Neural Surface Maps

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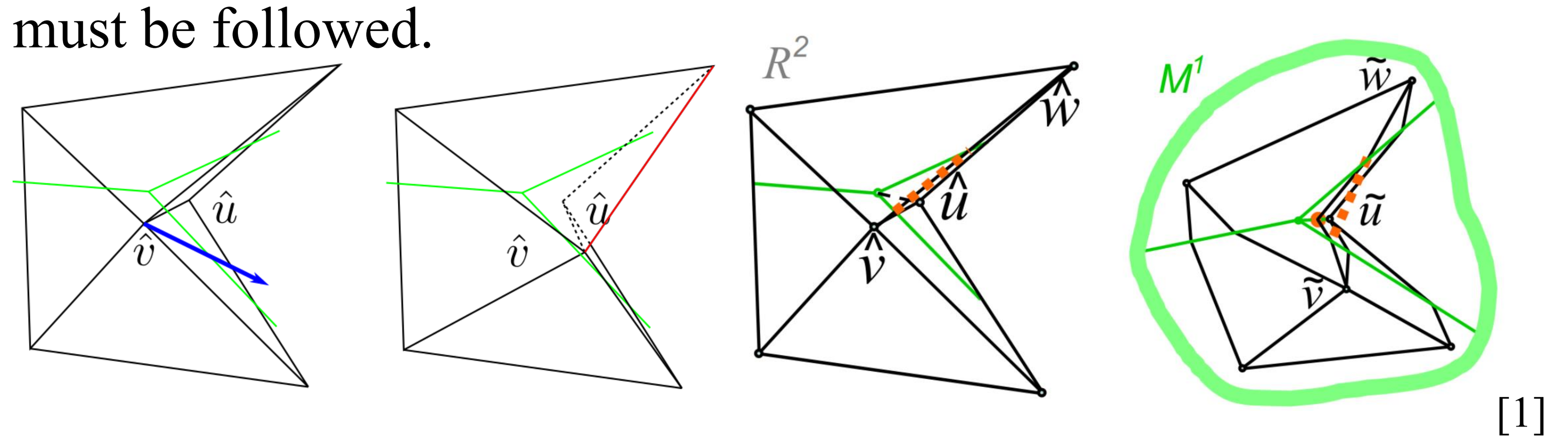
Motivation:

Meshes are the de-facto surface representation.

Manipulation is non-trivial due to discriteness and combinatorial nature.

Intricate rules must be followed.



Method:

We propose to encode surface maps with neural networks.

Why? Neural networks:

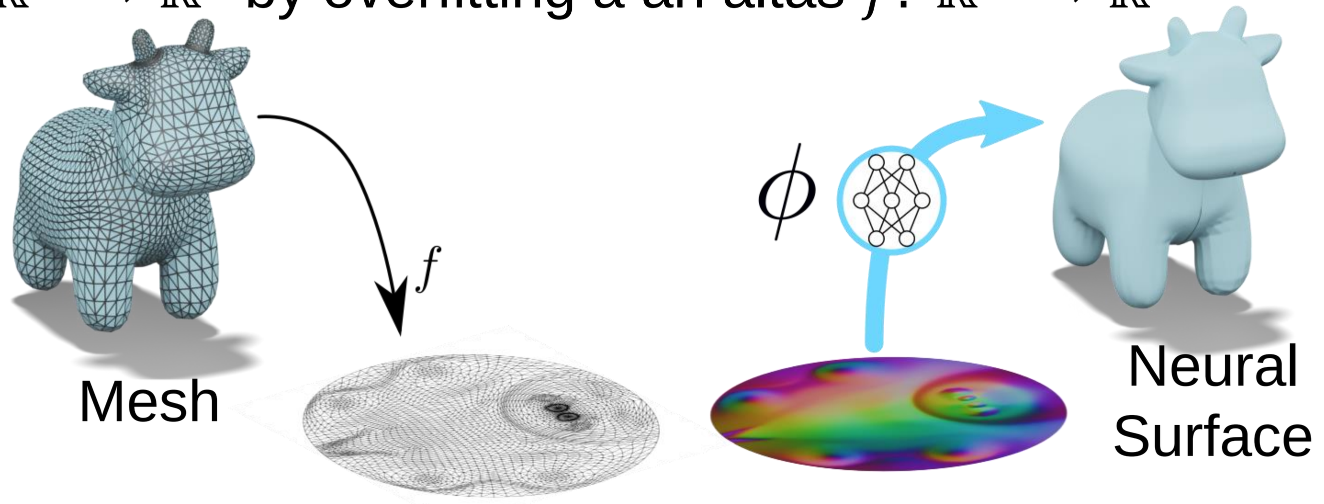
- are <u>continuous</u> and <u>differentiable</u>
- can be <u>composed</u> on one another

We define surfaces via atlases.

Neural Surface ϕ: $\mathbb{R}^2 \longrightarrow \mathbb{R}^3$ by overfitting a an altas f: $\mathbb{R}^3 \longrightarrow \mathbb{R}^2$

Minimize:

- surface deviation
- normals deviation



Differentiable objectives relating surfaces, e.g., distortion, can be optimized in trivial manner.

This simplifies a range of geometry processing tasks.

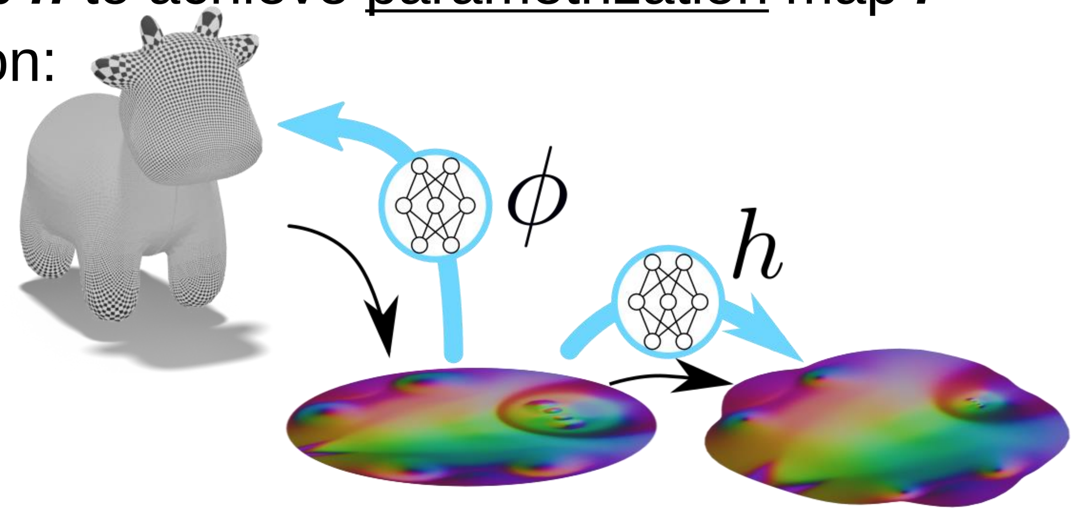
Compose ϕ with **neural map *h*** to achieve <u>parametrization</u> map ***f***

Optimize end-to-end distortion:

- Symmetric Dirichlet

or

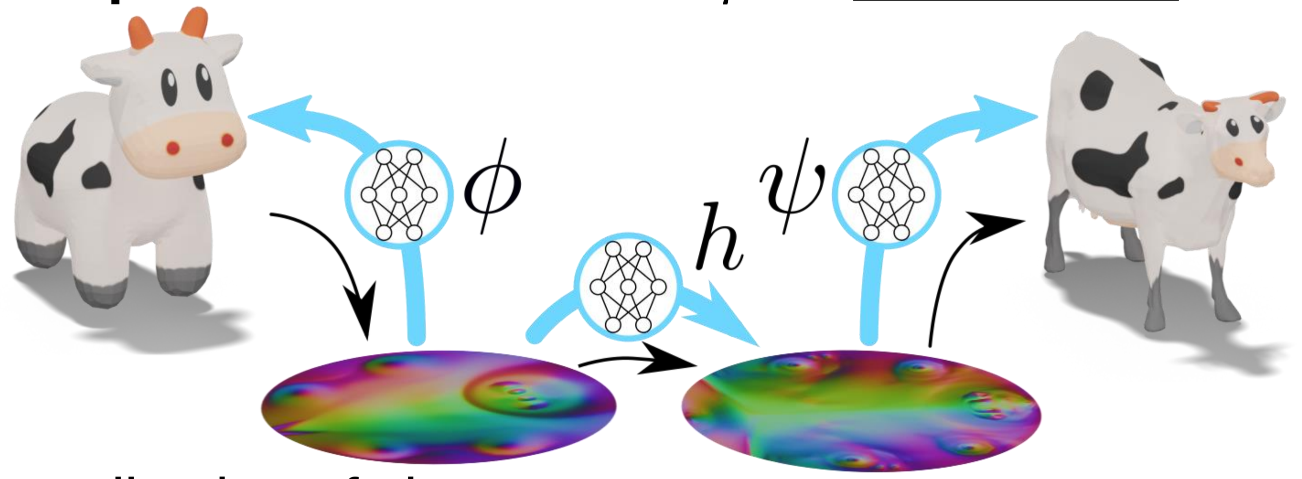
- Conformal distortion



Compose ϕ with **neural map *h*** and neural surface φ for <u>inter-surface</u> map ***f***

Optimize:

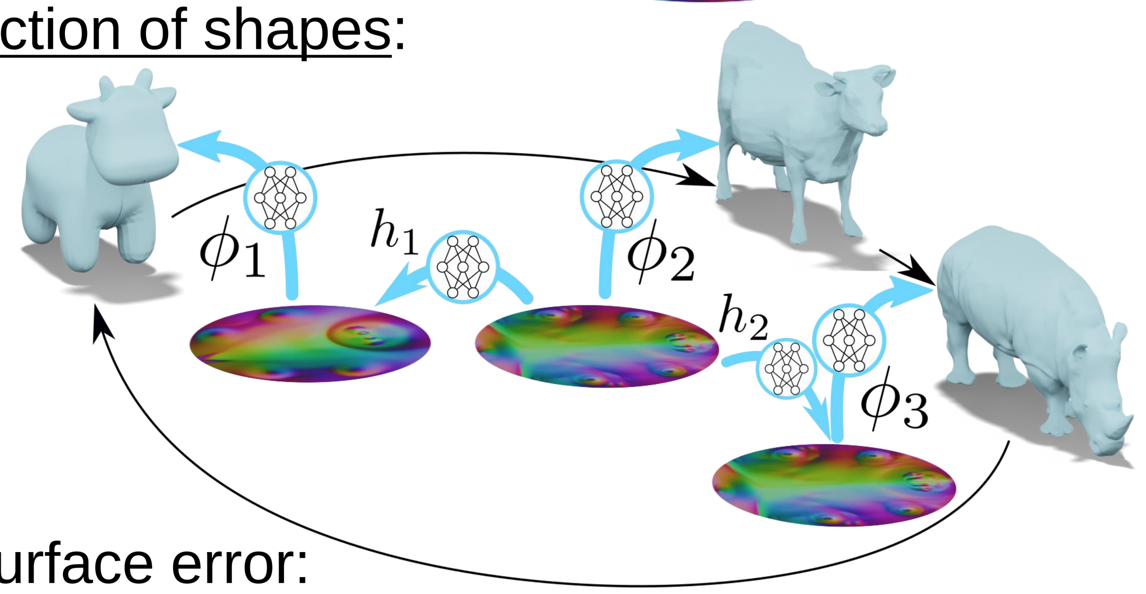
- distortion
- injectivity constraint
- domain constraints



Naturally extentends to a <u>collection of shapes</u>:

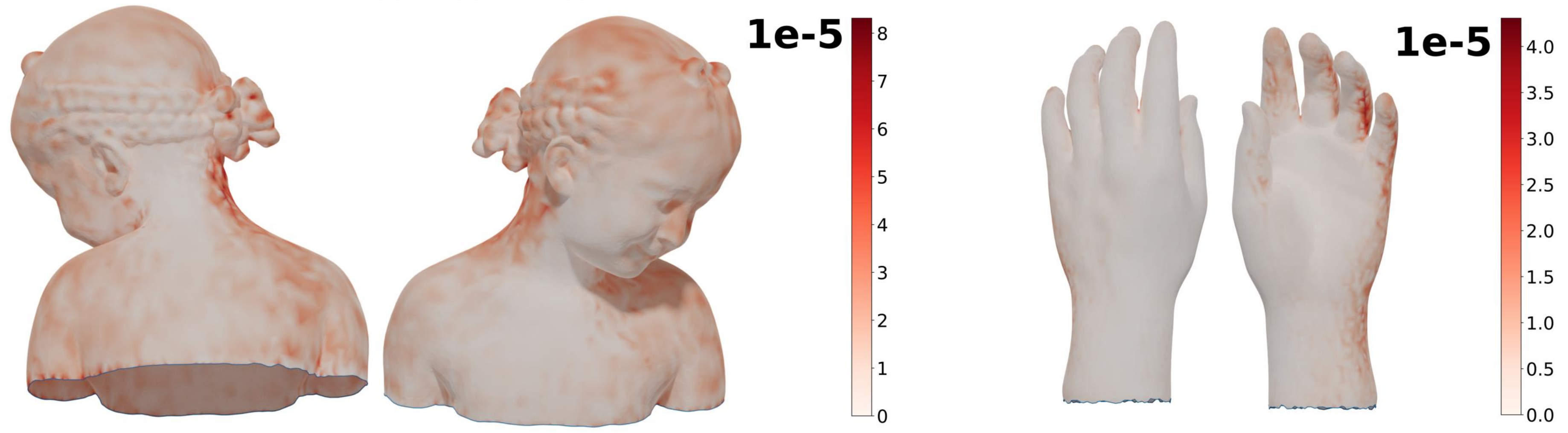
Optimize:

- distortion
- injectivity constraint
- domain constraint

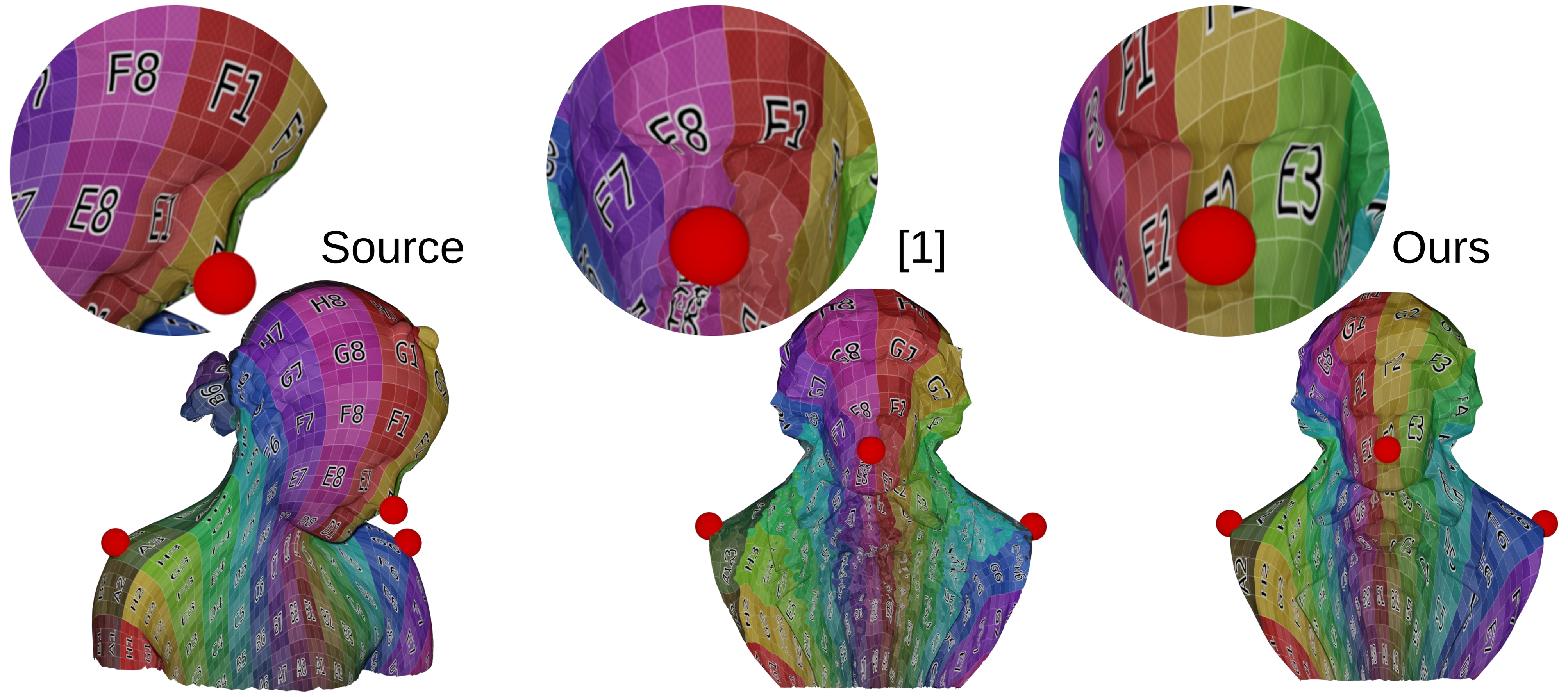


Results:

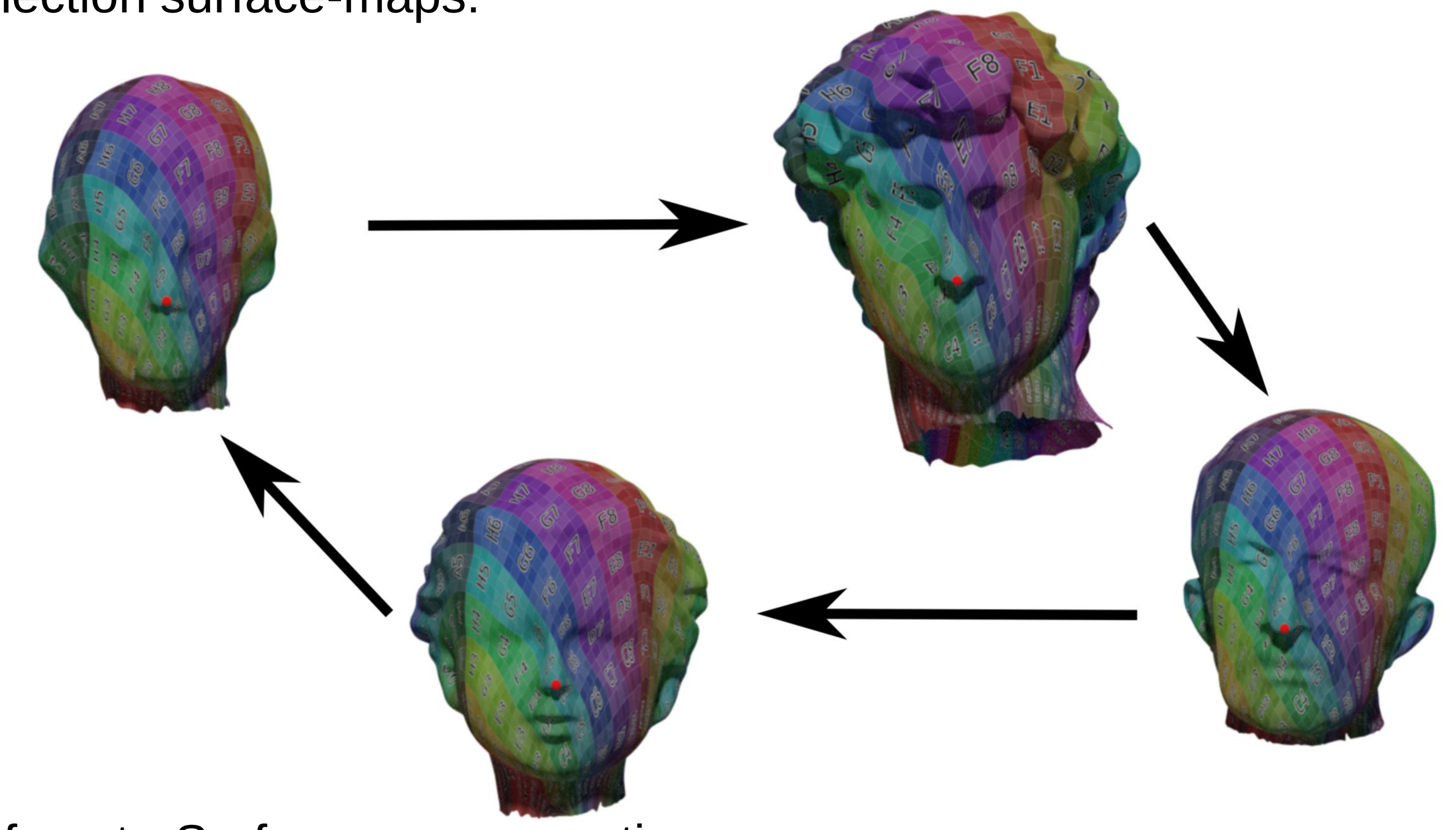
Neural Surfaces highlighting surface error:



Surface-to-surface maps comparison:



Collection surface-maps:



Surface-to-Surface map properties:

	Continuous	Injective	End-to-end optimization
Functional Maps[2]	×	×	✓
Common Domain	✓	✓	×
Neural Surface Maps	✓	✓	✓

Conclusion:

- Novel surface representaion
- Natural composition with maps

- Limited to disk topology and no partial cases
- Unable to handle partial maps
- Do not scale to large datasets

References:

[1] Schreiner et al. - Inter-surface mapping - 2004

[2] Ovsjanikov et al. - Functional Maps - 2012

Links: <u>Project page</u> <u>Code</u>