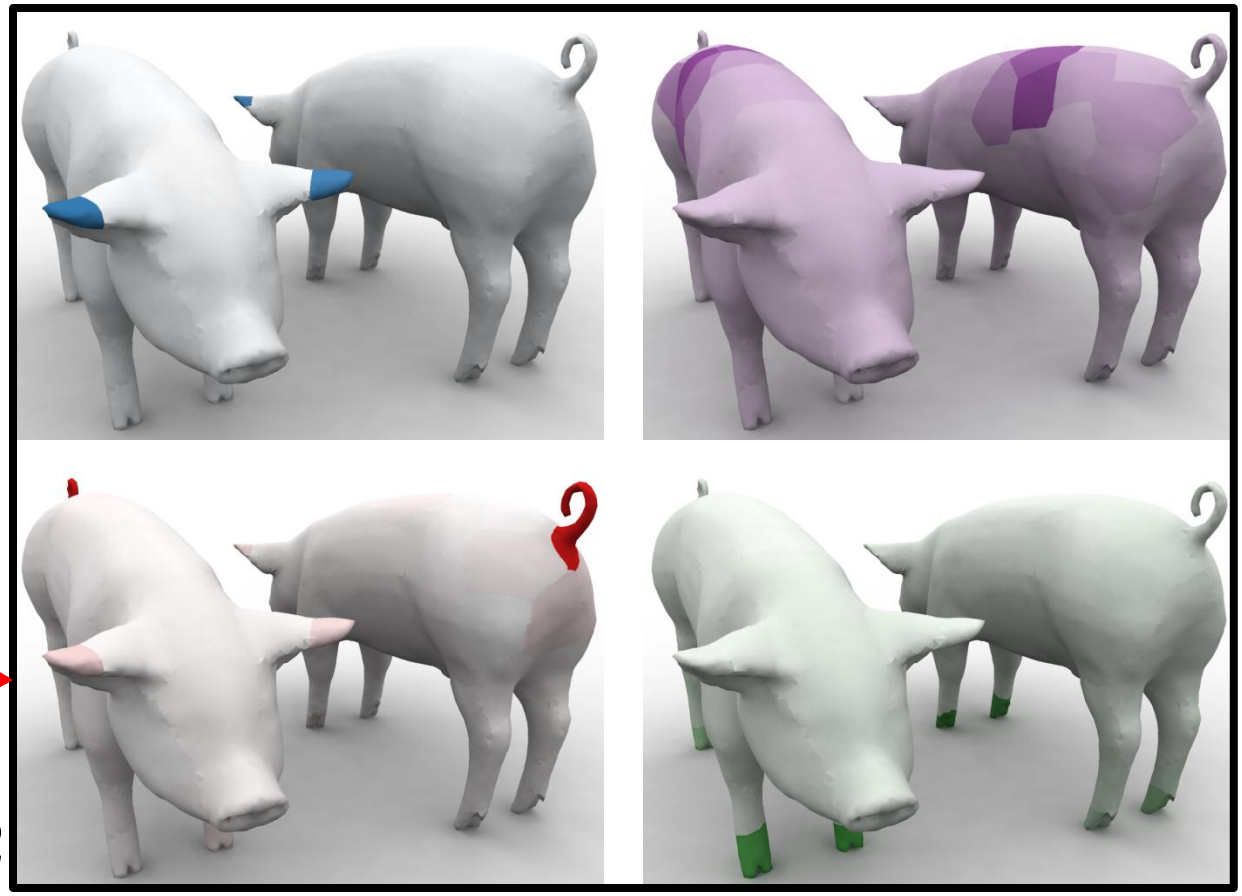
New Idea

Represent maps probabilistically

New Idea



M_1

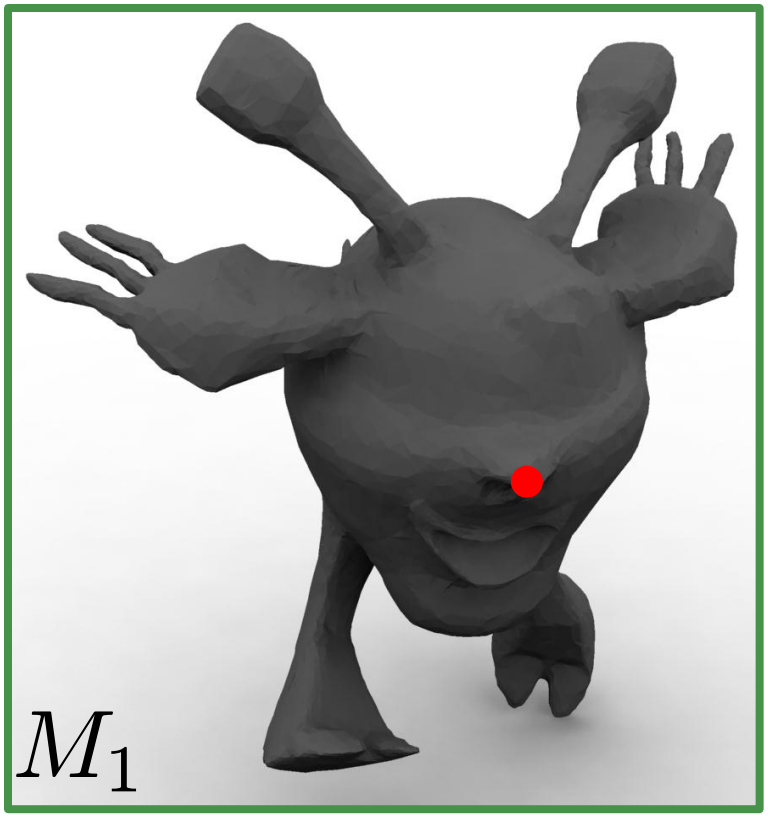


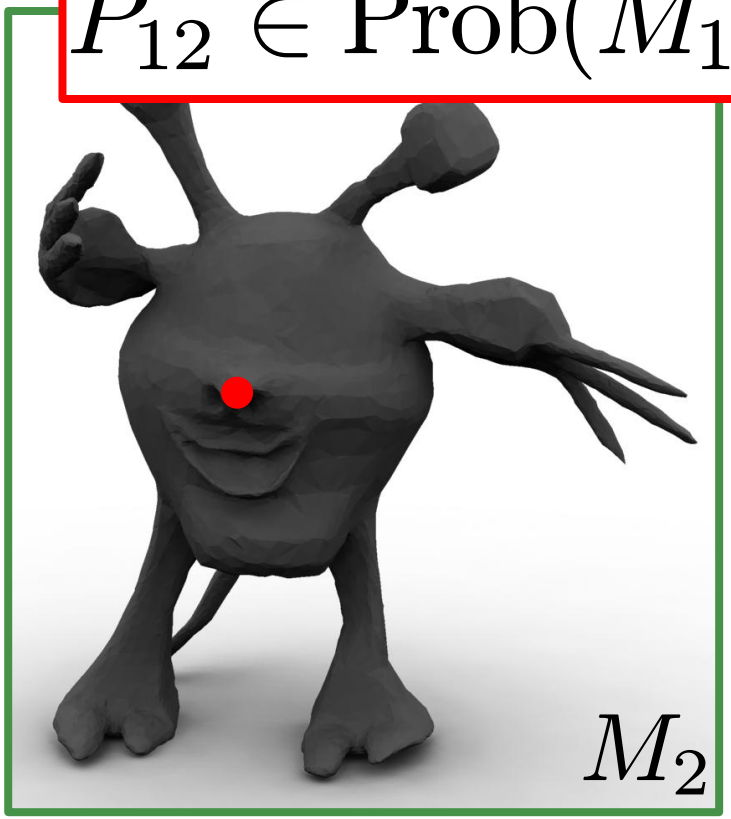
M_2

Represent maps probabilistically

Soft Correspondence

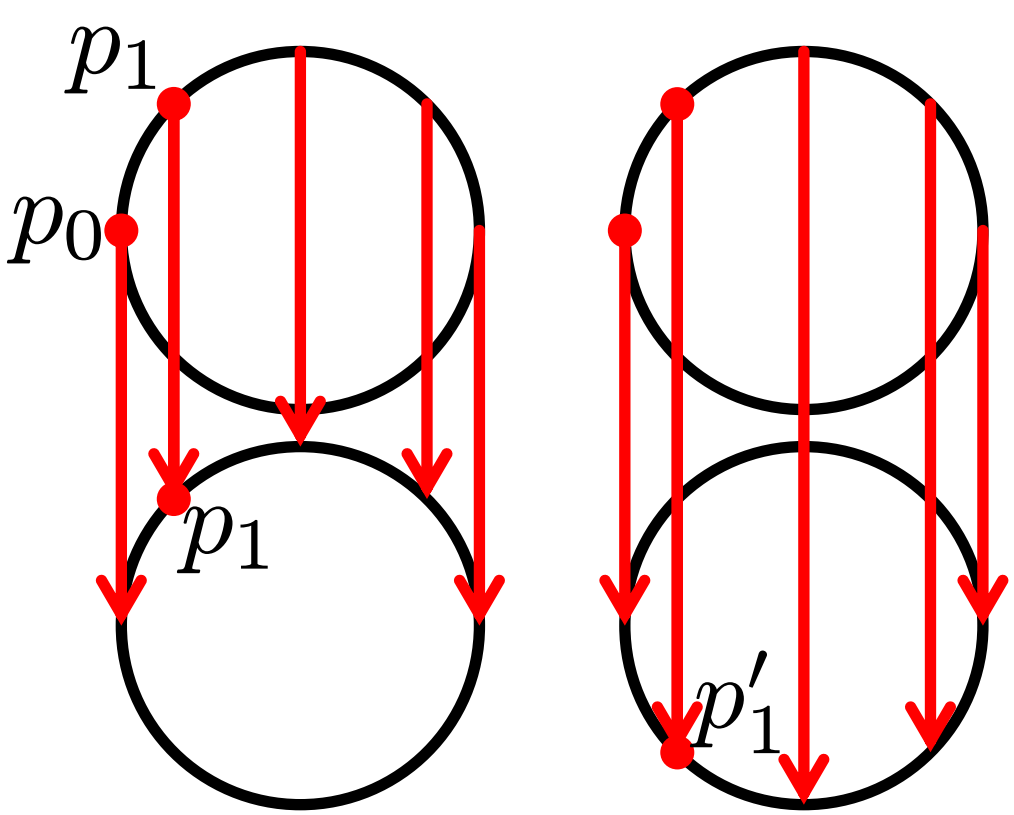
$$P_{12} \in \mathrm{Prob}(M_1 \times M_2)$$

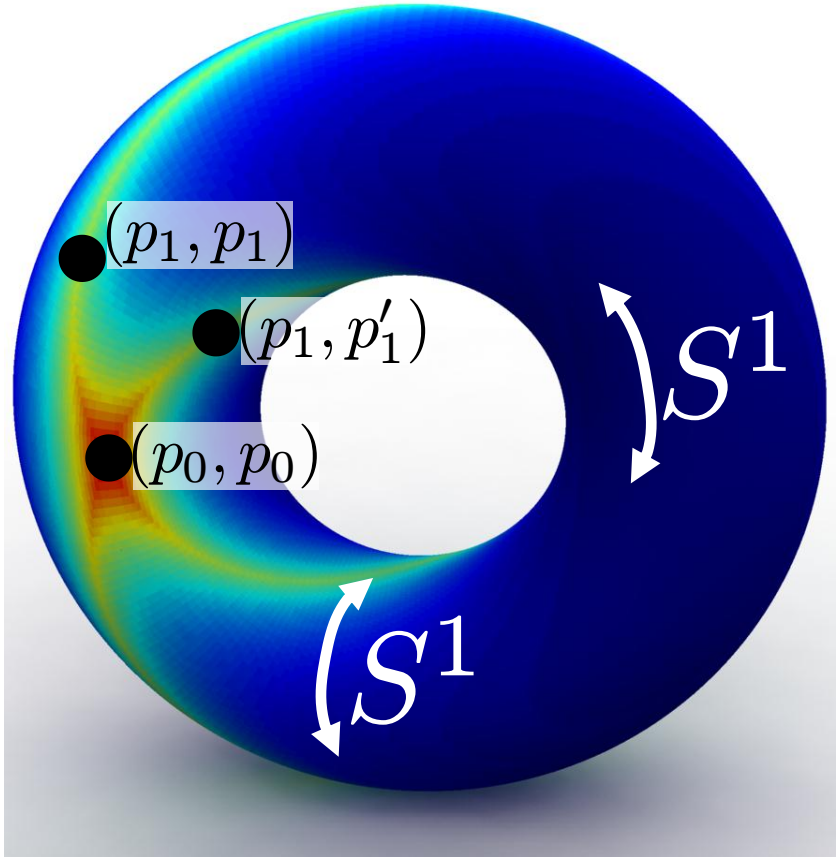




Likelihood of a matched pair

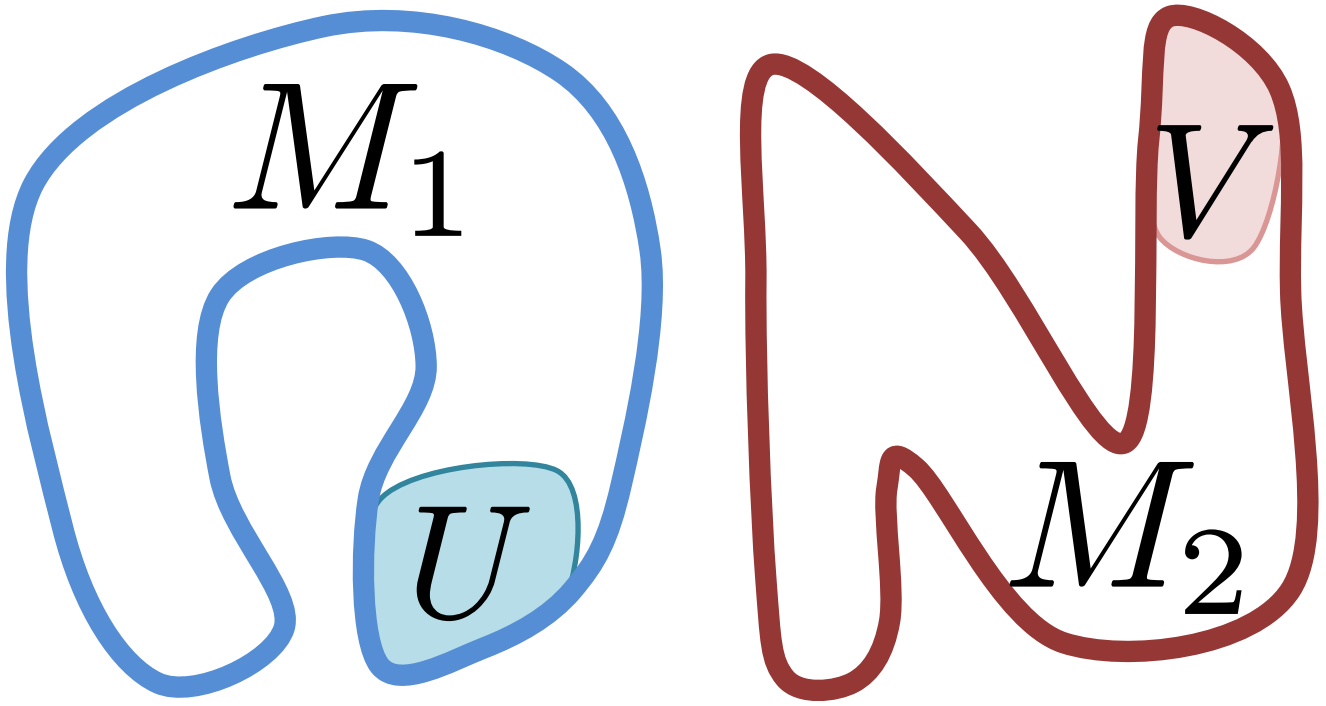
Soft Correspondence





Likelihood of a matched pair

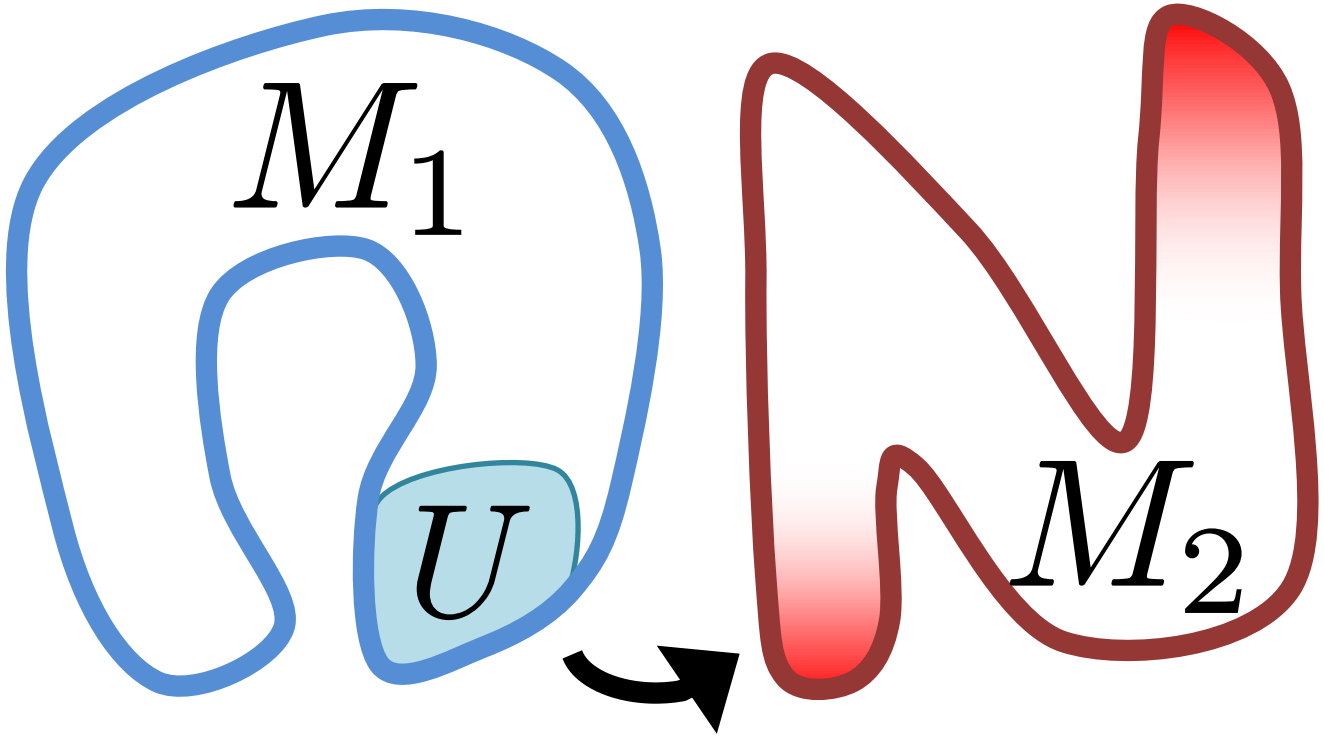
Soft Correspondence



$$P_{12}(U \times V) \in [0, 1]$$

Likelihood of a matched pair

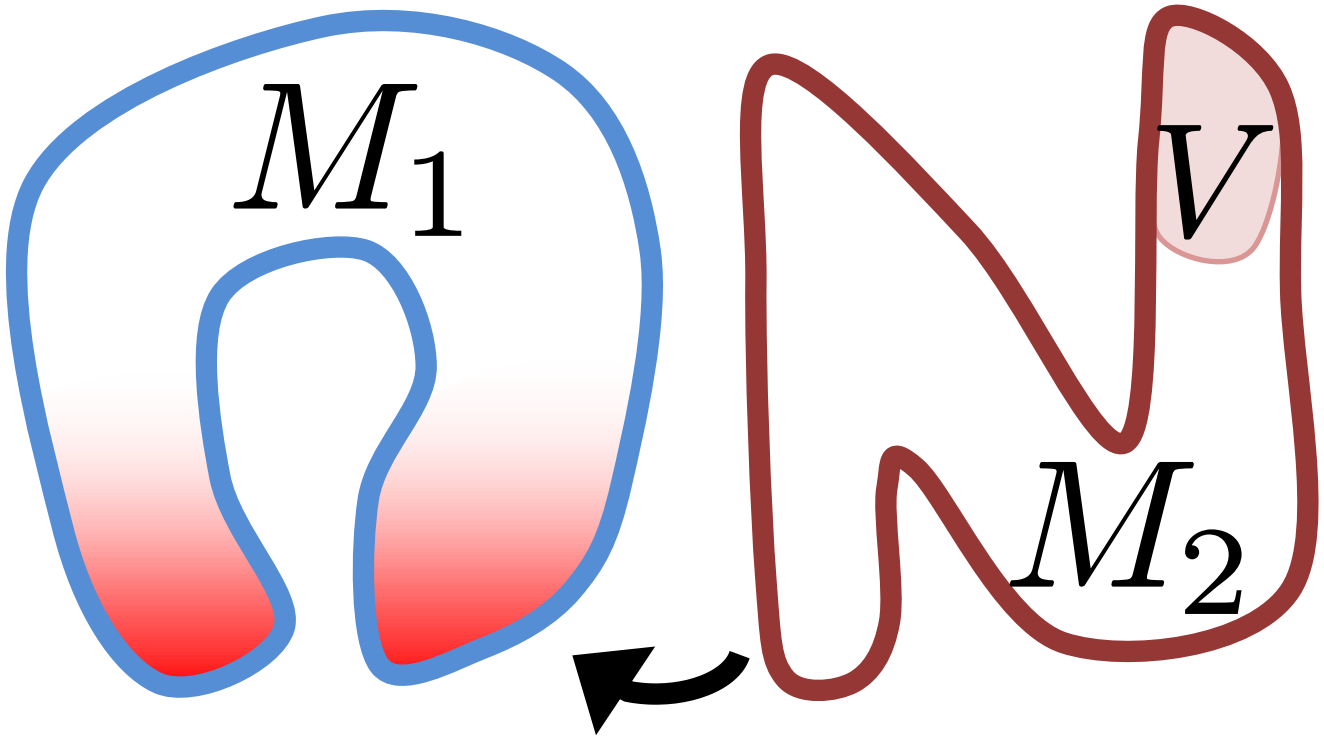
Soft Maps



$$P_{U2}(B) \in [0,1]$$

Conditional probability distribution

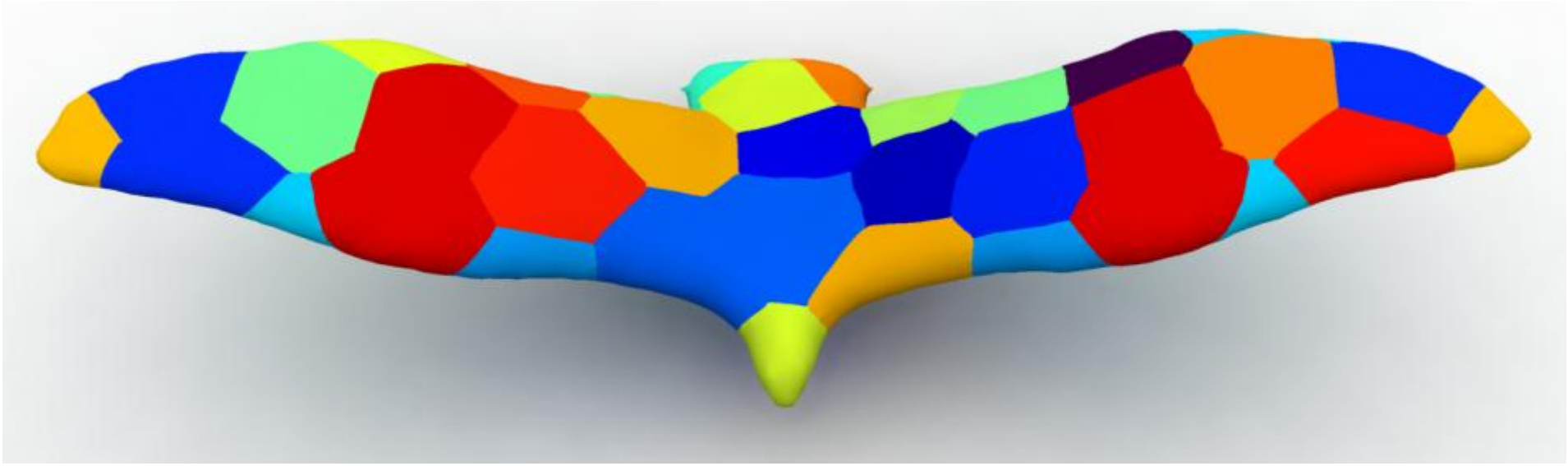
Soft Maps



$$P_{1V}(A) \in [0,1]$$

Conditional probability distribution

Discretization



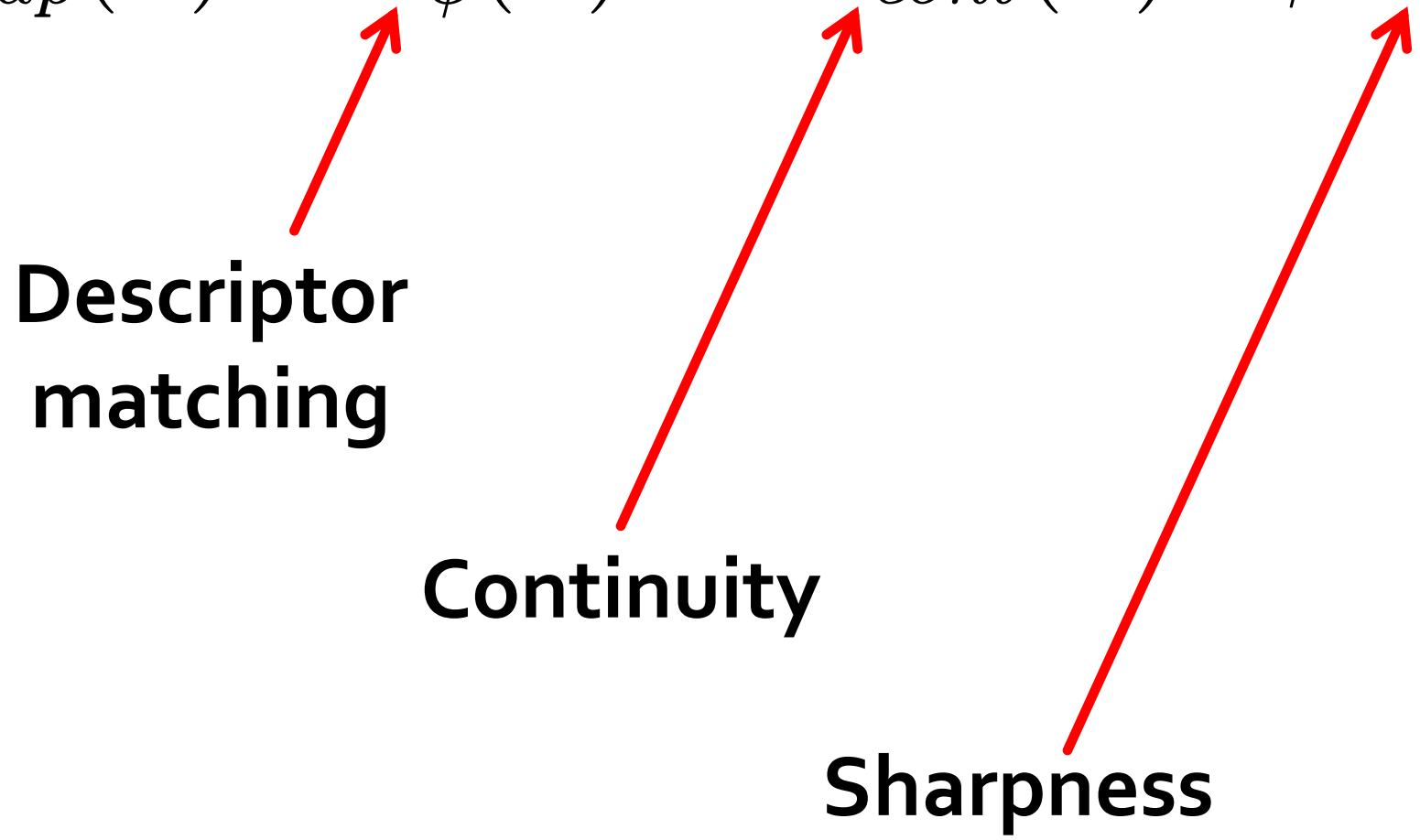
$$M_1 = U_1 \cup \cdots \cup U_{N_1}$$

$$M_2 = V_1 \cup \cdots \cup V_{N_2}$$

Voronoi cells

Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_{s}(A)$$



Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_{s}(A)$$

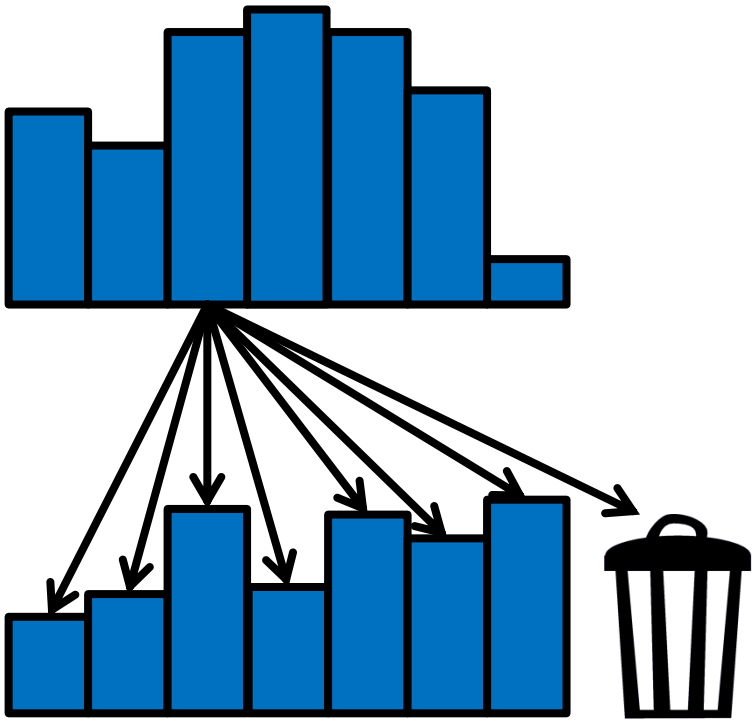
$$E_{\phi}(A) = \sum_{ij} a_{ij}\phi_{ij}$$

http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6130444

Descriptor matching

Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_{s}(A)$$

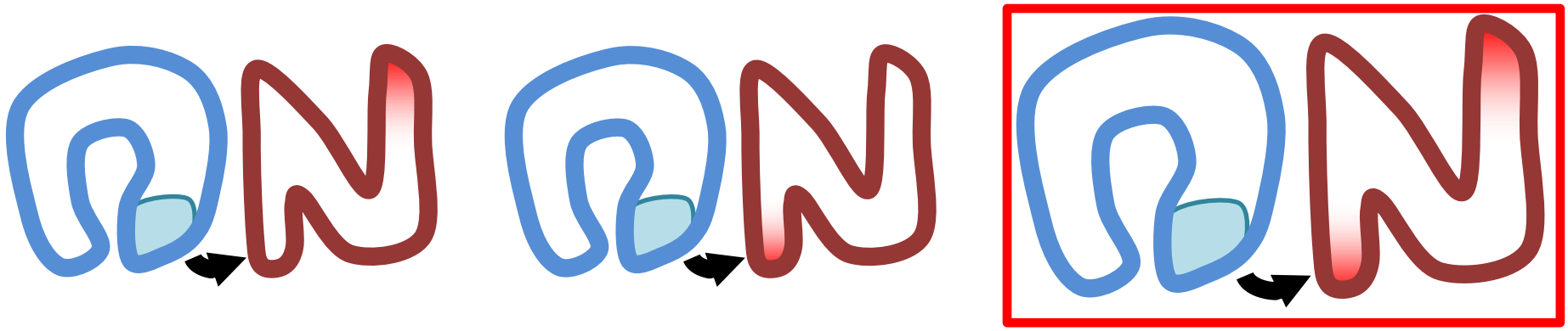


Earth Mover's Distance

Continuity

Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_s(A)$$

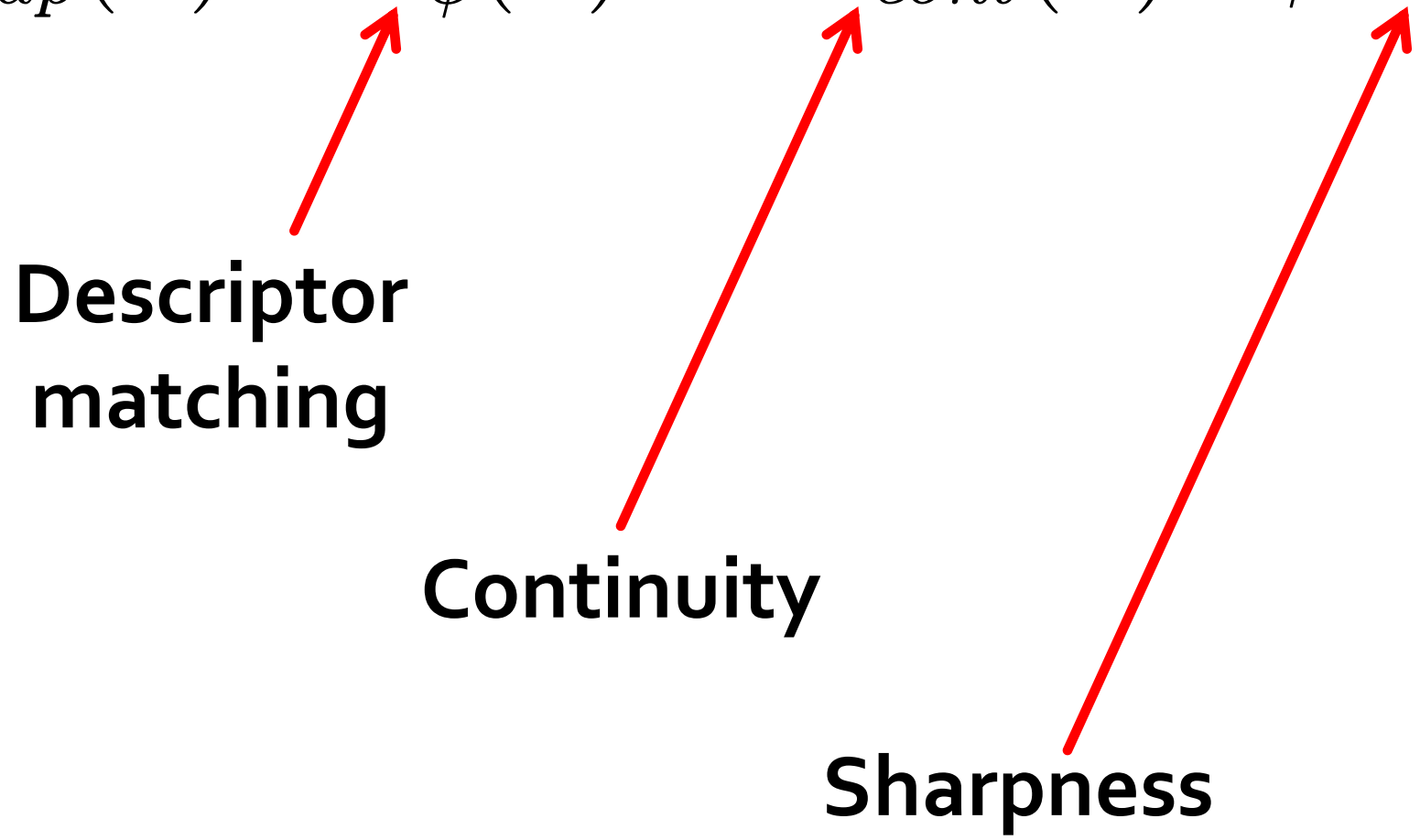


$$E_s(A) = \sum_{ij} a_{ij}^2 = \|A\|_{\text{Fro}}^2$$

Sharpness

Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_{s}(A)$$



Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_{s}(A)$$

Linear program!

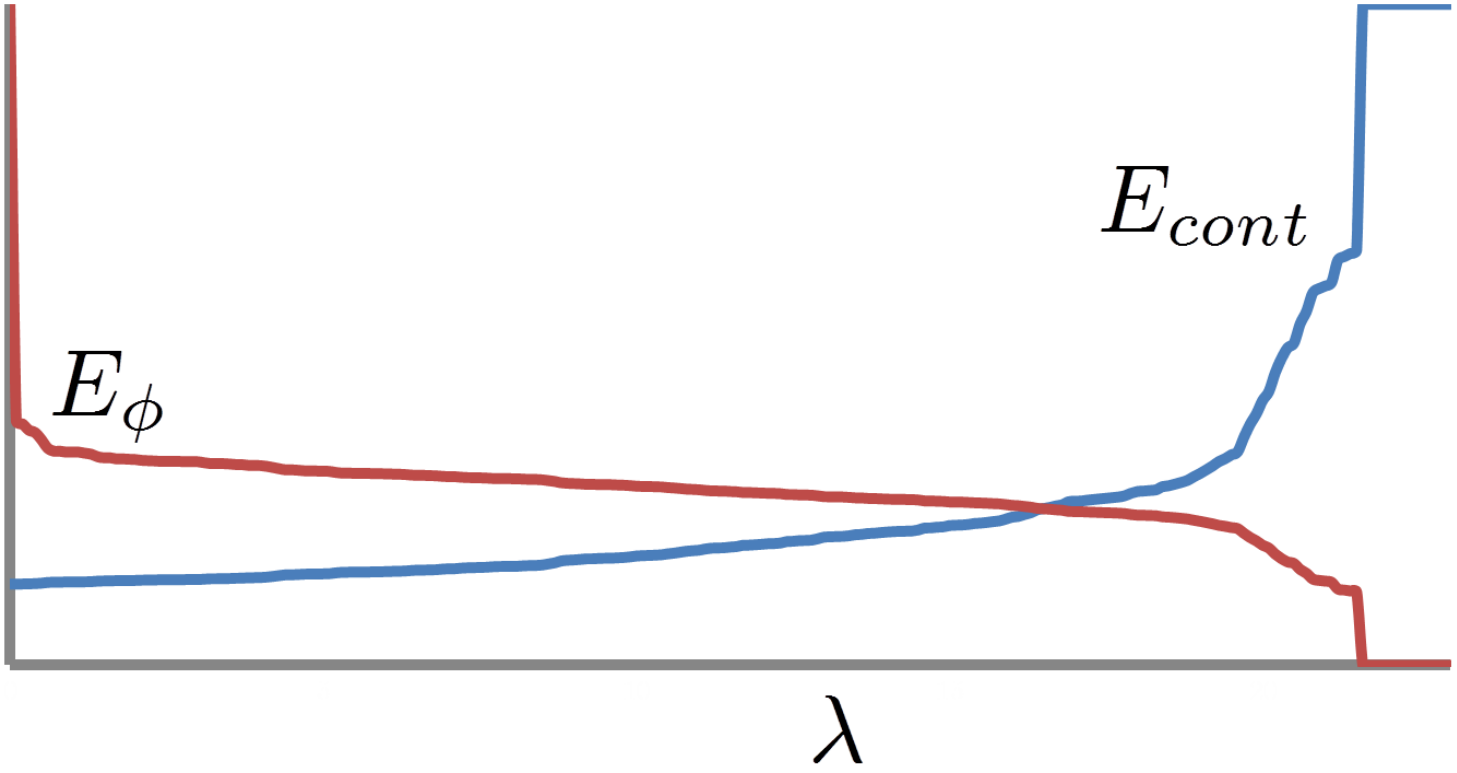
Descriptor matching

Continuity

Sharpness

Finding Soft Correspondences

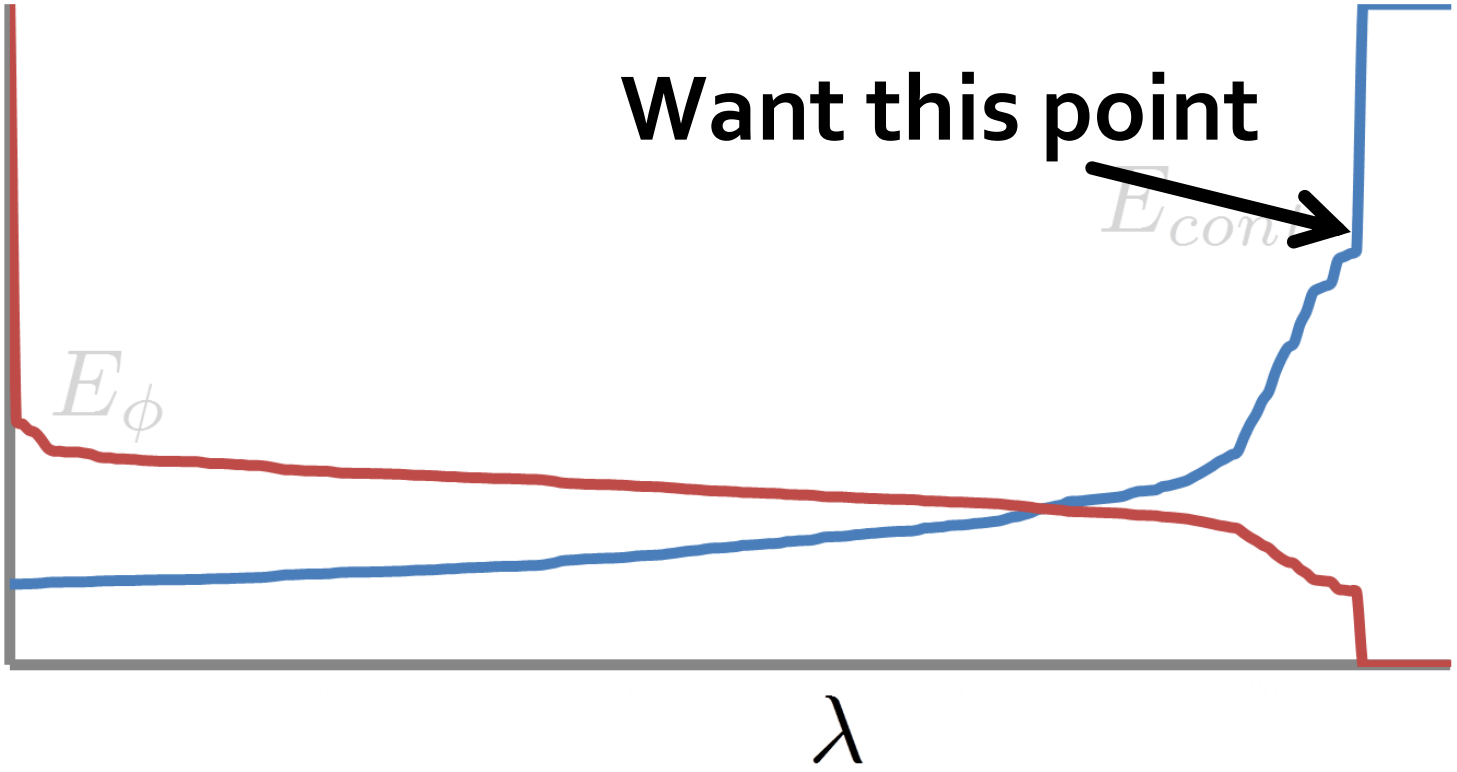
$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_{s}(A)$$



Sharp transition

Finding Soft Correspondences

$$E_{map}(A) = E_{\phi}(A) + \lambda E_{cont}(A) + \beta E_s(A)$$



Sharp transition

Finding Soft Correspondences

$$\min E_{\phi}(A) + \lambda E_{cont}(A)$$

Finding Soft Correspondences

$$\min \; E_\phi(A) + \lambda E_{cont}(A)$$

$$\text{such that}$$

Finding Soft Correspondences

$$\min \; E_\phi(A) + \lambda E_{cont}(A)$$

$$\text{such that}$$

Primal

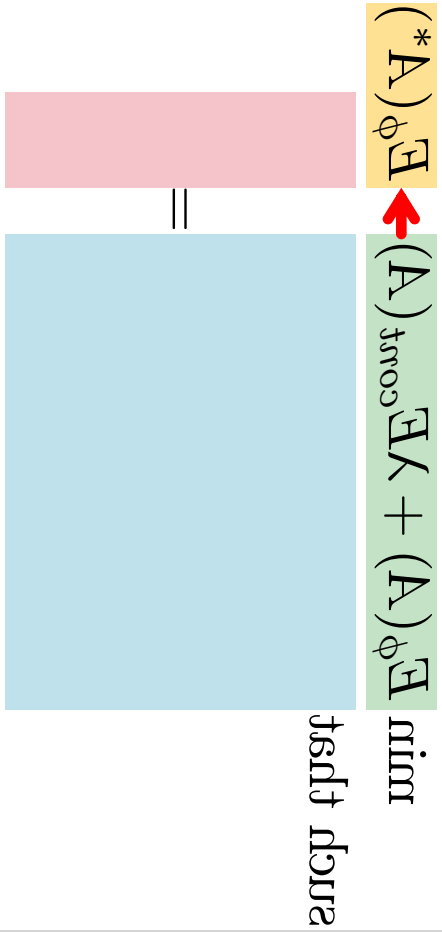
Finding Soft Correspondences

$$\min \; E_\phi(A) + \lambda E_{cont}(A) \rightarrow E_\phi(A^*)$$

$$\text{such that}$$

Primal

Finding Soft Correspondences



Dual

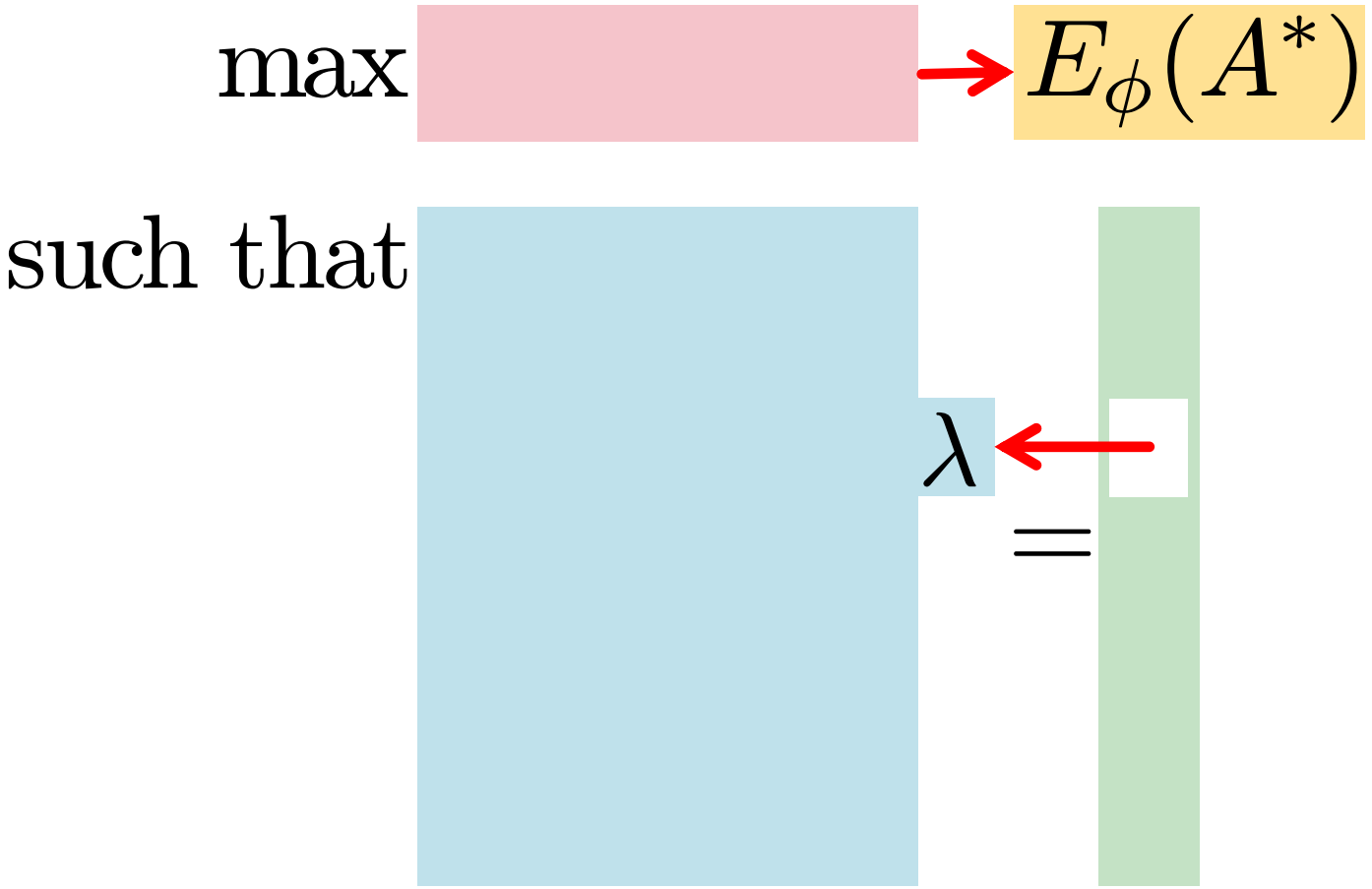
Finding Soft Correspondences

$$\max \quad \rightarrow E_\phi(A^*)$$

$$\text{such that} \quad = \lambda$$

Dual

Finding Soft Correspondences

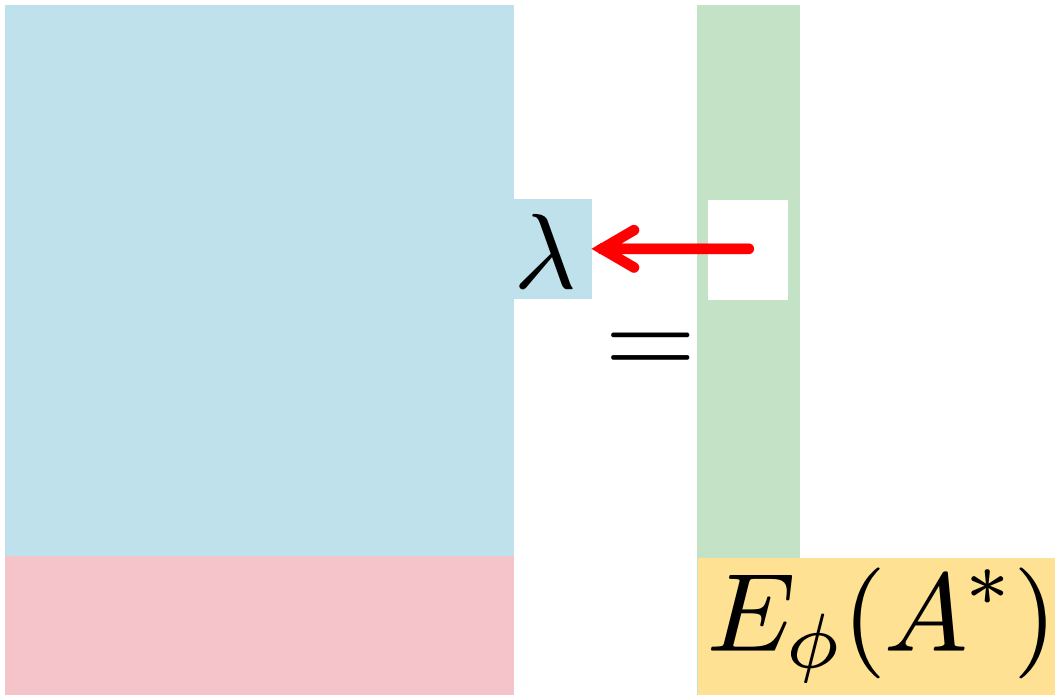


Dual

Finding Soft Correspondences

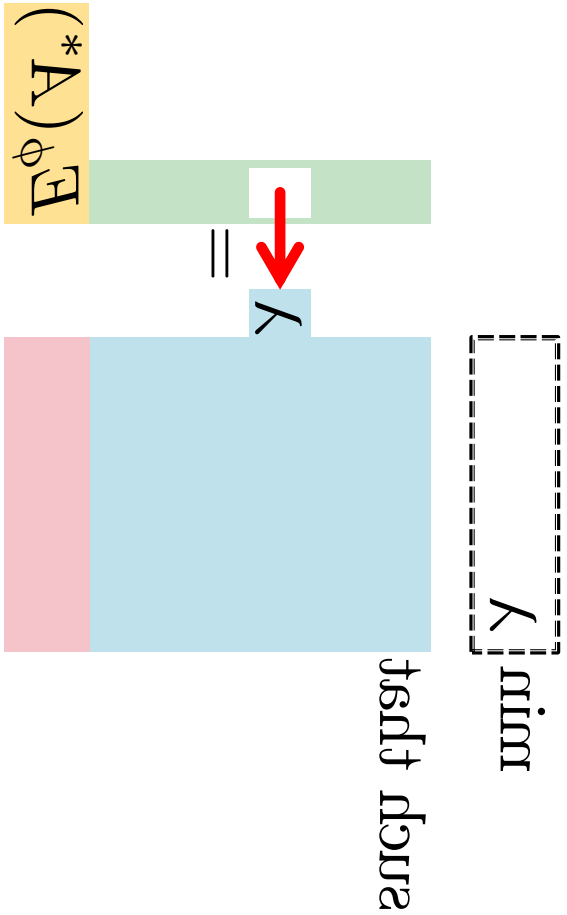
$$\min \lambda$$

$$\text{such that}$$



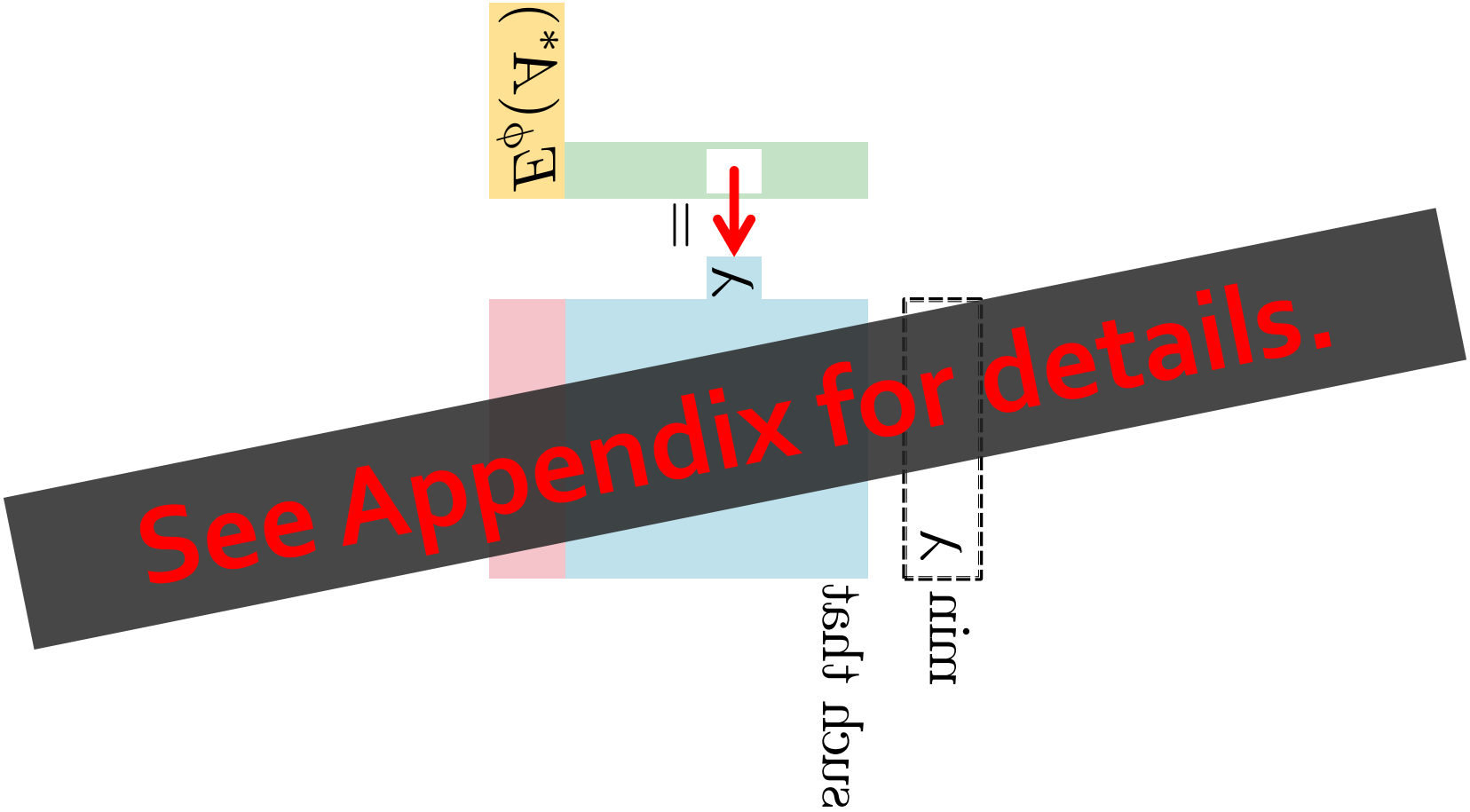
Dual

Finding Soft Correspondences



New primal

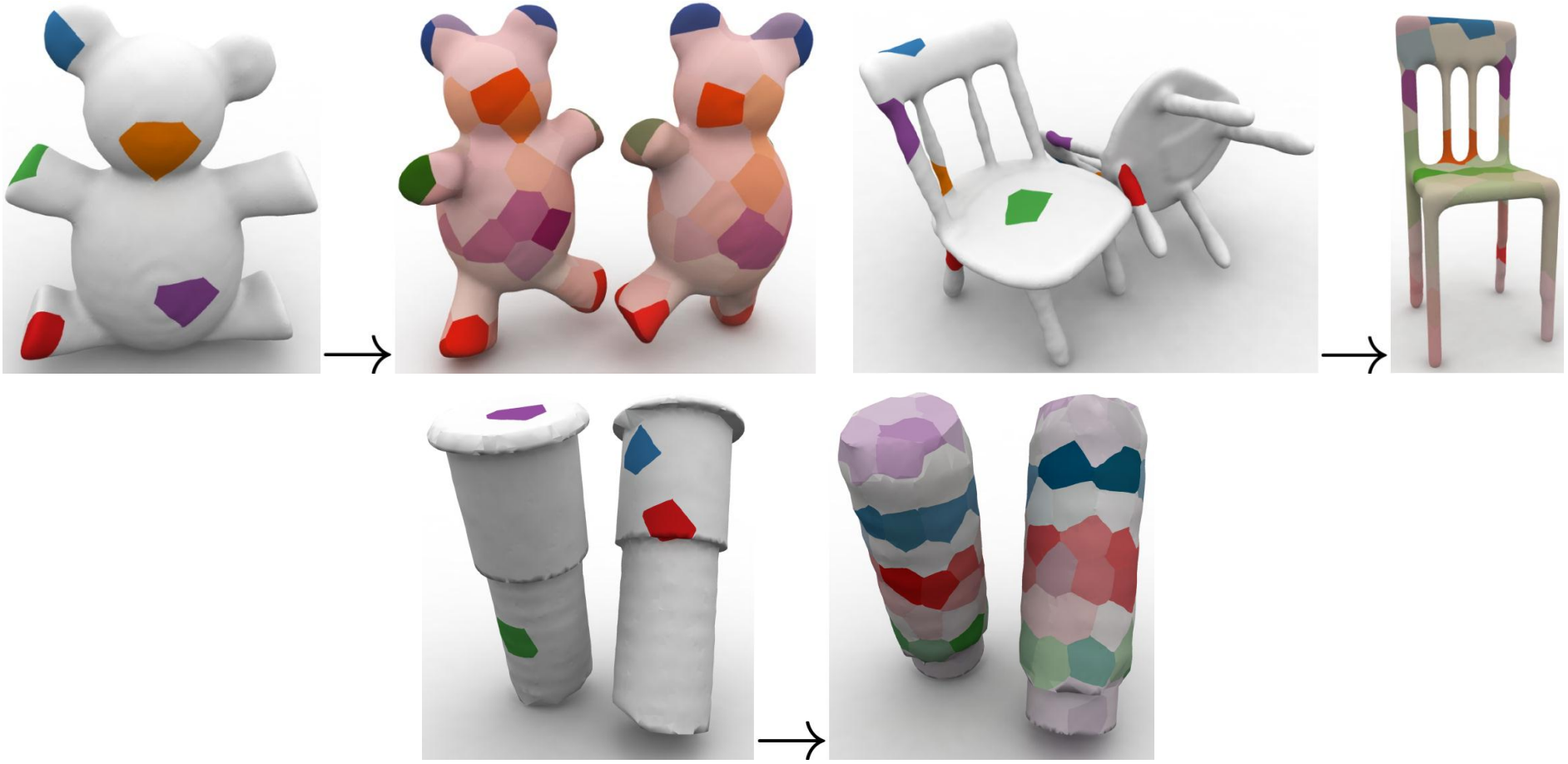
Finding Soft Correspondences



See Appendix for details.

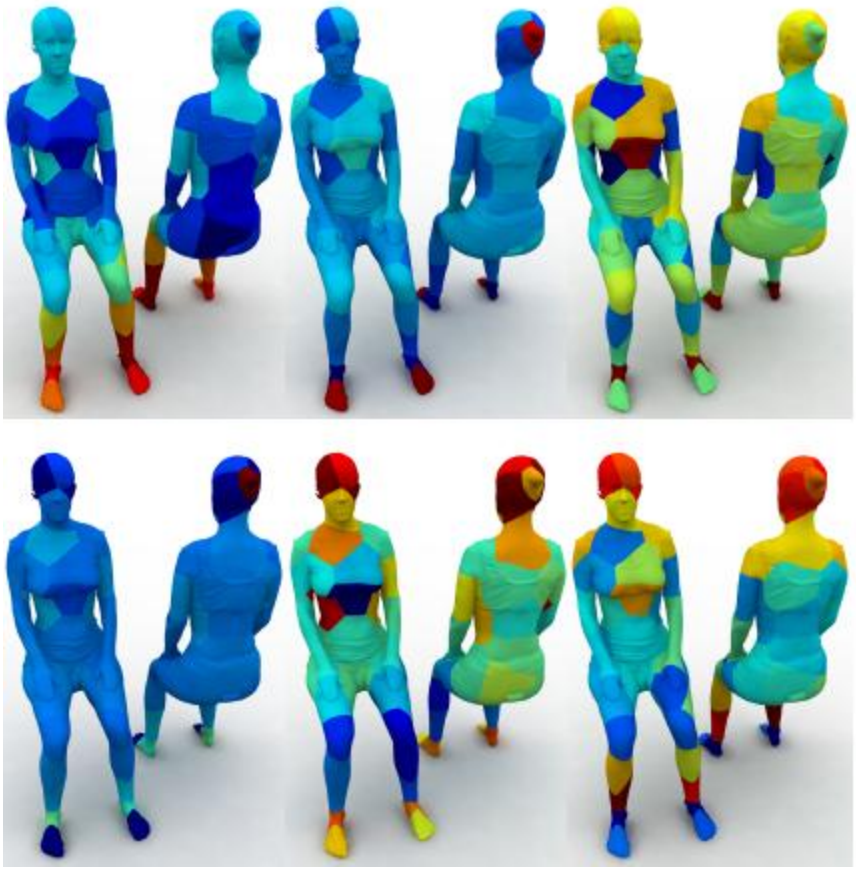
New primal

End Result



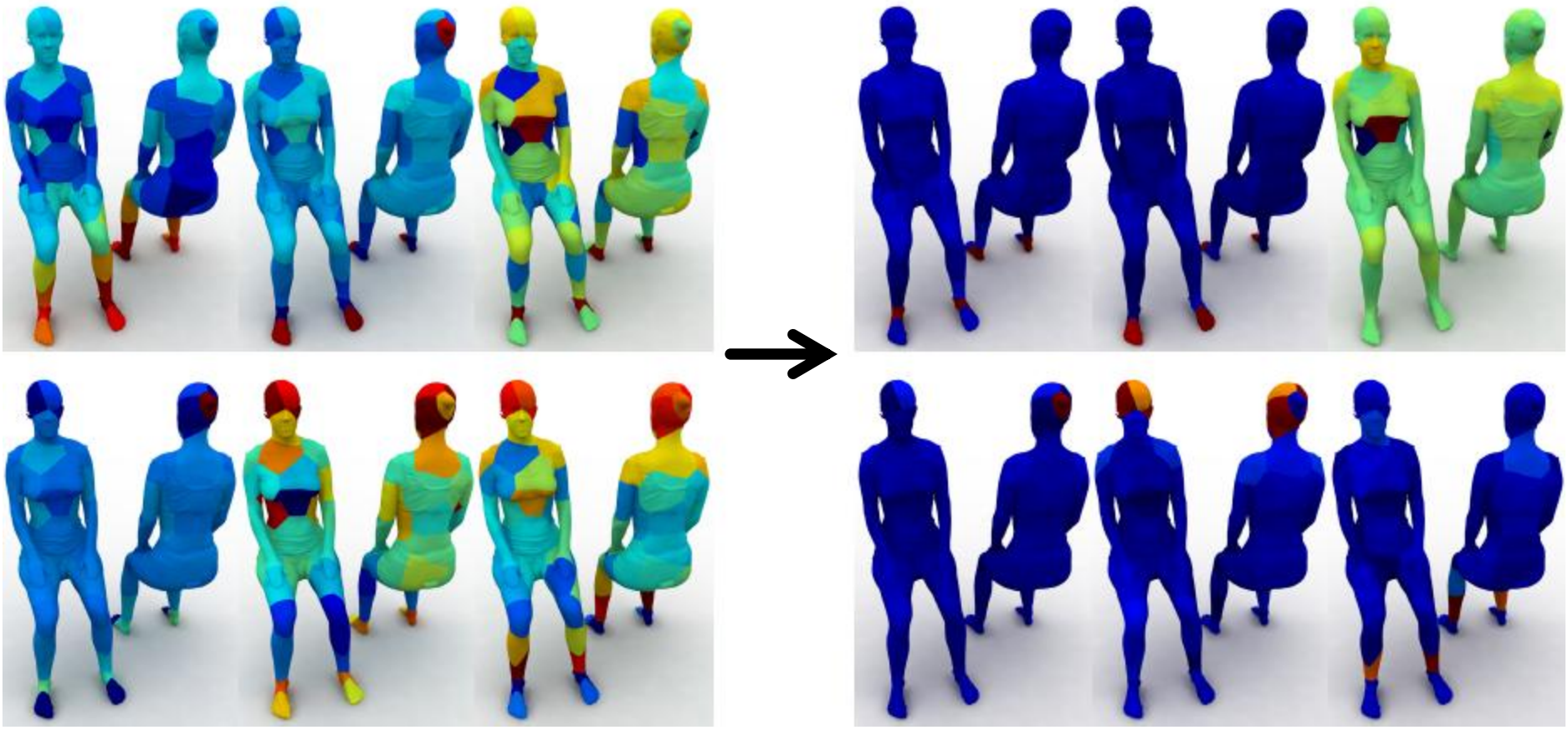
Continuous soft maps

PCA Analysis



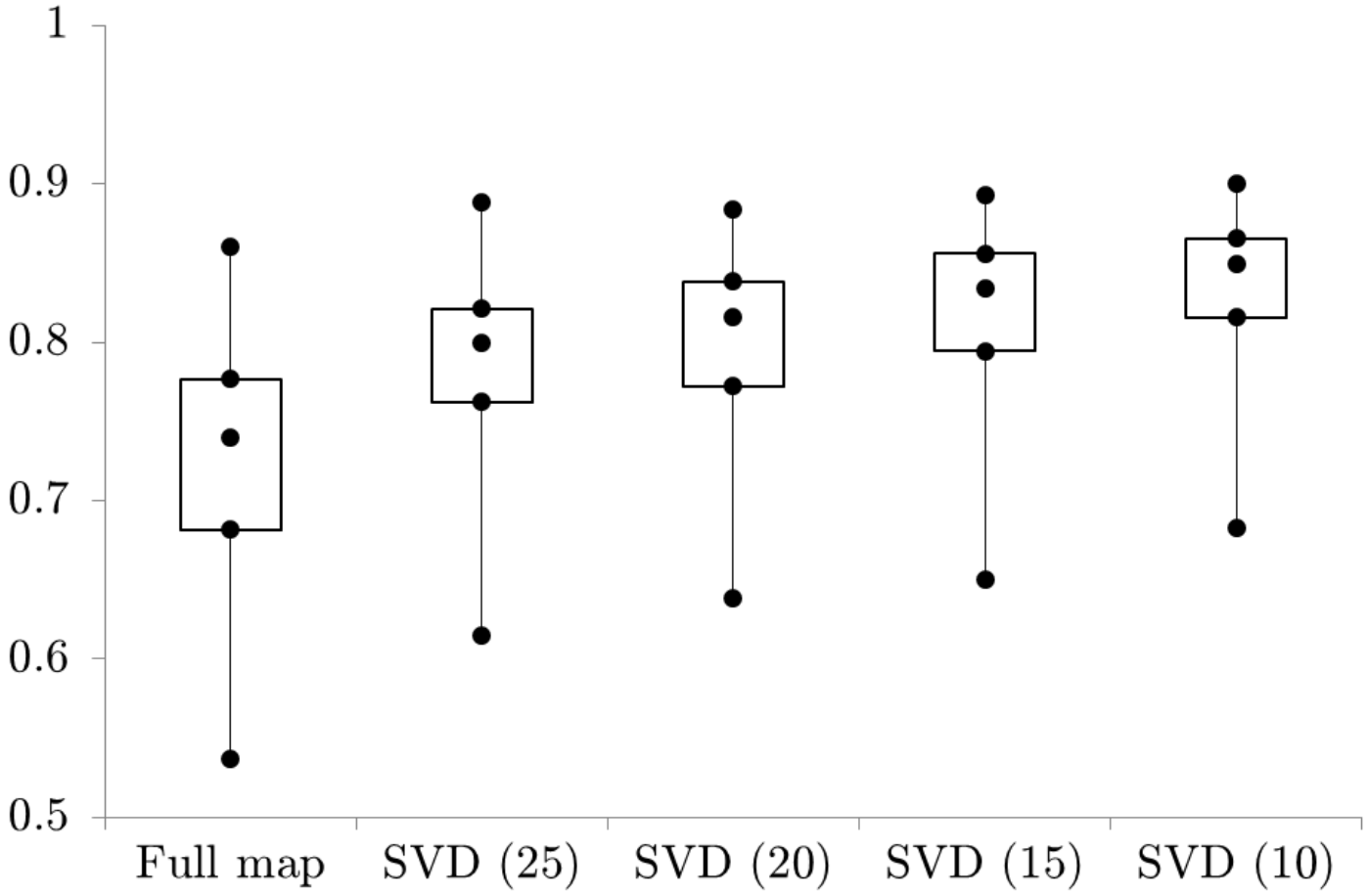
Basis for probability measures

PCA Analysis



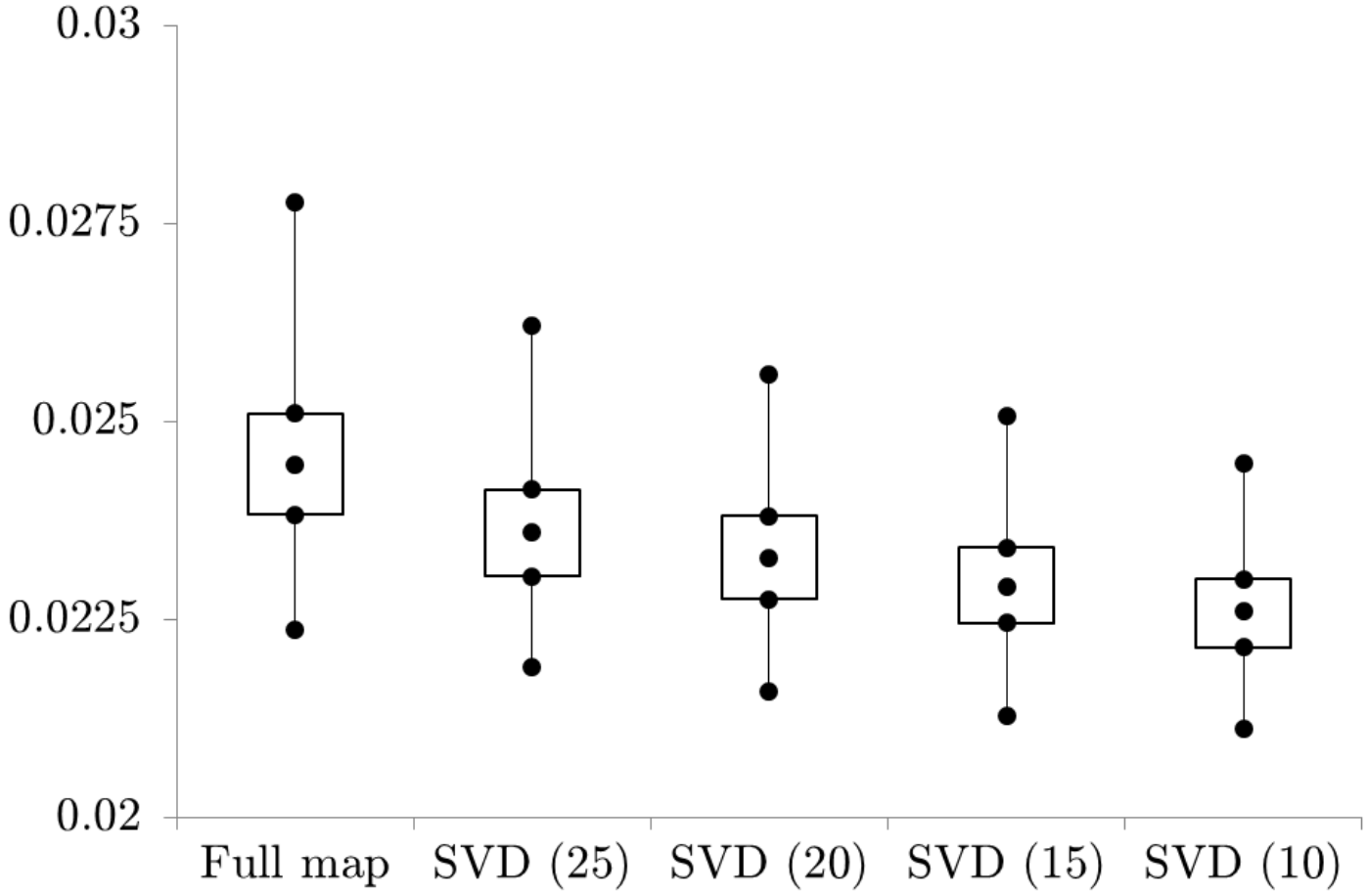
Basis for probability measures

Projection onto Basis



Validation improves

Projection onto Basis



Sharpness decreases

Future Work

- Computing denser maps
- Applications to graphics and other fields
- Map collections and composition

Special Thanks

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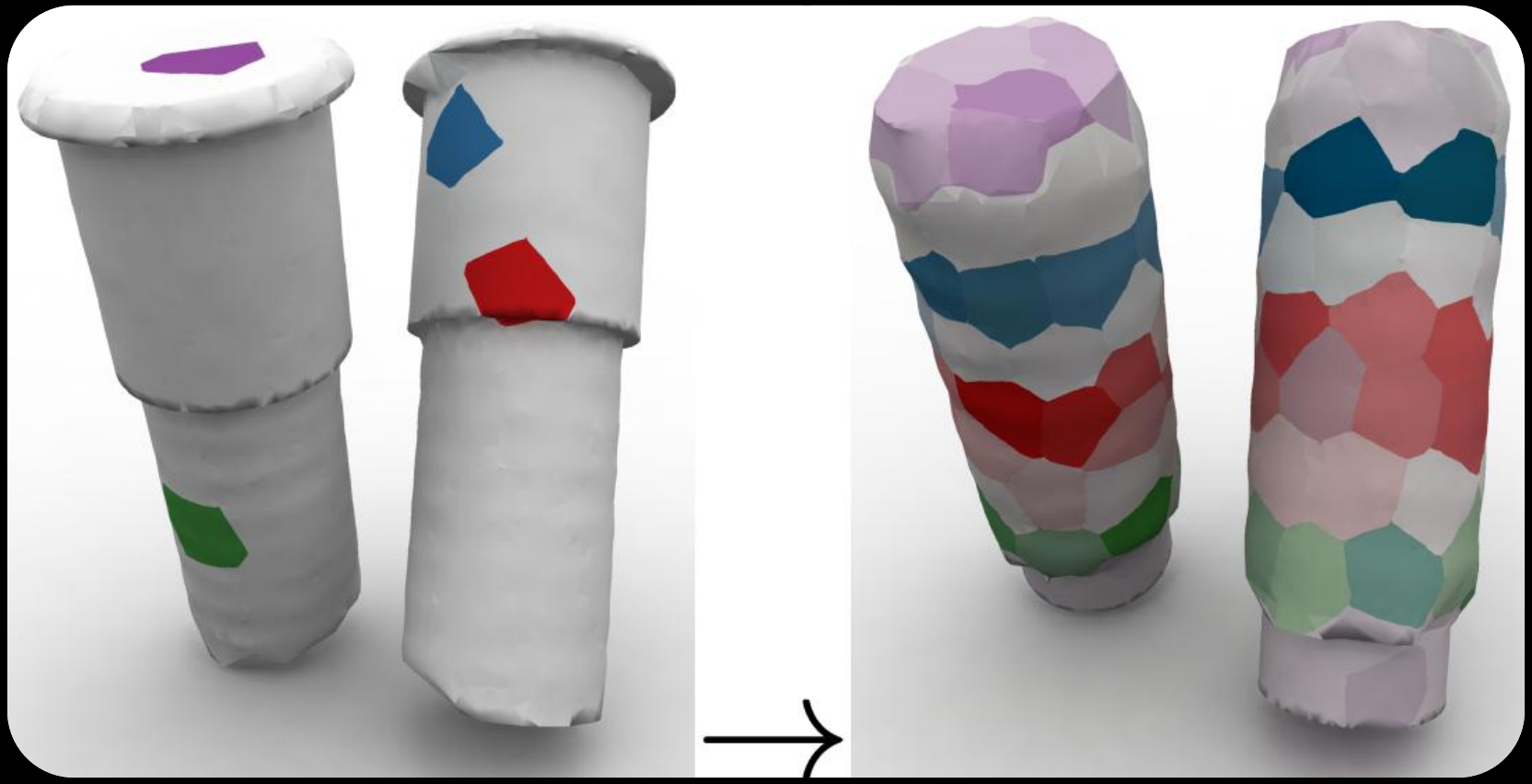

Soft Maps Between Surfaces

Questions?