

# **A primal-dual algorithm for image reconstruction with input-convex neural network regularizers**

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We consider a data-driven variational reconstruction framework, where the regularizer is parameterized by an input-convex neural network (ICNN). While gradient-based methods are commonly used to solve such problems, they struggle to effectively handle nonsmooth problems which often leads to slow convergence. Moreover, the nested structure of the neural network complicates the application of standard non-smooth optimization techniques, such as proximal algorithms. To overcome these challenges, we reformulate the problem and eliminate the network's nested structure. By relating this reformulation to epigraphical projections of the activation functions, we transform the problem into a convex optimization problem that can be efficiently solved using a primaldual algorithm. We also prove that this reformulation is equivalent to the original variational problem. Through experiments on several imaging tasks, we show that the proposed approach not only outperforms subgradient methods and even accelerated methods in the smooth setting, but also facilitates the training of the regularizer itself.