Master thesis / Semester project

Physics-informed Deep Neural Operators for Solid Mechanics

Description: Recently, physics-informed neural operators (PINOs) have been introduced as a new approach for solving complex problems in engineering, by combining data with knowledge of the underlying governing equations [1, 2]. The concept is an extension of previously successful purely data-driven deep neural operators. In this project, the student will explore the application of PINOs on solid mechanics problems, with the goal of simulating the behavior of materials under various loading conditions. Applications will be considered in the context of geotechnical or structural engineering. The generalization capabilities of the method will be evaluated, and its accuracy will be compared to conventional numerical solutions. The findings aim to advance computational tools for engineering design and analysis, bridging the gap between traditional numerical methods and scientific machine learning.

Prerequisites:

- Background and interest in scientific machine learning and solid mechanics
- Strong coding skills (Python)

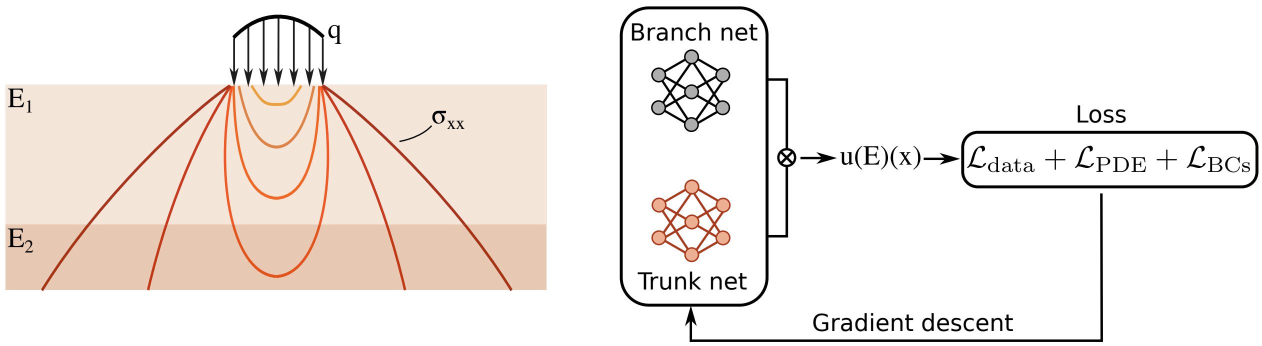

Figure 1: Example boundary value problem for a linear elastic medium (left) and architecture of a physics-informed deep neural operator network (right).

References

[1] Somdatta Goswami, Aniruddha Bora, Yue Yu, and George Em Karniadakis. Physics-informed deep neural operator networks. In *Machine Learning in Modeling and Simulation: Methods and Applications*, pages 219–254. Springer, 2023.

[2] Zongyi Li, Hongkai Zheng, Nikola Kovachki, David Jin, Haoxuan Chen, Burigede Liu, Kamyar Azizzadenesheli, and Anima Anandkumar. Physics-informed neural operator for learning partial differential equations. *ACM/JMS Journal of Data Science*, 1(3):1–27, 2024.

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