Computational Mechanics Group
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Topic proposal

Machine learning of material models

Nowadays, numerical simulations based e.g. on the finite element method are widely used to predict the behaviour of materials. A key ingredient of the models underlying these simulations are material laws, providing the mathematical description of the material behaviour. Finding a suitable model for a given material is not trivial. The classical approach is to firstly formulate a material model, secondly calibrate the model parameters based on data coming from experimental observations and thirdly check if the chosen model is able to describe the experimental observations well. If not, the model has to be repeatedly modified, calibrated and tested until a suitable model is found. This procedure is very time consuming and calls for an automation. Recently, it was shown that machine learning can be used to automatically discover material models (`https://arxiv.org/pdf/2010.13496.pdf`). The idea is to generate a large collection of models and find the one which best describes the given data by applying machine learning methods such as sparse regression. Until now, this framework is restricted to isotropic and elastic material models. The goal of this thesis is an extension to anisotropic, viscoelastic or elastoplastic material behaviour.

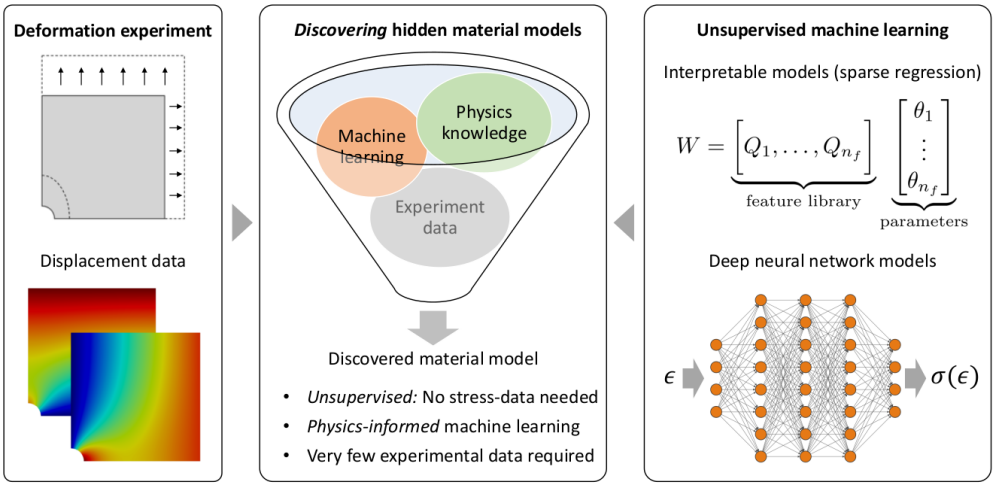

Figure: Unsupervised machine learning methods (right) are applied to displacement data from deformation experiments (left) to discover hidden material models (center).

Subtasks

1. Literature study on machine learning and its application to inverse problems in solid mechanics
2. Data generation for benchmark material models
3. Formulation and implementation of a material model discovery algorithm
4. Application of the algorithm to the benchmark data and critical discussion of the results

Prerequisites

Solving the described tasks requires application of techniques known from the fields of machine learning and computational solid mechanics. Prior knowledge in one of these fields is desired.

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