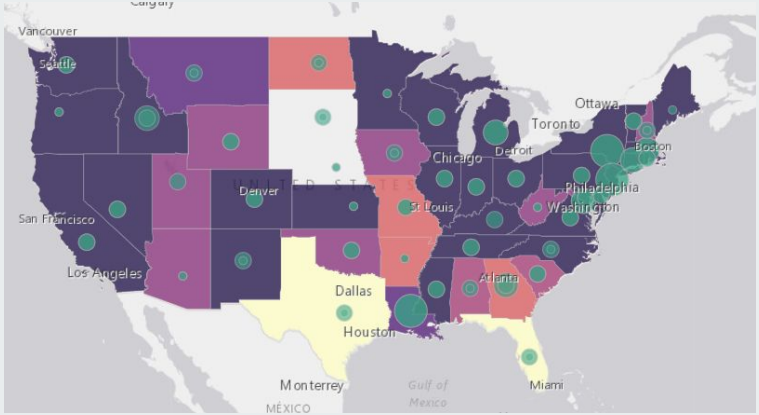
PHIGHT COVID

Help better understand and model the changes in the number of covid cases over time and the associated public health interventions



Melody Ma, Alvin Pan, Tracy Wang, Ben Yuan,

Dr. Rebecca Nugent, Dr. Seema Lakdawala(Pitt), Avery Annika (Pitt)

Carnegie Mellon University
Statistics & Data Science

Data Overview

- The dataset comes from **Center for Systems Science and Engineering (CSSE) at Johns Hopkins University + State/County public health websites**
- It contains data spanning from January to November 2020
- We are looking at the following variables:
  - States/Counties
  - Dates
  - Cumulative Confirmed Cases
  - Governor issued Public Health Intervention Executive Orders

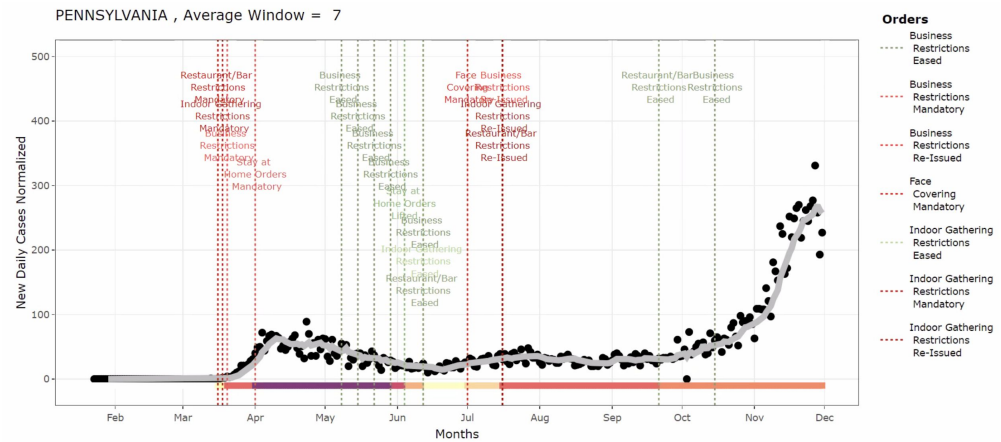
What did we add?

- **New Confirmed Cases**
  Cumulative Confirmed Cases (Today) - Cumulative Confirmed Cases (Yesterday)
- **New Confirmed Cases Normalized per 500,000**
  *New Confirmed Cases / State Population * 500,000*
- **Event Categorization**
  - Category 1: Stay at home order
  - Category 2: Non-essential business closures
  - Category 3: Indoor large gathering bans
  - Category 4: Restaurant and bar limitations/restrictions
  - Category 15: Mandatory Mask/Face Cover Order

What did we add?

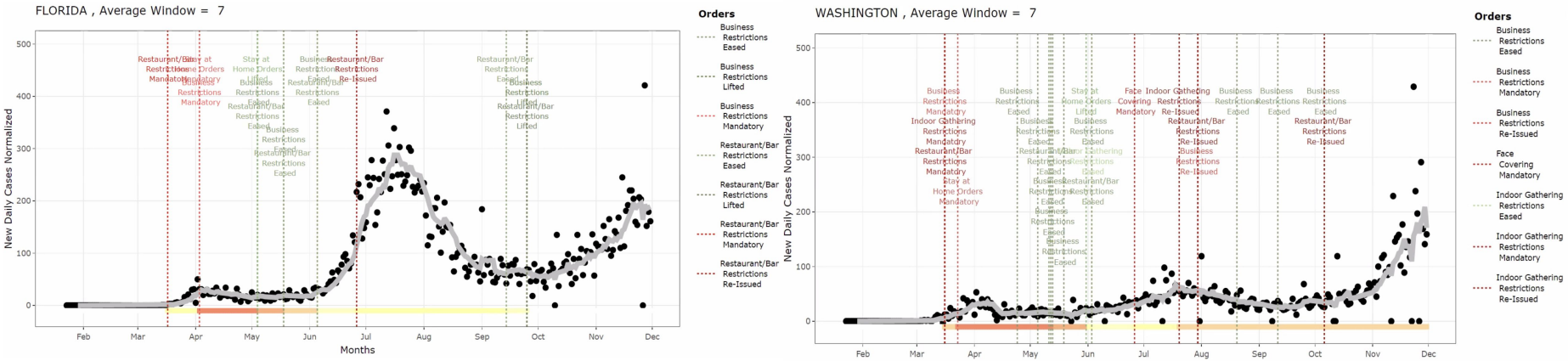
- **Scores (from 0 - 5.0)**
  - *Measures the level of strictness for public health intervention*
  - *Higher the score more restrictions and darkers color*
  - *We have a rubric on how to assign scores*
    - *For Example:*
      - *Issuing: Restaurant and bar limitations/restrictions +1.00*
      - *Easing: Restaurant: outside only dining with size limits -0.05*

Easing in Restrictions Followed by Increase in Cases

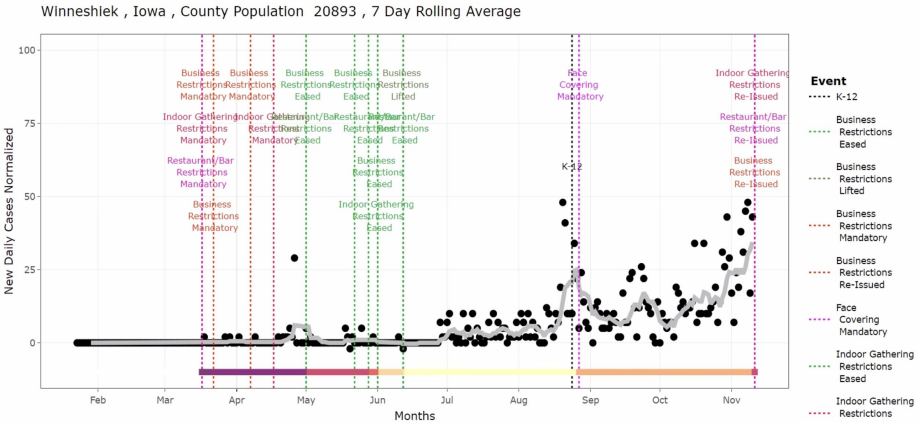


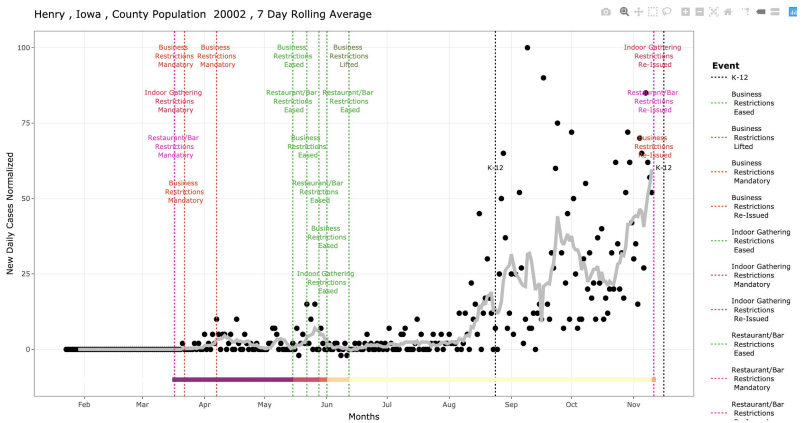
- Average Window:
  - Rolling average of cases among 7 days
- Text and Dotted Line Color
  - Red represents tightening of restrictions
  - Green represents easing of restrictions
- Score Bar: Darker color higher scores

States with Tighter Restrictions Have More Cases Under Control

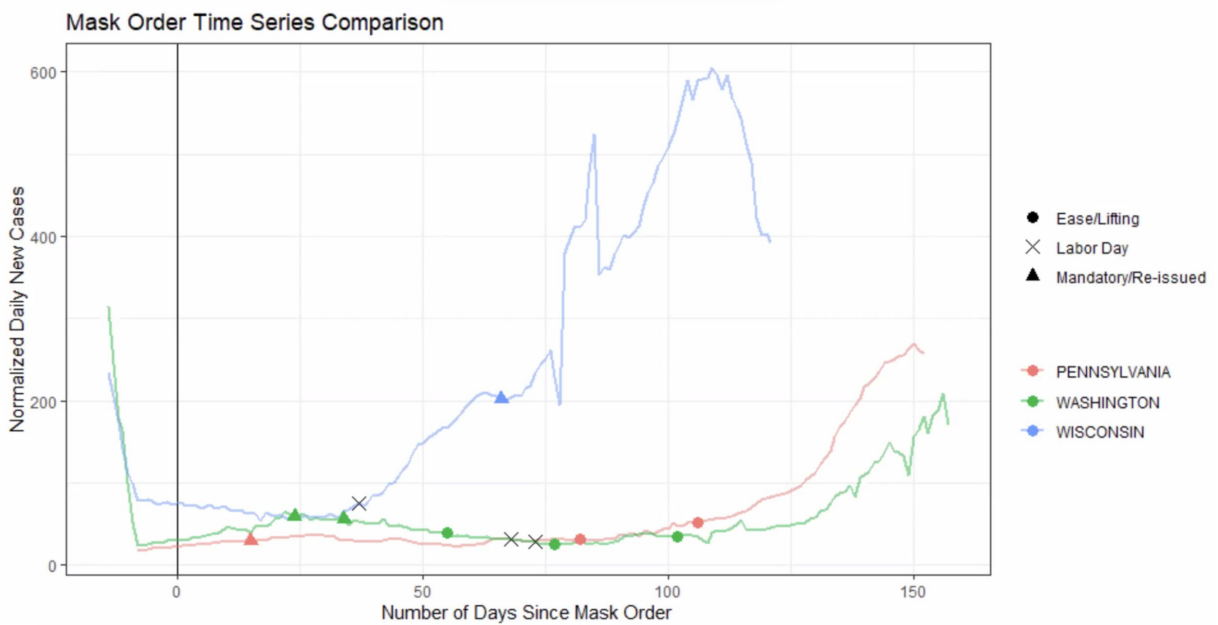


Decrease in Cases Followed By Mask Restrictions

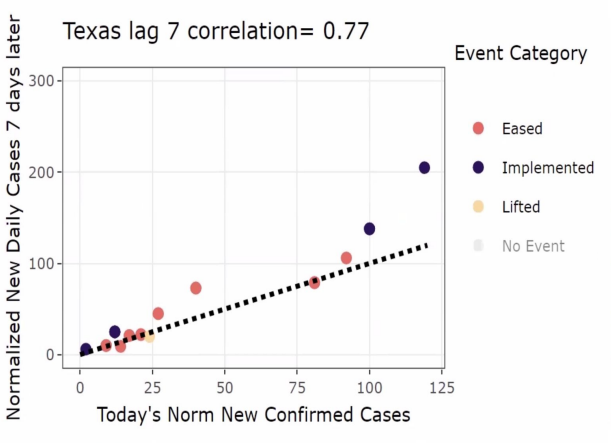


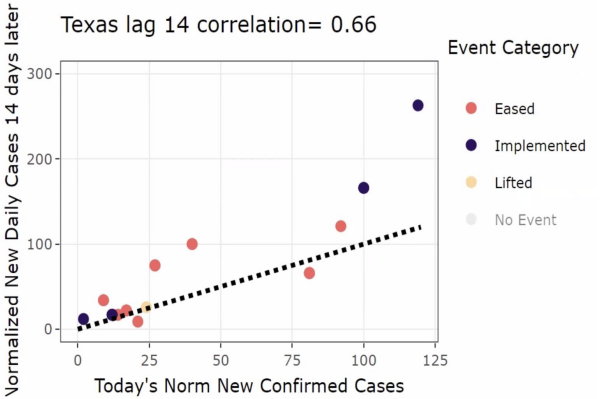


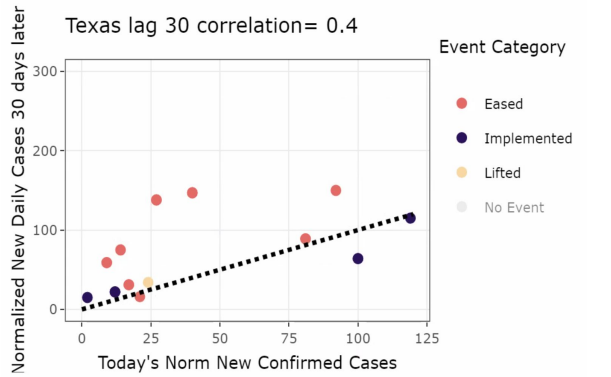
It Takes a While to See the Impact of Restrictions



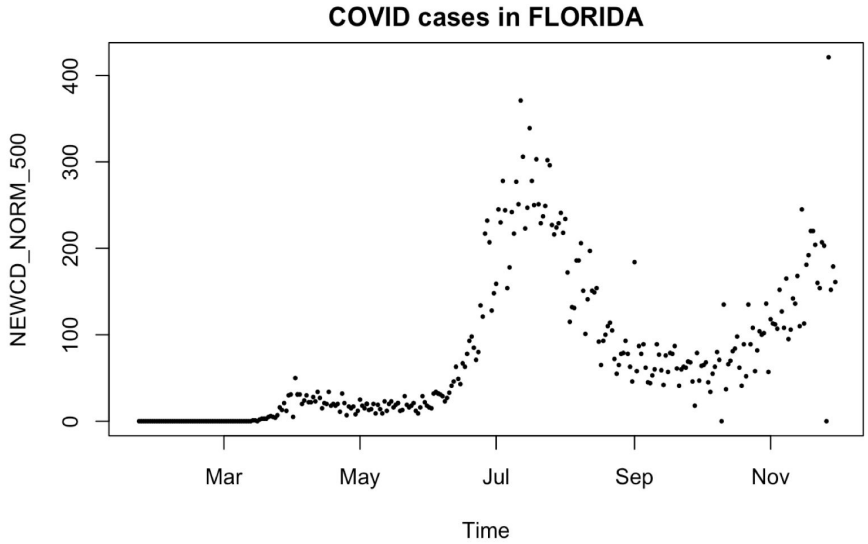
It Can Take up to 30 Days







Motivation: Model the underlying relationship/function of cases over time



Smoothing splines

$$\sum_{i=1}^{n}(y_i - f(x_i))^2 + \lambda \int f''(t)^2 dt$$

Goal: Minimize the mean squared error + estimate the penalization term lambda

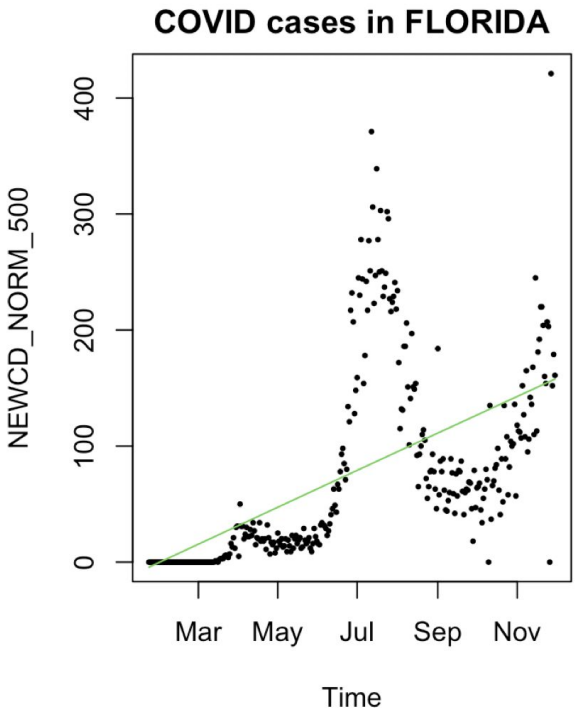
y = Number of (normalized) new cases, x = Time, integral over entire time domain

Low lambda: Overfitting and wiggly High lambda: More linear

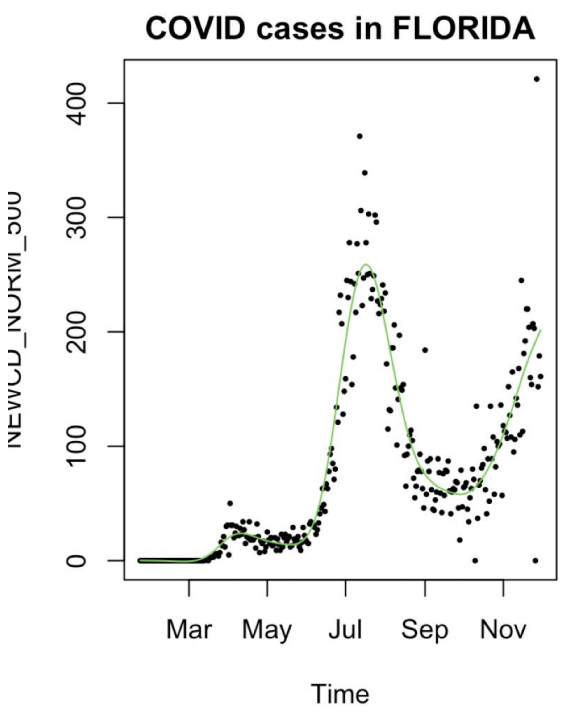
Degrees of freedom is roughly inversely proportional to lambda

Higher DF -> Lower Lambda -> Less linear, wigglier curve

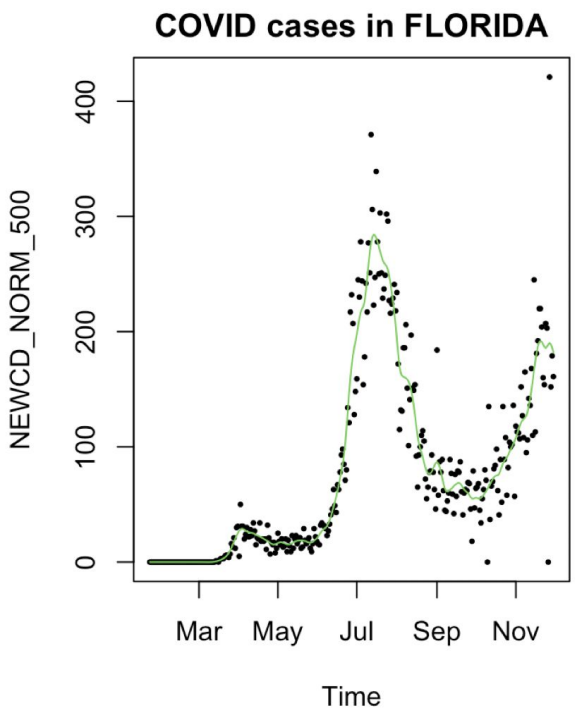
df = 2



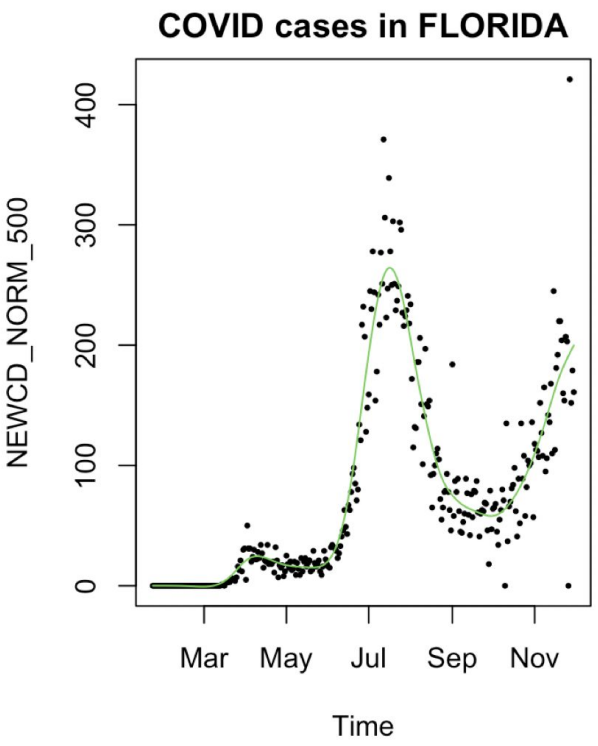
df = 15

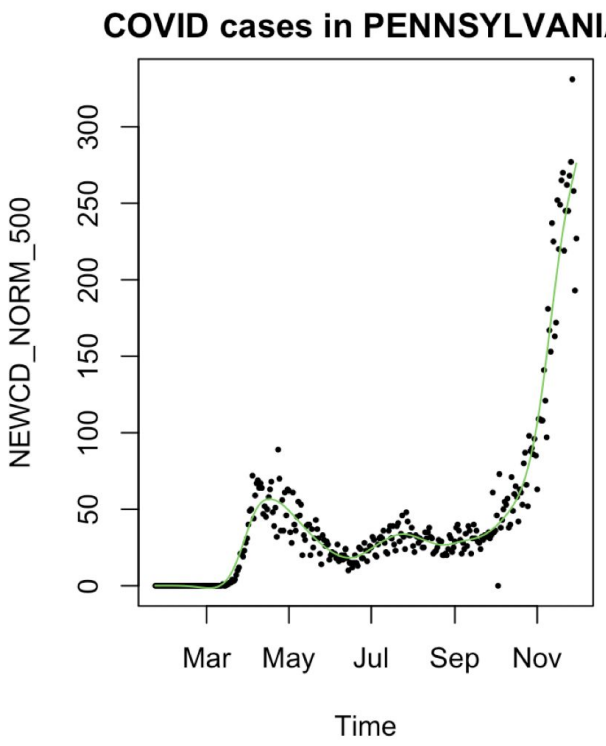


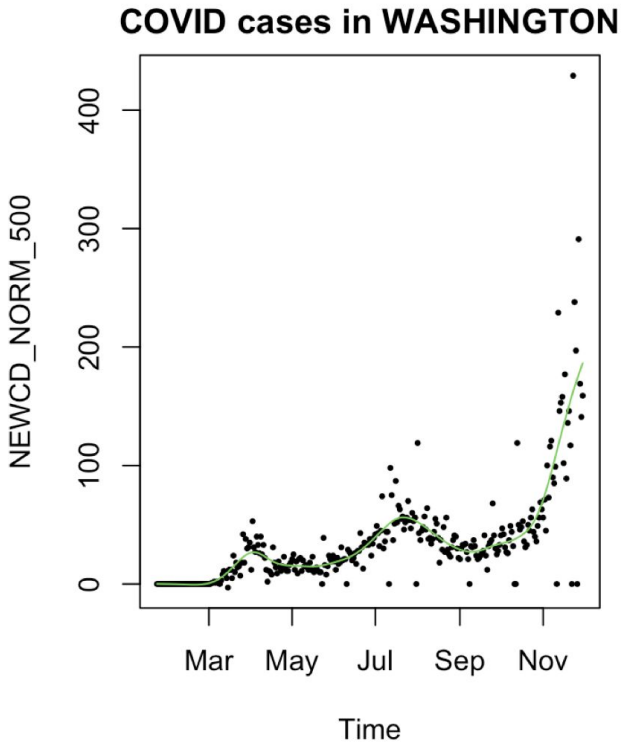
df = 50



Optimal: df=18 df=30 df=11







Future Work

- Model time series with ARMA (Autoregressive Moving Average) models
  - Incorporating multiple variables
- Update and combine new county data
- Compare effectiveness of different public health interventions statistically
- Design and Integrate UI with Shiny library
- Explore causal relationships among the variables(E.g. Deaths and scores)

Acknowledgement

Professor:

Prof. Rebecca Nugent, Dr. Seema Lakdawala

PHIGHT COVID Pitt Team:

Annika Avery, Elizabeth McGrady, Erica Yuqing Liang, Gabby Padovani*, Janie French*,

Logan Hellinger*, Shreya Jyotishi*, Roma Kerby*

* Past PHIGHT COVID Pitt Team Members