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Numerical Methods for Total Variation in Image Processing

Starting with the outstanding paper of Rudin, Osher, and Fatemi from 1992, total variation has become a versatile and powerful tool in modern image processing. Despite its popularity, a numerical treatment of total variation is not straightforward and many publications address this problem from various perspectives.

This presentation aims to introduce to numerical schemes for total variation and ways to bypass difficulties arising from the none differentiability of total variation. To keep the focus clear and concrete, image denoising serves as a template problem. The starting point is the minimization of joined energy functional, composed from a simple L_2-norm based data fitting term and a total variation based regularizer.

Moreover, the presentation summarizes, discusses, and relates popular approaches such as the naive primal, a dual approach of Vogel, the split Bregman method of Goldstein and Osher, and the augmented Lagrangian approach of Tai and Wu. As the starting point is a variational framework, emphasis is also given to alternative perspectives for a numerical treatment such as the optimize then discretize and discretize then optimize approaches.