A Multilevel Proximal Algorithm for Large Scale Composite Convex Optimization

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Composite convex optimization models consist of the minimization of the sum of a smooth convex function and a non-smooth convex function. Such models arise in many applications where, in addition to the composite nature of the objective function, a hierarchy of models is readily available. It is common to take advantage of this hierarchy of models by first solving a low fidelity model and then using the solution as a starting point to a high fidelity model. We adopt an optimization point of view and show how to take advantage of the availability of a hierarchy of models in a consistent manner. We do not use the low fidelity model just for the computation of promising starting points but also for the computation of search directions. We establish the convergence and convergence rate of the proposed algorithm and compare our algorithm with two widely used algorithms for this class of models (ISTA and FISTA). Our numerical experiments on large scale image restoration problems suggest that, for certain classes of problems, the proposed algorithm is significantly faster than both ISTA and FISTA.