Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Mechanics & Materials Laboratory
Prof. Dr. Dennis M. Kochmann
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Master thesis topic:

Inverse design of truss metamaterials for nonlinear stress-strain responses via supervised deep learning

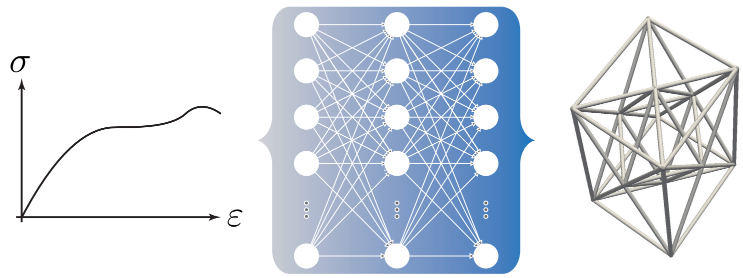

Figure 1: Inverting nonlinear structure-to-property maps via deep learning.

Description:

Periodically assembled microstructures based on lattices give the designer unprecedented freedom in tuning the macroscopic response of a material. Based on the choice of unit cell (UC), the effective mechanical properties can be tailored to the desired functionality. Despite the successful and steady enrichment of the truss design space, the inverse design has remained a challenge: while predicting properties such as the stress-strain response is now commonplace, efficiently identifying architectures with given target properties has remained a challenge, especially in the nonlinear regime.
This project will try to continue closing this gap by developing an inverse model for the nonlinear stress-strain response of a lattice metamaterial, i.e., to find a general method of identifying a truss UC that closely matches a given large-deformation stress-strain response in multiple load cases. First, a design parametrization has to be established which permits a large exploration of different stress-strain responses while still being feasible for deep learning methods in terms of its dimensionality. Second, a suitable data-driven inverse model must be developed with sufficiently high accuracy. Inspiration for both the design space and model architecture can be found in previous works.[1] Depending on the students interests and time constraints, this work can close by experimentally validating the inversely designed structures.

Pre-requisites:

Interested students should have a background and interest in mechanics and computational modeling. Specifically, programming skills in C++/Python are mandatory. Basic knowledge in machine learning and corresponding libraries such as PyTorch will be useful.

For more information please contact:

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[1] Bastek, J.-H. et al. Inverting the structure-property map of truss metamaterials by deep learning. (under review)