



Skolkovo Institute of Science and Technology



NYU



*Presenting*

# ABC Geometry Reconstruction Challenge

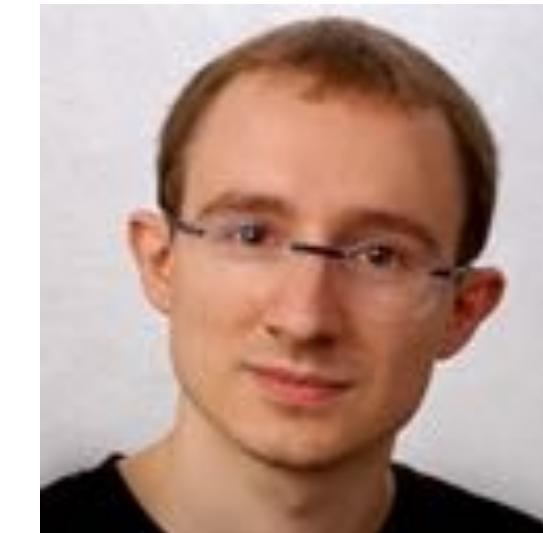
*at the*

## Deep Learning for Geometric Computing

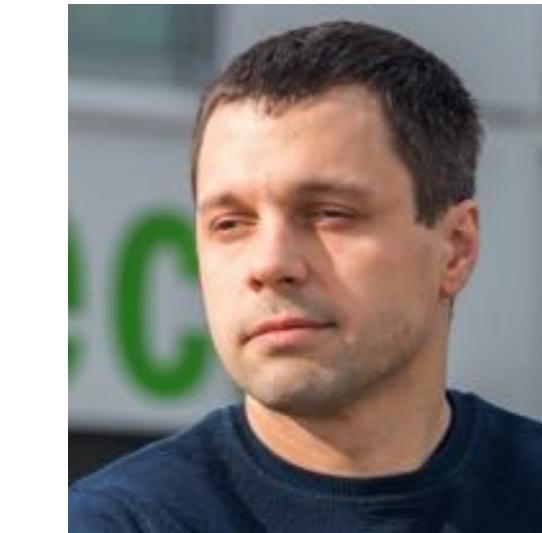
*CVPR 2020 Workshop and Challenge*



Denis Zorin



Daniele Panozzo



Evgeny Burnaev



Sebastian Koch



Alexey Artemov



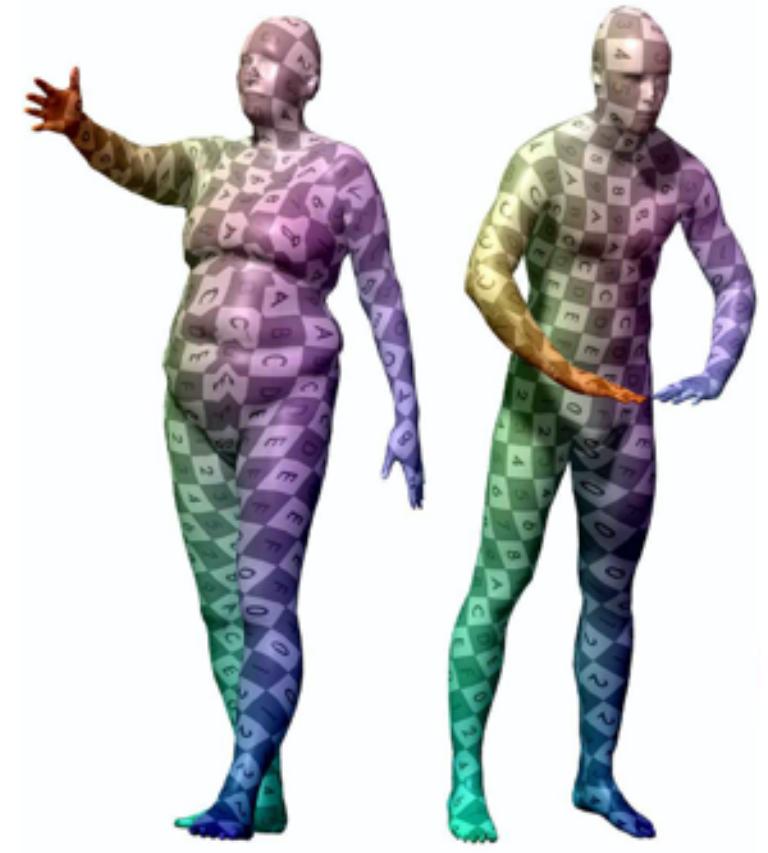
Albert Matveev

The work was supported by The Ministry of Education and Science of Russian Federation, grant No. 14.615.21.0004, grant code: RFMEFI61518X0004.  
Grant title: "Machine Learning Technologies for 3D Data Processing in Computer Vision and Remote Sensing Applications".

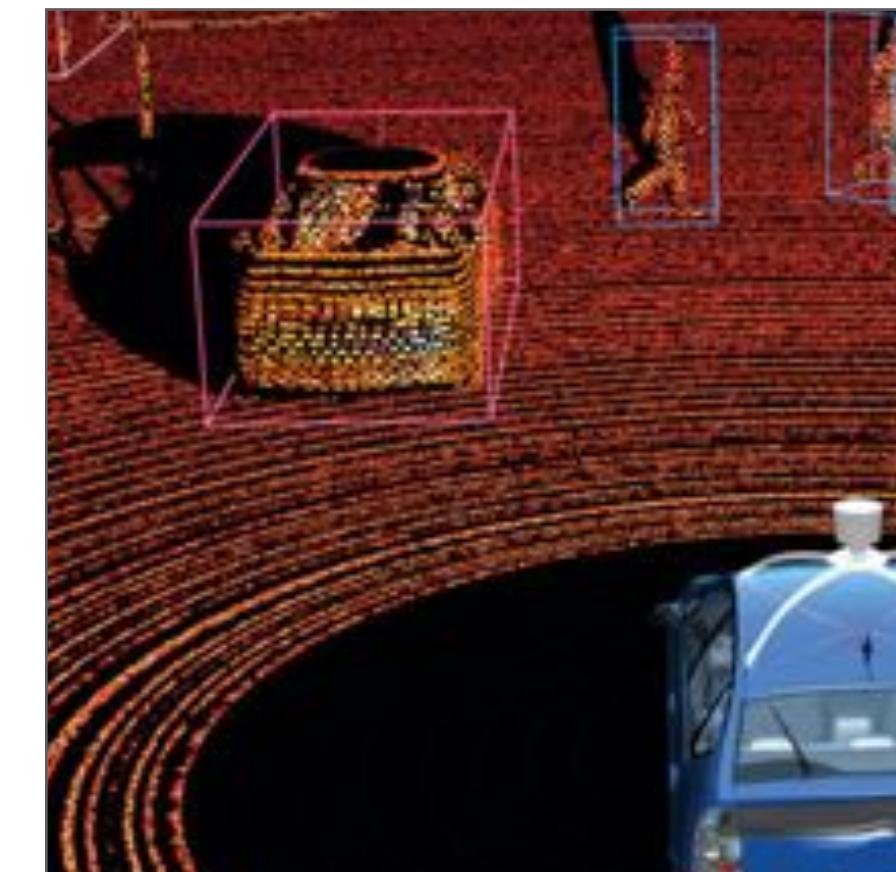
# Deep Learning      Geometric Deep Learning



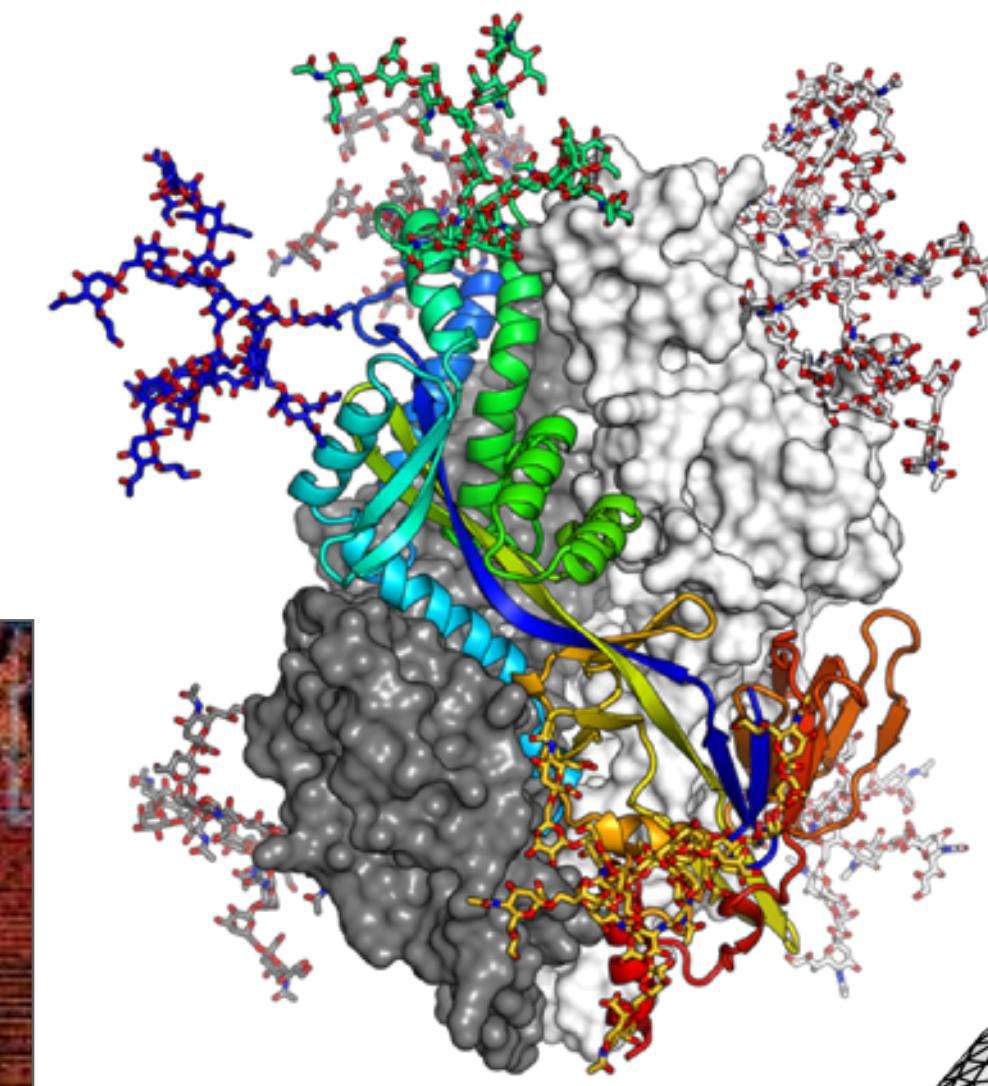
RGB images  
Video/audio



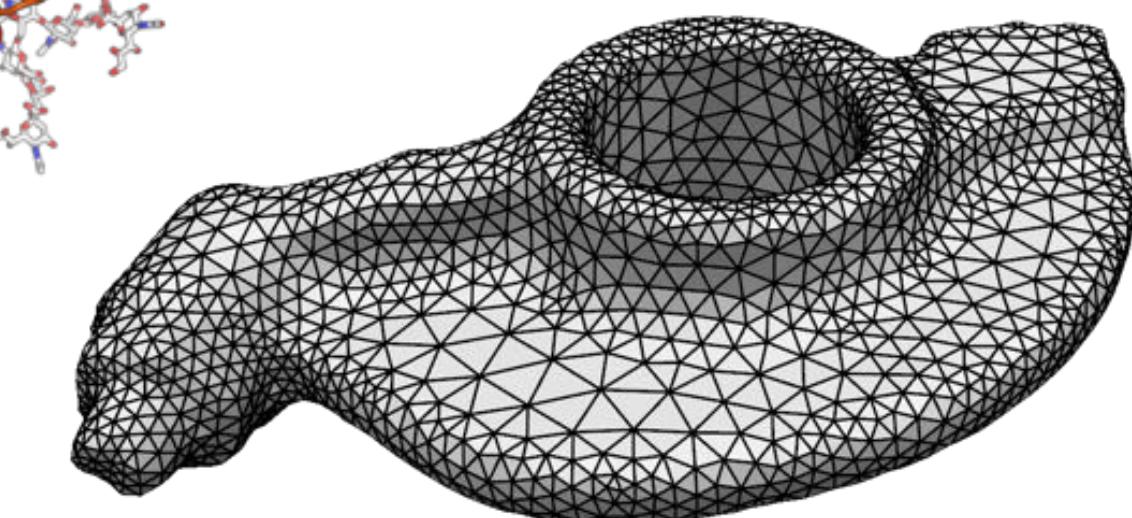
Surfaces  
& manifolds



Point sets

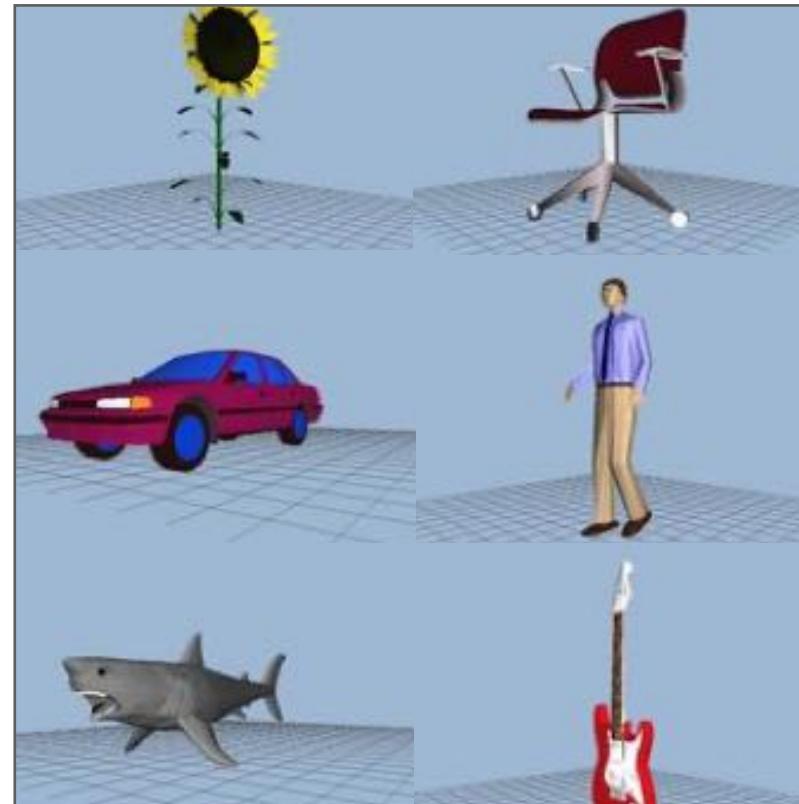


Graphs



Meshes

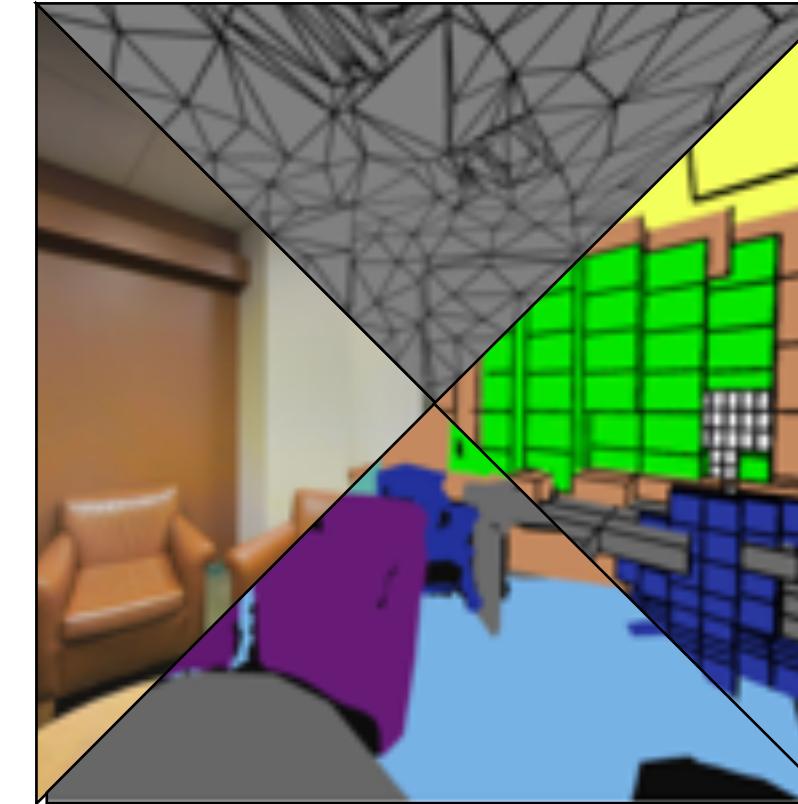
# 3D Shape Datasets



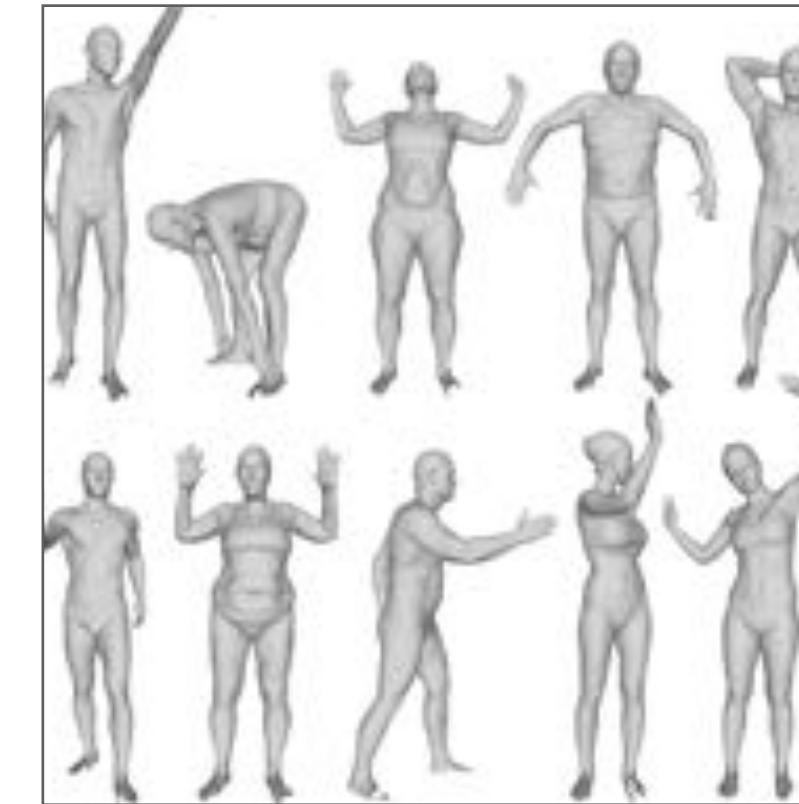
**PSB**  
(*Shilane et al., 2005*)



**ModelNet**  
(*Wu et al., 2015*)



**J2D3DS**  
(*Armeni et al., 2017*)



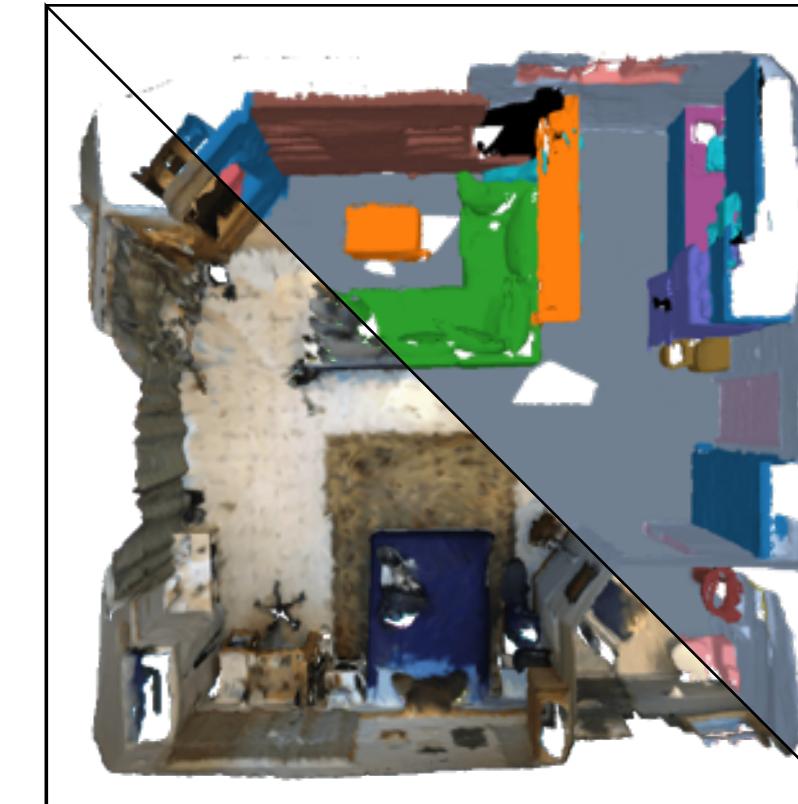
**FAUST**  
(*Bogo et al., 2014*)



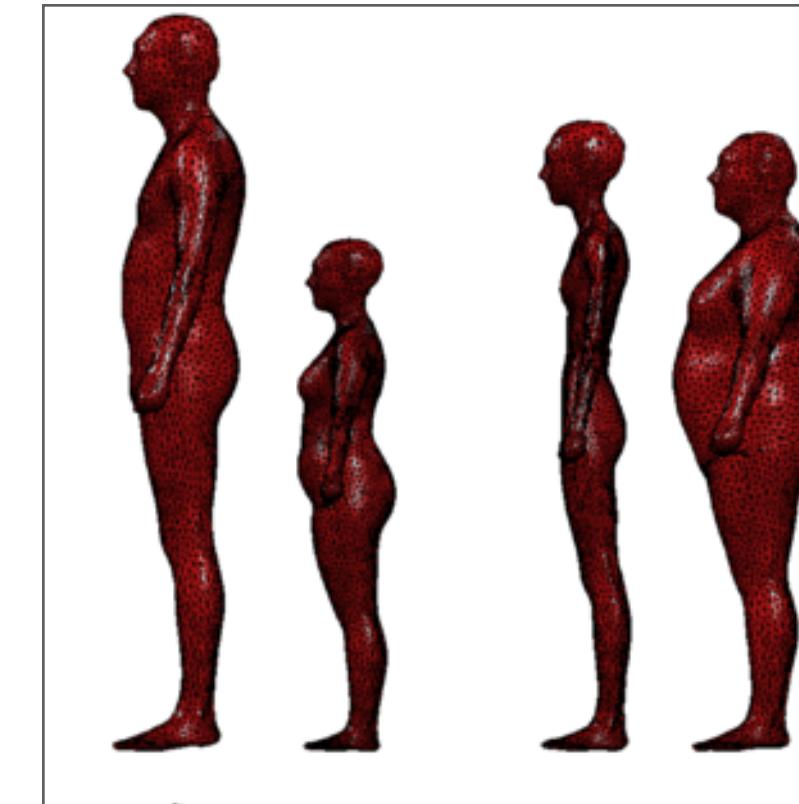
**ShapeNet**  
(*Chang et al., 2016*)



**Thingi10K**  
(*Zhou et al., 2016*)

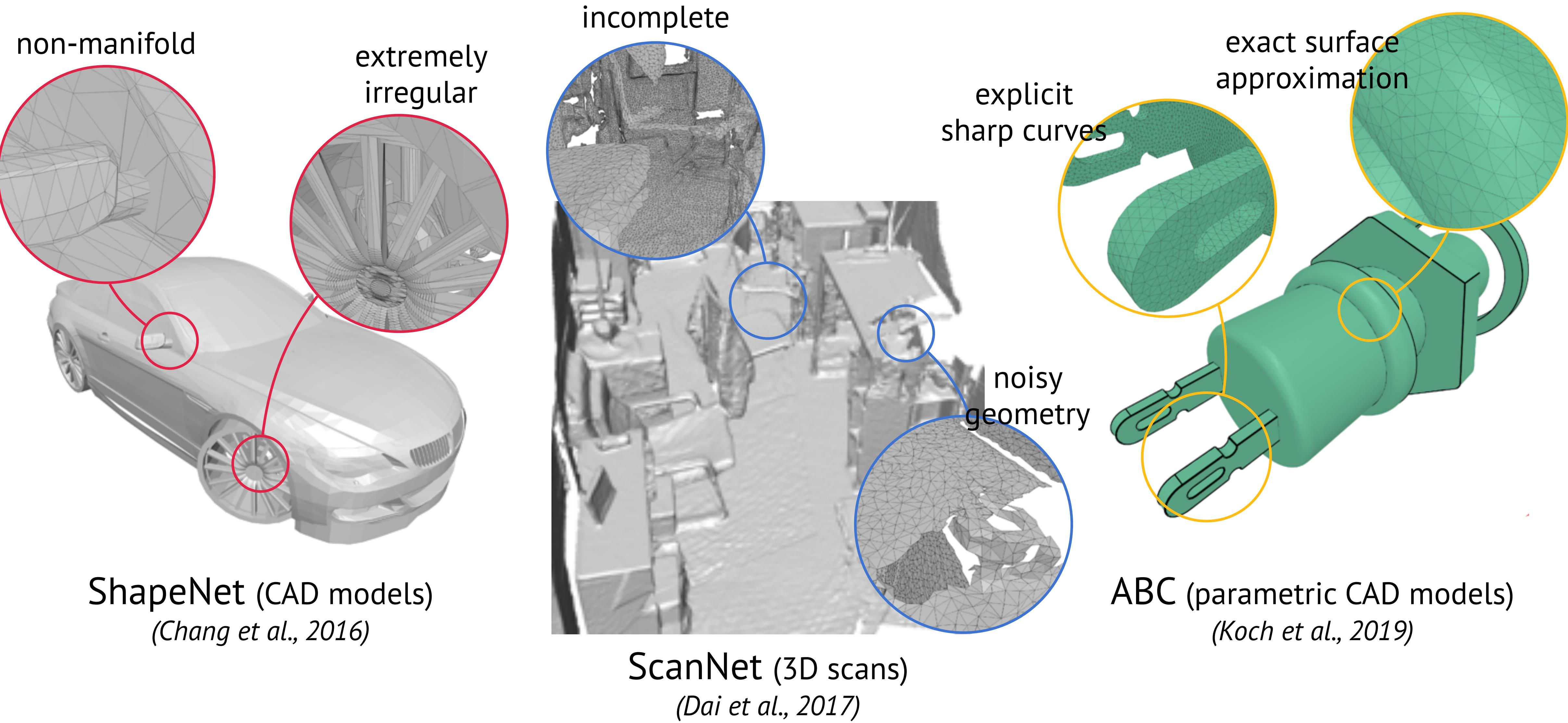


**ScanNet**  
(*Dai et al., 2017*)



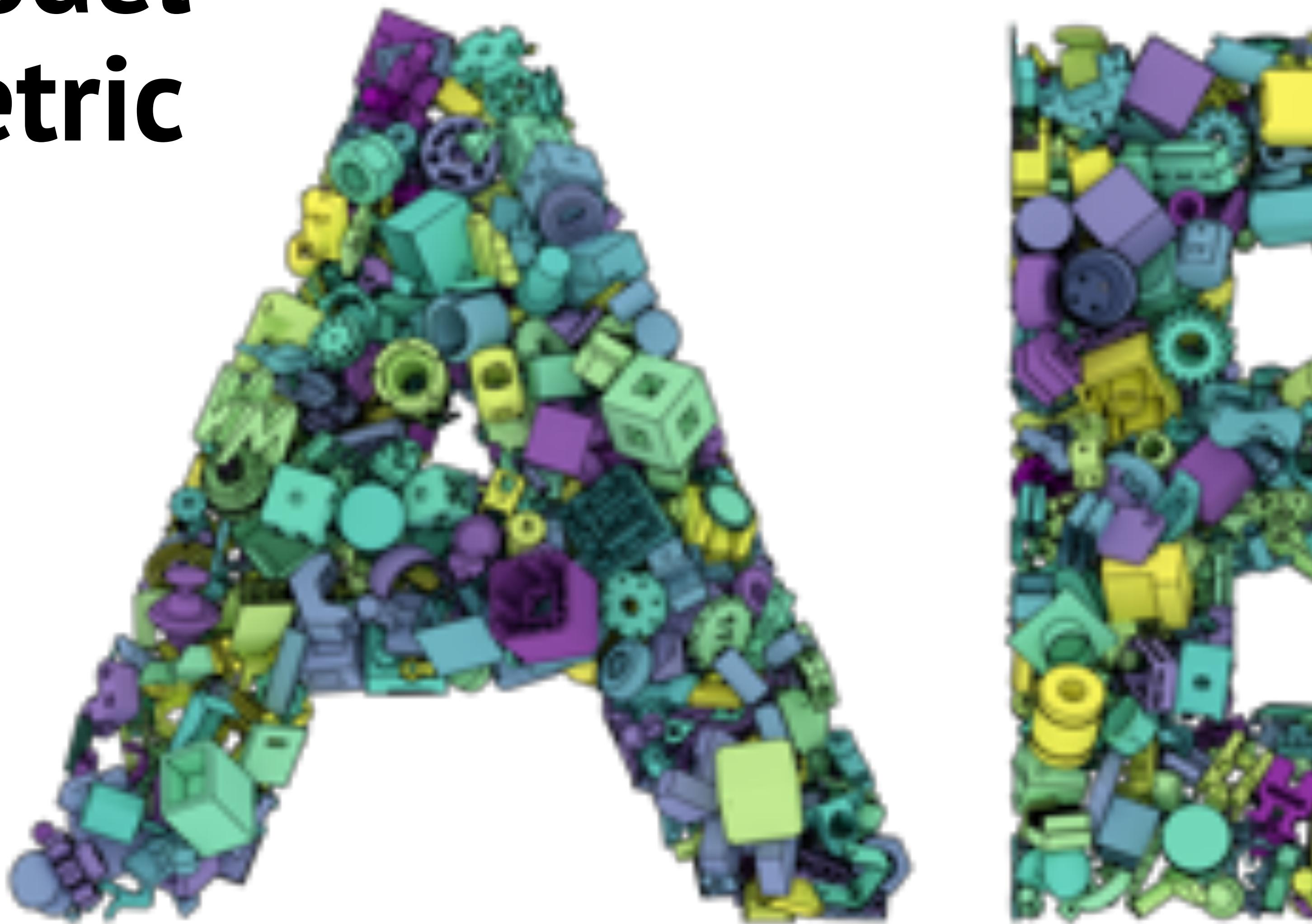
**MPII HS**  
(*Pishchulin et al., 2017*)

# Irregular 3D modalities



# ABC: A Big CAD Model Dataset for Geometric Deep Learning

(Koch et al., CVPR 2019)





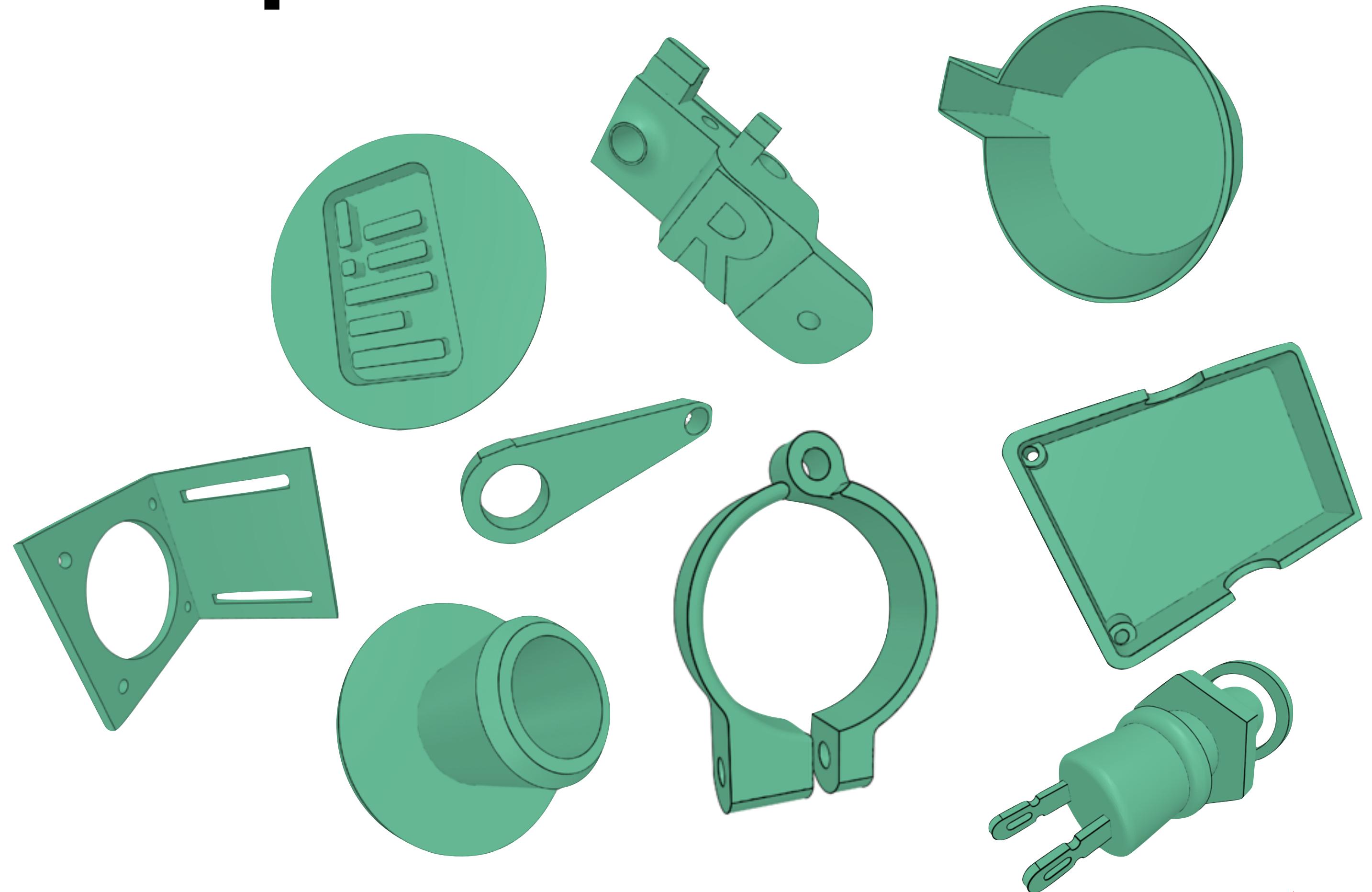
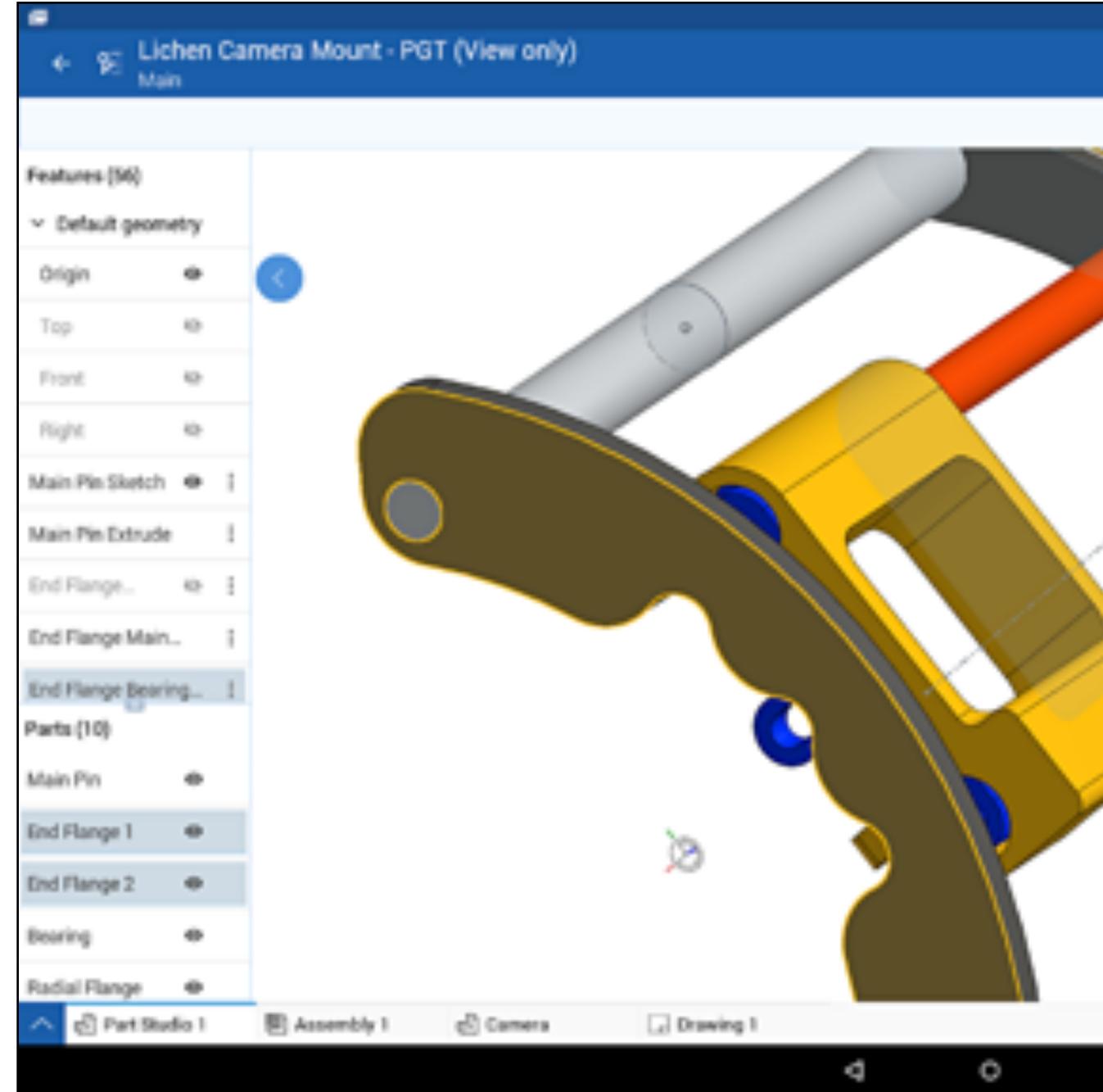
## Features:

- 1,000,000 *parametric* 3D CAD models
- Accurate geometric ground truth
  - patch decomposition
  - sharp feature lines
  - analytic differential properties

## Applications:

- Resampling at arbitrary resolutions
- Support connectivity, point-set, and parametric representations

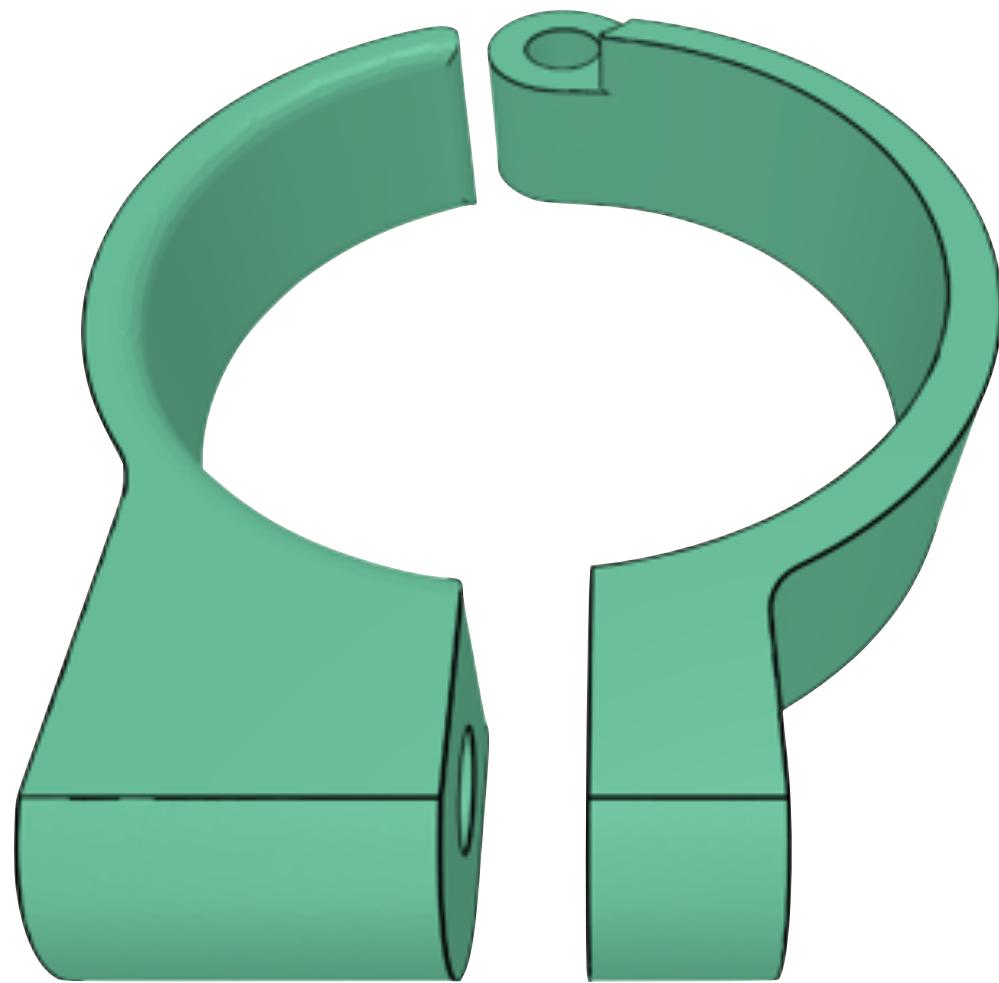
# Data Acquisition



**Onshape**

Boundary representation  
(STEP/Parasolid) models

# CAD Data Processing



Parametric  
representation



Meshering  
& discretization



Extracting  
annotation

.STL



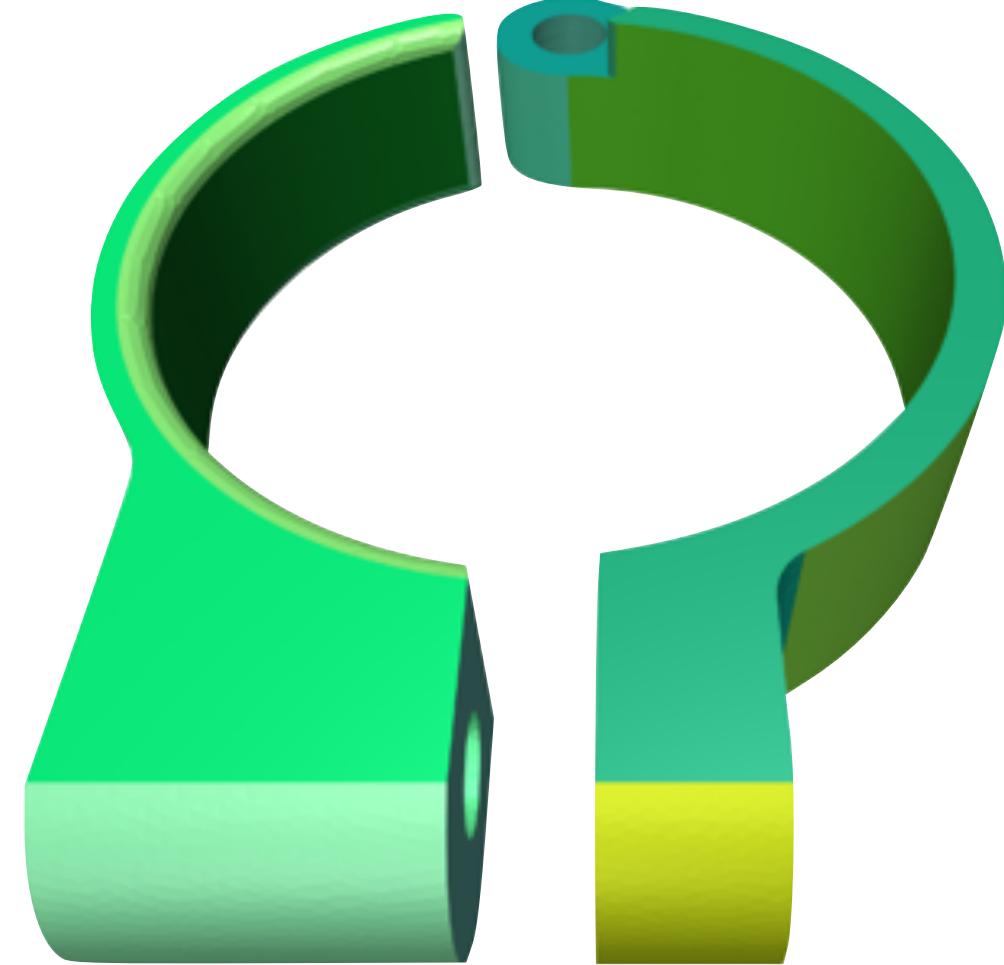
.STEP



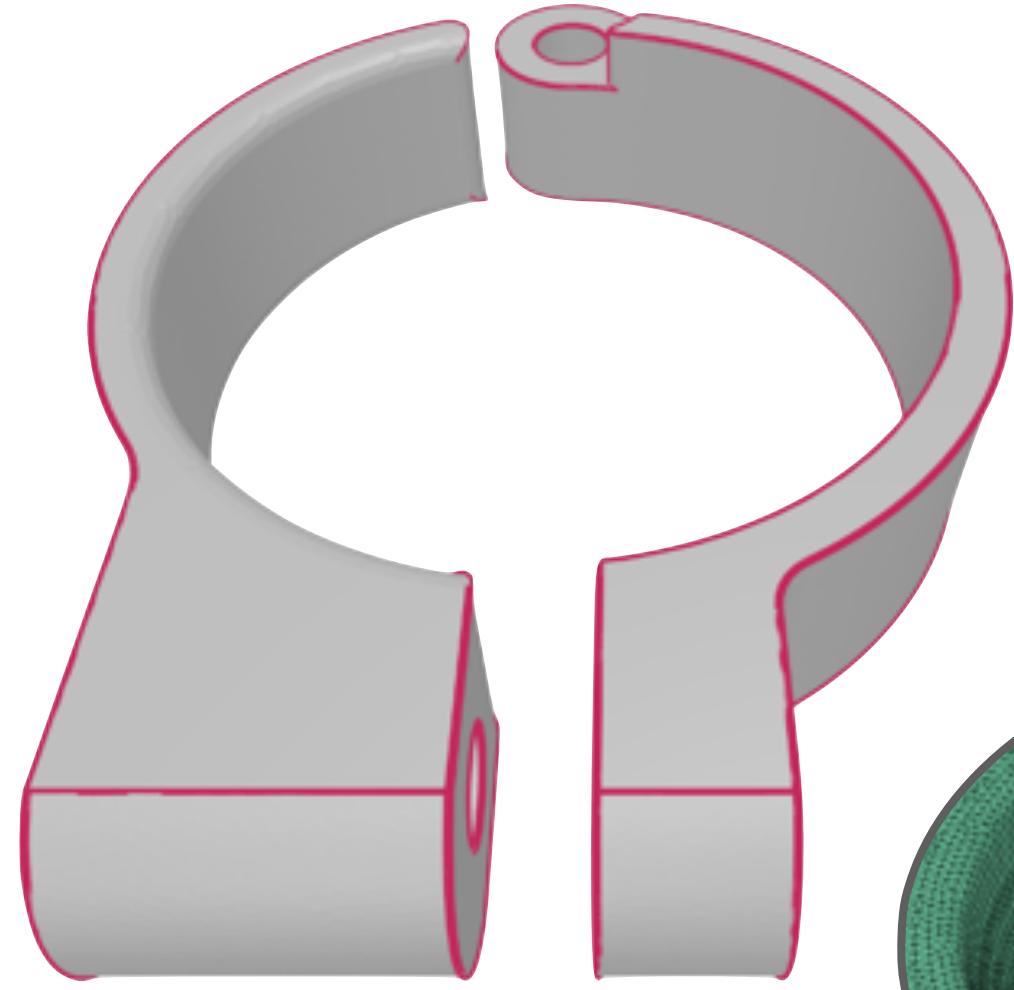
Released  
in common  
file formats

YAML

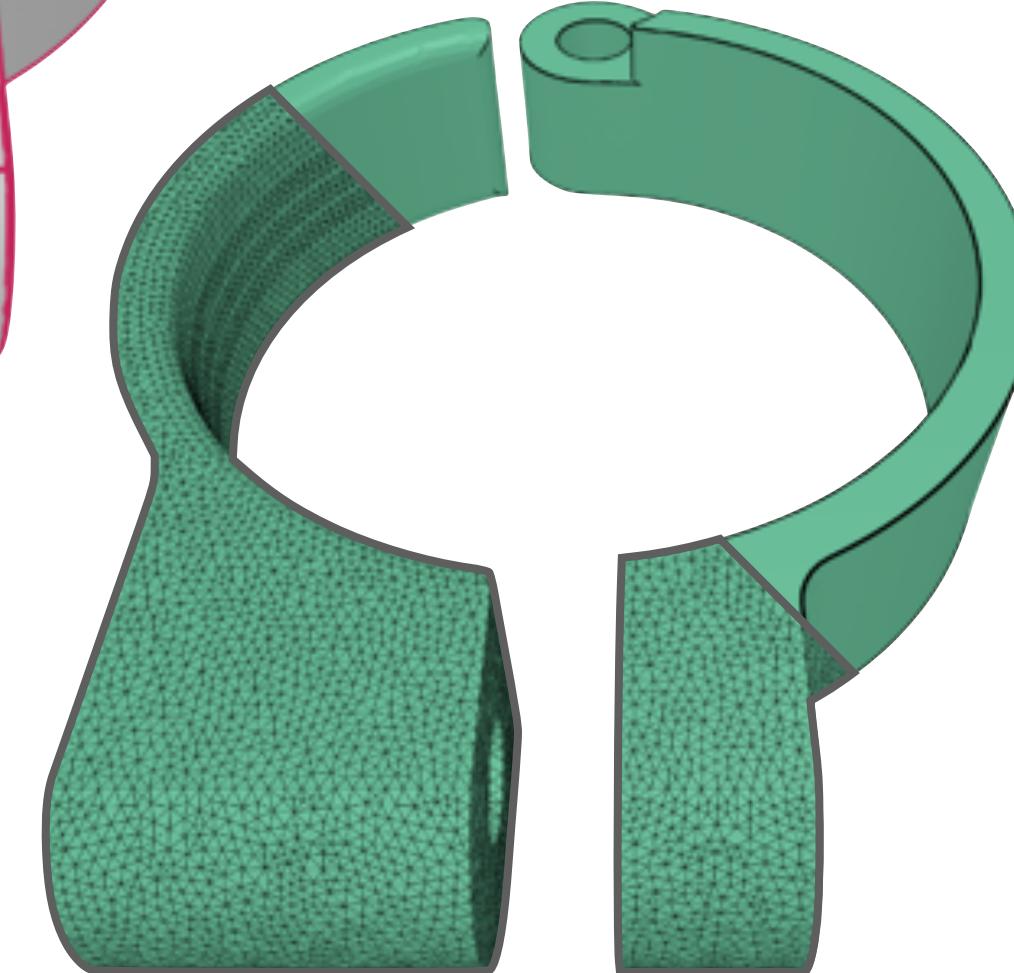
# Supported Applications



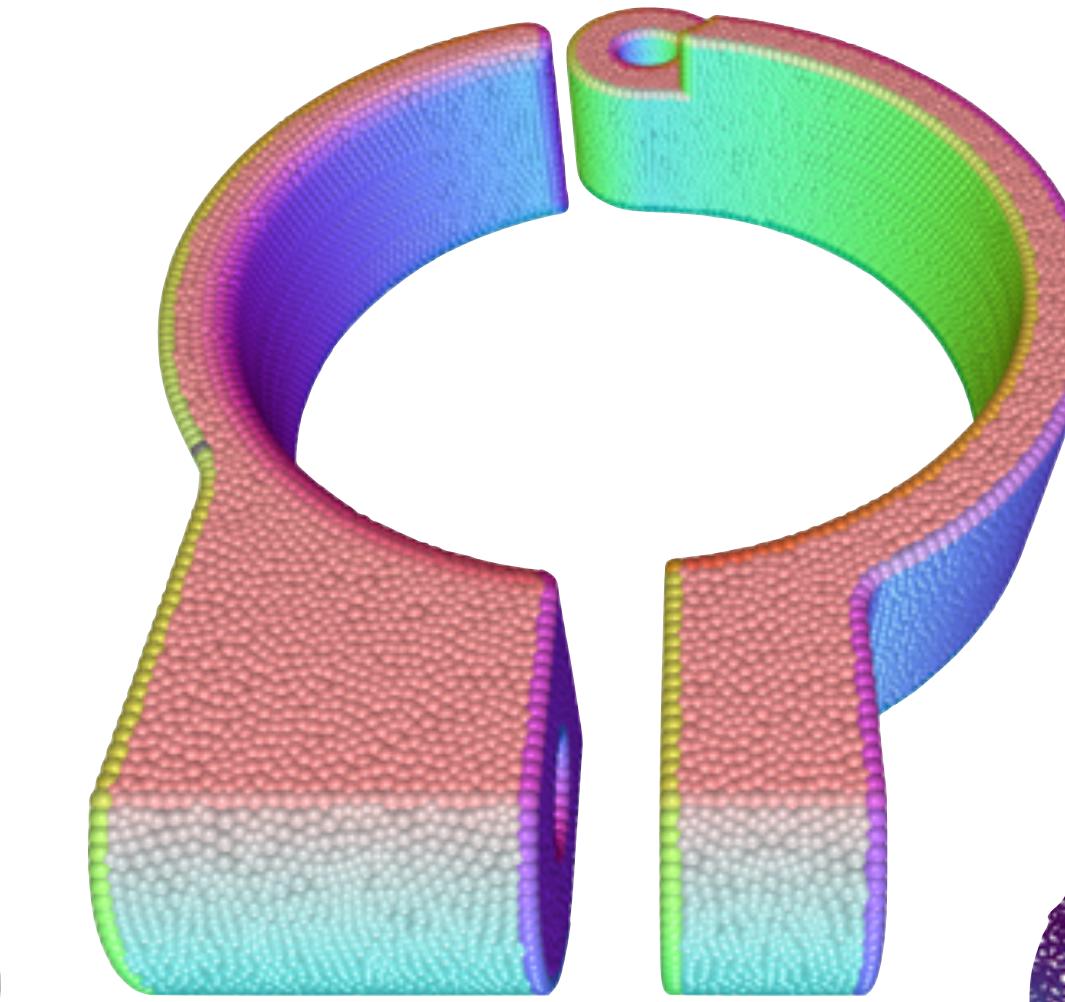
Patch decomposition



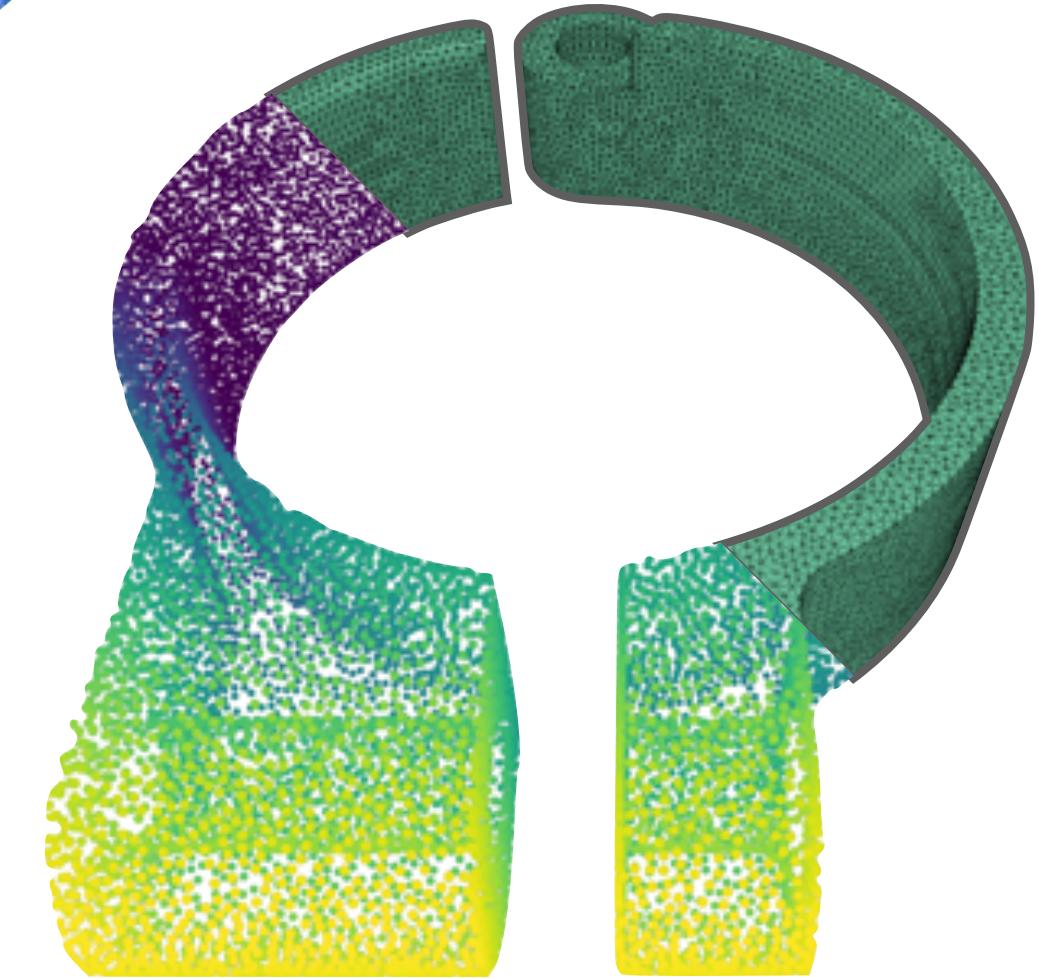
Sharp feature detection



Surface vectorization

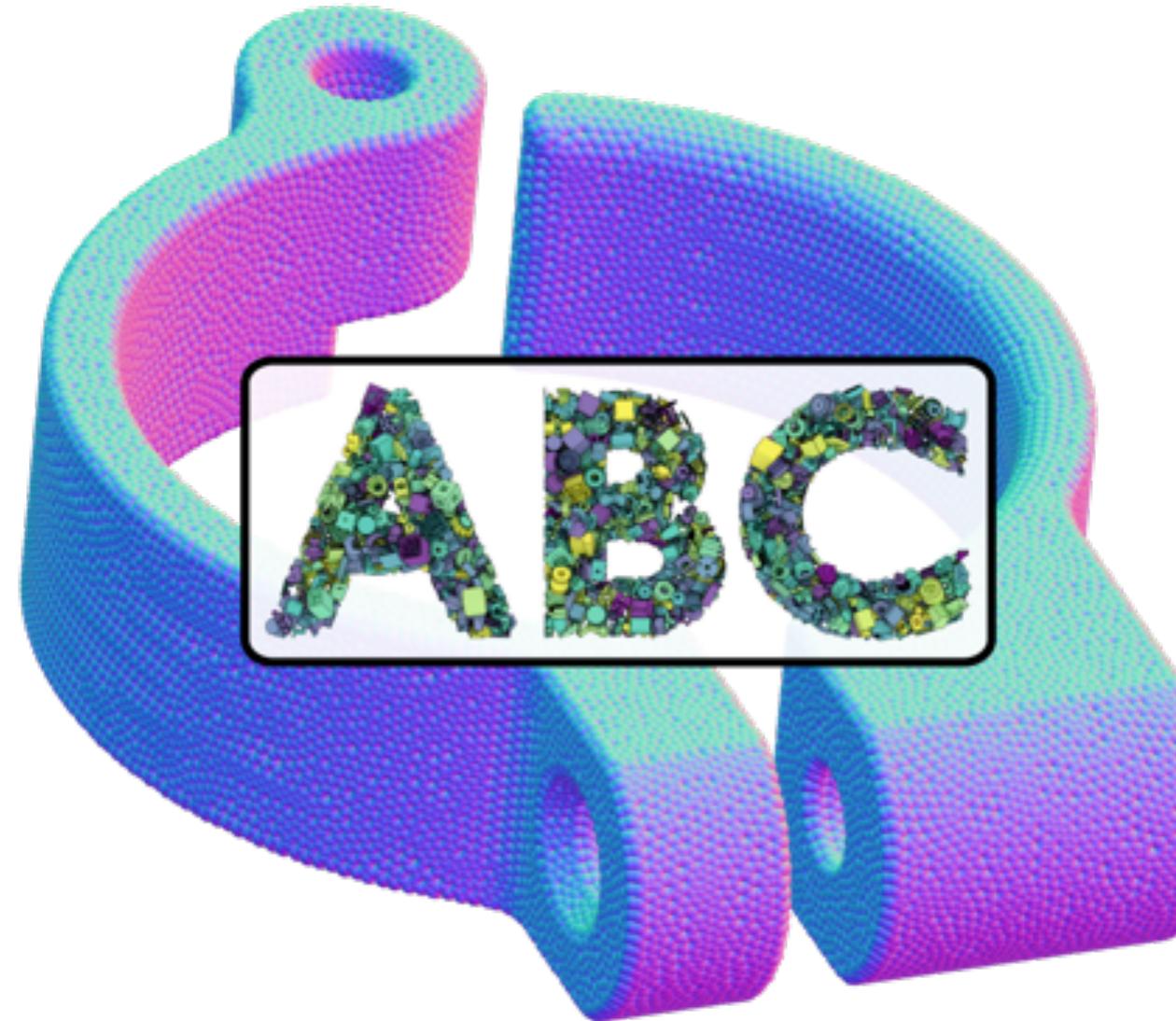


Differential quantities

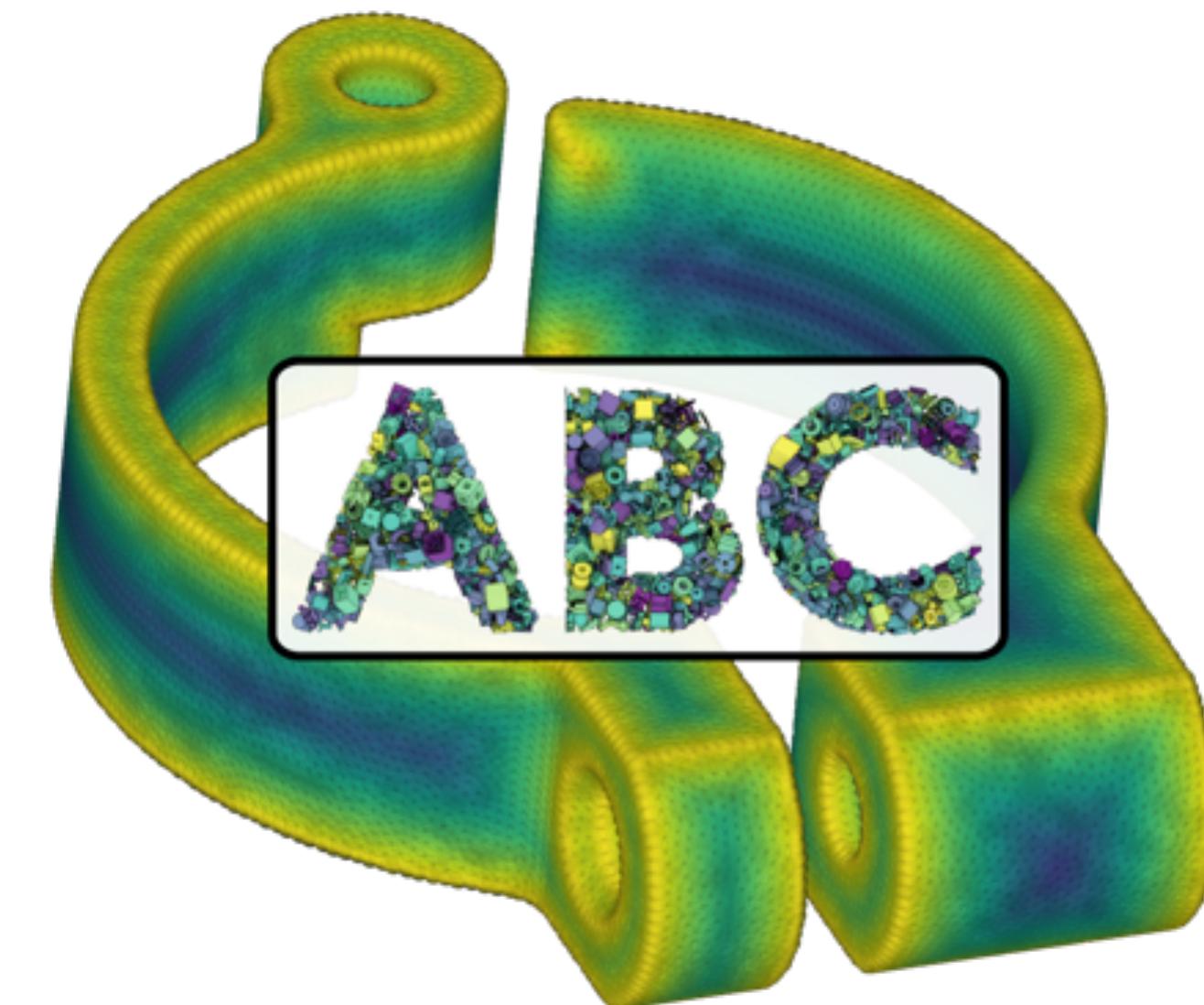


Shape reconstruction

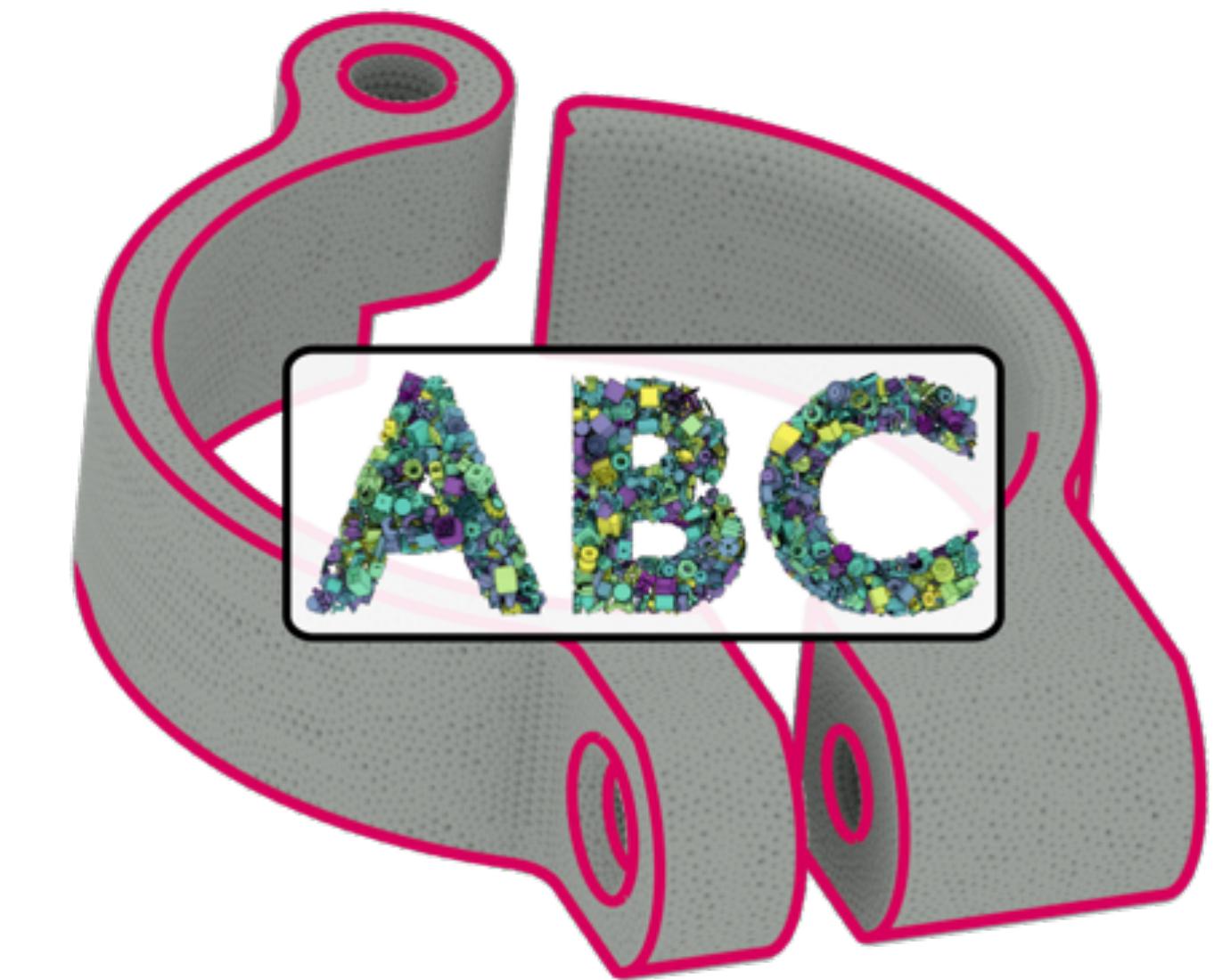
# ABC Geometry Reconstruction Challenges



Surface Normal Estimation



Sharpness Fields Extraction



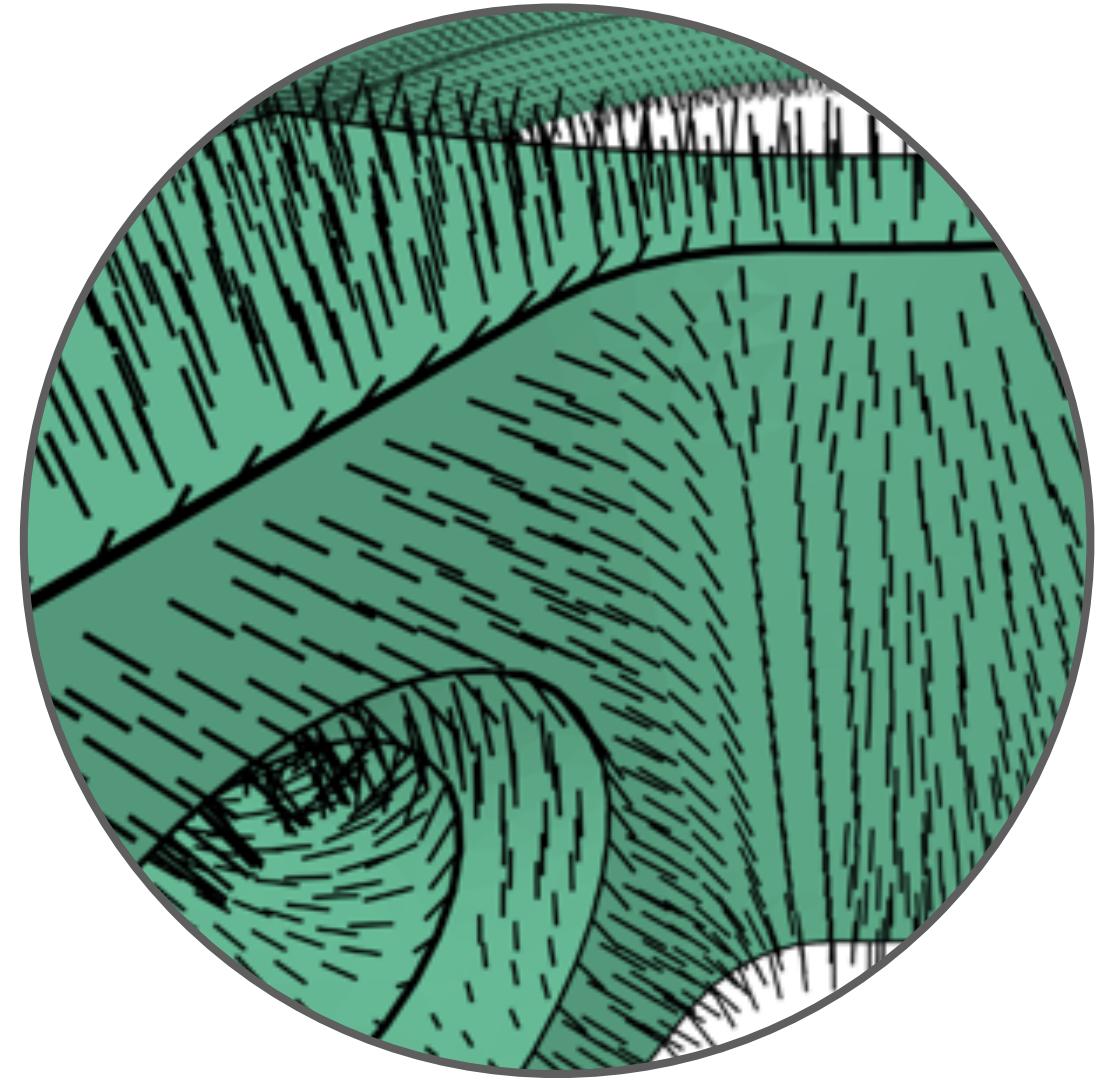
Geometric Shape Segmentation

# **Surface Normal Estimation**

# Surface Normal Estimation Dataset



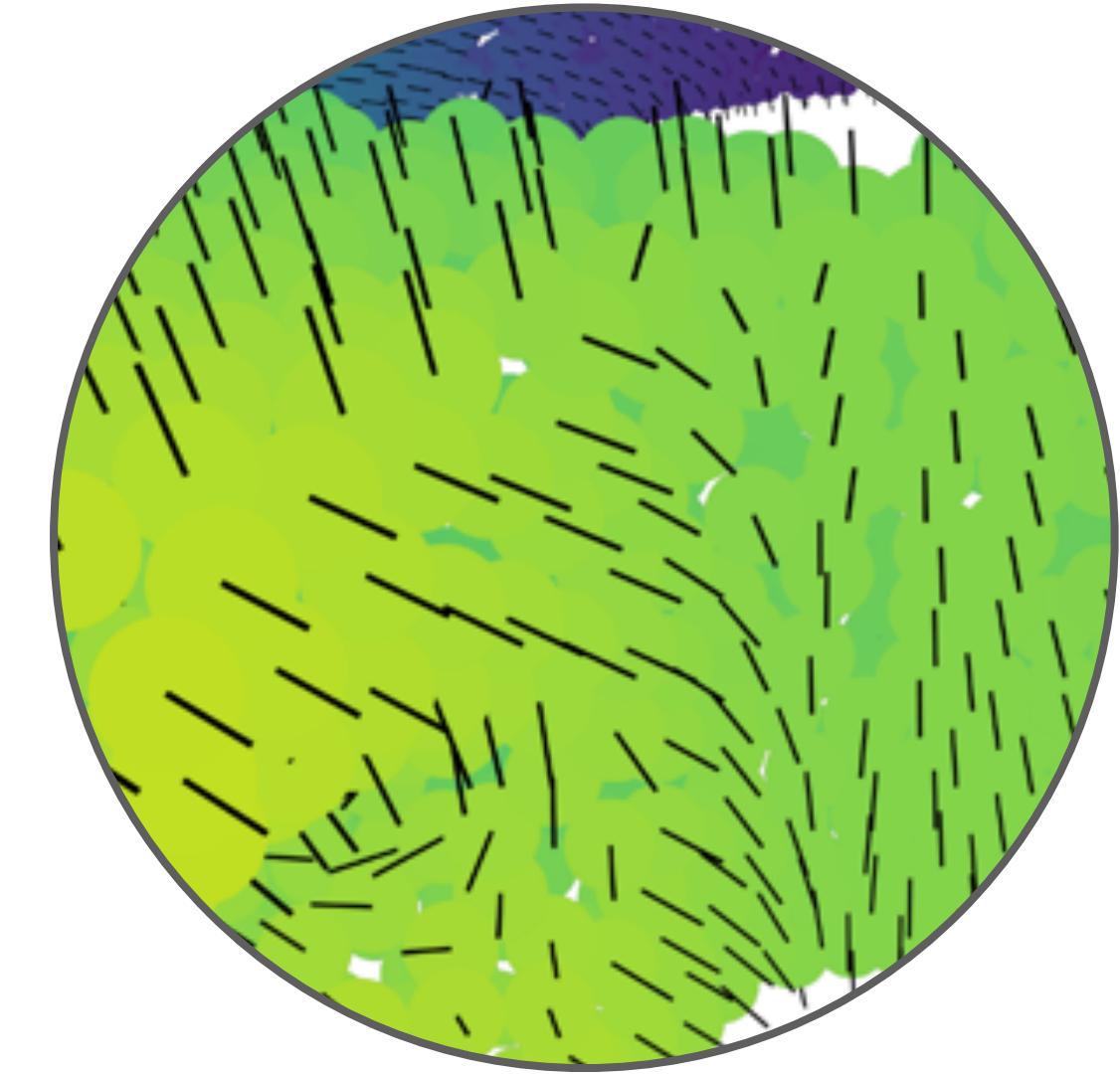
3D shape



Analytic (vector)  
normals



Point sampling



Annotated data  
instances

# Surface Normal Estimation Dataset



3D shape

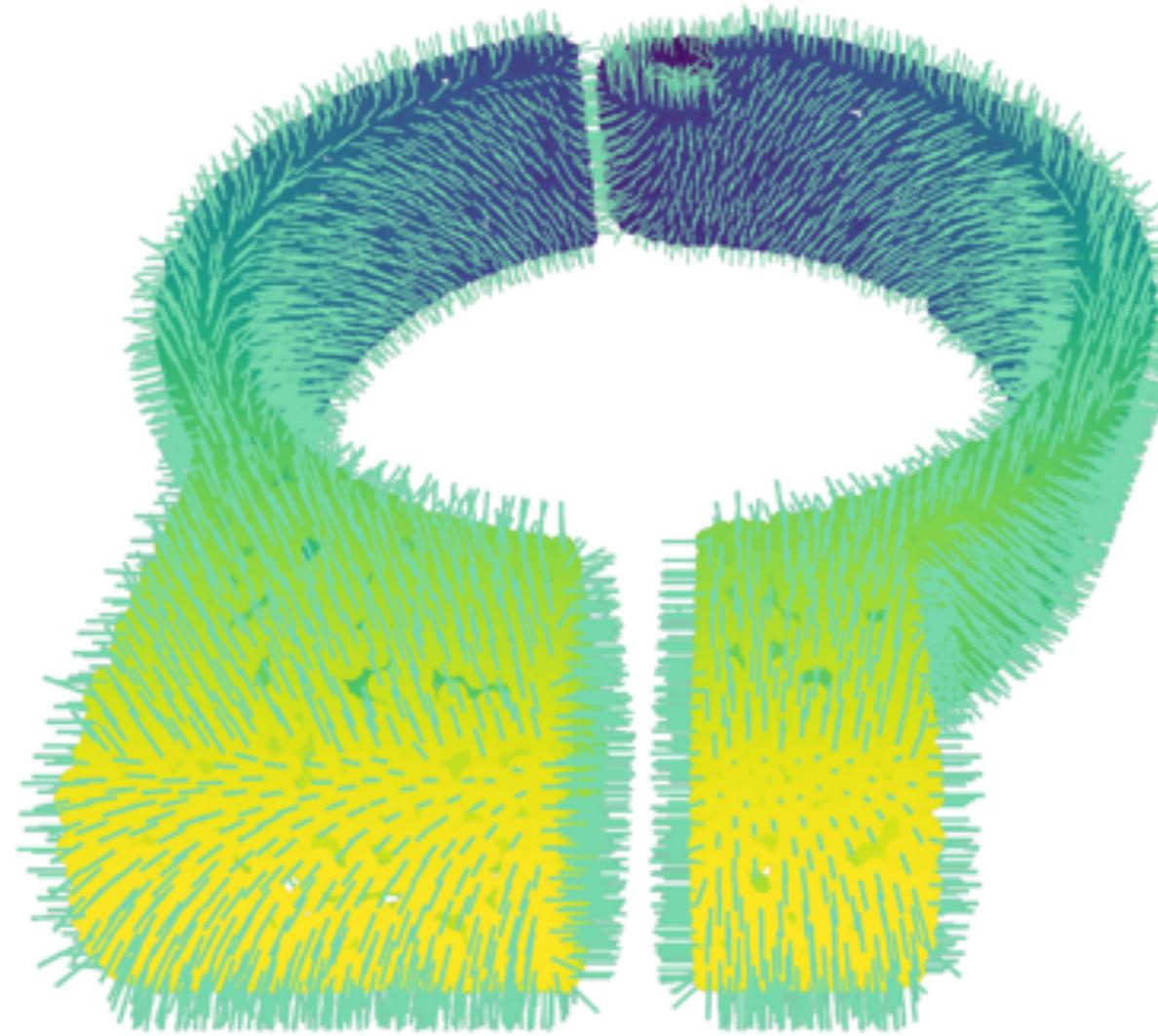


100K  $\times$  1K points

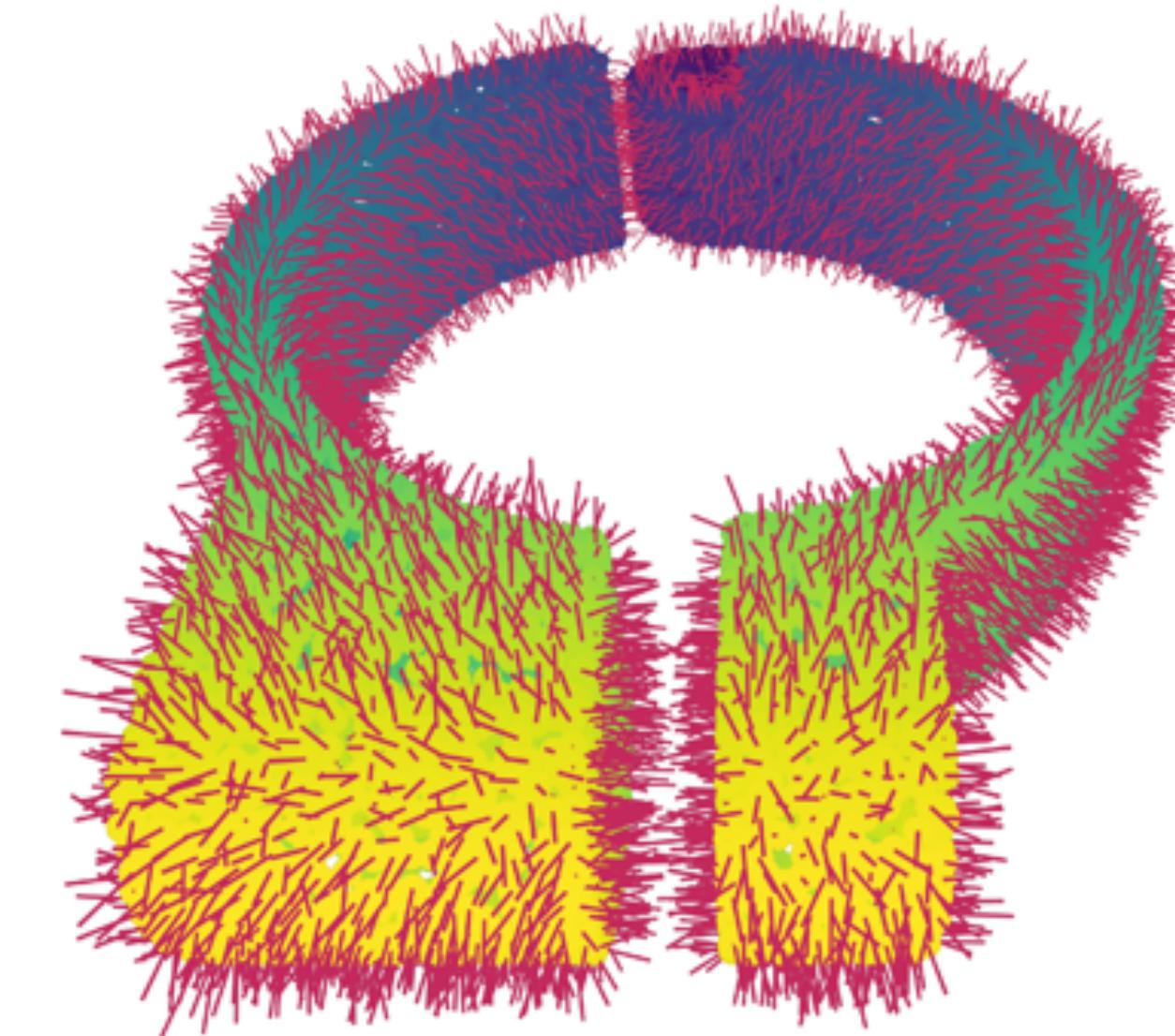
50K  $\times$  5K points

25K  $\times$  10K points

# Surface Normal Estimation Evaluation



Ground truth



Predicted

- Score using mean orientation similarity:  $(\mathbf{n} \cdot \mathbf{e})^2$
- Non-oriented normals

- Average over dataset
- *No-edge* and *All* evaluation modes

# Join the Challenge!

- Now live! Follow the links to join
- Phase 1 ends: November 30<sup>th</sup>, 2020, 23:59
- Phase 2 ends: December 31<sup>st</sup>, 2020, 23:59
- Prizes coming!

The screenshot shows the CodaLab competition interface for the "ABC: Surface Normal Estimation - CVPR 2020" challenge. The page includes a navigation bar with "Search Competitions", "My Competitions", "Help", "Sign Up", and "Sign In". The main content area displays the competition details: "ABC: Surface Normal Estimation - CVPR 2020", organized by skoch9, current server time June 13, 2020, 8:16 p.m. UTC. It shows two phases: "First phase" (Development, April 6, 2020, midnight UTC) and "End" (June 7, 2020, 11:59 p.m. UTC). Below the phases are tabs for "Learn the Details" (selected), "Phases", "Participate", "Results", and "Forums". The "Overview" tab is active, providing a brief description of the challenge: participants estimate unoriented surface normals for point clouds from CAD models. The "Evaluation" and "Terms and Conditions" tabs are also present. A section for "ABC Geometry Challenge: Surface Normal Estimation" provides a detailed description of the task, mentioning point cloud densities (1k, 5k, 10k points) and normal length requirements (1-3 unit length normals). It also links to other challenges and a workshop paper: <https://sites.google.com/view/dlgc-workshop-cvpr2020/home>. A code snippet for the paper reference is shown: 

```
@InProceedings{Koch_2019_CVPR,  
author = {Koch, Sebastian and Matveev, Albert and Jiang, Zhongshi and Williams, Francis and Artyomov, Alexey and Burnaev, Evgeny and Alexa, Marc and Zorin, Denis and Panozzo, Daniele},  
title = {ABC: A Big CAD Model Dataset For Geometric Deep Learning},  
booktitle = {The IEEE Conference on Computer Vision and Pattern Recognition (CVPR)},  
month = {June},  
year = {2019}}.
```

 At the bottom, there is a chart showing "High Score" and "Total Daily Submissions" over time, with a red line indicating the high score peaking around 1.2.

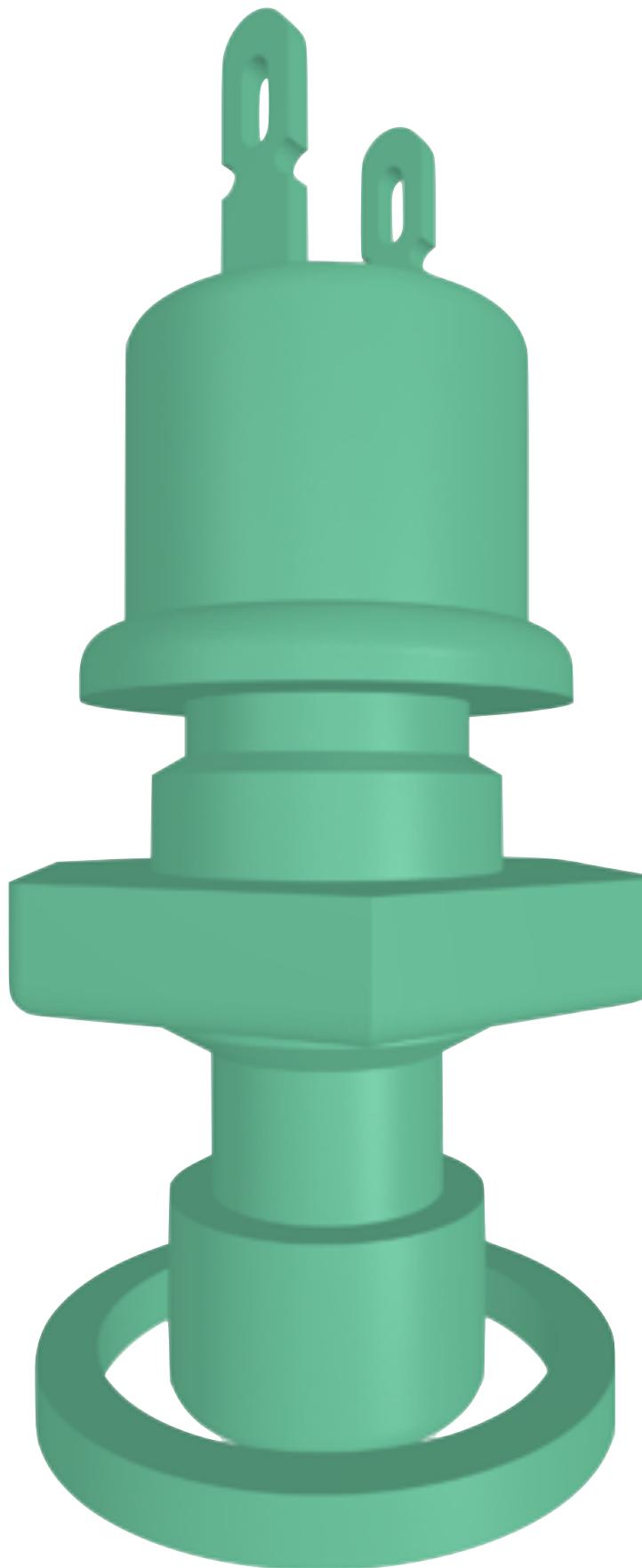
[adase.group/3ddl/abc-normals-challenge](https://adase.group/3ddl/abc-normals-challenge)

<https://competitions.codalab.org/competitions/24253>

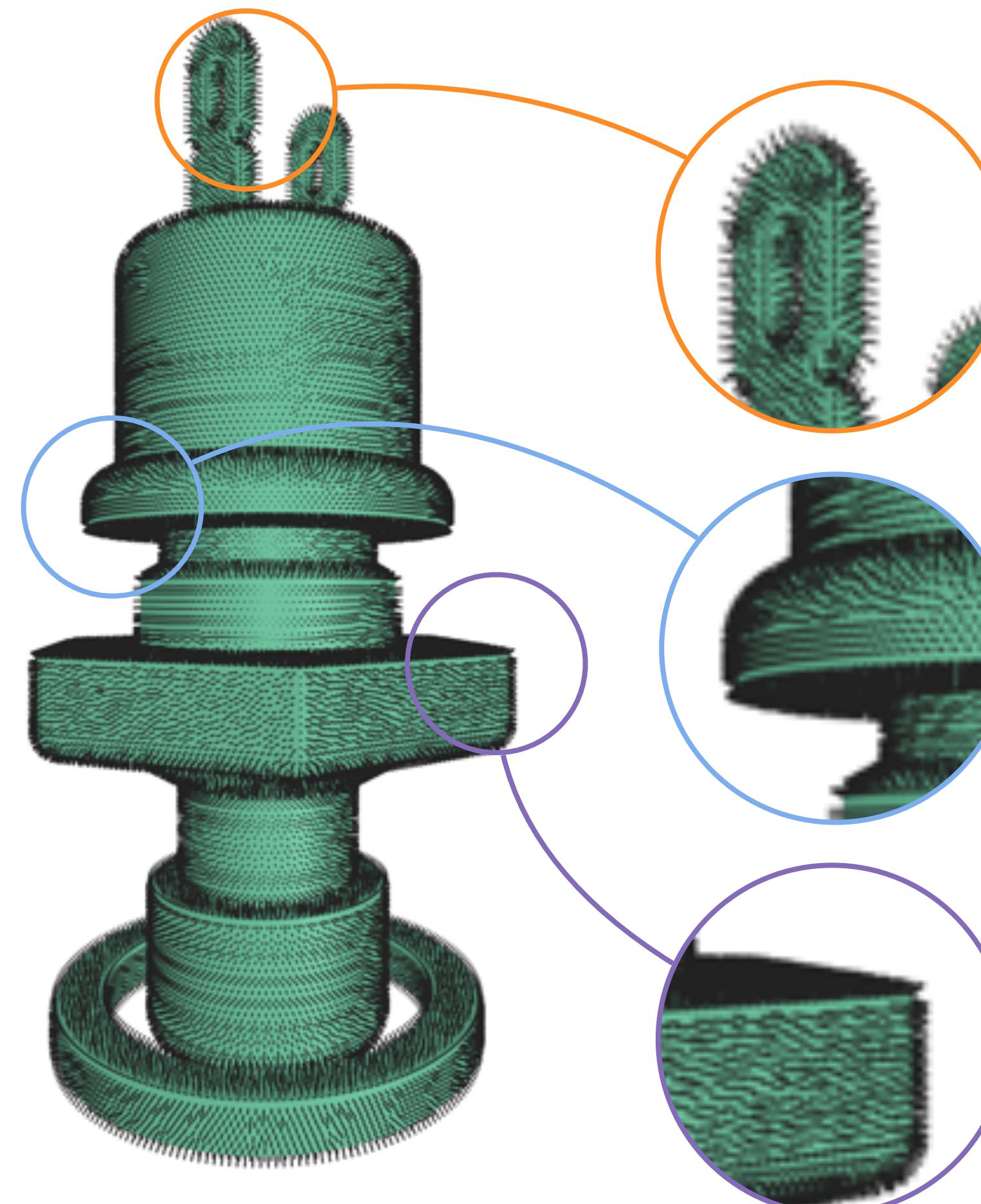
# **Sharpness Fields Extraction**

# **Geometric Shape Segmentation**

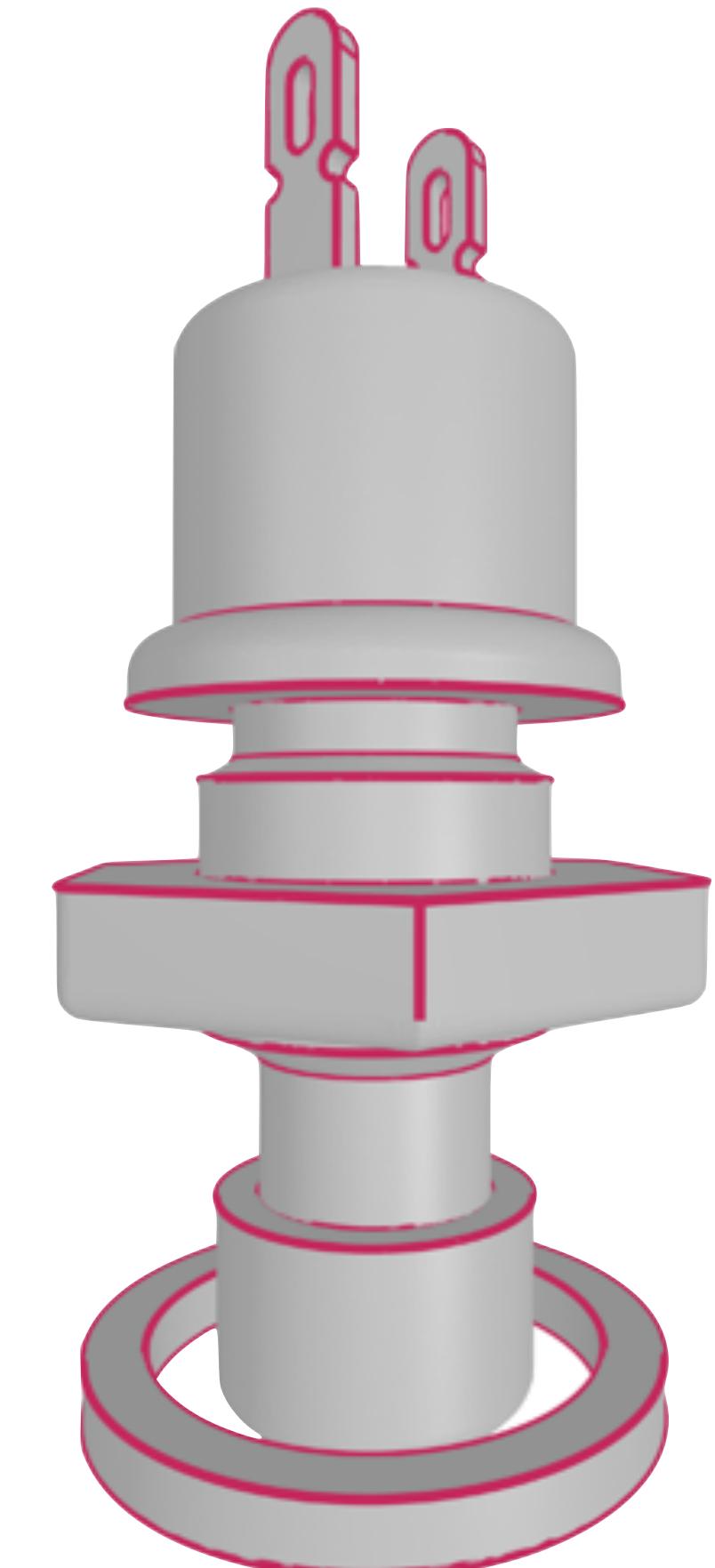
# Sharp Features: Fields and Segments



CAD model

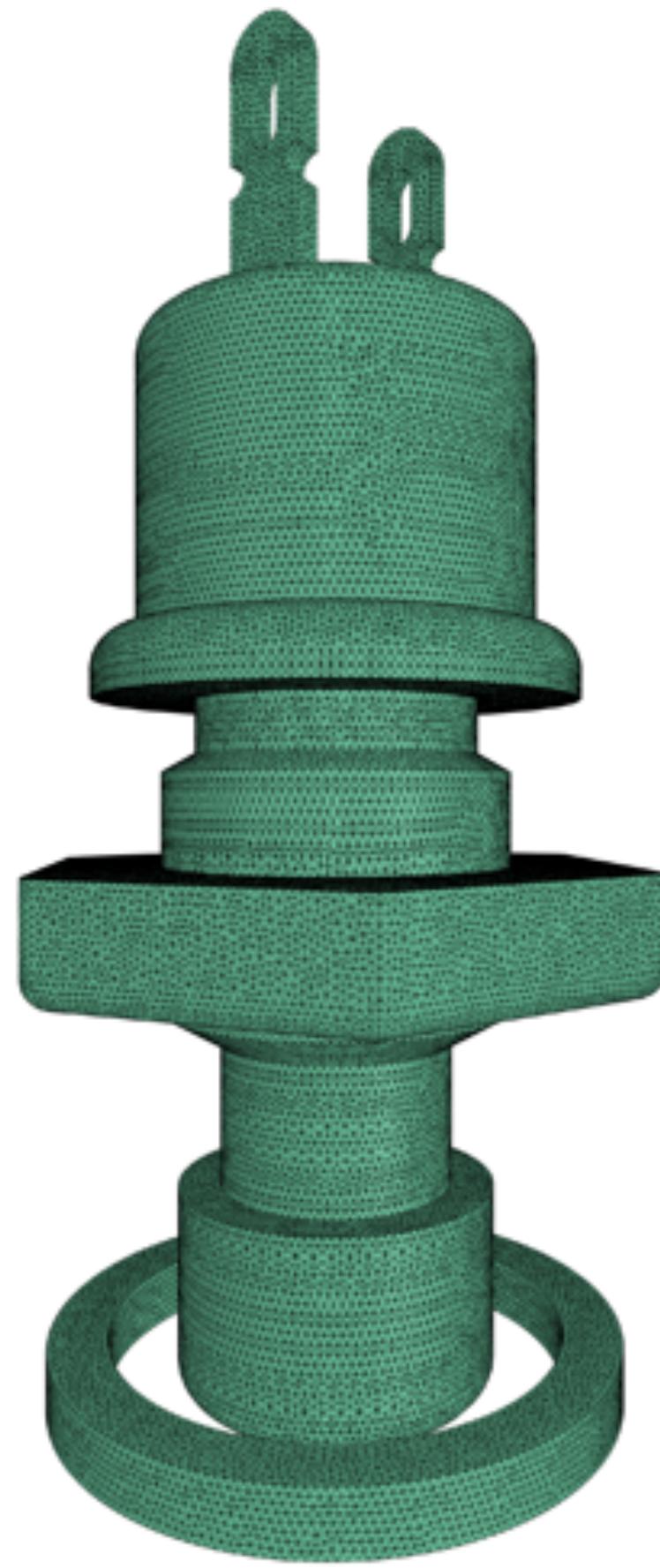


Rapid change in normals

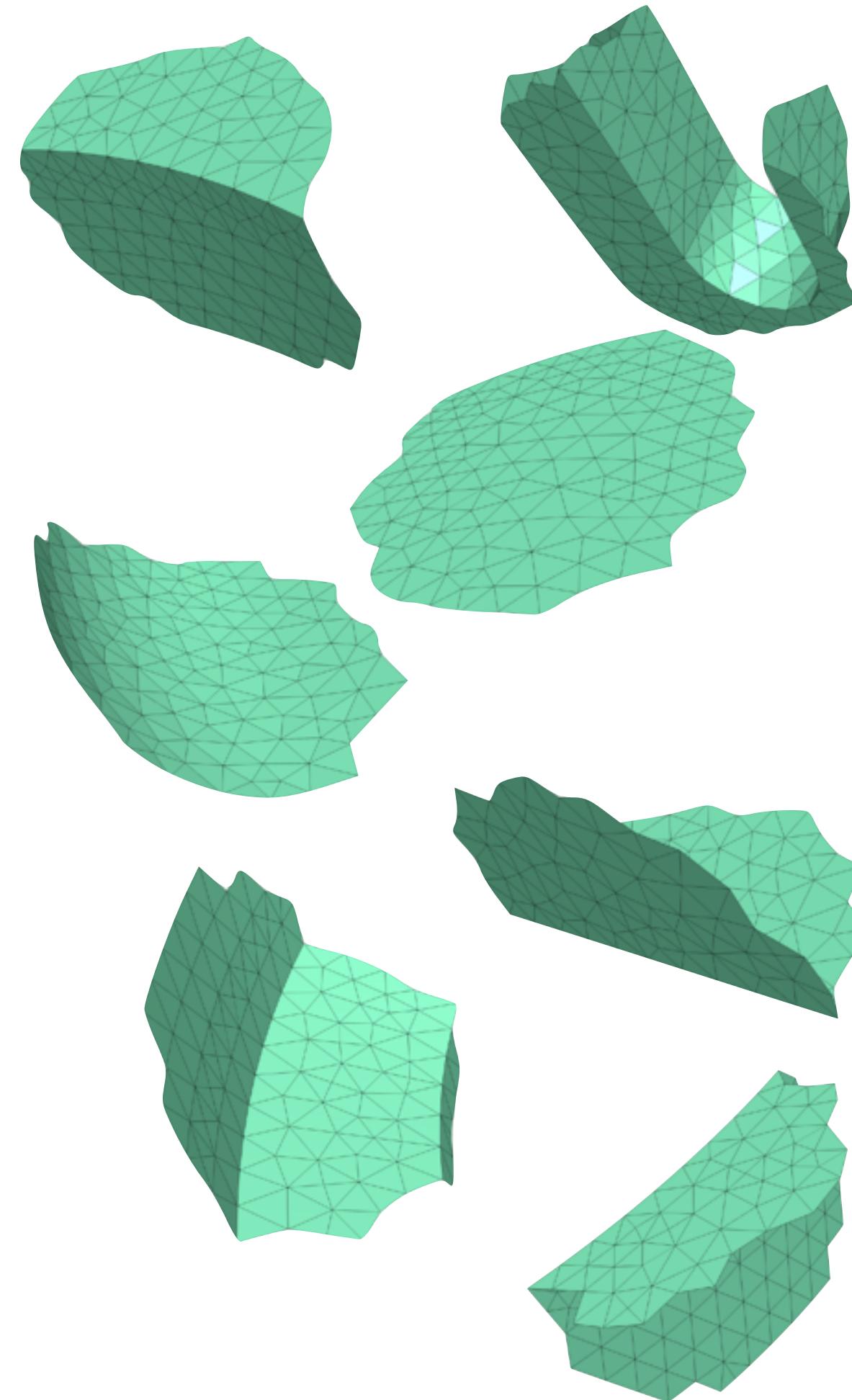


Sharp feature lines

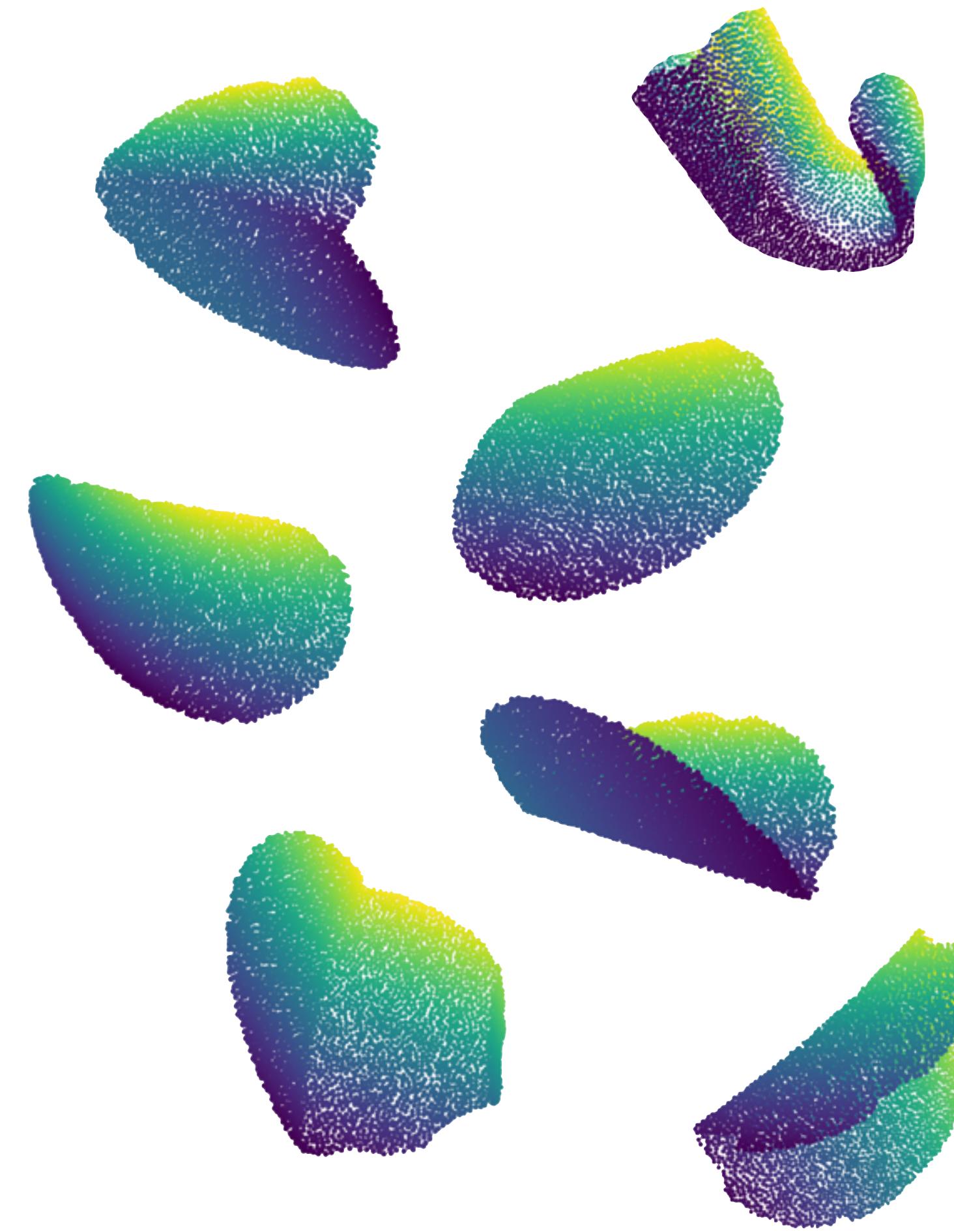
# Sharp Features Datasets



CAD model

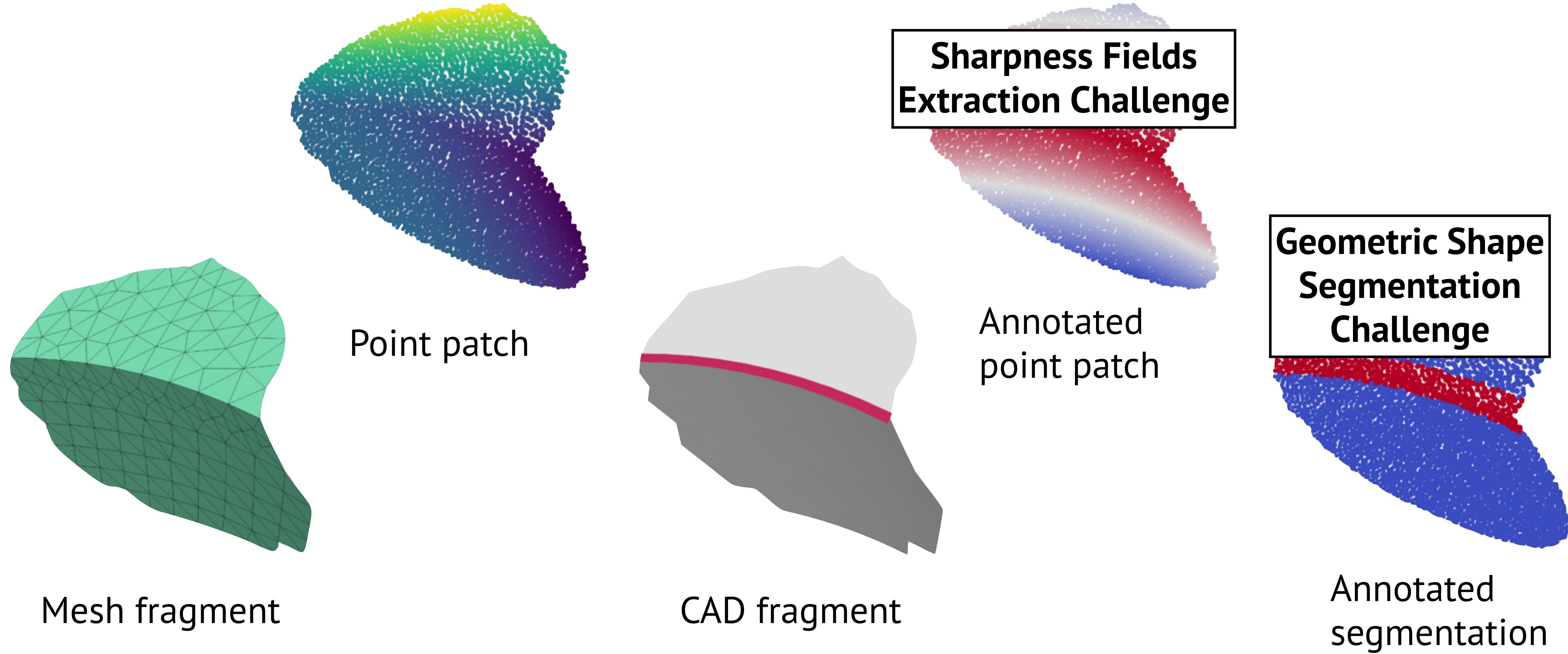


Mesh fragments

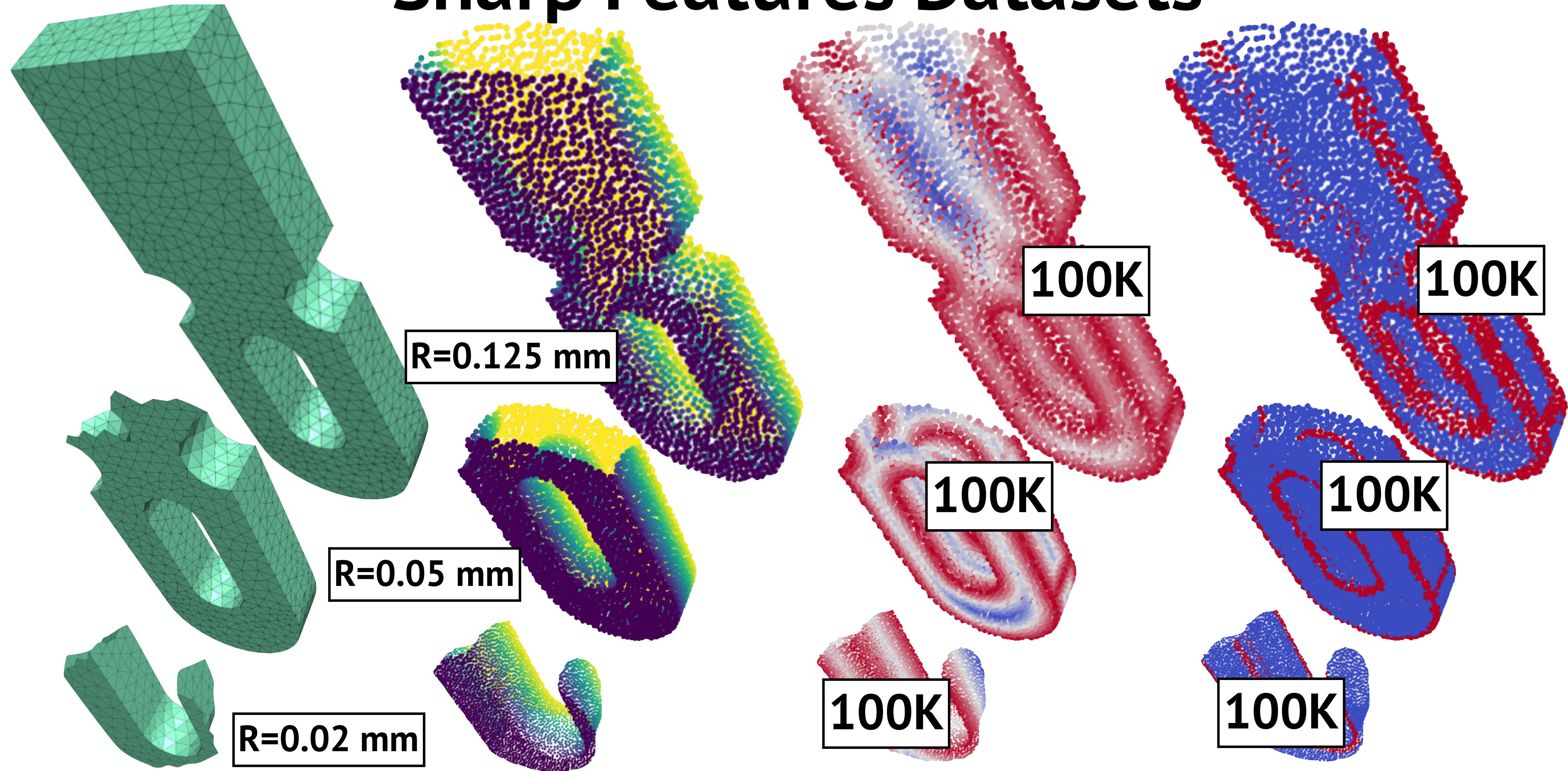


Point patches

# Sharp Features Annotation



# Sharp Features Datasets



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- Prizes coming!

[adase.group/3ddl/abc-sharpf-challenge](https://adase.group/3ddl/abc-sharpf-challenge)

[adase.group/3ddl/abc-geomseg-challenge](https://adase.group/3ddl/abc-geomseg-challenge)

<https://competitions.codalab.org/competitions/25079>

<https://competitions.codalab.org/competitions/25087>

The screenshot shows the CodaLab competition interface for the "ABC: Sharpness Fields Extraction - CVPR 2020" challenge. The page includes a logo featuring the letters "ABC" in a stylized green and blue font, and a brief description of the challenge: "In the sharpness fields extraction challenge, participants have to estimate distances to the closest feature lines for 3D point clouds. In the present dataset and challenge, feature lines are identified with surface lines where surface".

The screenshot shows the CodaLab competition interface for the "ABC: Geometric Shape Segmentation - CVPR 2020" challenge. The page includes a logo featuring the letters "ABC" in a stylized red and blue font, and a brief description of the challenge: "In the geometric shape segmentation challenge, participants have to predict segments of 3D point clouds which are close to the boundary of an underlying shape. In the present dataset and challenge, feature lines are identified with surface lines where surface normals undergo a change of at least 18°. Point clouds of CAD models are provided, which are randomly sampled from the surface with 4K points. For all points, ground truth binary segmentation masks derived from the CAD surface descriptions are given in the training set and have to be estimated for the evaluation set.".



Learn more at <https://deep-geometry.github.io/abc-dataset/>

Challenges at <https://sites.google.com/view/dlgc-workshop-cvpr2020>