COVID-19 ANALYSIS

Data Analytics

FINAL PROJECT

May 4th, 2020

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Part One - Abstract and Introduction

Description

The main goal of my final project is to compare two sets of data: COVID19 up-to-date data within the United States and COVID19 up-to-date data in China. In the following part of my data analysis, I will use the mortality rate, confirmed case number, suspected case number to understand why the COVID19 mortality rate is different from different countries.

I will use my data model and the scholar paper abstraction to get a conclusion. The second goal of my analyses is to understand whether the testing rate has anything to do with America's geographic location. That being said, I want to understand whether the higher latitude has the higher testing rate, or vice versa.

For the first part of my analysis, since mid-march, COVID-19 has hit America hard. I wanted to use the latest COVID-19 data as an excel file and perform various analyses on the COVID data. Mainly, my main interest is to analyze the COVID-19 data points within the United States across different states. In my data analyses, I will perform basic reports such as the historical number of max death in the states and number of minimum deaths within each state; number of confirmed cases maximum; mean and minimum within each state; number of maximum; and minimum and average recovered people within each state.

Part Two - Data Description

According to the summary of the COVID data, the min confirmed case across the state is 0; the maximum confirmed case across the state is 295106 historically until 04/28/2020; the average confirmed case from January through April is 4575; and the mean for confirmed case is 17162. In terms of total number of deaths, the minimum number of deaths is 0; the maximum number of deaths within a day is 22912; the average number of deaths across the states is 192 and the mean number of deaths is 989. In terms of recovered rate, the minimum number of recovered cases within a day is 0; the average recovered cases historically is 1146; and the maximum recovered cases is 115936.

```
> summary(covid042820)
      Province_State Country_Region              Last_Update       Lat              Long_           Confirmed     
 Alabama       : 1   US:59          2020-04-29 02:32:33:59   Min.   :-14.27   Min.   :-170.13   Min.   :     0  
 Alaska        : 1                                           1st Qu.: 34.59   1st Qu.:-101.17   1st Qu.:  1248  
 American Samoa: 1                                           Median : 39.06   Median : -87.94   Median :  4575  
 Arizona       : 1                                           Mean   : 36.84   Mean   : -85.21   Mean   : 17162  
 Arkansas      : 1                                           3rd Qu.: 42.36   3rd Qu.: -76.97   3rd Qu.: 15464  
 California    : 1                                           Max.   : 61.37   Max.   : 145.67   Max.   :295106  
 (Other)       :53                                           NA's   :3        NA's   :3                         
     Deaths            Recovered            Active              FIPS           Incident_Rate      People_Tested   
 Min.   :    0.0   Min.   :     0   Min.   :-115936   Min.   :    1.00   Min.   :   0.00   Min.   :     3  
 1st Qu.:   44.0   1st Qu.:   466   1st Qu.:   1458   1st Qu.:   18.25   1st Qu.:  97.66   1st Qu.: 20921  
 Median :  192.0   Median :  1146   Median :   4520   Median :   32.50   Median : 150.71   Median : 59251  
 Mean   :  989.1   Mean   :  6898   Mean   :  14453   Mean   : 3288.09   Mean   : 258.19   Mean   :103495  
 3rd Qu.:  761.0   3rd Qu.:  2260   3rd Qu.:  15227   3rd Qu.:   47.75   3rd Qu.: 252.84   3rd Qu.:115240  
 Max.   :22912.0   Max.   :115936   Max.   : 272194   Max.   :99999.00   Max.   :1750.23   Max.   :844994  
                   NA's   :22       NA's   :1         NA's   :1          NA's   :3         NA's   :3        
 People_Hospitalized Mortality_Rate        UID              ISO3      Testing_Rate      Hospitalization_Rate
 Min.   :   56.0     Min.   : 0.000   Min.   :      16   ASM: 1   Min.   :   5.392   Min.   : 6.788      
 1st Qu.:  277.0     1st Qu.: 2.995   1st Qu.:84000012   GUM: 1   1st Qu.:1271.876   1st Qu.:10.627      
 Median :  902.5     Median : 3.954   Median :84000028   MNP: 1   Median :1559.246   Median :15.888      
 Mean   : 3542.2     Mean   : 4.249   Mean   :76885809   PRI: 1   Mean   :1902.382   Mean   :15.725      
 3rd Qu.: 2227.8     3rd Qu.: 5.143   3rd Qu.:84000043   USA:54   3rd Qu.:2401.672   3rd Qu.:19.767      
 Max.   :64275.0     Max.   :14.286   Max.   :84099999   VIR: 1   Max.   :5446.019   Max.   :29.280      
 NA's   :29          NA's   :2                                    NA's   :3          NA's   :29          
```

Data summary on the US data

In order to get precise table summaries, I listed *covid042820* command and R demonstrated a clear readable way of my COVID-19 latest data:

```
> covid042820
          Province_State Country_Region         Last_Update      Lat     Long_ Confirmed Deaths Recovered
1                Alabama             US 2020-04-29 02:32:33  32.3182  -86.9023      6750    242        NA
2                 Alaska             US 2020-04-29 02:32:33  61.3707 -152.4044       351      9       228
3         American Samoa             US 2020-04-29 02:32:33 -14.2710 -170.1320         0      0        NA
4                Arizona             US 2020-04-29 02:32:33  33.7298 -111.4312      6955    275      1450
5               Arkansas             US 2020-04-29 02:32:33  34.9697  -92.3731      3127     57      1146
6             California             US 2020-04-29 02:32:33  36.1162 -119.6816     46164   1864        NA
7               Colorado             US 2020-04-29 02:32:33  39.0598 -105.3111     14316    736      2275
8            Connecticut             US 2020-04-29 02:32:33  41.5978  -72.7554     26312   2087        NA
9               Delaware             US 2020-04-29 02:32:33  39.3185  -75.5071      4575    137      1096
10      Diamond Princess             US 2020-04-29 02:32:33       NA        NA        49      0         0
11  District of Columbia             US 2020-04-29 02:32:33  38.8974  -77.0268      3994    190       660
12               Florida             US 2020-04-29 02:32:33  27.7663  -81.6868     32848   1171        NA
13               Georgia             US 2020-04-29 02:32:33  33.0406  -83.6431     24922   1036        NA
14        Grand Princess             US 2020-04-29 02:32:33       NA        NA       103      3         0
15                  Guam             US 2020-04-29 02:32:33  13.4443  144.7937       141      5       129
16                Hawaii             US 2020-04-29 02:32:33  21.0943 -157.4983       609     16       493
17                 Idaho             US 2020-04-29 02:32:33  44.2405 -114.4788      1952     60      1039
18              Illinois             US 2020-04-29 02:32:33  40.3495  -88.9861     48102   2125        NA
19               Indiana             US 2020-04-29 02:32:33  39.8494  -86.2583     16588    901        NA
```

```
20                     Iowa            US 2020-04-29 02:32:33  42.0115  -93.2105      6376    136      2164
21                   Kansas            US 2020-04-29 02:32:33  38.5266  -96.7265      3652    127        NA
22                 Kentucky            US 2020-04-29 02:32:33  37.6681  -84.6701      4375    225      1521
23                Louisiana            US 2020-04-29 02:32:33  31.1695  -91.8678     27286   1801     17303
24                    Maine            US 2020-04-29 02:32:33  44.6939  -69.3819      1040     51       585
25                 Maryland            US 2020-04-29 02:32:33  39.0639  -76.8021     20113   1016      1295
26            Massachusetts            US 2020-04-29 02:32:33  42.2302  -71.5301     58302   3153        NA
27                 Michigan            US 2020-04-29 02:32:33  43.3266  -84.5361     39262   3568      8342
28                Minnesota            US 2020-04-29 02:32:33  45.6945  -93.9002      4181    301      1912
29              Mississippi            US 2020-04-29 02:32:33  32.7416  -89.6787      6342    239        NA
30                 Missouri            US 2020-04-29 02:32:33  38.4561  -92.2884      7450    330        NA
31                  Montana            US 2020-04-29 02:32:33  46.9219 -110.4544       451     15       356
32                 Nebraska            US 2020-04-29 02:32:33  41.1254  -98.2681      3517     56        NA
33                   Nevada            US 2020-04-29 02:32:33  38.3135 -117.0554      4821    219        NA
34            New Hampshire            US 2020-04-29 02:32:33  43.4525  -71.5639      2010     60       798
35               New Jersey            US 2020-04-29 02:32:33  40.2989  -74.5210    113856   6442     15642
36               New Mexico            US 2020-04-29 02:32:33  34.8405 -106.2485      2974    105       666
37                 New York            US 2020-04-29 02:32:33  42.1657  -74.9481    295106  22912     51630
38           North Carolina            US 2020-04-29 02:32:33  35.6301  -79.8064      9755    363        NA
39             North Dakota            US 2020-04-29 02:32:33  47.5289  -99.7840       991     19       409
40 Northern Mariana Islands            US 2020-04-29 02:32:33  15.0979  145.6739        14      2        12
41                     Ohio            US 2020-04-29 02:32:33  40.3888  -82.7649     16769    799        NA
```

```
42                 Oklahoma            US 2020-04-29 02:32:33  35.5653  -96.9289      3410    207      2260
43                   Oregon            US 2020-04-29 02:32:33  44.5720 -122.0709      2385     99        NA
44             Pennsylvania            US 2020-04-29 02:32:33  40.5908  -77.2098     45137   2046        NA
45              Puerto Rico            US 2020-04-29 02:32:33  18.2208  -66.5901      1400     86        NA
46             Rhode Island            US 2020-04-29 02:32:33  41.6809  -71.5118      7927    239       466
47           South Carolina            US 2020-04-29 02:32:33  33.8569  -80.9450      5735    192      2830
48             South Dakota            US 2020-04-29 02:32:33  44.2998  -99.4388      2313     11      1392
49                Tennessee            US 2020-04-29 02:32:33  35.7478  -86.6923     10052    188      4921
50                    Texas            US 2020-04-29 02:32:33  31.0545  -97.5635     26357    719     11786
51                     Utah            US 2020-04-29 02:32:33  40.1500 -111.8624      4345     41      1704
52                  Vermont            US 2020-04-29 02:32:33  44.0459  -72.7107       862     47        NA
53           Virgin Islands            US 2020-04-29 02:32:33  18.3358  -64.8963        57      4        51
54                 Virginia            US 2020-04-29 02:32:33  37.7693  -78.1700     14339    492      1914
55               Washington            US 2020-04-29 02:32:33  47.4009 -121.4905     13842    786        NA
```

```
> summary(covidata)
            provinceName provinceShortName                  cityName   confirmedCount     suspectedCount
 Chongqing         : 41   Chongqing: 41     境外输入             : 19   Min.   :    0.00   Min.   :  0.000
 Guangdong Province: 22   Guangdong: 22     Luzhou               :  6   1st Qu.:    7.00   1st Qu.:  0.000
 Sichuan Province  : 22   Sichuan  : 22     Area to be identified:  3   Median :   18.00   Median :  0.000
 Henan Province    : 20   Henan    : 20     Fuzhou               :  2   Mean   :  349.84   Mean   :  3.226
 Beijing           : 19   Beijing  : 19     Suzhou               :  2   3rd Qu.:   52.75   3rd Qu.:  0.000
 Shanghai          : 19   Shanghai : 19     (Other)              :412   Max.   :68128.00   Max.   :384.000
 (Other)           :335   (Other)  :335     NA's                 : 34
  curedCount         deadCount
 Min.   :    0.0   Min.   :   0.00
 1st Qu.:    6.0   1st Qu.:   0.00
 Median :   16.0   Median :   0.00
 Mean   :  326.9   Mean   :  19.41
 3rd Qu.:   48.0   3rd Qu.:   0.00
 Max.   :63616.0   Max.   :4512.00
```

Above is the summary on the China data

In addition to the U.S. data, I also obtained a China data set. I performed the summary of my China dataset. Up till April 28th, the total death toll is 9276 people. Total confirmed case is: 167223 people. Total cured case is: 156270.

One important question I want to estimate is to calculate the mortality rate within the United States. I used the linear model to predict the mortality rate based on the number of deaths, number of recovered people and number of people who are still being hospitalized together and ran my linear regression model.

My summary of the mortality rate within the United State is 0.2; meaning if there are 100 people who are tested for COVID-19, there will be around 2 people to encounter death within the United States.

```
Call:
lm(formula = data$Mortality_Rate ~ data$Deaths + data$Recovered +
    data$People_Hospitalized)

Residuals:
    Min      1Q  Median      3Q     Max
-2.6200 -0.8327  0.2027  0.9321  2.0522

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)              2.3378824  0.5558322   4.206  0.00103 **
data$Deaths              0.0213010  0.0085718   2.485  0.02735 *
data$Recovered          -0.0003597  0.0003585  -1.003  0.33400
data$People_Hospitalized -0.0022215  0.0023340  -0.952  0.35857
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.347 on 13 degrees of freedom
Multiple R-squared:  0.5417,    Adjusted R-squared:  0.4359
F-statistic: 5.121 on 3 and 13 DF,  p-value: 0.01479
```

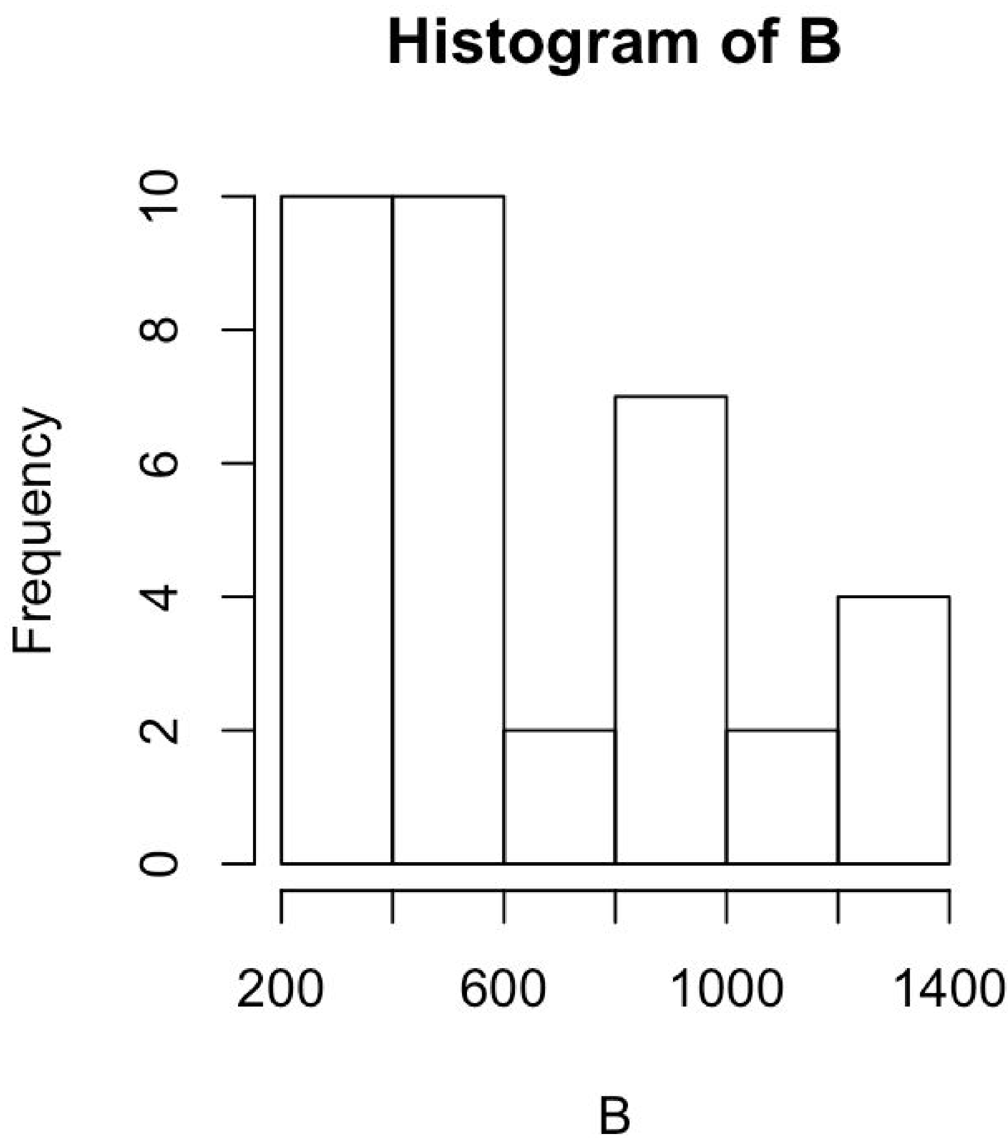
However, the mortality rate in China is only 0.011. My data shows me that for the same amount of people who have gotten COVID-19; people in the U.S are more likely to face death compared with the number in China.

I further analyze the COVID-19 data with a decision tree model. Decision tree is a supervised model for continuous input and output models. I want to use a decision tree to give me a visual analysis to see whether the testing rate within the United States has anything to do with America’s geographic location.

Part Three: Data Analysis, Model Development and Application of model(s)

I performed some basic analyses on the covid 19 data in the United States up to Apr 28th. For the smoothing and cleaning process, I got rid of useless values from the data rows. I performed linear regression on both U.S data and on the Chinese data.

Below is the Chinese dataset on a histogram on confirmed cases cumulatively in a day:



Below is the summary of the linear regression mortality rate for the Chinese data. I realized after reading my summary that my variable's coefficients are very small. So my assumption is that a linear regression model might not be the best model to analyze the predicted mortality rate using my variables. Another suspicion that I have is that the linear regression model probably needs more variables than my current variables such as confirmed cases and suspected cases.

```
> summary(lmMortalityRate)

Call:
lm(formula = data$Morality ~ data$Confirmed + data$Suspected +
    data$Current)

Residuals:
     Min       1Q   Median       3Q      Max
-0.01648 -0.01105 -0.01103 -0.01093  0.32231

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)     1.102e-02  1.678e-03   6.570 1.35e-10 ***
data$Confirmed -5.241e-06  5.422e-05  -0.097    0.923
data$Suspected -1.020e-06  7.495e-05  -0.014    0.989
data$Current    6.740e-06  5.829e-05   0.116    0.908
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.03588 on 465 degrees of freedom
Multiple R-squared:  0.01252,   Adjusted R-squared:  0.006148
F-statistic: 1.965 on 3 and 465 DF,  p-value: 0.1184
```

Linear regression model on China data.

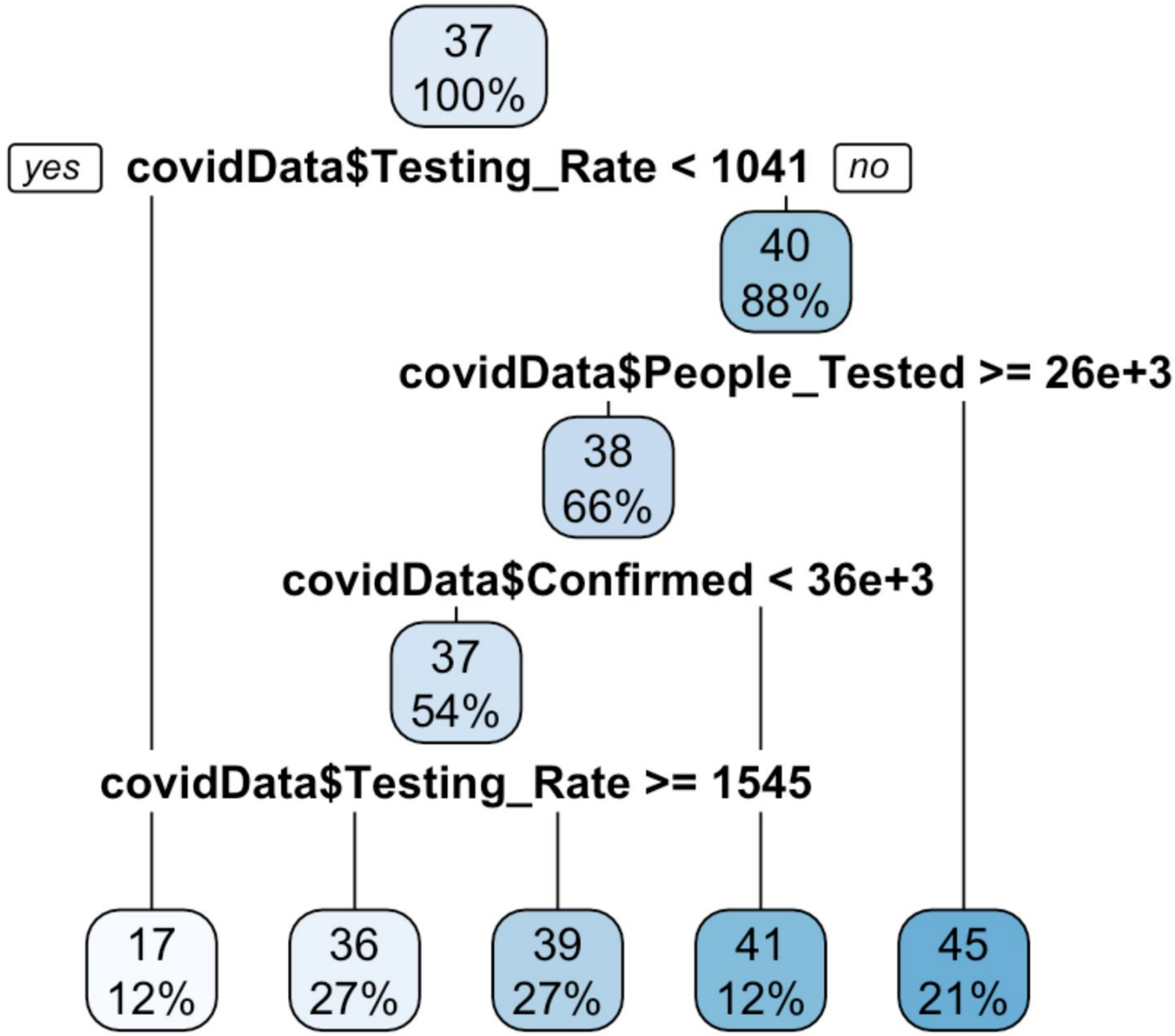
For the Chinese data, my linear regression result showed below:

```
> na.omit(data)
   Confirmed Suspected Current      Morality
1        939       384     586 0.0138445154
2        386        34     116 0.0000000000
3        263         8     195 0.0152091255
4         20         0      15 0.0000000000
5         27         0      25 0.0370370370
6         52         0      49 0.0576923077
7         47         0      43 0.0851063830
8         46         0      46 0.0000000000
9         43         0      42 0.0232558140
10        17         0      17 0.0000000000
11        15         0      15 0.0000000000
12        14         0      14 0.0000000000
13         5         0       5 0.0000000000
14         3         0       3 0.0000000000
15         1         0       1 0.0000000000
16      1037        47     811 0.0038572806
18       644       300     584 0.0108695652
```

My two different datasets showed me that the mortality rate is different in between the United States and China. I consulted different sources for clear clarification. For example, Johns Hopkins analysis. The analysis showed that there are different ways to measure the COVID-19 mortality rate. Different countries throughout the world have reported very different mortality ratios are likely due to a variety of reasons. Such reasons are different in the number of people tested, so for example, with more testing numbers, we could get a clearer picture on the population who are identified as COVID-19 carriers. With more testing, it also enables doctors to get more accurate data. Second reason is the demographic reason. Mortality rate is also related to the population of citizens who are elderly. Thus, we should consider people's average age within the country before doing the analysis. Third, it is important to understand the health care system in different countries. It is apparent that the better the health care system the country is, the lower mortality rate it should be. Thus, these factors are absolutely important to consider outside the mortality rate.

Second, different countries have different measurements toward the COVID-19 data. For example, within the United States, the country takes patients with pre-existing conditions as COVID-19 infected data. However, in China, if a patient has any pre-existing conditions, the patient does not count as COVID-19 patient.

The second model I used is the decision tree model. I want to understand whether the high latitude has anything to do with the testing rate. My decision tree graph demonstrated that the higher latitude is, the higher the testing rate is. For example, for latitude of around 40; the people who are tested is 88%; however, for latitude of around 38, only 66% of people who have been tested; for latitude of around 37, only 54% people who have tested.



In terms of the geographical differences for the COVID-19 mortality rate, there are also a number of different reasons. For example, we will find there are a range of states from Kentucky to Kansas are on the latitude of 38 lines. Thus, NY state, the state of Massachusetts are on the north of latitude 38; while California for example is on the latitude of 36. There are also a number of reasons for the mortality rate in terms of the latitude. For example, doing our analysis, NY state is more of a population dense state. Thus, since COVID-19 is an airborne disease, the number of people who are infected from COVID-19 might be higher than lower population dense states such as Utah.

Park IV: Conclusions and Discussion

My data told me two important things with COVID-19 in between the United States and China. First, the mortality rate of COVID-19 in China is 50% lower than the mortality rate within the United States. Second, within the United States, places with a higher latitude have a higher percentage to get tested.

With regards to the mortality rate differences in between the United States and China, there are a number of different reasons. Such reasons include the health care system, differences in terms of the COVID-19 measurements and differences in counting the COVID-19 data.

With regards to the mortality rate in relation with the latitude, there are also a number of different reasons to be considered. People need to count on the number of population density states and different health care facilities across different states . These factors are extremely important in terms of analyzing the mortality in our future analysis.