PHYSICS INFORMED NEURAL NETWORK FOR QUASISTATIC FAULT SLIP FORWARD AND INVERSE PROBLEMS

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Abstract. We consider the two-dimensional quasistatic linear elasticity equation for domains with slits. We use such construct to represent a slipping fault (slit) embedded in the Earth's crust, and relate displacements measured at the surface of the Earth with fault slip through the elasticity equations. Typically, the forward relationship is obtained by solving the elasticity equations for simplified physical models such as an homogeneous elastic half space [1], an stratified elastic medium [2], or for more complex media using Finite Element or Finite Differences methods. The inverse problem is typically solved by optimization or Bayesian methods [3]. In this work, in order to provide a surrogate for the forward and inverse problems, we apply physics-informed neural networks [4], this approach being a method of choice when dealing with partial information, as it allows for the straightforward incorporation of sensor observations. We solve the problems using the open-source DeepXDE [5] library, for both the forward and inverse settings (specifically, unique continuation problems [6]), demonstrating competitive performance and generalization even in the presence of missing and noisy information. To conclude, we delineate further actions required for the development of real-world data-centric, physics-informed fault simulation solvers.

Keywords: Physics informed neural network, linear elasticity, inverse problem.

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