AUTOMATIC SPACE-VARIANT ANISOTROPIC TIKHONOV REGULARIZATION THROUGH BILEVEL OPTIMIZATION

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When dealing with inverse problems whose solutions are known to have well-defined structures and discontinuities, better reconstructions can be obtained by employing a regularization method that takes into account such features. For instance, if the local orientation field of the solution is known, one may adopt Tikhonov regularization with an anisotropic regularization term given by a weighted norm of the directional derivatives of the solution. In this talk, considering problems that are inherently two-dimensional, we propose to automatically and simultaneously recover the regularized solution and the local orientation parameters (to define the anisotropic regularization term) by solving a bilevel optimization problem. Specifically, the lower level problem is Tikhonov regularization equipped with the anisotropic regularization term, while the objective function of the upper level problem encodes some natural assumptions about the local orientation parameters and the Tikhonov regularization parameter. Application of the proposed algorithm to a variety of inverse problems in imaging (such as denoising, deblurring, tomography and Dix inversion), with both real and synthetic data, shows its effectiveness and robustness.