Introduction and measurement

Topic 1 · Tuesday, January 5

EDUC 15: Statistics for Education Research
UCI School of Education

Plan for today

Welcome!

What statistics is for

Measurement

Welcome!

Please call me Andy

Andreas de Barros



Lectures

Student hours on Calendly

adb@uci.edu

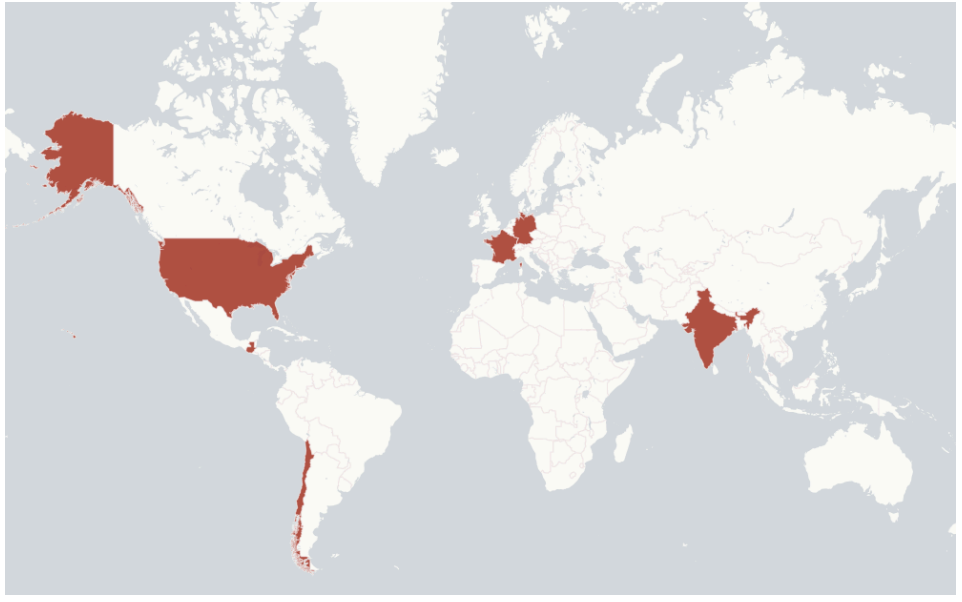
TA: Pritha Sengupta

Friday labs

Drop-in student hours

prithas@uci.edu

Shout out to all those here who find this place a bit strange



Where	What
Germany	BA and MA in Political Science, and teacher training, at Konstanz University
Guatemala	An education NGO in Ciudad de Guatemala
France	International education policy at UNESCO
Chile, India and the US	Education research at J-PAL and at MIT
US	PhD in Education at Harvard University

My work promotes large-scale research-practice partnerships, particularly in Sub-Saharan Africa and South Asia

Educational technology

Size	Partners
240 government schools	State Government of Haryana, Avanti Fellows, USAID DIV
250 early-childhood centers	State Government of Uttarakhand, Dost Education, The Agency Fund
30 government schools	State Government of Rajasthan, Educational Initiatives, Douglas B. Marshall Foundation

Assisting teachers in adjusting and improving their instruction

Size	Partners
292 government schools	State Government of Karnataka, Akshara Foundation, Omidyar
209 government schools	Cambodia Ministry of Education, Youth and Sport, The World Bank
273 government schools	Zambia Ministry of Education, TaRL Africa, VVOB, KIX
500+ government schools	Morocco Ministry of National Education, Pratham, J-PAL, Harvard

What you'll take from this course

Read and explain statistics in education research

Describe and define the key ideas

Do the calculations

We build intuition first: you'll run simulations, and always ask what's the truth and what's only our estimate

Your week has a routine

When	What	Where
Before class	Do the reading	The book, through MindTap
Tue and Thu, 12:30–1:50 PM	Lecture: 20 minutes of talk, then you do something, three times	EDUC 2009
Fri, 12:00–12:50 PM	Lab A1	EDUC 2009
Fri, 1:00–1:50 PM	Lab A2	EDUC 2001
Sun, 6 PM	MindTap homework is due	Canvas

Go to all classes. Go to your own lab. Lecture activities aren't scored

Fridays: regular labs and quiz days

Regular labs

A by-hand problem in pairs

The same idea on real data, in a spreadsheet or the simulator

One written sentence on what it means

Quiz days

A quiz in Labs 3, 6 and 10

Labs 6 and 10 also review for the exams

We'll explain the format in class

Labs 2 and 8 start with a 15-minute individual check. Use Google Sheets or Excel

It adds up to 350 points

What	Points	How it counts
Quizzes	40	Best 4 of 5 Friday events, 10 points each
Labs	21	Best 7 of 10 labs, 3 points each
Mastery Training	40	Best 8 of 9, 5 points each
Problem Sets	40	Best 8 of 9, 5 points each
Midterm	100	In person
Final	100	In person, cumulative
Course evaluation	9	For completing it

You earn 261 of the 350 points in person. Lecture attendance isn't graded

Two exams, both in person

Midterm

Tuesday, February 16, in class

80 minutes, Chapters 1 to 9

Final

Date to come from the Registrar

Cumulative

Each is 100 points of free response, built on the Mindspark data

Open book: bring any print materials, and your own notes

A calculator is the only device. We attach tables and a formula sheet

You can ask for a translated exam, in any language

Homework is due Sundays at 6 PM

Mastery Training

Unlimited attempts

Problem Sets

3 attempts, full credit at 75%

Chapters 5 to 12 and 14. The first set is due Sunday, January 17

An automatic one-day extension, to Monday at 6 PM

Your lowest score of each type drops

Get access to Cengage MindTap now, through Canvas

Use AI to learn, not to get answers

You're welcome to use AI to

Explain an idea

Make practice problems

Help with a spreadsheet formula

Don't use it to

Get answers to MindTap questions

Homework is your practice for exams and quizzes, where you'll have no AI and no devices

AI also makes mistakes in statistics, so check what it tells you

UCI's academic integrity rules still apply

Where to find things

Course website

educ15.de-barros.com

Syllabus, schedule, slides, lab handouts

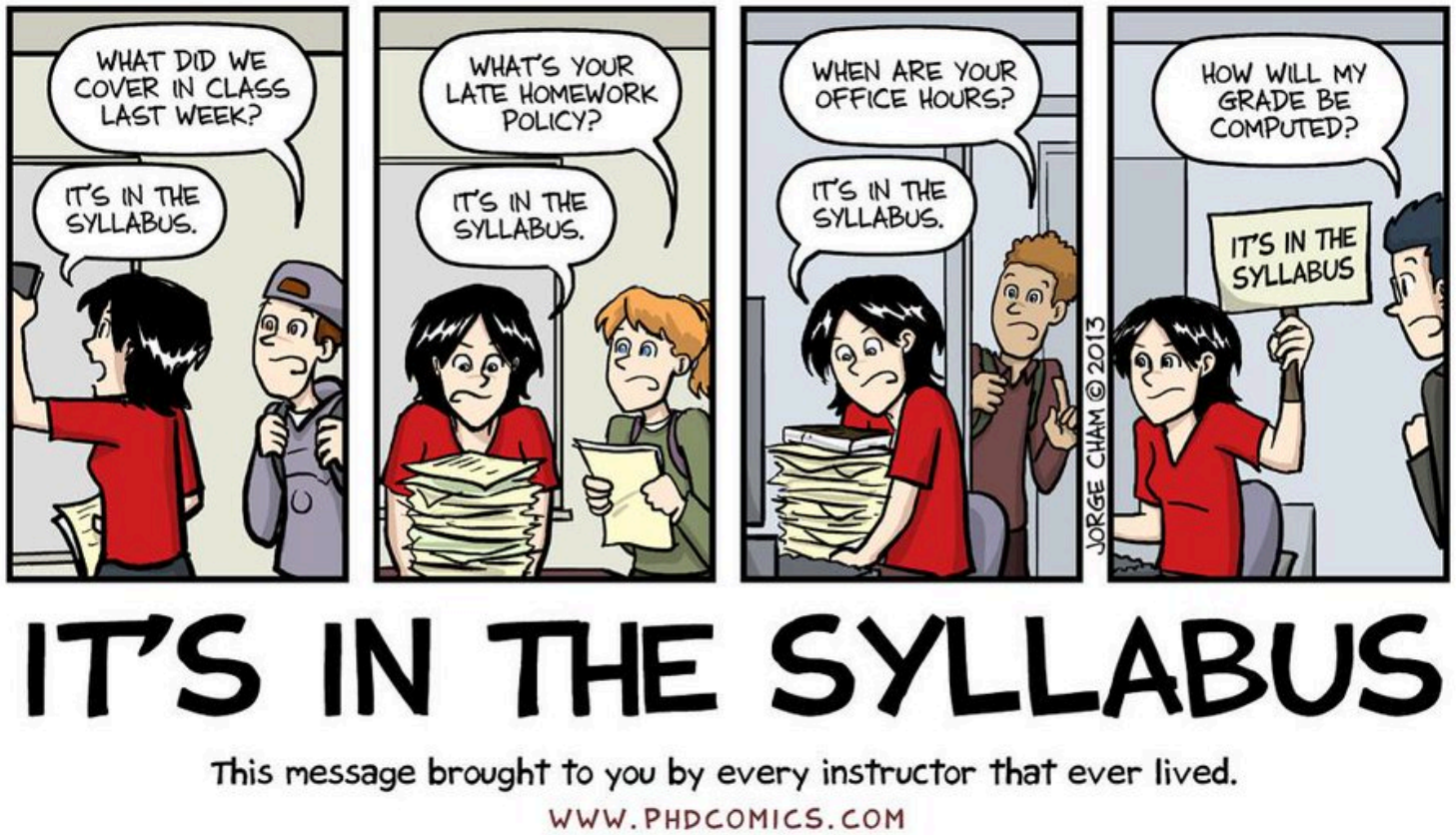
Canvas

MindTap and the ebook

Grades, solutions, and slide files

Not sure about a rule? It's in the syllabus

It's in the syllabus



"Piled Higher and Deeper" by Jorge Cham, www.phdcomics.com

Most importantly

Ask for help, and tell us how you're doing

Check yourself before you wreck yourself

(Sorry, Ice Cube)

Not sure about your math? Try the Math Skills Assessment in Appendix A

Play it: Course rules

In Jeopardy, the clue is an answer. Talk to a neighbor, then call out the question

100 · Sunday at 6 PM

200 · 7 of 10

300 · A calculator, and no other device

400 · Explain an idea, but not a MindTap answer

Play it: The questions

100 · When is homework due?

200 · How many labs count?

300 · What device can you use on an exam?

400 · What can AI do for you?

That's the rhythm of every lecture: some talk, then your turn

What statistics is for

Where are we?

Description

Summarize data

Visualize data

We start here



Prediction

Forecast the future

Focus is on Y

Explanation

Effect of X on Y

Focus is on X

Peter the Anteater at a UC Irvine basketball game.

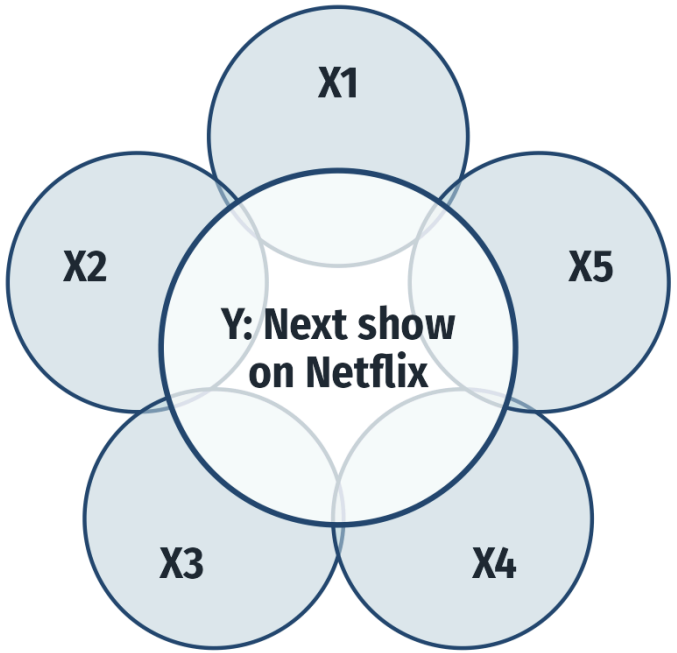
One topic, three kinds of question

	Description	Prediction	Explanation
Netflix	Which movie was watched most?	What's your next show?	What's the effect of the time of day on what you pick?
SNAP	What % of students are eligible?	Who will enroll?	What's the effect of SNAP on poverty?

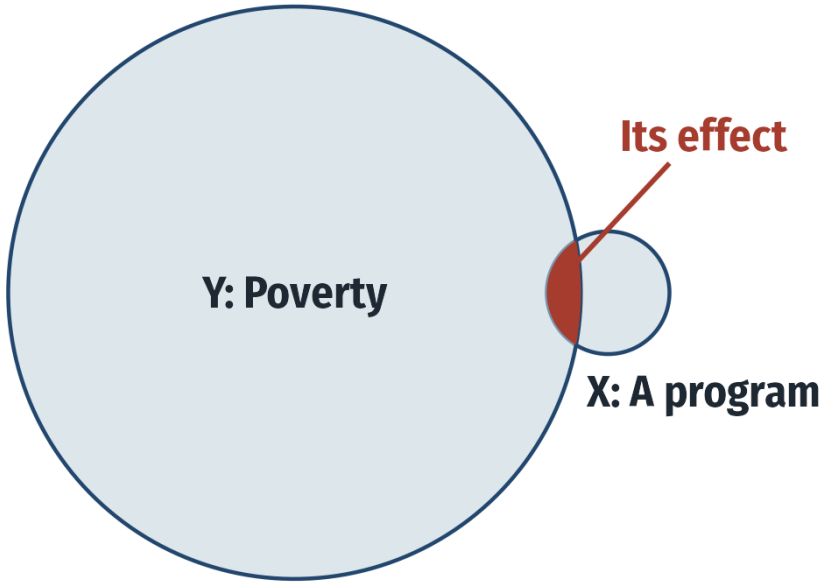
Before you pick a method, ask which of the three you're trying to do

Prediction focuses on Y. Explanation focuses on one X

Prediction: explain as much of Y as you can



Explanation: get that little sliver right



Adapted from Andrew Heiss's slides.

Meet Mindspark, our running example

Adaptive learning software in after-school centers in Delhi, India

619	3	95%
students	centers	in grades 6 to 9

You'll work with the real data in labs and on both exams

Data: Muralidharan, Singh, and Ganimian (2019).

A lottery decided who got it

Treatment

314 students got the program

18.68

average math score at endline

Control

305 students were promised it later

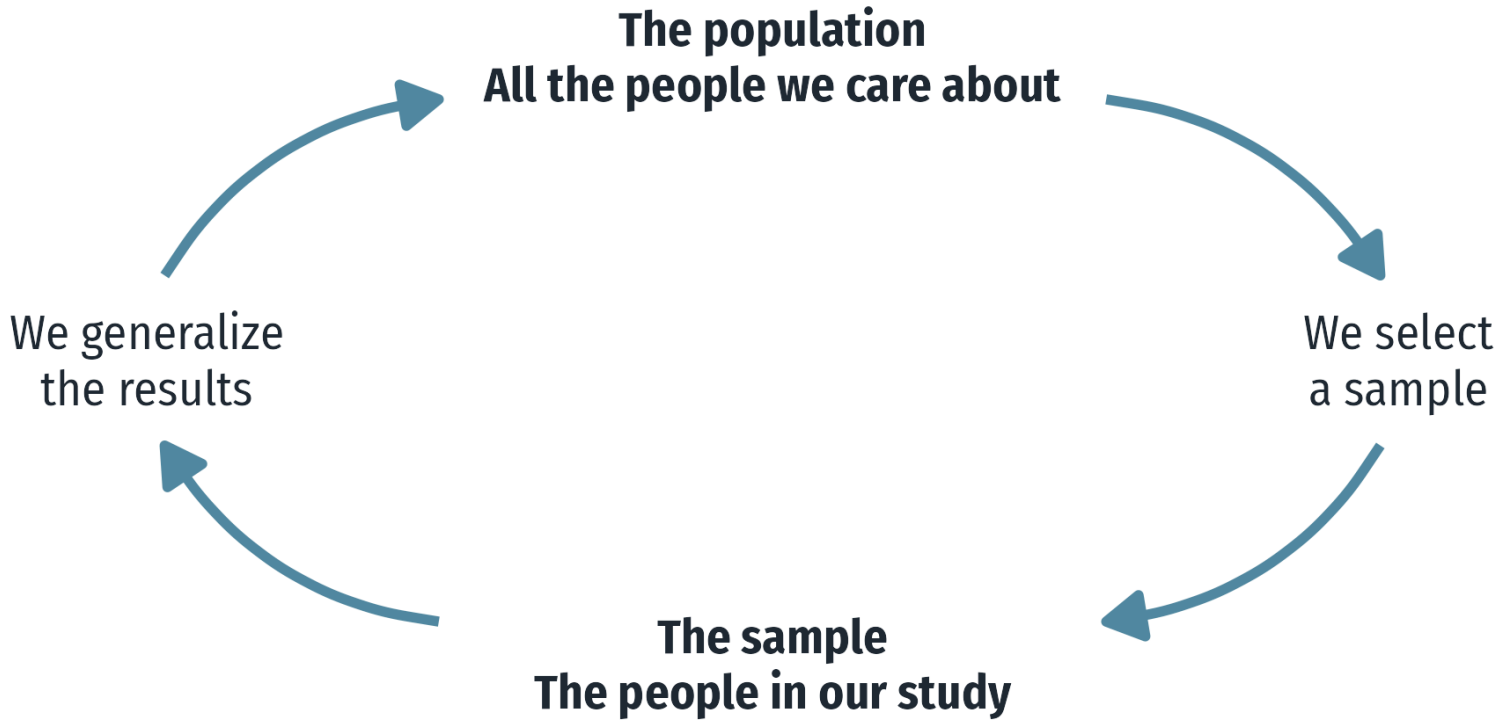
15.99

average math score at endline

Is a gap of 2.69 points real, or just luck? By March, you'll be able to say

Data: Muralidharan, Singh, and Ganimian (2019). Endline: 539 students.

From population to sample, and back



After Gravetter et al., *Essentials of Statistics for the Behavioral Sciences*, 10e.

We use data to estimate the truth

$$X \rightarrow M = \frac{\sum X}{n} \rightarrow \hat{\mu} \overset{\text{hopefully}}{\longrightarrow} \mu$$

Data	Calculation	Estimate	Truth
The scores we saw	The mean of those scores	Our best guess about the population	The population's real mean

A *parameter* describes a population. A *statistic* describes a sample

Greek means population. A Latin letter or a hat means an estimate

Predict it: Two samples from one population

Treat our 619 students as a population, with a mean math score of μ = 11.12

Two people each draw a random sample of 25 students and find M. What happens?

A Both get exactly 11.12

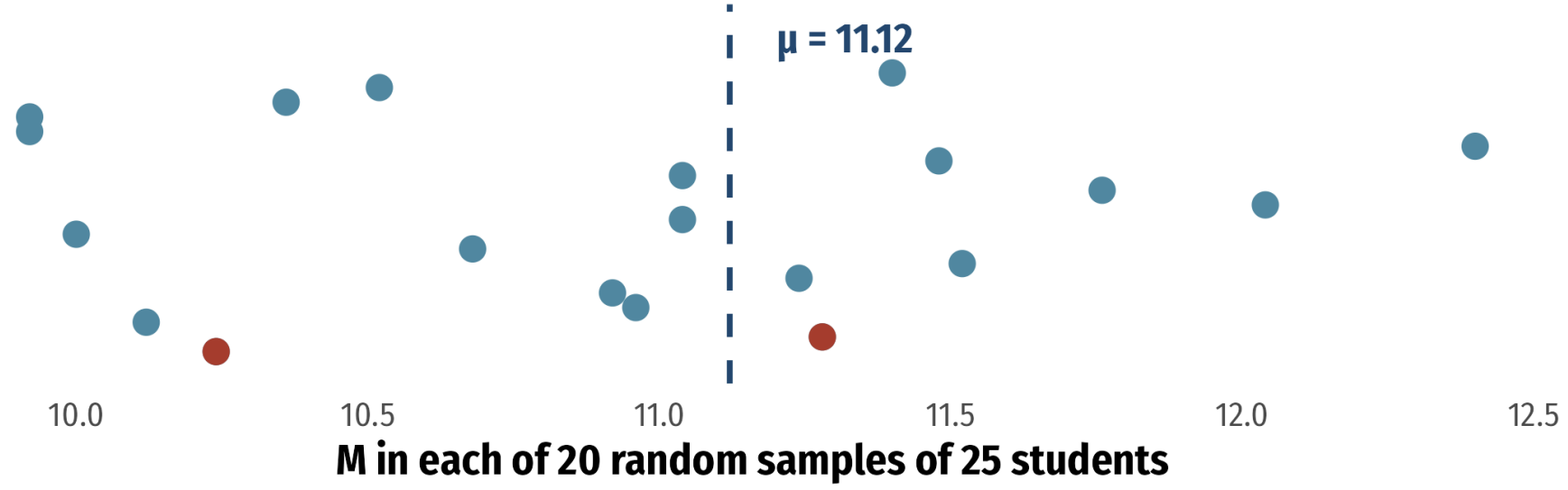
B They match, but miss 11.12

C They differ, and both land near 11.12

D They differ, and both land far from 11.12

Data: Muralidharan, Singh, and Ganimian (2019).

Predict it: Samples rarely agree



The first two samples, in red, got M = 10.24 and M = 11.28. The answer is C

***Sampling error* is the chance gap between an estimate and the truth**

Data: Muralidharan, Singh, and Ganimian (2019).

Measurement

Statisticians measure variables

A *variable* is a characteristic that differs from one person to the next

Center	Grade	Group	Math score
Chhatarpur	7	Control	12
Govindpuri	7	Treatment	14
Tekhand	6	Control	3
Chhatarpur	8	Treatment	15

Each row is a student. Each column is a variable

Data: Muralidharan, Singh, and Ganimian (2019). Four of the 619 students.

Many variables stand in for constructs

A *construct* is an internal attribute that we can't observe directly

Construct	Variable
Math ability, motivation, self-esteem	A test score, a survey answer

We can't see math ability. We can see how many questions a student gets right

Say what you mean, then measure it

Conceptualization

What do you mean?

A construct can be understood in many ways, so we have to define it

Math ability: which math, at what level?

Operationalization

How do you measure it?

Spell out the steps that turn it into something we can observe

A test, scored by the number of correct answers

Two related variables get special names

Y

Outcome variable

Response variable

Dependent variable

What you want to explain or predict

X

Explanatory variable

Predictor variable

Independent variable

What you use to explain or predict Y

Find the Y and the X

Talk to a neighbor. Is each study prediction or explanation?

A study examines the effect of smoking on lung cancer

You want to see if taking more AP classes in high school improves college grades

Researchers predict genocides by looking at negative media coverage, revolutions in neighboring countries, and economic growth

Netflix uses your past viewing history, the day of the week, and the time of day to guess which show you want to watch next

One X to explain, many X to predict

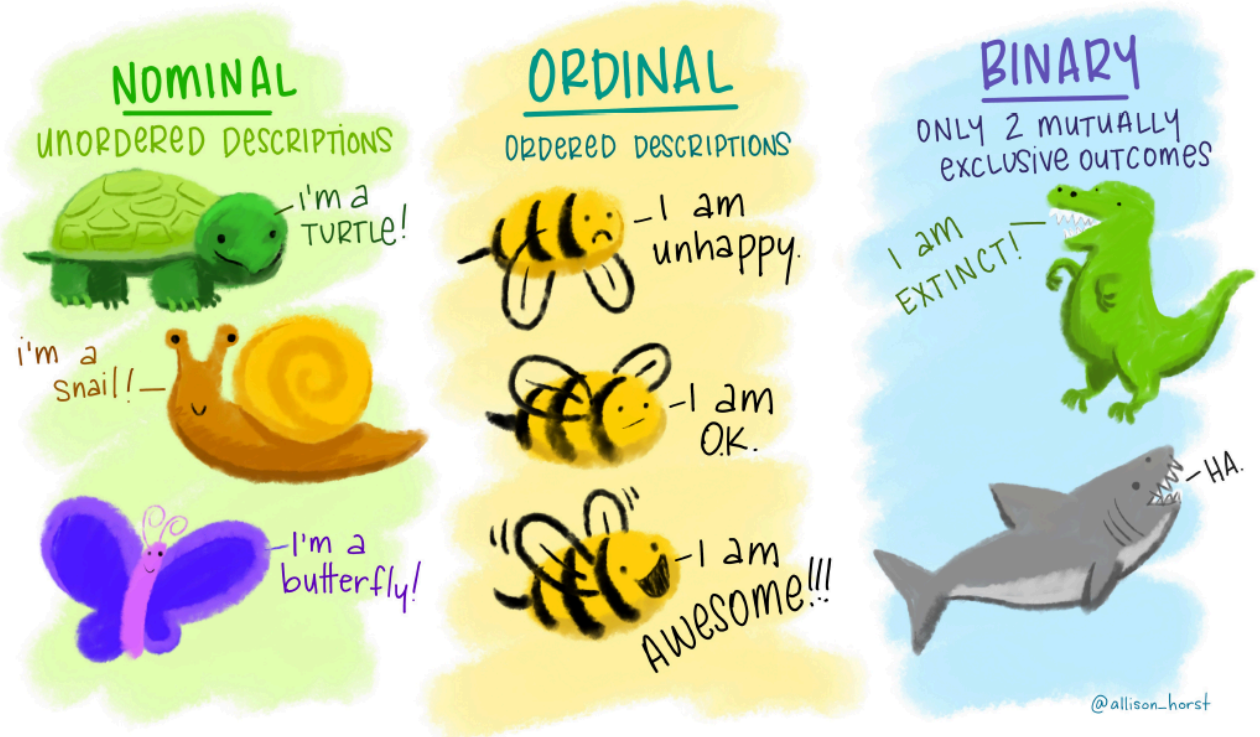
Study	Y	X	Purpose
Smoking	Lung cancer	Smoking	Explanation
AP classes	College grades	AP classes taken	Explanation
Genocides	Genocide	Media coverage, nearby revolutions, economic growth	Prediction
Netflix	Next show	Viewing history, day of the week, time of day	Prediction

The categories we use to measure a variable make up a scale

Scale	What it does	Examples
Nominal	Labels categories. No quantities	Gender, diagnosis, experimental or control
Ordinal	Puts categories in order of size	Rank in class, clothing sizes, Olympic medals
Interval	Equal steps, but an arbitrary zero or none	Temperature, IQ, golf scores above or below par
Ratio	Equal steps and an absolute zero	Number of correct answers, time to finish a task, gain in height

Each scale can do everything the one above it can, and a bit more

Nominal, ordinal and binary



Artwork by @allison_horst, CC BY 4.0.

Mindspark has all four scales

Variable	Its values	Scale	Why
Center	Chhatarpur, Govindpuri, Tekhand	Nominal	Names only
Extra math tuition	Less than 1 hour to more than 4 hours	Ordinal	The top group has no upper end
SES index	−5.6 to 4.8	Interval	Zero is just the group's average
Math score	0 to 35 correct	Ratio	It counts correct answers

A score of zero means no correct answers. It doesn't mean no math ability

Data: Muralidharan, Singh, and Ganimian (2019). Baseline.

Discrete or continuous?

Discrete

Only limited values, often counts

Students in a class

Children in a family

Continuous

Measured, so any value in a range

Time to finish a test

Height

Measured or counted?



Artwork by @allison_horst, CC BY 4.0.

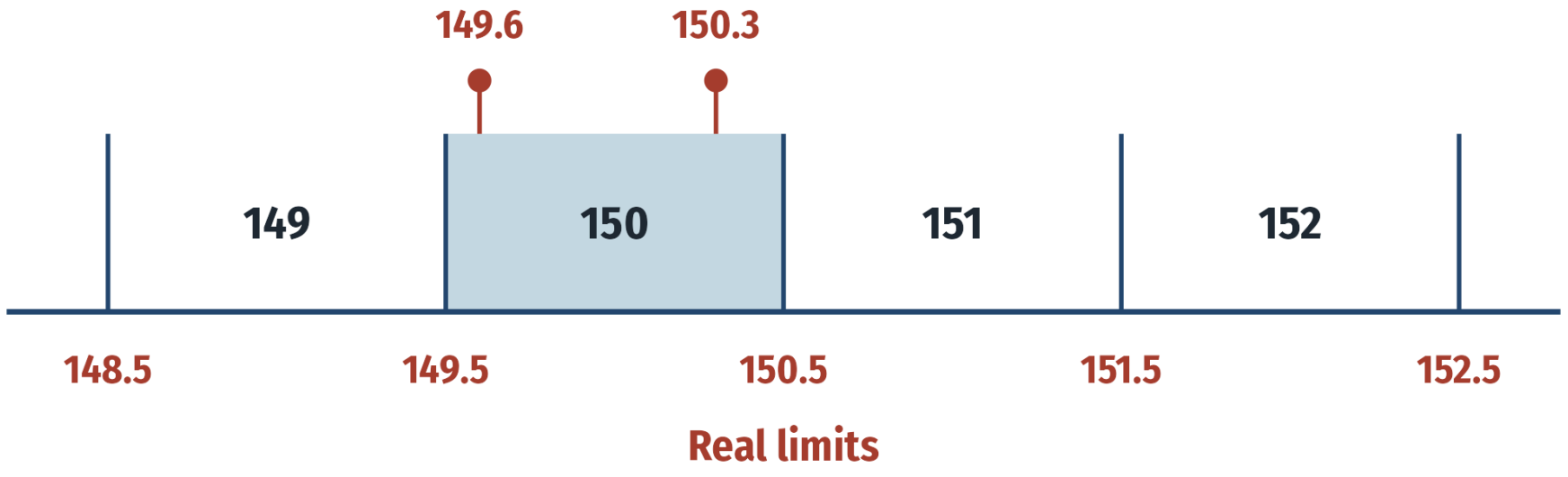
Switches and sliders



Getting the program is a switch: on or off. Age is a slider

Image: Andrew Heiss, *Program Evaluation for Public Service*, CC BY-NC 4.0.

A rounded value is really a small range



Recording weight to the nearest pound, 149.6 and 150.3 both become 150

After Gravetter et al., *Essentials of Statistics for the Behavioral Sciences*, 10e.

Try it: What scale is this?

Respond at **PollEv.com/adb**

Mindspark also records a math quintile for each student, from 1 (the lowest fifth) to 5 (the highest fifth). Which scale is that?

A Nominal

B Ordinal

C Interval

D Ratio

Data: Muralidharan, Singh, and Ganimian (2019).

What you can do now

Say how this course runs, and where to find things

Tell description, prediction and explanation apart

Label a number as a parameter or an estimate, and explain sampling error

Name a study's Y and X, and a variable's scale of measurement

Next steps

Thursday, January 7

Topic 2, displaying data. Read sections 2-1 to 2-3 first

Friday, January 8: Lab 1

Meet the data. Go to your own lab, and bring a calculator and a laptop

Nothing is due this Sunday. Get MindTap through Canvas now