Karlsruher Institut für Technologie

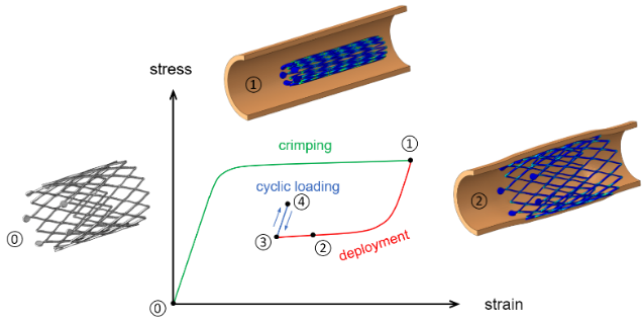
Institut für Angewandte Materialien

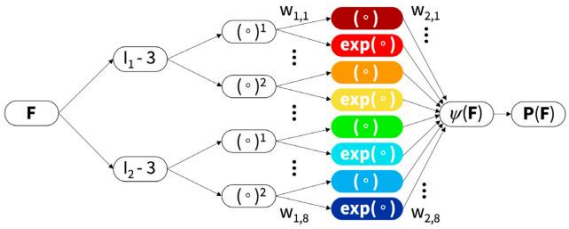
Master Thesis

Physics informed neural networks for shape memory alloys

Background:

Shape Memory Alloys (SMAs) are widely used in engineering applications due to their unique properties, such as superelasticity and shape memory effects. Accurately modeling their complex, nonlinear behavior is crucial for designing reliable components, e.g. medical products like stents or heart valve frames. Traditional constitutive models often require extensive experimental data and intricate mathematical formulations. In recent years, Constitutive Artificial Neural Networks (CANNs) have emerged as a powerful tool for data-driven material modeling.





Goals of the thesis:

This master thesis aims to develop and implement CANN-based models to predict the mechanical behavior of SMAs. The thesis involves theoretical conceptual work as well as implementing/programming with python. The final part of the work will be the training of the neural networks on experimental and simulated datasets, which will be provided by Admedes GmbH (a leading German medicine technology company located in Pforzheim). The thesis will also compare CANN-based models with conventional approaches to assess their accuracy and efficiency. The candidate will gain experience in machine learning, material modeling, and numerical simulations. The findings of the thesis may contribute to the advancement of data-driven methods in SMA applications in industry and research.

Requirements :

- Interest in continuum mechanics as well as data-driven and numerical modeling
- Programming experience (Python, MATLAB, or similar)
- Experience with machine learning libraries (NumPy, PyTorch/TensorFlow, JAX) is advantageous
- First experience with automatic differentiation is welcome, but not mandatory

Contact:

Prof. Dr.-Ing. Katrin Schulz

Institut für Angewandte Materialien – Zuverlässigkeit und Mikrostruktur (IAM-ZM)

Gebäude 30.48 Raum 105, ***Email: katrin.schulz@kit.edu***