

Image credit: xkcd.com "Boyfriend"

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Teaching Introduction to Statistics

This land acknowledgment recognizes systemic and institutional systems of power that have oppressed Indigenous peoples, with many of the same systems in place today that continue to marginalize those with less power.

Original People of Los Angeles County



Map of territories of Original Peoples with county boundaries in Southern California, Los Angeles Almanac, 2019.

Information sources: *Handbook of North American Indians, Vol. 8, California*, William C. Sturtevant (Gen. Editor) & Robert F. Heizer (Vol. Editor), 1978, Smithsonian Institute, and Dr. E. Gary Stickel, Ph.D. (UCLA), Tribal Archeologist, Kizh Nation / Gabrieleño Band of Mission Indians.

image credit: <http://www.laalmanac.com/history/hi05.php>

First time through: focus on class time

- organize the topics before the semester starts
- make sure the class time runs smoothly
(prepare your lecture!)
- use HW assignments from the text
- give in-class exams (use gradescope to grade)
- do web searches for “t-test quiz”
- projects / extensive HW / solutions / etc. come at the next iteration of the class

#1 hardest thing to teach

sampling distributions
are confusing

- use tactile activities
- use applets
- use R
- use theory

Helper babies

Social evaluation by preverbal infants

Taken from ISCAM Investigation 1.1
Beth Chance and Allan Rossman

[J. Kiley Hamlin](#)  [Karen Wynn](#)  & [Paul Bloom](#)

[Nature](#) **450**, 557–559 (2007) | [Cite this article](#)



<https://www.youtube.com/watch?v=WqEV9Otdp58>

<https://www.youtube.com/watch?v=YX6PTixcS5I>

Babies: 14 of 16 chose the helper shape



<https://www.youtube.com/watch?v=dijiqWrUOx0>

Why might a baby choose a helper shape?

- like the color blue
- parents give indication
 - random chance
- babies taught to like helper
- babies inherently like helper
 - like triangles
 - ...

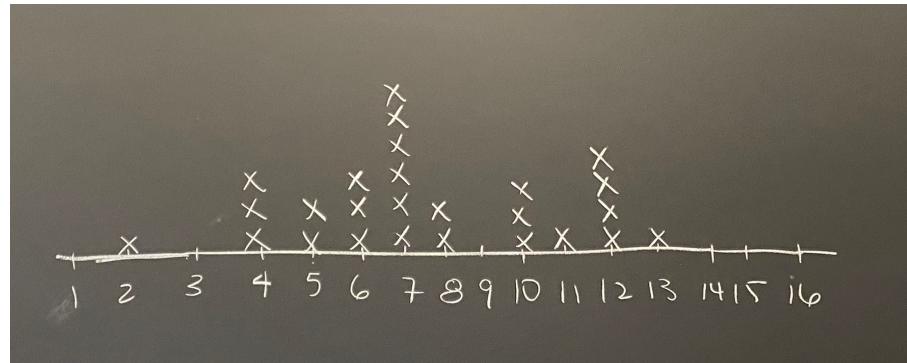
Why might a baby choose a helper shape?

<u>Experimental Design</u>	<u>Research Question</u>	<u>Random Chance</u>
<ul style="list-style-type: none">• like the color blue• like triangles• parents give indication	<ul style="list-style-type: none">• babies taught to like helper• babies inherently like helper	<ul style="list-style-type: none">• random chance

clicker questions

Tactile

- 14 out of 16 babies chose the helper
- give each student a coin
- have them come up with what to do



Applet

One Proportion

Describe process:

Probability of heads:
Number of tosses:
Number of repetitions:

Show animation

Total Repetitions = 200



Most recent results



Number of Heads = 6



Number of Tails = 10

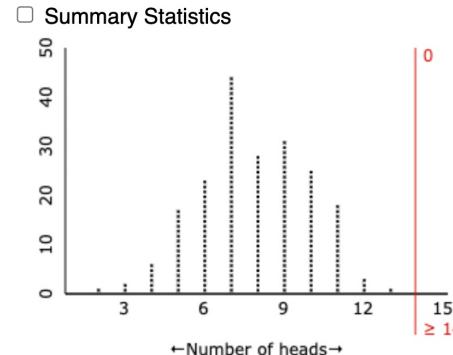
Choose statistic:

- Number of heads
 Proportion of heads

Count samples

As extreme as \geq

Proportion of repetitions:
 $0 / 200 = 0$



Options:

- Two-sided
 Exact Binomial
 Normal Approximation

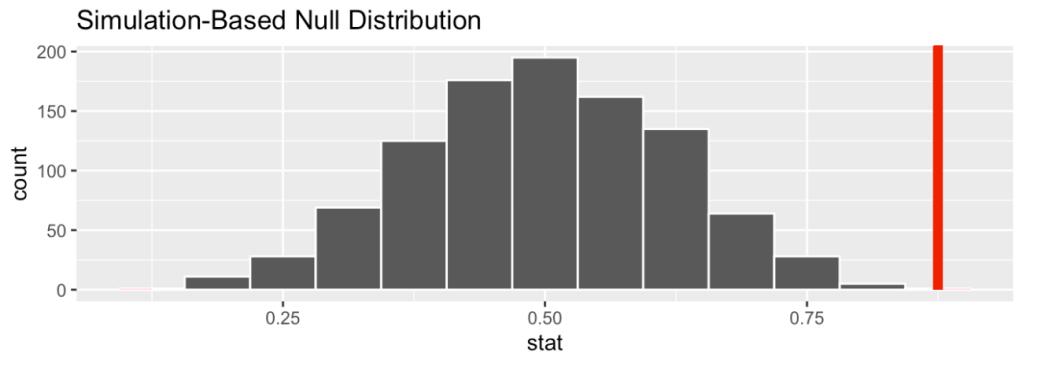
Show previous results

Show sliders

R

```
null_help <- Infants %>%
  specify(response = choice, success = "helper") %>%
  hypothesize(null = "point", p = .5) %>%
  generate(reps = 1000, type = "simulate") %>%
  calculate(stat = "prop")

# then visualize the null sampling distribution & p-value
visualize(null_help, bins = 13) +
  shade_p_value(obs_stat = p_obs, direction = "two_sided")
```



<http://st47s.com/Math58/Notes/intro.html#ex:helper>

infer

<https://infer.netlify.app/>

Theory

• not yet, according to my schedule of topics.

date	topic	agenda	readings	article (Tues)	assignments
Week 1 1.17.23	Intro + variables & studies SLR	<ul style="list-style-type: none">• course info• tests• studies• causation	Introduction Studies ISCAM 1.1 IMS 1 + 2	none Felicity Enders	WU1 WU2 HW 0.pdf HW 0 Rmd
Week 2 1.24.23	Correlation + Least squares	<ul style="list-style-type: none">• correlation• linear model• R²	Cor Least Sq ISCAM 5.6, 5.7, 5.8 IMS 7 guess corr least sq	AstraZeneca W.E.B. Du Bois	WU3 WU4 HW 1.pdf HW 1 Rmd Lab 1.pdf Lab 1 Rmd
Week 3 1.31.23	Hyp Test + Randomization Test	<ul style="list-style-type: none">• structure of hypothesis testing	Tests 2x2 Rand IMS 11	chocolate Regina Nuzzo	WU5 WU6 HW 2.pdf HW 2 Rmd Lab 2.pdf Lab 2 Rmd
Week 4 2.7.23	Bootstrapping	<ul style="list-style-type: none">• boot samp dist• boot CI	Bootstrapping Boot CIs StatKey CIs IMS 12	confounding David Blackwell	WU7 WU8 HW 3.pdf HW 3 Rmd Lab 3.pdf Lab 3 Rmd
Week 5 2.14.23	normality + CLT	<ul style="list-style-type: none">• normal dist• CLT• Z-score• empirical rule• conf int• norm prob• hyp test	CLT Norm dist Samp Dist IMS	efficacy vaccines Florence Nightingale	WU9 WU10 HW 4.pdf HW 4 Rmd Lab 4.pdf Lab 4 Rmd

Clicker questions

- I never track student responses (I don't assess)
- The best Q are those that most people get wrong
- Can ask Q spontaneously
- Very important when students are sleepy

The screenshot shows a Microsoft Word document titled "iClickMath58_s21". The ribbon is visible at the top with tabs like Home, Insert, Draw, Design, Layout, References, Tell me, Comments, and Editing. The Home tab is selected. Below the ribbon is a toolbar with icons for Paste, Font, Paragraph, Styles, Dictate, Sensitivity, Editor, Create and Share Adobe PDF, and Request Signatures. A ruler is also visible.

1. If 16 infants with no genuine preference choose 16 toys, what is the most likely number of "helping" toys that will be chosen?

(a) 4
(b) 7
(c) 8
(d) 9
(e) 10

2. What percent of the time will the simulation produce exactly 8 heads?

(a) 0-15%
(b) 16-30%
(c) 31-49%
(d) 50%
(e) 51-100%

3. What if we flipped a coin 160 times? What percent of the time will the

Clicker questions have evolved



4. Is our actual result of 14 (under the coin model)...⁴
- a. very surprising?
 - b. somewhat surprising?
 - c. not very surprising?

Clicker questions have evolved

The screenshot shows a web browser window with two tabs open. Both tabs are titled "Introduction to Biostatistics" and show the URL "m58-intro-stats.netlify.app/clicker_slides#/1/4". The browser interface includes standard navigation buttons (back, forward, search) and a toolbar with icons for Slides, Tools, and Close.

The main content area displays a question from a Clicker Q slide:

4. Is our actual result surprising?

a. very surprising

b. somewhat surprising

c. not very surprising

A dropdown menu is open over the list of options, showing the following list items:

- .reveal ol ol { list-style-type:...
- Clicker Q
- If 16 infants with...
- How likely is it...
- What if we flipped...
- Is our actual result...
- Based on the first...
- Based on the second...
- A possible confounding...
- The main reason we...
- The main reason we...
- Are there effects...
- Do people tend to...
- Does cell phone use...

Different versions of the clicker questions

The screenshot shows a web browser window with the following details:

- Tab title: Introduction to Biostatistics - C
- URL: m58-intro-stats.netlify.app/clicker_study
- Header: Introduction to Biostatistics (highlighted in orange), Syllabus, Class Notes, Project, Clicker Q, Search icon
- User profile: A small user icon and "Update" button

Clicker Q

to go with **Introduction to Modern Statistics** by Çentinkaya-Rundel & Hardin. Math 58B - Introduction to Biostatistics.

1. If 16 infants with **no genuine preference** choose 16 toys, what is the most likely number of "helping" toys that will be chosen?¹

- a. 4
- b. 7
- c. 8
- d. 9
- e. 10

2. How likely is it that exactly 8 helpers will be chosen (if there is no preference)?²

- a. 0-15%
- b. 16-30%
- c. 31-49%
- d. 50%
- e. 51-100%

3. What if we flipped a coin 160 times? What percent of the time will the simulation flip exactly

80 heads?³

- a. 0-15%

can put the solution
into the footnote

Rstudio & R

The screenshot shows the RStudio interface with a cooking metaphor overlay. The code editor contains a script named 'Untitled1.R' with the following content:

```
1 # Yummy pasta recipe -
2 # get out the equipment we need (load the packages)
3 library(saucepan)
4 library(colander)
5 # get the ingredients out on to the counter (load data)
6 pasta<- read_csv("pasta.csv")
7 cheese<- read_csv("cheese.csv")
8 sauce<- read_csv("yummy_sauce.csv")
9 water<- read_csv("tap_water.csv")
10 # cook pasta then drain it and then add the cheese and the sauce
11 cooked_pasta<-Saucepan(pasta + water)
12 drained_pasta<-colander(cooked_pasta)
13 yummy_pasta <- c(drained_pasta, cheese, sauce)
14
15 Scripts are recipes – records of how to do things
16 Write and save your recipes here so that R knows what
17 to cook
```

The console window shows the following output:

```
> # get out the equipment we need (load the packages)
> library(saucepan)
library
```

A callout box highlights the console area with the text: "The console is where the cooking happens. Send recipes here (run code) to cook them". Another callout box highlights the script area with the text: "Scripts are recipes – records of how to do things. Write and save your recipes here so that R knows what to cook".

The global environment pane contains a note: "The environment is like the kitchen counter you can put ingredients(data) and finished dishes (model outputs) here to use while you cook".

The help viewer pane contains three sections:

- "Files are like ingredients in your cupboards – you need to get them out onto the kitchen counter (the environment) to use them. The files that you need can be specified in the recipe so you know exactly what you need to get out"
- "Packages are like tools – when you need to use a saucepan you go out and buy one that someone has already designed and made (install.packages()) Each time you want to use that pan you just take it out of the cupboard (library())"

- Reinforces concepts
- Important skills
- Super fun
- Scaffold assignments

Worksheets

Taken from ISCAM Investigation 4.3
Beth Chance and Allan Rossman

Psychologist Stanley Coren has conducted several studies investigating the life expectancy of lefthanders compared to right-handers, believing that the stress of being left-handed in a right-handed world leads to earlier deaths among the left-handers. In one study Coren and Halpern (1991) sent surveys to thousands of next-of-kin of recently deceased southern Californians and asked whether the person had been right-handed or left-handed. They were very careful in how they collected their data. First, they consulted a bereavement counselor who suggested that they not contact anyone unless at least 9 months had passed since the death. The counselor also suggested that they make the contact as gentle as possible and not follow up or press people for responses. The researchers also decided that they would not contact next of kin if the death had been a result of murder or suicide or if the deceased was a child age 6 or younger. They received 987 replies and found that the average age of right-handed people at death was 75 years and for left-handed people it was 66 years.

Worksheets

text jhardin447 to 37607 → once to join.

then submit a word or two with your reflection on the worksheet

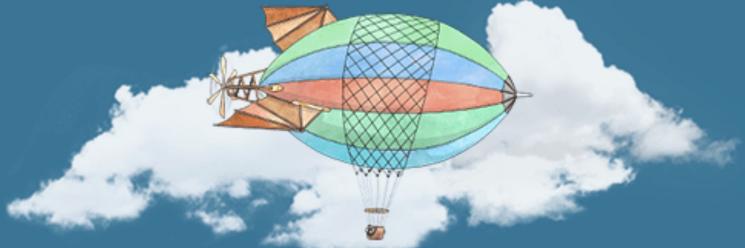
Worksheets

- participation points
- read / feedback every day
- a method for learning names
- students get to know each other

The Islands

← → 🔍 theislands.umn.edu/login.php

THE ISLANDS



Welcome to the home of the Islanders, a virtual human population that has been developed to support learning and teaching in experimental design, epidemiology and statistical reasoning.

The three Islands of Ironbard, Providence and Bonne Santé were settled by the survivors of simultaneous shipwrecks around 341 years ago. The initial settlements have grown and there are now twenty-seven villages with a combined population of over forty thousand Islanders for you to study. Login below to visit them.

The Islands

- Power analysis
- Reproducibility
- Ethical Concerns
- The entire pipeline

VIKTORIA BLOMGREN

About Tasks Chat

26/342 15:19
White Blood Cell Count
 $9.0 \times 10^9/L$

26/342 15:19
Viktoria consented to be in your study

Recent Tasks
White Blood Cell Count
Balance Test Eyes Closed
Blood Estrogen
Pseudoephedrine 30 mg
Psilocybin Mushrooms 10 g

Documents

Physiology

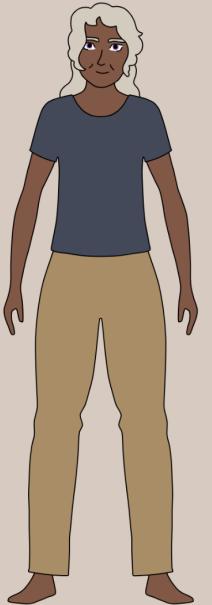
Blood Tests

Mental Tasks

Exercise

Coordination

Alcoholic Drinks



Good luck!

- Use the PTT network
- Try new things, but don't overwhelm yourself
- Re-use what other people have done!
- If you don't know, say so and bring the answer to the next class.

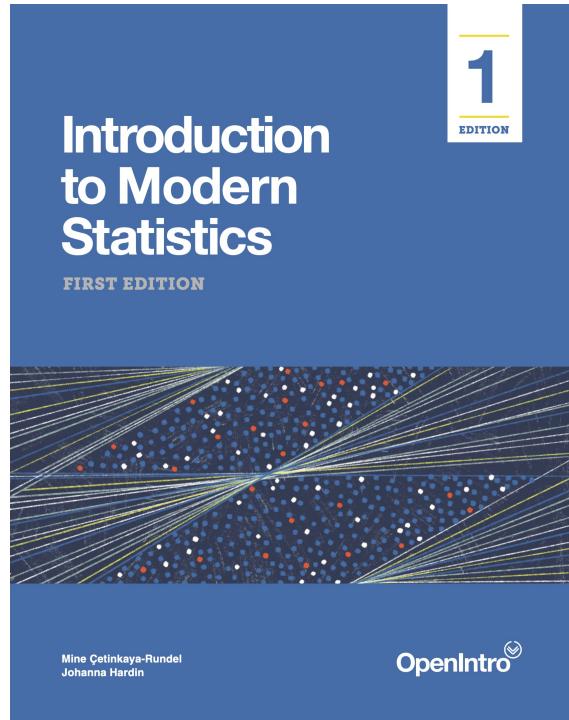
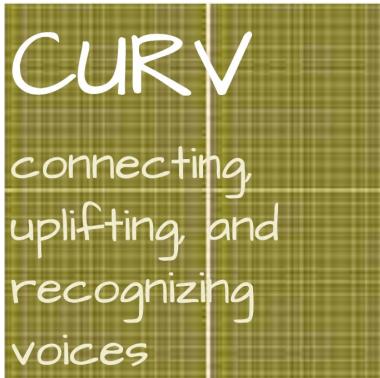
Resources

- My Intro Stats website:
<https://m58-intro-stats.netlify.app/>
- Introduction to Modern Statistics
(w Mine Çetinkaya-Rundel):
<https://openintro-ims.netlify.app/>
- ISCAM applets:
<https://www.rosmance.com/applets/index2021.html>

Passion Projects



<https://datascijedi.org/>



Keeping Busy with Data Science



image credit: Allison Horst

1. GitHub
2. Starting with R
3. Model data
4. Natural Language Processing
5. Practice doing data science
6. Interactive graphics
7. Art and R
8. Watch videos and take classes
9. Participate in the data science community
10. Write an R package

Thank you



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<https://github.com/hardin47>

<https://hardin47.netlify.app/>

Image credit: Pomona College

