COVID19 Report

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COVID19 Analysis

This report is based on an covid data that is publicly available on Johns Hopkins github site.

The agenda of this report is to analyze on below:

- Shows the cases and deaths due to COVID19 in all the countries since 2019.
- Show the number of cases and deaths due to COVID since 2019.
- Compare the fatality ratio in US verses all the countries in the world.

Case Fatality ratio is calculated as follows

$$(\frac{Number\ of\ Cases\ reported\ in\ which\ patient\ died}{Number\ of\ Cases\ Reported}) * 100$$

Load Data

Below set of lines load the COVID19 data available at Johns Hopkins github site. It is the data about the confirmed cases and deaths are available in separate csv file.

```
url_in <- "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_cov
file_names <- c("time_series_covid19_confirmed_US.csv",
                "time_series_covid19_confirmed_global.csv",
                "time_series_covid19_deaths_US.csv",
                "time_series_covid19_deaths_global.csv",
                "time_series_covid19_recovered_global.csv")
urls <- paste(url_in,file_names,sep = "")
urls
```

```
## [1] "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_
## [2] "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_
## [3] "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_
## [4] "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_
## [5] "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_
```

```
if(file.exists("global_confirmed_loaded.Rdata")) {
  print ('Loading Global Cases from cache')
  global_confirmed_loaded <- get(load("global_confirmed_loaded.Rdata"))
}else {
  print ('Loading Global Cases from URL')
```

```
  global_confirmed_loaded <- read_csv(urls[2])
  save(global_confirmed_loaded,file = "global_confirmed_loaded.Rdata")
}
```

```
## [1] "Loading Global Cases from URL"
```

```
## Rows: 289 Columns: 1101
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr    (2): Province/State, Country/Region
## dbl (1099): 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_confirmed_loaded
```

```
## # A tibble: 289 x 1,101
##    Provin~1 Count~2   Lat   Long 1/22/~3 1/23/~4 1/24/~5 1/25/~6 1/26/~7 1/27/~8
##    <chr>    <chr>   <dbl>  <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
##  1 <NA>     Afghan~  33.9  67.7        0       0       0       0       0       0
##  2 <NA>     Albania  41.2  20.2        0       0       0       0       0       0
##  3 <NA>     Algeria  28.0   1.66       0       0       0       0       0       0
##  4 <NA>     Andorra  42.5   1.52       0       0       0       0       0       0
##  5 <NA>     Angola  -11.2  17.9        0       0       0       0       0       0
##  6 <NA>     Antarc~ -71.9  23.3        0       0       0       0       0       0
##  7 <NA>     Antigu~  17.1 -61.8        0       0       0       0       0       0
##  8 <NA>     Argent~ -38.4 -63.6        0       0       0       0       0       0
##  9 <NA>     Armenia  40.1  45.0        0       0       0       0       0       0
## 10 Austral~ Austra~ -35.5 149.         0       0       0       0       0       0
## # ... with 279 more rows, 1,091 more variables: `1/28/20` <dbl>,
## #   `1/29/20` <dbl>, `1/30/20` <dbl>, `1/31/20` <dbl>, `2/1/20` <dbl>,
## #   `2/2/20` <dbl>, `2/3/20` <dbl>, `2/4/20` <dbl>, `2/5/20` <dbl>,
## #   `2/6/20` <dbl>, `2/7/20` <dbl>, `2/8/20` <dbl>, `2/9/20` <dbl>,
## #   `2/10/20` <dbl>, `2/11/20` <dbl>, `2/12/20` <dbl>, `2/13/20` <dbl>,
## #   `2/14/20` <dbl>, `2/15/20` <dbl>, `2/16/20` <dbl>, `2/17/20` <dbl>,
## #   `2/18/20` <dbl>, `2/19/20` <dbl>, `2/20/20` <dbl>, `2/21/20` <dbl>, ...
```

```
if(file.exists("global_death_loaded.Rdata")) {
  print ('Loading Global Deaths from cache')
  global_death_loaded <- get(load("global_death_loaded.Rdata"))
} else {
  global_death_loaded <- read_csv(urls[4])
  save(global_death_loaded,file = "global_death_loaded.Rdata")
}
```

```
## Rows: 289 Columns: 1101
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr    (2): Province/State, Country/Region
## dbl (1099): 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.
```

```
if(file.exists("global_recovered_loaded.Rdata")) {
  global_recovered_loaded <- get(load("global_recovered_loaded.Rdata"))
} else {
  global_recovered_loaded <- read_csv(urls[5])
  save(global_recovered_loaded,file = "global_recovered_loaded.Rdata")
}
```

```
## Rows: 274 Columns: 1101
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr    (2): Province/State, Country/Region
## dbl (1099): 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.
```

```
if(file.exists("us_confirmed_loaded.Rdata")) {
  print ('Loading US Confirmed from cache')
  us_confirmed_loaded <- get(load("us_confirmed_loaded.Rdata"))
} else {
  us_confirmed_loaded <- read_csv(urls[1])
  save(us_confirmed_loaded,file = "us_confirmed_loaded.Rdata")
}
```

```
## Rows: 3342 Columns: 1108
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr    (6): iso2, iso3, Admin2, Province_State, Country_Region, Combined_Key
## dbl (1102): 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.
```

```
if(file.exists("us_death_cache.Rdata")) {
  print ('Loading US Deaths from cache')
  us_death_loaded <-get(load("us_death_cache.Rdata"))
} else {
  us_death_loaded <- read_csv(urls[3])
  save(us_death_loaded,file = "us_death_cache.Rdata")
}
```

```
## Rows: 3342 Columns: 1109
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr    (6): iso2, iso3, Admin2, Province_State, Country_Region, Combined_Key
## dbl (1103): 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.
```

Transforming Global data

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

```
##  Country_Region          Date                Cases               Deaths
##  Length:318130      Min.   :2020-01-22   Min.   :        0   Min.   :      0
##  Class :character   1st Qu.:2020-10-22   1st Qu.:      591   1st Qu.:      3
##  Mode  :character   Median :2021-07-23   Median :    12787   Median :    138
##                     Mean   :2021-07-23   Mean   :   901951   Mean   :  12945
##                     3rd Qu.:2022-04-23   3rd Qu.:   210940   3rd Qu.:   2848
##                     Max.   :2023-01-22   Max.   :102005805   Max.   :1104118
##                                          NA's   :1097        NA's   :1097
##    Recovered
##  Min.   :      -1
##  1st Qu.:       0
##  Median :       0
##  Mean   :   78154
##  3rd Qu.:    1053
##  Max.   :30974748
##  NA's   :17552
```

```
## # A tibble: 318,130 x 5
##    Country_Region Date       Cases Deaths Recovered
##    <chr>          <date>     <dbl>  <dbl>     <dbl>
##  1 Afghanistan    2020-01-22     0      0         0
##  2 Afghanistan    2020-01-23     0      0         0
##  3 Afghanistan    2020-01-24     0      0         0
##  4 Afghanistan    2020-01-25     0      0         0
##  5 Afghanistan    2020-01-26     0      0         0
##  6 Afghanistan    2020-01-27     0      0         0
##  7 Afghanistan    2020-01-28     0      0         0
##  8 Afghanistan    2020-01-29     0      0         0
##  9 Afghanistan    2020-01-30     0      0         0
## 10 Afghanistan    2020-01-31     0      0         0
## # ... with 318,120 more rows
```

```
## # A tibble: 37 x 5
##    YearMonth       Cases   Deaths Recovered FatalityRatio
##    <date>          <dbl>    <dbl>     <dbl>         <dbl>
##  1 2020-01-01      38527      891       869          2.31
##  2 2020-02-01    1671823    46976    380839          2.81
##  3 2020-03-01    8904936   414417   2701204          4.65
##  4 2020-04-01   62554158  4605222  16017554          7.36
##  5 2020-05-01  142784237 10236916  52953018          7.17
##  6 2020-06-01  243843190 14190509 117057627          5.82
##  7 2020-07-01  428473822 19539691 239581869          4.56
##  8 2020-08-01  668393458 25306146 420122385          3.79
##  9 2020-09-01  891340946 29751989 604919337          3.34
## 10 2020-10-01 1223567347 36071703 838117294          2.95
## # ... with 27 more rows
```

Transforming the US COVID19 data

US COVID data is transformed as:

```
us_confirmed <- us_confirmed_loaded %>%
  pivot_longer(cols = -c("UID": 'Combined_Key'),
               names_to = "Date",
               values_to = "Cases") %>%
  select('Admin2':'Cases') %>%
  mutate(Date = mdy(Date)) %>%
  select (-c('Lat', 'Long_')) %>%
  rename ( County = 'Admin2')

us_death <- us_death_loaded %>%
  pivot_longer(cols = -c("UID": 'Combined_Key'),
               names_to = "Date",
               values_to = "Deaths") %>%
  select('Admin2':'Deaths') %>%
  mutate(Date = mdy(Date)) %>%
  select (-c('Lat', 'Long_')) %>%
  rename ( County = 'Admin2')
```

```
## Warning: 3342 failed to parse.
```

```
us_cases <- us_confirmed %>% full_join(us_death) %>% filter(Cases > 0)
```

```
## Joining, by = c("County", "Province_State", "Country_Region", "Combined_Key",
## "Date")
```

```
us_cases
```

```
## # A tibble: 3,324,940 x 7
##    County  Province_State Country_Region Combined_Key    Date       Cases Deaths
##    <chr>   <chr>          <chr>          <chr>           <date>     <dbl>  <dbl>
##  1 Autauga Alabama        US             Autauga, Alaba~ 2020-03-24     1      0
##  2 Autauga Alabama        US             Autauga, Alaba~ 2020-03-25     5      0
##  3 Autauga Alabama        US             Autauga, Alaba~ 2020-03-26     6      0
##  4 Autauga Alabama        US             Autauga, Alaba~ 2020-03-27     6      0
##  5 Autauga Alabama        US             Autauga, Alaba~ 2020-03-28     6      0
##  6 Autauga Alabama        US             Autauga, Alaba~ 2020-03-29     6      0
##  7 Autauga Alabama        US             Autauga, Alaba~ 2020-03-30     8      0
##  8 Autauga Alabama        US             Autauga, Alaba~ 2020-03-31     8      0
##  9 Autauga Alabama        US             Autauga, Alaba~ 2020-04-01    10      0
## 10 Autauga Alabama        US             Autauga, Alaba~ 2020-04-02    12      0
## # ... with 3,324,930 more rows
```

```
#us_cases_by_month <- us_cases %>%
#  mutate(
#    Month = month(Date),
 #   Year = year(Date)
#         ) %>%
#  unite (YearMonth, c( 'Year', 'Month' ), sep = '-', na.rm = TRUE, remove= FALSE) %>%
```

```
 # group_by(YearMonth, Country_Region, Date) %>%
#  summarize(Cases = sum(Cases),
#            Deaths = sum(Deaths))

us_cases_by_month <- us_cases %>%
  group_by(YearMonth = lubridate::floor_date(Date, 'month'), Country_Region) %>%
  summarize(Cases = sum(Cases),
            Deaths = sum(Deaths))
```

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

```
us_cases_by_month_w_fr <- us_cases_by_month %>% mutate(FatalityRatio = (Deaths/Cases * 100))
us_cases_by_month_w_fr
```

```
## # A tibble: 37 x 5
## # Groups:   YearMonth [37]
##    YearMonth  Country_Region     Cases  Deaths FatalityRatio
##    <date>     <chr>              <dbl>   <dbl>         <dbl>
##  1 2020-01-01 US                    41       0         0
##  2 2020-02-01 US                   420       1         0.238
##  3 2020-03-01 US               1121565   23973         2.14
##  4 2020-04-01 US              19977575  993919         4.98
##  5 2020-05-01 US              45414972 2700641         5.95
##  6 2020-06-01 US              64902874 3564131         5.49
##  7 2020-07-01 US             111253119 4318723         3.88
##  8 2020-08-01 US             166652074 5247535         3.15
##  9 2020-09-01 US             199762036 5850150         2.93
## 10 2020-10-01 US             251587325 6747877         2.68
## # ... with 27 more rows
```

```
us_cases_by_state <- us_cases %>%
  group_by(County, Province_State, Country_Region, Date) %>%
  summarize(Total_Cases = sum(Cases), Total_Deaths = sum(Deaths)) %>%
  select('Province_State', 'Country_Region', 'Date', 'Total_Cases', 'Total_Deaths') %>%
  ungroup()
```

```
## `summarise()` has grouped output by 'County', 'Province_State',
## 'Country_Region'. You can override using the `.groups` argument.
## Adding missing grouping variables: `County`
```

```
tail(us_cases_by_state)
```

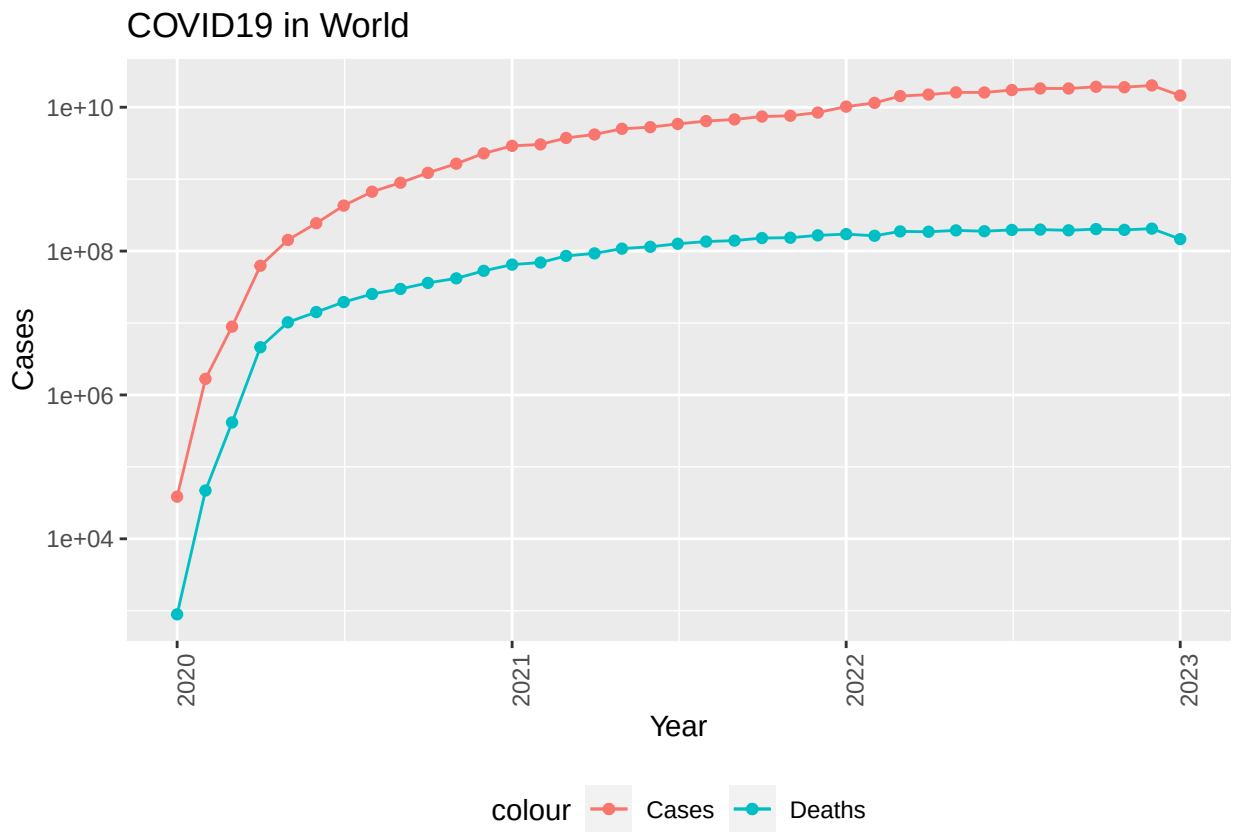
```
## # A tibble: 6 x 6
##   County Province_State Country_Region Date       Total_Cases Total_Deaths
##   <chr>  <chr>          <chr>          <date>           <dbl>        <dbl>
## 1 <NA>   Virgin Islands US             2023-01-17       24138          129
## 2 <NA>   Virgin Islands US             2023-01-18       24176          129
## 3 <NA>   Virgin Islands US             2023-01-19       24228          129
## 4 <NA>   Virgin Islands US             2023-01-20       24269          129
## 5 <NA>   Virgin Islands US             2023-01-21       24269          129
## 6 <NA>   Virgin Islands US             2023-01-22       24269          129
```

```
us_total_cases <- us_cases_by_state %>%
  group_by(Country_Region, Date) %>%
  summarize(
    Total_Cases = sum(Total_Cases),
    Total_Deaths = sum(Total_Deaths)
    ) %>%
  select(Country_Region, Date, Total_Cases, Total_Deaths) %>%
  ungroup()
```

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

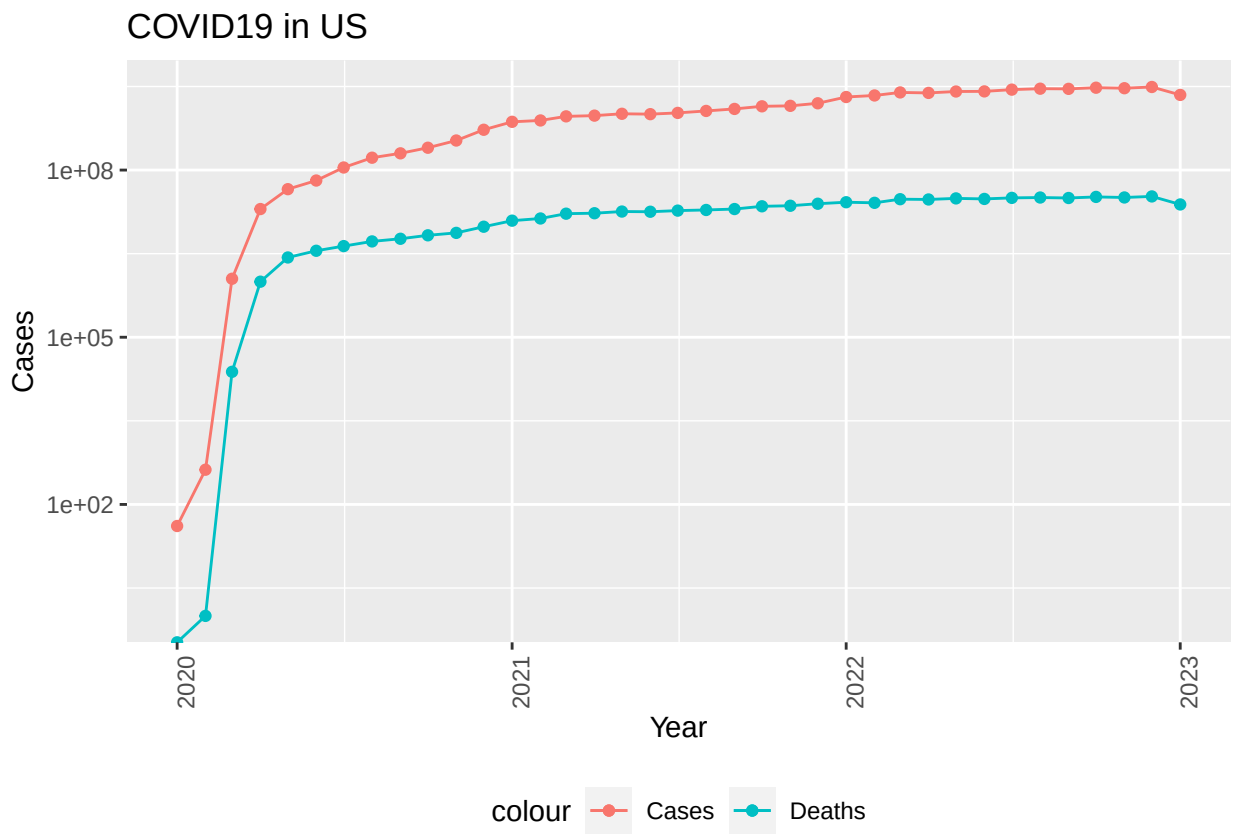
Visualization

```
ggplot(data = global_cases_by_month, aes(x=YearMonth,y=Cases)) +
  geom_line(aes(color='Cases')) +
  geom_point(aes(color='Cases')) +
  geom_point(aes(y= Deaths, color='Deaths')) +
  geom_line(aes(y=Deaths, color = 'Deaths')) +
  scale_y_log10() +
  theme(legend.position = 'bottom', axis.text.x = element_text(angle=90)) +
  labs(title = "COVID19 in World", y = 'Cases', x = 'Year')
```



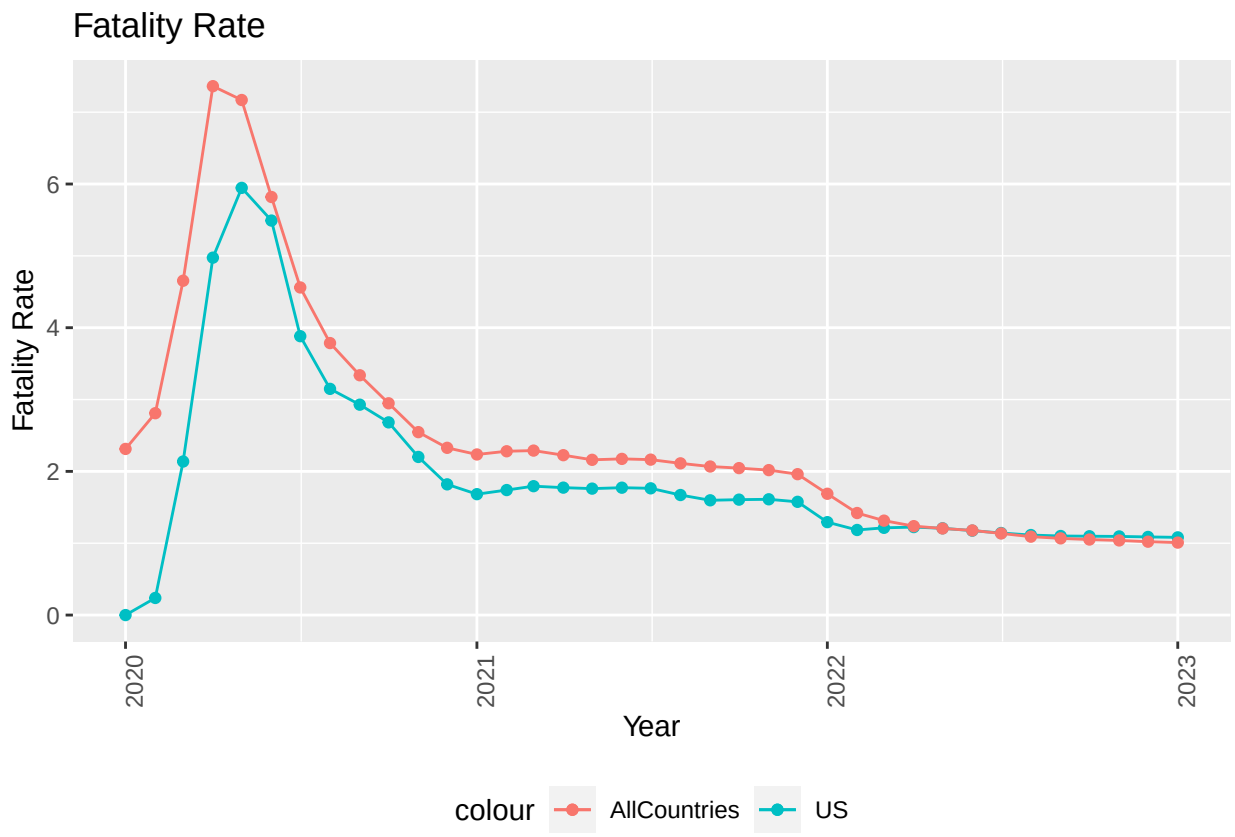
```
ggplot(data = us_cases_by_month, aes(x=YearMonth,y=Cases)) +
  geom_line(aes(color='Cases')) +
  geom_point(aes(color='Cases')) +
  geom_point(aes(y= Deaths, color='Deaths')) +
  geom_line(aes(y=Deaths, color = 'Deaths')) +
  scale_y_log10() +
  theme(legend.position = 'bottom', axis.text.x = element_text(angle=90)) +
  labs(title = "COVID19 in US",y = 'Cases',  x = 'Year')
```

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




```
all_fatality_rate <- us_cases_by_month_w_fr %>%
  rename(FatalityRatioUS = FatalityRatio) %>%
  right_join(global_cases_by_month_w_fr,by="YearMonth") %>%
  rename(FatalityRatioAllCountries = FatalityRatio) %>%
  select (c(YearMonth, FatalityRatioUS, FatalityRatioAllCountries))

ggplot(data = all_fatality_rate, aes(x=YearMonth,y=FatalityRatioUS)) +
  geom_point(aes(color='US')) +
  geom_line(aes(color='US')) +
  geom_point(aes(y= FatalityRatioAllCountries, color='AllCountries')) +
  geom_line(aes(y=FatalityRatioAllCountries, color = 'AllCountries')) +
  theme(legend.position = 'bottom', axis.text.x = element_text(angle=90)) +
  labs(title = "Fatality Rate", x='Year', y= 'Fatality Rate')
```



Modelling

The below model identifies the number of deaths based on the total number of cases reported.

Please note that it doesn't consider external factors like availability of vaccination, immunity gained in people who already had COVID in the past, etc. The Model uses all the available data to train the data, and the same data is used to plot the values to check how well the model is trained on the current data. Ideally, a different dataset should have been used to test it well.

```
#us_total_cases_w_pred_shuffled <- us_total_cases[sample(1:nrow(us_total_cases)), ]

#us_total_cases_w_pred_train_data <- us_total_cases_w_pred_shuffled[us_total_cases_w_pred_shuffled$Tota

#us_total_cases_w_pred_test_data <- us_total_cases_w_pred_shuffled[us_total_cases_w_pred_shuffled$Total_

#mod <- lm(Total_Deaths ~ Total_Cases, data = us_total_cases_w_pred_train_data)
#summary(mod)

#us_total_cases_w_pred <- us_total_cases_w_pred_test_data %>% mutate(PRED_DEATHS = predict(mod))
#tail(us_total_cases_w_pred)

mod <- lm(Total_Deaths ~ Total_Cases, data = us_total_cases)
summary(mod)
```

```
##
```

```
## Call:
## lm(formula = Total_Deaths ~ Total_Cases, data = us_total_cases)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -145840  -63973  -11730   89065  140048
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.458e+05  3.911e+03   37.29   <2e-16 ***
## Total_Cases 1.022e-02  6.860e-05  148.97   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 80300 on 1095 degrees of freedom
## Multiple R-squared:  0.953,  Adjusted R-squared:  0.9529
## F-statistic: 2.219e+04 on 1 and 1095 DF,  p-value: < 2.2e-16
```

```
us_total_cases_w_pred <- us_total_cases %>% mutate(PRED_DEATHS = predict(mod))

ggplot(data = us_total_cases_w_pred ) +
  geom_point(aes(x = Total_Cases, y = Total_Deaths ), color = "blue") +
  geom_point(aes(x = Total_Cases, y = PRED_DEATHS ), color = "red") +
  theme(legend.position = 'bottom', axis.text.x = element_text(angle=90)) +
  labs(title = "COVID-19 Actual verses Predicted", x='Cases', y= 'Deaths')
```