Thesis proposal:

Manufacturing of a robotic probe to perform local underground: the importance of the tip shape soil monitoring.

Background

In the last decade, grand challenges like the advancement of climate change, scarcity of resources, need of energy transition, ask for new, sustainable solutions for for soil characterisation, **deployment and maintenance** of sensors and utilities, **tunnelling** in areas inaccessible to conventional instruments.
As it often happens, smart strategies already exist in nature to answer similar needs, as animals have adapted over time to burrow effectively in different soil conditions. For example, earthworms have a soft body able to exploit **peristalsis locomotion** to excavate and move in soil. An earthworm can anchor in soft ground, penetrate in stiff underground layers or loose sand. Biological strategies provide a unique source of inspiration to design "innovative" technologies able to address modern engineering challenges.

Aim

The goal of this cross-disciplinary project will be to investigate the importance of the tip shape for the prototype of in the soil digging. As seen from nature, shape is importnt based on the develop a **self-burrowing probe** using the techniques of soft robotics. The robot will mimic the earthworm shape and the sequence of motions involved in peristaltic locomotion.
The student will investigate the best burrowing strategies to overcome the soil penetration resistance, recognise and adapt to obstacles encountered during the penetration test.

Method

Experimental research:
Collaboration between the Soft Robotic lab and the Soil Micromechanics Chair. The student will be asked to study, **design, fabricate and test** a earthworm-inspired soft robot to explore and collect data about soils and buried infrastructures.
The motion of the robotic earthworm in soil, as well as the soil response to the burrowing mechanisms will be investigated using a combination of:

- x-ray microtomography,
- digital image correlation,
- sensors for tip resistance, friction sleeve, pore pressure.

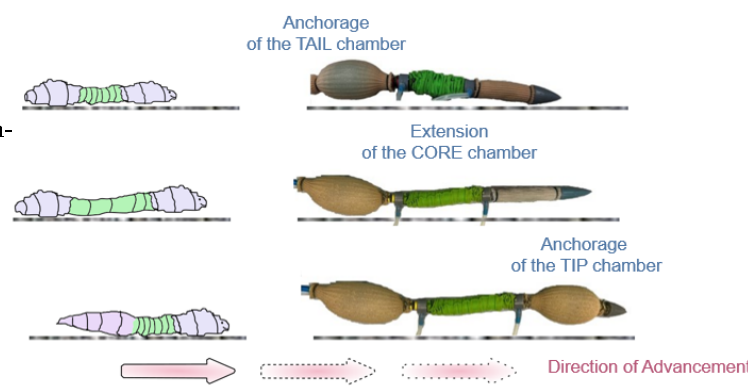

Figure 1: Left: Movement pattern of an earthworm. Right: Prototype of earthworm robot

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See the robot digging in soil!

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