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Analysis of Chambolle-Pock through the lens of duality

We extensively analyze the operator associated with the primal-dual hybrid gradient algorithm (or the Chambolle-Pock algorithm) that is used to solve the composite monotone inclusion problem for maximally monotone operators. Through the lens of a dual structure on the underlying space of the operator, we obtain several properties of the underlying solution sets. We also recover known results for the Douglas-Rachford algorithm. On giving additional structure to the operators—such as being paramonotone, or subdifferentials of proper lower semicontinuous convex functions, the solution sets are further simplified.