Using supervised learning to improve multiscale modelling of damage

Abstract

Damage and Fracture Mechanics have been studied for many years now. During the last 50 years, numerical modelling of crack propagation has been a real challenge since accurate modelling of inelasticity and failure of geomaterials is the key to the success of a diverse range of engineering challenges including the topic of CO2 sequestration, nuclear waste disposal and hydrocarbon production plus civil engineering projects for tunnels or excavations. However, the geomaterials are notoriously difficult to model due to the complexity of the micro-structure, heterogeneities and anisotropy at all scales. **Localization of damage**, in particular, can be critical factor in determining the success or failure of an engineering project.

Another key aspect in project development is **monitoring of the actual processes in play**. Such monitoring generally requires the use of geophysical techniques such as **seismic/acoustic imaging**. Such monitoring is however only of real benefit if it can be linked back to the modeling and thus engineering development plan.

Considering the two arguments previously stated, an **automatic tool for detecting and describing cracks in real images** would definitely be a gain. Such an instrument which would be able to numerically quantify cracks' properties such as length and orientation, to classify and to describe the cracks' evolution over a period of time, or describe rocks texture, would be a must for obtaining pertinent input data for the Finite Element codes used in damage and fracture mechanics.

One way to obtain this tool is through supervised learning using neural networks. For image applications convolutional neural networks (CNN) are often used. The aim of the next presentation is to briefly introduce the domain, to discuss a traditional learning algorithm - the logistic regression, and to point out how Machine Learning and Damage Mechanics can be linked through this approach.