# `svysim`:
# Creating Realistic Simulations of (Biased) Survey Data

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https://github.com/kuriwaki/svysim

# Motivation: Existing simulations of survey response are too simplistic

Simulated data are important for demonstrating predictive accuracy and proper coverage of estimators, but existing simulations ...

- Use continuous predictors, but almost all survey data is categorical
- Assume no multilevel / clustering structure
- Assume no selection bias

(for exceptions, see Kennedy and Gabry)

# Package `svysim`: Realistic simulation, with control over the sampling scheme

- Population ($N = 600,000$): CCES Data, expanded using post-stratification weights
  - This is technically not a census, but it has a natural covariance structure and makes the simulation realistic.
- Sample ($n = 1,000$): Simple Random Sample (SRS), OR a biased sample where the propensity score for population member $i \in \{1, ..., N\}$ is determined by a propensity score $p_i$.
- Then I get a sample by: `sample(1:N, size = n, replace = FALSE, prob =` Propensity Score$_i$`)`

# Sampling Functions

$p_i = \text{invlogit}(bX)$ where

"High Education": here $bX$ is:

$$= \left\{ -4 + 2\text{Urban}_i + \begin{bmatrix} 1.0 \\ 0.8 \\ 0.7 \\ 0.6 \\ 0.5 \end{bmatrix}^\top \begin{bmatrix} \text{White}_i \\ \text{Black}_i \\ \text{Hispanic}_i \\ \text{Asian}_i \\ \text{All Other}_i \end{bmatrix} + \begin{bmatrix} 4.0 \\ 3.0 \\ 1.2 \\ 0.5 \end{bmatrix}^\top \begin{bmatrix} \text{Post-Grad}_i \\ \text{4-Year}_i \\ \text{Some College}_i \\ \text{HS or Less}_i \end{bmatrix} + \begin{bmatrix} 4.0 \\ 1.0 \\ 0.4 \\ 0.3 \end{bmatrix}^\top \begin{bmatrix} \text{Follow News}_i \\ \text{Sometimes}_i \\ \text{Now and Then}_i \\ \text{Hardly}_i \end{bmatrix} \right\}$$

where e.g. $\text{White}_i$ is an indicator variable for whether respondent $i$ is White.

"High Ed + Partisanship" adds the following partisan component to $bX$:

$$-2 + \begin{bmatrix} 1.25 \\ 0.75 \\ 1 \end{bmatrix}^\top \begin{bmatrix} \text{Dem}_i \\ \text{Indep}_i \\ \text{GOP}_i \end{bmatrix}$$

# Simulated Outcome

$$
\begin{aligned}
Y_i &= \frac{1}{10}(-3 + A_i + 0.2B_i + 0.8C_i + u_i) \\
Z_i &= \text{invlogit}(Y_i)
\end{aligned}
$$

where:

$$
A_i = 0.5\log(\text{Age}_i) - 2\mathbb{1}(\text{White Male Non-Postgrad}_i) + 2(\text{Follow News}_i) + \begin{bmatrix} 0 \\ 1.5 \\ -0.5 \end{bmatrix}^\top \begin{bmatrix} \text{Dem}_i \\ \text{Indep}_i \\ \text{GOP}_i \end{bmatrix}
$$

$B_i \sim \text{Bern}(\pi_{\text{state}[i]})$, such that $ICC = 0.15$

$C_i \sim \text{Bern}(\pi_{\text{district}[i]})$, such that $ICC = 0.3$

$u_i \sim \sqcup(0, \text{df} = 5)$

in which $\pi_{\text{state}[i]}$ is the state-level average of $\text{invlogit}(Y_i)$, and ICC is the intraclass cluster coefficient

# Strong error when sampling explicitly is a function of outcome