Social Data Science

SOCIOL 114

Causal inference by outcome modeling

Learning goals for today

By the end of class, you will be able to

- connect causal inference (a missing data problem)

  to statistical modeling (predicting missing data)

A running example

I feel confident that I can answer quantitative questions with tools from data science.

- 1 = Agree
- 0 = Disagree

A running example

I feel confident that I can answer quantitative questions with tools from data science.

- $1 =$ Agree
- $0 =$ Disagree

What is the average causal effect of taking this class on confidence in data science skills?

Using potential outcomes

Each Row is a Student in This Class	Outcome under 114	Outcome under no 114
	$Y_1^{\text{Takes 114}}$	$Y_1^{\text{No 114}}$
	$Y_2^{\text{Takes 114}}$	$Y_2^{\text{No 114}}$
	$Y_3^{\text{Takes 114}}$	$Y_3^{\text{No 114}}$
	$Y_4^{\text{Takes 114}}$	$Y_4^{\text{No 114}}$
	$Y_5^{\text{Takes 114}}$	$Y_5^{\text{No 114}}$
	$Y_6^{\text{Takes 114}}$	$Y_6^{\text{No 114}}$

$Y =$ I feel confident that I can answer quantitative questions with tools from data science

Using potential outcomes

Each Row is a Student in This Class	Outcome under 114	Outcome under no 114
1	$Y_1^{\text{Takes 114}}$	?
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3	$Y_3^{\text{Takes 114}}$	?
4	$Y_4^{\text{Takes 114}}$	?
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6	$Y_6^{\text{Takes 114}}$	?

$Y =$ I feel confident that I can answer quantitative questions with tools from data science

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$Y =$ I feel confident that I can answer quantitative questions with tools from data science

How could we learn about the (?)

Strategy: Adjust for measured confounders

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For each of you, we could compare

1. your opinion after 114
2. the average opinion of non-114 students who look like you

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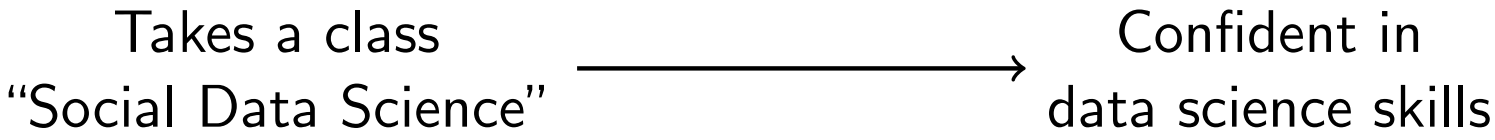
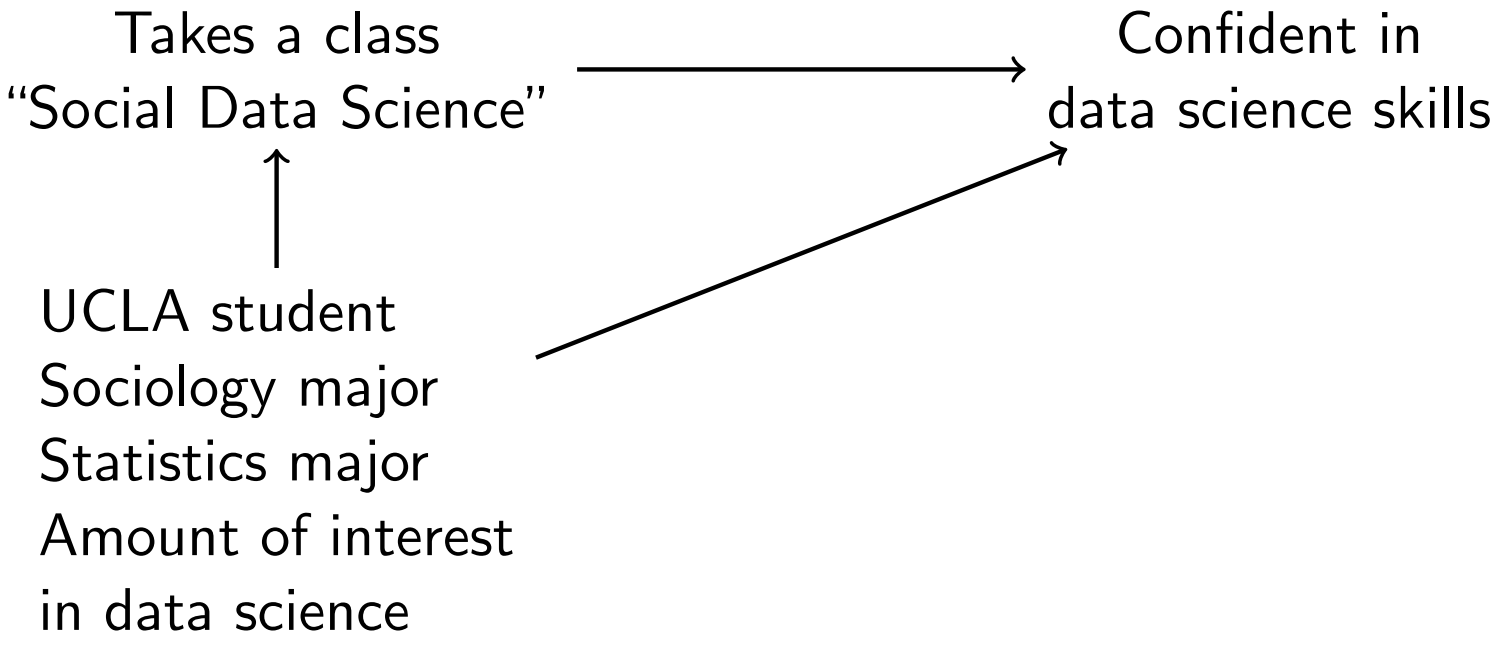
Looks like you in what ways? What else belongs in this DAG?



Strategy: Adjust for measured confounders



Suppose these are a sufficient adjustment set.

Strategy: Adjust for measured confounders

Nonparametric estimation:

For each student in the class, find someone else who

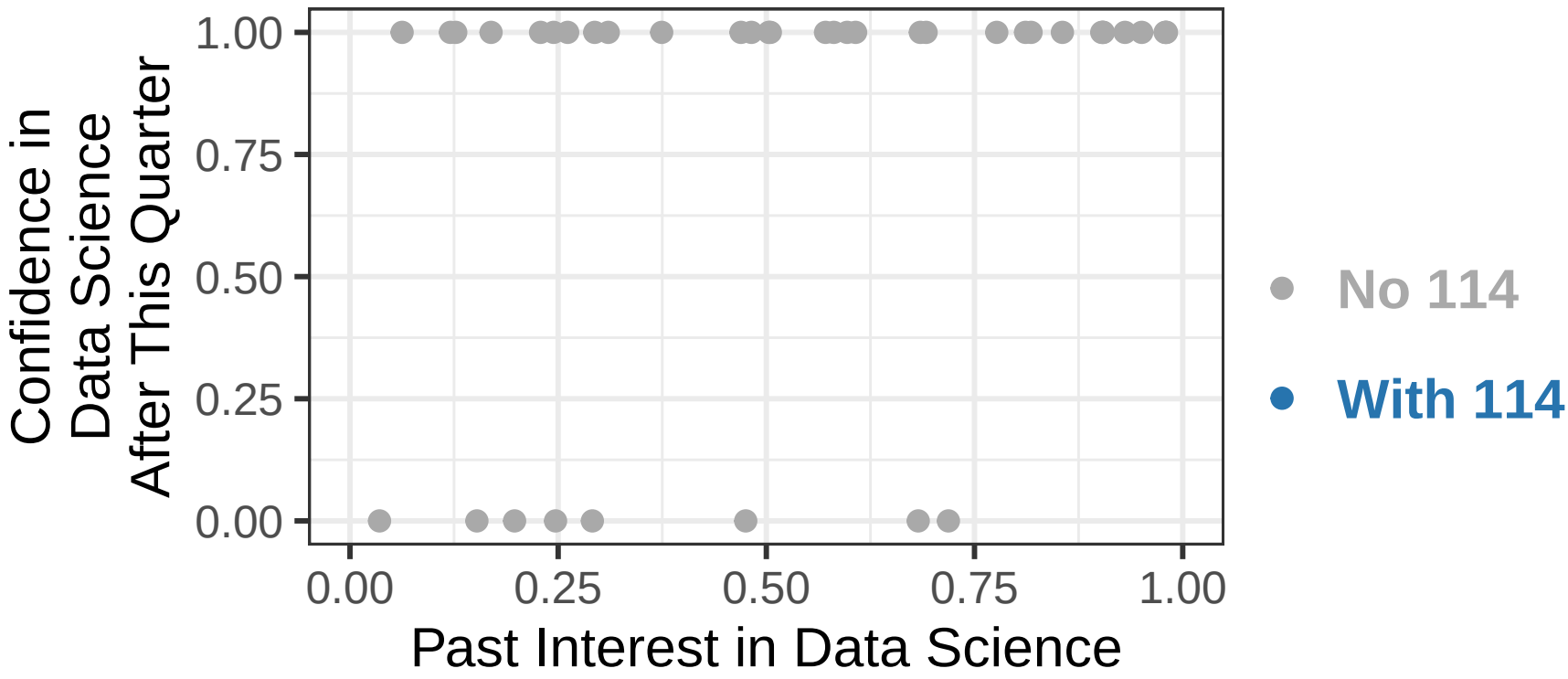
- is a student at UCLA
- shares your major
- is exactly as interested in data science as you are
- but did not take this class

Use your **match** to infer your $Y_i^{\text{No 114}}$ for people like you:

$$\mathrm{E}(Y^0 \mid \vec{X} = \vec{x}_i) = \underbrace{\mathrm{E}(Y \mid A = 0, \vec{X} = \vec{x}_i)}_{\text{estimated from your match}}$$

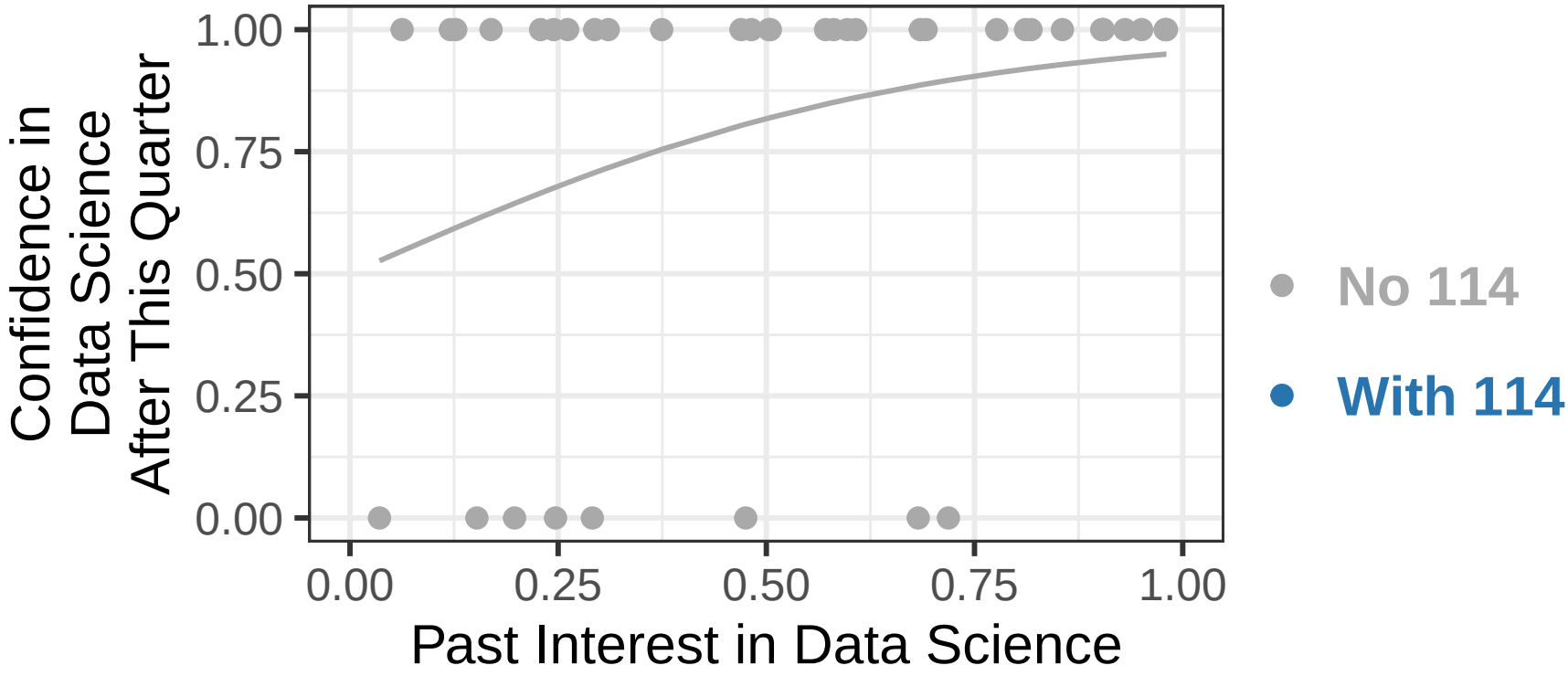
since we have assumed conditional exchangeability given $\vec{X}$.

Generalizing to a model



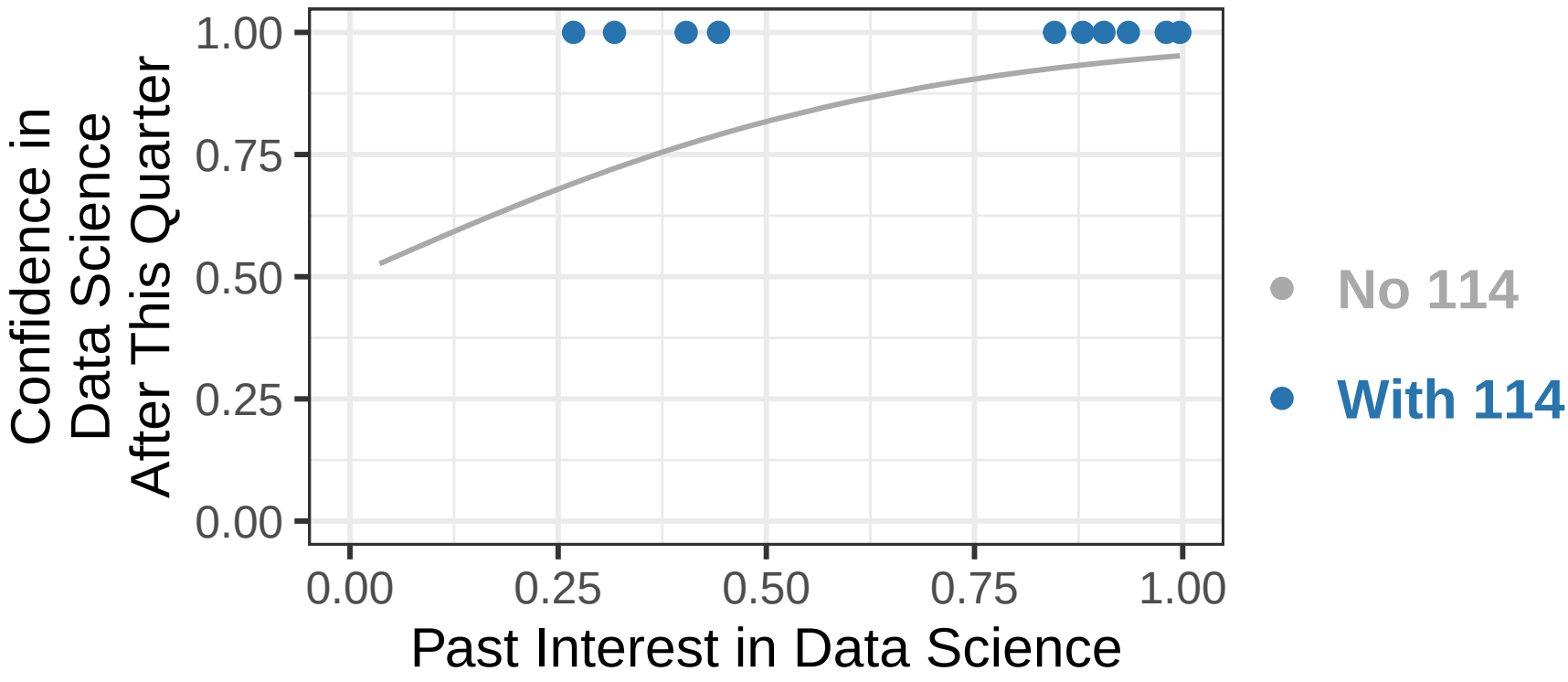
1) Find control units who didn't take this class

Generalizing to a model



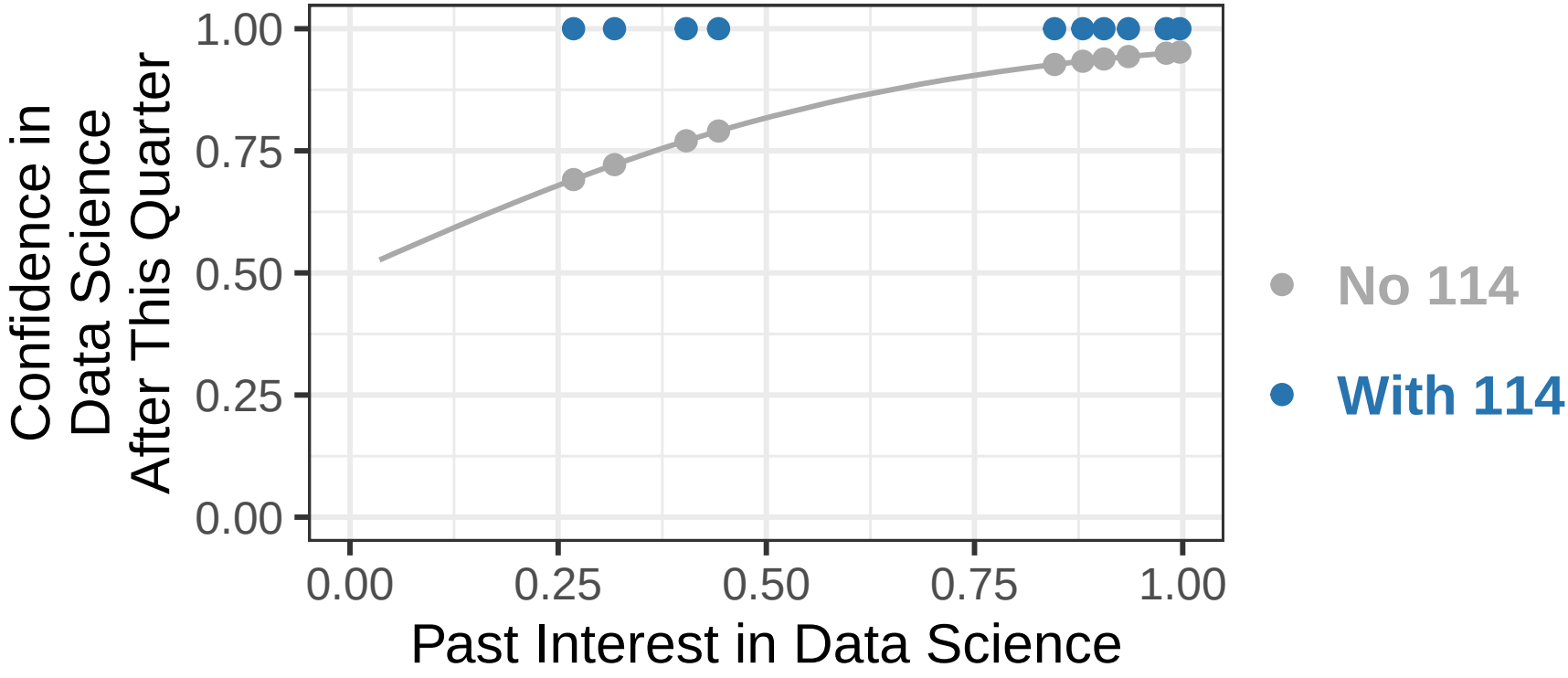
2) Model their outcomes given pre-treatment variables

Generalizing to a model



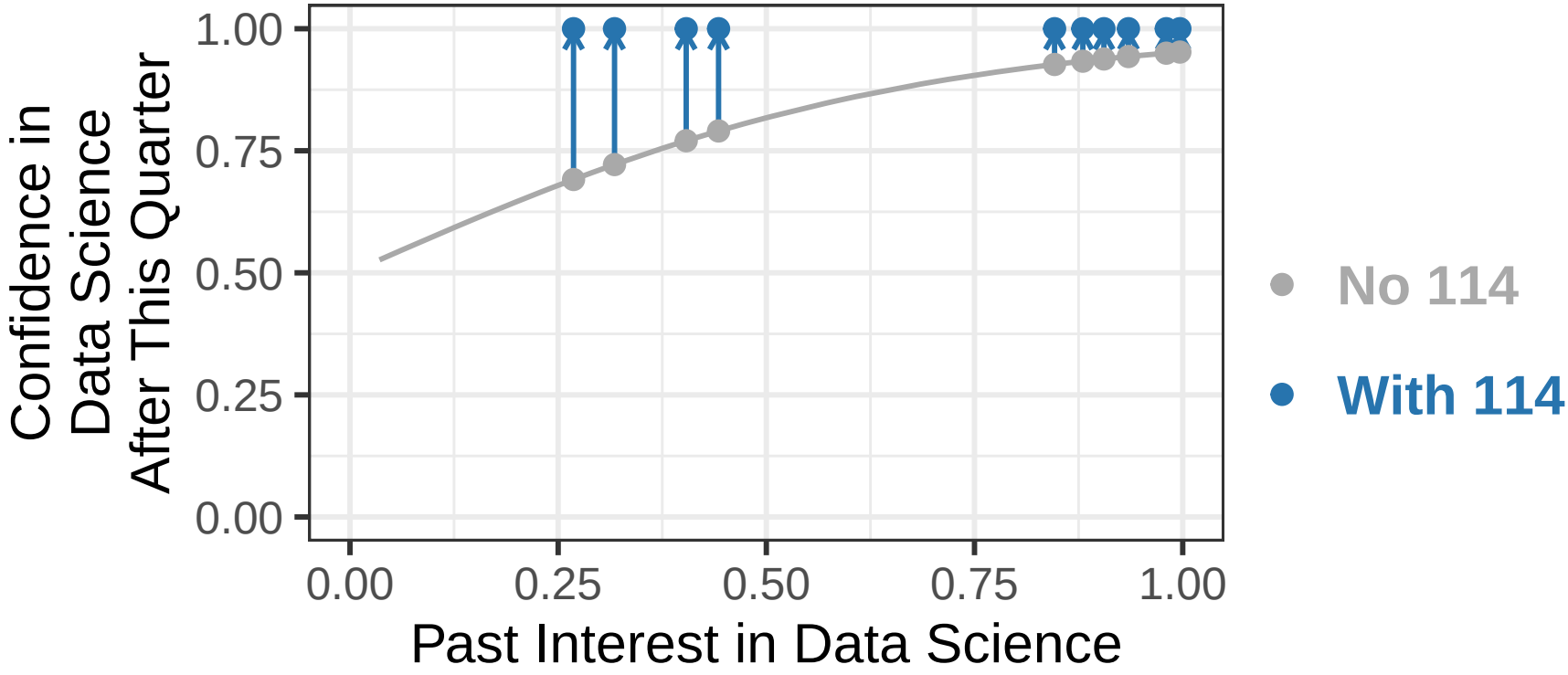
3) Find the treated units of interest

Generalizing to a model



4) Predict their counterfactual outcomes

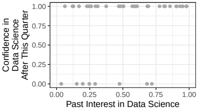
Generalizing to a model



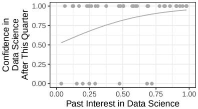
5) Infer causal effect for each person. Average over people

Strategy 2: Generalizing to a model

1) Find control units who didn't take this class



2) Model their outcomes given pre-treatment variables



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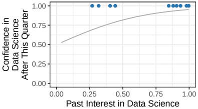

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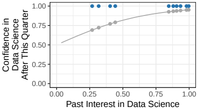
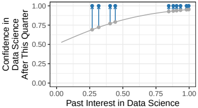


5) Infer causal effect for each person. Average over people



Summary: Outcome model for causal inference

Each Row is a Student in This Class

Outcome under 114	Outcome under no 114
$Y_1^{\text{Takes 114}}$	?
$Y_2^{\text{Takes 114}}$	?
$Y_3^{\text{Takes 114}}$	?
$Y_4^{\text{Takes 114}}$	?
$Y_5^{\text{Takes 114}}$	?
$Y_6^{\text{Takes 114}}$	?

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General approach

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General approach

1) Define potential outcomes

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General approach

1) Define potential outcomes
2) Define target population

Summary: Outcome model for causal inference

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General approach

1) Define potential outcomes
2) Define target population
3) Make causal assumptions

Summary: Outcome model for causal inference

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General approach

1) Define potential outcomes
2) Define target population
3) Make causal assumptions
4) Model unobserved outcomes

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General approach

1) Define potential outcomes
2) Define target population
3) Make causal assumptions
4) Model unobserved outcomes
5) Predict them

Summary: Outcome model for causal inference

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General approach

1) Define potential outcomes
2) Define target population
3) Make causal assumptions
4) Model unobserved outcomes
5) Predict them
6) Report an average

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  to statistical modeling (predicting missing data)