Universität Stuttgart

Baustatik und Baudynamik

Master Thesis

Model order reduction for different discretizations

To accelerate simulations of similar systems, data-based surrogate models can be used. Such models can be trained by combining dimensionality reduction methods with regression algorithms, such as proper orthogonal decomposition (POD) with neural networks, to learn a parameter dependency in a reduced space. The need to examine many similar systems can arise in structural optimization. Therefore, the systems can vary in geometry and topology. The physical dimensions of the structure can be adjusted and also topological changes such as adding or removing structural parts are possible in order to find the optimal structure for a certain use case. Due to the possible large variations in the geometry of the structures, different discretizations are required to ensure accurate finite element solutions.

One common model order reduction technique is the snapshot POD. Issues arise when different discretizations are used for the structures. In order to be able to perform a snapshot POD, the different discretizations need to be mapped to one reference geometry.

The aim of the thesis is to implement a snapshot POD that can be applied to arbitrary finite element discretizations. Therefore, especially the requirements of the reference geometry need to be investigated for large geometrical and topological changes of a structure. The implemented method should be tested for a few numerical examples.

Image compression as a possible use case of model reduction techniques.

The specific tasks are

- Literature research on the snapshot POD for arbitrary finite element discretizations
- Investigation of the requirements for the reference geometry
- Implementation of the method, e.g. in Matlab, Python or C++
- Test of the method for examples with different geometry changes such as the removal or addition of structural parts
- Summary and evaluation of the results

Recommended fields of interest

Finite elements, model order reduction, surrogate modelling