Geographic Surveillance of Key COVID-19 Metrics Using a R Shiny App

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Overview

- Background
- R, RShiny, and ShinyApps
  - Code and file format
- Quick demo + GitHub link
- Exploratory Data Analysis Tools
- Strengths and Limitations

Bottom Line

- A free framework in R to visualize multiples sources of COVID-19 data.

- Code and fake sample data are free!
- Can be on GitHub at:
- https://github.com/bchd/COVID_APP

Background

- Need to integrate COVID-19 data into one dashboard
  - Confirmed Cases
  - Laboratory
  - Vaccine Data (*added since abstract submission)

- Target Audiences
  - Senior Leadership, Epidemiologists, Mobile Testing and Vaccination: need to monitor, plan, and intervene.

Purpose

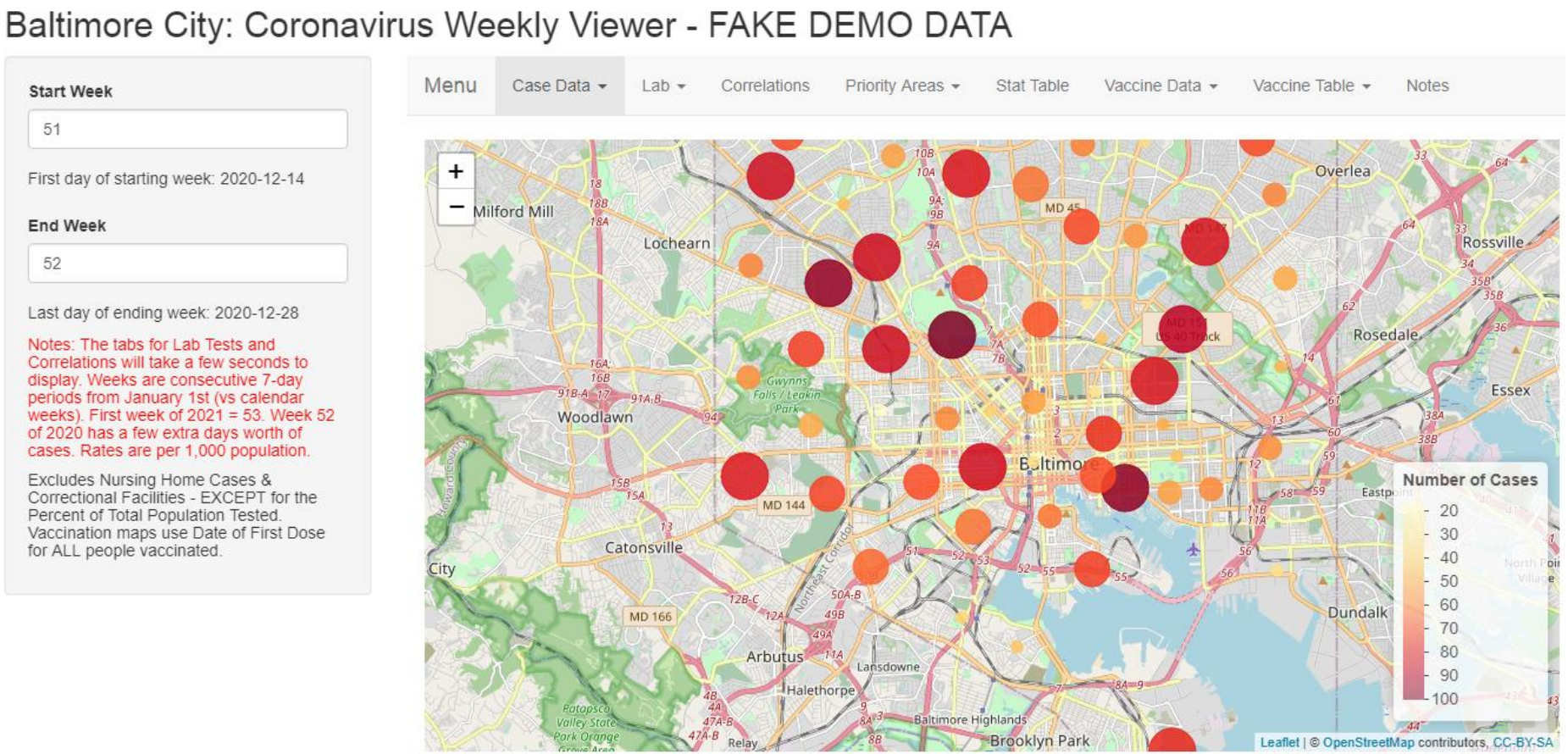
- Understand community spread
- Monitor vaccination progress*
- Reduce disparities
- Establishing Priority Areas for public health interventions
- App in use from July 1st, 2020-present.

Sample Data

- Data shown today and on GitHub is fake/demo data.
- Generated entirely using random numbers and does not represent true COVID-19 activity in Baltimore City.

App Demonstration

Screenshots of COVID App



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Screenshots of COVID App

Baltimore City: Coronavirus Weekly Viewer - FAKE DEMO DATA

Start Week

30

First day of starting week: 2020-07-20

End Week

52

Last day of ending week: 2020-12-28

Notes: The tabs for Lab Tests and Correlations will take a few seconds to display. Weeks are consecutive 7-day periods from January 1st (vs calendar weeks). First week of 2021 = 53. Week 52 of 2020 has a few extra days worth of cases. Rates are per 1,000 population.

Excludes Nursing Home Cases & Correctional Facilities - EXCEPT for the Percent of Total Population Tested. Vaccination maps use Date of First Dose for ALL people vaccinated.

Menu | Case Data | Lab | Correlations | Priority Areas | Stat Table | Vaccine Data | Vaccine Table | Notes

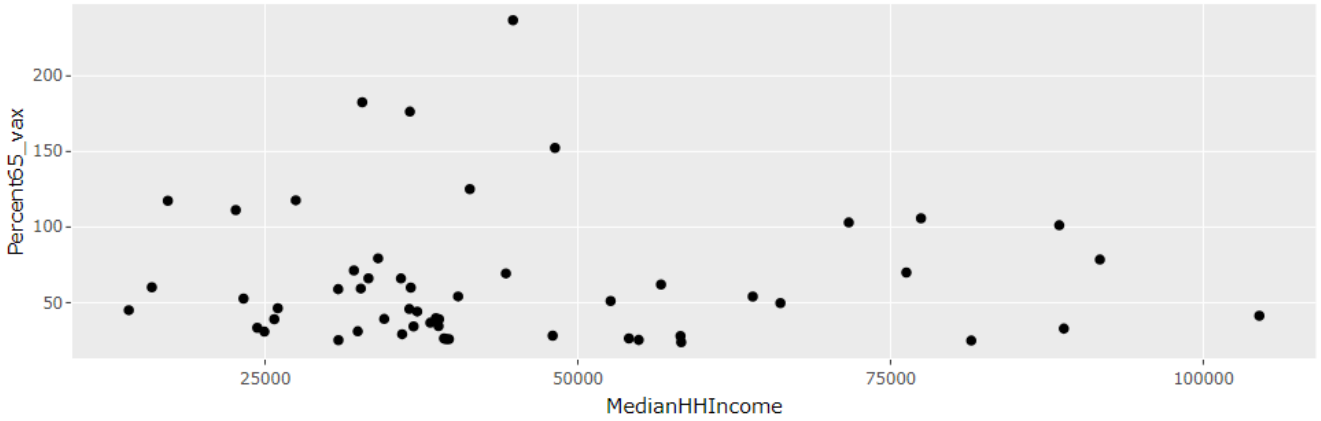
Explanatory Variable

MedianHHIncome

Outcomes

Percent65_vax

Pearson's R: -0.02 | Spearman's Rank: -0.09 . If correlation statistics are NA, decrease the start week to include more data. NHP data uses slightly different denominators, so you may see small differences in rates and percentages on this tab compared to the maps.



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Takes rank of variable and allows user to select weights for priority areas. If you do not want to include a variable, add a weight of 0. Consider expanding number of weeks if you want more certainty. Deaths and Hospitalizations also lag. Click the next tab to see results. Formula= (Rank - Quantile of Factor1 x Weight1)+(Rank 2 x weight2)+(Rank 3 x Weight3)

First Priority

COVID_Rate

First Weight

0.33

Second Priority

Percent65_vax

Second Weight

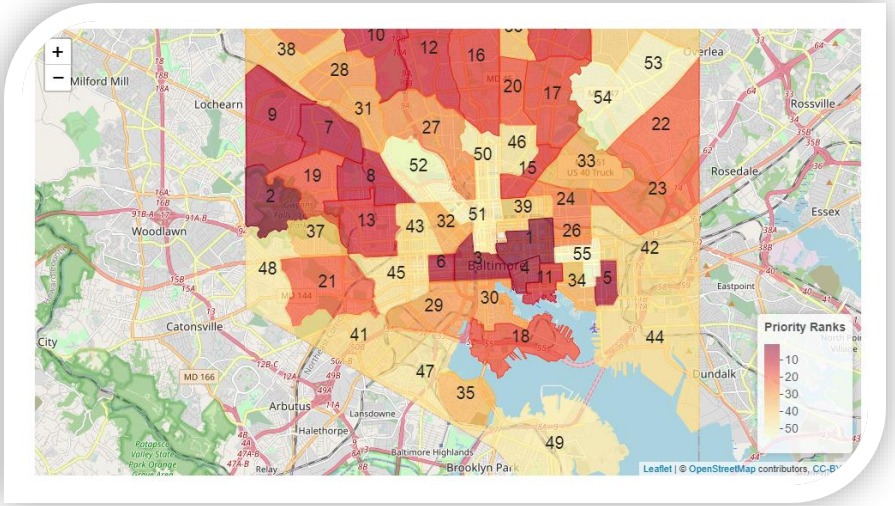
0.33

Third Priority

Percent_Hospitalized

Third Weight

0.33



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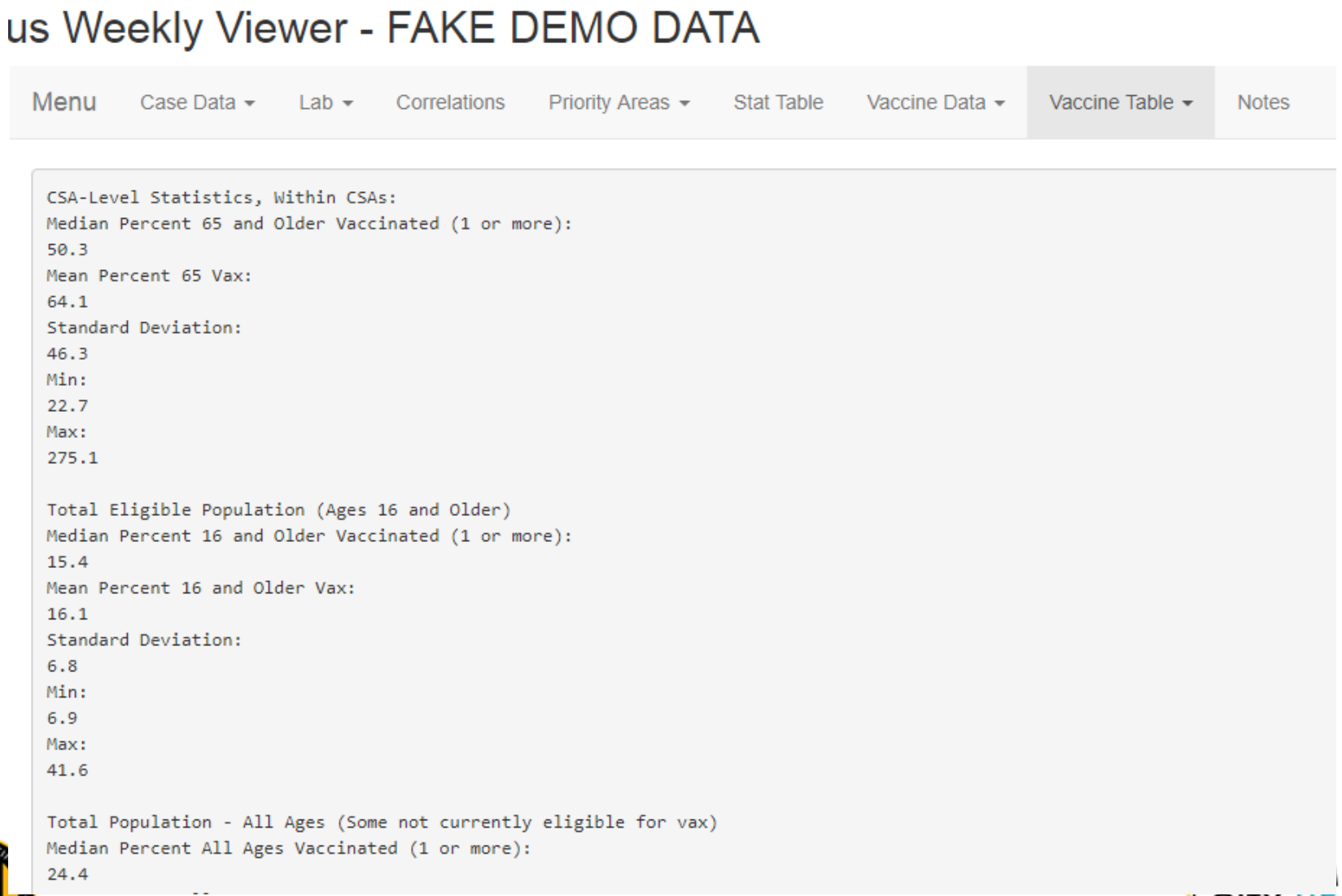
Show 25 entries Search:

CSA2010	Total_Population	Population_65	Pop_16Plus	Percent_vax_65	Number_65_Vax	age16plus
Downtown/Seton Hill	6446	245	5974	275.1	674	1303
Dickeyville/Franklintown	4101	355	3121	192.4	683	1299
Harbor East/Little Italy	5407	357	4208	159.1	568	1099
Washington Village/Pigtown	5503	447	4480	150.6	673	1271
Madison/East End	7781	514	5538	116.0	596	1171
Poppleton/The Terraces/Hollins Market	5086	475	3922	113.3	538	1127
Highlandtown	7250	670	6308	111.5	747	1374
Cherry Hill	8202	687	5520	108.9	748	1486
Westport/Mount	7119	598	5248	102.2	611	1125

Screenshots of COVID App



R, R Shiny, and ShinyApps

- R
  - Free statistical program
  - https://www.r-project.org/
- R Shiny
  - R package that translates R code in HTML
  - https://shiny.rstudio.com
- ShinyApps
  - Hosting site, free and paid subscriptions
  - https://www.shinyapps.io/

Code

- R Version: 3.5
- Required Packages: Only 9
- One R file (UI and server code combined)
- Length: ~1200 line with comments
  - But some of this is copy and paste/same code repeated with slight variations.

Code

- Imports de-identified data and reference GIS and indicator data.

- Unit of analysis
  - Community Statistical Area (CSA)-week
  - Space-time unit/repeated measures

Community Statistical Areas (CSAs)

- Unit of analysis (n=55)
- Groupings of Census Tracts developed by BNIA JFI and Planning Department.
- Indicator data released annually by BNIA.
- Few enough to easily interpret, but small sample size may reduce statistical power.

R Packages

Category	Name	Use
Data manipulation	dplyr	Filtering and reshaping data…
Import Excel	readxl	Import spreadsheets, extra options
App framework/Web	shiny	User interface, server
Mapping	rgdal	Import spatial data, projections
Mapping	sp	Work with spatial data
Web-based mapping	leaflet	Make interactive maps
Graphing	plotly	Make interactive graphs
Table formatting	kableExtra	Pretty tables
Aesthetics	shinythemes	Optional: can be used to easily modify appearance.

Data Inputs: 6 Files

Category	Type	Filename	Description
COVID	*.csv	COVIDWeek	Cases by geographic unit and week
COVID	*.csv	COVIDWeek_Lab	Lab results (1 per person per week) by geographic unit and week
COVID	*.csv	COVIDWeek_vax	Vaccination data by week and geographic unit based on first date
Indicator	*.xlsx	NHP	Neighborhood Health Profile Data
GIS	*.shp	VS18	Polygons for geographic unit and Census Population Denominators, WGS 1984
GIS	*.shp	CSA_CentroidsSHP	Centroids for geographic units (latitude and longitude)

Sample Tabular Data

- Sample data are fake: generated entirely from random numbers.

- Three *.csvs with tabular data:
  - Case Data
  - Lab Data (Fake id)
  - Vaccine

Case Data Format

CSA2010	week	year	cases	hospitalizations	deaths	nursing
Allendale/Irvington/S. Hilton	1	2020	1	1	0	0
Allendale/Irvington/S. Hilton	1	2020	1	1	0	1
Allendale/Irvington/S. Hilton	1	2020	1	1	0	1
Allendale/Irvington/S. Hilton	1	2020	1	1	0	1
Allendale/Irvington/S. Hilton	1	2020	1	0	0	1
Allendale/Irvington/S. Hilton	1	2020	1	0	0	0
Allendale/Irvington/S. Hilton	1	2020	1	0	0	1
Allendale/Irvington/S. Hilton	1	2020	1	1	0	1

Lab and vaccine data are very similar

COVID-19 Metrics

- Confirmed case counts, incidence rate, number tested, percent of population tested, percent positive, percent of cases hospitalized, hospitalization rate, death counts, and mortality rates.

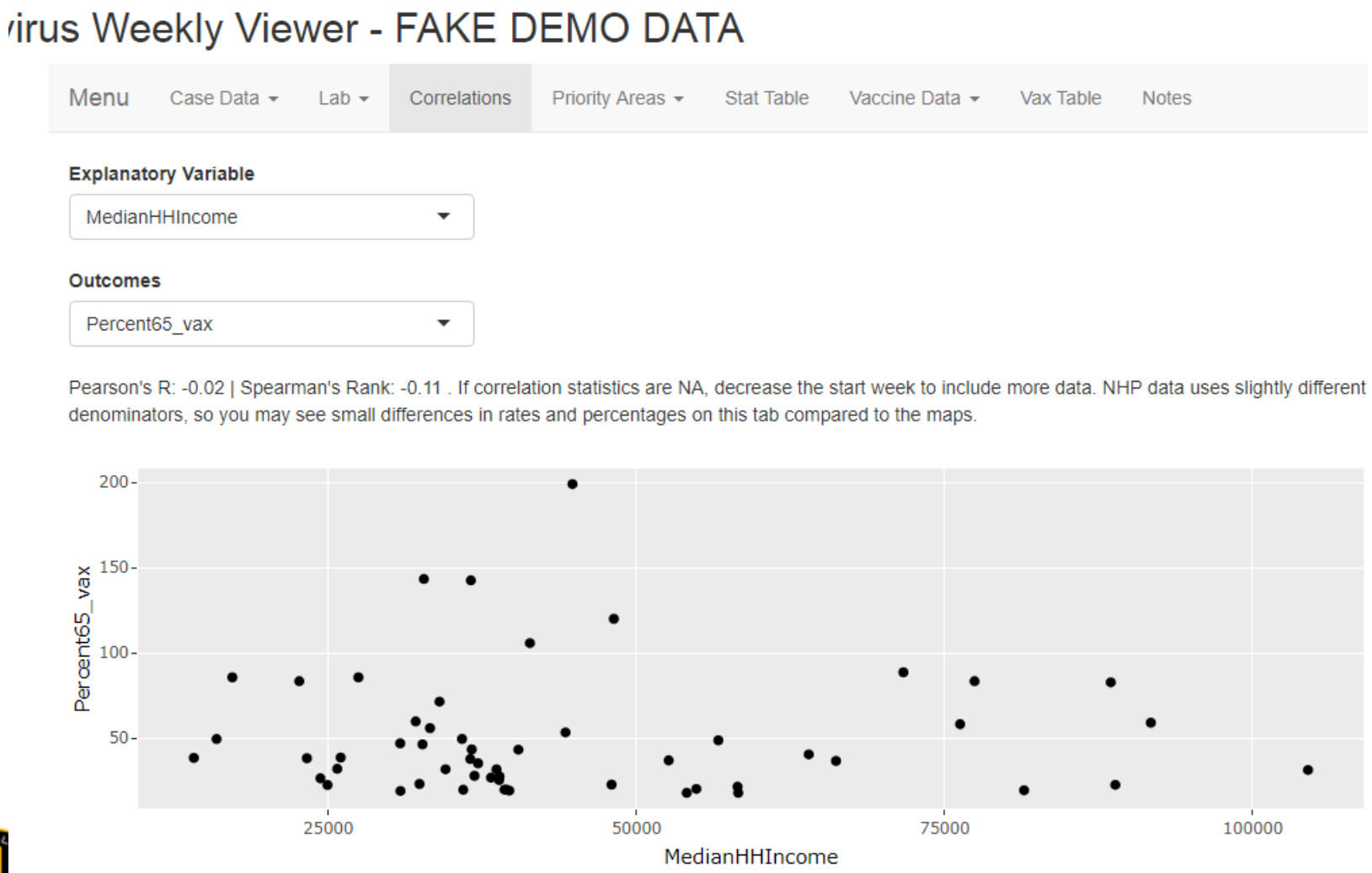
- Many deaths occurred in facilities settings.

- Some metrics are filtered/info collected elsewhere.

Reactive Dataset

- Data changes based on user input.
- Helps to shorten code.
- Particularly important for Priority Area Calculator and Correlation Explorer
- dataInput<-reactive({})

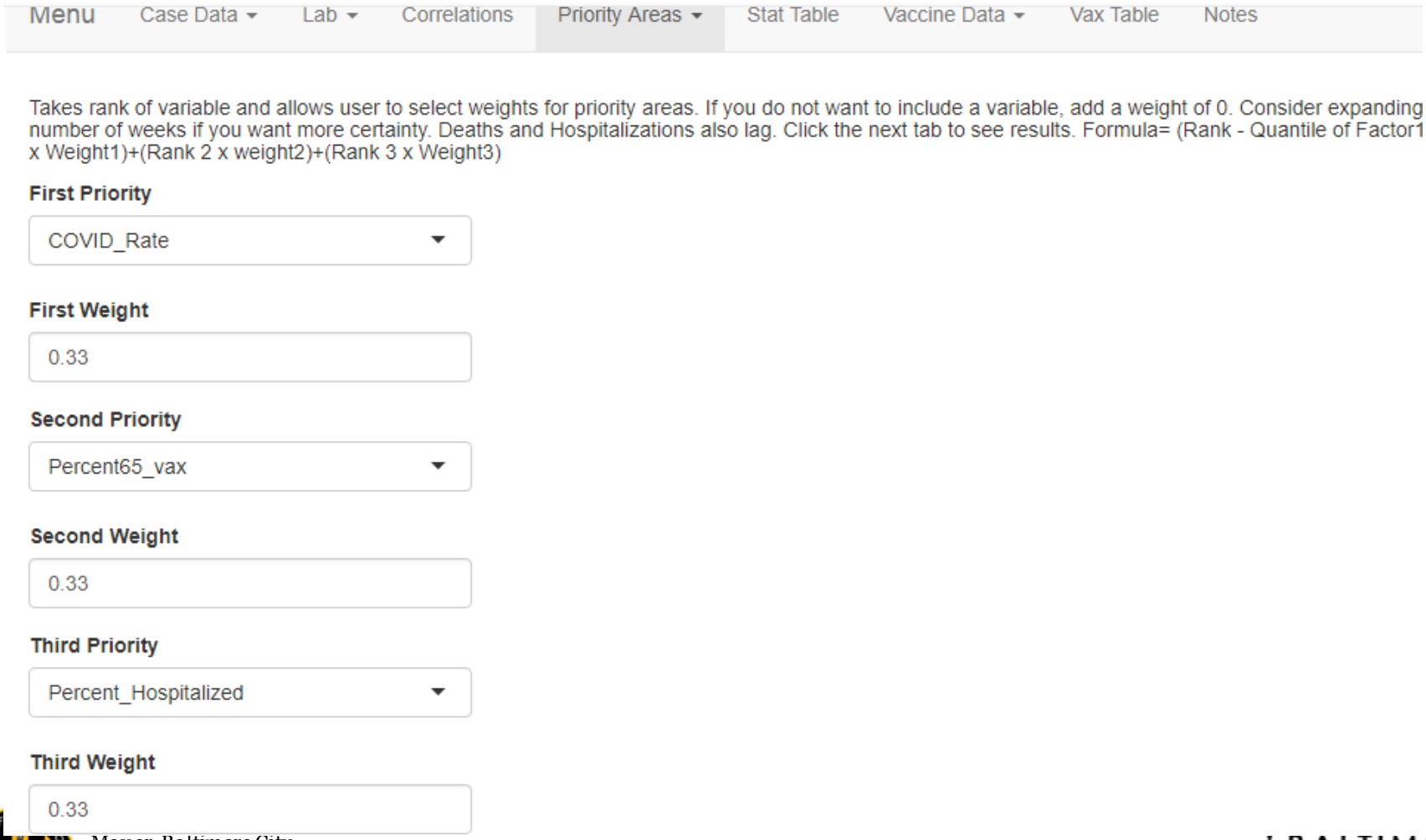
Correlation Explorer



Priority Area Calculator

- Changed name from "Priority Testing" Calculator to reflect wide range of potential interventions.
- User selects up to 3 criteria to prioritize geographic areas
- User also selects weights
- Score is calculated and results are displayed in a table and map.

Priority Area Calculator



Priority Area Calculator

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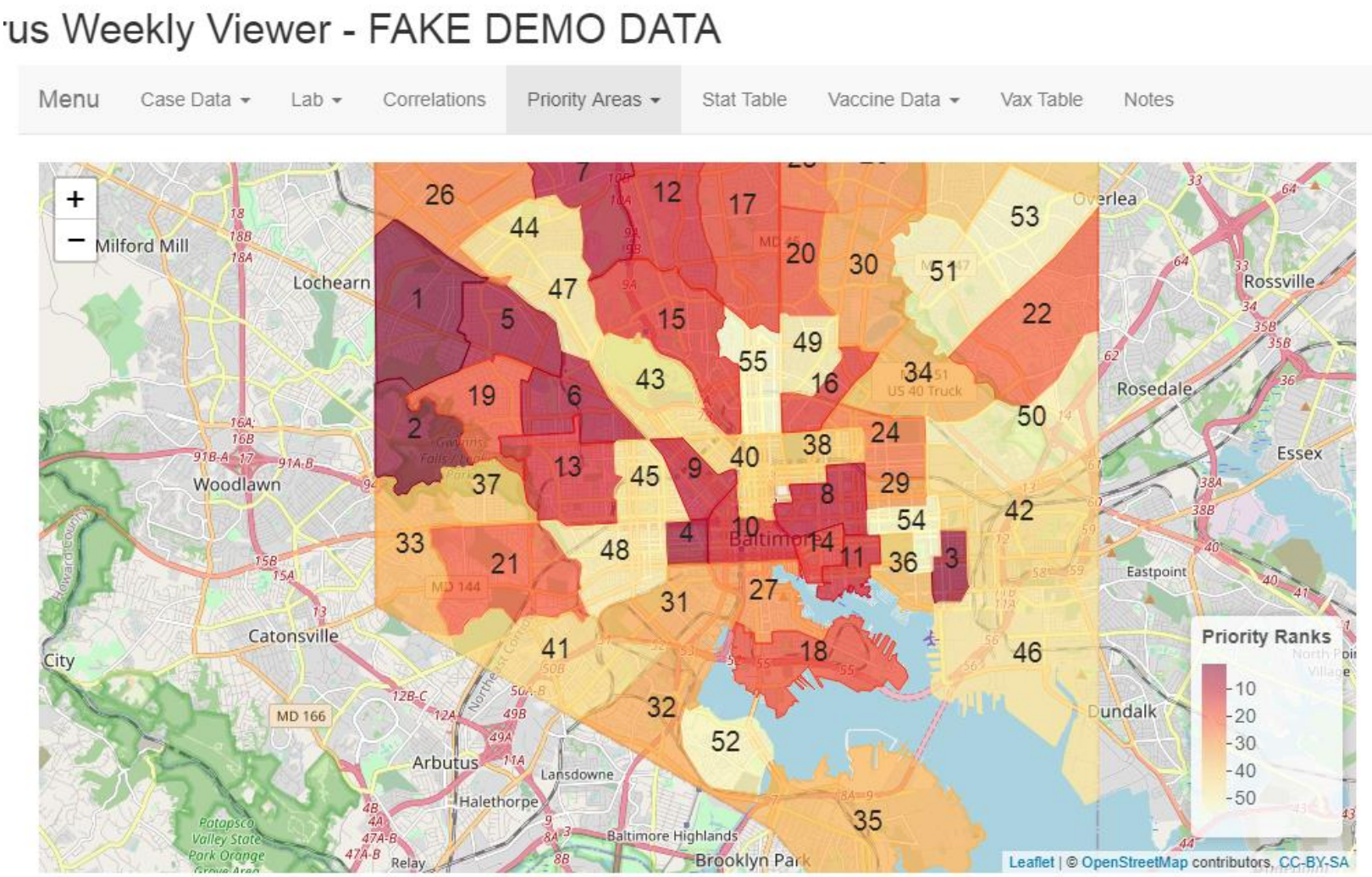
Show 25 entries Search:

Rank	CSA2010	COVID_Rate	Percent_Hospitalized	Mortality_Rate	Case_Fatality	Percent_Positive
1	Poppleton/The Terraces/Hollins Market	16.52	54.8	0.20	1.2	43.3
2	Dorchester/Ashburton	8.15	55.2	0.17	2.1	49.7
3	Greater Mondawmin	9.01	53.6	0.21	2.4	52.6
4	Clifton-Berea	8.30	42.7	0.10	1.2	51.2
5	Dickeyville/Franklintown	14.14	58.6	0.24	1.7	53.5
6	Canton	6.54	60.4	0.25	3.8	47.9
7	Cross-Country/Cheswolde	5.37	51.4	0.00	0.0	52.0
8	Forest Park/Walbrook	7.41	57.5	0.10	1.4	51.1

"Ties" / tied scores can be an issue.

Priority Area Calculator



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Strengths

- Interactive
- Fast and flexible
  - Tabs can be copied, pasted, edit
- Only uses 7 R packages
- Reduced workload/allowed for other work
- Can be used for any disease/condition
- Correlation Explorer
- Priority Area Calculator

Strengths

- App reduced workload and allowed for other work.
- Can be used for any disease/condition
- Exploratory Data Analysis
  - Correlation Explorer
  - Priority Area Calculator
- Show inequalities and lack of health equity.

Limitations

- R has a steep learning curve.
- Code could be shortened.
- Not fully automated but could be!
- Could add Antibody Testing.
- Tied scores in Priority Area Calculator

Other COVID Work in R

Activity	Purpose	Notes
Space-time surveillance of COVID-19 clusters	Planning and intervention	Build-on previous work in non-fatal overdoses
Confirmed Case Report	Case, hospitalization, and death statistics, counts, rates, etc.	1 button push
Social Network Analysis	Examine relationships between cases and contacts	
Outbreak Summary	Summarize contact tracing data	

(STATA GIS Facilities Report: matching case addresses to lists of facilities (Nursing Homes, etc.)

Importance of Public Health Funding

- App built-on existing work for violence and overdose prevention.
- Without earlier funding, the app likely would not have existed for COVID.
- Collaborate!

Resources

- R shiny: https://shiny.rstudio.com/tutorial/
- Leaflet in R: https://rstudio.github.io/leaflet/
- Neighborhood Health Profiles: https://health.baltimorecity.gov/neighborhoods/neighborhood-health-profile-reports
- Baltimore Neighborhood Indicators Alliance (BNIA): https://bniajfi.org/

Questions?

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