ML-surrogate model for the material modelling in an LBM for solids

TECHNISCHE UNIVERSITÄT DARMSTADT

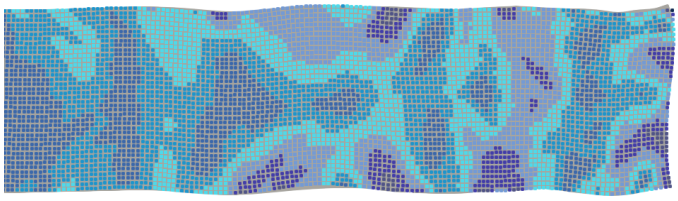
SolidLBM: A novel approach for computational solid and fracture mechanics

Master-Thesis: Mechanics / CE / Mechanical Engineering / Civil Engineering

8. Juni 2025

Lattice Boltzmann methods (LBMs) stem from the computation of fluid flows. They work on the mesoscale with a statistical formulation based in kinetic theory. These methods promise great gains in the computational performance with good scaling for large systems. In recent years, an effort has been undertaken to develop LBMs for the simulation of solid mechanics as well.

For solids, long-range interactions are crucial. These are incorporated through force terms, which accounts for an important part of the constitutive model. The latest advancement handles non-linear solids with typical macroscopic stress-strain-relations.



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SolidLBM

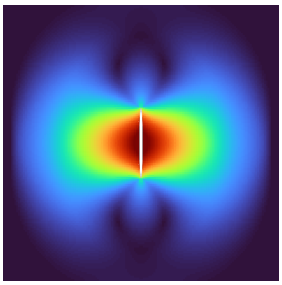
https://git.rwth-aachen.de/SolidLBM/pyLBM

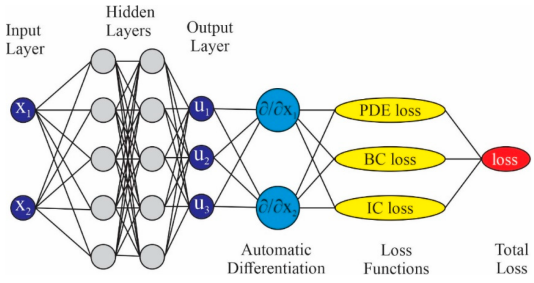
Scope of the thesis

Evaluating the constitutive forcing term is complex, as it requires multiple steps and intermediate quantities. A surrogate model could reduce this complexity by approximating the force term directly from the method's primary quantities. This necessitates the application of state-of-the-art *machine learning* (ML) techniques within the context of computational engineering.

The following problems could be investigated in a master's thesis:

- design of the surrogate model architecture
- investigation of training strategies
- implementation of the algorithm in the software
- validation through benchmarks and performance analysis





Requirements
continuum mechanics (elastodynamics);
basics in programming (object-orientation & Python)

The specific tasks will be discussed and assigned individually.

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