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FAILURE PREDICTION IN NUMERICALLY MODELED SANDSTONES USING ACOUSTIC EMISSION AND MACHINE LEARNING ALGORITHM RANDOM FOREST

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Acoustic emission is related to the process of deformation and fracturing of materials. Research on acoustic emission provides useful information in many areas of geoscience, such as industrial applications of materials, glacier calving, stick-slip cycles or sheared granular fault experiments. For example, it is known that machine learning can predict time to failure in laboratory earthquakes basing solely on acoustic emission.

Here, acoustic emission was monitored in numerical simulations of uniaxial compression of cylindrical sandstone samples. Numerical modeling was performed using Discrete Element Method. Models were calibrated to obtain macroscopic Young's modulus, Poisson Ratio and Unconfined Compressive Strength such as in real sandstones. Acoustic emission was recorded in the form of particles velocity signal and other features related to the occurrence of fractures in the material.

The collected data were used to train the supervised machine learning algorithm Random Forest. The algorithm was applied to predict the time to failure and axial stress in a material at any time during the simulation, basing solely on the currently recorded signal. Performance metrics were at a very good level with coefficient of determination R2 reaching 99% on the training set and 95% on the test set. SHapley Additive exPlananations SHAP was used to assess the impact of individual input features on the algorithm's output. The obtained results suggest that with sufficient data on the acoustic emission, the machine learning algorithm is able to make predictions with very high accuracy, which can shed new light on the fracturing processes.