Karlsruher Institut für Technologie

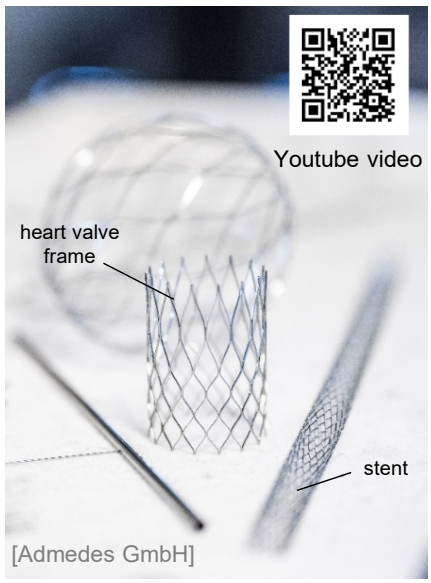
Institut für Angewandte Materialien

Master Thesis

Material modeling of shape memory alloys using constitutive artificial neural networks

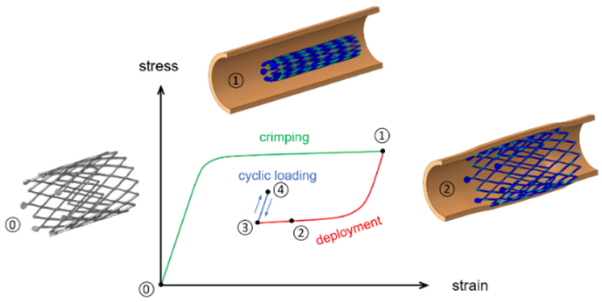
Background:

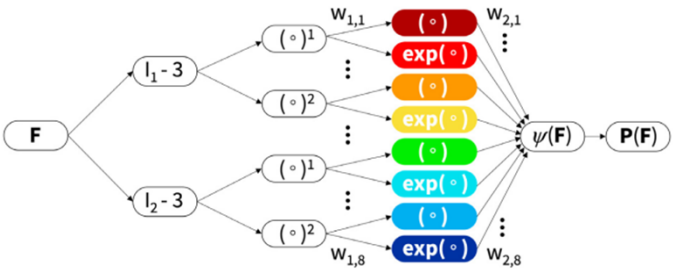
Shape Memory Alloys (SMAs) are widely used in engineering applications due to their unique properties, such as superelasticity and shape memory effects. Accurately modeling their complex, nonlinear behavior is crucial for designing reliable components, e.g. medical products like stents or heart valve 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. Unlike classical neural networks, which treat material modeling as a purely data-driven problem, CANNs incorporate physical constraints (thermodynamic consistency, material objectivity, etc.) directly into their input, architecture and activation functions.



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. 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 may contribute to advancing data-driven methods for SMA applications in industry and research.





Requirements :

- interest and good knowledge in continuum mechanics
- programming knowledge of python is advantageous but not mandatory

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