Where Granularity Matters: Calibrating Subdomain Inference for Binary Outcomes

Small area estimation (SAE) helps us make accurate estimates for local communities or groups, such as counties, neighborhoods, or demographic subgroups, when there are not enough data for each area. This is important for targeting local resources and policies, especially when national-level or large-area data mask variation at a more granular level. Researchers often fit hierarchical Bayesian models to stabilize estimates when data are sparse. Ideally, Bayesian procedures also exhibit good frequentist properties, as demonstrated by calibrated Bayes techniques. However, hierarchical Bayesian models tend to shrink subdomain estimates toward the overall mean and may produce credible intervals that do not maintain nominal coverage. Hoff et al. developed the Frequentist, but Assisted by Bayes (FAB) intervals for subgroup estimates with normally distributed outcomes. However, non-normally distributed data present new challenges, and multiple types of intervals have been proposed for estimating proportions. We examine subdomain inference with binary outcomes and extend FAB intervals to improve nominal coverage and estimation efficiency. We describe how to numerically compute FAB intervals in the binary case and demonstrate their improvement through repeated simulation studies. Finally, we apply the proposed methods to estimate COVID-19 infection rates in subgroups, based on geography and demographic characteristics. This is joint work with Rayleigh Lei.

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