Influence of Travel Ban Intervention on Covid-19 Spread in Wisconsin

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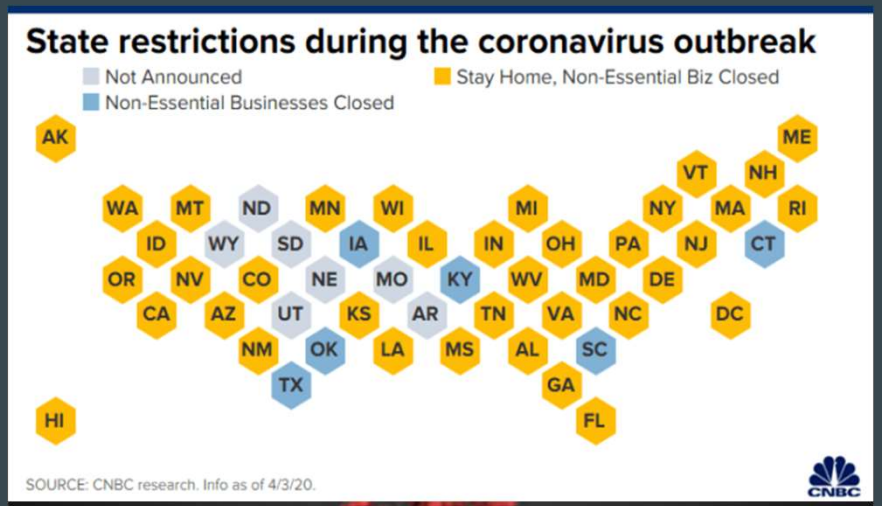
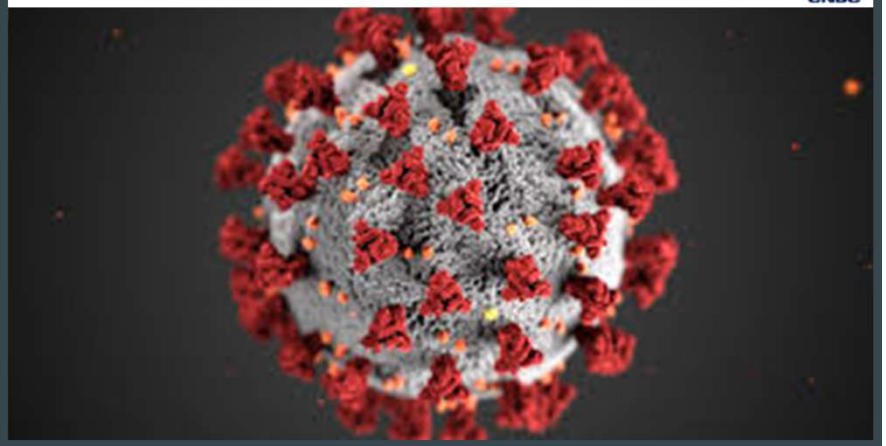
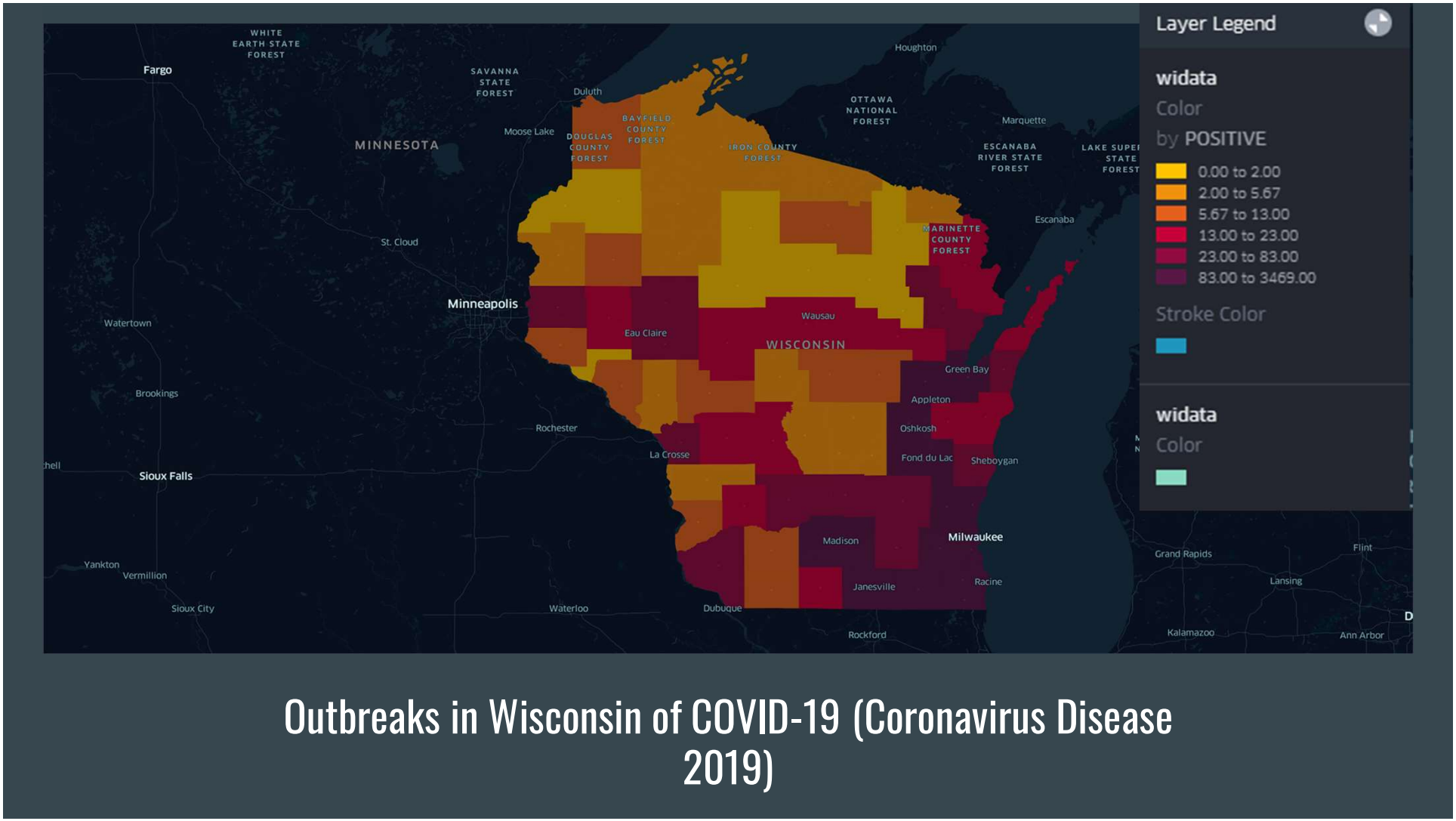
Boyu Shen, Detao Yu

Introduction

- COVID-19 continues to spread and affect many parts of the U.S. and the rest of the world. It is the best time to act in ways that slow the spread. Human mobility patterns and changes could be one indicator for understanding this virus.Our project is going to detect infected cases in each county in Wisconsin, analyze the infected cases distribution after implementation of travel ban and “stay at home” policy, we want to explore how human mobility changes influence Covid-19 spread.
- We will consider various factors including population density and other mobility factors.
    - Grocery & pharmacy
    - Parks
    - Transit stations
    - Retail & recreation
    - Residential
    - Workplaces







Outbreaks in Wisconsin of COVID-19 (Coronavirus Disease 2019)

Data

There are four base datasets needed for completing this project. Google COVID-19 Community Mobility Reports provides human mobility percent changes.

Coronavirus Locations: COVID-19 Map by County and State provides a base data set that include population for each county in Wisconsin.

COVID-19 Historical Data Table gives us information about the number of confirmed case in each.

We also use google shape file for counties in Wisconsin to get the geographic information.

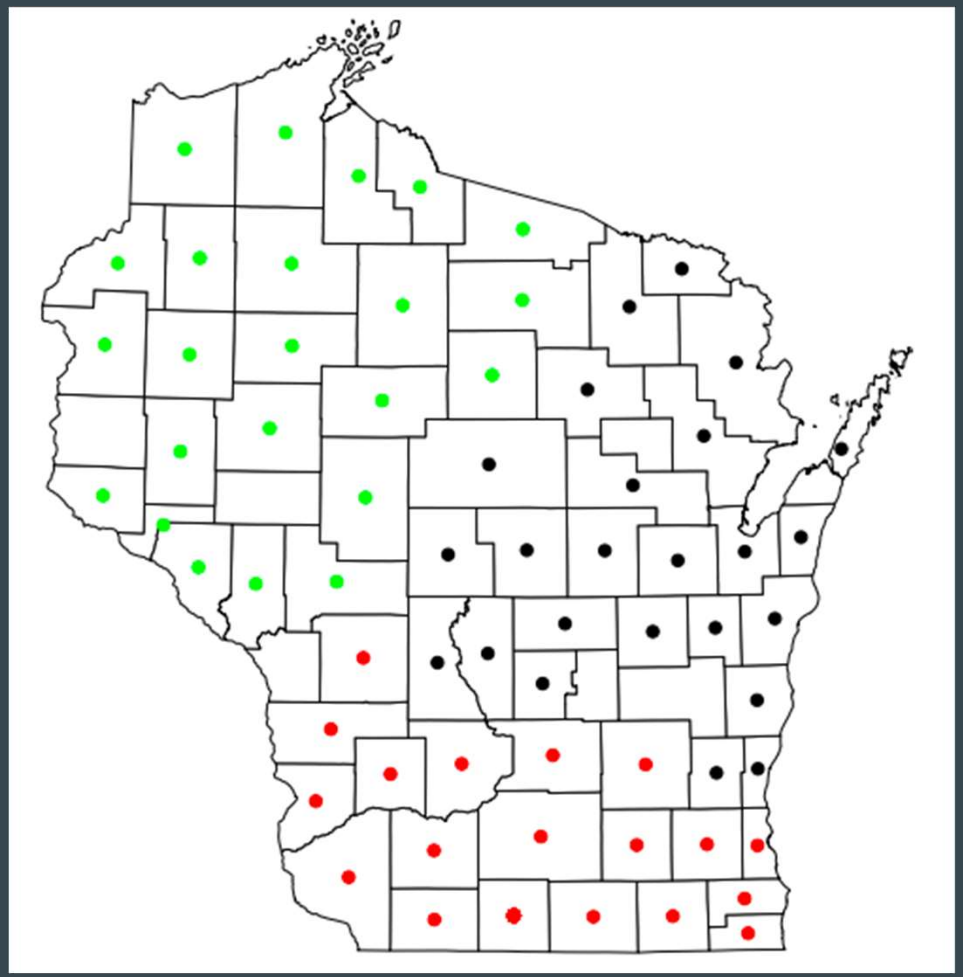
Finally we merge all of the above data to form a single data frame and removed NaN values.

Method

We used both supervised and unsupervised methods:

- Spatial Clustering: Apply K-Medoid Clustering method to classify 71 counties in Wisconsin into three clusters
- For each cluster, find the best model of a multiple linear regression in Rstudio to regress the number of confirmed cases in each county on percent change in human mobility of different places and population density
- We will apply Time Space Analysis using Kepler.gl to analyse the flights changes over time from January to April

Results and Findings



Apply K-Medoid Clustering method to form cluster of Counties :

Features used:

1. Number of Confirmed cases
2. Geographical coordinates

Multiple Linear Regressions for Different Clusters

1. Model for Southern counties(red points):

All variables are numerical and continuous

Confirmed cases =67.70+ 6.352*10^-3*pop + 59.49*residen + 20.77*work
+ 7.740*gro_ph + 14.6*retail
+ -1.315*10^-4*population *grocery_pharmacy_mean
+ -1.882*10^-3*population * residential_mean
+ -6.57*10^-4*population * Workplaces_mean

Pop- county population
Residen- mean value of percent mobility change for residence place
Work-mean value of percent mobility change for workplace
Gro_ph -Mean value of percent mobility change for grocery store and pharmacy
Retail - mean value of percent mobility change for retail and recreation

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Coefficients:
                                  Estimate Std. Error
(Intercept)                      6.770e+01  3.671e+02
population                       6.352e-03  3.015e-03
residential_mean                 5.949e+01  2.399e+01
workplaces_mean                  2.077e+01  2.157e+01
grocery_pharmacy_mean            7.740e+00  2.637e+01
retail_recreation_mean           1.460e+01  2.397e+01
population:grocery_pharmacy_mean -1.315e-04  2.444e-04
population:residential_mean      -1.882e-03  3.408e-04
population:workplaces_mean       -6.570e-04  2.274e-04
                                 t value Pr(>|t|)
(Intercept)                        0.184 0.858277
population                         2.106 0.068245 .
residential_mean                   2.480 0.038131 *
workplaces_mean                    0.963 0.363713
grocery_pharmacy_mean              0.293 0.776634
retail_recreation_mean             0.609 0.559353
population:grocery_pharmacy_mean  -0.538 0.605350
population:residential_mean       -5.522 0.000559 ***
population:workplaces_mean        -2.889 0.020233 *
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Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 126.5 on 8 degrees of freedom
  (3 observations deleted due to missingness)
Multiple R-squared:  0.9882,    Adjusted R-squared:  0.9764
F-statistic: 83.83 on 8 and 8 DF,  p-value: 6.57e-07
```

Multiple Linear Regressions for Different Clusters

2. Model for Northwestern counties(green points):

All variables are numerical and continuous

Confirmed cases =780.9+ -1.501*10^-2*population + 1.188*10^2residential_mean + 1.037*10^2*workplaces_mean + -13.88grocery_pharmacy_mean + -1.803retail_recreation_mean + 7.989*10^-4*population *grocery_pharmacy_mean + -3.914*10^-3*population * residential_mean + -2.870*10^-3*population * workplaces_mean

```
Coefficients:
                                  Estimate Std. Error
(Intercept)                       7.809e+02  1.189e+03
population                       -1.501e-02  1.366e-02
residential_mean                  1.188e+02  8.035e+01
workplaces_mean                   1.037e+02  5.497e+01
grocery_pharmacy_mean            -1.388e+01  3.916e+01
retail_recreation_mean           -1.803e+00  1.303e+01
population:grocery_pharmacy_mean  7.989e-04  4.147e-04
population:workplaces_mean       -2.870e-03  8.042e-04
population:residential_mean      -3.914e-03  1.904e-03
                                 t value Pr(>|t|)
(Intercept)                        0.657  0.52760
population                        -1.099  0.30021
residential_mean                   1.479  0.17323
workplaces_mean                    1.887  0.09176 .
grocery_pharmacy_mean             -0.354  0.73119
retail_recreation_mean            -0.138  0.89302
population:grocery_pharmacy_mean   1.927  0.08612 .
population:workplaces_mean        -3.569  0.00603 **
population:residential_mean       -2.055  0.07002 .
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Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 196.6 on 9 degrees of freedom
  (6 observations deleted due to missingness)
Multiple R-squared:  0.8604,    Adjusted R-squared:  0.7363
F-statistic: 6.934 on 8 and 9 DF,  p-value: 0.004413
```

3 Model for Northeastern counties(black points):

All variables are numerical and continuous

Confirmed cases =637.1+ -1.473*10^-2*population + -8.96*residential_mean + 32.1*workplaces_mean + -7.056*grocery_pharmacy_mean + -4.587*10^-1*retail_recreation_mean + 1.447*10^-4*population *grocery_pharmacy_mean + 4.047*10^-4*population * residential_mean + -6.41*10^-4*population * workplaces_mean

```
Coefficients:
                                  Estimate Std. Error
(Intercept)                       6.371e+02  1.326e+02
population                       -1.473e-02  3.207e-03
residential_mean                 -8.960e+00  7.755e+00
workplaces_mean                   3.210e+01  9.040e+00
grocery_pharmacy_mean            -7.056e+00  3.031e+00
retail_recreation_mean           -4.587e-01  3.651e-01
population:residential_mean       4.047e-04  2.939e-04
population:grocery_pharmacy_mean  1.447e-04  7.311e-05
population:workplaces_mean       -6.410e-04  2.488e-04
                                 t value Pr(>|t|)
(Intercept)                        4.806    0.131
population                        -4.592    0.137
residential_mean                  -1.155    0.454
workplaces_mean                    3.551    0.175
grocery_pharmacy_mean             -2.328    0.258
retail_recreation_mean            -1.257    0.428
population:residential_mean        1.377    0.400
population:grocery_pharmacy_mean   1.979    0.298
population:workplaces_mean        -2.576    0.236

Residual standard error: 2.56 on 1 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.989,     Adjusted R-squared:  0.9007
F-statistic: 11.21 on 8 and 1 DF,  p-value: 0.2272
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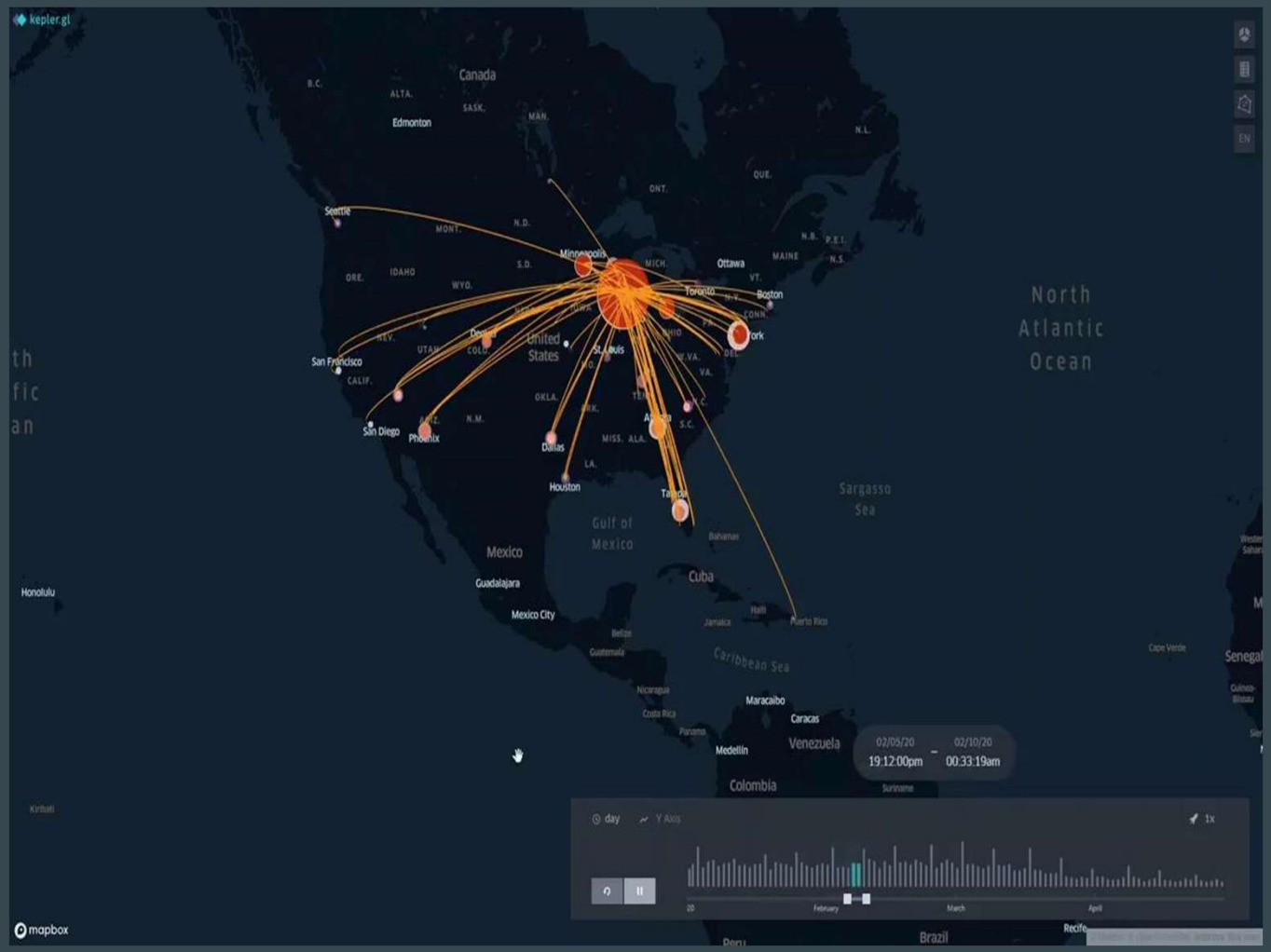

Time Playback: Flight changes of all airports in Wisconsin (January - April)

Conclusion

- The travel ban policy have an important impact on the spread of coronavirus, this policy restricted on people's travels, reduced the mobility, therefore cut off the opportunity of spread of the virus.
- Mobility trends for retail, recreation, grocery, pharmacy, and workplaces and dropped a lot compared to the baseline, which means that governments' travel ban and "stay at home" policies have prevented people from going out to those places for recreation or travelling.

Reference

- Google COVID-19 Community Mobility Reports
- COVID-19 United States Cases by County
- WiDNR Open Data
- COVID-19: County Data
- Coronavirus Locations: COVID-19 Map by County and State
- Crowdsourced air traffic data from The OpenSky Network 2020
- The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak
- COVID-19 Historical Data Table