Neural Convolutional Surfaces (NCS)

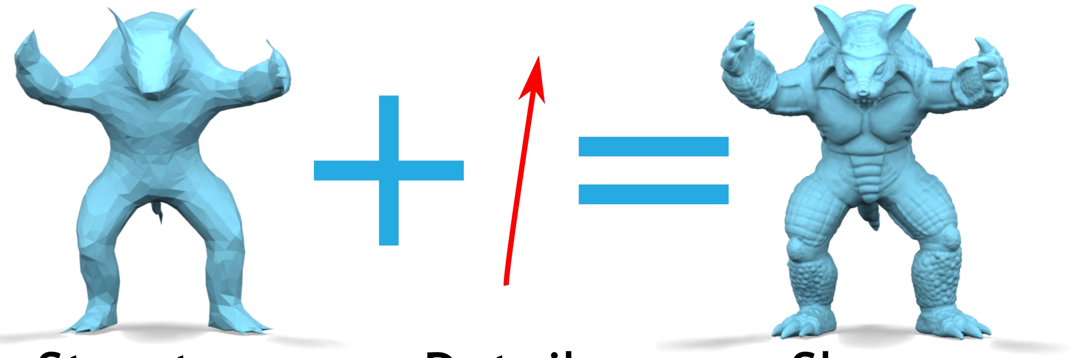
Luca Morreale[1] Noam Aigerman[2] Paul Guerrero[2] Vladimir G. Kim[2] Niloy J. Mitra[1,2]

[1]University College London [2]Adobe Research

Motivation:

Common shape representation entangle **geometric detail** with overall **shape structure**.These descriptions include triangle meshes, neural implicit fields [1,2] and neural atlases [3].

Neural Convolutional Surfaces distentangles the two as show below.

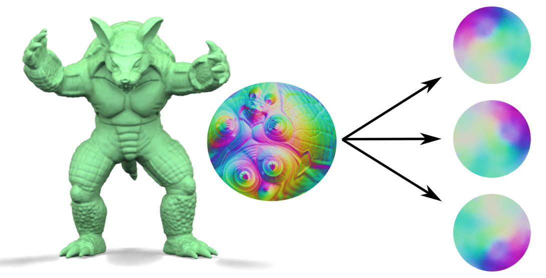


Method:

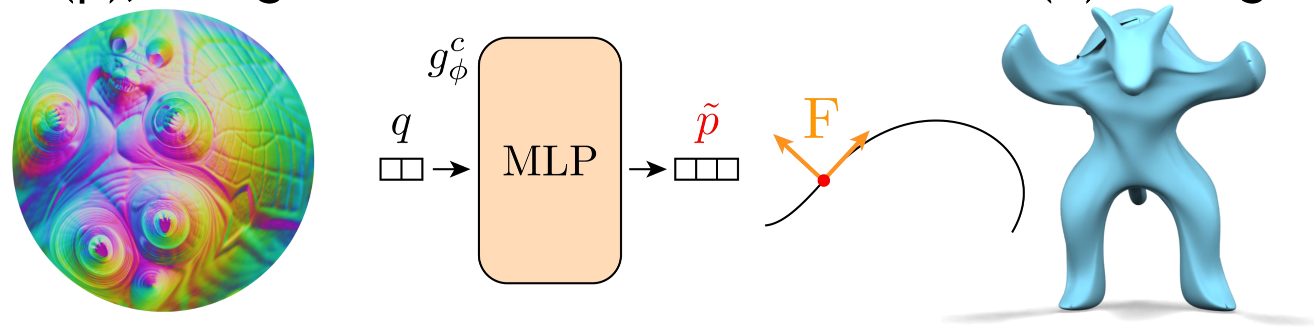
Neural Convolutional Surfaces offers:

- **unsupervised disentanglement**
- describes the **global structure** with an **MLP**
- exploit **weight sharing** of **CNN** for surface detail

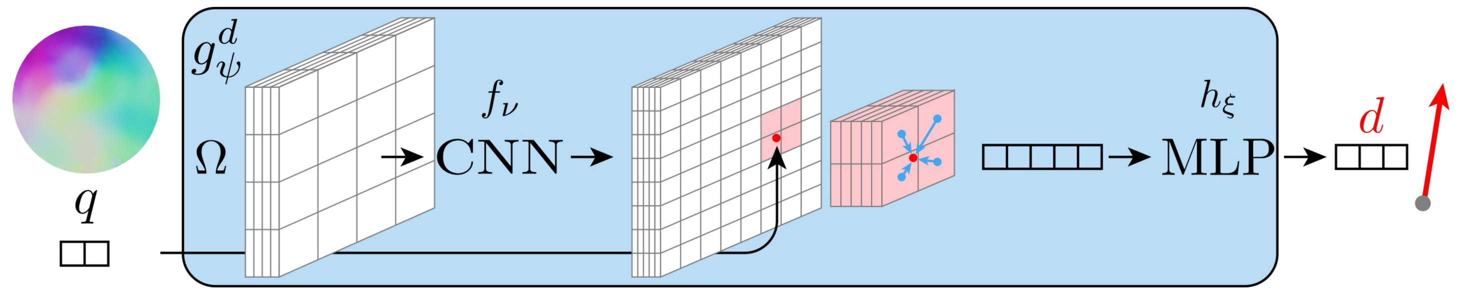
Split the mesh into patches and parametrize them as preprocessing.



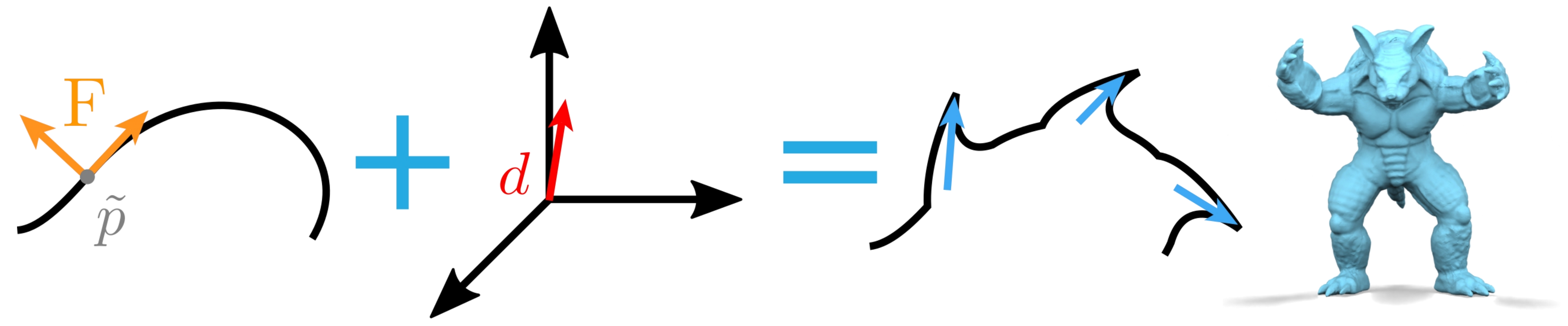
An MLP defines the **coarse** surface: it maps point-wise 2D points (q) onto the surface (p), and gives us a Local Reference Frame (F) through auto-diff.



Repeating surface details are auto-decoded with CNN from a latent vector: the CNN upsamples the patch latent vector, then through interpolation feature vector are decoded into displacements.

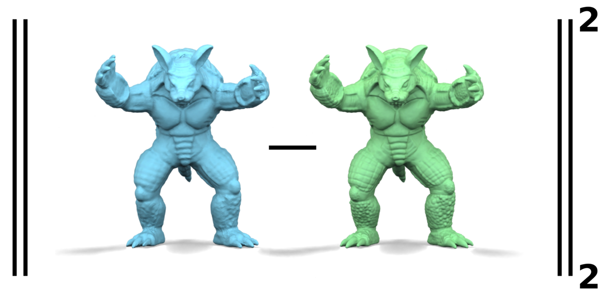


Place detail on the coarse structure: use the Local Reference Frame (F) to project the displacement on top of the coarse reconstruction.



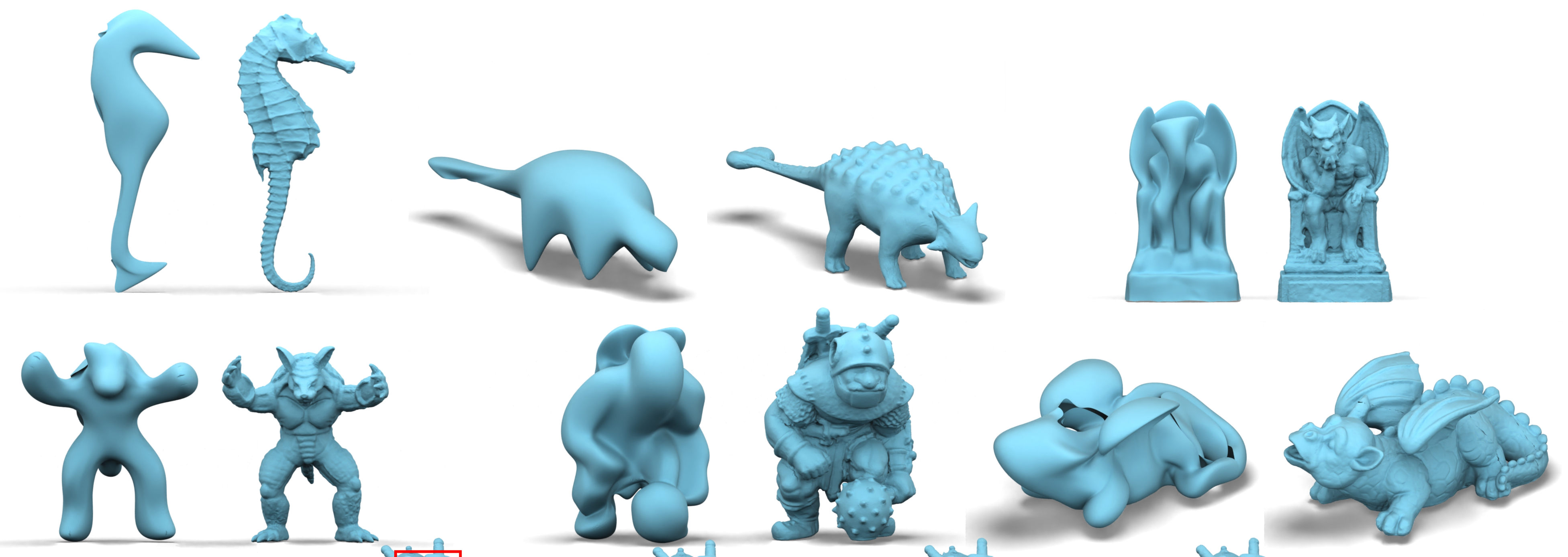
The use of Local reference Frame (F) enables **weight sharing** between patches.

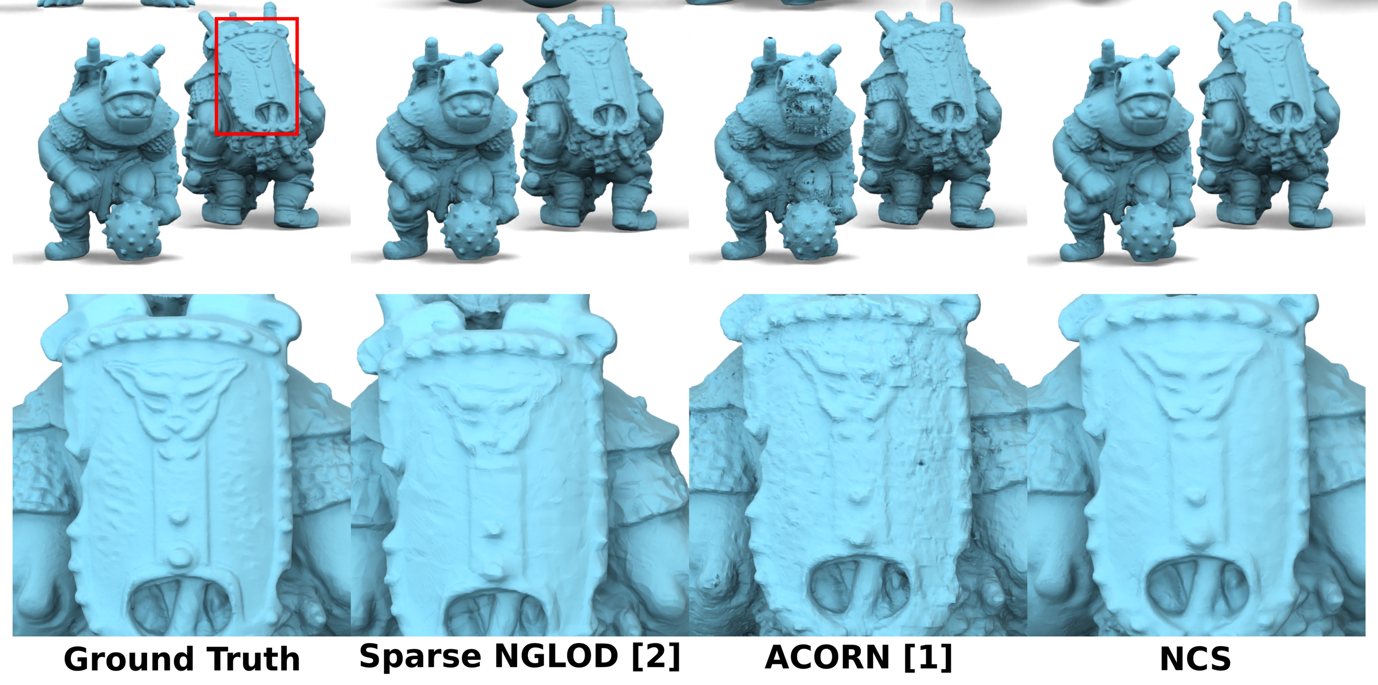
Optimize the network to reproduce the original geometry.

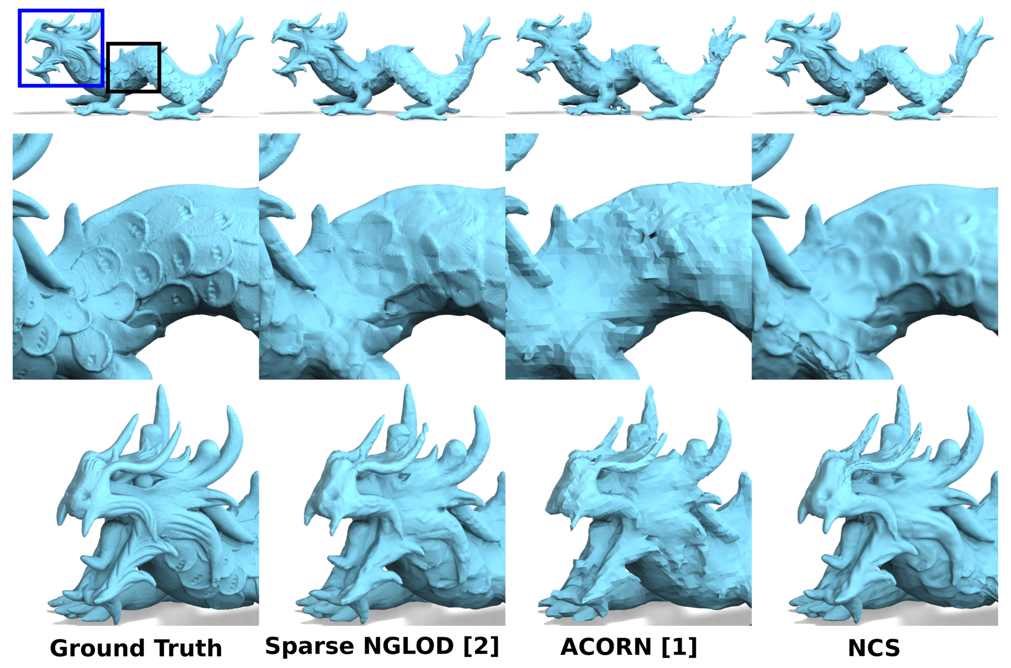


Results:

Examples of NCS reconstruction **coarse and fine**, for different models.

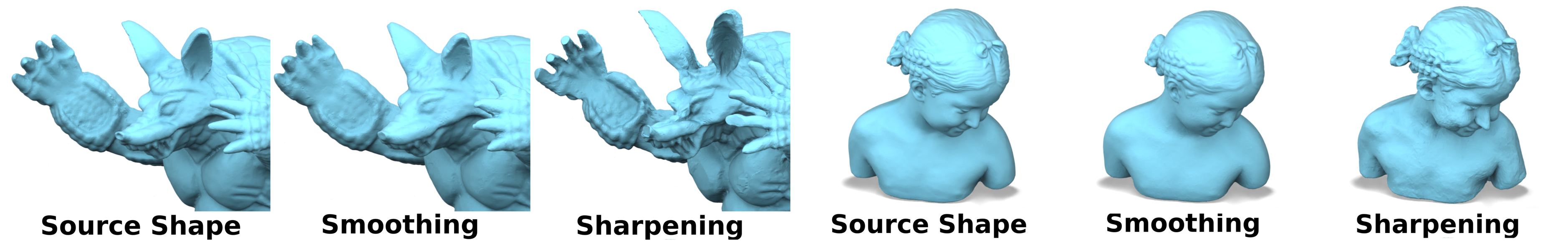




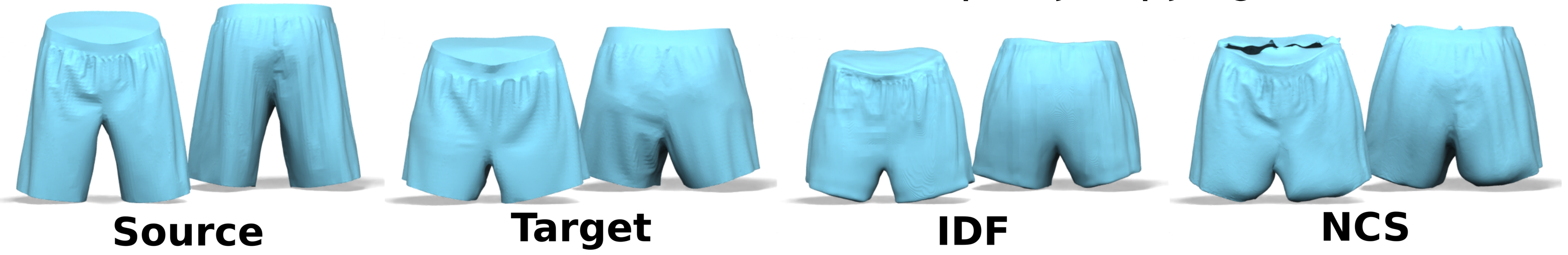


	[2]	Sparse [2]	[4]	NCS
Armadillo	1.95	1.34	1.06	**0.54**
Bimba	2.30	2.07	2.09	**1.04**
Dino	1.70	1.55	2.55	**1.48**
Dragon	1.57	1.12	0.62	**0.57**
Grog	2.06	1.06	**0.81**	1.28
Seahorse	1.26	1.15	-	**0.44**
Elephant	4.06	**2.24**	3.93	2.49
Gargoyl	6.30	-	8.51	**2.29**

It enables local editing by increasing (sharpening) or decreasing (smoothing) CNN feature.



It transfers surface detail to a different shape by copying CNN module.



Summary/Conclusion:

Unsupervised disentanglement into coarse and fine.
Highly accurate reconstruction with low amout of parameters.
Enables editing through feature manipulation.

References:

[1] Acorn - Martel et al. - SIGGRAPH 2021
[2] Neural Geometric Level of Detail - Takikawa et al. - CVPR 2021
[3] Neural Surface Maps - Morreale et al. - CVPR 2021
[4] IDF - Yifan et al. - ICLR 2022

Project Page:
(with paper & code)