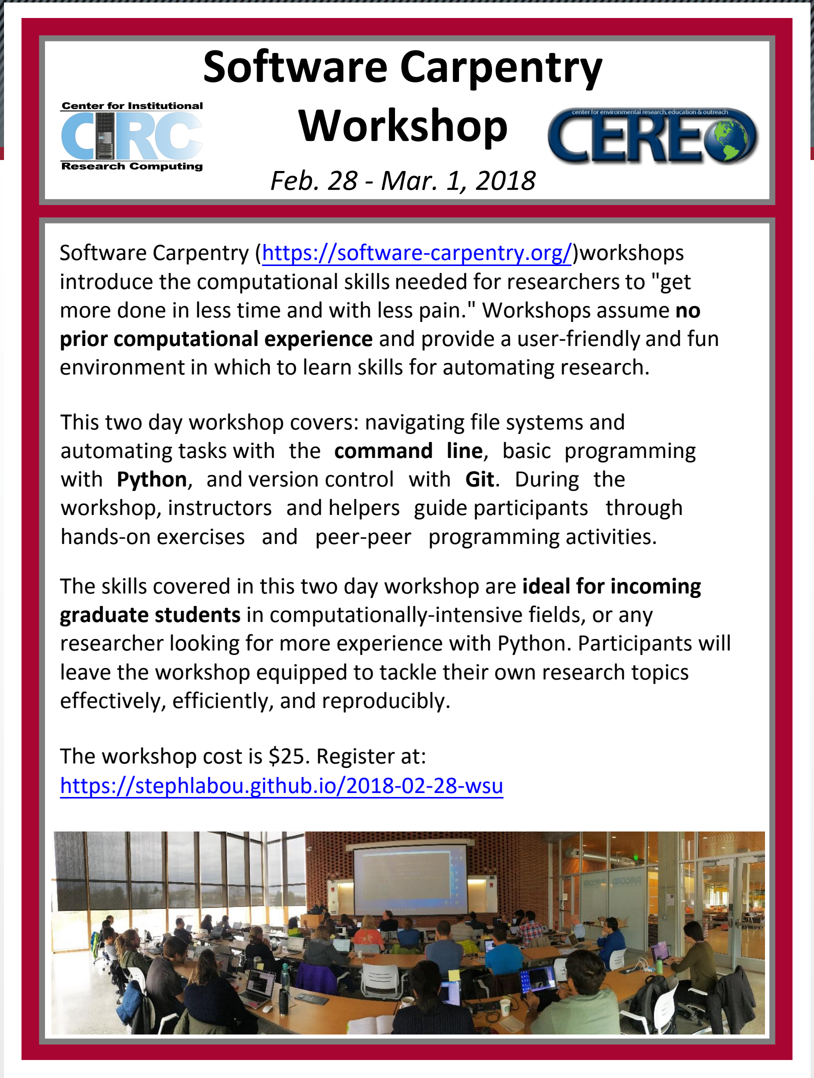
Analysis in Epidemiology

Contact Information & Course Website

- Office: Allen Center 311
- Office Hours: By Appointment
- Email: Eric.Lofgren@wsu.edu

Course material will be posted on GitHub at: https://github.com/epimodels/AnalysisInEpi

Generally I will try to have material up the day before class.



Software Carpentry Workshop

Feb. 28 - Mar. 1, 2018

Software Carpentry (https://software-carpentry.org/)workshops introduce the computational skills needed for researchers to "get more done in less time and with less pain." Workshops assume **no prior computational experience** and provide a user-friendly and fun environment in which to learn skills for automating research.

This two day workshop covers: navigating file systems and automating tasks with the **command line**, basic programming with **Python**, and version control with **Git**. During the workshop, instructors and helpers guide participants through hands-on exercises and peer-peer programming activities.

The skills covered in this two day workshop are **ideal for incoming graduate students** in computationally-intensive fields, or any researcher looking for more experience with Python. Participants will leave the workshop equipped to tackle their own research topics effectively, efficiently, and reproducibly.

The workshop cost is $25. Register at:
https://stephlabou.github.io/2018-02-28-wsu

Purpose of this Course

- Build a functional vocabulary in regression models
- Let you engage with the literature, work on your own problems, etc.
- Know when and how to get help

Some Resources for the Curious

- *Modern Epidemiology 3rd Edition*
- stats.stackexchange.com
  - Generally speaking posting homework questions there is discouraged, but this can be a valuable resource for the future
- CISER
- The usual advice: Get help EARLY!

CISER
Center for Interdisciplinary Statistical
Education and Research

Questions?

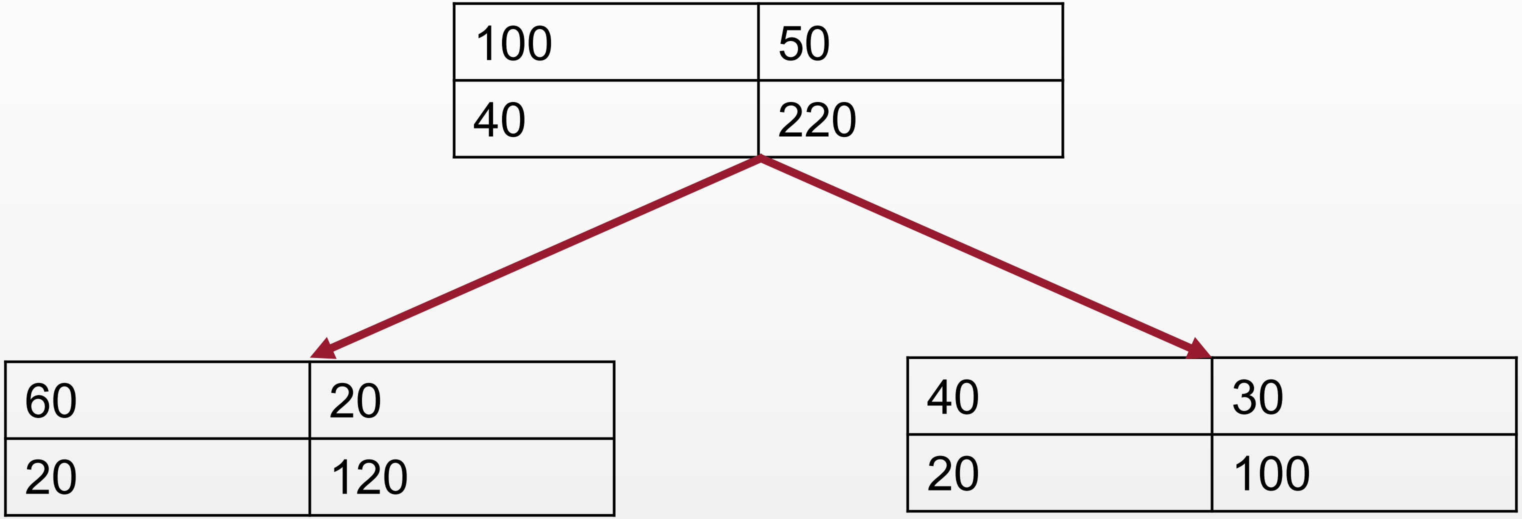
Types of Observational Data

- Most of these got covered in Module 1
- Binary/Continuous
- People/Time/Events
- The decision on *how* to model is largely dictated by *what* you are modeling

Why Regression?

- Module 1 taught you how to calculate measures of association with 2x2 tables, long division, etc.
- Adjusting for confounding using stratification
- All of this seemed to work well enough, can be done in Excel, on a whiteboard, etc. – why bother with regression?

Stratification

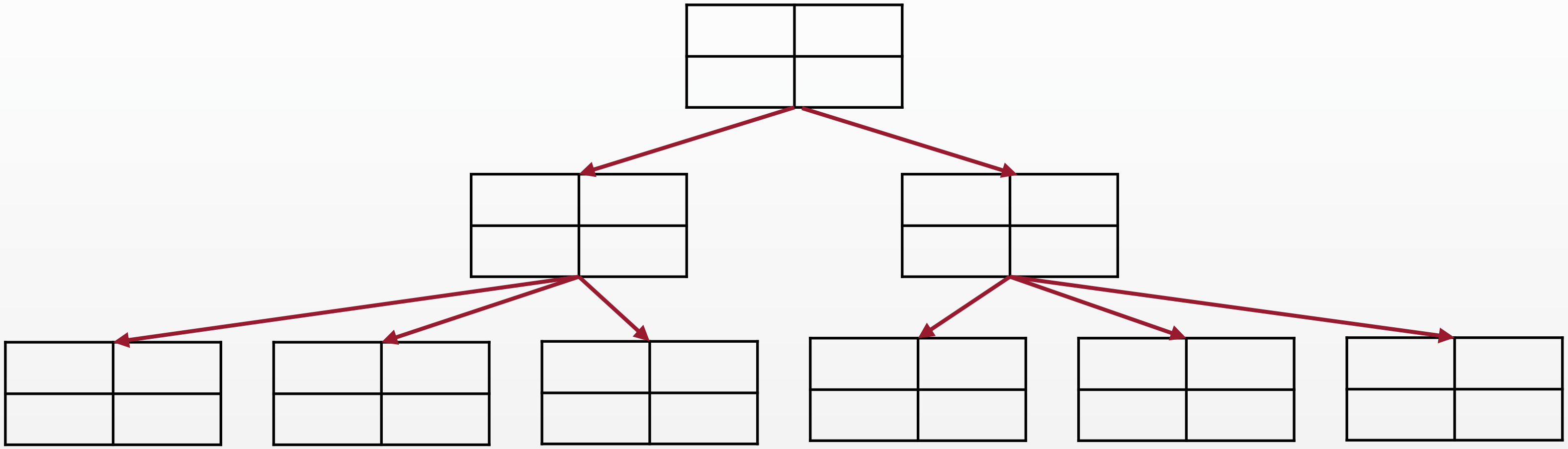


100	50
40	220

60	20
20	120

40	30
20	100

Stratification



And this is just for two variables…what about 16?

Strengths of Regression

- Can handle adjustment by *many* variables
- Can handle non-categorical data
- Can smooth/spackle over empty cells
  - If you know what happens to 26 year olds and 28 year olds, you can guess what happens to 27 year olds
- You can predict
  - Given m, X and b, solve for Y
  - Regression is the foundational toolset of machine learning/data science

What Regression Isn’t

Regression Can't…

- Automatically fix bad data collection
- Control for bias that it (or you) don't know about
- Solve your sample size problems for you
- …solve *any* of your problems **for** you – regression is a tool, and a dumb one at that

Assumptions and Problems of Regression

- Positivity: An individual has a non-zero probability of having any combination of parameter values
  - Regression assumes cells with 0's happened by chance – what if those cells are impossible?
- Model misspecification: Missing confounders, the wrong distribution, etc. will give you the wrong answer
  - This is, I would argue, the biggest problem in observational epi
- Nonidentifiability: Two (or more) combinations of parameters are equally supported by the data, and there is no "best fit"
- Others we will discuss as the class goes on
- There are *more* assumptions necessary for causal inference, which is beyond the scope of this module

Reading a Regression Equation

- Regression is essentially progressively more complex versions of y = mx +b

$$Y = \underbrace{\beta_0 + \beta_1 A + \varepsilon}_{\text{Linear Predictor}}$$

$$Y = \alpha + \beta_1 A + \gamma \boldsymbol{Z}$$

What’s a Link Function?

- A link function is a function that describes the relationship between Y and the rest of the equation
- Linear Predictor: $\mathbf{X}\boldsymbol{\beta}$
- Link function: $g(\mathrm{Y}) = \mathbf{X}\boldsymbol{\beta}$
- Identity: $\mathrm{Y} = \mathbf{X}\boldsymbol{\beta}$
- Log: $\ln(\mathrm{Y}) = \mathbf{X}\boldsymbol{\beta}$
- Logit: $\frac{Y}{1-Y} = \mathbf{X}\boldsymbol{\beta}$

What is a Distribution?

- Linear regression assumes things came from a normal distribution
- This is *often* not true
- Other distributions are common
- Binomial: Binary data
- Poisson/Negative Binomial: Counts and rates
- Exponential/Weibull/Gamma: Time
- When unspecified, it is often assumed to be normal

Least Squares and Maximum Likelihood

- Two ways to estimate the best fitting parameter
- Linear regression often uses least squares
- Most of the other models we will discuss use some form of maximum likelihood