# Deformation-Guided Unsupervised Non-Rigid Shape Matching

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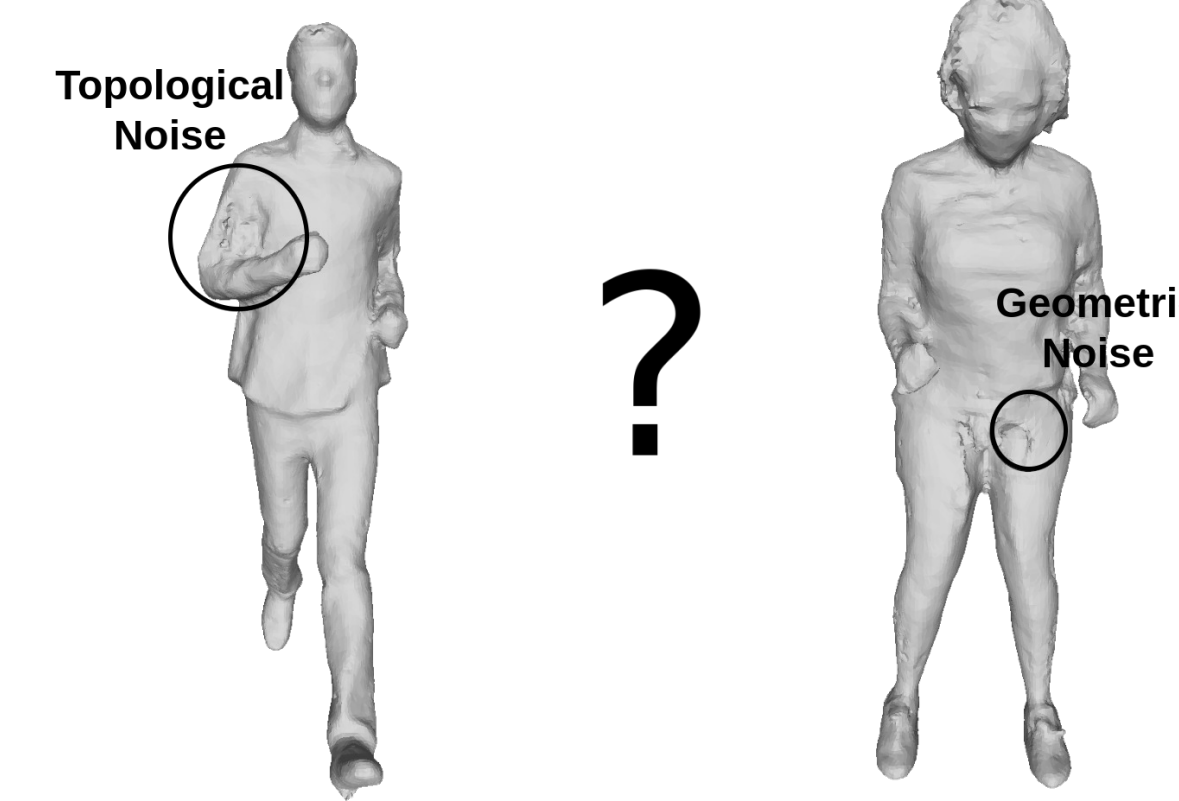[1]Inria Centre at the University Grenoble Alpes, [2]Interdigital

## Problem

**Non-Rigid Shape Matching** Extract meaningful correspondences between two 3D meshes that differ in their shape or pose.

**Goal** Generalise to raw 3D scans that display large deformations and are plagued by geometric and topological noise.



**Strategy**

- Leverage multi-scale matching for robustness to noise and deformation guidance to capture global shape properties and generalise to unseen deformations.

## Contributions

- Novel spatial unsupervised data-driven non-rigid shape matching approach that combines multi-scale association maps with a piecewise near-rigid deformation model.

- Outperform state-of-the-art on matching raw 3D scans captured using a multi-camera platform while being on-par on standard test scenarios.
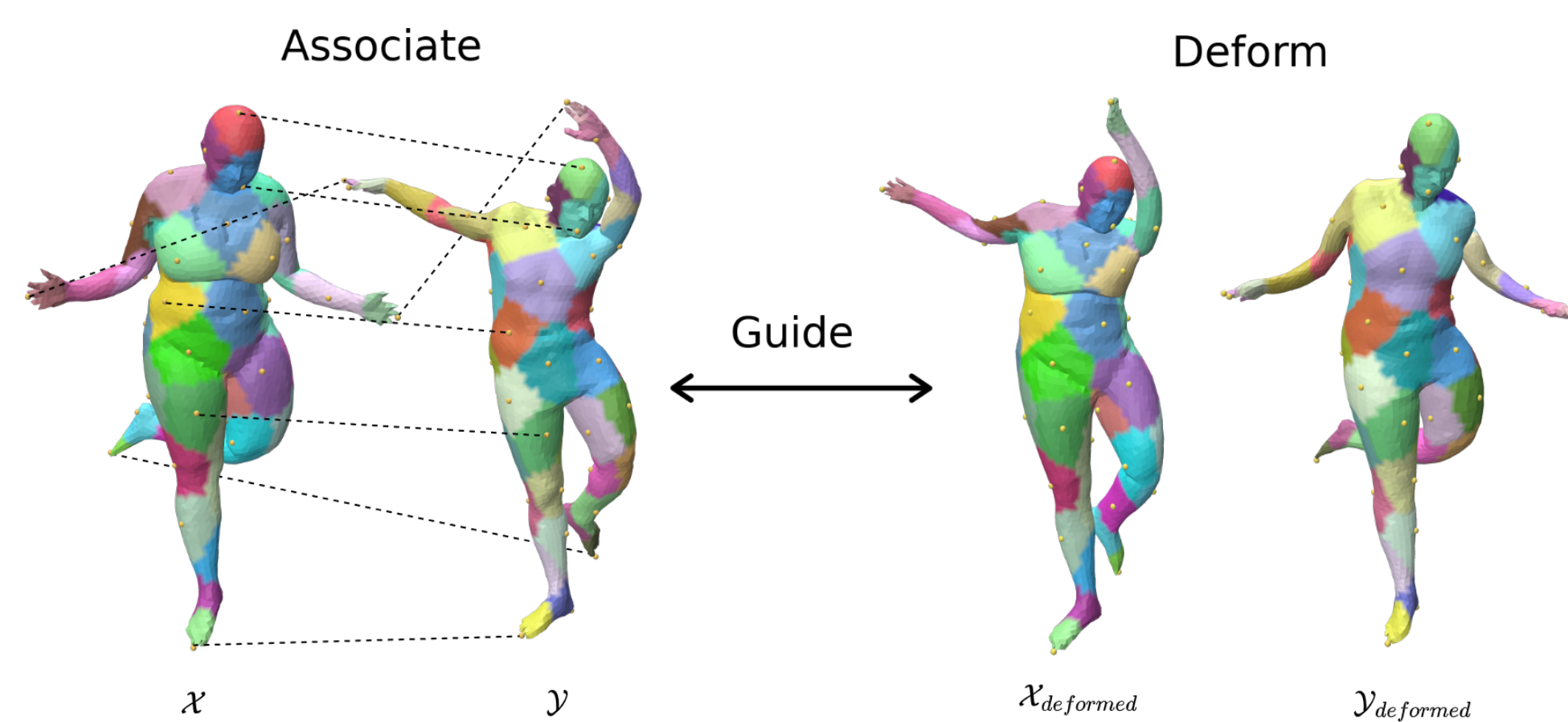
## Proposed Approach

**1. Multi-scale Matching** Match shapes at increasing levels of detail, from coarse surface patches to vertices.
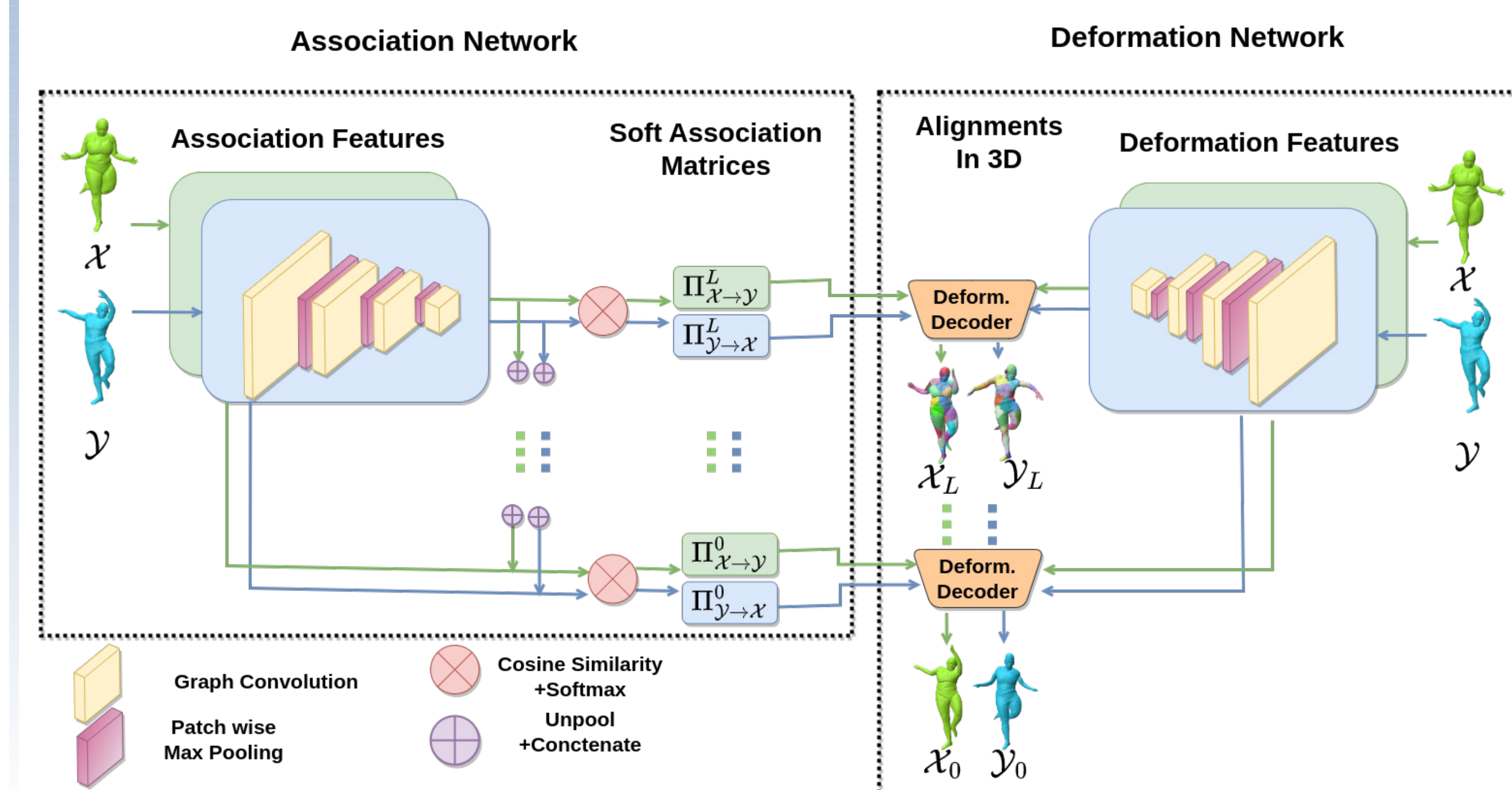


$\longrightarrow$ Allows robustness to noise and reduces the dimensionality of the problem when matching at coarse scales.

**2. Deformation Guidance** Fit the hierarchical patch associations to a patch-wise near rigid deformation model [1].
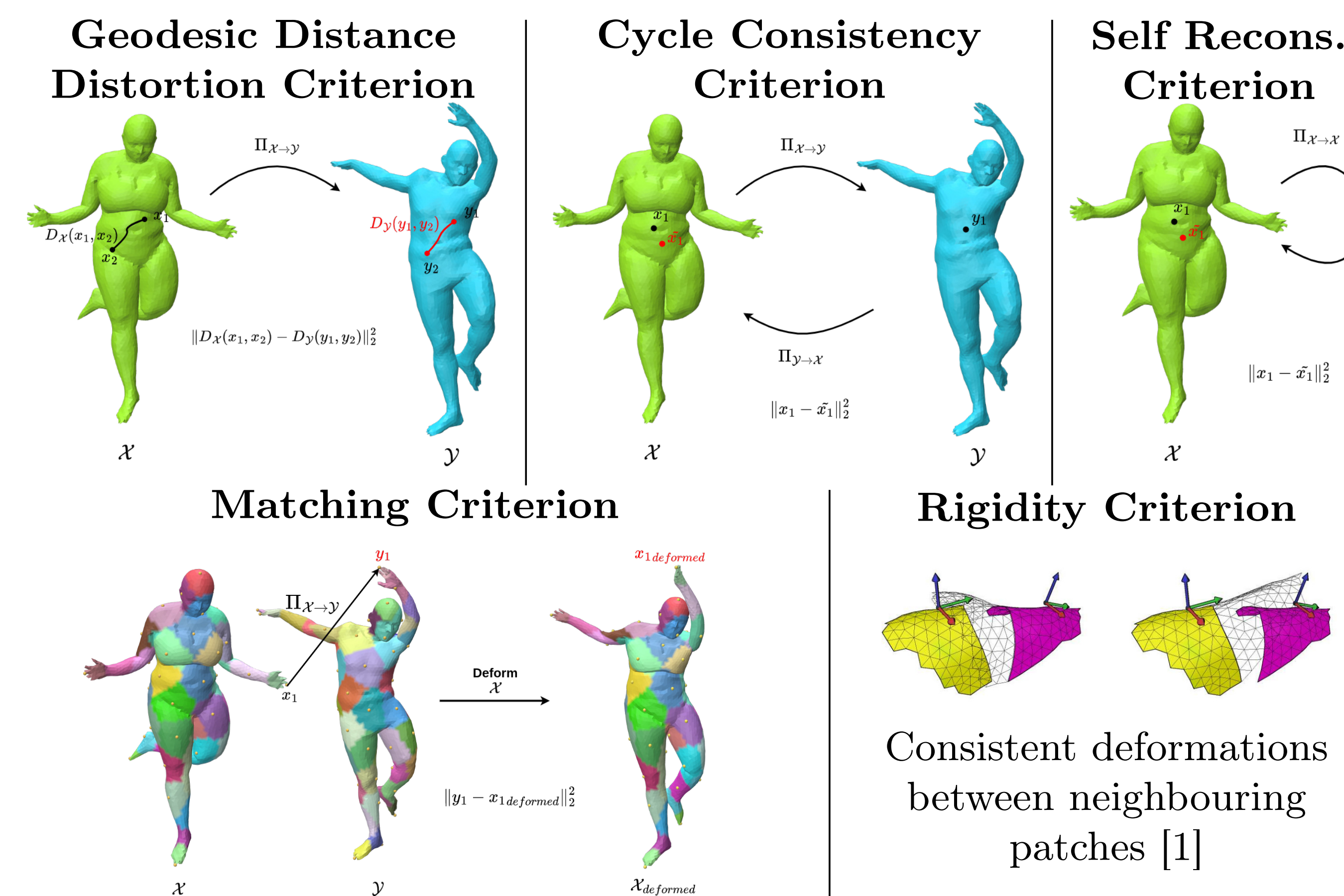


$\longrightarrow$ Links associations of individual shape elements to extract global shape properties for a better generalisation.
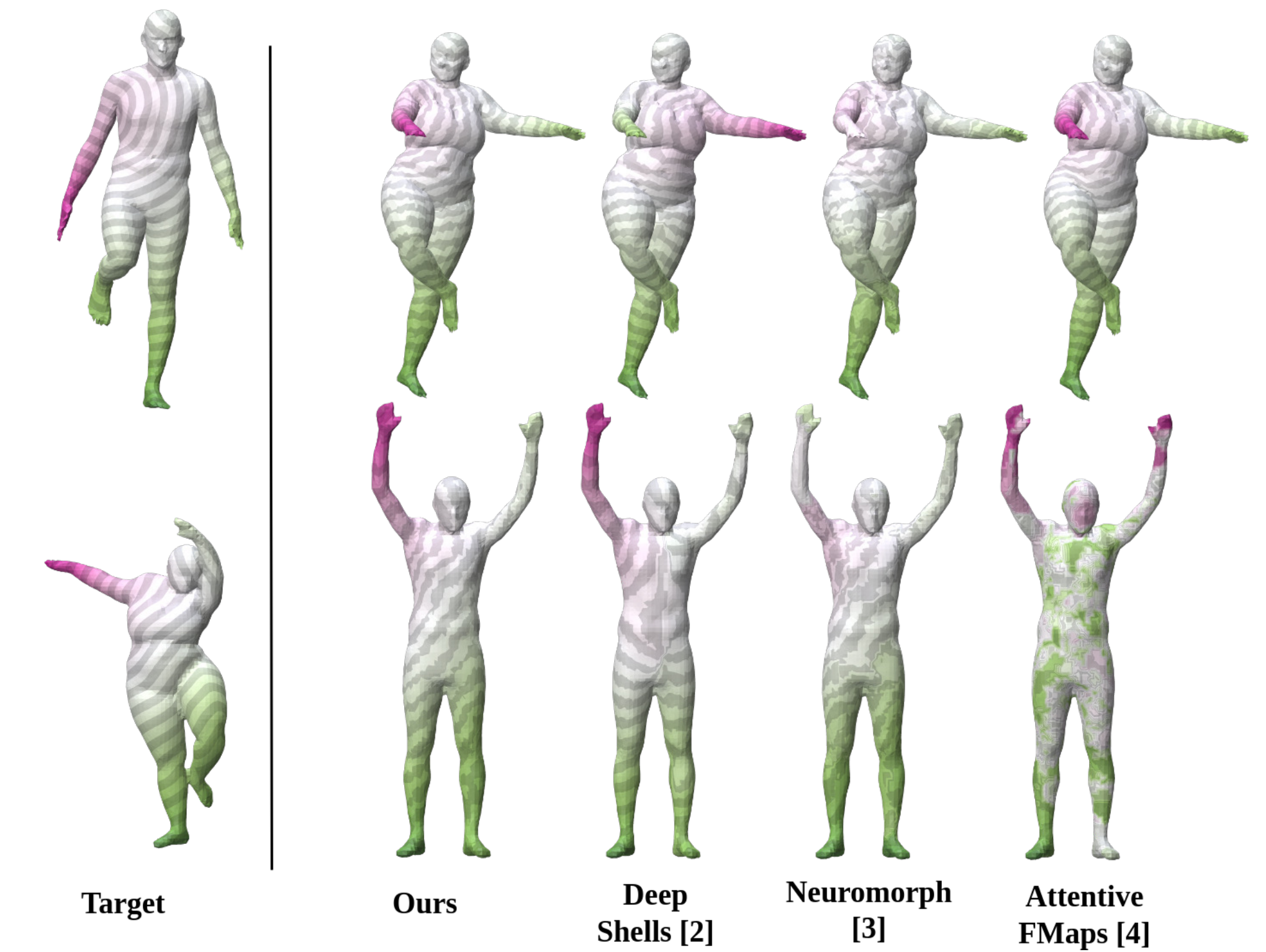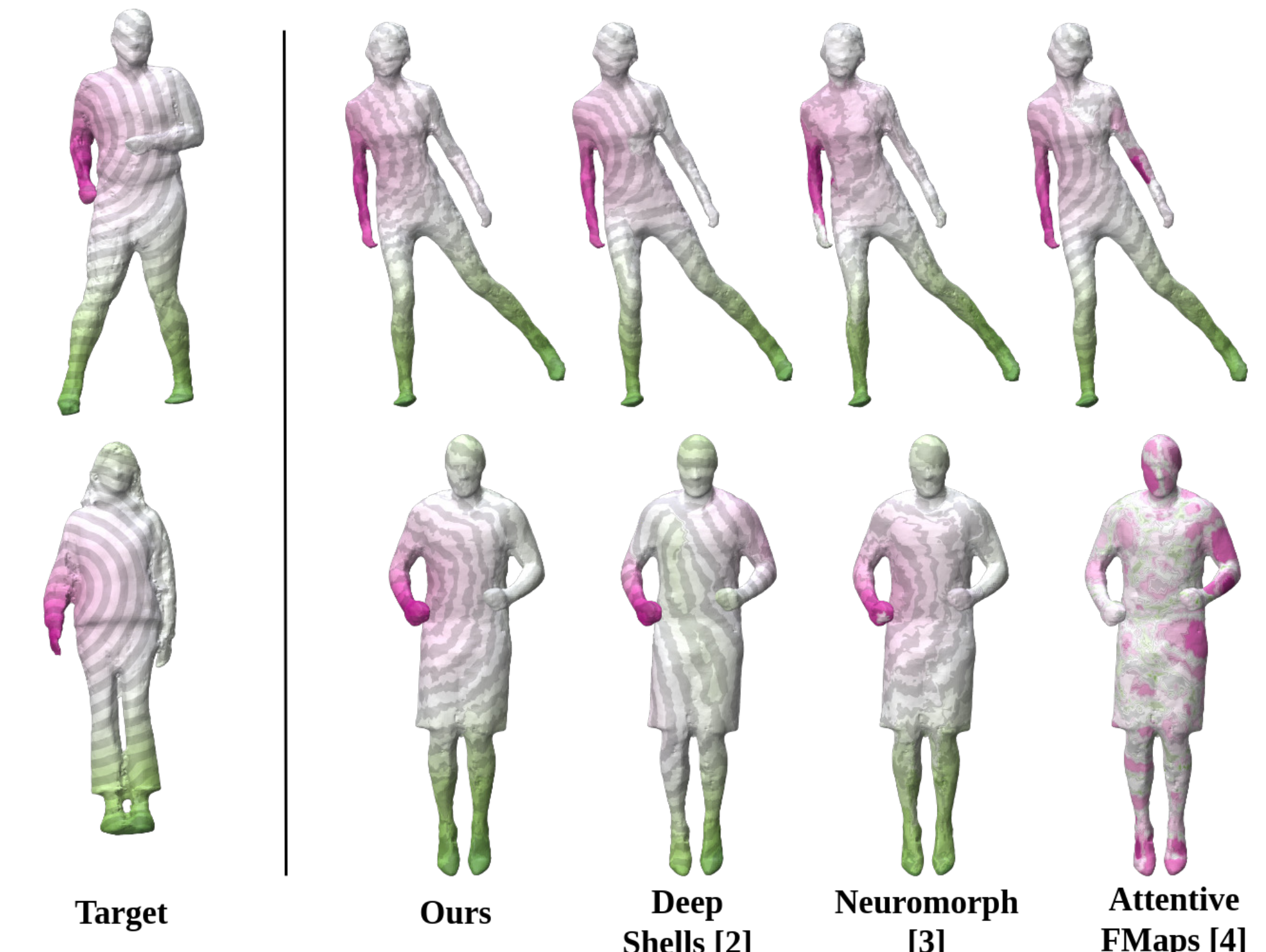
## Network Architecture



## Self-Supervised Learning Criteria



**Geodesic Distance Distortion Criterion**

**Cycle Consistency Criterion**

**Self Recons. Criterion**

**Matching Criterion**

**Rigidity Criterion**

Consistent deformations between neighbouring patches [1]

## Results

### On Template Fitted Humans



Target — Ours — Deep Shells [2] — Neuromorph [3] — Attentive FMaps [4]

### On Raw 3D Human Scans



Target — Ours — Deep Shells [2] — Neuromorph [3] — Attentive FMaps [4]

### On Template Fitted Animals



Target — Ours — Deep Shells [2] — Neuromorph [3] — Attentive FMaps [4]

## References

[1] C. Cagniart, E. Boyer, and S. Ilic: *Free-form mesh tracking: a patch-based approach*, CVPR (2010)

[2] M. Eisenberger, A. Toker, L. Leal-Taixé, and D. Cremers *Deep shells: Unsupervised shape correspondence with optimal transport*, NeurIPS (2020)

[3] M. Eisenberger, D. Novotny, G. Kerchenbaum, P. Labatut, N. Neverova, D. Cremers, and A. Vedaldi: *Neuromorph: Unsupervised shape interpolation and correspondence in one go*, CVPR (2021)

[4] L. Li, N. Donati, and M. Ovsjanikov: *Learning multi-resolution functional maps with spectral attention for robust shape matching*, NeurIPS (2022)