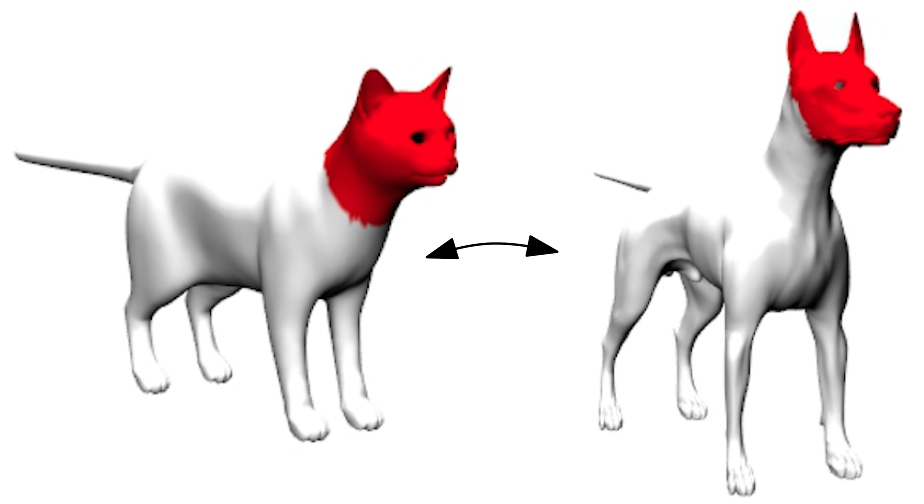
Region-based Correspondence Between 3D Shapes via Spatially Smooth Biclustering

M. Denitto[1], S. Melzi[1], M. Bicego[1], U. Castellani[1],
A. Farinelli[1], M. A. T. Figueiredo[2], Y. Kleiman[3], M. Ovsjanikov[3]
University of Verona[1], *Universidade de Lisboa*[2], *Ecole Polytechnique*[3]

Background

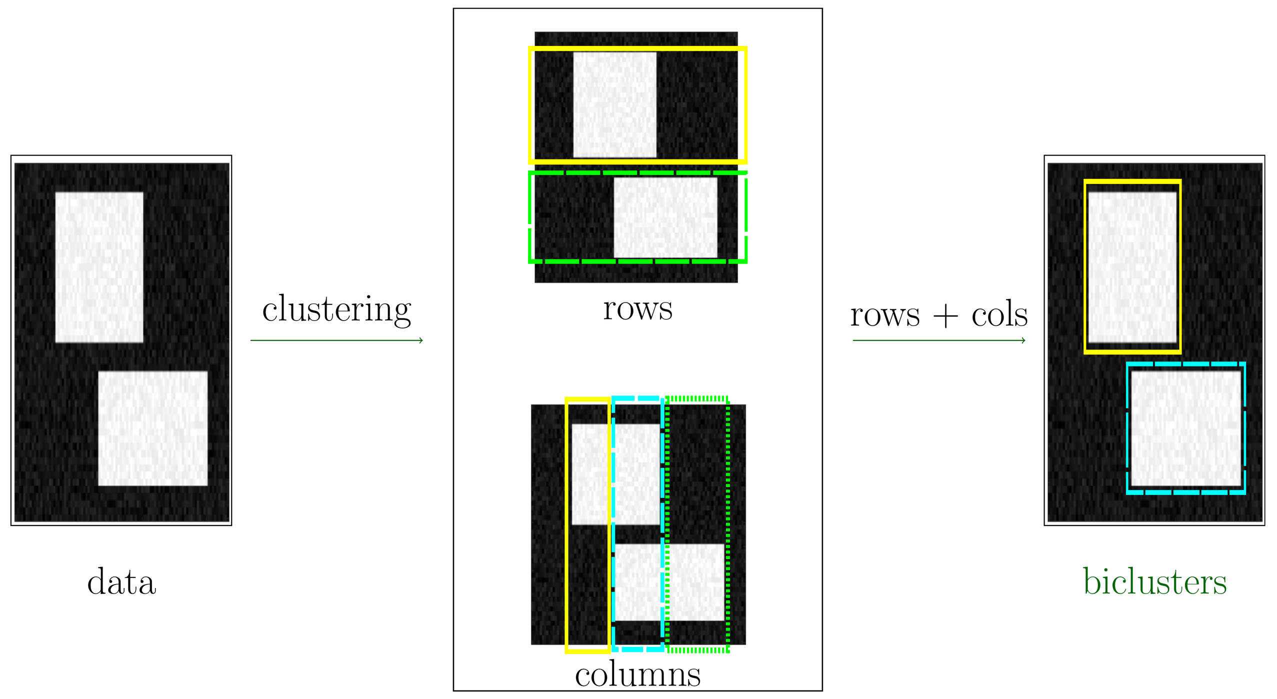
Region-based Correspondence

Given a couple of shapes, RBC aims at finding regions on the shapes that behave similarly and can thus be easily put in correspondence



Biclustering

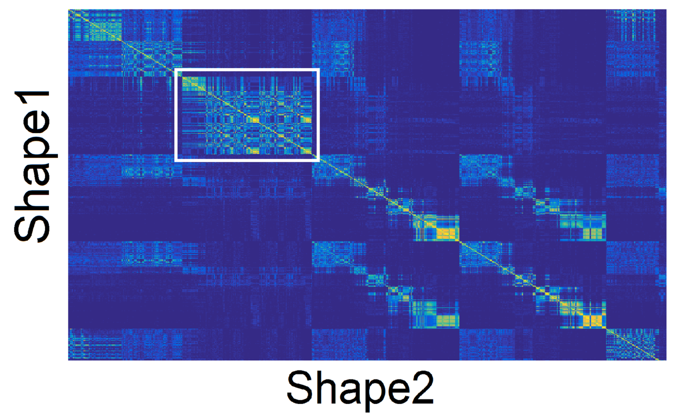
Simultaneous clustering of both rows and columns of a given data matrix



Bicluster: sub-matrix where rows present a coherent behaviour with columns (and viceversa)

Starting viewpoint

1. StableRegion [SGP '16]
2. Similarity criterion between two vertices of different shapes
3. Affinity Matrix

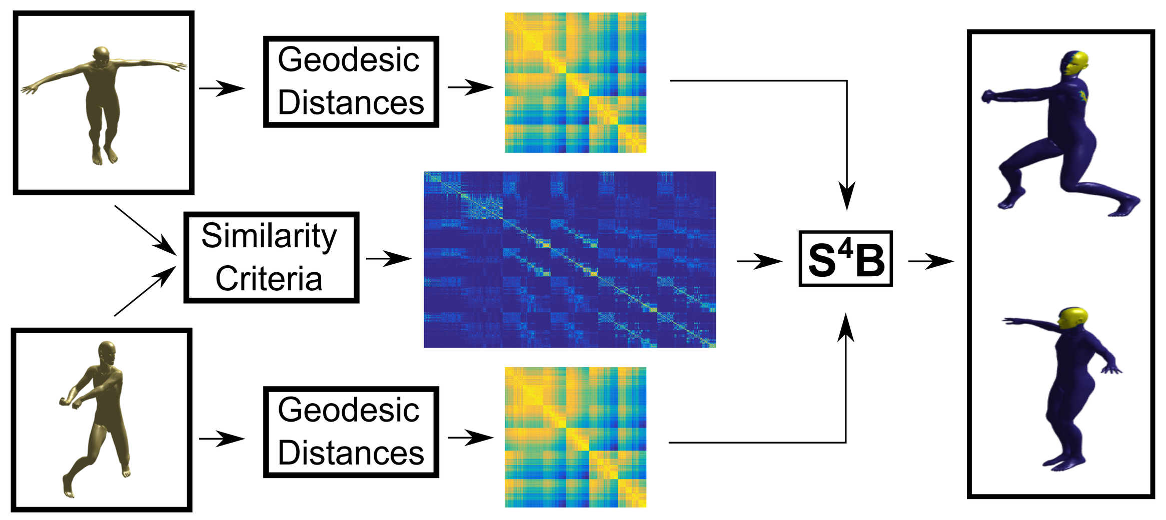


RBC is a biclustering problem. Bicluster: vertices of the first shape presenting a coherent behaviour with vertices of the second shape

The method

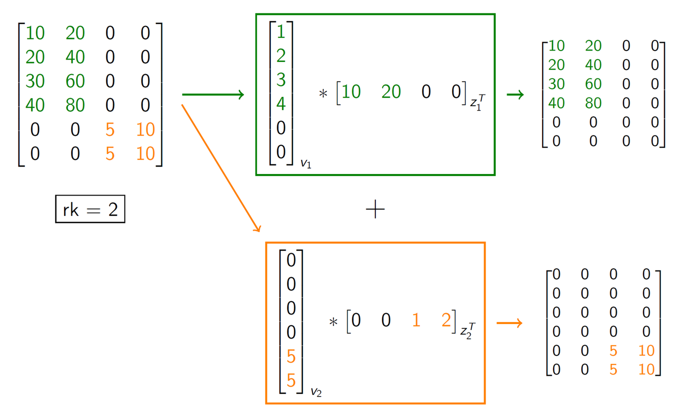
IDEA:
Near vertices should be grouped together!

Overview



S⁴B Ingredients

1. low-rank matrix factorization



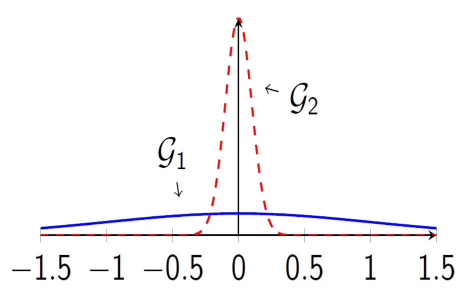
$$D = \sum_{p=1}^{k} v_p * z_p^T = VZ$$

with $V = [v_1, \dots, v_k]$ and $Z = [z_1, \dots, z_k]^T$

2. Spike and Slab prior

Two Normal Distributions

- $G_2 = \mathcal{N}(0, \tau_2) \rightarrow$ generate zero points
- $G_1 = \mathcal{N}(0, \tau_1) \rightarrow \sim$ uniform function
- $\tau_1 \gg \tau_2$



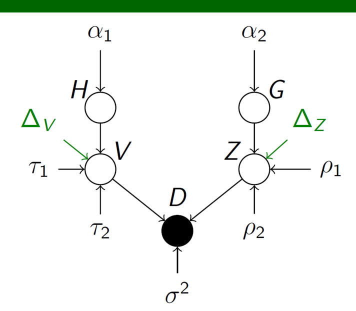
$$\mathcal{P}(d) = \alpha G_1 + (1 - \alpha) G_2$$

3. Spatial Smoothness

- Encourage similar rows (cols) to be in the same bicluster
- Δ_V, Δ_Z similarity matrices
- $s_{ij} \geq 0$: preference for i^{th} and j^{th} columns (or rows) to be in the same bicluster

The model

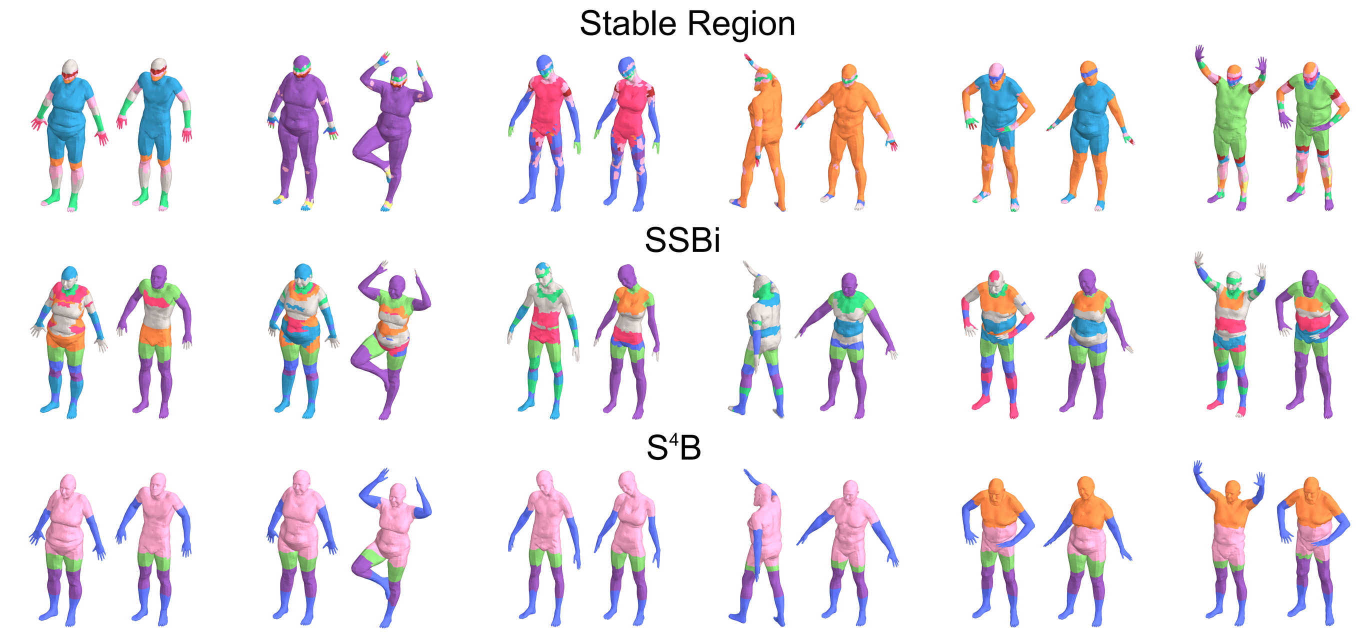
- Bayesian Network
- EM algorithm
- closed form update rules (GEM)



Results

FAUST Dataset

Qualitative results



Quantitative results

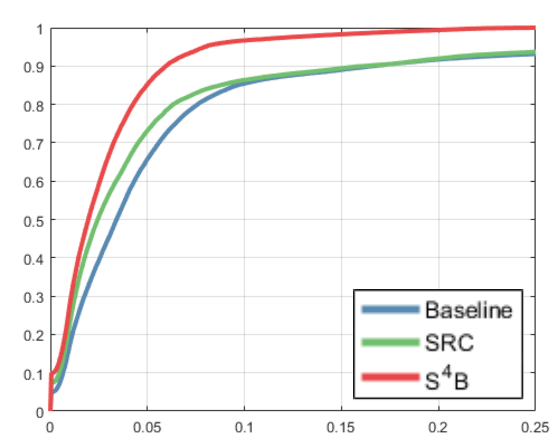
	Stable Region	BIM Voronoi	BIM S⁴B	SSBi	S⁴B
scenario1	95.37	95.87	**97.98**	29.91	97.36
scenario2	85.34	95.35	94.21	30.39	**95.73**
scenario3	85.39	92.51	92.5	32.32	**94.25**
global	86.58	93.26	93.36	31.8	**94.8**

	Stable Region	BIM Voronoi	BIM S⁴B	SSBi	S⁴B
scenario1	94.95	96.76	97.84	30.07	**97.98**
scenario2	87.42	96.17	93.82	30.95	**96.63**
scenario3	87.63	92.82	92.55	33.77	**94.96**
global	89.33	93.1	93.15	31.26	**95.52**

Table 1: Scenario1: same subject in different poses. Scenario2: different subjects in the same pose. Scenario3: different subjects in different poses. Mean/median scores for each scenario, and the global mean/median score. SSBi is the S⁴B algorithm withouth the spatial smoothness prior. BIM details at [SIG '11].

Point-wise map estimation

- Functional maps [TOG '12]: framework for p2p-map recovery
- such map is obtained combining information of vertices descriptors and known regions
- we compare the standard baseline, with SRC regions and with S⁴B regions
- **S⁴B regions clearly improve the performance!**



References

[SGP '16]: Stable Region Correspondences Between Non-Isometric Shapes, *V. Ganapathi-Subramanian et al*
[TOG '12]: Functional maps: a flexible representation of maps between shapes. *M. Ovsjanikov et al*
[SIG '11]: Blended intrinsic maps. *V. G. Kim*