EPFL

LMD
Data-Driven Mechanics Laboratory

Master thesis / Semester project

Graph Neural Networks for Granular Mechanics

Description: Granular materials form complex networks of force chains arising from frictional interactions between particles. Under applied shear, this network of contacts can undergo complex topological and geometrical rearrangements. The connection between these grain-scale patterns and the macroscopic behavior of the material is still a field of active research [1]. In this project we will employ Graph Neural Networks (GNNs) to shed light on these processes, focusing on the regime where granular materials approach unjamming and failure. The models will be trained on data from high fidelity discrete element simulations as well as experimental measurements with grain-scale resolution.

Prerequisites:

- Background in computational mechanics and machine learning
- Strong coding skills (Python, C++)

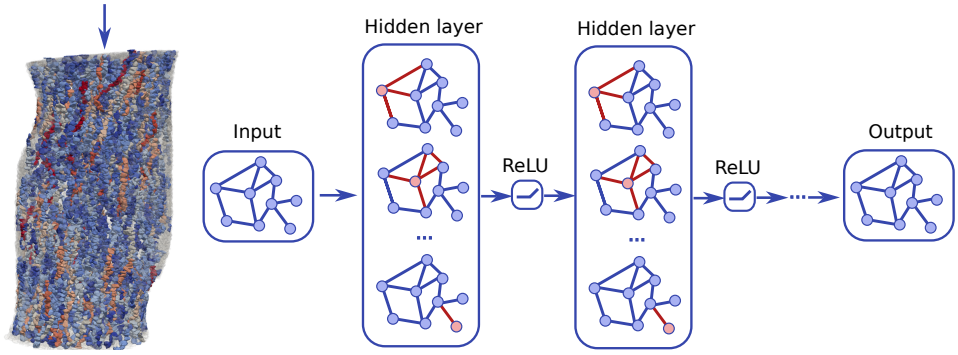

Figure 1: Clusters of grains forming force chains during triaxial compression of a digital specimen of sand simulated with the Level-set Discrete Element Method [1] (left), architecture of a graph neural network (right).

References

[1] K. Karapiperis and J.E. Andrade. Nonlocality in granular complex networks: Linking topology, kinematics and forces. *Extreme Mechanics Letters*, 42:101041, 2021.

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