

Off-the-grid regularisation for Poisson inverse problems

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Fluorescence microscopy is a fundamental tool to investigate biological structures. Acquisitions are affected by blurring, arising from light diffraction, and noise, making the reconstruction of fine scale details challenging. In the recent years, several variational optimisation methods have been formulated in the continuous setting of measures spaces. Off-the-grid approaches are endowed with a solid mathematical theory and very good performance in applications for reconstructing point sources.

Most of these approaches consider an ℓ^2 data term usually coupled with the TV norm (BLASSO problem) of the unknown measure.

For better modeling the presence of a Poisson photon-counting noise process, we consider a non-quadratic data fidelity term, i.e. the Kullback-Leibler divergence and a non-negativity constraint.

For the numerical computation of the solution, we adapt the Sliding Frank Wolfe algorithm to such scenario and perform a grid-search strategy for the regularisation parameter to compare the results obtained with the two data terms.

We then propose an homotopy strategy for the automatic selection of the regularisation parameter, provided that an estimation of the noise level is known, which gives good quality reconstructions and significantly speeds up the algorithm. We present some comparative results in 1D and 2D and show a 3D real data reconstruction obtained with Homotopy-SFW with the KL.

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