A Binary Level Set Model for Inverse Problems with Discontinuous Coefficients

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Abstract

We propose a variant of a binary level set approach for solving inverse problems with piecewise constant coefficients. The inverse problem is solved by a variational augmented Lagrangian approach with a total variation regularisation.

In the binary level set formulation, the seeked interfaces between the subdomains with different coefficient value are represented by discontinuities of the level set functions. The level set functions shall only take two discrete values, i.e. 1 and -1, but the minimisation functional is smooth and locally convex.

The proposed method is applied on both elliptic inverse problems and on two phase porous media flow problems. In the latter case we have utilised both well data and seismic time-lapse data in order to estimate the permeability in the field. Our formulation can, under moderate amount of noise in the observations, recover rather complicated geometries without requiring any initial curves of the geometries, only a reasonable guess of the constant levels is needed.