Chair of Computational Modeling and Simulation
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Software Lab:

Phase-Field Fracture with Physics-Informed Neural Networks

Description

Physics-informed Neural Networks [1] are a new and promising way of solving partial differential equations. The basic principle behind this approach is to predict a solution of the equation with a neural network by training the network with the residual of the equation. Currently, more traditional approaches, such as the finite element method still outperform the physics-informed neural network in most problems. This margin is however smaller for problems of higher complexity, such as for example in fracture mechanics. Recently, physics-informed neural networks have been combined with phase-field fracture models by [3, 4] with promising results. The goal is to understand, replicate, and possibly improve these results.

Task

Implement a 2D phase-field fracture framework using physics-informed neural networks. Test your implementation and the method with benchmark cases from literature and assess its viability.

- Get familiar with Neural Networks and common frameworks.
- Understand Physics-Informed Neural Networks [1].
- Implement a physics-informed framework to solve the 2D linear elastic problems [2].
- Extend the framework for phase-field fracture [3,4].
- Test your implementation with benchmark cases from literature.

Supervisor

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References

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[4] Goswami, S., Yin, M., Yu, Y., & Karniadakis, G. (2021). A physics-informed variational DeepONet for predicting the crack path in brittle materials. arXiv preprint