

# PPSurf

Combining Patches and Point Convolutions for Detailed Surface Reconstruction

Philipp Erler, Lizeth Fuentes-Perez, Pedro Hermosilla,  
Paul Guerrero, Renato Pajarola and Michael Wimmer

Institute of Visual Computing & Human-Centered Technology

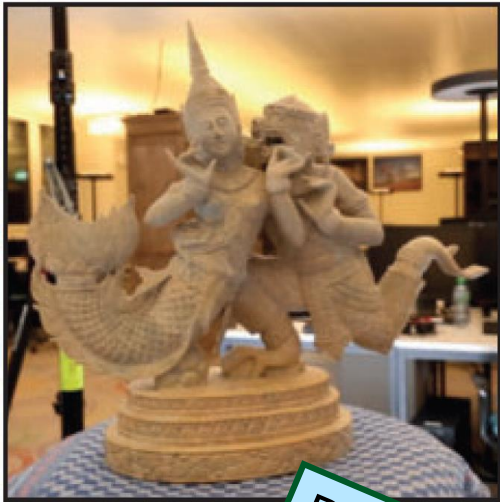
Research Unit of Computer Graphics

TU Wien, Austria



# Motivation

## Photos



## Unoriented Point Cloud



Photogrammetry

## Mesh



Reconstruction

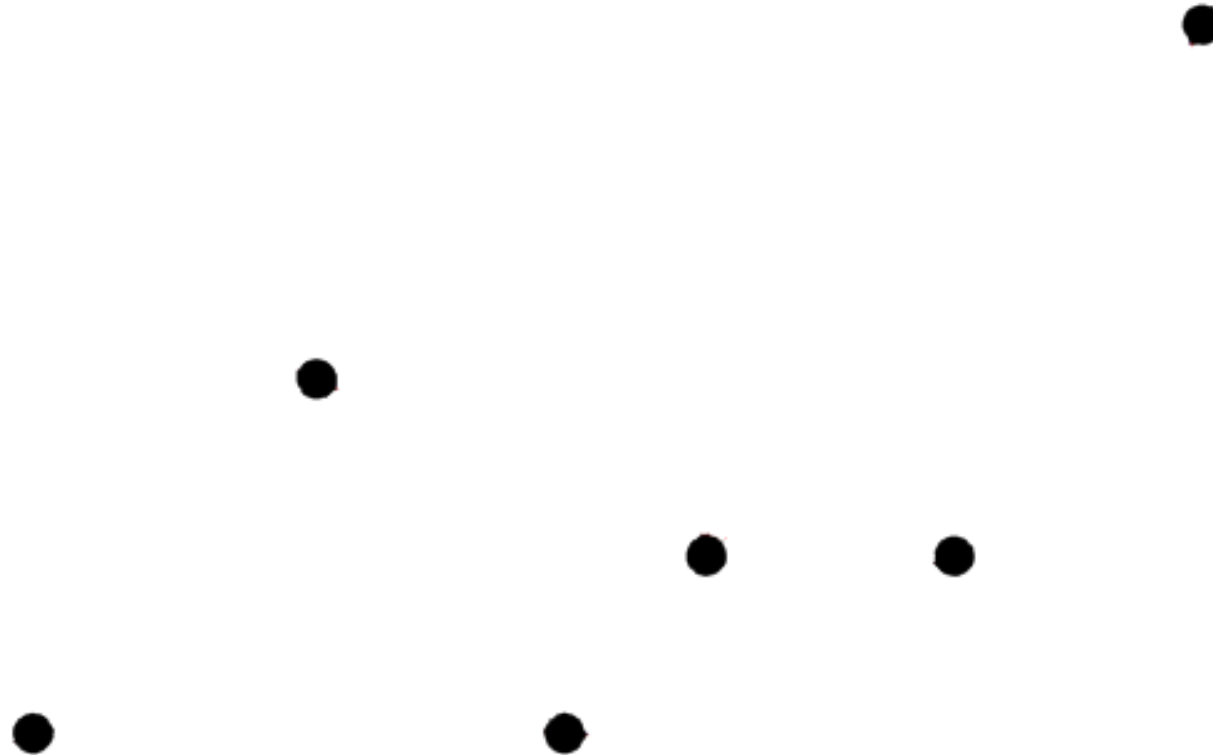
## 3D Print



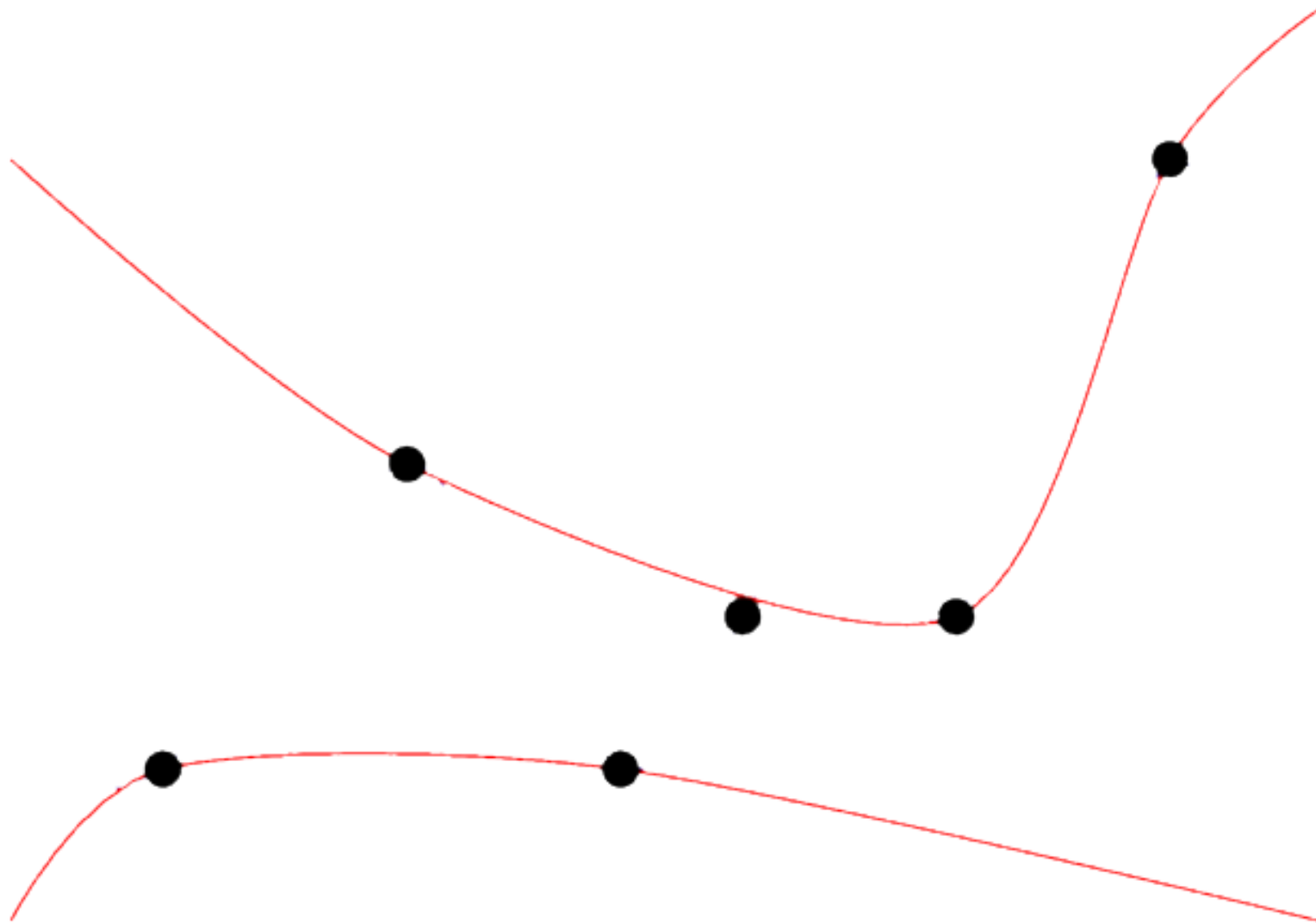
Export

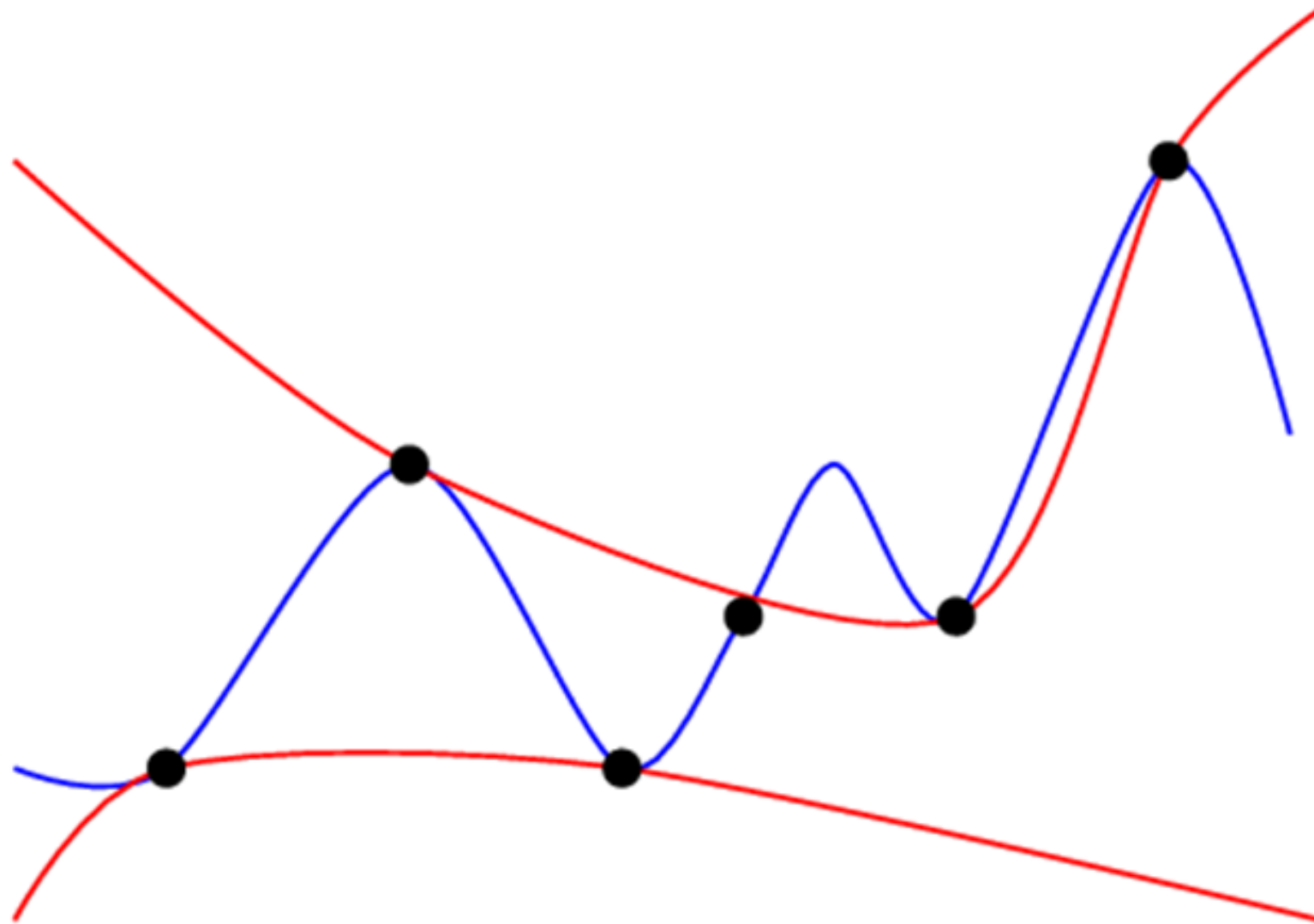
Yücer, Kaan, et al. "Efficient 3D object segmentation from densely sampled light fields with applications to 3D reconstruction." *ACM Transactions on Graphics (TOG)* 35.3 (2016): 1-15.

# Surface Reconstruction

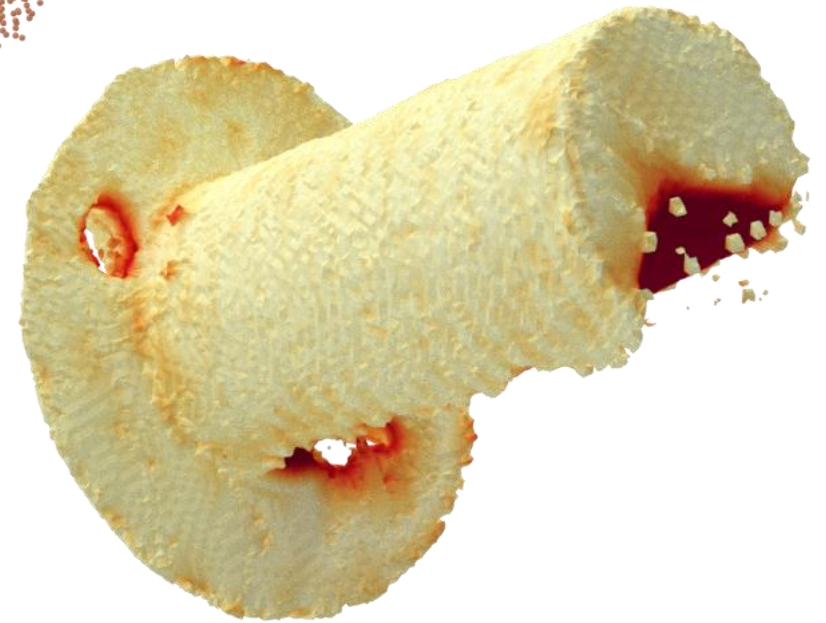
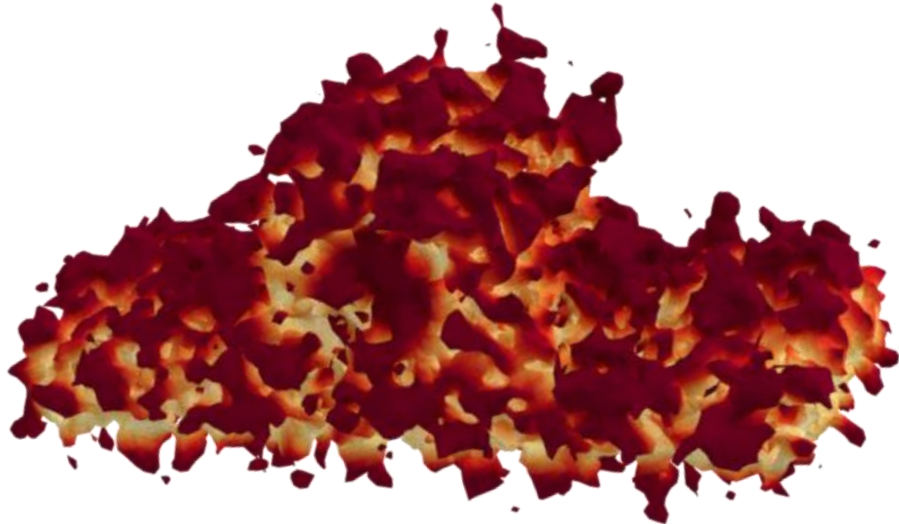


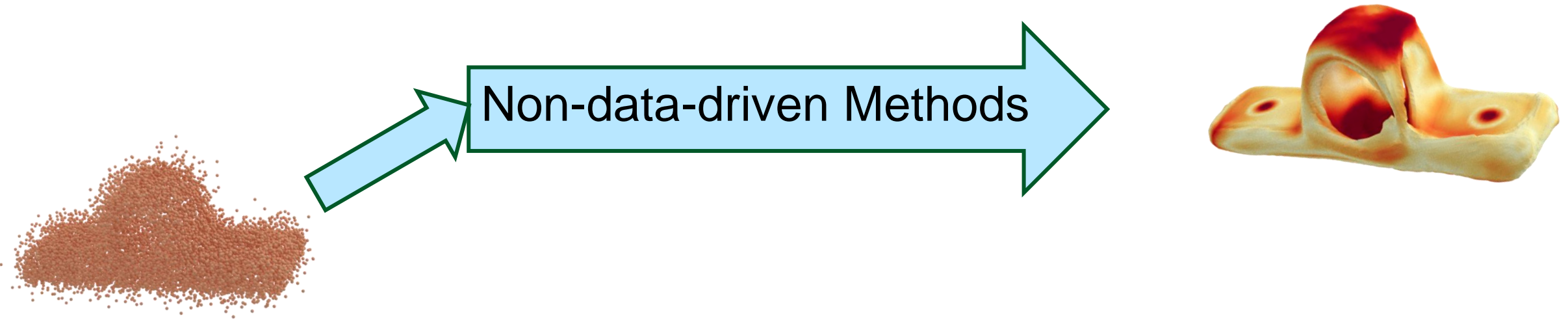
# Surface Reconstruction





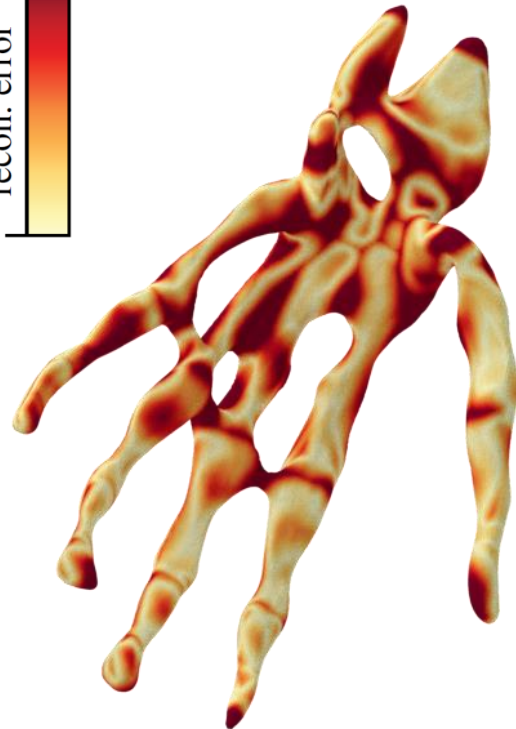
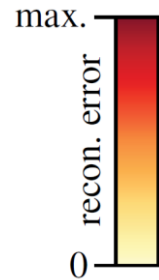
# Reconstruction Difficulties







## Neural-IMLS



## SAP (unlearned)



## PGR



WANG Z., WANG P., WANG P., DONG Q., GAO J., CHEN S., XIN S., TU C., WANG W.: Neural-impls: Self-supervised implicit moving least-squares network for surface reconstruction. IEEE Transactions on Visualization and Computer Graphics (2023), 1–16. doi: 10.1109/TVCG.2023.3284233.

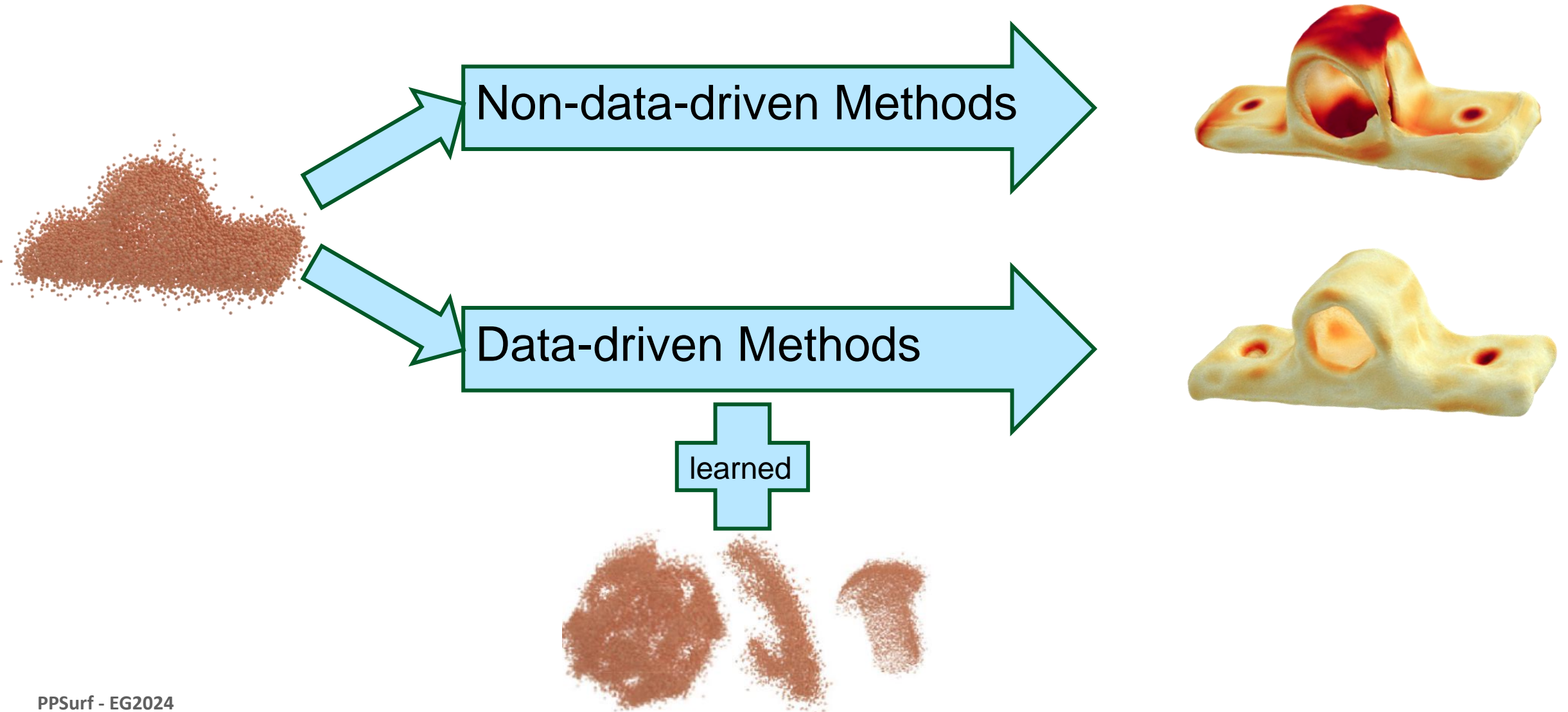
Peng S., Jiang C. M., Liao Y., Niemeyer M., Pollefeys M., Geiger A.: Shape as points: A differentiable poisson solver. In Advances in Neural Information Processing Systems (NeurIPS) (2021).

LIN S., XIAO D., SHI Z., WANG B.: Surface reconstruction from point clouds without normals by parametrizing the gauss formula. ACM Trans. Graph. 42, 2 (oct 2022). URL: <https://doi.org/10.1145/3554730>, doi:10.1145/3554730.

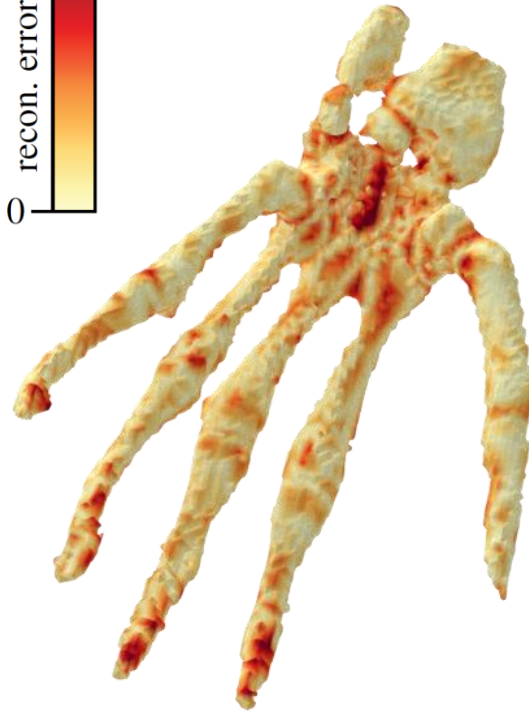
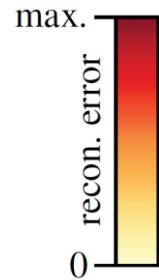




# Method Categories



## Points2Surf



## SAP (learned)



## POCO

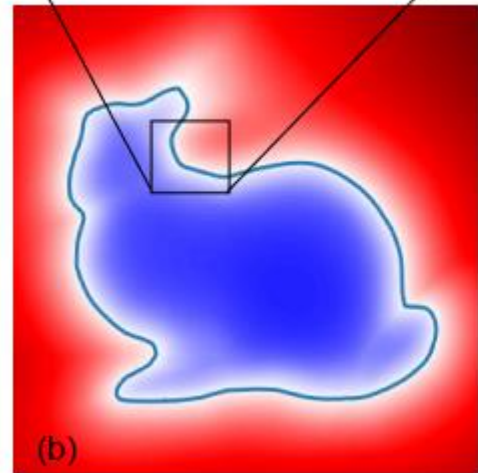
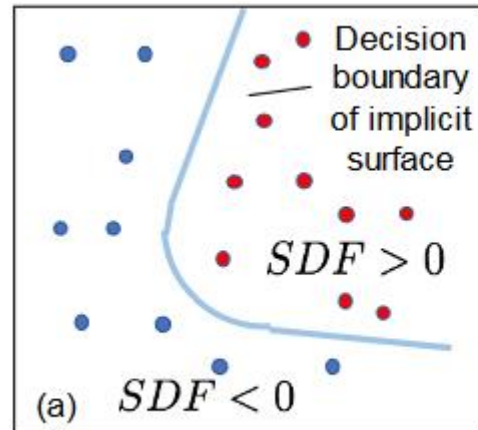


ERLER P., GUERRERO P., OHRHALLINGER S., MITRA N. J., WIMMER M.: Points2Surf: Learning implicit surfaces from point clouds. In European Conference on Computer Vision (ECCV) (2020).

Peng S., Jiang C. M., Liao Y., Niemeyer M., Pollefeys M., Geiger A.: Shape as points: A differentiable poisson solver. In Advances in Neural Information Processing Systems (NeurIPS) (2021).

BOULCH A., MARLET R.: Poco: Point convolution for surface reconstruction. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) (June 2022), pp. 6302–6314.

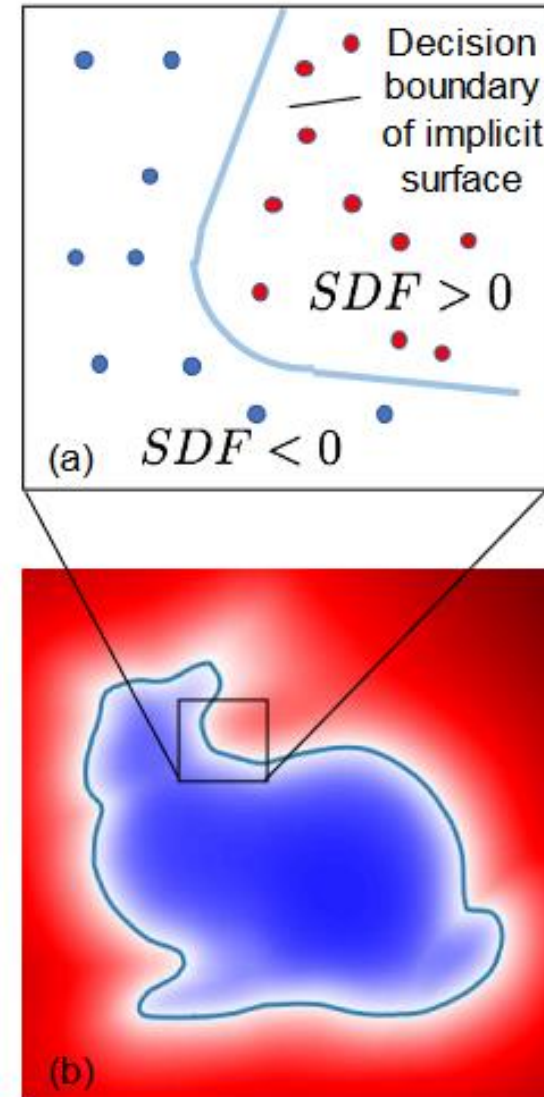




Park, Jeong Joon, et al. "DeepSDF: Learning continuous signed distance functions for shape representation." *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition*. 2019.



- TSDF:  $[-1, +1]$
- Occupancy:  $[0, 1]$
- Occupancy Probability (POCO):
  - In:  $[0, 1]$
  - Out:  $[0, 1]$
  - $\text{Occ\_prob} = (\text{Out} - \text{In})$



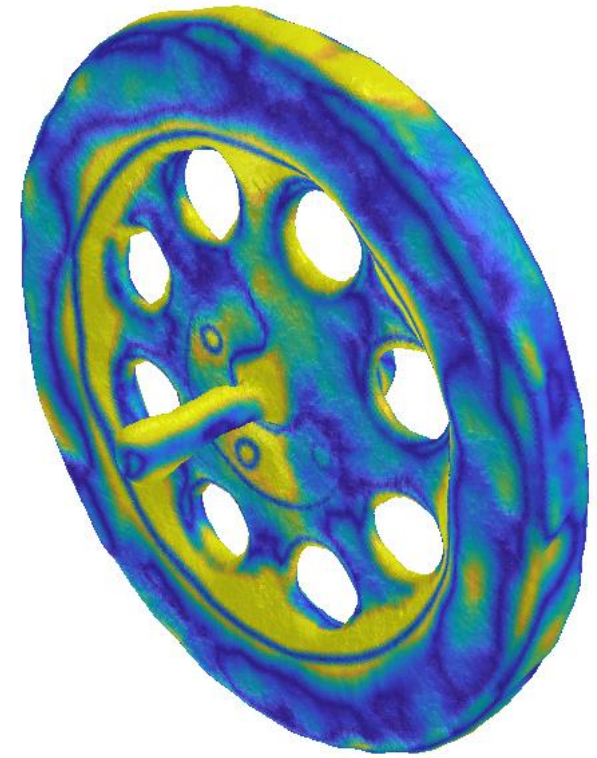
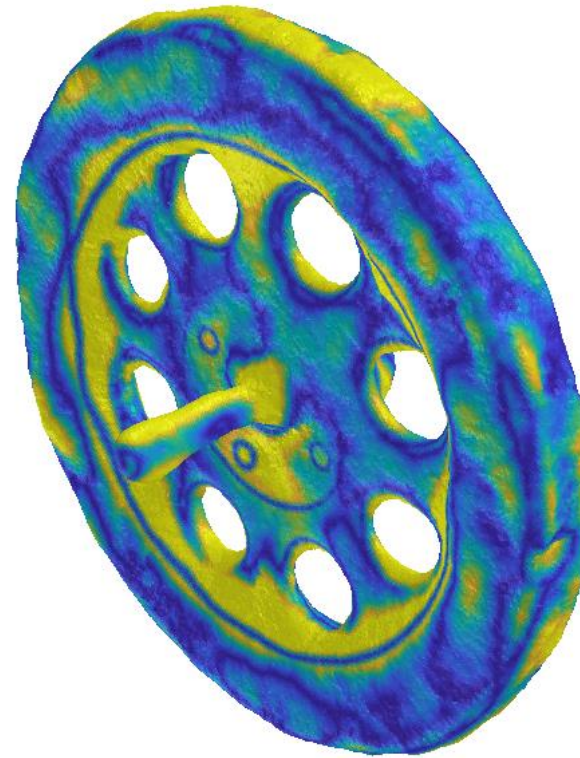
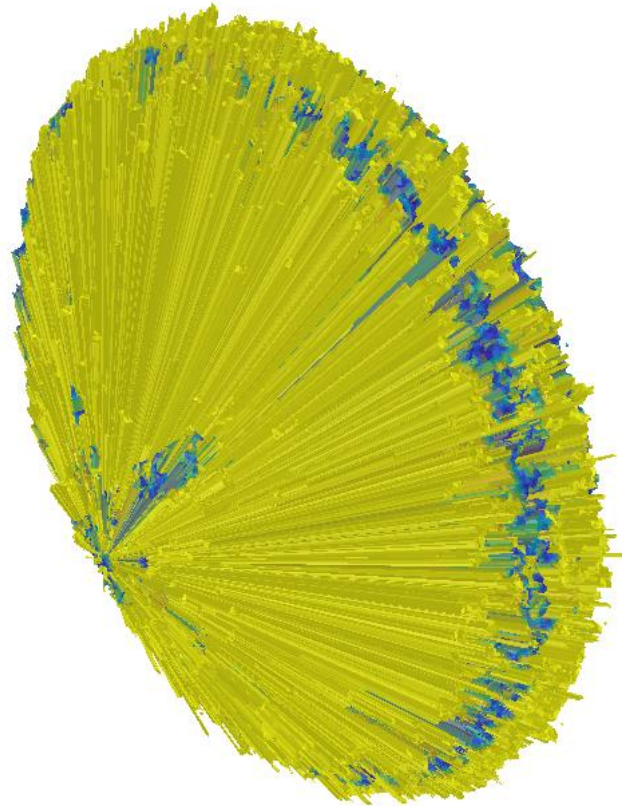
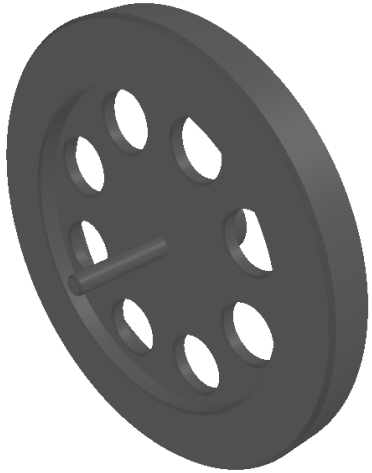


# Global and Local Information

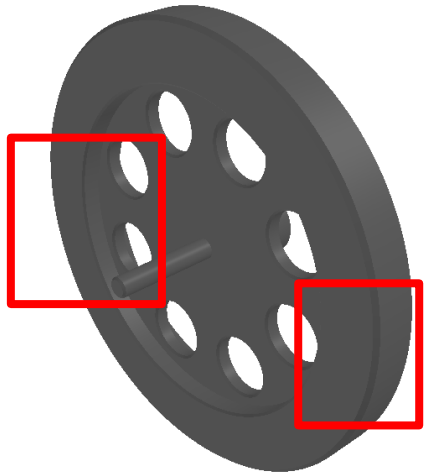
Only Local

Only Global

Local + Global



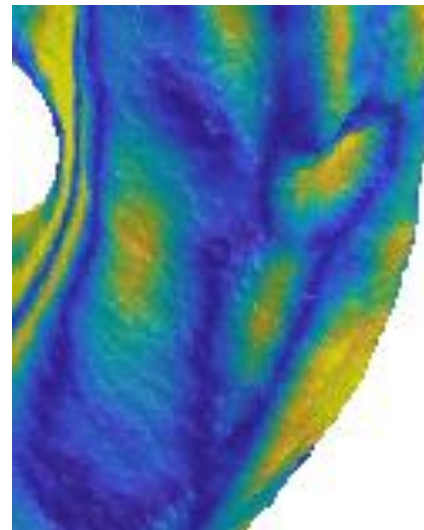
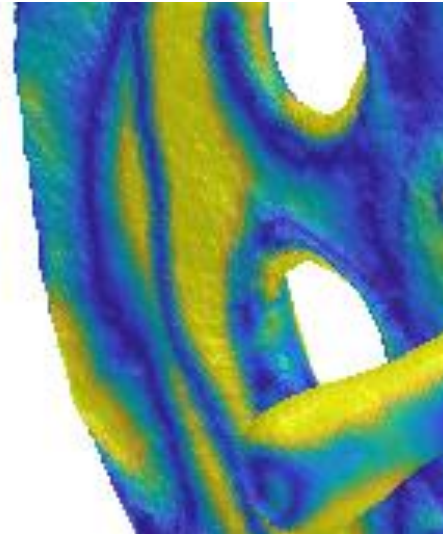
# Global and Local Information



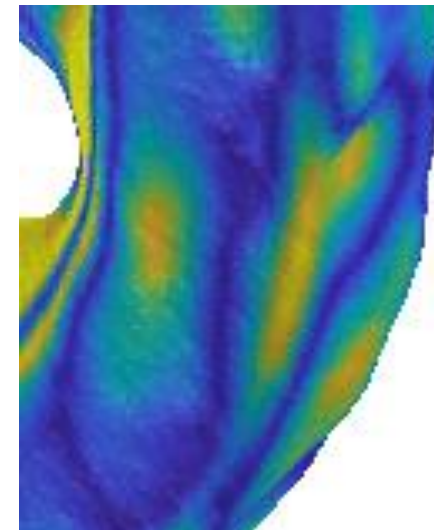
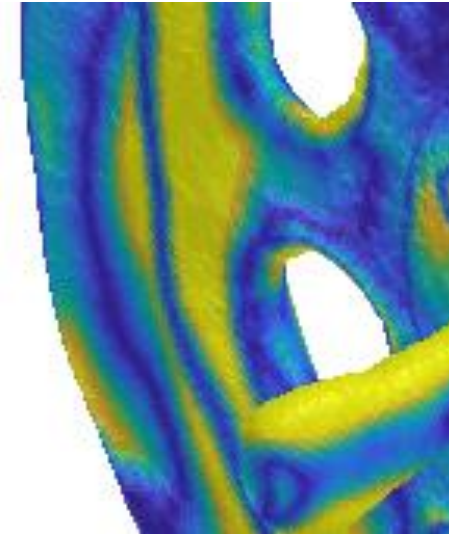
GT



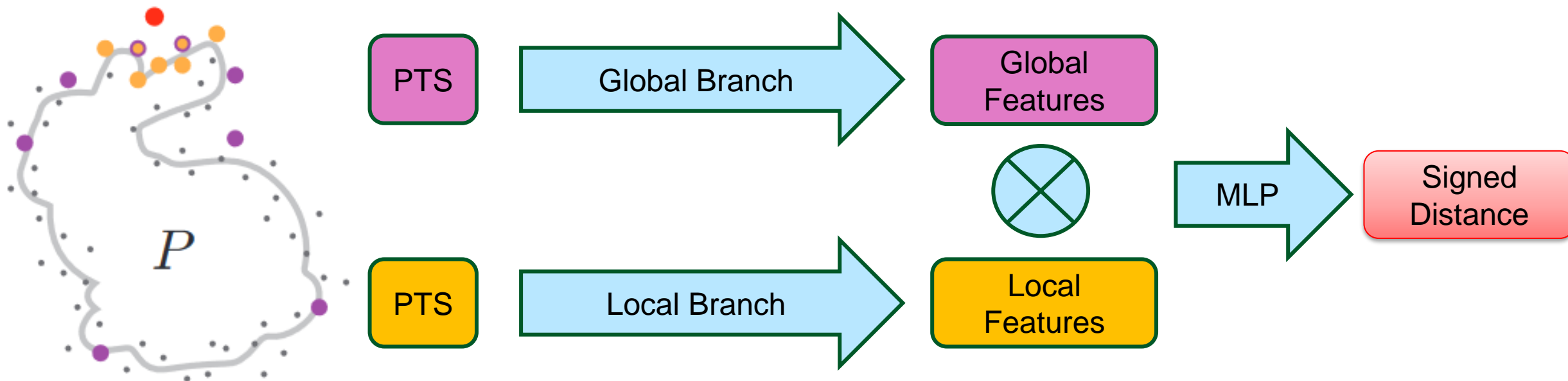
Only Global



Local + Global

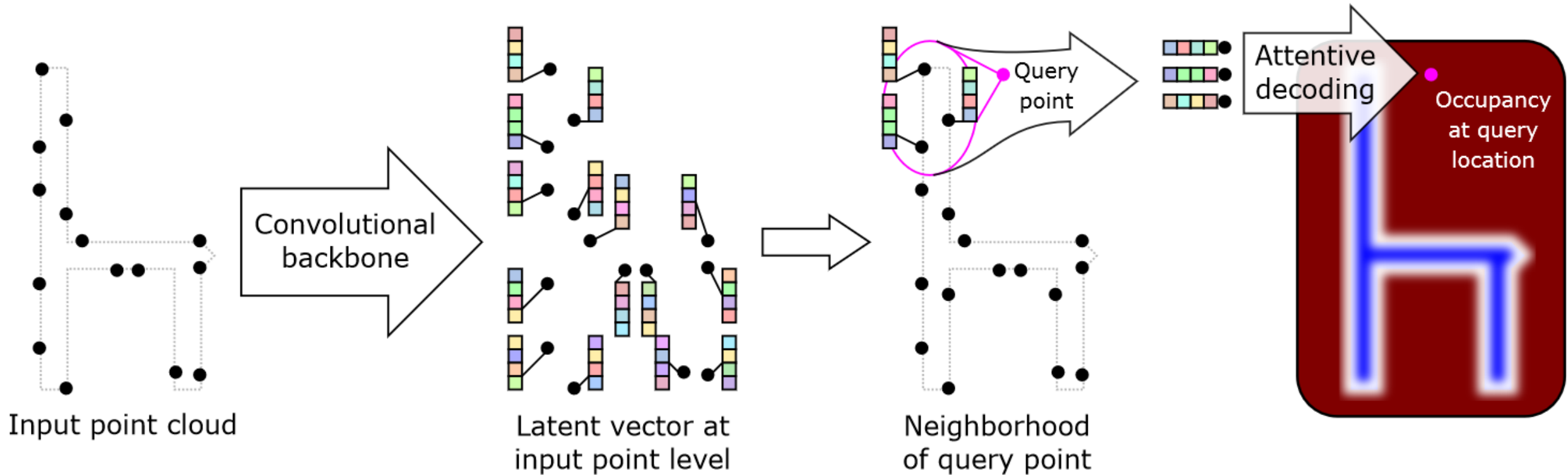


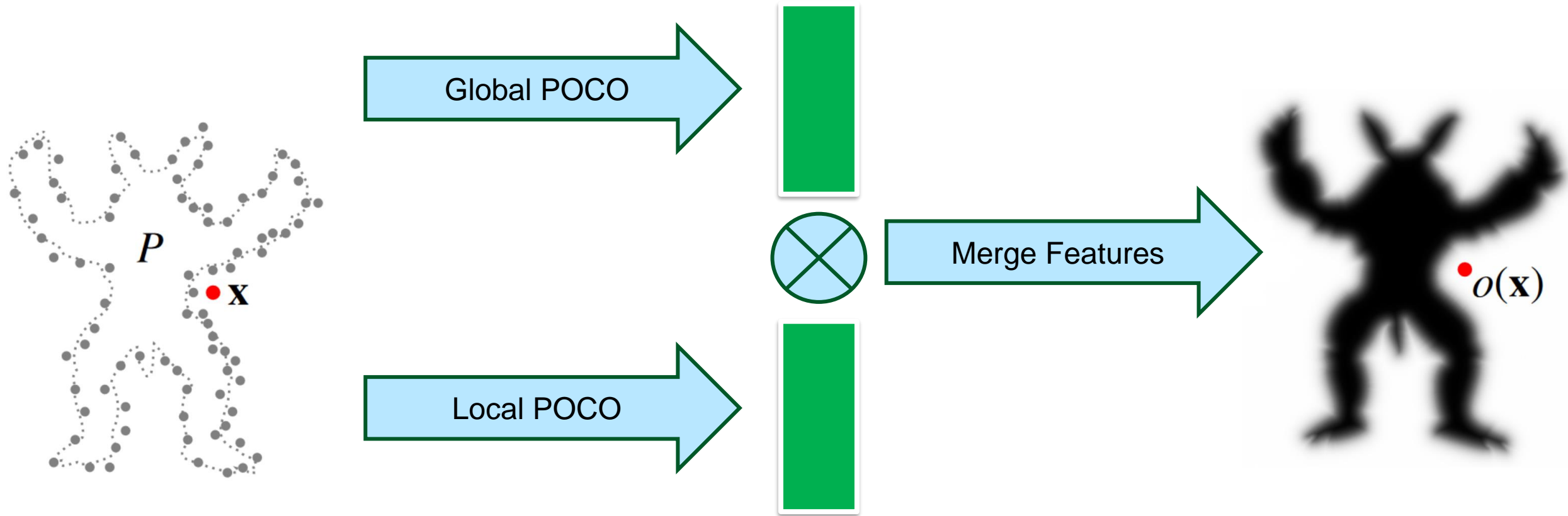




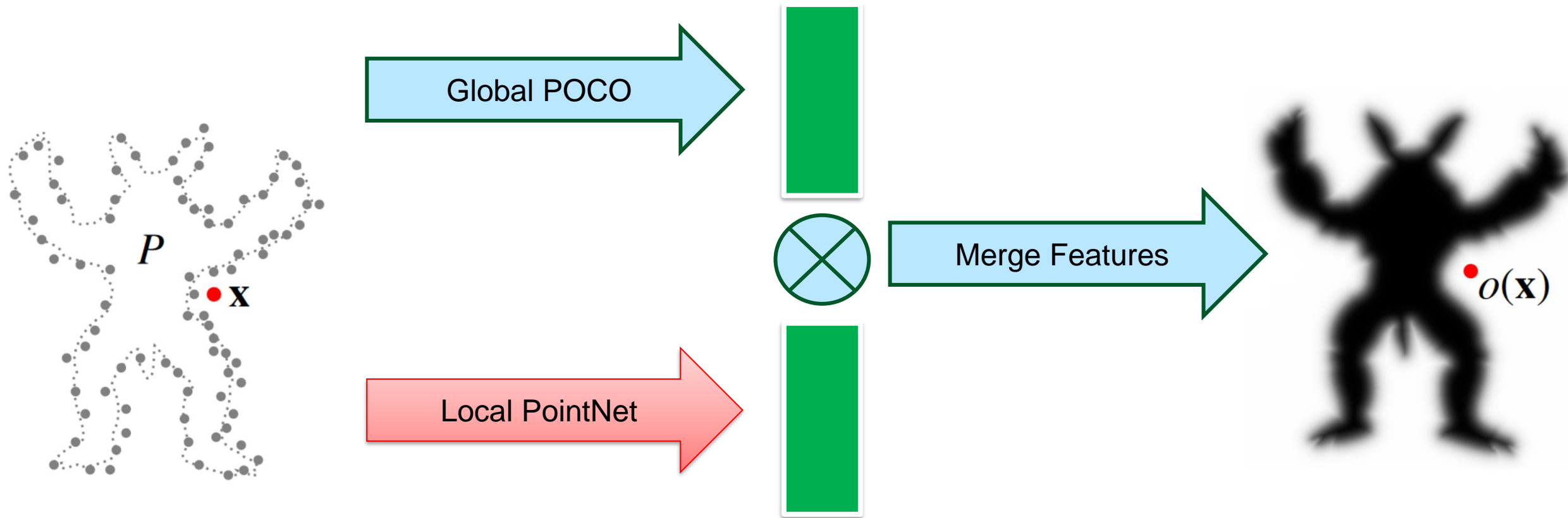
## Shape encoding at point level

## Local decoding

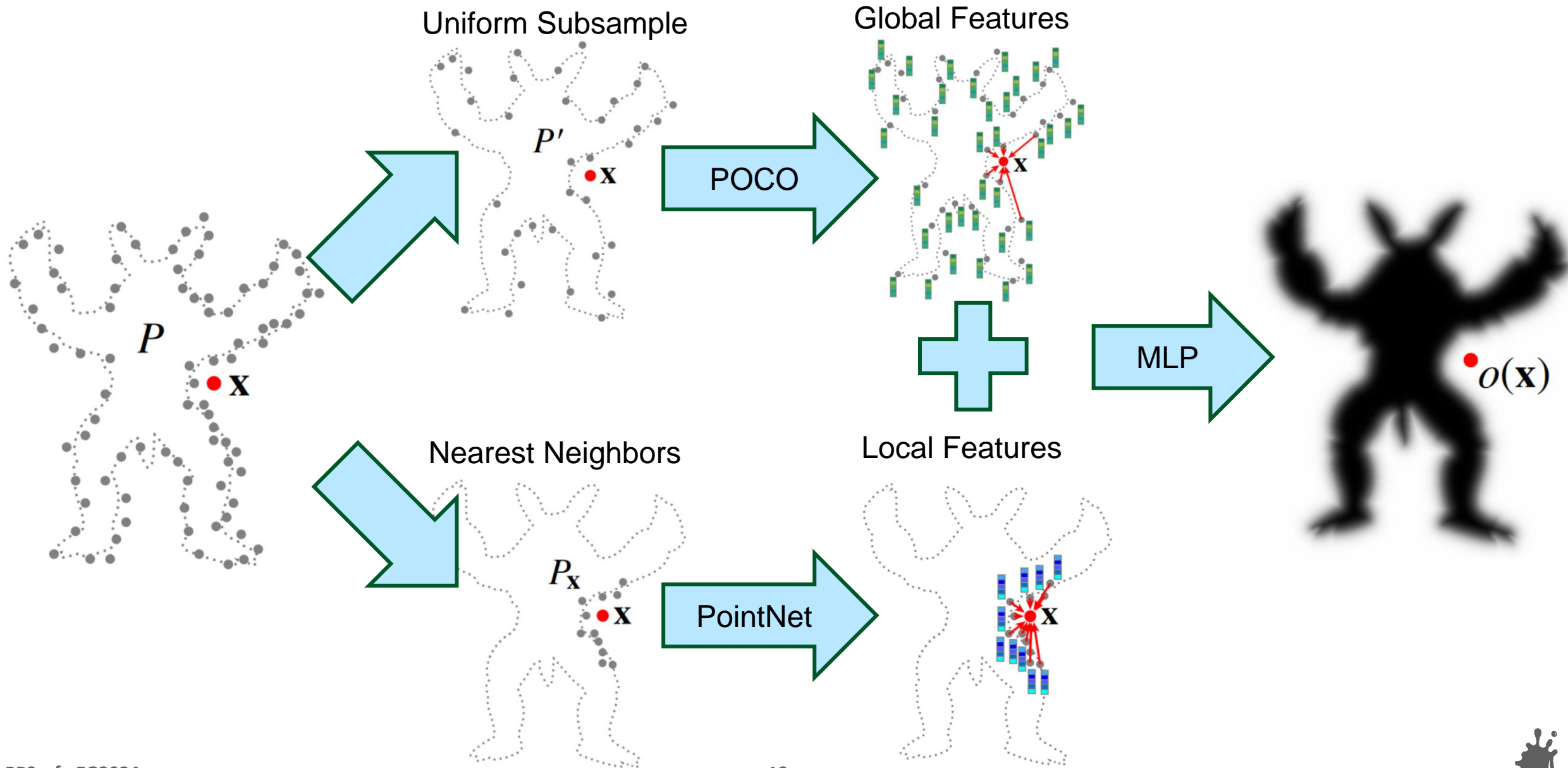




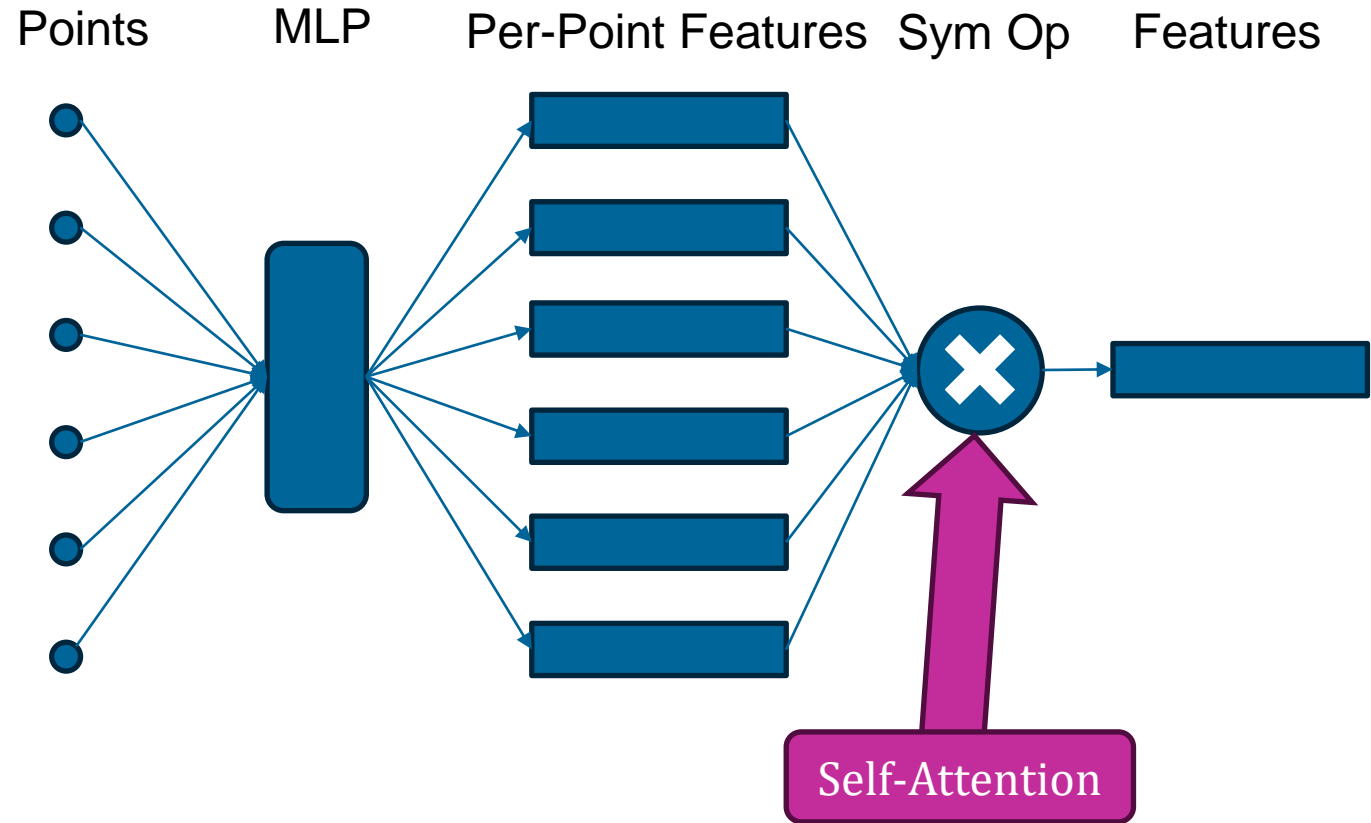
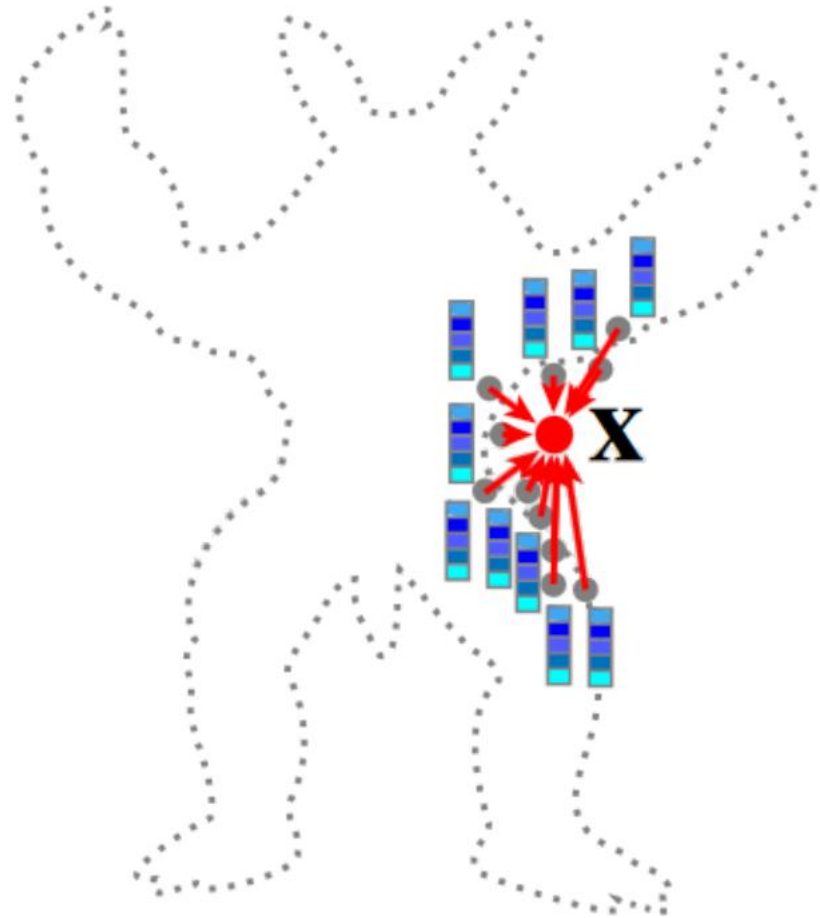
# Idea



# PPSurf Architecture



# PPSurf: Local Branch





POCO

PPSurf (ours)

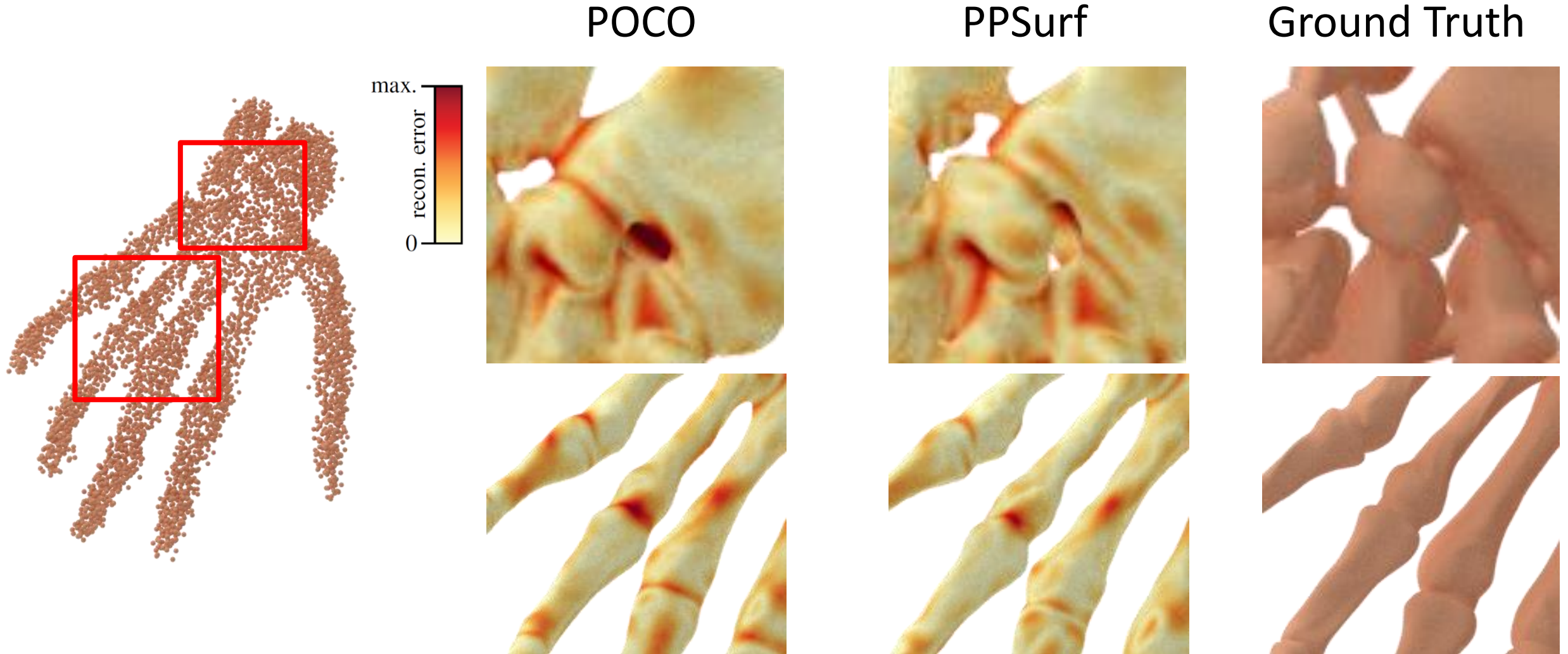
Ground Truth



BOULCH A., MARLET R.: Poco: Point convolution for surface reconstruction. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) (June 2022), pp. 6302–6314.

Erler, Philipp, et al. "PPSurf: Combining Patches and Point Convolutions for Detailed Surface Reconstruction." *Computer Graphics Forum*. Vol. 43. No. 1. 2024.





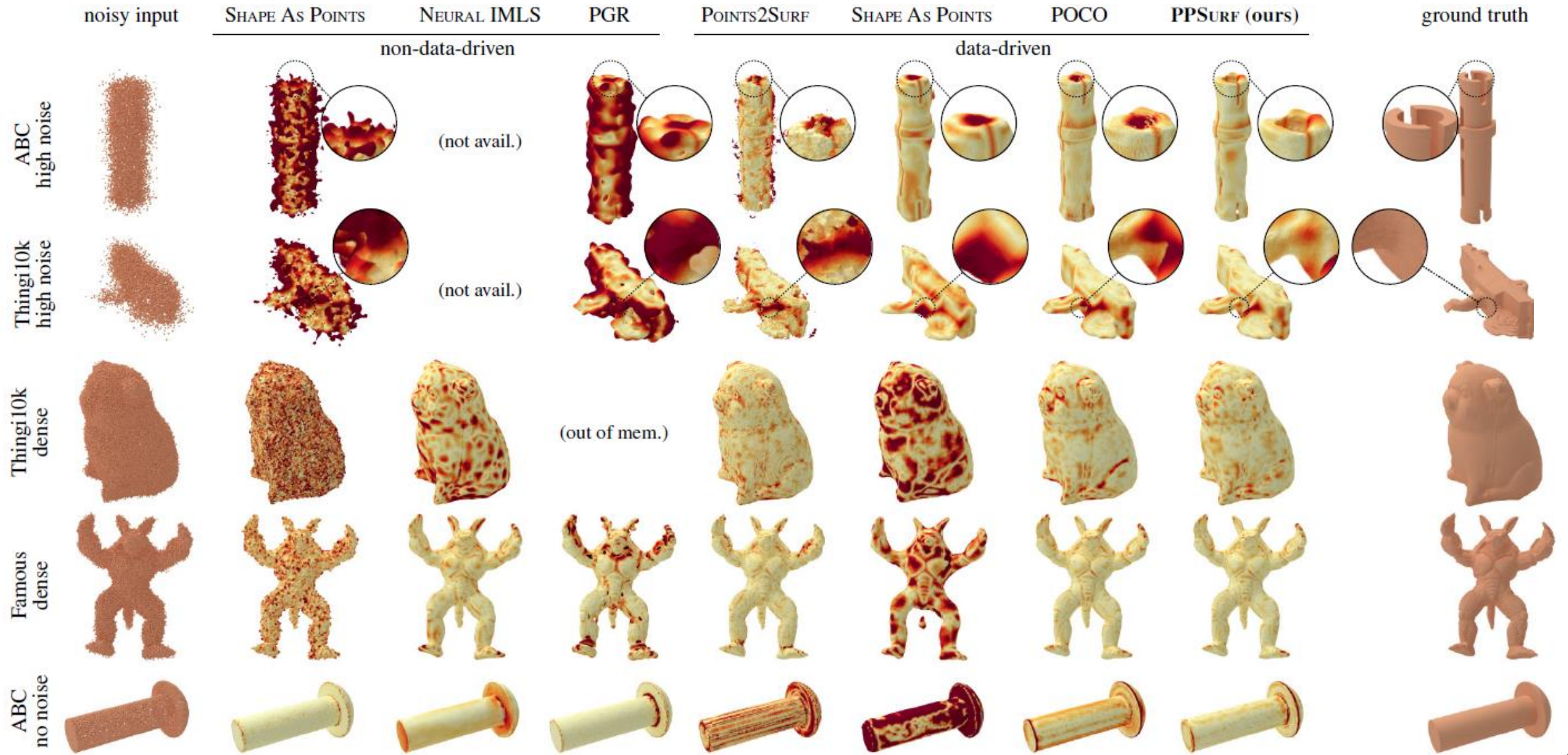
BOULCH A., MARLET R.: Poco: Point convolution for surface reconstruction. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) (June 2022), pp. 6302–6314.

Erler, Philipp, et al. "PPSurf: Combining Patches and Point Convolutions for Detailed Surface Reconstruction." *Computer Graphics Forum*. Vol. 43. No. 1. 2024.



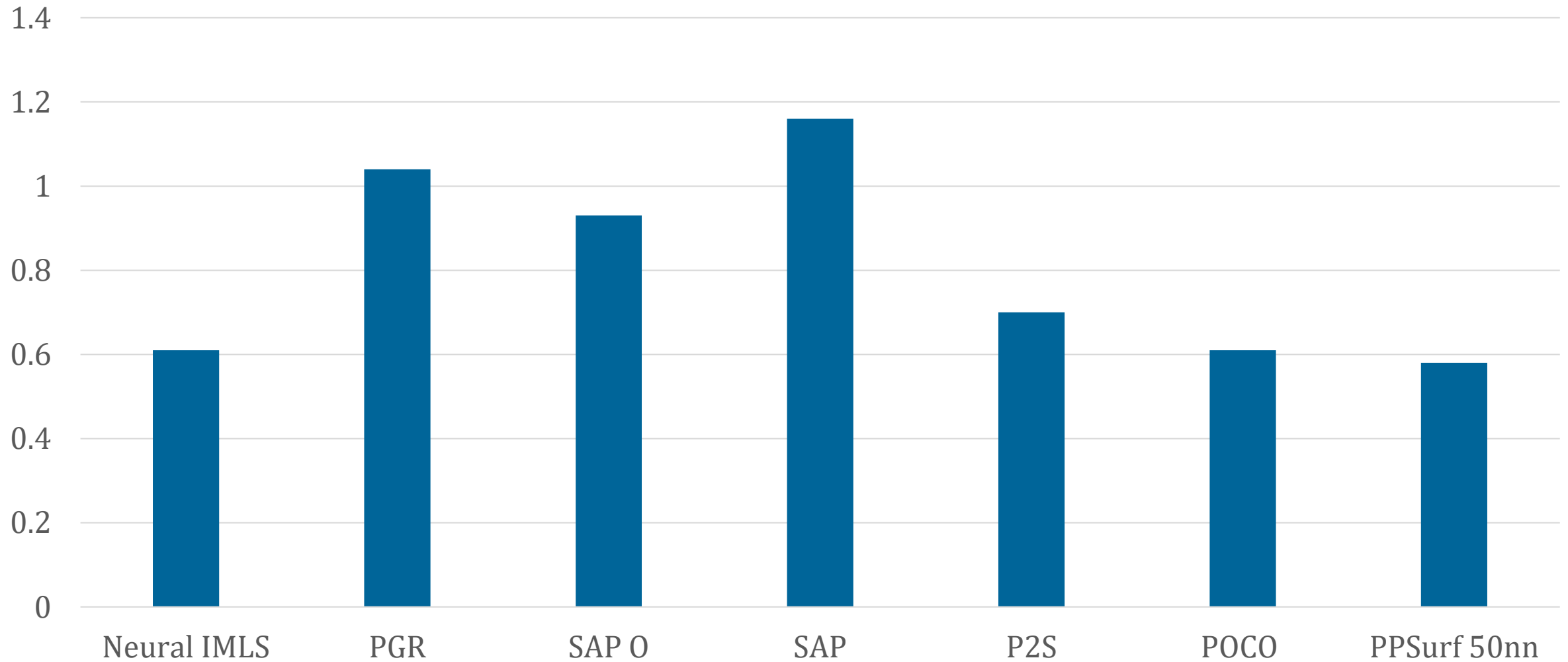


# Qualitative Comparison

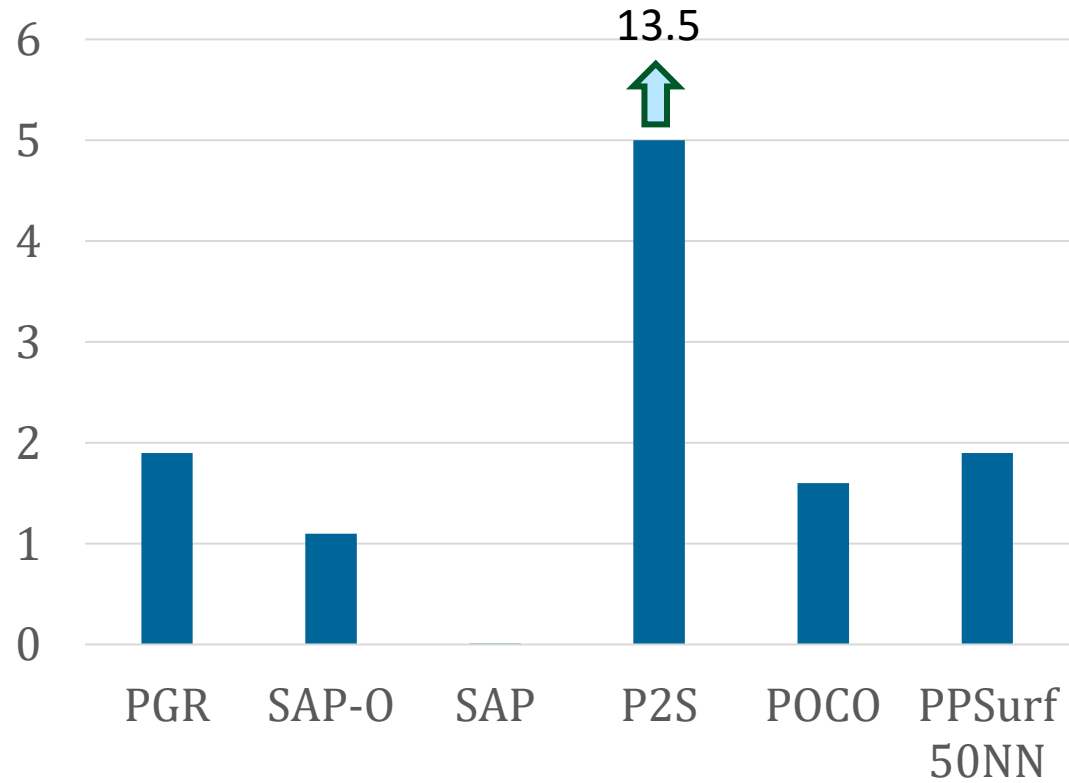


# Quantitative Comparison

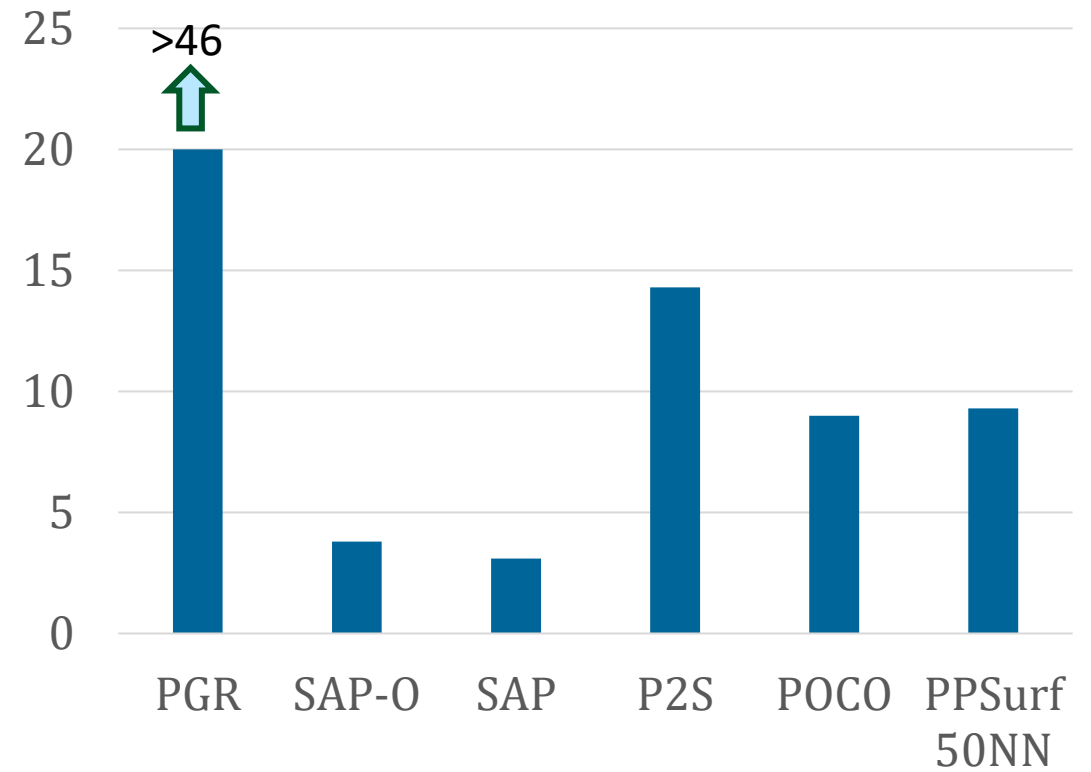
Chamfer Distance (x100) ↓



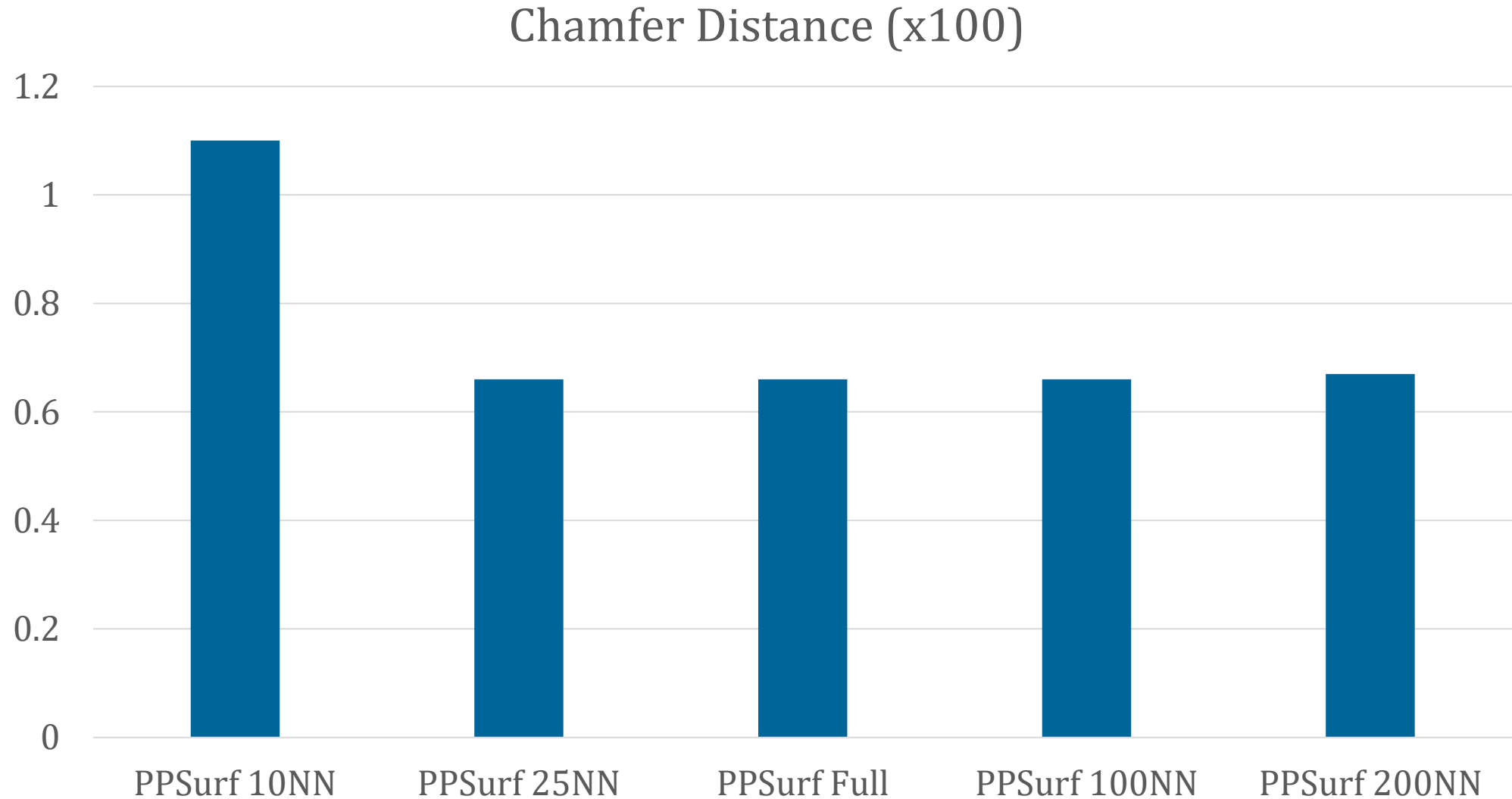
## Time per Shape (min)



## Max GPU Memory (GB)

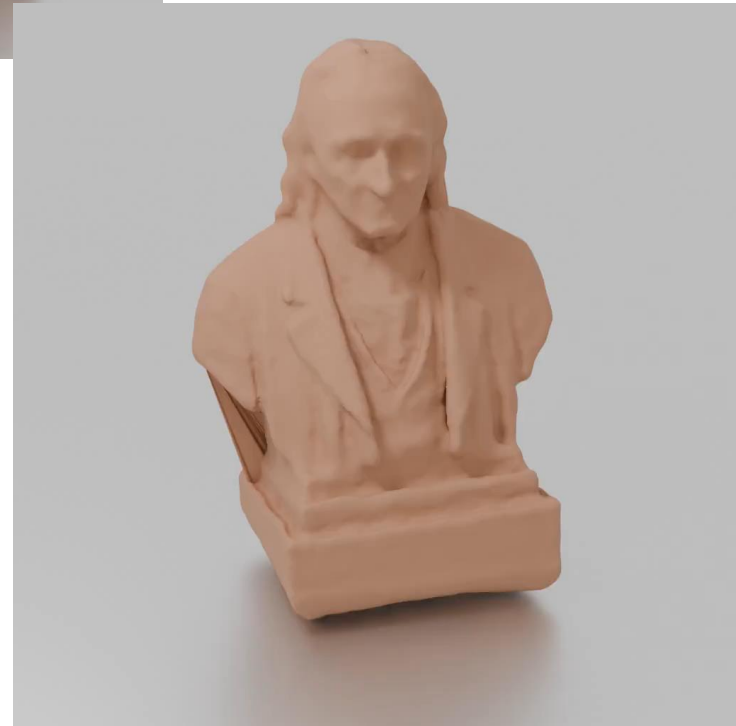


# Ablation Study

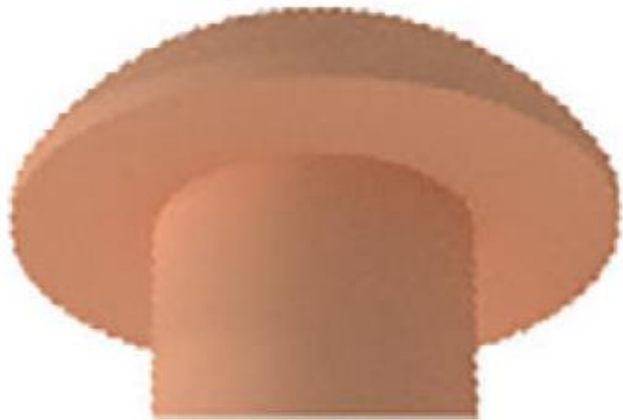




# Real-World Examples



ground truth



Neural IMLS



PPSurf (ours)



# Limitations

noisy input



ground truth



PPSurf (ours)



# PPSurf Live System

<https://huggingface.co/spaces/perler/ppsurf>

The screenshot shows the HuggingFace Space interface for PPSurf. At the top, it says "Spaces | perler/ppsurf" with a like count of 1 and a status of "Running on ZERO". The main title is "PPSurf: Combining Patches and Point Convolutions for Detailed Surface Reconstruction".

**Github**

Supported file formats:

- o PLY, STL, OBJ and other mesh files,
- o XYZ as whitespace-separated text file,
- o NPY and NPZ (key='arr\_0'),
- o LAS and LAZ (version 1.0-1.4), COPC and CRS. Best results for 50k-250k points.

**Project Info**

This method is meant for scans of single and few objects. Quality for scenes and landscapes will be lower.

Inference takes up to 180 seconds.

For faster inference without waiting in queue, you may duplicate the space and upgrade to GPU in settings. [Duplicate Space](#)

**Reconstructed 3D model**

Drop File Here  
- or -  
Click to Upload

Grid Resolution (larger for more details) 129

Padding Factor (larger if object is cut off at boundaries) 0.05

Subsample Manifold Iterations (larger for larger point clouds) 10

Edge Refinement Iterations (larger for more details) 10

Reconstruct with PPSurf

