

Hierarchical Optimization: Fast and Robust Multiscale Stochastic Reconstructions with Rescaled Correlation Functions

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Abstract

© 2018 American Physical Society. Stochastic reconstructions based on universal correlation functions allow obtaining spatial structures based on limited input data or to fuse multiscale images from different sources. Current application of such techniques is severely hampered by the computational cost of the annealing optimization procedure. In this study we propose a novel hierarchical annealing method based on rescaled correlation functions, which improves both accuracy and computational efficiency of reconstructions while not suffering from disadvantages of existing speeding-up techniques. A significant order of magnitude gains in computational efficiency now allows us to add more correlation functions into consideration and, thus, to further improve the accuracy of the method. In addition, the method provides a robust multiscale framework to solve the universal upscaling or downscaling problem. The novel algorithm is extensively tested on binary (two-phase) microstructures of different genesis. In spite of significant improvements already in place, the current implementation of the hierarchical annealing method leaves significant room for additional accuracy and computational performance tweaks. As described here, (multiscale) stochastic reconstructions will find numerous applications in material and Earth sciences. Moreover, the proposed hierarchical approach can be readily applied to a wide spectrum of constrained optimization problems.

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