

Joint Learning of 3D Shape Retrieval and Deformation

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Motivation

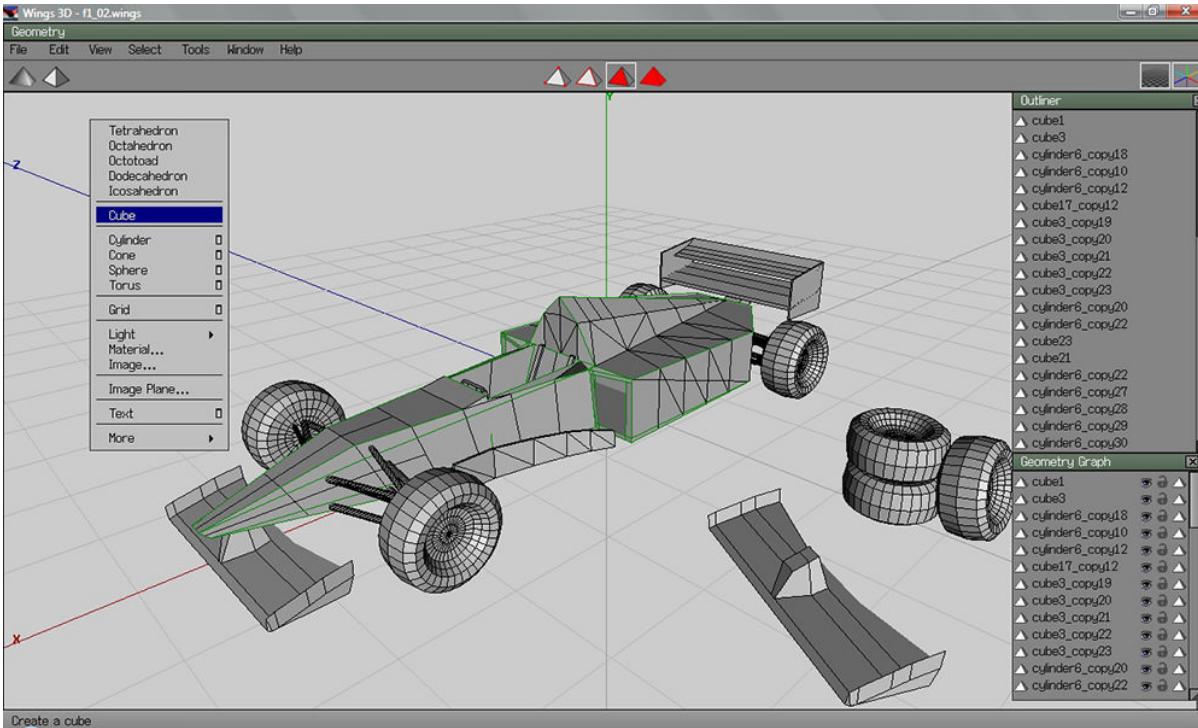


Photo taken from DeepSDF

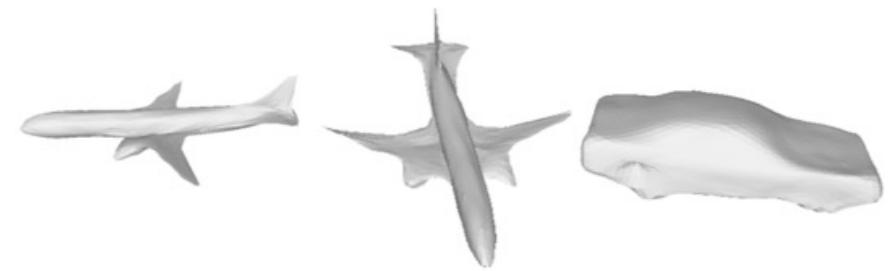


Photo taken from Pixel2Mesh++

- [1] DeepSDF: Learning Continuous Signed Distance Functions for Shape Representation. Park, et. al., CVPR 2019.
- [2] Pixel2Mesh++: Multi-View 3D Mesh Generation via Deformation. Wen, et. al., ICCV 2019.

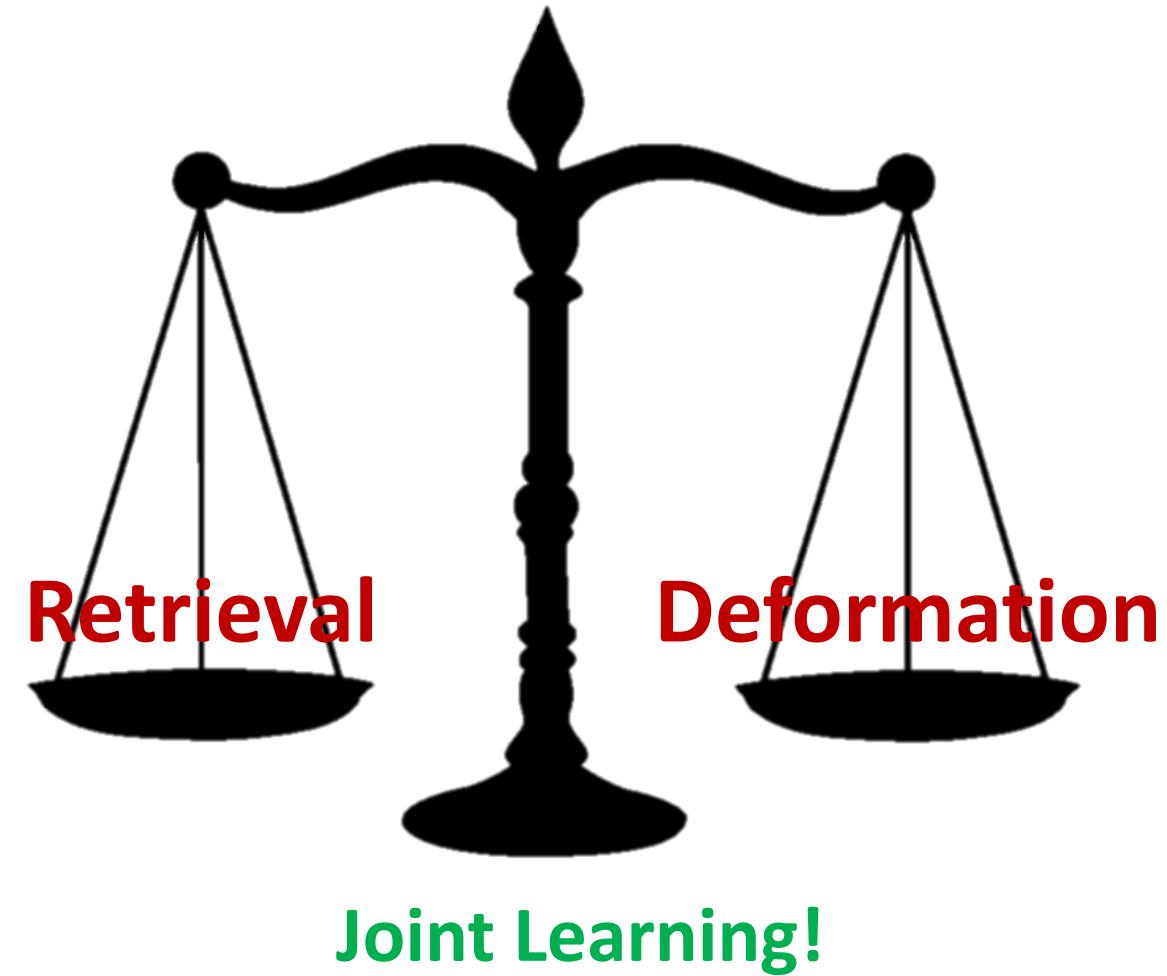
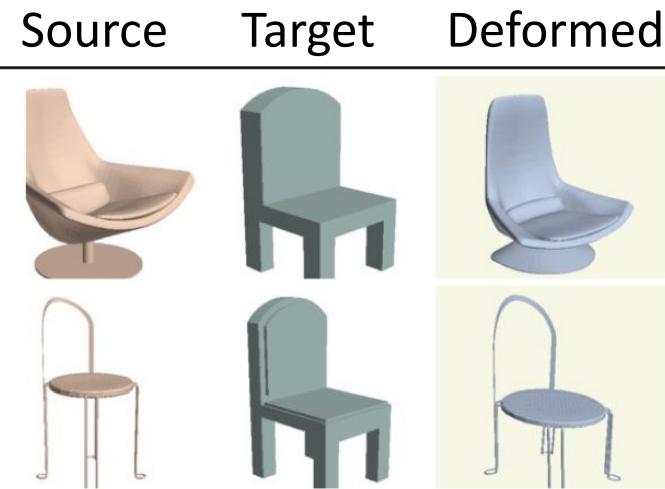


Motivation

Retrieval



Deformation

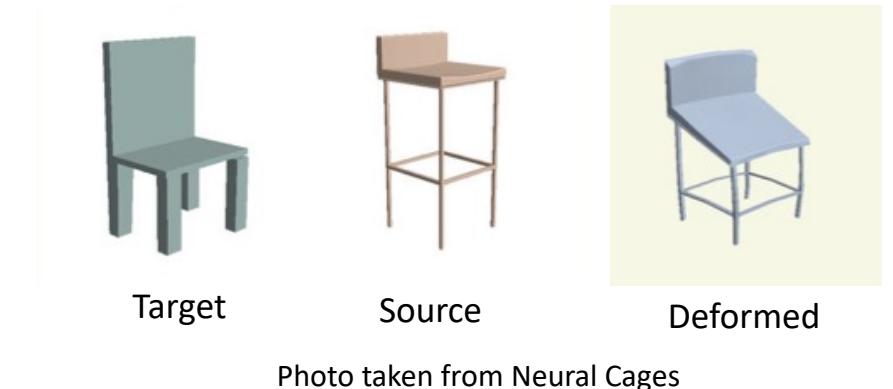


[3] Joint Embedding of 3D Scan and CAD Objects. Dahnert, et. al., ICCV 2019.

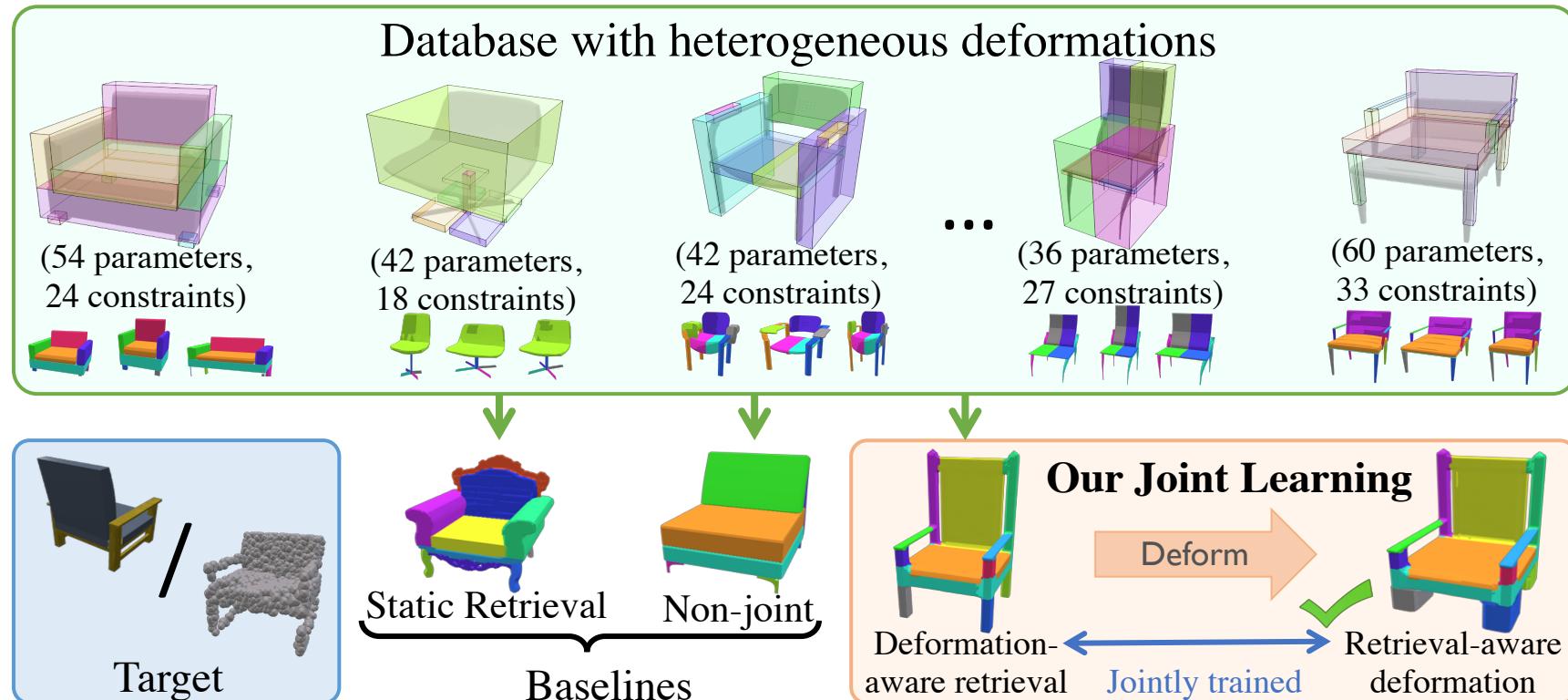
[4] Neural Cages for Detail-Preserving 3D Deformations. Wang, et. al., CVPR 2020.

Why Joint Learning?

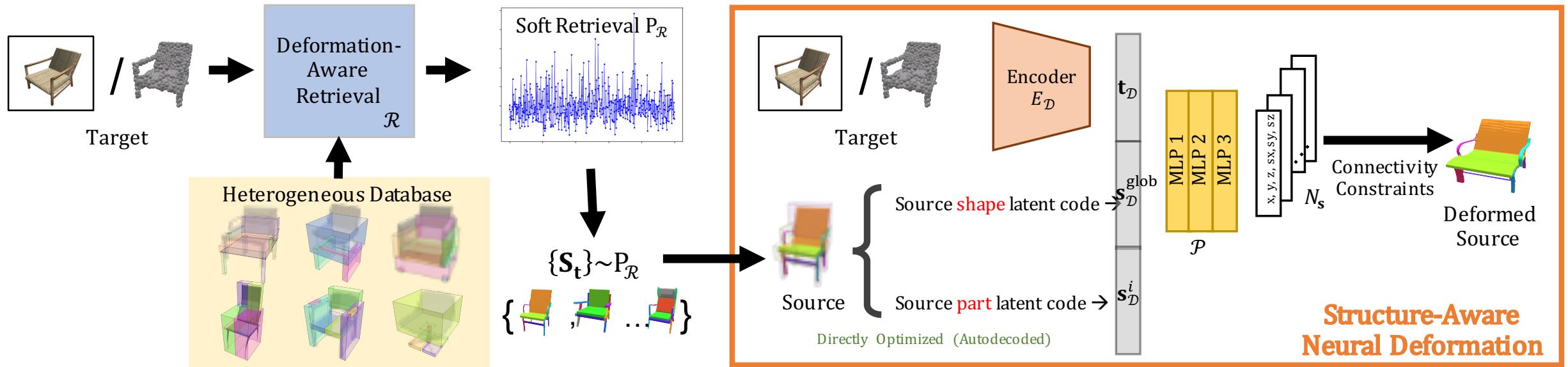
- **Deformation-aware Retrieval [5]**
 - Learns an embedding that retrieves models that fit **after** deformation.
- **Retrieval-aware Deformation**
 - Embedding [5] can aid the selection of better source-target pairs for deformation learning.
 - Thus, deformation module is **optimized to fit retrieved shapes** to target shapes instead of random pairs.
- Joint learning optimizes network capacity to only learn **meaningful deformations**.



Problem Statement

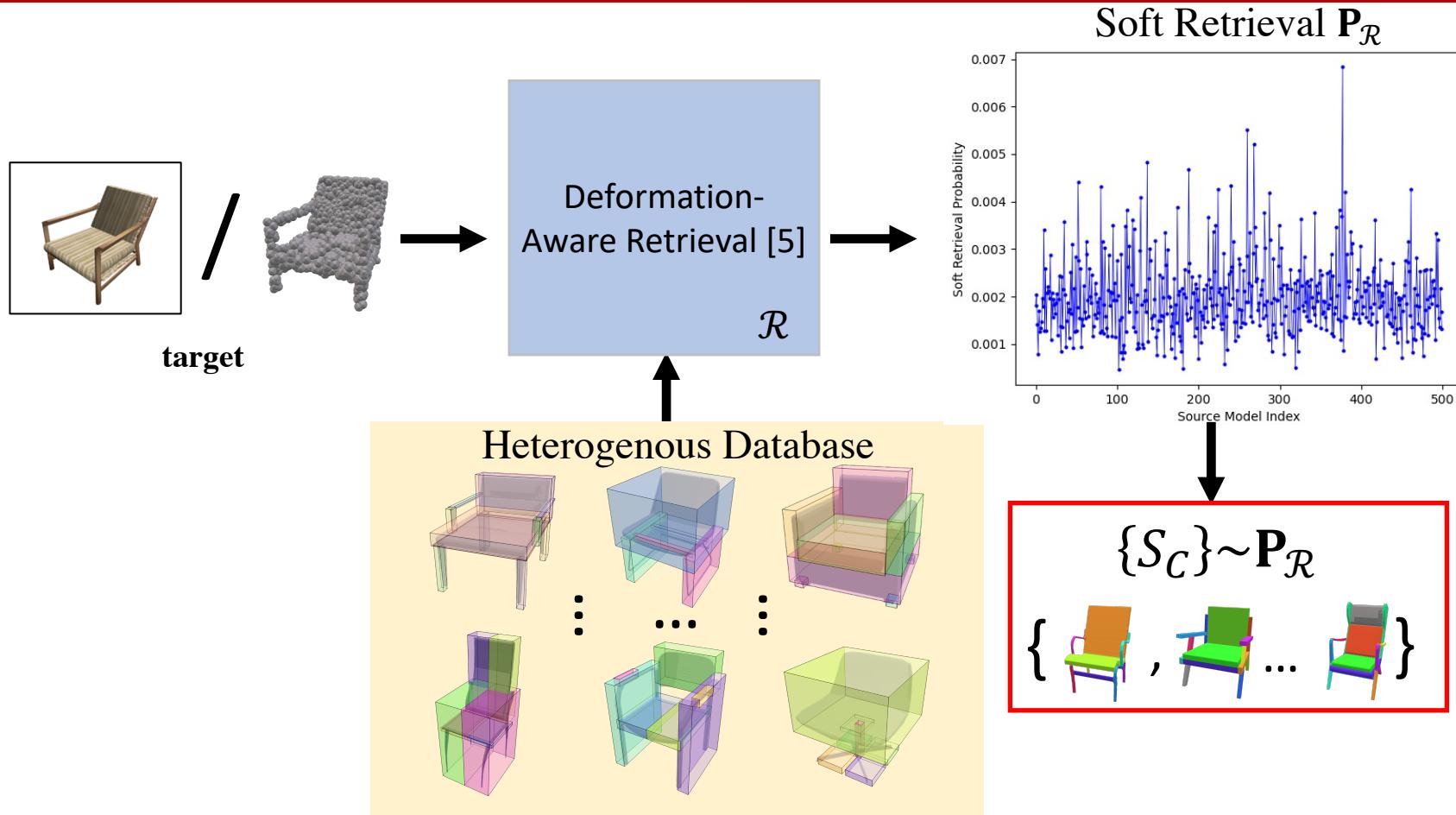


Our Approach



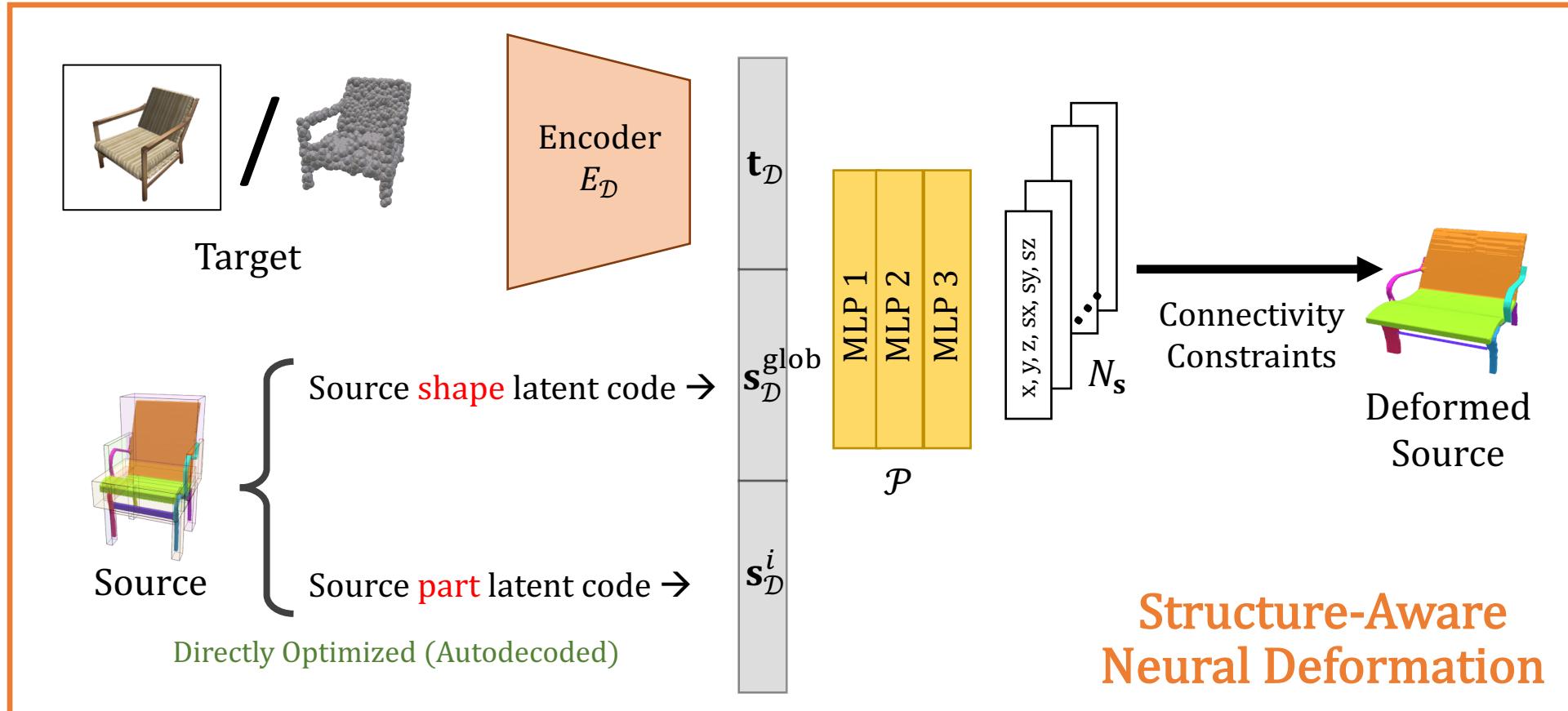
- Given a database of parametric **source** models $s \in S$, we aim to choose a source and deform it to fit a given **target** t with respect to a fitting metric (Chamfer distance).
- We jointly learn source-dependent deformation functions $\{\mathcal{D}_s\}$ and the retrieval latent space \mathcal{R} where it retrieves based on distance measure $d_{\mathcal{R}}$.

Joint Training



$$\mathcal{P}_{\mathcal{R}}(\mathbf{s}, \mathbf{t}) = \frac{\exp(-d_{\mathcal{R}}(\mathbf{s}, \mathbf{t})/\sigma_0)}{\sum_{\mathbf{s}'} \exp(d_{\mathcal{R}}(\mathbf{s}', \mathbf{t})/\sigma_0)}$$

Structure-Aware Neural Deformation

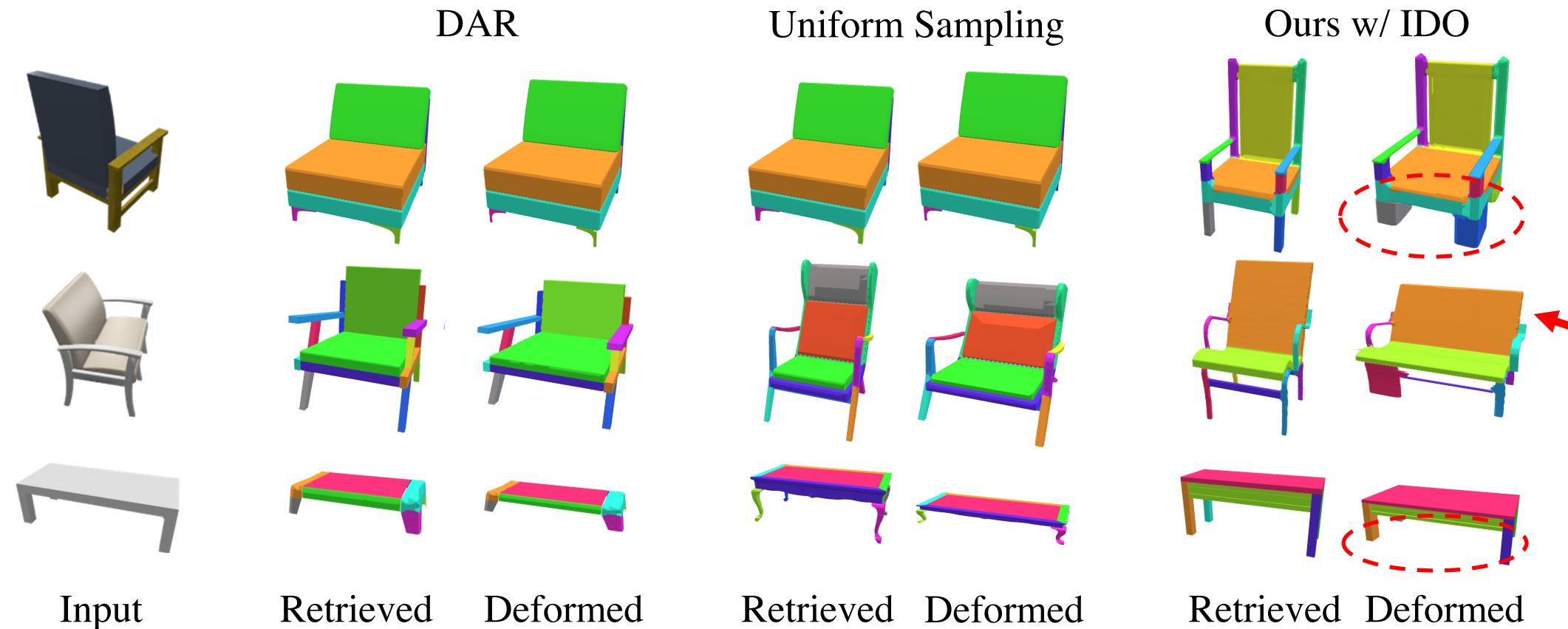


Baselines

- DAR [3]
 - Deformation-aware retrieval but NOT retrieval-aware deformation.
- Uniform Sampling
 - Without the soft retrieval module.

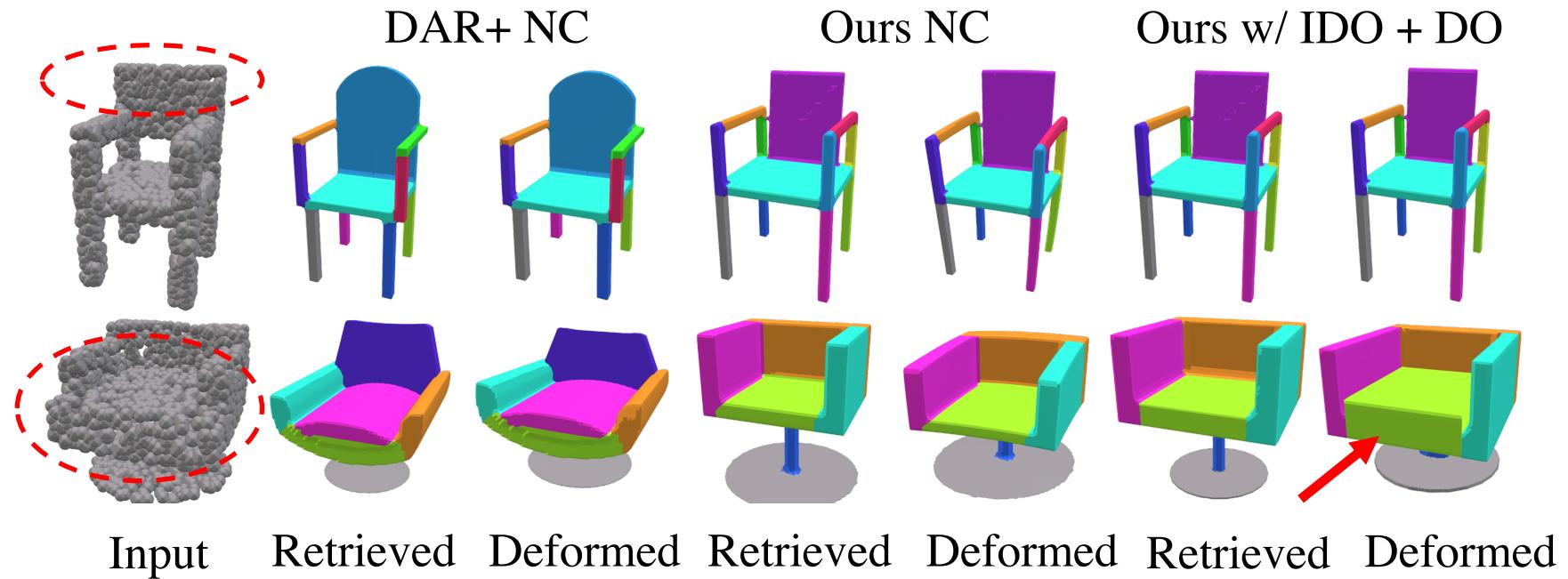


Results

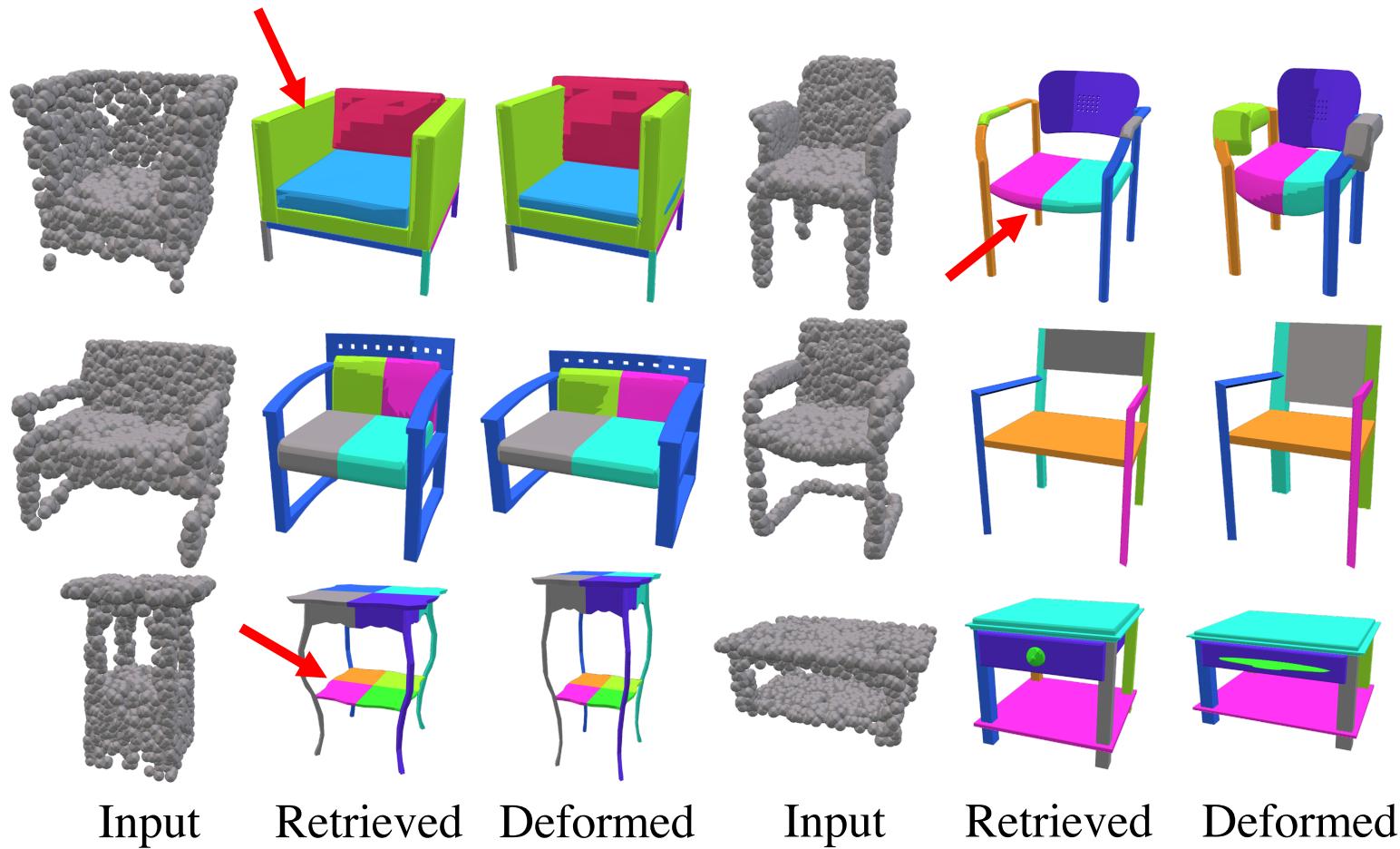


Results – other deformation network

- Our joint approach on Neural Cages [4]:



Results – autosegmented dataset

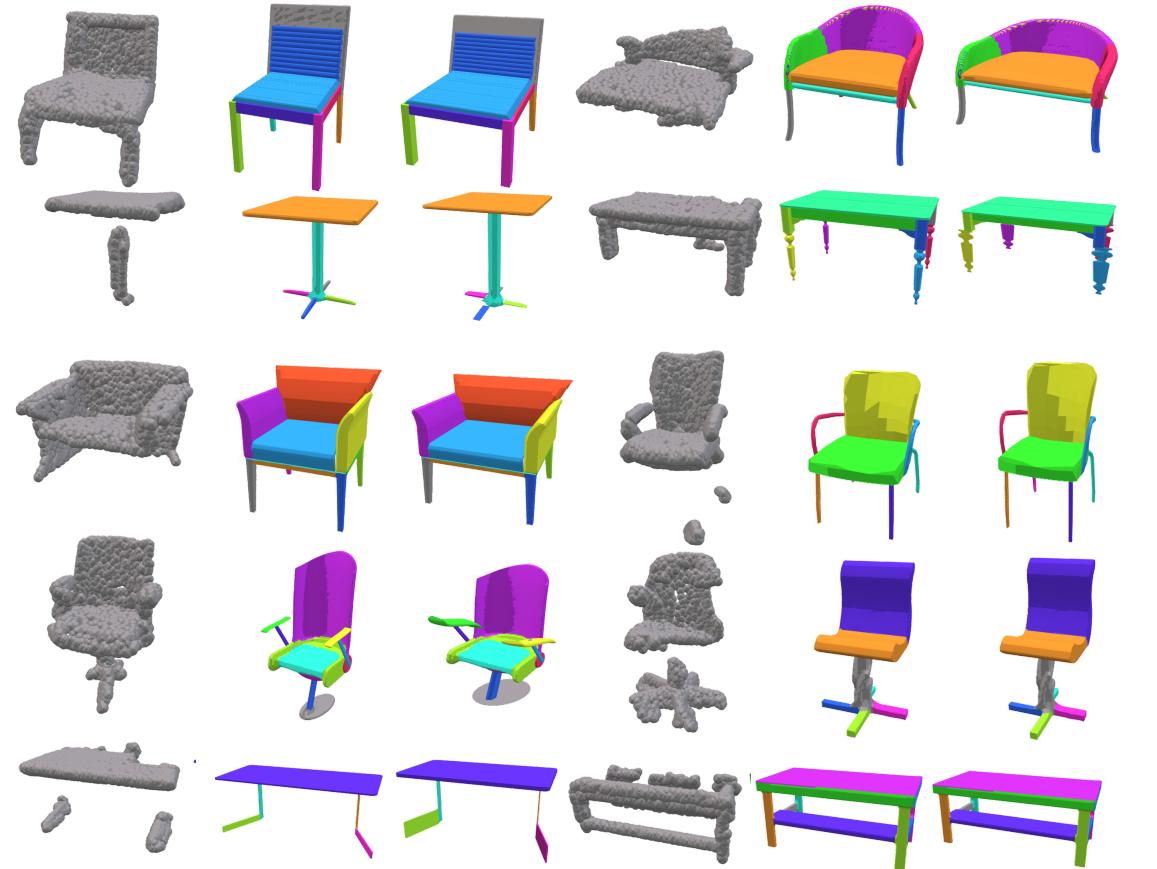


Applications

Product Images from Google search:



Real Scans:



Thank you!



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