COVID_19

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Coronavirus Disease 2019 (COVID-19)

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus.

COVID-19 affects different people in different ways. Infected people have had a wide range of symptoms reported – from mild symptoms to severe illness.

```
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────
tidyverse 1.3.1 ──
```

```
## ✔ ggplot2 3.3.6     ✔ purrr   0.3.4
## ✔ tibble  3.1.7     ✔ dplyr   1.0.9
## ✔ tidyr   1.2.0     ✔ stringr 1.4.0
## ✔ readr   2.1.2     ✔ forcats 0.5.1
```

```
## ── Conflicts ────────────────────────────────────────
tidyverse_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
```

```
## Download data in 4 files:
url_in <- "C:/Users/pavle/Desktop/COVID-19/"
file_names <- c("time_series_covid19_confirmed_global.csv",
                "time_series_covid19_deaths_global.csv",
                "time_series_covid19_confirmed_US.csv",
                "time_series_covid19_deaths_US.csv")
urls <- str_c(url_in, file_names)
urls
```

```
## [1] "C:/Users/pavle/Desktop/COVID-
19/time_series_covid19_confirmed_global.csv"
## [2] "C:/Users/pavle/Desktop/COVID-
19/time_series_covid19_deaths_global.csv"
## [3] "C:/Users/pavle/Desktop/COVID-
19/time_series_covid19_confirmed_US.csv"
## [4] "C:/Users/pavle/Desktop/COVID-
19/time_series_covid19_deaths_US.csv"
```

Reading Data:

```
global_cases <- read_csv(urls[1])
```

```
## Rows: 285 Columns: 871
## ── Column specification
──────────────────────────────────────────────────────
## Delimiter: ","
## chr   (2): Province/State, Country/Region
## dbl (869): Lat, Long, 1/22/20, 1/23/20, 1/24/20, 1/25/20, 1/26/20,
1/27/20, ...
##
## ℹ Use `spec()` to retrieve the full column specification for this
data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

```
global_deaths <- read_csv(urls[2])
```

```
## Rows: 285 Columns: 871
## ── Column specification
──────────────────────────────────────────────────────
## Delimiter: ","
## chr   (2): Province/State, Country/Region
## dbl (869): Lat, Long, 1/22/20, 1/23/20, 1/24/20, 1/25/20, 1/26/20,
1/27/20, ...
##
## ℹ Use `spec()` to retrieve the full column specification for this
data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

```
US_cases <- read_csv(urls[3])
```

```
## Rows: 3342 Columns: 878
## ── Column specification
──────────────────────────────────────────────────────
## Delimiter: ","
## chr   (6): iso2, iso3, Admin2, Province_State, Country_Region,
Combined_Key
## dbl (872): UID, code3, FIPS, Lat, Long_, 1/22/20, 1/23/20, 1/24/20,
1/25/20,...
##
## ℹ Use `spec()` to retrieve the full column specification for this
data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

```
US_deaths <- read_csv(urls[4])
```

```
## Rows: 3342 Columns: 879
## ── Column specification
```

```
──────────────────────────────────────────────────────────────
## Delimiter: ","
## chr   (6): iso2, iso3, Admin2, Province_State, Country_Region,
Combined_Key
## dbl (873): UID, code3, FIPS, Lat, Long_, Population, 1/22/20,
1/23/20, 1/24/...
##
## ℹ Use `spec()` to retrieve the full column specification for this
data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

Cleanup Data:

```
global_cases <- global_cases %>%
  pivot_longer(cols = -c(`Province/State`,
                         `Country/Region`, Lat, Long),
               names_to = "date",
               values_to = "cases") %>%
  select(-c(Lat, Long))
global_cases
```

```
## # A tibble: 247,095 × 4
##    `Province/State` `Country/Region` date    cases
##    <chr>            <chr>            <chr>   <dbl>
##  1 <NA>             Afghanistan      1/22/20     0
##  2 <NA>             Afghanistan      1/23/20     0
##  3 <NA>             Afghanistan      1/24/20     0
##  4 <NA>             Afghanistan      1/25/20     0
##  5 <NA>             Afghanistan      1/26/20     0
##  6 <NA>             Afghanistan      1/27/20     0
##  7 <NA>             Afghanistan      1/28/20     0
##  8 <NA>             Afghanistan      1/29/20     0
##  9 <NA>             Afghanistan      1/30/20     0
## 10 <NA>             Afghanistan      1/31/20     0
## # … with 247,085 more rows
```

```
global_deaths <- global_deaths %>%
  pivot_longer(cols = -c(`Province/State`,
                         `Country/Region`, Lat, Long),
               names_to = "date",
               values_to = "deaths") %>%
  select(-c(Lat, Long))
global_deaths
```

```
## # A tibble: 247,095 × 4
##    `Province/State` `Country/Region` date    deaths
##    <chr>            <chr>            <chr>    <dbl>
##  1 <NA>             Afghanistan      1/22/20      0
##  2 <NA>             Afghanistan      1/23/20      0
##  3 <NA>             Afghanistan      1/24/20      0
```

```
##  4 <NA>             Afghanistan      1/25/20      0
##  5 <NA>             Afghanistan      1/26/20      0
##  6 <NA>             Afghanistan      1/27/20      0
##  7 <NA>             Afghanistan      1/28/20      0
##  8 <NA>             Afghanistan      1/29/20      0
##  9 <NA>             Afghanistan      1/30/20      0
## 10 <NA>             Afghanistan      1/31/20      0
## # … with 247,085 more rows
```

```
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
global <- global_cases %>%
  full_join(global_deaths) %>%
  rename(Country_Region = `Country/Region`,
         Province_State = `Province/State`) %>%
  mutate(date = mdy(date))
```

```
## Joining, by = c("Province/State", "Country/Region", "date")
```

```
global
```

```
## # A tibble: 247,095 × 5
##    Province_State Country_Region date       cases deaths
##    <chr>          <chr>          <date>     <dbl>  <dbl>
##  1 <NA>           Afghanistan    2020-01-22     0      0
##  2 <NA>           Afghanistan    2020-01-23     0      0
##  3 <NA>           Afghanistan    2020-01-24     0      0
##  4 <NA>           Afghanistan    2020-01-25     0      0
##  5 <NA>           Afghanistan    2020-01-26     0      0
##  6 <NA>           Afghanistan    2020-01-27     0      0
##  7 <NA>           Afghanistan    2020-01-28     0      0
##  8 <NA>           Afghanistan    2020-01-29     0      0
##  9 <NA>           Afghanistan    2020-01-30     0      0
## 10 <NA>           Afghanistan    2020-01-31     0      0
## # … with 247,085 more rows
```

```
summary(global)
```

```
##  Province_State     Country_Region          date
cases
##  Length:247095      Length:247095      Min.   :2020-01-22   Min.   :
0
##  Class :character   Class :character   1st Qu.:2020-08-25   1st Qu.:
299
##  Mode  :character   Mode  :character   Median :2021-03-30   Median :
```

```
6912
##                                          Mean   :2021-03-30   Mean   :
588646
##                                          3rd Qu.:2021-11-02   3rd Qu.:
129326
##                                          Max.   :2022-06-06   Max.   :
84882287
##      deaths
##  Min.   :      0
##  1st Qu.:      2
##  Median :     86
##  Mean   :  10452
##  3rd Qu.:   1967
##  Max.   :1008857
```

```
global <- global %>% filter(cases > 0)

global %>% filter(cases > 28000000)
```

```
## # A tibble: 990 × 5
##    Province_State Country_Region date          cases deaths
##    <chr>          <chr>          <date>        <dbl>  <dbl>
##  1 <NA>           Brazil         2022-02-18 28072238 643340
##  2 <NA>           Brazil         2022-02-19 28177367 644195
##  3 <NA>           Brazil         2022-02-20 28218180 644592
##  4 <NA>           Brazil         2022-02-21 28258458 644918
##  5 <NA>           Brazil         2022-02-22 28361951 645735
##  6 <NA>           Brazil         2022-02-23 28493336 646714
##  7 <NA>           Brazil         2022-02-24 28589235 647703
##  8 <NA>           Brazil         2022-02-25 28679671 648496
##  9 <NA>           Brazil         2022-02-26 28749552 649184
## 10 <NA>           Brazil         2022-02-27 28776794 649437
## # … with 980 more rows
```

```
US_cases <- US_cases %>%
  pivot_longer(cols = -(UID:Combined_Key),
               names_to = "date",
               values_to = "cases") %>%
  select(Admin2:cases) %>%
  mutate(date = mdy(date)) %>%
  select(-c(Lat, Long_))

US_cases
```

```
## # A tibble: 2,897,514 × 6
##    Admin2  Province_State Country_Region Combined_Key         date
cases
##    <chr>   <chr>          <chr>          <chr>                <date>
<dbl>
##  1 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-22     0
```

```
##  2 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-23     0
##  3 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-24     0
##  4 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-25     0
##  5 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-26     0
##  6 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-27     0
##  7 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-28     0
##  8 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-29     0
##  9 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-30     0
## 10 Autauga Alabama        US             Autauga, Alabama, US 2020-
01-31     0
## # … with 2,897,504 more rows
```

```
US_deaths <- US_deaths %>%
  pivot_longer(cols = -(UID:Population),
               names_to = "date",
               values_to = "deaths") %>%
  select(Admin2:deaths) %>%
  mutate(date = mdy(date)) %>%
  select(-c(Lat, Long_))

US_deaths
```

```
## # A tibble: 2,897,514 × 7
##    Admin2  Province_State Country_Region Combined_Key
Population date
##    <chr>   <chr>          <chr>          <chr>
<dbl> <date>
##  1 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-22
##  2 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-23
##  3 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-24
##  4 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-25
##  5 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-26
##  6 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-27
##  7 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-28
##  8 Autauga Alabama        US             Autauga, Alabama…
```

```
55869 2020-01-29
##  9 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-30
## 10 Autauga Alabama        US             Autauga, Alabama…
55869 2020-01-31
## # … with 2,897,504 more rows, and 1 more variable: deaths <dbl>

US <- US_cases %>%
  full_join(US_deaths)

## Joining, by = c("Admin2", "Province_State", "Country_Region",
"Combined_Key",
## "date")

US

## # A tibble: 2,897,514 × 8
##    Admin2 Province_State Country_Region Combined_Key date
cases Population
##    <chr>  <chr>          <chr>          <chr>        <date>
<dbl>      <dbl>
##  1 Autau… Alabama        US             Autauga, Al… 2020-01-22
0      55869
##  2 Autau… Alabama        US             Autauga, Al… 2020-01-23
0      55869
##  3 Autau… Alabama        US             Autauga, Al… 2020-01-24
0      55869
##  4 Autau… Alabama        US             Autauga, Al… 2020-01-25
0      55869
##  5 Autau… Alabama        US             Autauga, Al… 2020-01-26
0      55869
##  6 Autau… Alabama        US             Autauga, Al… 2020-01-27
0      55869
##  7 Autau… Alabama        US             Autauga, Al… 2020-01-28
0      55869
##  8 Autau… Alabama        US             Autauga, Al… 2020-01-29
0      55869
##  9 Autau… Alabama        US             Autauga, Al… 2020-01-30
0      55869
## 10 Autau… Alabama        US             Autauga, Al… 2020-01-31
0      55869
## # … with 2,897,504 more rows, and 1 more variable: deaths <dbl>

global <- global %>%
  unite("Combined_Key",
        c(Province_State, Country_Region),
        sep = ", ",
        na.rm = TRUE,
        remove = FALSE)
global
```

```
## # A tibble: 227,505 × 6
##    Combined_Key Province_State Country_Region date       cases
deaths
##    <chr>        <chr>          <chr>          <date>     <dbl>
<dbl>
##  1 Afghanistan  <NA>           Afghanistan    2020-02-24     5
0
##  2 Afghanistan  <NA>           Afghanistan    2020-02-25     5
0
##  3 Afghanistan  <NA>           Afghanistan    2020-02-26     5
0
##  4 Afghanistan  <NA>           Afghanistan    2020-02-27     5
0
##  5 Afghanistan  <NA>           Afghanistan    2020-02-28     5
0
##  6 Afghanistan  <NA>           Afghanistan    2020-02-29     5
0
##  7 Afghanistan  <NA>           Afghanistan    2020-03-01     5
0
##  8 Afghanistan  <NA>           Afghanistan    2020-03-02     5
0
##  9 Afghanistan  <NA>           Afghanistan    2020-03-03     5
0
## 10 Afghanistan  <NA>           Afghanistan    2020-03-04     5
0
## # … with 227,495 more rows

uid_lookup_url <-
"https://raw.githubusercontent.com/CSSEGISandData/COVID-
19/master/csse_covid_19_data/UID_ISO_FIPS_LookUp_Table.csv"

uid <- read_csv(uid_lookup_url) %>%
  select(-c(Lat, Long_, Combined_Key, code3, iso2, iso3, Admin2))

## Rows: 4317 Columns: 12

## ── Column specification
────────────────────────────────────────────────────────
## Delimiter: ","
## chr (7): iso2, iso3, FIPS, Admin2, Province_State, Country_Region,
Combined_Key
## dbl (5): UID, code3, Lat, Long_, Population
##
## ℹ Use `spec()` to retrieve the full column specification for this
data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet
this message.

url_in <- "https://github.com/CSSEGISandData/COVID-
19/tree/master/csse_covid_19_data/csse_covid_19_time_series"
```

```
uid <- read_csv(uid_lookup_url) %>%
  select(-c(Lat, Long_, Combined_Key, code3, iso2, iso3, Admin2))
```

```
## Rows: 4317 Columns: 12
## ── Column specification
──────────────────────────────────────────────────────
## Delimiter: ","
## chr (7): iso2, iso3, FIPS, Admin2, Province_State, Country_Region,
Combined_Key
## dbl (5): UID, code3, Lat, Long_, Population
##
## ℹ Use `spec()` to retrieve the full column specification for this
data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

```
global <- global %>%
  left_join(uid, by = c("Province_State", "Country_Region")) %>%
  select(-c(UID, FIPS)) %>%
  select(Province_State, Country_Region, date,
         cases, Population,
         Combined_Key)
global
```

```
## # A tibble: 227,505 × 6
##    Province_State Country_Region date       cases Population
Combined_Key
##    <chr>          <chr>          <date>     <dbl>      <dbl> <chr>

##  1 <NA>           Afghanistan    2020-02-24     5   38928341
Afghanistan
##  2 <NA>           Afghanistan    2020-02-25     5   38928341
Afghanistan
##  3 <NA>           Afghanistan    2020-02-26     5   38928341
Afghanistan
##  4 <NA>           Afghanistan    2020-02-27     5   38928341
Afghanistan
##  5 <NA>           Afghanistan    2020-02-28     5   38928341
Afghanistan
##  6 <NA>           Afghanistan    2020-02-29     5   38928341
Afghanistan
##  7 <NA>           Afghanistan    2020-03-01     5   38928341
Afghanistan
##  8 <NA>           Afghanistan    2020-03-02     5   38928341
Afghanistan
##  9 <NA>           Afghanistan    2020-03-03     5   38928341
Afghanistan
## 10 <NA>           Afghanistan    2020-03-04     5   38928341
Afghanistan
## # … with 227,495 more rows
```

```
US_by_state <- US %>%
  group_by(Province_State, Country_Region, date) %>%
  summarise(cases = sum(cases), deaths = sum(deaths),
            Population = sum(Population)) %>%
  mutate(deaths_per_mill = deaths *1000000 / Population) %>%
  select(Province_State, Country_Region, date,
         cases, deaths, deaths_per_mill, Population) %>%
  ungroup()
```

```
## `summarise()` has grouped output by 'Province_State',
'Country_Region'. You can
## override using the `.groups` argument.
```

```
US_by_state
```

```
## # A tibble: 50,286 × 7
##    Province_State Country_Region date       cases deaths
deaths_per_mill
##    <chr>          <chr>          <date>     <dbl>  <dbl>
<dbl>
##  1 Alabama        US             2020-01-22     0      0
0
##  2 Alabama        US             2020-01-23     0      0
0
##  3 Alabama        US             2020-01-24     0      0
0
##  4 Alabama        US             2020-01-25     0      0
0
##  5 Alabama        US             2020-01-26     0      0
0
##  6 Alabama        US             2020-01-27     0      0
0
##  7 Alabama        US             2020-01-28     0      0
0
##  8 Alabama        US             2020-01-29     0      0
0
##  9 Alabama        US             2020-01-30     0      0
0
## 10 Alabama        US             2020-01-31     0      0
0
## # … with 50,276 more rows, and 1 more variable: Population <dbl>
```

```
US_totals <- US_by_state %>%
  group_by(Country_Region, date) %>%
  summarise(cases = sum(cases), deaths = sum(deaths),
            Population = sum(Population)) %>%
  mutate(deaths_per_mill = deaths *1000000 / Population) %>%
  select(Country_Region, date,
         cases, deaths, deaths_per_mill, Population) %>%
  ungroup()
```

```
## `summarise()` has grouped output by 'Country_Region'. You can
override using
## the `.groups` argument.

US_totals
```

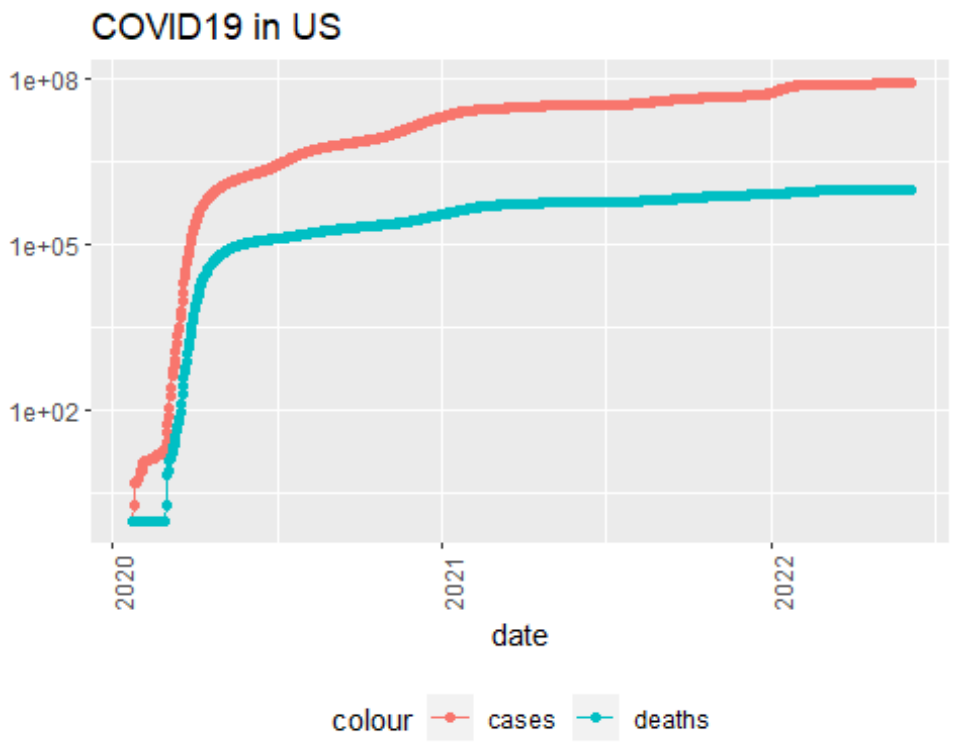
```
## # A tibble: 867 × 6
##    Country_Region date       cases deaths deaths_per_mill Population
##    <chr>          <date>     <dbl>  <dbl>           <dbl>      <dbl>
##  1 US             2020-01-22     1      1         0.00300  332875137
##  2 US             2020-01-23     1      1         0.00300  332875137
##  3 US             2020-01-24     2      1         0.00300  332875137
##  4 US             2020-01-25     2      1         0.00300  332875137
##  5 US             2020-01-26     5      1         0.00300  332875137
##  6 US             2020-01-27     5      1         0.00300  332875137
##  7 US             2020-01-28     5      1         0.00300  332875137
##  8 US             2020-01-29     6      1         0.00300  332875137
##  9 US             2020-01-30     6      1         0.00300  332875137
## 10 US             2020-01-31     8      1         0.00300  332875137
## # … with 857 more rows
```

```
tail(US_totals)
```

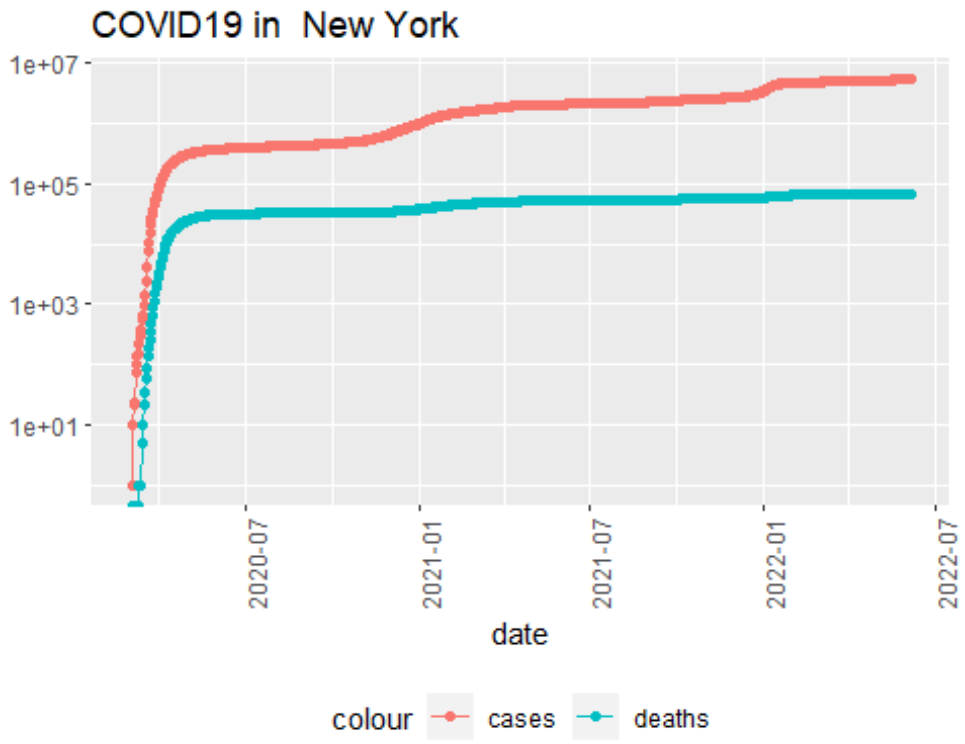
```
## # A tibble: 6 × 6
##   Country_Region date          cases  deaths deaths_per_mill
Population
##   <chr>          <date>        <dbl>   <dbl>           <dbl>
<dbl>
## 1 US             2022-06-01 84451901 1007714           3027.
332875137
## 2 US             2022-06-02 84570325 1008031           3028.
332875137
## 3 US             2022-06-03 84724329 1008422           3029.
332875137
## 4 US             2022-06-04 84748884 1008567           3030.
332875137
## 5 US             2022-06-05 84762022 1008585           3030.
332875137
## 6 US             2022-06-06 84882287 1008857           3031.
332875137
```

```
## Include Plots:

###COVID19 in US
US_totals %>%
  filter(cases > 0) %>%
  ggplot(aes(x = date, y = cases)) +
  geom_line(aes(color = "cases")) +
  geom_point(aes(color = "cases")) +
  geom_line(aes(y = deaths, color = "deaths")) +
  geom_point(aes(y = deaths, color = "deaths")) +
```

```
  scale_y_log10() +
  theme(legend.position = "bottom",
        axis.text.x = element_text(angle = 90)) +
  labs(title = "COVID19 in US", y = NULL)
```




```
###COVID19 in New-York
state <- "New York"
US_by_state %>%
  filter(Province_State == state) %>%
  filter(cases > 0) %>%
  ggplot(aes(x = date, y = cases)) +
  geom_line(aes(color = "cases")) +
  geom_point(aes(color = "cases")) +
  geom_line(aes(y = deaths, color = "deaths")) +
  geom_point(aes(y = deaths, color = "deaths")) +
  scale_y_log10() +
  theme(legend.position = "bottom",
        axis.text.x = element_text(angle = 90)) +
  labs(title = str_c("COVID19 in  ", state), y = NULL)

## Warning: Transformation introduced infinite values in continuous y-
axis
## Transformation introduced infinite values in continuous y-axis
```



###

Analysing Data: max(US_totals$date)

max(US_totals$deaths)

US_by_state <- US_by_state %>% mutate(new_cases = cases - lag(cases), new_deaths = deaths - lag(deaths)) US_totals <- US_totals %>% mutate(new_cases = cases - lag(cases), new_deaths = deaths - lag(deaths))

tail(US_totals)

tail(US_totals %>% select(new_cases, new_deaths, everything()))

US_totals %>% ggplot(aes(x = date, y = new_cases)) + geom_line(aes(color = “new_cases”)) + geom_point(aes(color = “new_cases”)) + geom_line(aes(y = new_deaths, color = “new_deaths”)) + geom_point(aes(y = new_deaths, color = “new_deaths”)) + scale_y_log10() + theme(legend.position = “bottom”, axis.text.x = element_text(angle = 90)) + labs(title = “COVID19 in US”, y = NULL)

state <- “New York” US_by_state %>% filter(Province_State == state) %>% ggplot(aes(x = date, y = new_cases)) + geom_line(aes(color = “new_cases”)) + geom_point(aes(color = “new_cases”)) + geom_line(aes(y = new_deaths, color = “new_deaths”)) + geom_point(aes(y = new_deaths, color = “new_deaths”)) + scale_y_log10() + theme(legend.position = “bottom”, axis.text.x = element_text(angle = 90)) + labs(title = str_c(“COVID19 in”, state), y = NULL)

US_state_totals <- US_by_state %>% group_by(Province_State) %>% summarize(deaths = max(deaths), cases = max(cases), population =

max(Population), cases_per_thou = 1000 * cases / population, deaths_per_thou = 1000 * deaths / population) %>% filter(cases > 0, population > 0)

US_state_totals %>% slice_min(deaths_per_thou, n = 10)

US_state_totals %>% slice_min(deaths_per_thou, n = 10) %>% select(deaths_per_thou, cases_per_thou, everything())

US_state_totals %>% slice_max(deaths_per_thou, n = 10) %>% select(deaths_per_thou, cases_per_thou, everything())

Modeling Data:

mod <- lm(deaths_per_thou ~ cases_per_thou, data = US_state_totals) summary(mod)

US_state_totals %>% slice_min(cases_per_thou) US_state_totals %>% slice_max(cases_per_thou)

x_grid <- seq(1, 151) new_df <- tibble(cases_per_thou = x_grid) US_state_totals %>% mutate(pred = predict(mod))

US_tot_w_pred <- US_state_totals %>% mutate(pred = predict(mod)) US_tot_w_pred

US_tot_w_pred %>% ggplot() + geom_point(aes(x = cases_per_thou, y = deaths_per_thou), color = "blue") + geom_point(aes(x = cases_per_thou, y = pred), color = "red")