Technische Universität Braunschweig
Institute of Applied Mechanics
Pockelsstraße 3
38106 Braunschweig

Prof. Dr.-Ing. Ralf Jänicke

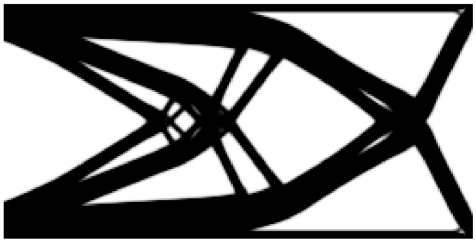
www.tu-braunschweig.de/iam

Contact
Dr. Knut Andreas Meyer
+49 (0) 531 391 94357
k.a.meyer@tu-braunschweig.de
Alexander Henkes, M.Sc.
+49 531 / 391-94529
a.henkes@tu-braunschweig.de

Master thesis/Studienarbeit

Topology optimization using machine learning

Topology optimization is a method for optimizing the design of a structure with respect to a certain objective, such as maximizing the stiffness for a given weight. However, with large and detailed structures, those optimizations become too time consuming due to the expensive finite element problem that must be solved in each optimization iteration. This project investigates if a deep neural networks can be trained to predict the stiffness, following recent trends in the scientific literature [1]. This would alleviate the need to run the finite element simulation in each iteration, resulting in a faster optimization, paving the way for new applications of topology optimization previously considered infeasible.



Topology optimization of a bracket [Meenakshsundaram, CC BY-SA 3.0]

The project will start by setting up the topology optimization stiffness optimization. This will provide a baseline that the machine learning approach can be compared with. Next, a convolutional neural network will be trained to predict the stiffness of different structures, described by the same density design parameters used in the topology optimization problem. Finally, the trained network will be used to optmize the structure, and results will be compared to the standard topology optimization method.
Prerequisites: Linear Solid Mechanics, Good knowledge of finite elements, Programming experience/interest

Tasks

- Setting up the topology optimization environment
- Generating training data for the neural network
- Train a convolutional neural network to predict the stiffness result.
- Optimize the design using both topology optimization and the neural network.

References

[1] S. Lee, H. Kim, Q. X. Lieu, and J. Lee, "CNN-based image recognition for topology optimization," Knowledge-Based Syst., vol. 198, p. 105887, Jun. 2020, doi: 10.1016/J.KNOSYS.2020.105887.