PPSurf

Combining Patches and Point Convolutions for Detailed Surface Reconstruction

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Motivation

Photos

Photogrammetry

Unoriented Point Cloud

Reconstruction

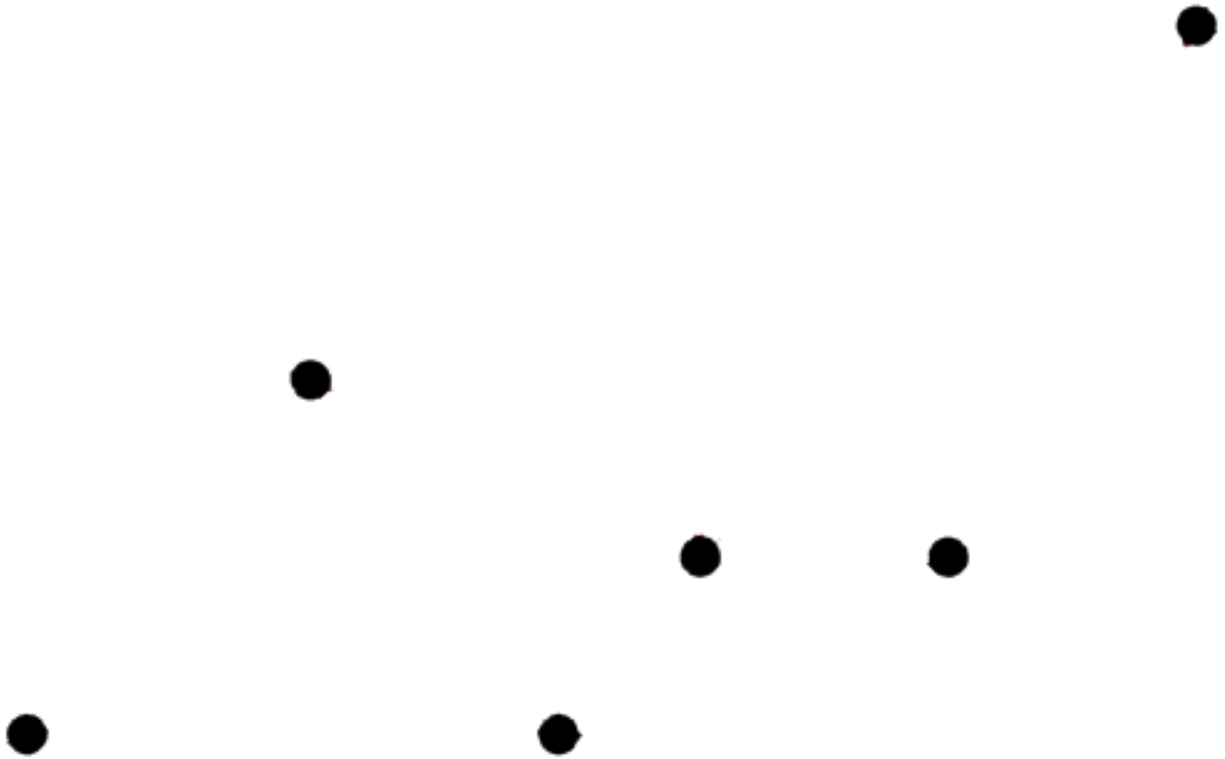
Mesh

Export

3D Print

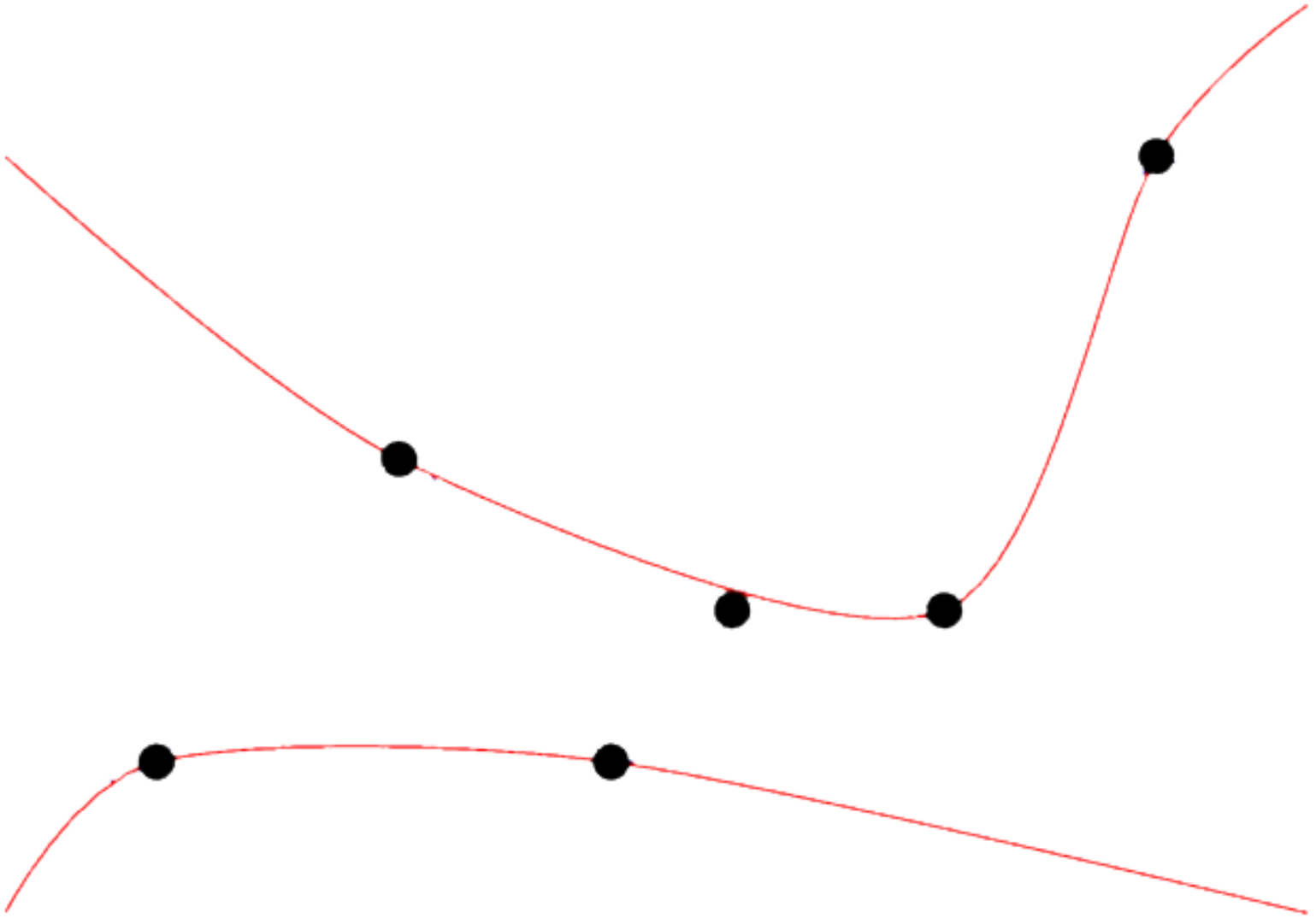
Yücer, Kaan, et al. "Efficient 3D object segmentation from densely sampled light fields with applications to 3D reconstruction." *ACM Transactions on Graphics (TOG)* 35.3 (2016): 1-15.

Surface Reconstruction



Sulzer, Raphael et al. “A Survey and Benchmark of Automatic Surface Reconstruction from Point Clouds.” ArXiv abs/2301.13656 (2023): n. pag.

Surface Reconstruction



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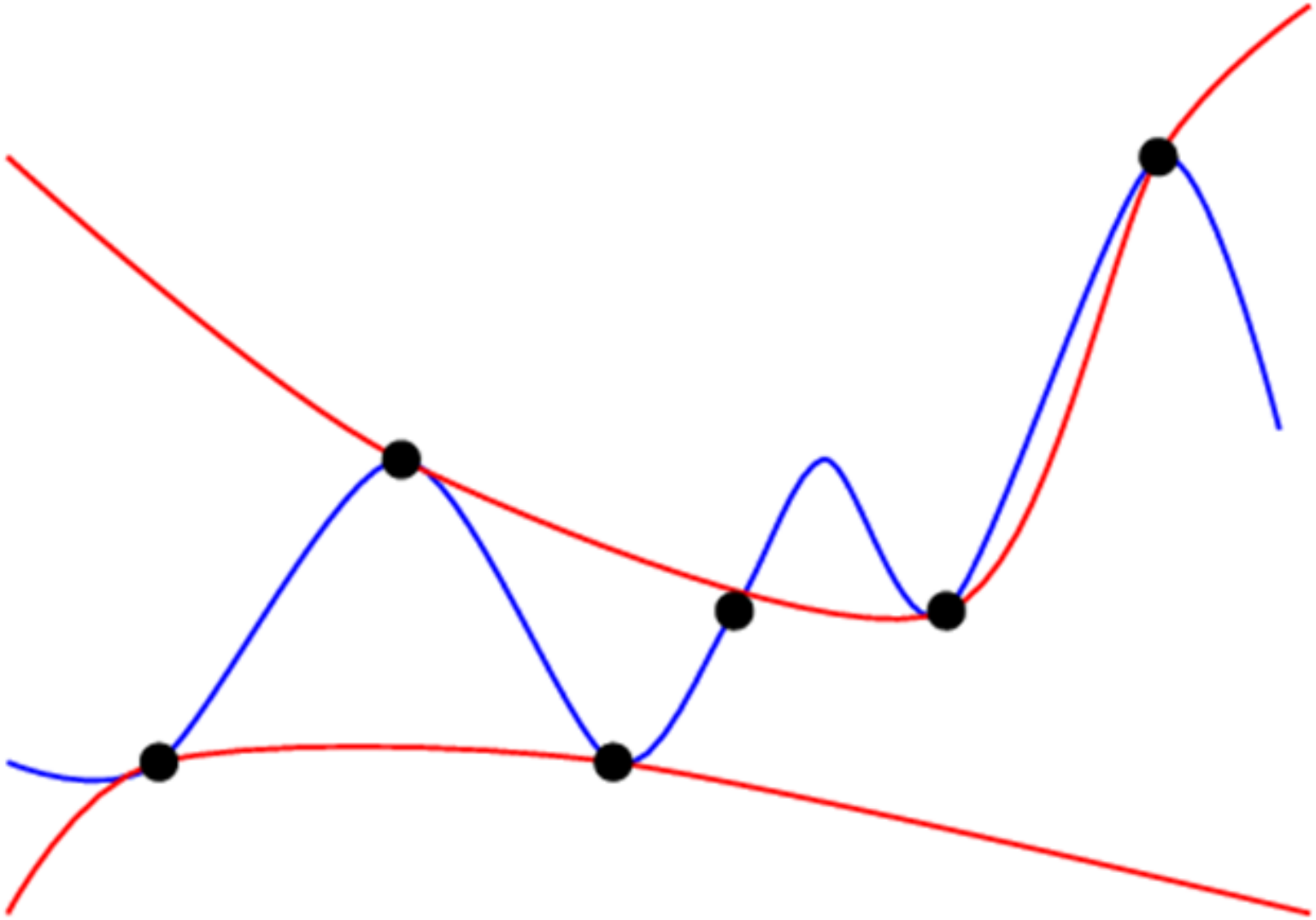
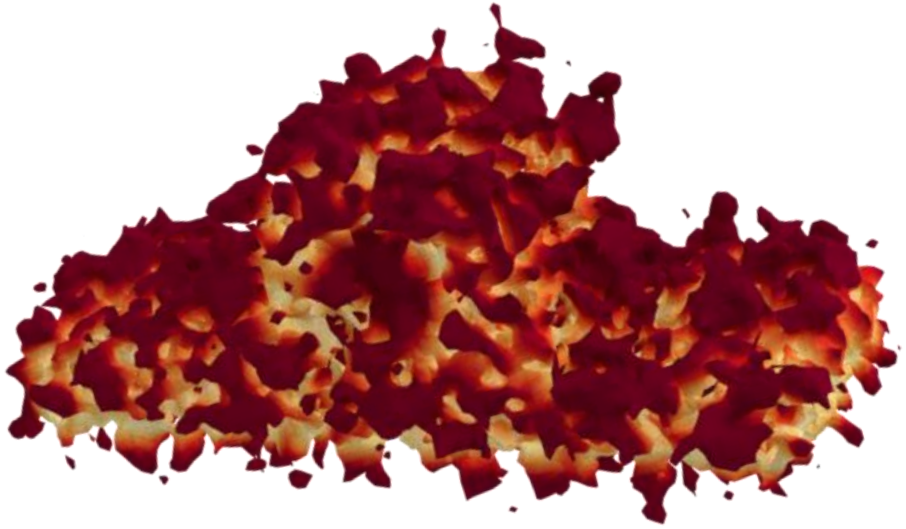
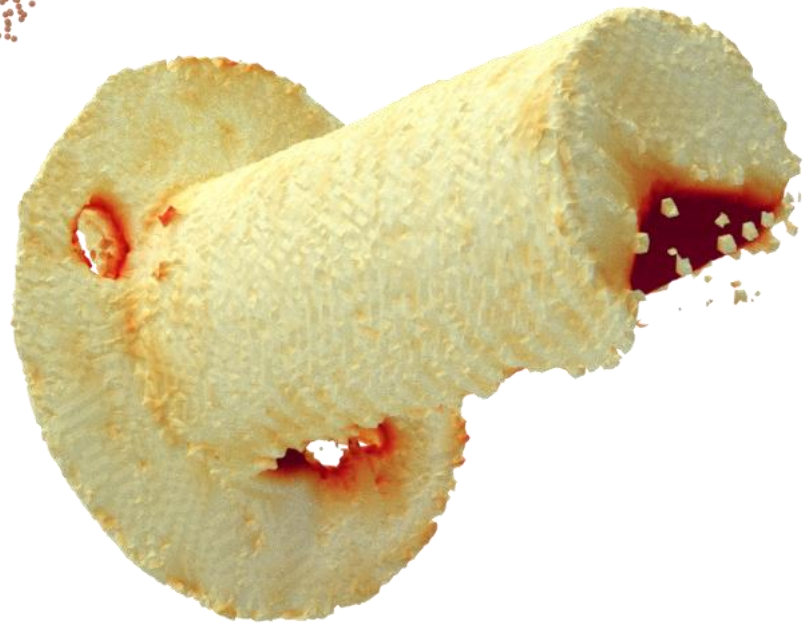
Surface Reconstruction



Sulzer, Raphael et al. "A Survey and Benchmark of Automatic Surface Reconstruction from Point Clouds." ArXiv abs/2301.13656 (2023): n. pag.

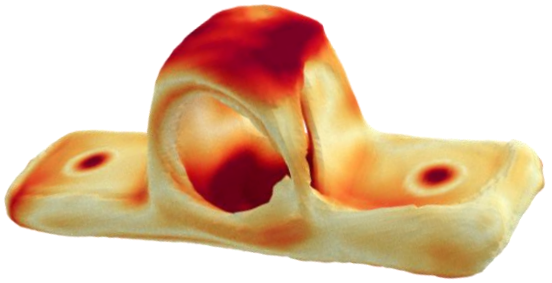
Reconstruction Difficulties





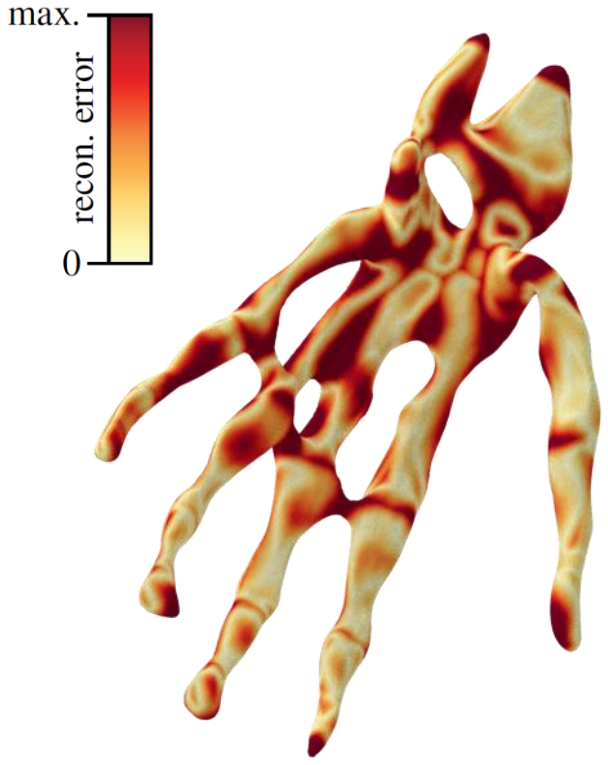
Method Categories

Non-data-driven Methods



Non-Data Driven Methods

Neural-IMLS



WANG Z., WANG P., WANG P., DONG Q., GAO J., CHEN S., XIN S., TU C., WANG W.: Neural-imls: 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.

SAP (unlearned)

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).

PGR

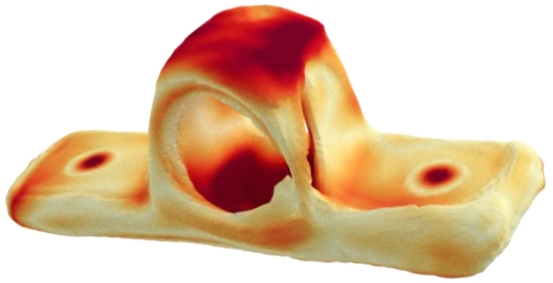
LIN S., XIAO D., SHI Z., WANG B.: Surface reconstruction from point clouds without normals by parametrizing the gauss formula. ACM Trans. Graph. 42, 2 (oct 2022). URL: https://doi.org/10.1145/3554730, doi:10.1145/3554730.

Method Categories

Non-data-driven Methods

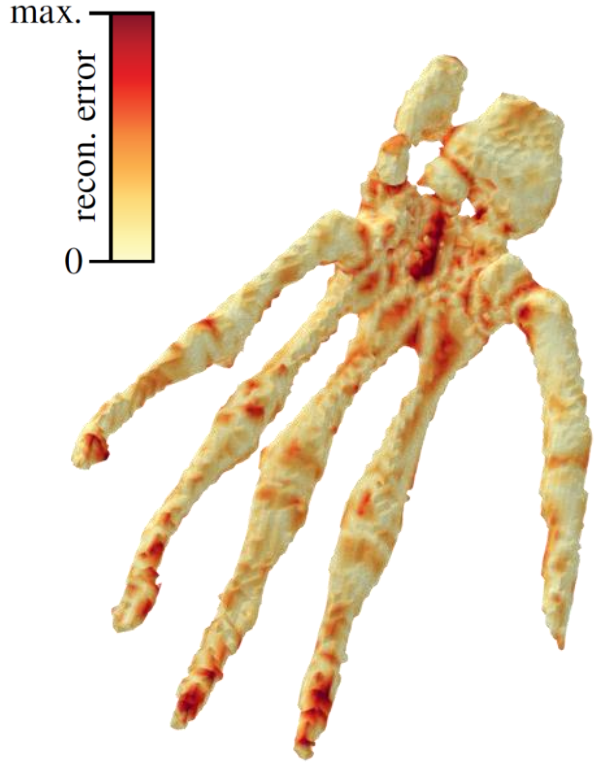
Data-driven Methods

learned



Data Driven Methods

Points2Surf



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).

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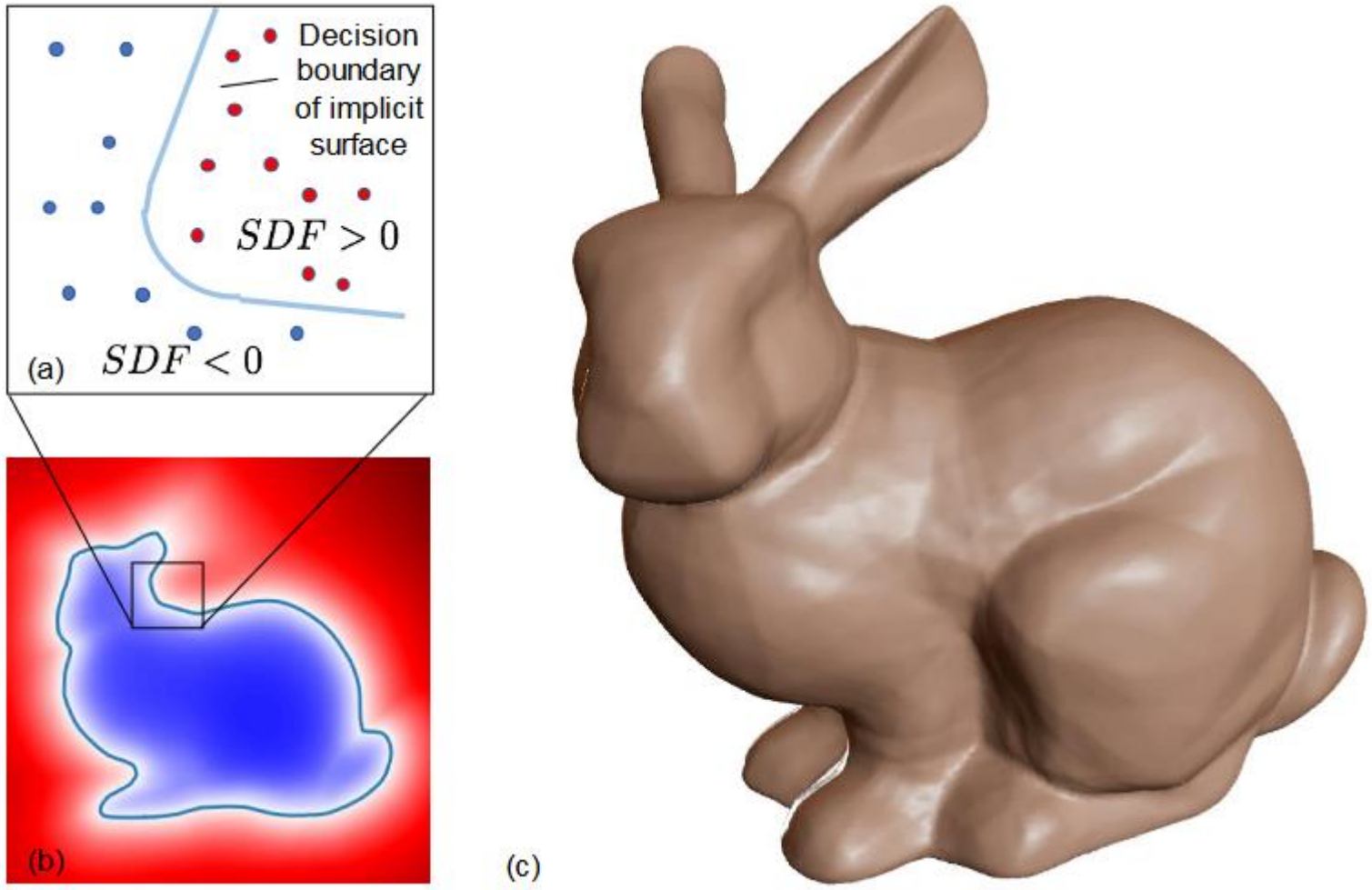
POCO

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.

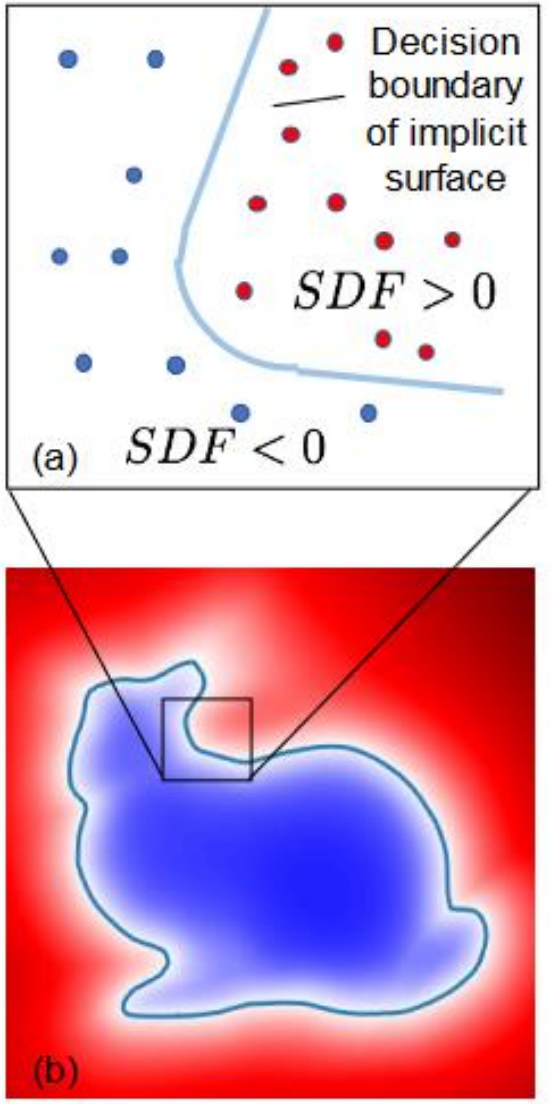
Predicting Implicit Surfaces



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.

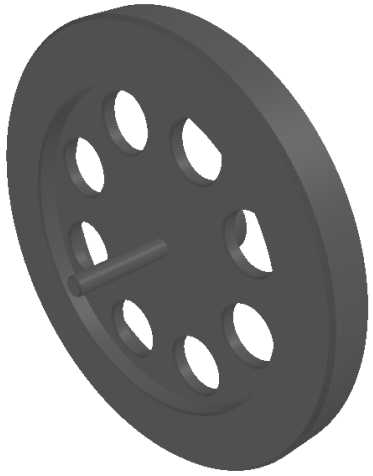
Occupancy Probability

- TSDF: [-1, +1]
- Occupancy: [0, 1]
- Occupancy Probability (POCO):
  - In: [0, 1]
  - Out: [0, 1]
  - Occ_prob = (Out – In)

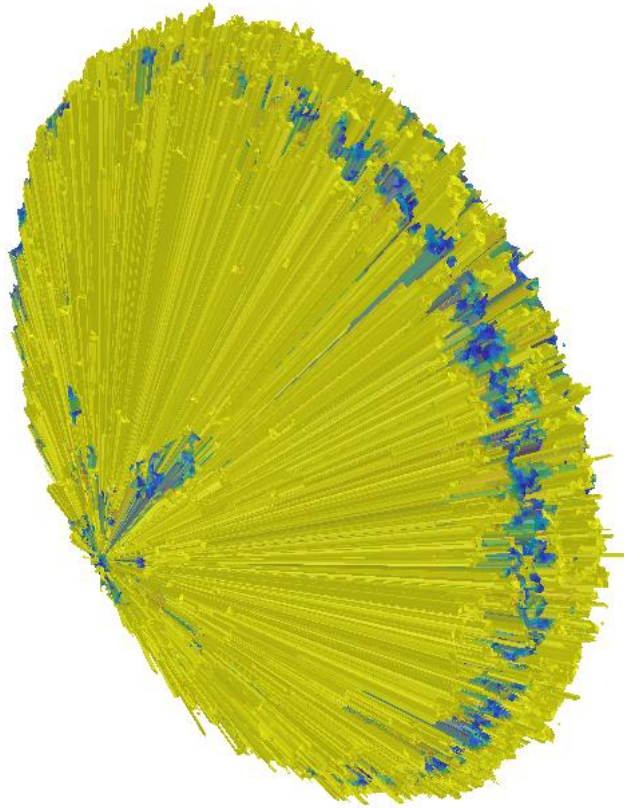


Park, Jeong Joon, et al. "Deepsdf: Learning continuous signed distance functions for shape representation." *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition*. 2019.

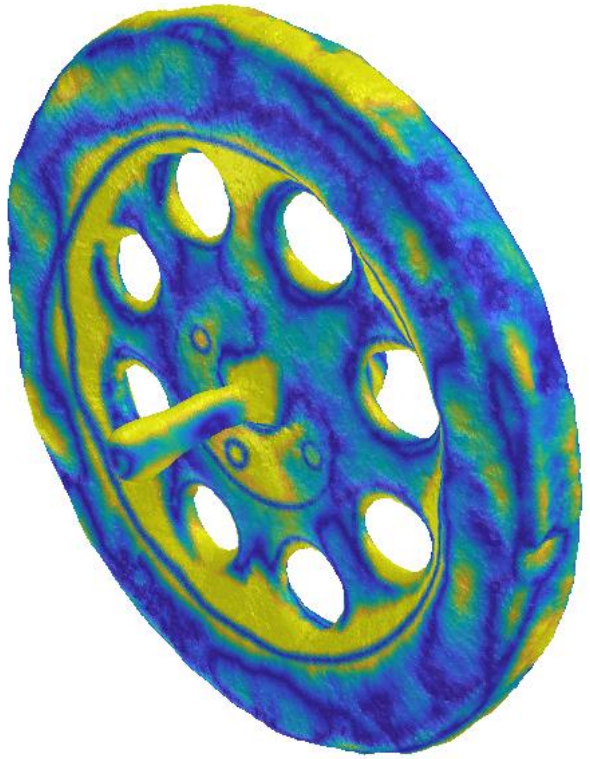
Global and Local Information



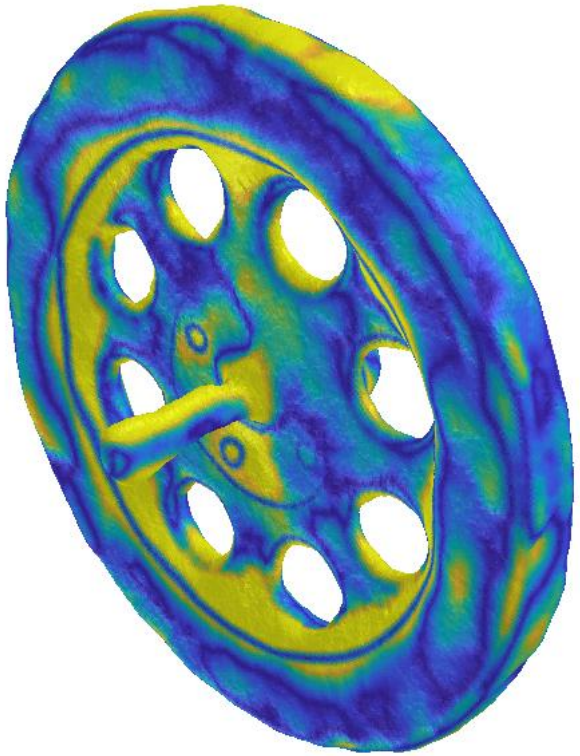
Only Local



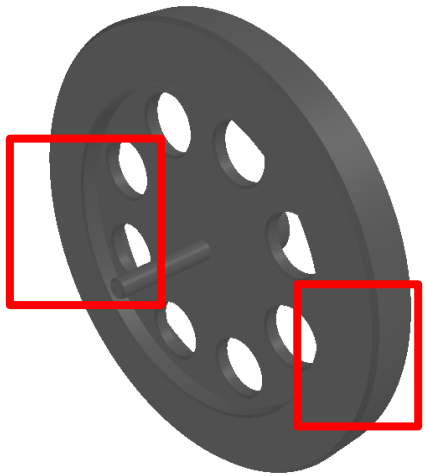
Only Global



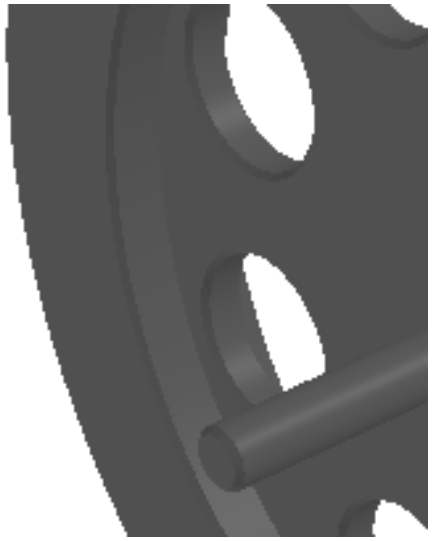
Local + Global



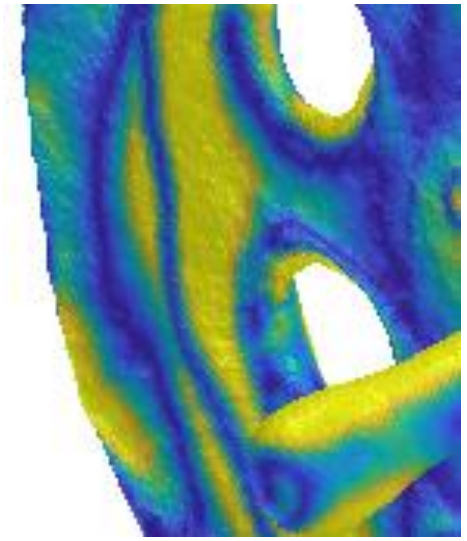
Global and Local Information

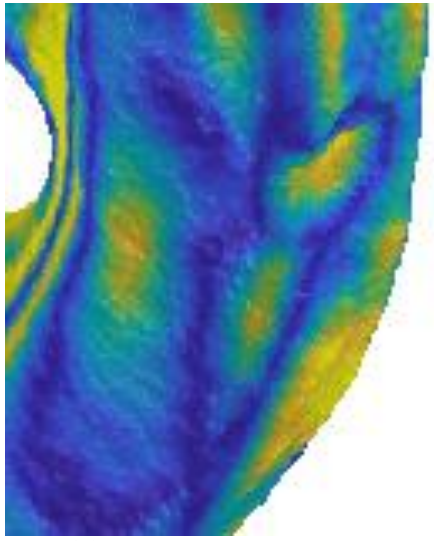


GT

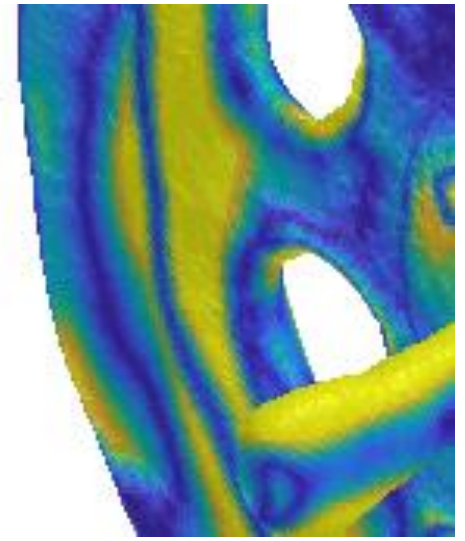


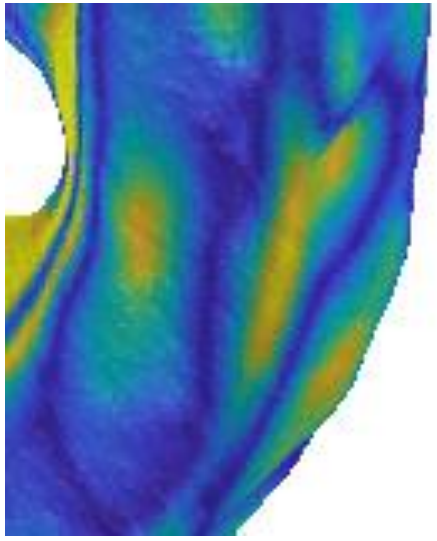
Only Global



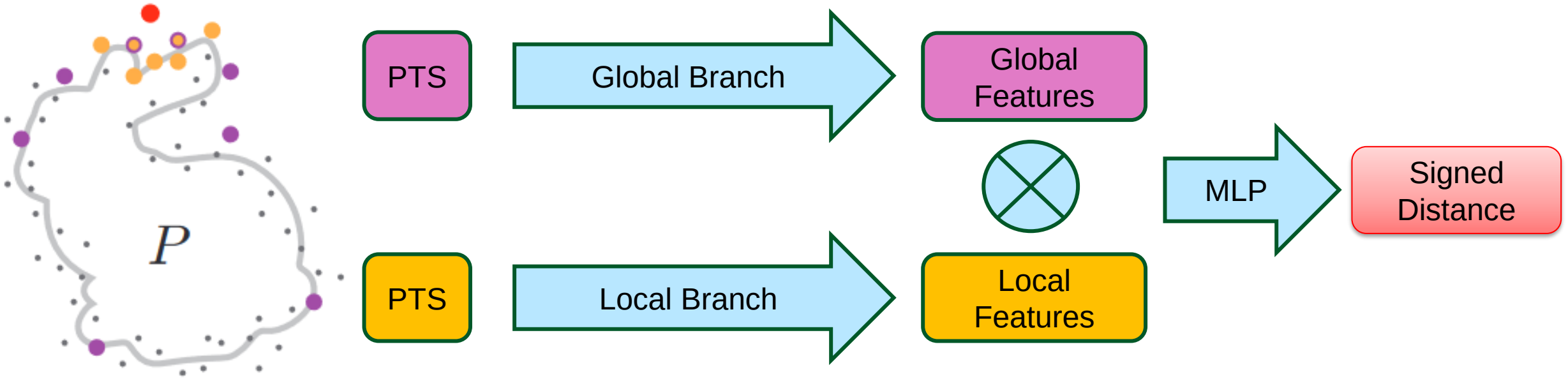


Local + Global



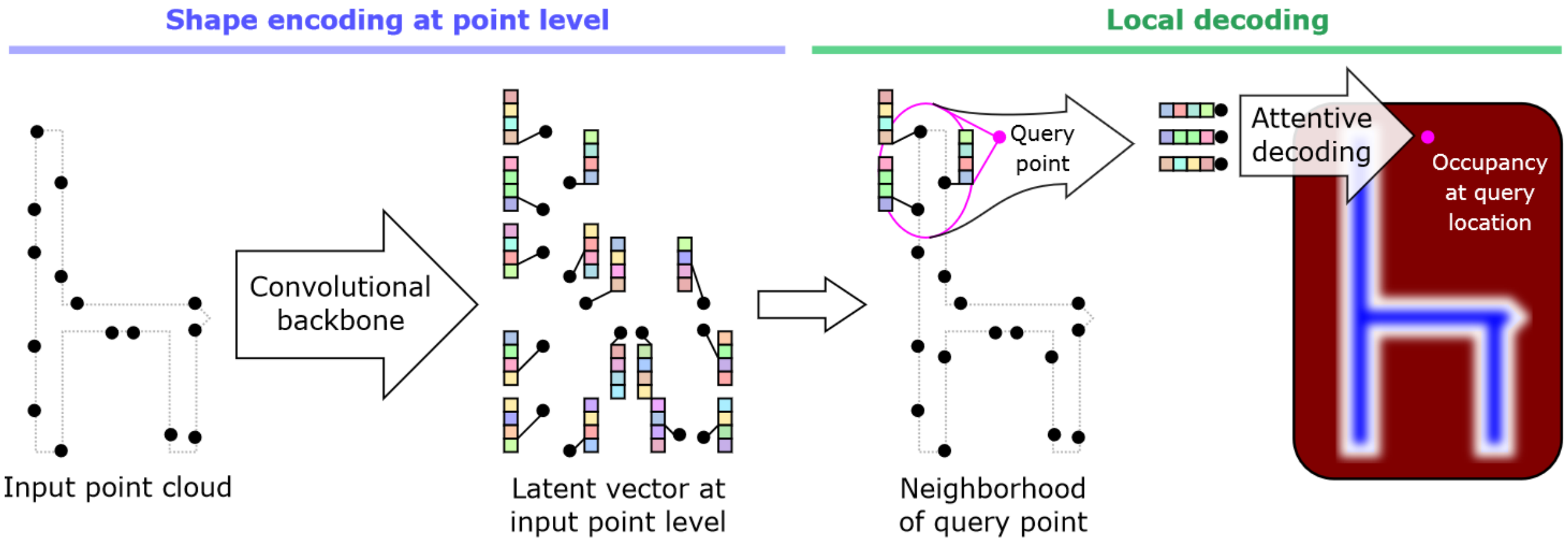


Points2Surf



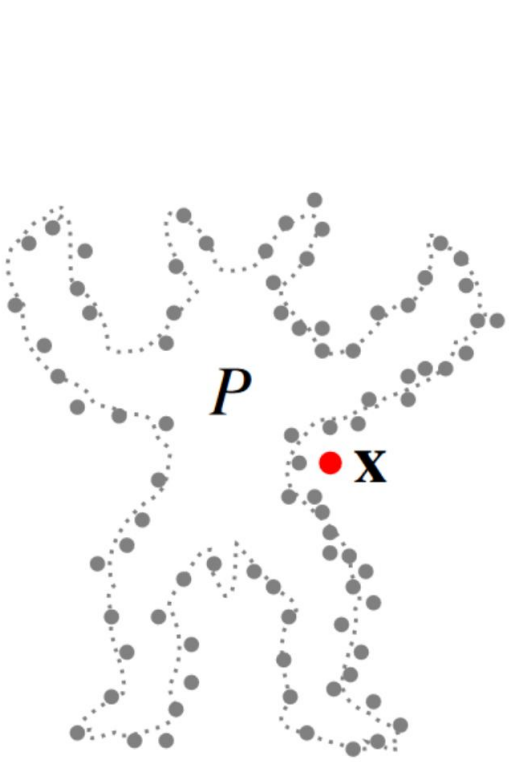
Erler P., Guerrero P., Ohrhallinger S., Mitra N. J., Wimmer M.: Points2Surf: Learning implicit surfaces from point clouds. In European Conference on Computer Vision (ECCV) (2020).

POCO



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.

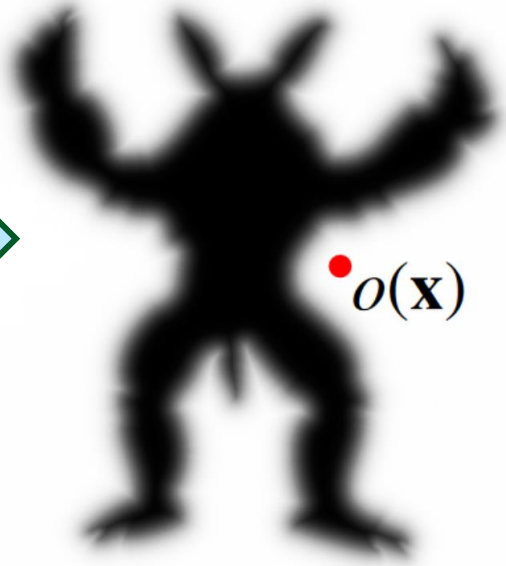
Idea



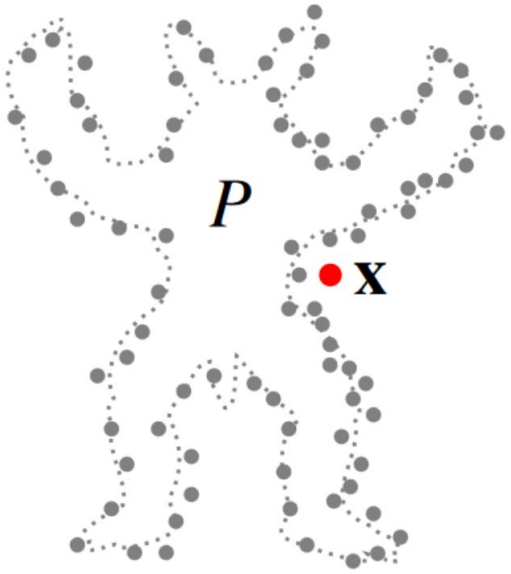
Global POCO

Local POCO

Merge Features

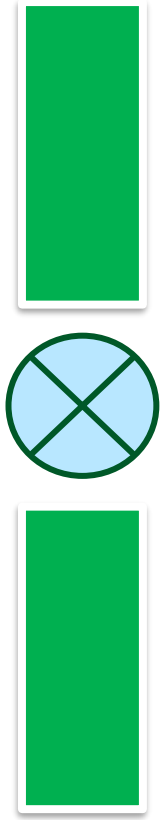


Idea

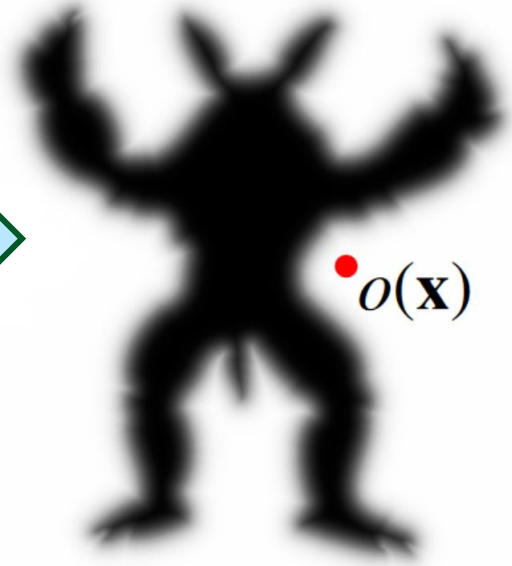


Global POCO

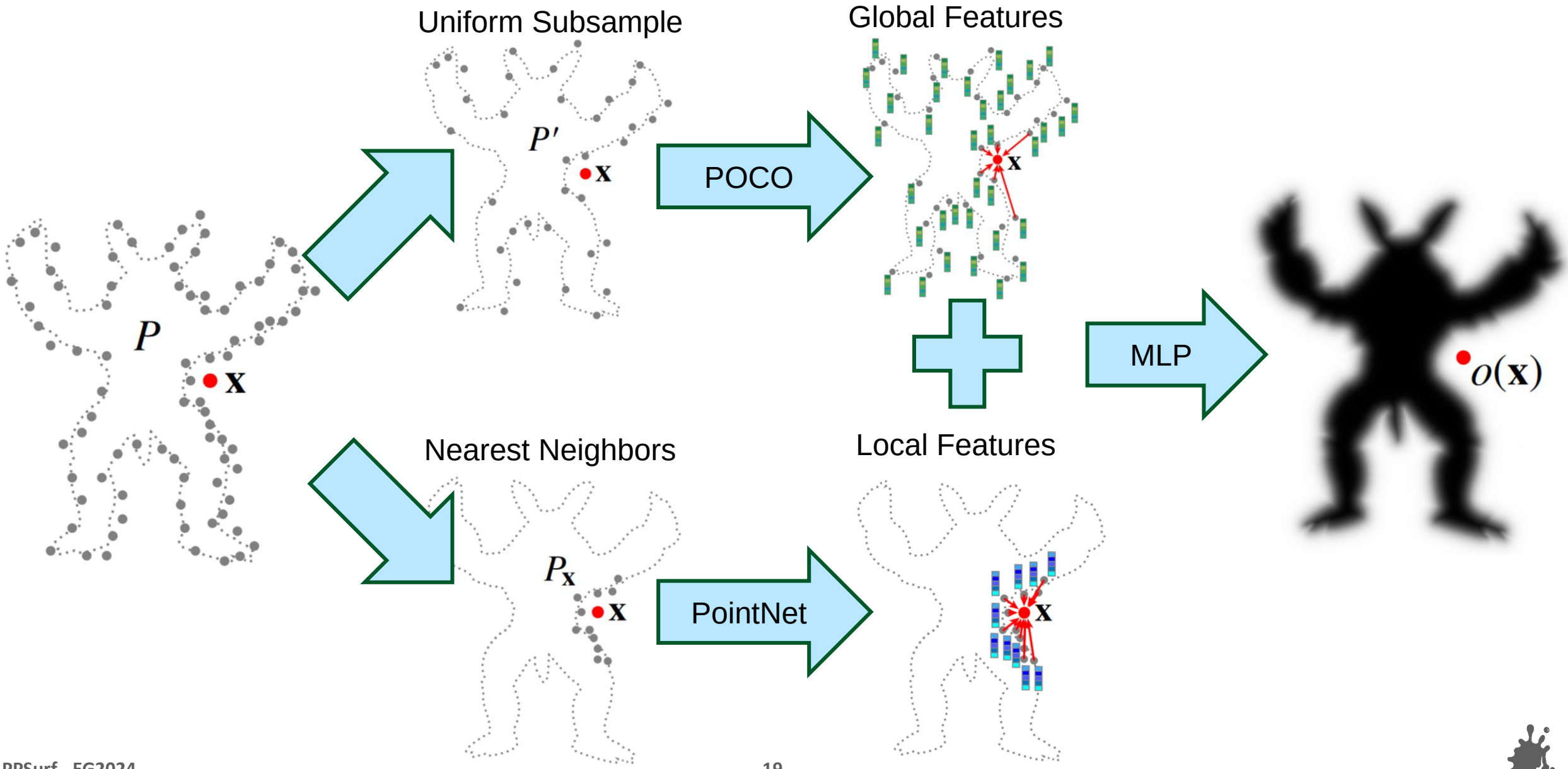
Local PointNet



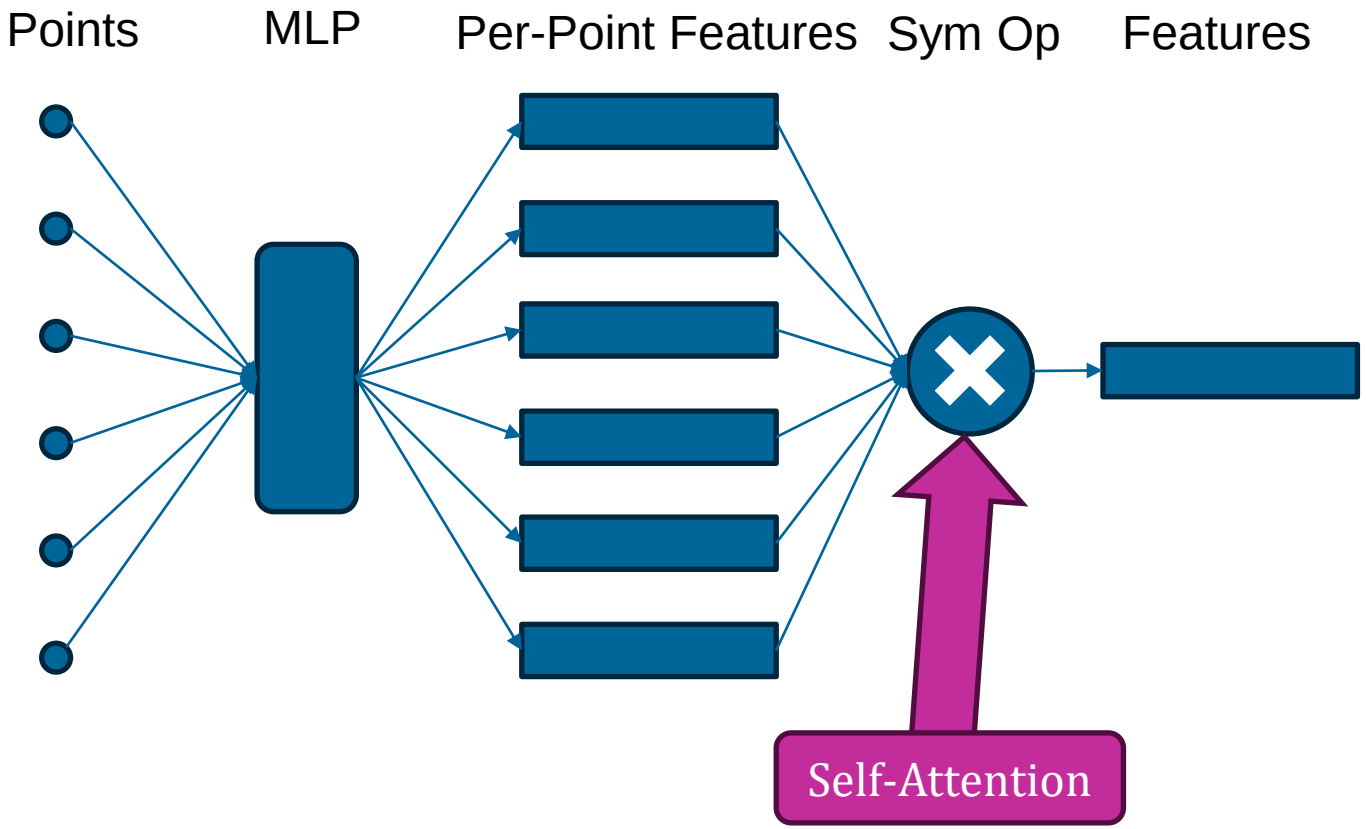
Merge Features



PPSurf Architecture



PPSurf: Local Branch

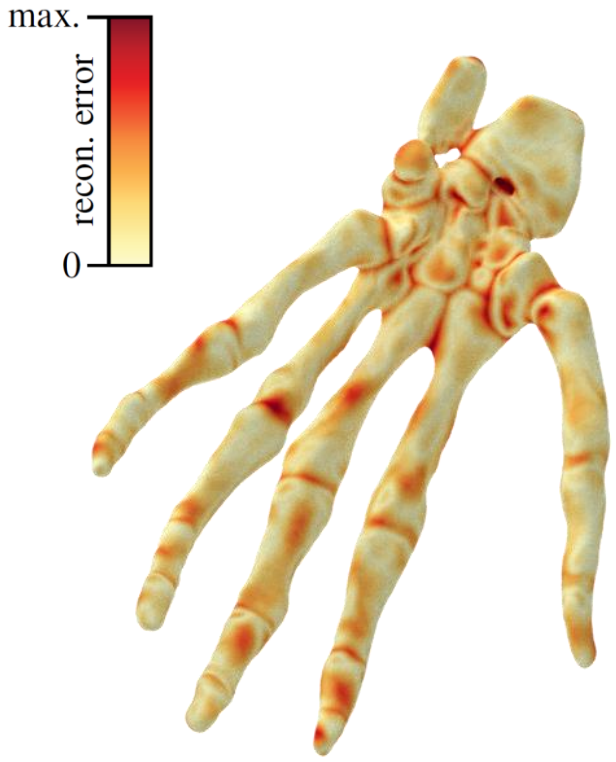


Data Driven Methods

POCO

PPSurf (ours)

Ground Truth



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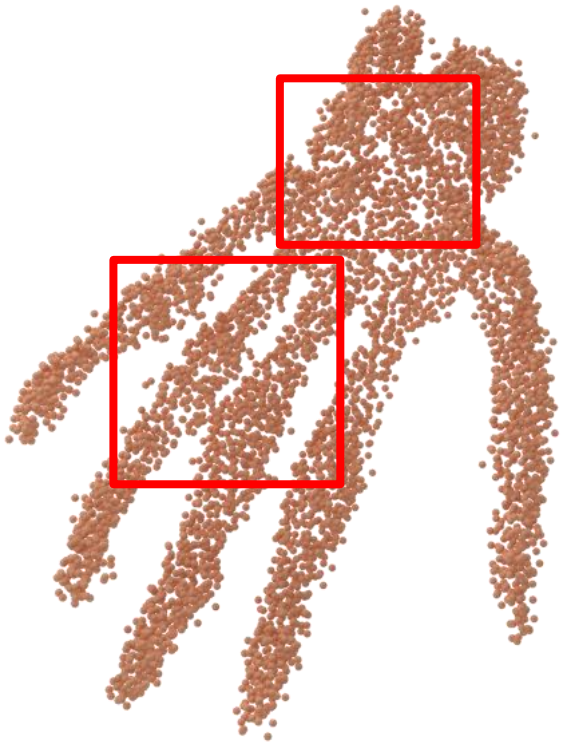
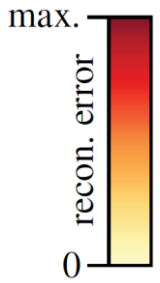
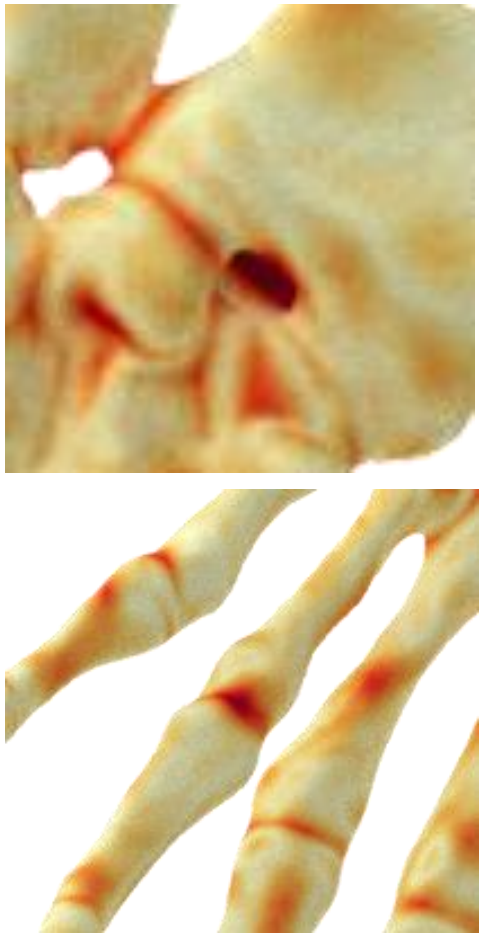
Data Driven Methods

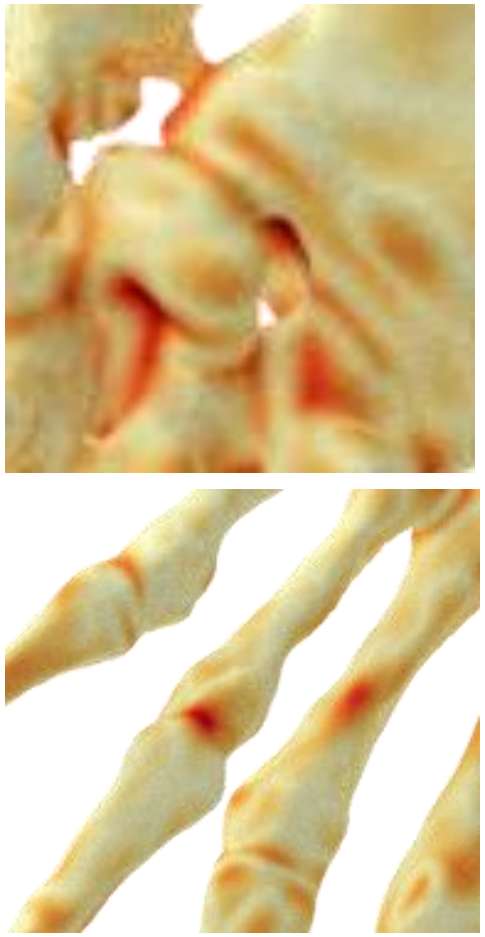




POCO



PPSurf



Ground Truth

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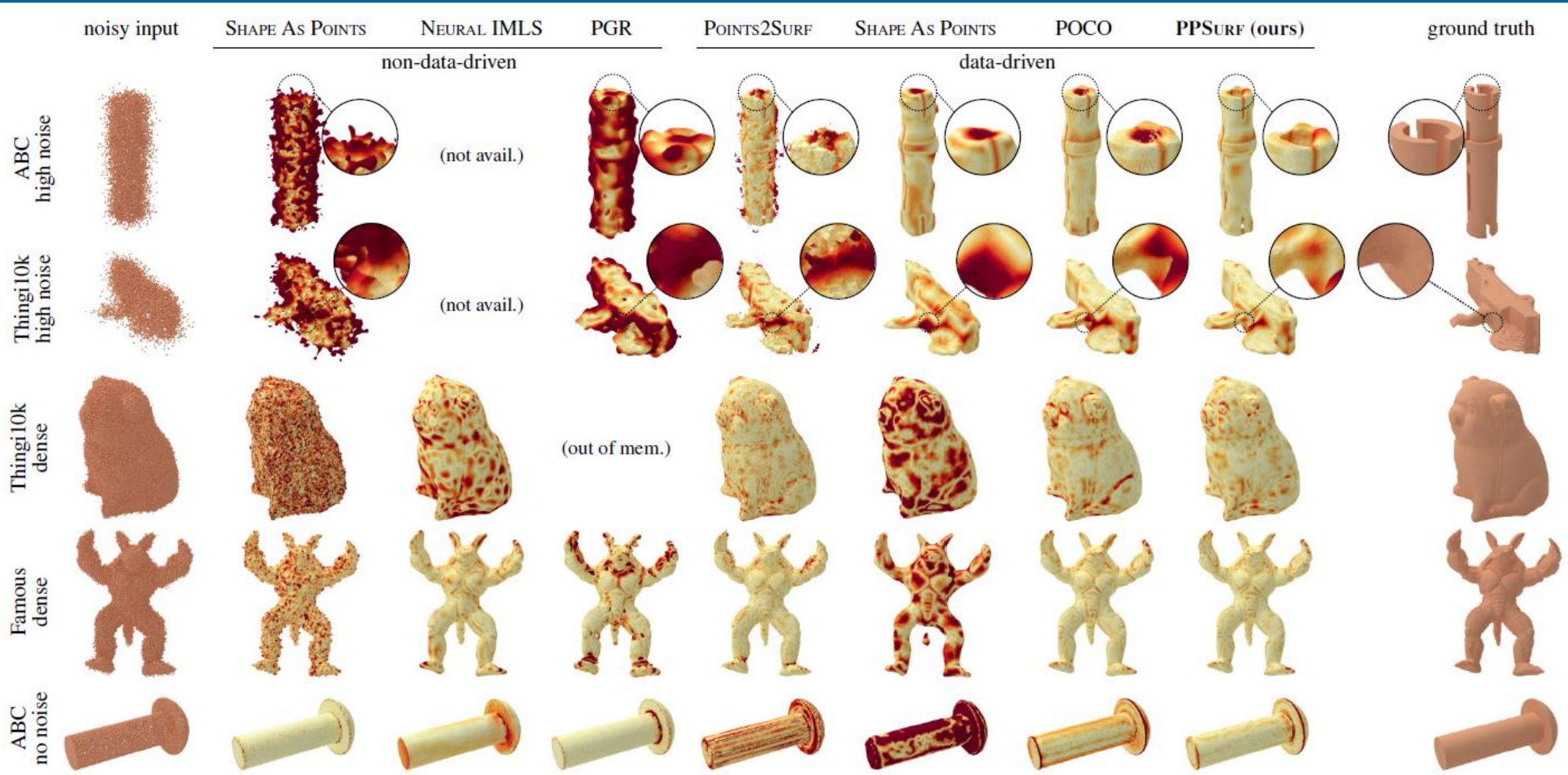
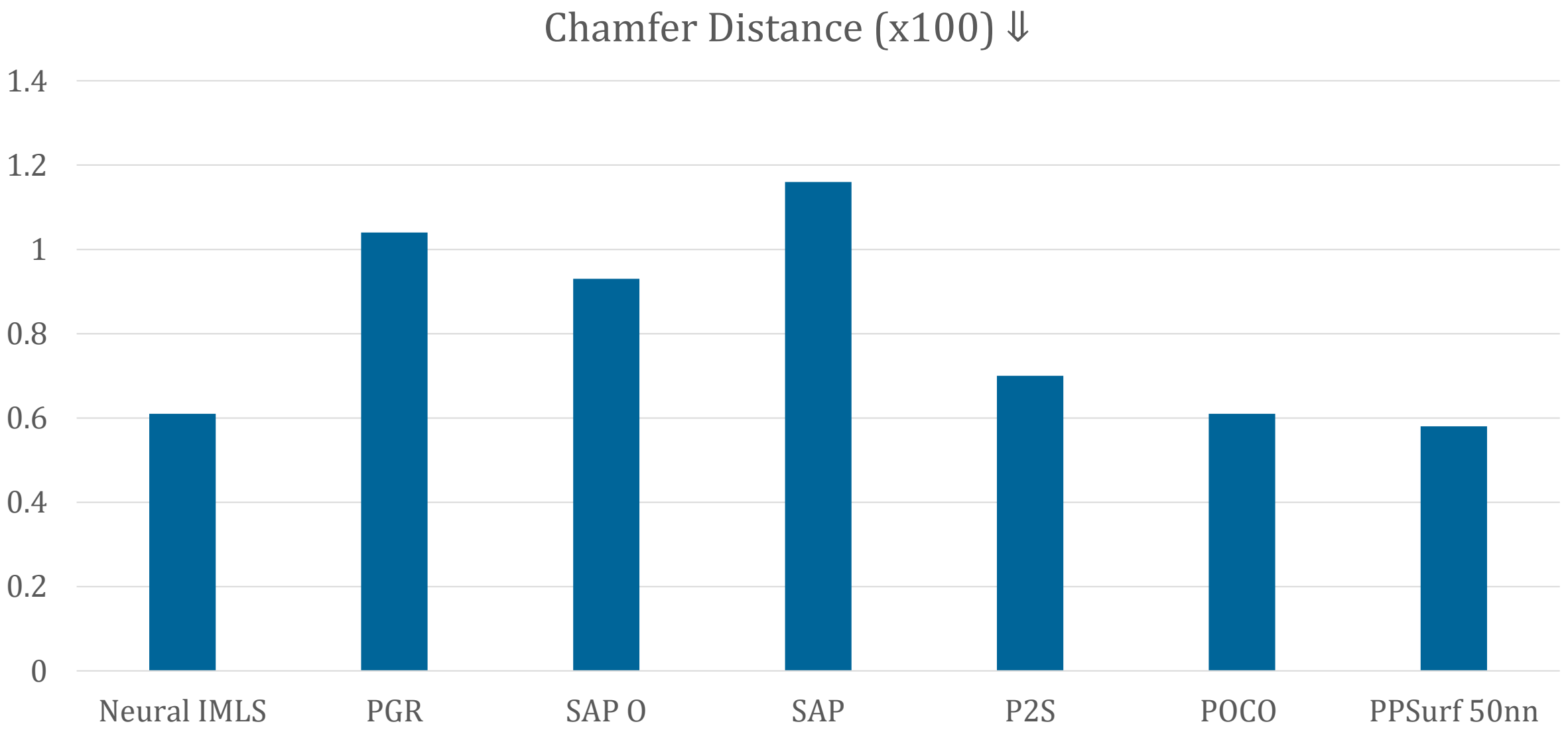
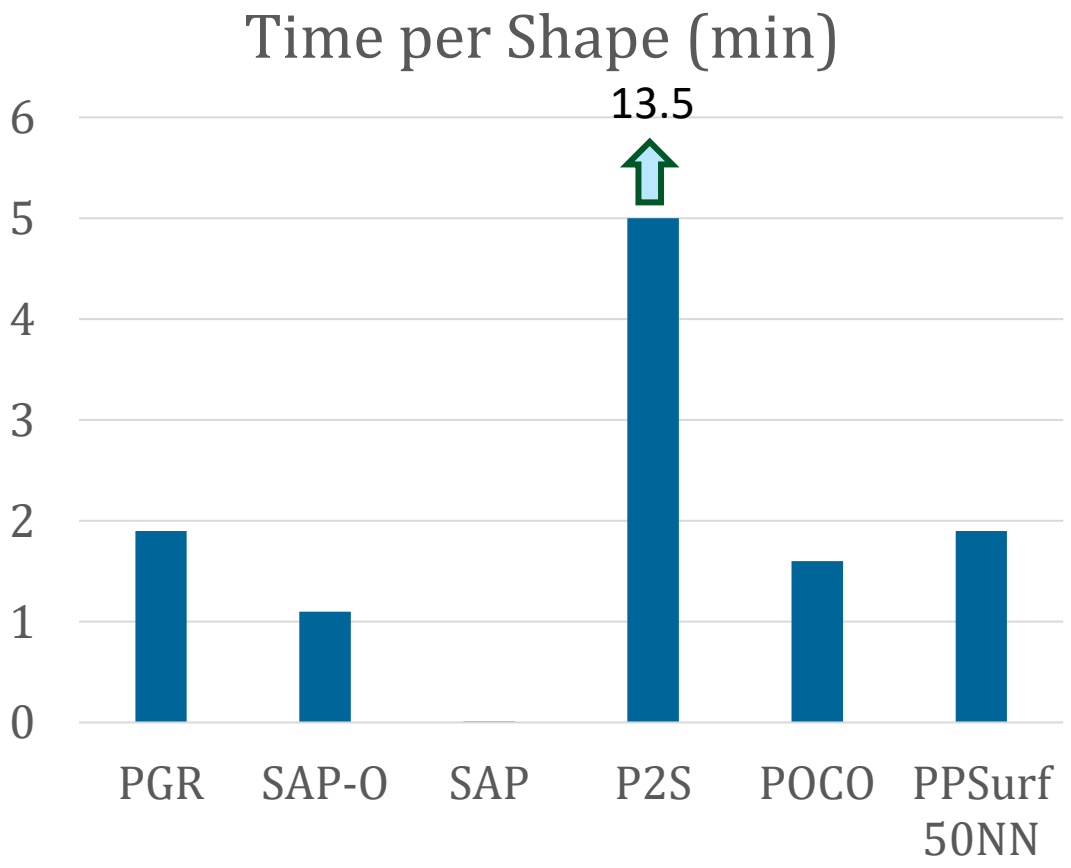
Qualitative Comparison

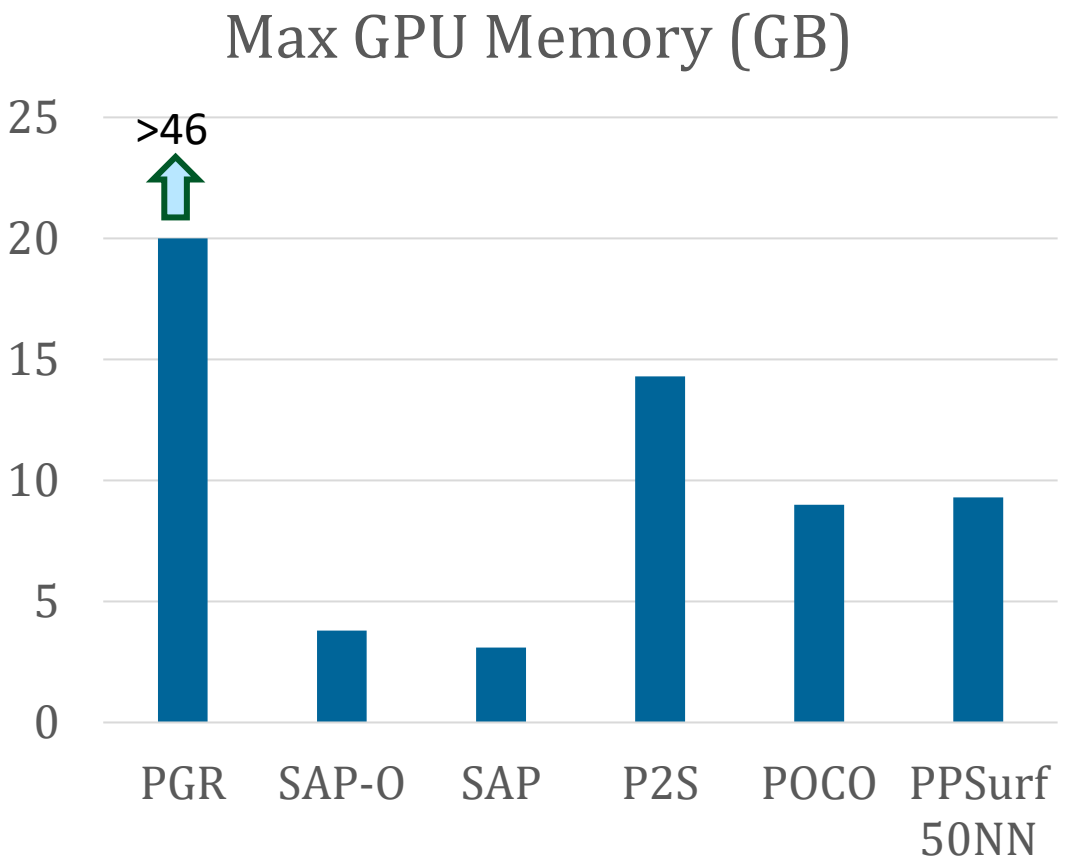


Quantitative Comparison

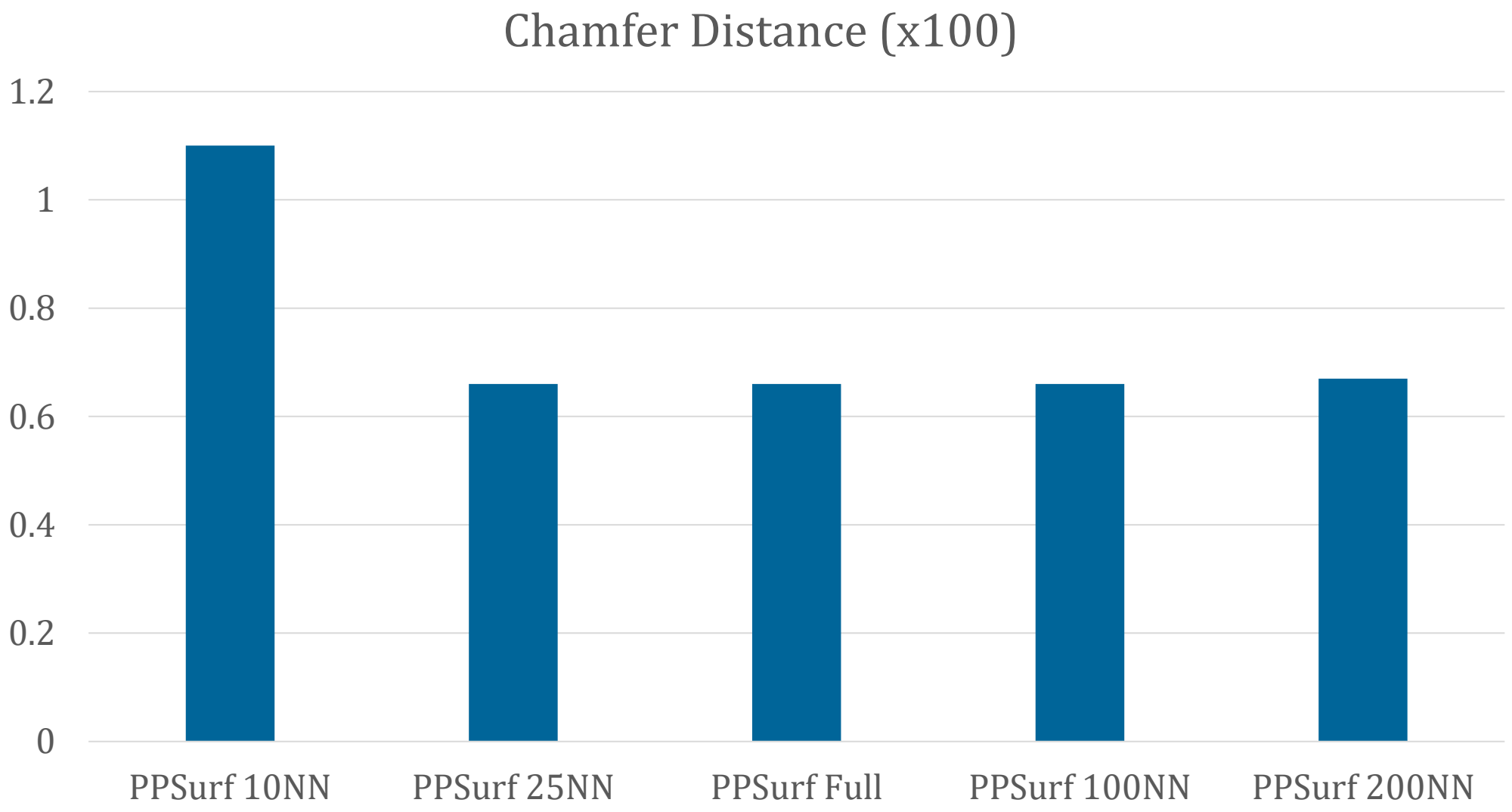


Time and Memory

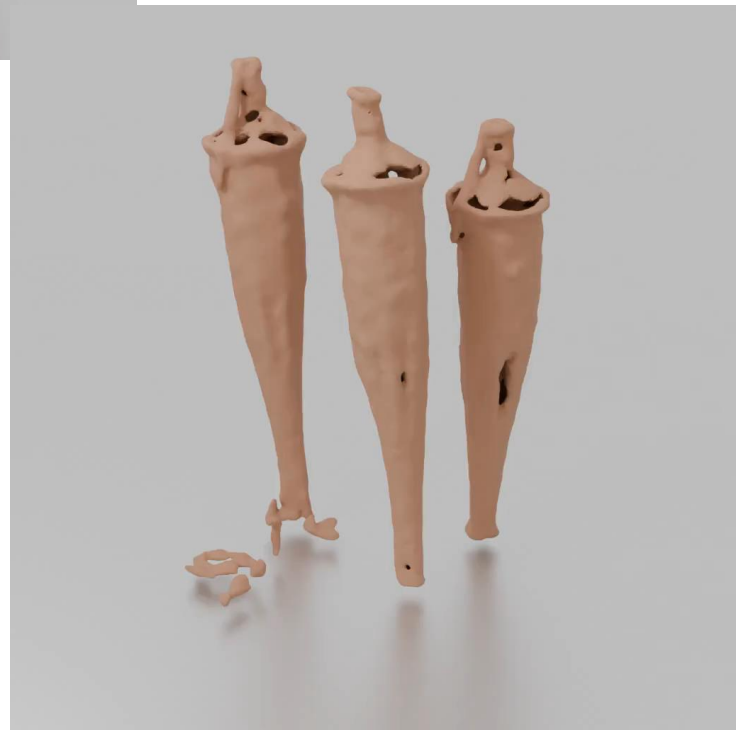




Ablation Study

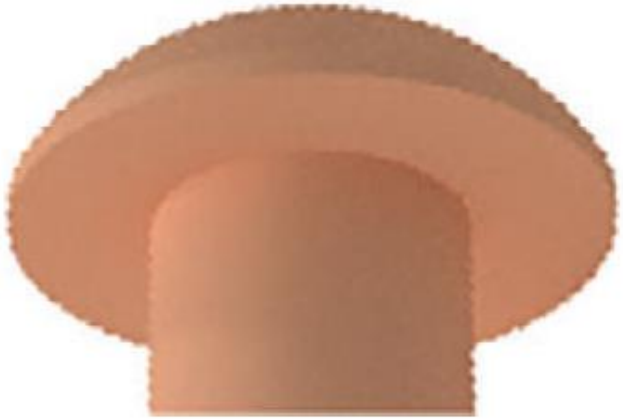


Real-World Examples



Limitations

ground truth



Neural IMLS

PPSurf (ours)

Limitations

noisy input

ground truth

PPSurf (ours)

PPSurf Live System

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