AMBER: Adaptive Mesh Generation by Iterative Mesh Resolution Prediction

Motivation

- Adaptive meshing is crucial for **simulation**
  - Yet, it often requires **human expertise**
- A mesh is characterized by its local element density, i.e., its **sizing field**
  - A sizing field thus **reconstructs the mesh**
- We combine
  - Message Passing Networks (MPNs) and
  - automatic online label acquisition

  for **iterative mesh generation**, where each mesh **guides** the next one.

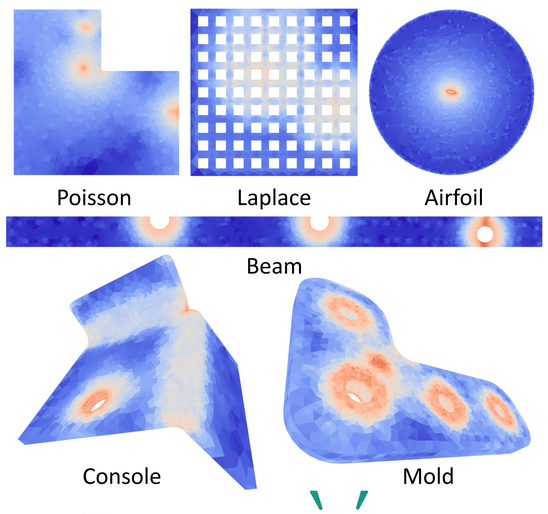
Inference

1. Input an **unseen geometry** (e.g., an .stl file)
2. Generate a coarse **uniform mesh**
3. Iteratively
   - **Encode** the mesh as a graph
   - **Predict** a sizing field with a MPN
   - **Generate** an adapted mesh

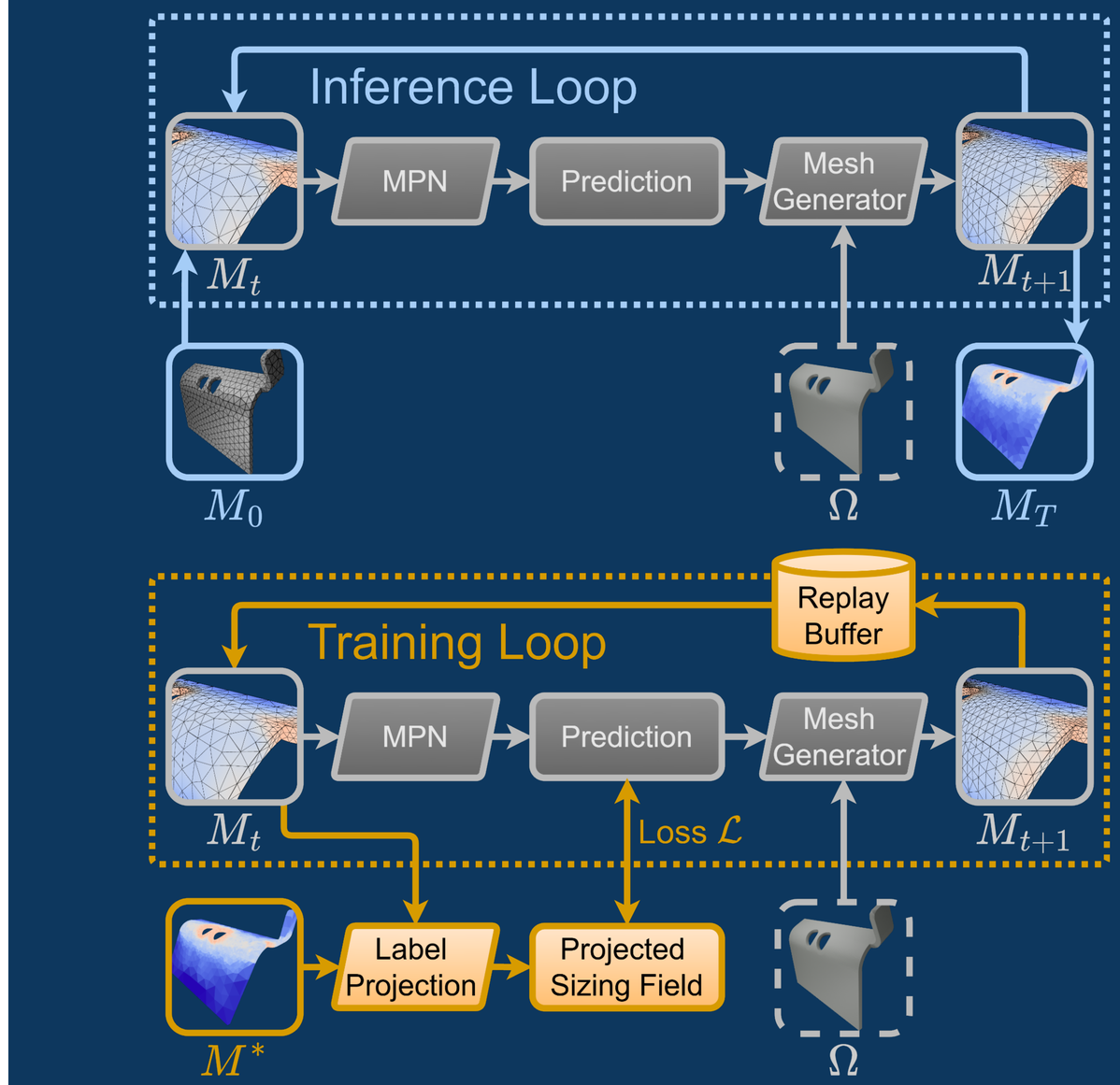
Training

1. **Collect** a few (~20) **expert meshes**
2. **Generate** coarse uniform meshes
3. **Iteratively**
   - **Project** expert sizing field to mesh
   - **Encode the** mesh as a graph
   - Train MPN to **predict** sizing field
   - **Generate** an adapted mesh
   - Add this mesh to a **replay buffer**

Datasets



Autonomous Learning Robots Lab



Niklas Freymuth[1]* *Tobias Würth*[2] *Nicolas Schreiber*[1] *Balazs Gyenes*[1]
Andreas Boltres[1,3] *Johannes Mitsch*[2] *Aleksandar Taranovic*[1] *Tai Hoang*[1]
Philipp Dahlinger[1] *Philipp Becker*[1] *Luise Kärger*[2] *Gerhard Neumann*[1]

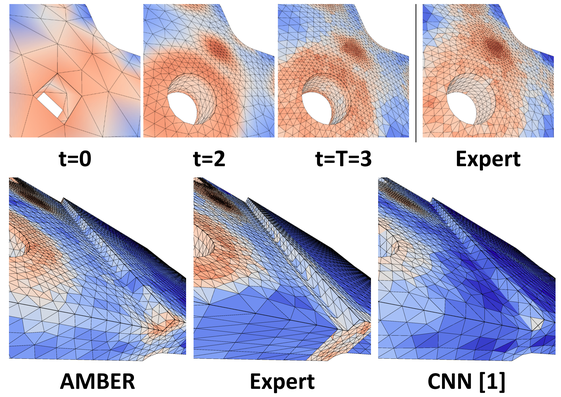
[1]Autonomous Learning Robots, Karlsruhe Institute of Technology, Karlsruhe
[2]Institute of Vehicle Systems Technology, Karlsruhe Institute of Technology, Karlsruhe
[3]SAP SE
*niklas.freymuth@kit.edu

Paper on arXiv

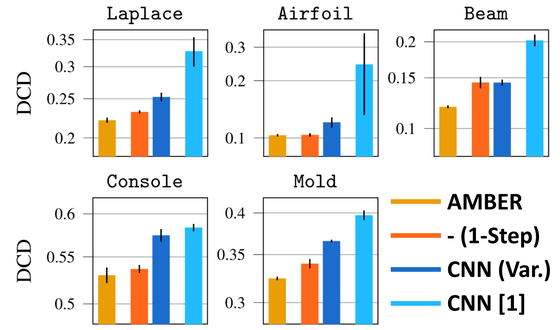
Code on GitHub

Experiments

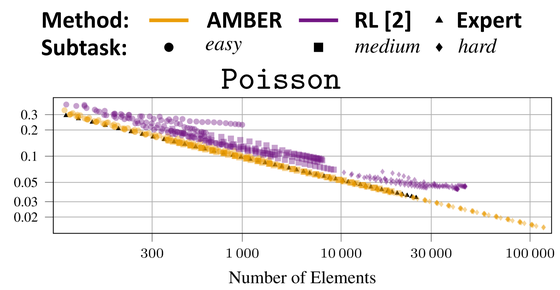
Accurate Iterative Mesh Generation



Closely Match Human Experts



Zero-Shot Generalization



References

[1]Huang, K., et al. *Machine learning-based optimal mesh generation in computational fluid dynamics.*
[2]Freymuth, N., et al. *Swarm reinforcement learning for adaptive mesh refinement.*

Karlsruhe Institute of Technology