We still need theoretical modelling

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Since its origin in the seventeenth century, the scientific method has proven its robustness and allowed considerable progress for mankind. Its iterative process is now very understood and is based on a never-ending succession of observations, model formulation and testing – experimentally or numerically – to (in)validate and refine hypotheses. With the exponential increase of data availability, there is currently an enormous focus on artificial intelligence/machine learning, which saw the development of new methods to surpass what was previously possible in many domains. On the back of such a successful approach, there is however a danger to sleepwalk through some of the other steps of the scientific method and in particular fall under the false impression than all underlying physical models are now well defined, with the only remaining tasks consisting in calibrating parameters.

In this contribution, we highlight the importance of pushing the research on physical models and showcase how theoretical work can lead to fundamental understandings in geomechanics, kickstarting the same scientific method as a result, only not from the modelling perspective rather than the more common experimental or observational angles. We focus on the periodicity of crack patterns in rocks under compression and investigate a recent theory [1] capable of explaining them with some purpose-built numerical tools. The high nonlinearity of the underlying partial differential equation indeed represents a challenge from the numerical point of view and a new stabilized finite element method [2] is introduced to overcome this issue (Figure 1). This technique allows us to explore a wider spectrum of solutions than those offered by classical finite element formulations, in order to analyse the influence of certain equation parameters in the solution behaviour, and devise physical experiments in the future to prove the validity of the approach.

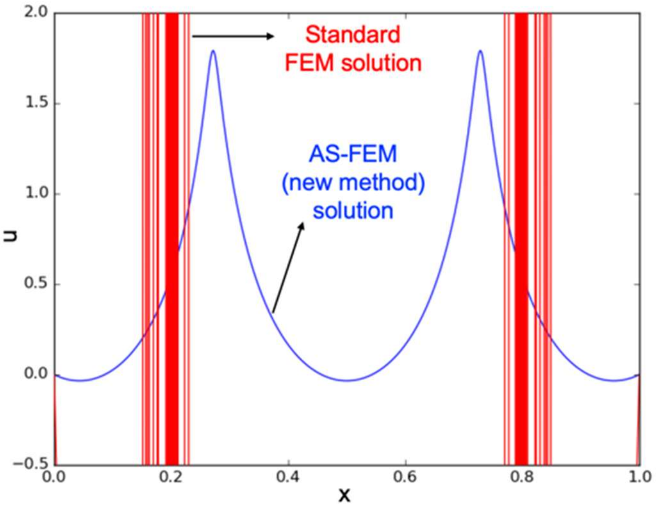

Figure 1. Comparison of numerical solutions using the new method and standard Finite Element Method.

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