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Unrolled iterative algorithm for CT image reconstruction with learned penalty term

In the last three to four years there has been an explosion of interest in using deep learning techniques to address challenging problems in computed tomography (CT) image reconstruction, such as low-dose, sparse-view, and limited angle imaging. A wide variety of approaches have been proposed, including using deep neural networks (DNN) as pre- or post-processing steps, using neural networks to encode prior information within existing iterative reconstruction algorithms, or learning to solve the inverse problem altogether.

We present a CT reconstruction approach which unrolls a standard iterative algorithm and trains it end-to-end as a DNN. The DNN consists of fixed layers, corresponding to the basic iterative algorithm, as well as trainable layers, which have the effect of perturbing the solution between iterations. The trainable layers can be viewed as replacing the negative gradient of an unknown penalty function or regularizer, which can vary with the iteration number. In numerical experiments, we test the approach on sparse-view and limited-angle CT problems, and study the effect of network architecture on the effectiveness of the algorithm. The proposed method provides significant improvement over the basic iterative algorithm, as well as total variation minimization approach. Joint work with Yiran Jia, Noah McMichael, Pedro Mokarzel, and Dong Si (UW Bothell).