A primal-dual fixed-point algorithm for minimization of multi-block convex separable functions

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Many problems arising in signal processing and imaging science can be formulated as minimization of multi-block convex separable functions. Particularly, we first discuss the scenario of three-block minimization that involves a smooth function with Lipschitz continuous gradient, a linear composite nonsmooth function and a nonsmooth function. We propose a primal-dual fixed-point (PDFP) scheme to solve the above class of problems. The proposed algorithm for three block problems is a fully splitting symmetric scheme, only involving explicit gradient and linear operators without inner iteration, when the nonsmooth functions can be easily solved via their proximity operators, such as ℓ_1 type regularization. We study the convergence of the proposed algorithm. We then extend PDFP to solve two kinds of separable multi-block minimization problems and illustrate how practical and fully decoupled schemes can be derived, especially for parallel implementation of large scale problems. The connections and comparisons to ADMM are also present. Finally, some experiments on image restoration and sparse approximation are provided to illustrate the performance of several schemes derived by the PDFP algorithm.