Huang, Shiwei Final Project
Data Analytics

1. **Abstract and Introduction (2%) Describe your motivation, initial hypothesis/ idea that you wanted to investigate, and if applicable any prior work, interest in the topic (like an intro for a paper, with references), Min. 1/2 page.**

Introduction:

The 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, suspected case to try to understand why the COVID19 mortality rate is different from different countries. I will use my data model to compare with the scholar paper and hopefully get a conclusion.

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 state and number of minimum death within each state; number of confirmed cases maximum, mean and minimum within each state; number of maximum, minimum and average recovered people within each state.

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 state 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.

2. Data Description (3%) 1NOTE: 6000-level students must develop at least two different types of models, not just change the number of variables for a given model type. Describe how you determined which datasets you used in this project, the criteria, source, data and information- types in detail, associated documentation and any other supporting materials. Min. 1/2 page text (+graphics if applicable).

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 number of death, number of recovered people and number of people who are still being hospitalized together and ran my linear regression model.

My summary of the morality 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
```

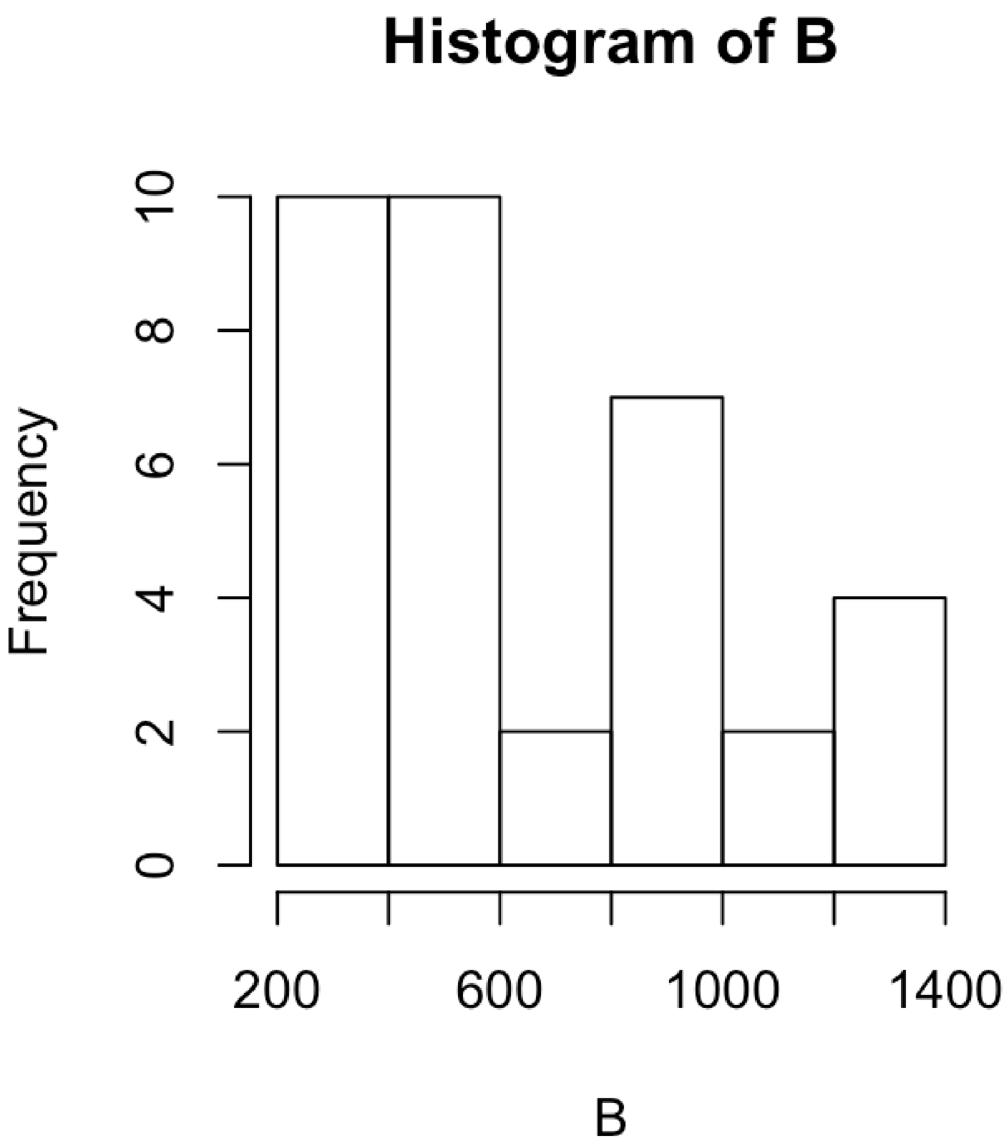
However, the mortality rate in China is only 0.011. My data shows me that for the same amount of people who have gotten COVID-19; people in the U.S are more likely to face death compared with the number in China.

I further analyze the COVID-19 data with a decision tree model. Decision tree is a supervised model for continuous input and output models.

3. Analysis (5%) Explore the statistical aspects of your datasets. Perform any transformations, interpolations, smoothing, cleaning, etc. required on the data, to begin to explore your hypothesis/ questions. Analyze the distributions; provide summaries of the relevant statistics and plots of any fits you made. Discuss and specify or estimate possible sources of error, uncertainty or bias in the data you used (or did not use). Min. 2 pages text + graphics.

First, I performed some basic analyses on the covid 19 data 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:



4. Model Development and Application of model(s) (12%) What types of models you used to describe the data (regression, classification, clustering, etc.), patterns/ trends you found, visual approaches that helped you choose models, and or variables (type/ number) in the model, other parameter choices or settings for the models (e.g. distance metrics, kernels, etc.). Apply the models to assess model performance (i.e. predict). Discuss the confidence in your results including any statistic measures. Discuss how you validated your models and performed any optimization (give details). Min. 6 pages text + graphics.

This 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 need 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
```

19	305	4	253	0.0000000000
20	111	0	109	0.0090090090
21	61	0	60	0.0163934426
22	22	0	21	0.0454545455
23	19	0	19	0.0000000000
24	18	0	17	0.0555555556
25	16	0	15	0.0625000000
26	14	0	14	0.0000000000
27	13	0	13	0.0000000000
28	11	0	11	0.0000000000
29	9	0	9	0.0000000000
30	9	0	7	0.2222222222
31	9	0	9	0.0000000000
32	7	0	7	0.0000000000
33	6	0	6	0.0000000000
34	6	0	6	0.0000000000
35	4	0	4	0.0000000000
36	4	0	4	0.0000000000

37	199	34	145	0.0050251256
38	123	34	71	0.0000000000
39	8	0	7	0.0000000000
40	11	0	11	0.0000000000
41	11	0	11	0.0000000000
42	9	0	9	0.0000000000
43	9	0	9	0.0000000000
44	8	0	7	0.1250000000
45	7	0	7	0.0000000000
46	7	0	7	0.0000000000
47	3	0	3	0.0000000000
48	2	0	2	0.0000000000
49	1	0	1	0.0000000000
50	306	1	253	0.0098039216
51	61	0	11	0.0000000000
52	120	0	117	0.0250000000
53	26	0	26	0.0000000000
54	26	0	26	0.0000000000

55	17	0	17	0.0000000000
56	15	0	15	0.0000000000
57	13	0	13	0.0000000000
58	8	0	8	0.0000000000
59	8	0	8	0.0000000000
60	7	0	7	0.0000000000
61	3	0	3	0.0000000000
62	1	0	1	0.0000000000
63	1	0	1	0.0000000000
64	593	164	538	0.0151770658
66	64	0	0	0.0000000000
67	53	0	0	0.0000000000
68	174	3	129	0.0000000000
69	43	0	3	0.0000000000
70	39	0	16	0.0000000000
71	25	0	2	0.0000000000
72	29	0	10	0.0000000000
73	19	0	1	0.0000000000

74	16	0	3	0.0000000000
75	14	0	1	0.0000000000
76	7	0	0	0.0000000000
77	7	0	0	0.0000000000
78	14	0	9	0.0000000000
79	3	0	2	0.0000000000
80	1	0	0	0.0000000000
81	10	0	10	0.0000000000
83	197	18	160	0.0000000000
84	64	18	27	0.0000000000
85	37	0	37	0.0000000000
86	20	0	20	0.0000000000
87	19	0	19	0.0000000000
88	12	0	12	0.0000000000
89	10	0	10	0.0000000000
90	8	0	8	0.0000000000
91	8	0	8	0.0000000000
92	7	0	7	0.0000000000

93	6	0	6	0.0000000000
94	4	0	4	0.0000000000
95	2	0	2	0.0000000000
96	1587	11	1547	0.0050409578
97	504	4	489	0.0019841270
98	461	1	447	0.0065075922
99	100	1	94	0.0000000000
100	20	0	18	0.0500000000
101	17	0	16	0.0000000000
102	5	0	4	0.0000000000
103	103	1	102	0.0097087379
104	100	0	99	0.0100000000
105	69	0	69	0.0000000000
106	62	0	62	0.0000000000
107	26	0	26	0.0000000000
108	24	0	24	0.0000000000
109	24	2	24	0.0000000000
110	14	0	14	0.0000000000

5. Conclusions and Discussion (3%) Describe your conclusions; interpret the results, predictions you made, the models and their characteristics, and a give summary of what changed as you went through the project (data, analysis, model choices, etc.), what you would do next, or do differently in a subsequent exploration. Min. 1 page text + graphics (optional). References – websites, papers, packages, data refs, etc. should be included at the end. Include your R scripts! (e.g. in a zip file) and also include the Github URL that contains the code. There is no specific citation format, just be consistent.

Reference:

https://www.datacamp.com/community/tutorials/decision-trees-R