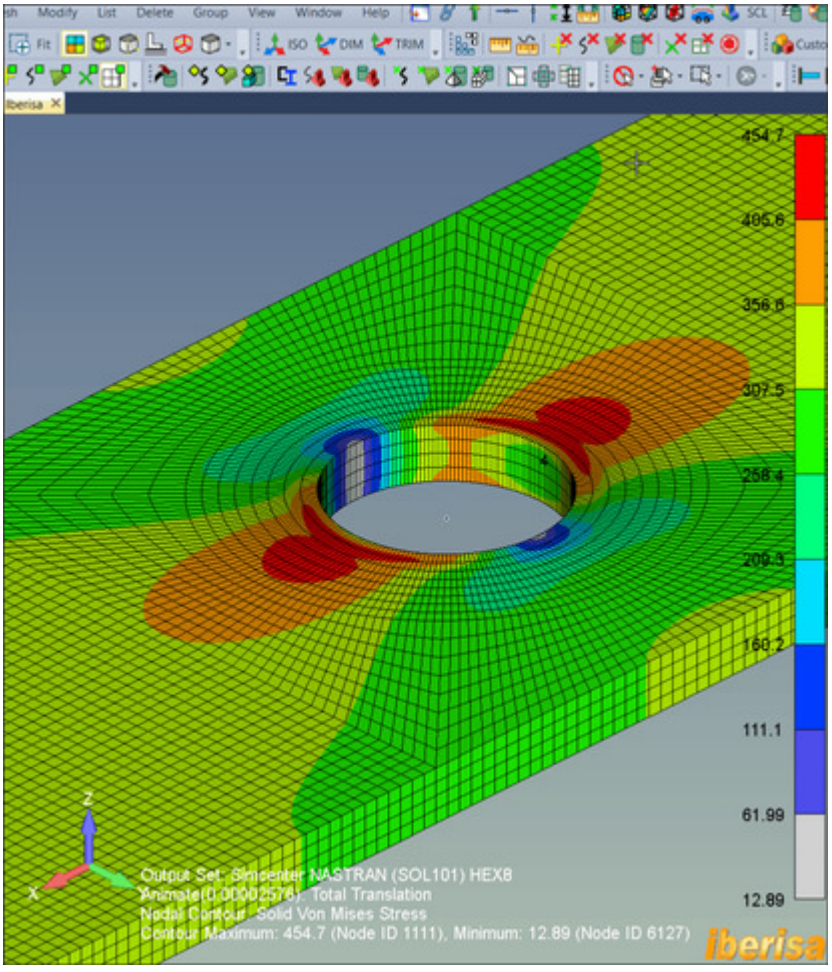
ML4Science MeshGraphNet

Research Goal

- Have fast simulations for the dynamics of continuous materials like plane panels.



Dataset

- Available on Google Deep Mind and Related Paper
- 1000 training, 100 validation, and 100 test samples

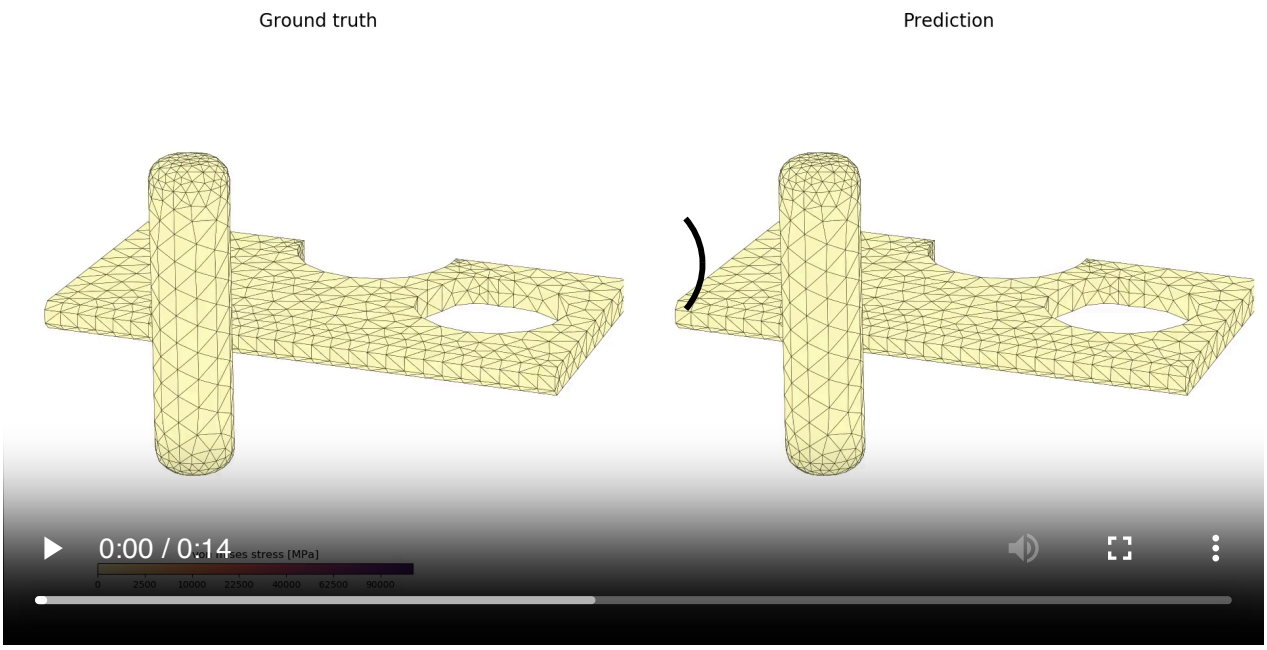
- Dataset of deformable plate meshes
- Finite Element Simulation results (COMSOL Software)
- Predict movement of plate (velocity/acceleration) and yield Stress (color)
- Trained on 400 steps and rollout for 40'000
- **Main Challenge: Simulate correct physical rollout!**

ML Task

- Scalar prediction of stress (von Mises stress)
- Vector prediction of speed/acceleration

Challenges

- Prediction of irregular structures
- Physically consistent rollout
- Find the video here



Method

- Graph Neural Networks to predict system behaviour under load.
  - Message Passing and Convolutions (GCN and MPNN)
  - Physically consistent behavior (EGnets and PINNs)
  - Equivariant Symmetries (EGNN)
  - Hierarchical Relationships (GraphUnet)

Short Project Description

1. Understand the dataset
2. Apply different graph-neural networks to Google DeepMind plate dataset
   1. Use existing architectures that incorporate equicariance, physics, and hierarchies
   2. Apply one custom GNN architecture
3. Analyze their architecture, similarities and differences and how they can affect the performance
4. Implement own architecture and argue the choices

Related Papers and Links

- Dataset and Method Benchmark Paper
- Multiscale Meshgraph
- list of relevant architectures (Probably EGNN, GraphUnet and ...)

- physical background on FEM and stress
- coming ...