Local Inferences via Nonparametric Model-Assisted Methods

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Scales of Local Inference in Surveys

- **Large area:**
  - sample itself suffices for inference
  - no model needed

- **Medium area:**
  - use auxiliary information through a model
  - model helps inference but is not critical

- **Small area:**
  - sample size is small or zero
  - inference must be based on a model
Specific and Generic Inference

- **Specific:** one study variable, few population parameters
  - lots of modeling resources to specify, estimate, and diagnose a model
  - willingness to defend the model
- **Generic:** many study variables, many population parameters
  - no resources to model every variable
  - no single model is adequate/defensible
Generic Inferences in Aquatic Resources

- Generic inference is a common problem for federal, state, and tribal agencies.
- **Example:** conduct a survey and prepare a report:
  - analyze large numbers of chemical, biological, and physical variables
  - estimate means, quantiles, and distribution functions
  - break down both by political classifications and by various ecological classifications
Model-Assisted Survey Inference

- Scarce modeling resources for generic inference, so we don’t trust models.
- Can we use a model without depending on the model?
- Model-assisted inference:
  - efficiency gains if model is right
  - sensible inference even if model is wrong
Model-Assisted Estimators

Form of model-assisted estimator:
- (model-based prediction) + (design bias adjustment)
- model incorporates auxiliary information
- bias adjustment corrects for bad models

Classical parametric model-assisted:
- prediction from linear regression model

Our idea: nonparametric model-assisted
- prediction from kernel regression or other "smoother"
Why Nonparametric?

- More flexible model specification
  - smooth mean function, positive variance function
- Approximately correct more often
  - more opportunities for efficiency gains from auxiliary information
  - often, not a large efficiency loss if parametric specification is correct
Goals of Our Research

- Incorporate auxiliary information for small or medium-scale local inference
- Focus on generic inference
- Use flexible nonparametric models to reduce misspecification bias
- Make the methods operationally feasible for state and tribal agencies
Future Directions

- Adapt the methodologies to new design contexts:
  - multiple phases, multiple stages
- Investigate alternative smoothing methodologies:
  - semiparametric and additive models
- Prove theorems:
  - smoothing parameter selection
Outline of Presentations

- Siobhan Everson-Stewart
  - “Nonparametric Survey Regression Estimation in Two-Stage Spatial Sampling”

- Alicia Johnson
  - “Estimating Distribution Functions from Survey Data Using Nonparametric Regression”

- Mark Delorey
  - “Semiparametric Mixed Models in Small Area Estimation”