

# Mesh Repairing using Deep Networks

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Thesis Disputation, Munich, Germany  
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# Outline

1 Motivation

2 Related Work

3 Methods and Implementation

- Dataset Generator
- Approach 1: Global Approach
- Approach 2: Hole Filling Approach

4 Evaluation

5 Conclusion



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# Motivation

## Polygon Meshes

- Important 3D object representation
- May have flaws
- Mesh Repairing:  
fix these flaws



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- Important 3D object representation
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- Mesh Repairing: fix these flaws



Self-Intersection



Hole with Island



Gap



Noise

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- Important 3D object representation
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Hole with Island

## Deep Learning

- CNNs popular for 2D image tasks:  
classification, face recognition, ...
- Outstanding results
- Recently applied to meshes



Gap



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# Related Work

## Mesh Repairing

- Hole Filling
  - Step-by-step triangulation
  - Using heuristics
- [Varnuška et al., 2005]
- [Gou et al., 2022]



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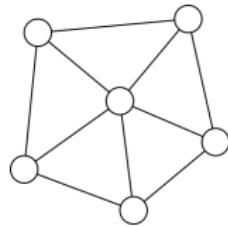
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- Mesh structure irregular
- CNN architectures
  - Graph convolution
  - MeshCNN  
[Hanocka et al., 2019]
- Deformation Process
  - Initial mesh
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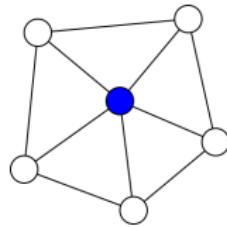
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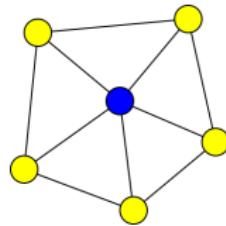
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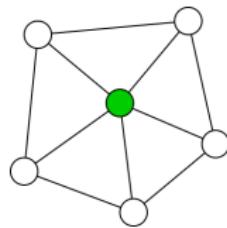
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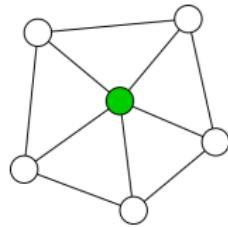
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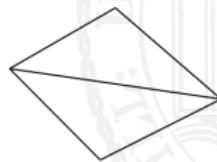
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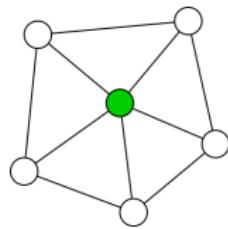
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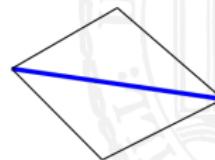
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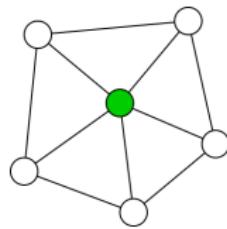
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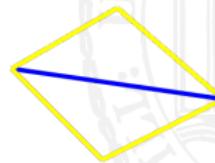
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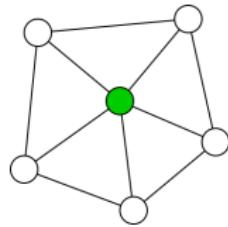
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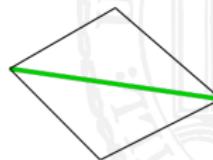
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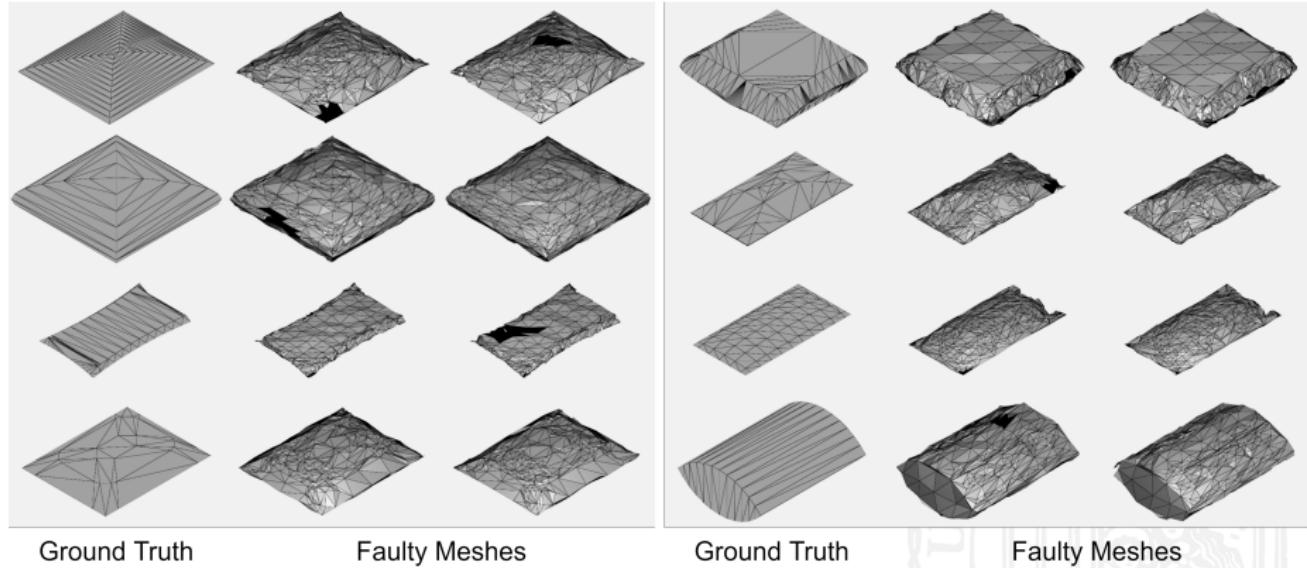


# Dataset Generator

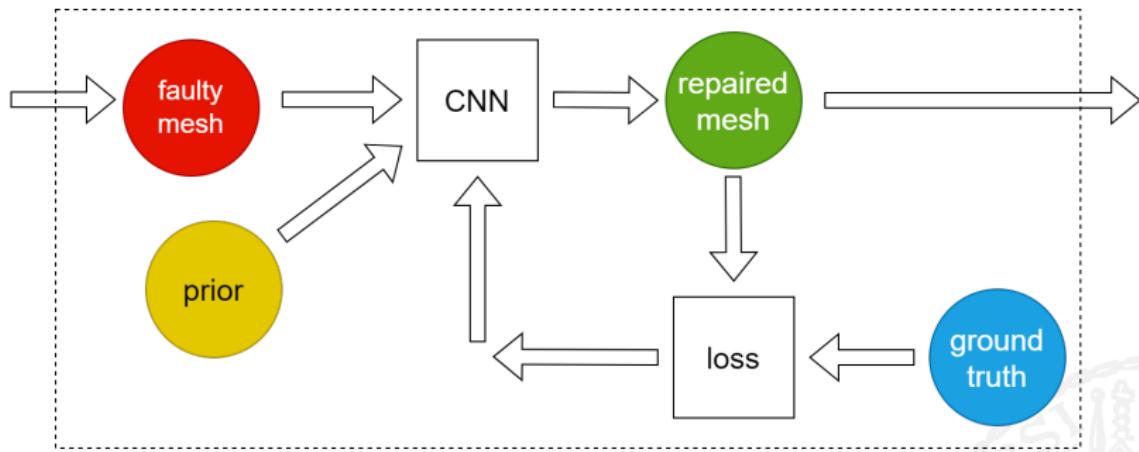


- Goals:
  - Supervised training
  - Controlled experiment
- Input: meshes without flaws
- Output: dataset with faulty meshes
- Capabilities:
  - Holes
  - Gaps
  - Vertex displacements
  - Face subdivisions
- Blender as backend

# Dataset – Example



# Global Approach: Pipeline



- Initial mesh: sphere with 642 vertices
- CNN: vertex displacements
- No direct map between vertices
- Only one displacement step

# Global Approach: Losses

## Chamfer Distance:

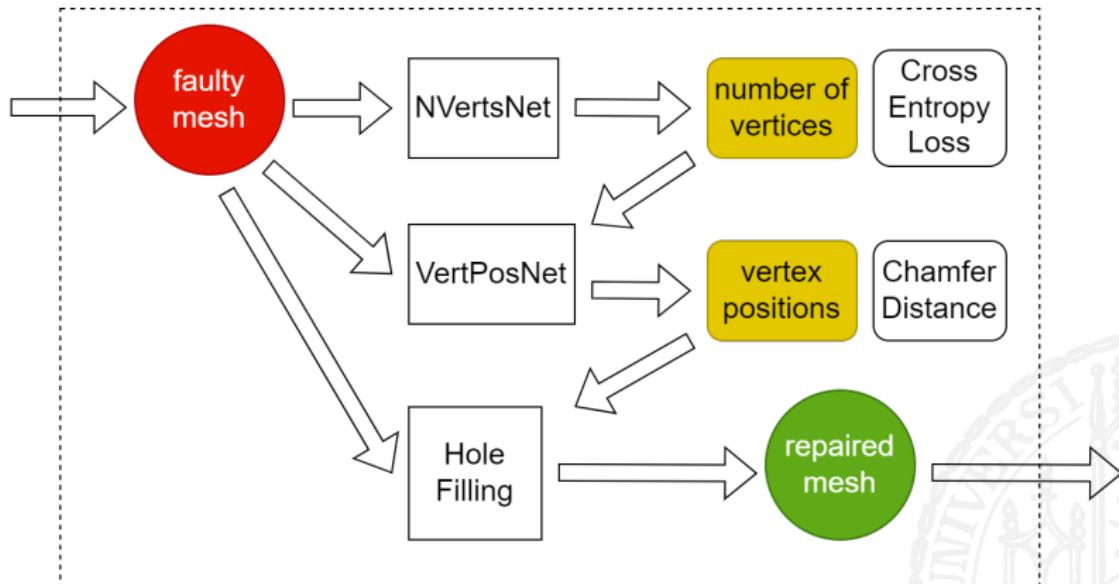
- Similarity between two meshes
- $x = 5000$  point samples from each mesh

## Self-Intersection Penalty:

- Number of pairwise SI's between all faces
- Result: improvements, but not perfect



# Hole Filling Approach: Pipeline



- Input: manifold, exactly one hole

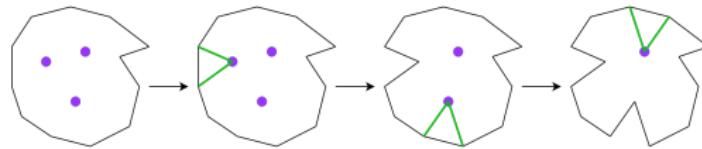
# Hole Filling Approach: Triangulation

- Step-by-step
- Heuristic: similarity to equilateral triangle



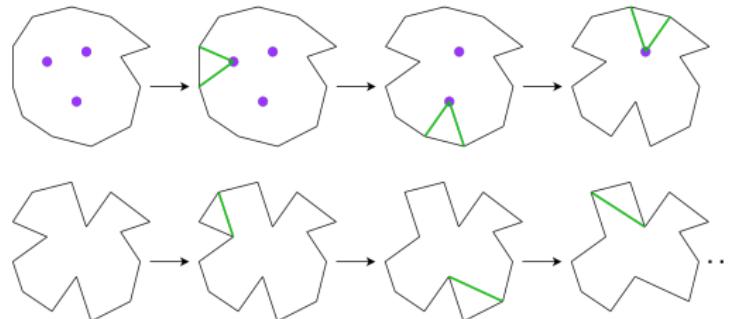
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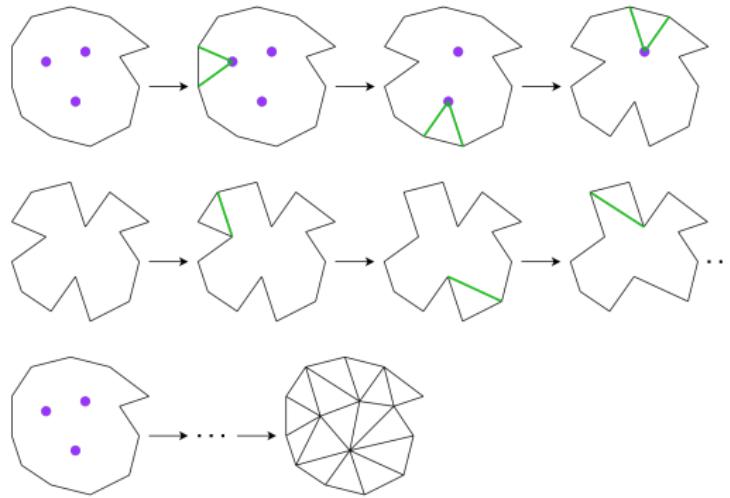
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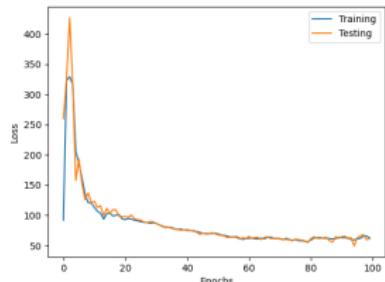
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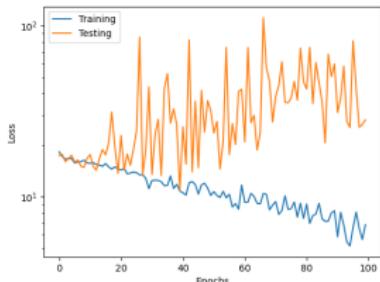
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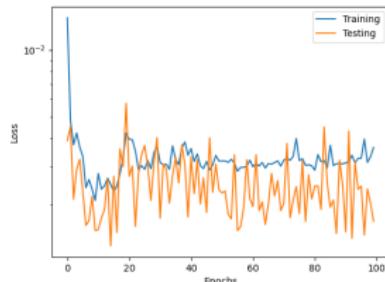
# Evaluation



GlobalNet



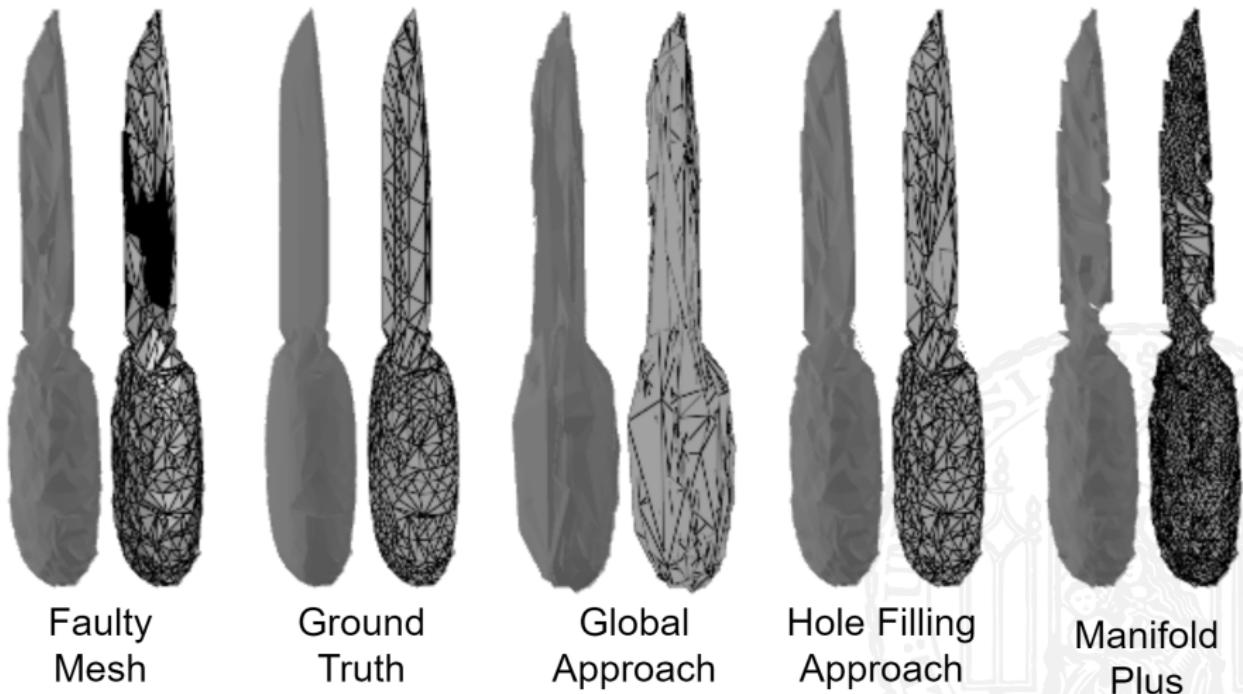
NVertsNet



VertPosNet

- Two datasets, created from ShapeNet models:
  - Knife, Pillows
- Compared to ManifoldPlus [Huang et al., 2020]
- **Quantitative:** Chamfer distance & Laplacian smoothing
  - ManifoldPlus: best results
  - Global: decent Chamfer distance
  - Hole Filling: decent Laplacian smoothing

# Evaluation – Qualitative Results



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# Conclusion

- Results not yet perfect
- But: also advantages over other algorithms
- A lot of research still necessary



# Questions

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# Further Readings I

-  Gou, G., Sui, H., Li, D., Peng, Z., Guo, B., Yang, W., and Huang, D. (2022). LIMOFilling: Local Information Guide Hole-Filling and Sharp Feature Recovery for Manifold Meshes.  
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## Further Readings II



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Wang, N., Zhang, Y., Li, Z., Fu, Y., Liu, W., and Jiang, Y.-G. (2018).

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