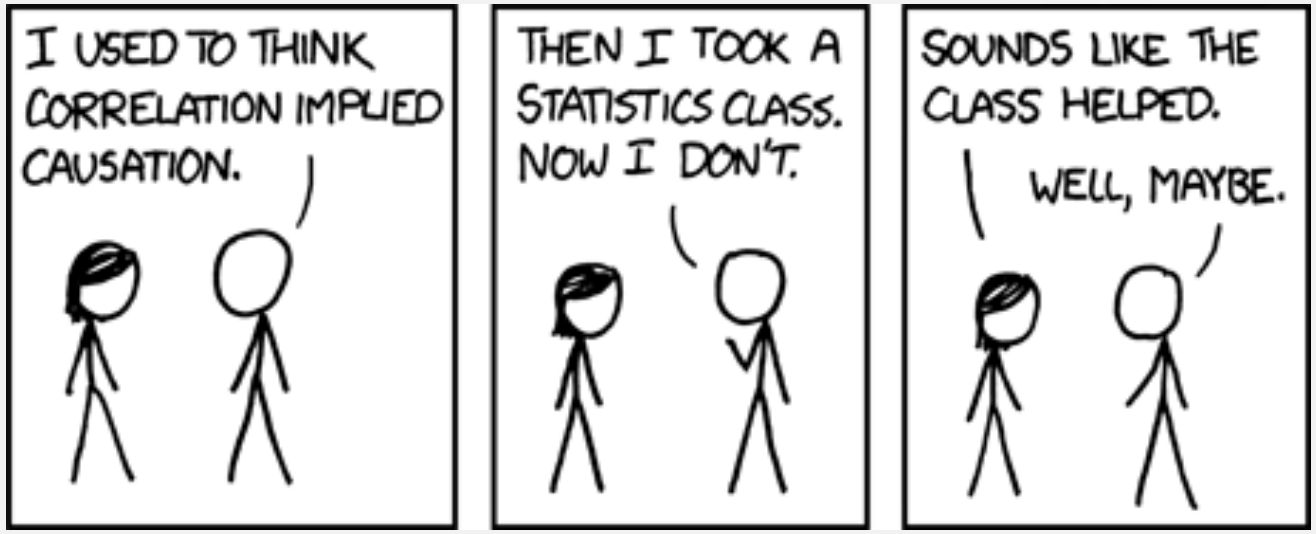
Experimental Design

Biology 683

Lecture 1

Heath Blackmon



Today

- Introductions
  1. Name
  2. Lab
  3. Project / Data
- Syllabus / website
- Big problems in stats (outside world / within academia)
- Why you need this class
- Prep for next week

The public impression of statistics

- *Figures will not lie but liars will figure*
- *There are three kinds of lies: lies, damned lies, and statistics*
- *You can make statistics say anything*
- *Statistics are no substitute for good judgement*

Our response

Misuse of statistics is unethical

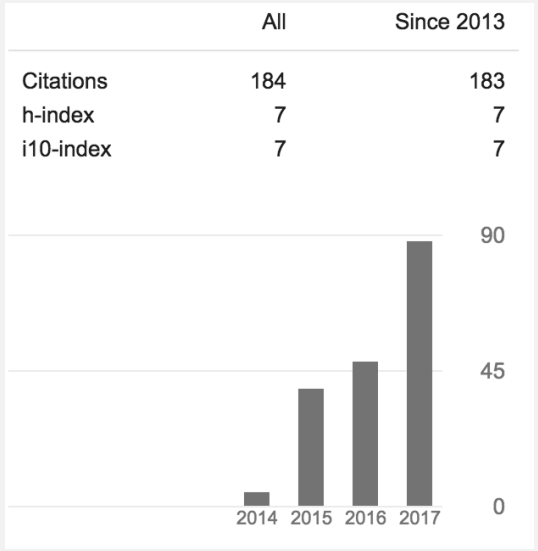
Poor training and maleficence are both responsible for failures

Statistical literacy in the general public is essential

Do your part: learn science of important topics and help friends and family understand them!

Reproducibility crisis

- Started in the social sciences but some problems are widespread
- pressure to publish
- file drawer problem
- small sample sizes
- p-hacking
- unethical researchers



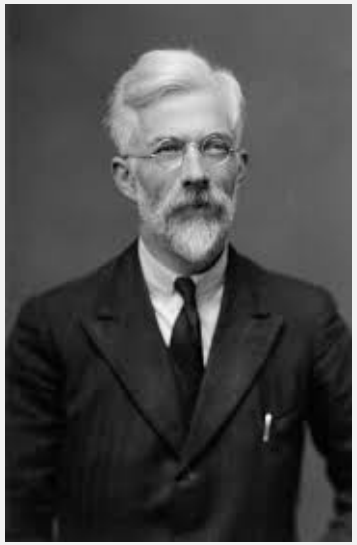
Solutions

- Study preregistration
- PeerJ / PLOS ONE
- Preprint Servers
- Altimetrics
- Systemic change - unlikely

The Origin of Statistics

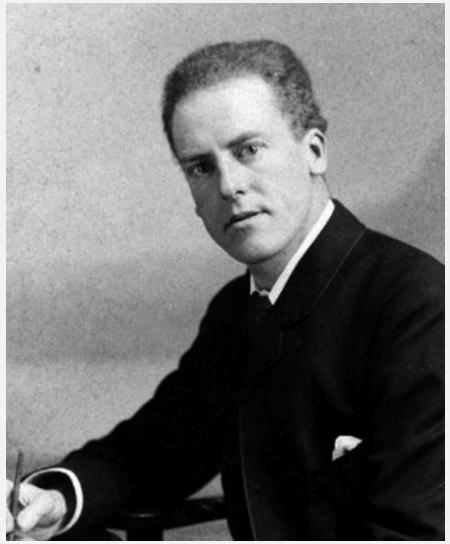
In many ways, therefore, modern statistics was an offshoot of evolutionary biology

R. FISHER
ANOVA

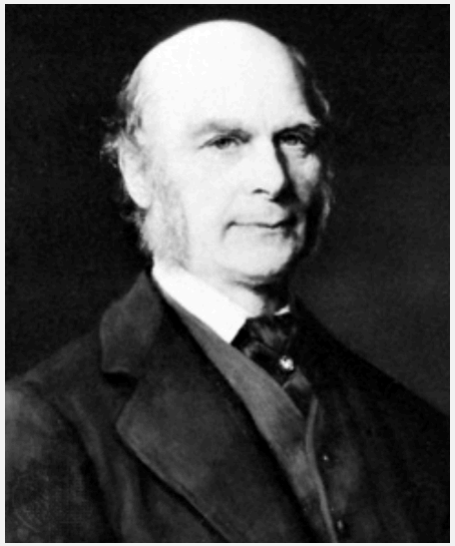


S. WRIGHT
PATH ANALYSIS

K. PEARSON
CORRELATION



F. GALTON
REGRESSION



Why do biologists need statistics

- We want to test hypotheses.
- To test a hypothesis we have to design an experiment
- Not all experiments have a traditional control and experimental treatment and this isn't always how we want to test a hypothesis
- It is quite possible to design a study or collect data that cannot answer the questions that we have
- This leads to poor manuscripts and can lead to bad practices like p-hacking – or mastering out

Experimental Design

So, to design an experiment you need to understand how the data will be analyzed statistically.

1. How can you sample the population in which you are interested?
2. What tests are appropriate for your data?
3. What biases must be controlled for?
4. What sample size will be necessary?

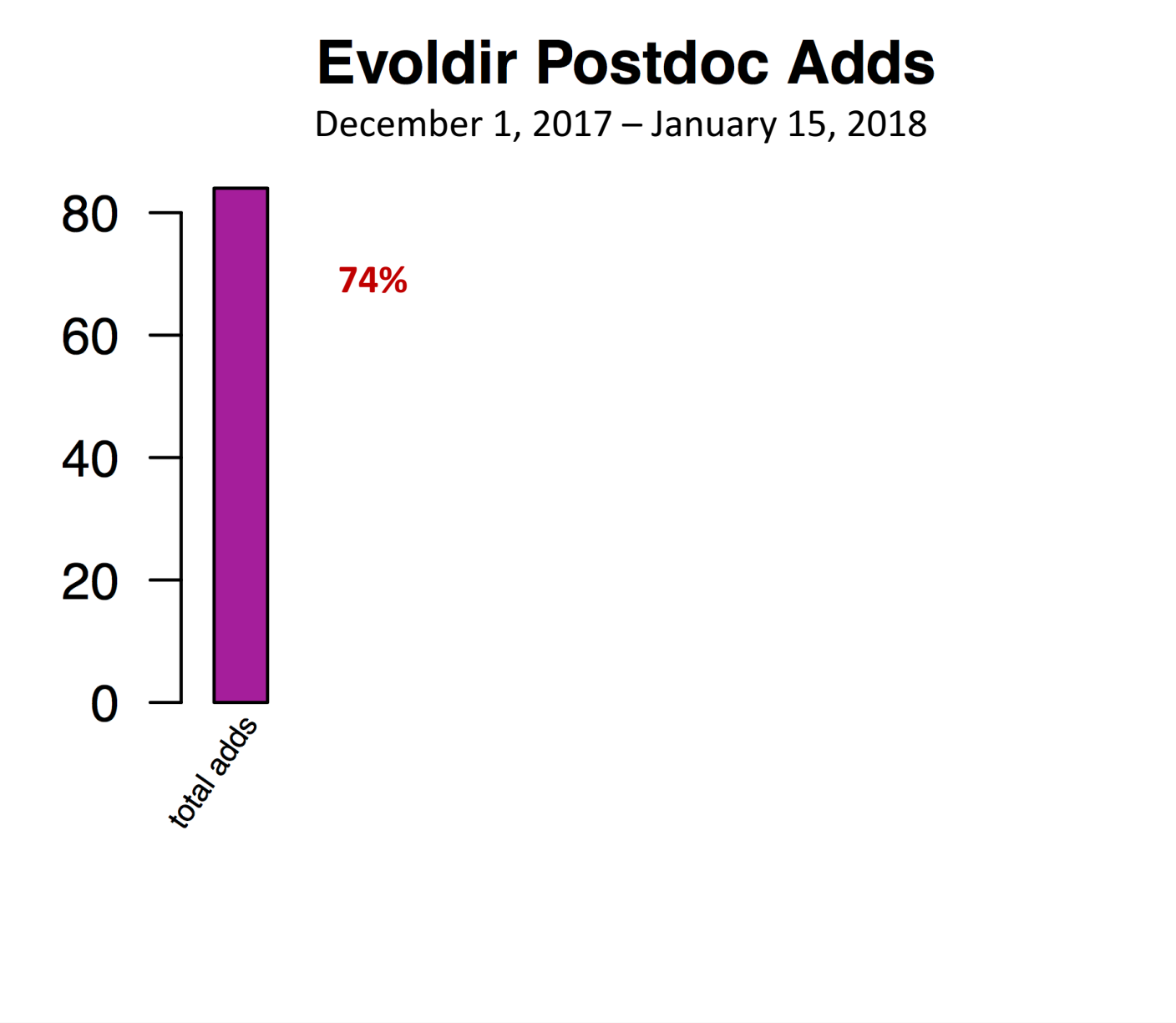
Why not just collaborate with a statistician

1. In some cases this is a great option, but you have to understand enough to communicate.
2. If you publish a study you are responsible for its validity.
3. For most experiments simple methods suffice.
4. In many fields of biology there are sets of statistical tests that are expected for certain types of data.
5. For all of these reasons statistical analysis **needs to involve people who understand the biological problem**

My stats philosophy

- Statistics is just another tool
- My responsibility as a scientists is to report the truth as accurately as possible and statistics help me in this regard
- We may NEED statistics to discern patterns in our data
- You need to understand where the signal that makes for a significant test comes from. Visualizing your data in the right way can do this!

Why am I teaching this class?



What is R

- R is an open and free statistical programming language that focuses on stats and graphics
- It works very similarly on all major operating systems
- It’s also a full-fledged high level programming language (similar to Python)
- *FYI: Very popular in industry so looks great on a CV.*

Why use R

1. Many statistical approaches have been implemented in the R environment.

2. Because it's open source, there are no proprietary secrets, as might be hiding in commercially available statistical packages.

3. Any program written in R will have access to all of R's tools for statistics and graphing.

4. New methods of analysis are being implemented in R by the scientists developing the methods.

Why use R

5. If you use R you can include a script with your manuscript
   Reproducibility / Open science
   Reviewing
   Revising

6. Many methods (mixed models, quantitative genetics, etc.) are only available in R.

7. PLOTTING

Downsides of R

- Today R is basically a requirement to maximize your productivity in STEM.

- Learning curve
- Anyone can make a package - so there is some junk out there
- Memory issues
- No language lasts forever and no language can do everything
    - Python
    - Awk
    - Julia

Installing R and RStudio

Installing R

1. Go to the R homepage and click download R.
2. Pick a mirror that is in Texas or at least in the United States.
3. Select the correct version for your system and follow the prompts.

Installing Rstudio

1. Go to the RStudio homepage and click on the download link below the free version of RStudio Desktop.
2. Select the correct version for your system and follow the prompts.

For Thursday

1. Do homework 1.
2. Read chapters 1 and 2 of WS – good supplemental readings too!
3. Install R and Rstudio on a laptop
4. Come and see me **BEFORE** class on Tuesday if you run into problems

Bring laptop to class!

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