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Laplace deconvolution with noisy observations

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In the present paper we consider Laplace deconvolution on the basis of discrete noisy data observed on the interval which length may increase with a sample size. Although this problem arises in a variety of applications, to the best of our knowledge, it has not been systematically studied in statistical literature and the objective is to fill this gap. The present paper essentially provides the first comprehensive statistical treatment of Laplace deconvolution problem. The main contribution of the paper is the explicit construction of the Laplace deconvolution estimator. We show that the original Laplace deconvolution problem can be essentially reduced to estimating regression function and its derivatives on the interval of growing length T_n. Whereas the forms of the estimators essentially remain standard, the choices of the parameters and the minimax convergence rates, which are expressed in terms of T_n^2/n in this case, are affected by the asymptotic growth of the length of the interval.
We derive an adaptive kernel estimator of the function of interest, and establish its asymptotic minimaxity over a range of Sobolev classes. We illustrate the theory by examples of construction of explicit expressions of Laplace deconvolution estimators. A limited simulation study shows that, in addition to providing asymptotic optimality as the number of observations turns to infinity, the proposed estimator demonstrates good performance in finite sample examples. The paper is concluded by a study of application of Laplace deconvolution to analysis of Dynamic Contrast Enhanced Computed Tomography data.

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