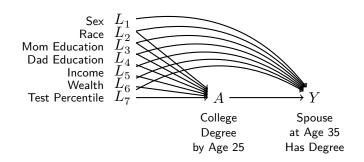
# Discussion. Parametric g-formula: Outcome modeling

Cornell STSCI / INFO / ILRST 3900 Fall 2023 causal3900.github.io

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#### Where lecture ended



# 100% of the sample

is in a subgroup with either 0 treated or 0 untreated units



Follow the instructions on Ed to download the data!

### Statistical modeling

Under exchangeability,

$$E\left(Y^{a}\mid\vec{L}=\vec{\ell}\right)=E\left(Y\mid A=a,\vec{L}=\vec{\ell}\right)$$

To estimate, we have been taking the subgroup mean

$$\hat{E}(Y\mid A=a,\vec{L}=\vec{\ell}) = \frac{1}{n_{a,\vec{\ell}}} \sum_{i:A_i=a,\vec{L}_i=\vec{\ell}} Y_i$$

When subgroups are empty, we need a model. Example:

$$\hat{E}\left(Y\mid A=a,\vec{L}=\vec{\ell}\right)=\hat{\alpha}+A\hat{\beta}+\vec{L}'\hat{\vec{\gamma}}+A\vec{L}'\hat{\vec{\eta}}$$

### Parametric g-formula: Outcome modeling

- 1. Learn a model to predict Y given  $\{A, \vec{L}\}$
- 2. For each i, predict
  - $\blacktriangleright \ \{A=1, \vec{L}=\vec{\ell}_i\},$  the conditional average outcome under treatment
  - $\blacktriangleright~\{A=0, \vec{L}=\vec{\ell}_i\},$  the conditional average outcome under control
- 3. Take the difference for each unit
- 4. Average over the units

1. Learn a model to predict Y given  $\{A, \vec{L}\}$ 

2. Predict conditional average potential outcomes for every unit

3. Difference to estimate conditional average effects

```
conditional_average_effects <-
  conditional_average_outcomes %>%
  mutate(effect = yhat1 - yhat0)
```

### 4. Average over units

```
conditional_average_effects %>%
  select(yhat1, yhat0, effect) %>%
  summarize_all(.funs = mean)
```

```
# A tibble: 1 x 3
  yhat1 yhat0 effect
  <dbl> <dbl> <dbl>
1 0.404 0.163 0.241
```

### Recap. Parametric g-formula: Outcome modeling

- 1. Learn a model to predict Y given  $\{A, \vec{L}\}$
- 2. For each i, predict
  - $\blacktriangleright \{A=1, \vec{L}=\vec{\ell}_i\},$  the conditional average outcome under treatment
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- 3. Take the difference for each unit
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# Extension 1: Conditional average effects

Modify the procedure above to estimate the average effect in subgroups defined by mom's education:

- 1. those with sex == Male
- 2. those with sex == Female

If you finish, choose a subgroup of interest to you and summarize.

## Extension 1: Conditional average effects

Modify the procedure above to estimate the average effect in subgroups defined by mom's education:

- 1. those with sex == Male
- 2. those with sex == Female

If you finish, choose a subgroup of interest to you and summarize.

One way to code it:

```
conditional_average_effects %>%
  group_by(sex) %>%
  select(sex, yhat0, yhat1, effect) %>%
  summarize_all(.funs = mean)
```

Extension 2: Logistic regression

In groups: Repeat the steps above with logistic regression

$$\log \left( \frac{\hat{P}\left(Y \mid A=a, \vec{L}=\vec{\ell}\right)}{1-\hat{P}\left(Y \mid A=a, \vec{L}=\vec{\ell}\right)} \right) = \hat{\alpha} + A\hat{\beta} + \vec{L}'\hat{\vec{\gamma}} + A\vec{L}'\hat{\vec{\eta}}$$

#### Helpful hints:

- ▶ read about using glm() to estimate logistic regression
- when using predict(), search to find out how to predict probabilities

### Extension: Logistic regression

#### Fit a model

### Extension: Logistic regression

Predict and summarize to estimate the average effect

```
d %>%
 mutate(yhat1 = predict(fit,
                         newdata = d %>%
                           mutate(a = "college"),
                         type = "response"),
         yhat0 = predict(fit,
                         newdata = d %>%
                           mutate(a = "no_college"),
                         type = "response"),
         effect = yhat1 - yhat0) %>%
  select(yhat1,yhat0,effect) %>%
  summarize all(.funs = mean)
```

```
# A tibble: 1 x 3
  yhat1 yhat0 effect
  <dbl> <dbl> <dbl> 1 0.406 0.165 0.241
```

### Recap. Parametric g-formula: Outcome modeling

- 1. Learn a model to predict Y given  $\{A, \vec{L}\}$
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  - $\blacktriangleright~\{A=0, \vec{L}=\vec{\ell}_i\}$  , the conditional average outcome under control
- 3. Take the difference for each unit
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