Efficient Randomized Experiments Using Foundation Models

Piersilvio De Bartolomeis, Javier Abad, Guanbo Wang, Konstantin Donhauser,
Raymond Duch, Fanny Yang, Issa Dahabreh

Problem Setting

- We collect an experimental sample $(X_i, A_i, Y_i)_{i=1}^n$ with fixed treatment probability $\pi = \mathbb{P}(A = 1)$
- We want to estimate $\theta = \mathbb{E}[Y \mid A = 1] - \mathbb{E}[Y \mid A = 0]$
- The average treatment effect is estimated with AIPW

$$\widehat{\theta}(\widehat{h}) = \sum_{i=1}^{n} \frac{A_i - \pi}{\pi(1-\pi)}(Y_i - \widehat{h}(X_i, A_i)) + \widehat{h}(X_i,1) - \widehat{h}(X_i,0)$$

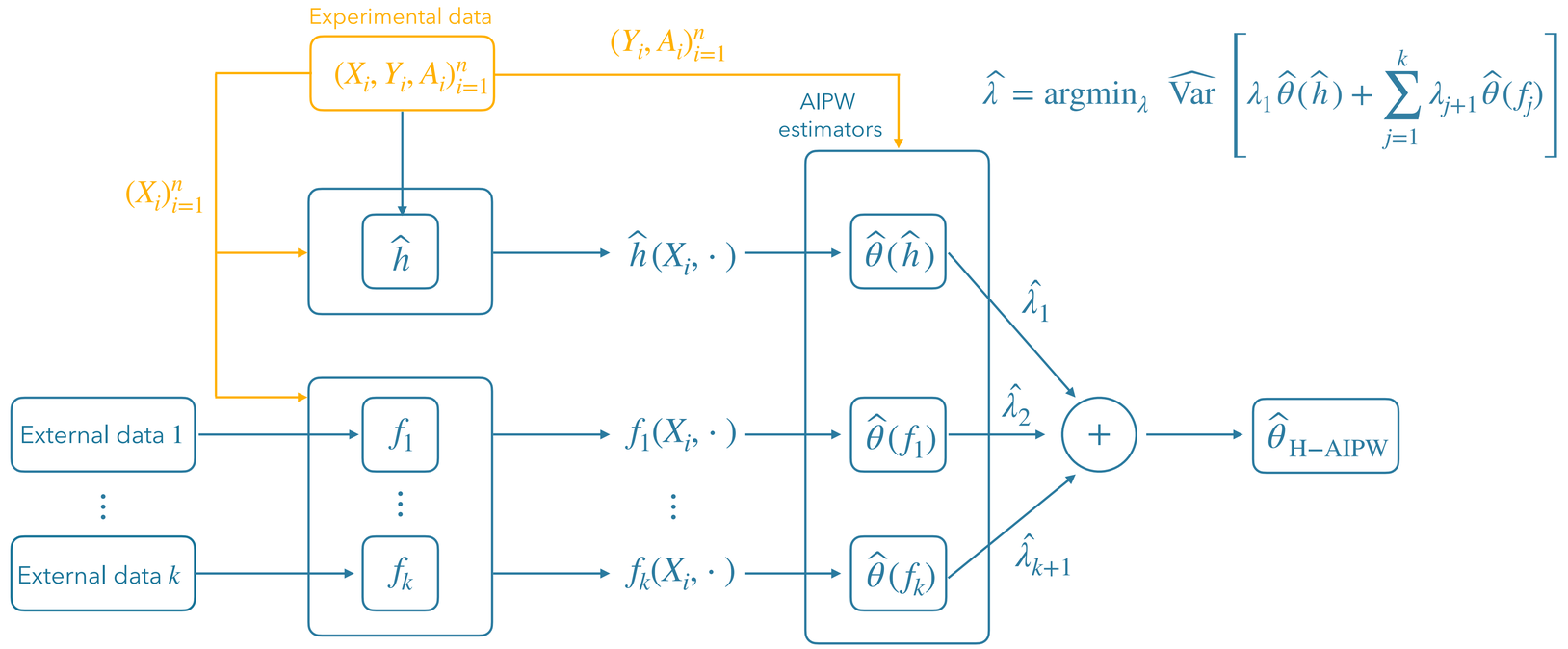
- But the model $\widehat{h} = \widehat{\mathbb{E}}[Y \mid X, A]$ is learned from the small experimental sample using e.g. linear regression
  - **Idea:** use external data and flexible models to learn $\widehat{h}$

We propose the **H**ybrid **A**ugmented **I**nverse **P**robabillity **W**eighting **(H-AIPW)**, a novel estimator that safely leverages foundation models to improve efficiency.

☑ Protects against bias from the foundation models

☑ Always at least as efficient as the classic AIPW estimator

Method



Prior work

PPI/PPCT	✗ Can be less efficient than AIPW ✗ Does not handle multiple models
PROCOVA	✗ Finite sample unstable (empirically)
Shrinkage	✗ No protection against bias

Experiments