

# Continuous exposures and g-computation

Malcolm Barrett

Stanford University

Normal regression estimates associations. But we want *causal* estimates: what would happen if *everyone* in the study were exposed to x vs if *no one* was exposed.

# G-Computation/G-Formula

- 1 Fit a model for  $y \sim x + z$  where  $z$  is all covariates
- 2 Create a duplicate of your data set for each level of  $x$
- 3 Set the value of  $x$  to a single value for each cloned data set (e.g  $x = 1$  for one,  $x = 0$  for the other)

# G-Computation/G-Formula

- 1 Make predictions using the model on the cloned data sets
- 2 Calculate the estimate you want, e.g.  $\text{mean}(x_1) - \text{mean}(x_0)$

# ***Advantages of the parametric G-formula***

Often more statistically precise than propensity-based methods

Incredibly flexible

Basis of other important causal models, e.g. causal survival analysis and TMLE

# Greek Pantheon data (greek\_data)

The name of a Greek god	A prognostic factor	The treatment, a heart transplant	The outcome, death
Rheia	0	0	0
Kronos	0	0	1
Demeter	0	0	0
Hades	0	0	0
Hestia	0	1	0
Poseidon	0	1	0
Hera	0	1	0
Zeus	0	1	1
Artemis	1	0	1
Apollo	1	0	1

+ 10 more rows

# 1. Fit a model for $y \sim a + 1$

```
1 greek_model <- lm(y ~ a + 1, data = greek_data)
```

## 2. Create a duplicate of your data set for each level of **a**

The name of a Greek god	A prognostic factor	The treatment, a heart transplant	The outcome, death
Rheia	0	0	0
Kronos	0	0	1
Demeter	0	0	0
Hades	0	0	0
Hestia	0	1	0
Poseidon	0	1	0
Hera	0	1	0
Zeus	0	1	1
Artemis	1	0	1
Apollo	1	0	1



# 2. Create a duplicate of your data set for each level of a

The name of a Greek god	A prognostic factor	The treatment, a heart transplant	The outcome, death
Rheia	0	0	0
Kronos	0	0	1
Demeter	0	0	0
Hades	0	0	0
Hestia	0	1	0
Poseidon	0	1	0
Hera	0	1	0
Zeus	0	1	1
Artemis	1	0	1
Apollo	1	0	1

The name of a Greek god	A prognostic factor	The treatment, a heart transplant	The outcome, death
Rheia	0	0	0
Kronos	0	0	1
Demeter	0	0	0
Hades	0	0	0
Hestia	0	1	0
Poseidon	0	1	0
Hera	0	1	0
Zeus	0	1	1
Artemis	1	0	1
Apollo	1	0	1

# 3. Set the value of **a** to a single value for each cloned data set

The name of a Greek god	A prognostic factor	a	The outcome, death
Rheia	0	0	0
Kronos	0	0	1
Demeter	0	0	0
Hades	0	0	0
Hestia	0	0	0
Poseidon	0	0	0
Hera	0	0	0
Zeus	0	0	1
Artemis	1	0	1
Apollo	1	0	1

The name of a Greek god	A prognostic factor	a	The outcome, death
Rheia	0	1	0
Kronos	0	1	1
Demeter	0	1	0
Hades	0	1	0
Hestia	0	1	0
Poseidon	0	1	0
Hera	0	1	0
Zeus	0	1	1
Artemis	1	1	1
Apollo	1	1	1

### 3. Set the value of **a** to a single value for each cloned data set

```
1 # set all participants to have a = 0
2 untreated_data <- greek_data |>
3   mutate(a = 0)
4
5 # set all participants to have a = 1
6 treated_data <- greek_data |>
7   mutate(a = 1)
```

## 4. Make predictions using the model on the cloned data sets

```
1 # predict under the data where everyone is untreated
2 predicted_untreated <- greek_model |>
3   augment(newdata = untreated_data) |>
4   select(untreated = .fitted)
5
6 # predict under the data where everyone is treated
7 predicted_treated <- greek_model |>
8   augment(newdata = treated_data) |>
9   select(treated = .fitted)
10
11 predictions <- bind_cols(
12   predicted_untreated,
13   predicted_treated
14 )
```

# 5. Calculate the estimate you want

```
1 predictions |>
2   summarise(
3     mean_treated = mean(treated),
4     mean_untreated = mean(untreated),
5     difference = mean_treated - mean_untreated
6   )
```

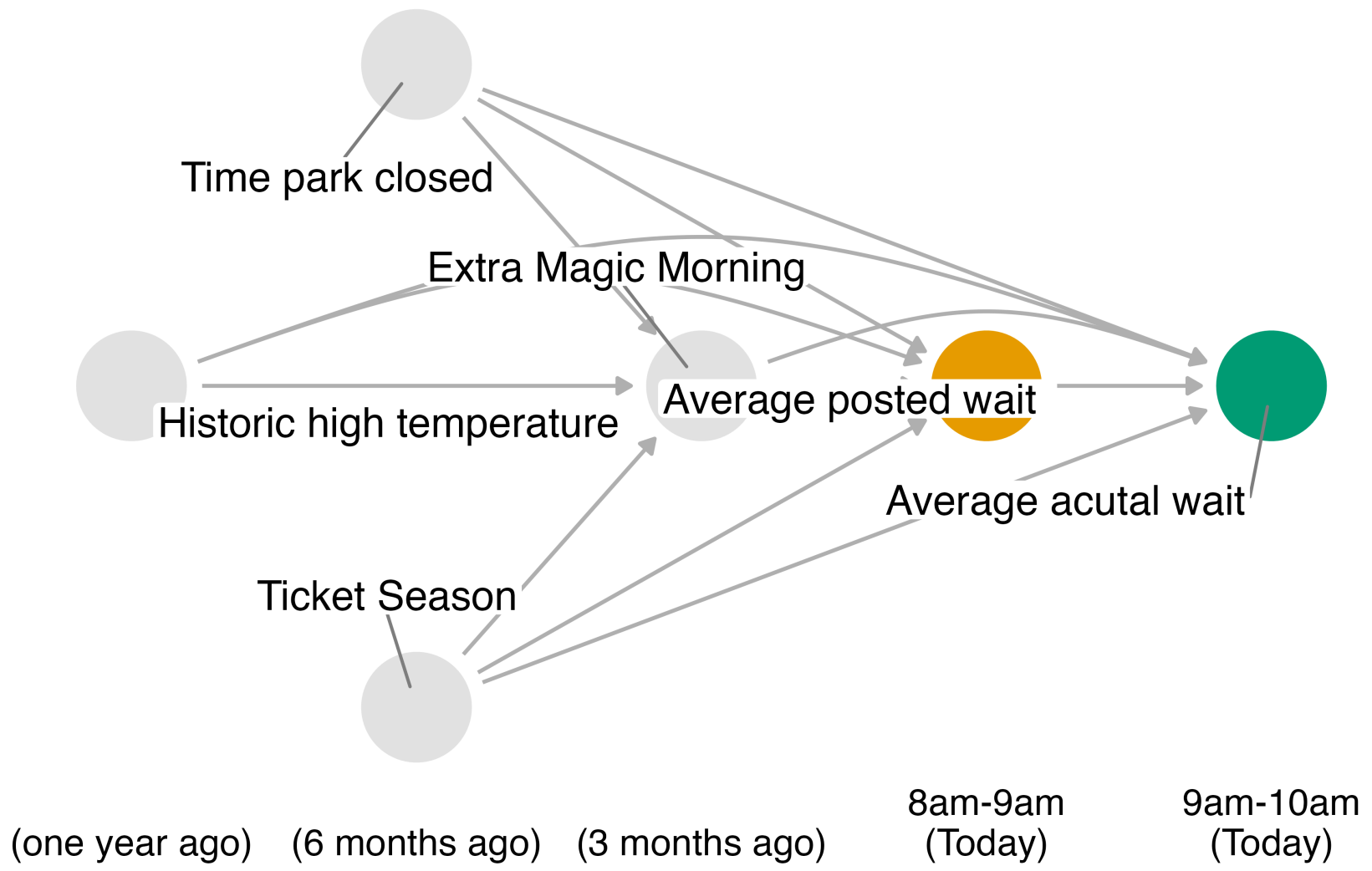
# A tibble: 1 × 3

	mean_treated	mean_untreated	difference
	<dbl>	<dbl>	<dbl>
1	0.5	0.5	0

# Continuous exposures

**We recommend g-computation  
over propensity scores for  
continuous exposures because of  
stability issues**

# Do *posted* wait times at 8 am affect *actual* wait times at 9 am?





## *Your Turn*

**Work through Your Turns 1-3 in `10-continuous-g-computation-exercises.qmd`**

10:00