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A machine learning based approach to predict the stress intensity factors in 2D linear elastic fracture mechanics

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Within the framework of linear elastic fracture mechanics, the stress intensity factors (SIFs) are the mostly applied crack-tip characterizing parameters. To obtain the SIFs, approximate formulae are widely used because exact analytical solutions are available only for very simple geometrical and loading configurations [1]. However, even approximate solutions for SIFs are also rather limited to very simple geometrical and loading conditions. In this work, an accurate and efficient SIF prediction model based on Physics-informed neural network (PINN) [4] is developed, where we incorporate the equilibrium equations and constitutive relations into the PINN. In order to capture the singular behavior of the stress and displacement fields around the crack tip, we extend the standard PINN structure by adding two more trainable parameters $\widetilde{K}_{\mathrm{I}}$ and $\widetilde{K}_{\mathrm{II}}$ recording to the crack-tip asymptotic functions. Then the enhanced physics-informed neural networks are trained to satisfy the governing equations and the boundary conditions.

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