Nonparametric Regression Estimation Based on Spatially Inhomogeneous Data: Minimax Global Convergence Rates and Adaptivity

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We consider the nonparametric regression estimation problem of recovering an unknown response function f on the basis of spatially inhomogeneous data when the design points follow a known compactly supported density g with a finite number of well separated zeros. In particular, we consider two different cases: when g has zeros of a polynomial order and when g has zeros of an exponential order. These two cases correspond to moderate and severe data losses, respectively. We obtain asymptotic minimax lower bounds for the global risk of an estimator of f and construct adaptive wavelet nonlinear thresholding estimators of f which attain those minimax convergence rates (up to a logarithmic factor in the case of a zero of a polynomial order), over a wide range of Besov balls.

The spatially inhomogeneous ill-posed problem that we investigate is inherently more difficult than spatially homogeneous problems like, e.g., deconvolution. In particular, due to spatial irregularity, assessment of minimax global convergence rates is a much harder task than the derivation of minimax local convergence rates studied recently in the literature. Furthermore, the resulting estimators exhibit very different behavior and minimax global convergence rates in comparison with the solution of spatially homogeneous ill-posed problems. For example, unlike in deconvolution problem, the minimax global convergence rates are greatly influenced not only by the extent of data loss but also by the degree of spatial homogeneity of f. Specifically, even if 1/g is not integrable, one can recover f as well as in the case of an equispaced design (in terms of minimax global convergence rates) when it is homogeneous enough since the estimator is "borrowing strength" in the areas where f is adequately sampled.

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