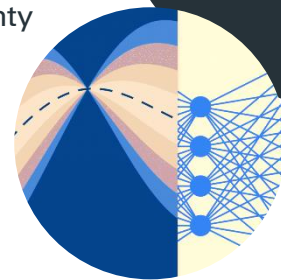


**University of Stuttgart**  
Germany

Department for Stochastic Simulation  
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## Uncertainty Quantification for Model Constitutive Relations



### **B.Sc / SimTech Forschungsmodul Topic**

The Finite Volume Neural Network (FINN) is a framework that allows us to learn operators and constitutive relations of a system, where the existing knowledge is already incorporated into a PDE model and the unknown parts are to be learned using ML, i.e. artificial neural networks (ANNs). However, the learned operators and constitutive relations are deterministic and not provided with uncertainty statements. Besides, the quantification of uncertainty on ANNs is still under development, variational inference and MCMC methods are restrictive or lead to mathematically and computationally difficult problems.

PI3NN is a recently developed and easy-to-use method for learning prediction intervals of an ANN by training three ANNs only once.

The aim of this work is to combine FINN with PI3NN. To this end, a pipeline is developed to propagate prediction intervals (PI) of a quantity of interest obtained with FINN through the framework to obtain PIs for a learned operator or constitutive relation. Numerical experiments will be performed on synthetic and real data to uncover problems and adjust the PI propagation through FINN.

Successful completion of this work is expected to lead to participation in a publication.

### **Prospective Tasks**

- Familiarization with the Finite Volume Neural Network (FINN) and PI3NN
- Implementation of PI3NN in the FINN framework
- Numerical experiments for synthetic and real data
- Visualization of results and discussion

### **General Information**

- Advisor: Stefania Scheurer
- Examiner: Prof. Sergey Oladyshkin, Prof. Wolfgang Nowak

### **Desirable Skills**

- Advanced scientific programming in Python
- Solid understanding of machine learning, statistics and probability theory



**Apply now!**

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