Smoothing, Clustering, and Benchmarking for Small Area Estimation

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We develop methods of constrained Bayes estimation for small-area estimation. We deal with two kinds of constraints: those that require smoothness with respect to some form of similarity across areas, such as geographic proximity or a clustering by covariates; and bench-marking constraints, requiring (weighted) means and variances of estimates to agree across levels of aggregation, or with external sources of information. We develop our tools for constrained estimation both geometrically, by projecting the unconstrained Bayes estimate into the feasible set, and decision-theoretically, by minimizing the posterior risk. We show that our constrained estimators can be obtained as solutions to tractable convex optimization problems, and in some cases get closed-form solutions. Meansquared errors of the constrained estimators are calculated via bootstrapping. Our techniques are free of distributional assumptions, and equally applicable whether the estimator is linear or non-linear, univariate or multivariate. We illustrated our methodology by applying it to data from the U.S. Census?s Small Area Income and Poverty Estimates program.

Keywords: small area estimation, benchmarking, smoothing, clustering.