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Total generalized variation for piecewise constant functions

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The total generalized variation (TGV) was introduced as a generalization to the total variation regularizer to avoid the staircasing effect. In particular, the kernel of second-order TGV consists of linear polynomials.

Strictly speaking, the functional measures TV on piecewise constant data, however, the concept has become state of the art for recontruction of pixel images using an appropriate discretization.

A discrete version of second-order TGV for piecewise constant functions on triangulated meshes is presented in the FEniCS framework. The non-smooth regularizer prefers equally distributed jumps over larger constant areas and thus prevents the visible staircasing effect compared to TV.

This is demonstrated for image denoising problems on structured as well as unstructured planar meshes using an implementation of the split Bregman method in FEniCS.

The functional is suitable for data on surfaces and can be extended to manifold valued data to measure the total generalized variation of the normal vector.