ECON 1190: Econometrics 2:
Class 1: Intro and Stats Review Blitz

Claire Duquennois

Syllabus and course logistics

Course description

- hands-on skills in applied econometric research methods
- focus on research design and approaches to establish empirical relationships of cause and effect
- advanced methods in regression analysis

Topics covered include:

- omitted variable bias, fixed effects, instrumental variables, randomized control trials, difference-and-differences, and regression discontinuities.
- learning the basic tools of programming and coding in R (no prior knowledge is required)
- learn to present results in nice formatted tables and figures

Is this course right for me?

- I am interested in how economists do research with data
- I am interested in developing my (highly marketable!) data analysis skills
- I have taken a class such as ECON 1150: Applied Econometrics 1 (or STAT 1221, IF 1071) and am comfortable with:
  - basic probability and statistics
  - basic linear regressions
- to use other classes as prerequisites, check with Katherine Wolfe (kwolfeATpitt.edu)
- I am ready to work hard!

Contact

Email: ced87-at-pitt.edu

Office hours: Mondays after class: 4:30-5:30

Personal advising/discussion: Sign up at https://sites.google.com/view/claireduquennois/teaching

Required materials

- Rstudio Cloud Student Account:
  - Purchase a Student account ($5/month for duration of term).
- Homework article readings:
  - 5 academic journal articles that we will replicate
  - available on canvas to be read by the dates indicated in the course schedule
- Lecture notes and slides available on course github page: https://github.com/claireduq/econ1190
- Reference texts as needed:
  - Nick Huntington-Klein The Effect (Available online).
  - Cunningham, Scott. Causal Inference: The Mixtape (Available online)
  - Wooldridge, Jeffery. Introductory Econometrics: A modern Approach. (Any edition).
  - Angrist, Joshua D and Pischke, J. Mostly Harmless Econometrics. Princeton University Press, 2008.

Grades

- Homework assignments 50%: 6 assignments, best 4 count for 10% each, lowest 2 for 5% each)
- 2 Exams 40%: Your best performance is worth 25% your lowest 15%
- 25 daily top hat 'Tiny Quizzes' 10%:
  - Participation 6%: Each of 20 for 0.3% (5 lowest are dropped)
  - Accuracy 4%: let score be the number of correct answers on tiny quizzes
    - if $7 <$ score ≤ 10: 1%
    - if $10 <$score ≤ 13: 2%
    - if $13 <$ score ≤ 16: 3%
    - if $16 <$ score: 4%

Homework assignments

- To deepen your understanding, practice coding in R, and see how real research is done in empirical applied economics
- To be done in R markdown via R Studio Cloud, submitted as PDF's on Gradescope
- You can help each other but submitted assignments cannot be identical (0 grade).
- Due as indicated on canvas (usually Tuesdays at 10 pm)
  - No assignments accepted more than 1 week late
  - each student has a quota of 90 late **hours** to use as needed
  - beyond this each extra hour costs 0.01 points off of final grade.
  - Save these for EMERGENCIES!
- Regrade request to be done within a week of getting graded assignment. Avoid regrade requests for minor point changes.

Exams

- will be written, timed, traditional pen and paper exams
- you will not be asked to code but will be asked to interpret code
- you will be allowed 1 page of handwritten notes
- see posted old exams to get an idea of what to expect

Other first day stuff

- Introduce yourself!

Send me an email and let me know if there is anything I need to know or you would like to share about yourself (eg. unique interests, pronouns, preferred names, special accommodations, anticipated absences on exams...) reach out and keep in touch!

Review Blitz: Probability, Statistics and regressions

Review: Probability

The probability of event A ($P(A)$) is a number between 0 and 1:

$$0 \leq P(A) \leq 1$$

Conditional Probability

The probability of an an event might change when additional information becomes available

$$P(A|B) = \text{probability of A given that B occured}$$

Statistical Independence

Two events are statistically independent if the information that one of them has happened does not change the probability of the other

$$\text{A and B are independent if } P(A|B) = P(A)$$

Stats Review: Random Variables

Random variables:

a variable whose value depends on random events

For a given outcome x we may be interested in the probability that the variable X achieves that outcome

$$P(X = x) = ?$$

These outcomes could be discreet or continuous

Stats Review: Discreet random variables

Discreet random variables take a finite number of values

There is a probability associated with each of it's possible values

$$\sum_{allx} P(X = x) = 1$$

Stats Review: Continuous random variables

Continuous random variables take an infinite number of possible values

The density function gives the probability that a random variable is smaller than some value so that

$$P(X \leq a) = \int_{-\infty}^{a} f(x)dx$$

with

$$\int_{-\infty}^{\infty} f(x)dx = 1$$

A cumulative density function maps out

$$F(a) = P(X \leq a)$$

Stats Review: Summarizing random variables

Measures of location:

- mean:

$$\text{Discreet: } E[X] = \mu_X = \sum_{allx} xP(X = x)$$

$$\text{Continuous: } E[X] = \mu_X = \int_{-\infty}^{\infty} xf(x)dx$$

- Also median, percentiles (ex: quartiles) ...

Stats Review: Summarizing random variables

Measures of dispersion:

- Variance

$$\text{Discreet: } Var(X) = \sigma_X^2 = \sum_{allx} (x - \mu_X)^2 P(X = x)$$

$$\text{Continuous: } Var(X) = \sigma_X^2 = \int_{-\infty}^{\infty} (x - \mu_X)^2 f(x) dx$$

- Standard deviation:

$$Std.Dev.(X) = \sigma_x = \sqrt{\sigma_X^2}$$

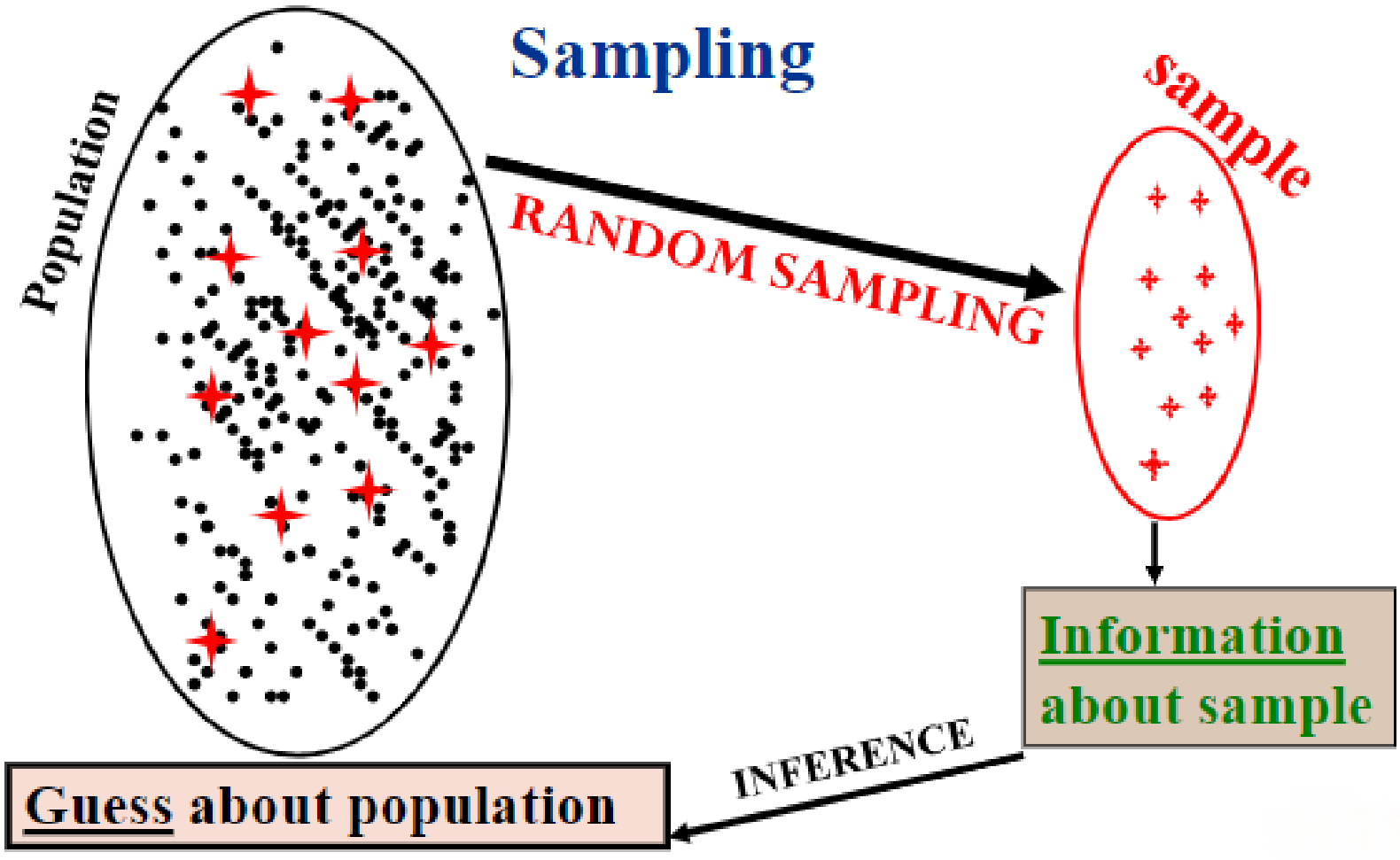
Stats Review: Important distributions

Uniform: the same probability to all values of the random variable

Normal: Important mainly because of the central limit theorem

Standard normal: A normal with mean 0 and standard deviation 1

Stats Review: Sampling, estimation and inference



Stats Review: Sampling, estimation and inference

What information do we get from the sample?

Get the sample mean

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

If you collected a new random sample, your sample mean will be different:

$$\bar{X}_1 \neq \bar{X}_2 \neq \bar{X}_3 \neq \bar{X}_4 ...$$

So what can we learn from the SAMPLE mean about the POPULATION mean μ (what we really care about)?

Stats Review: The Central Limit Theorem

Consider a random sample of n observations taken from a population X with expected value μ_X and standard deviation σ_X. The following are always true of the sample mean $\bar{X}$.

- The probability distribution of $\bar{X}$ approaches a normal distribution as n increases (i.e. with bigger sample size, the distribution of possible $\bar{X}_i$'s looks like a bell curve)
- The expected value of $\bar{X}$ equal μ_X (i.e this bell curve is centered on the population mean)
- The standard deviation of $\bar{X}$ (aka the **standard error**) equals $\frac{\sigma_X}{\sqrt{n}}$ (i.e. the bell curve is tighter as the sample size increases)

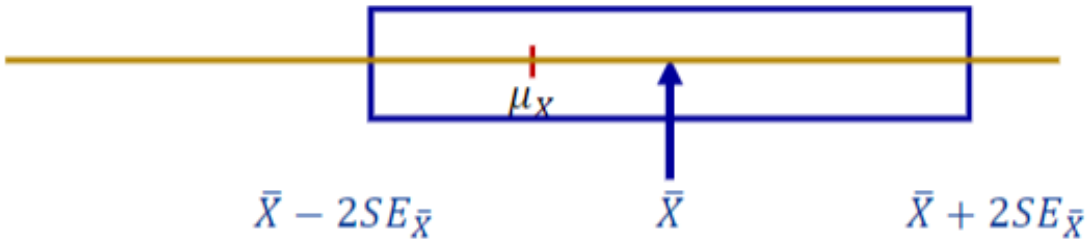
Stats Review: Standard errors and confidence intervals

So given our sample, our best guess of the population mean is the sample mean

$$E[\mu_X] = \bar{X}$$

How good is this guess? How far away from the population mean from the sample mean?

- We build confidence intervals around $\bar{X}$ with its standard error $SE_{\bar{X}}$
- To do this we use a critical value, often $1.96 (\approx 2)$, that reflects how certain we want to be that the confidence interval includes the population mean.



Stats Review: Hypothesis testing

Using these confidence intervals, we can REJECT or FAIL TO REJECT a Null Hypothesis.

- Reject the Null Hypothesis if there is "enough' ' evidence against it

p-value: The largest probability of observing sample data as extreme as your draw given that the Null is true

Upcoming

Next class:

- Intro to R Studio Cloud and R Markdown
- (consider bringing your laptops)
- To do before class: Sign up for a student account ($5 / month) and accept my invitation to the class workspace

After that:

- More review: Regressions and regressions in R