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Geophysical Inversion through Hierarchical Genetic Algorithm Scheme

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Geophysical investigation is a powerful tool that allows non-invasive and non-destructive mapping of subsurface states and properties. However, non-uniqueness associated with the inversion process halts these methods from becoming of more quantitative use. One major direction researchers are going is constraining the inverse problem by hydrological observations and models. An alternative to the commonly used direct inversion methods are global optimization schemes (such as genetic algorithms and Monte Carlo Markov Chain methods). However, the major limitation here is the desired high resolution of the tomographic image, which leads to a large number of parameters and an unreasonably high computational effort when using global optimization schemes.
One way to overcome these problems is to combine the advantages of both direct and global inversion methods through hierarchical inversion. That is, starting the inversion with relatively coarse resolution of parameters, achieving good inversion using one of the two inversion schemes (global or direct), and then refining the resolution and applying a combination of global and direct inversion schemes for the whole domain or locally. In this work we explore through synthetic case studies the option of using a global optimization scheme for inversion of electrical resistivity tomography data through hierarchical refinement of the model resolution.