An Outlier Robust Block Bootstrap for Small Area Estimation

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The industry standard for small area estimation is to base inference on models containing both fixed and random effects. In this context, use of the linear mixed model is ubiquitous, with maximum likelihood, or its close relative, restricted maximum likelihood (REML), the standard method for estimating the parameters of this model. These parameter estimates, and in particular the resulting predicted values of the random area effects, are then used to construct empirical best linear unbiased predictors (EBLUPs) of the unknown small area means. It is now well known that the EBLUP can be unstable when there are outliers in sample data, and an outlier-robust EBLUP, or REBLUP, based on modifying the parameter estimating functions to make them less sensitive to sample outliers, has been proposed. Unfortunately, these modified estimating functions can be numerically unstable, and mean squared error estimation for the REBLUP is not straightforward. Taking a somewhat different approach, we describe an outlier robust bounded block bootstrap approach to fitting a linear mixed model in the presence of both area level and unit level outliers. A natural extension of this bounded block bootstrap can then be used to define an alternative outlier robust version of the EBLUP and a simple way of estimating its mean squared error. In this presentation we elaborate on this approach and develop its properties. We then present Monte Carlo simulation results as well as details from a real data application that provide some evidence for our claim that the new method is robust to the influence of outliers. In particular, it leads to an outlier robust alternative to the EBLUP as well as an easily computed and stable estimate of its mean squared error.

Key Words: Mixed models, robust estimation, variance components, unit-level models, random effect block bootstrap, mean squared error estimation