

# Covid

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```
library(stringr)
library(tidyverse)
```

```
url_in <- "https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_data"

file_names <- c("time_series_covid19_confirmed_global.csv", "time_series_covid19_deaths_global.csv", "time_series_covid19_recovered_global.csv")
```

```
urls <- str_c(url_in, file_names)
```

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

```
## Rows: 289 Columns: 1147
## -- Column specification -----
## Delimiter: ","
## chr      (2): Province/State, Country/Region
## dbl (1145): 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: 289 Columns: 1147
## -- Column specification -----
## Delimiter: ","
## chr      (2): Province/State, Country/Region
## dbl (1145): 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: 1154
## -- Column specification -----
## Delimiter: ","
## chr      (6): iso2, iso3, Admin2, Province_State, Country_Region, Combined_Key
## dbl (1148): 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: 1155
## -- Column specification -----
## Delimiter: ","
## chr      (6): iso2, iso3, Admin2, Province_State, Country_Region, Combined_Key
## dbl (1149): 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.
```

```
global_cases <- global_cases %>% pivot_longer(cols = -c(`Province/State`, `Country/Region`, `Lat`, `Long_`))
global_deaths <- global_deaths %>% pivot_longer(cols = -c(`Province/State`, `Country/Region`, `Lat`, `Long_`))
global <- global_cases %>% full_join(global_deaths) %>% rename(Country_Region = `Country/Region`, Province_State = `Province/State`)
```

```
## Joining with 'by = join_by('Province/State', 'Country/Region', date)'
```

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

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_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 <- us_cases %>%
  full_join(us_deaths)
```

```
## Joining with 'by = join_by(Admin2, Province_State, Country_Region,
## Combined_Key, date)'
```

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

```

    remove = FALSE)

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

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

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

us_by_state <- us %>%
  group_by(Province_State, Country_Region, date) %>%
  summarize(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()

us_totals <- us_by_state %>%
  group_by(Country_Region, date) %>%
  summarize(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()

tail(us_totals)

```

```

## # A tibble: 6 x 6
##   Country_Region date           cases  deaths deaths_per_mill Population
##   <chr>          <date>         <dbl>   <dbl>         <dbl>         <dbl>
## 1 US            2023-03-04 103650837 1122172         3371.  332875137
## 2 US            2023-03-05 103646975 1122134         3371.  332875137
## 3 US            2023-03-06 103655539 1122181         3371.  332875137
## 4 US            2023-03-07 103690910 1122516         3372.  332875137
## 5 US            2023-03-08 103755771 1123246         3374.  332875137
## 6 US            2023-03-09 103802702 1123836         3376.  332875137

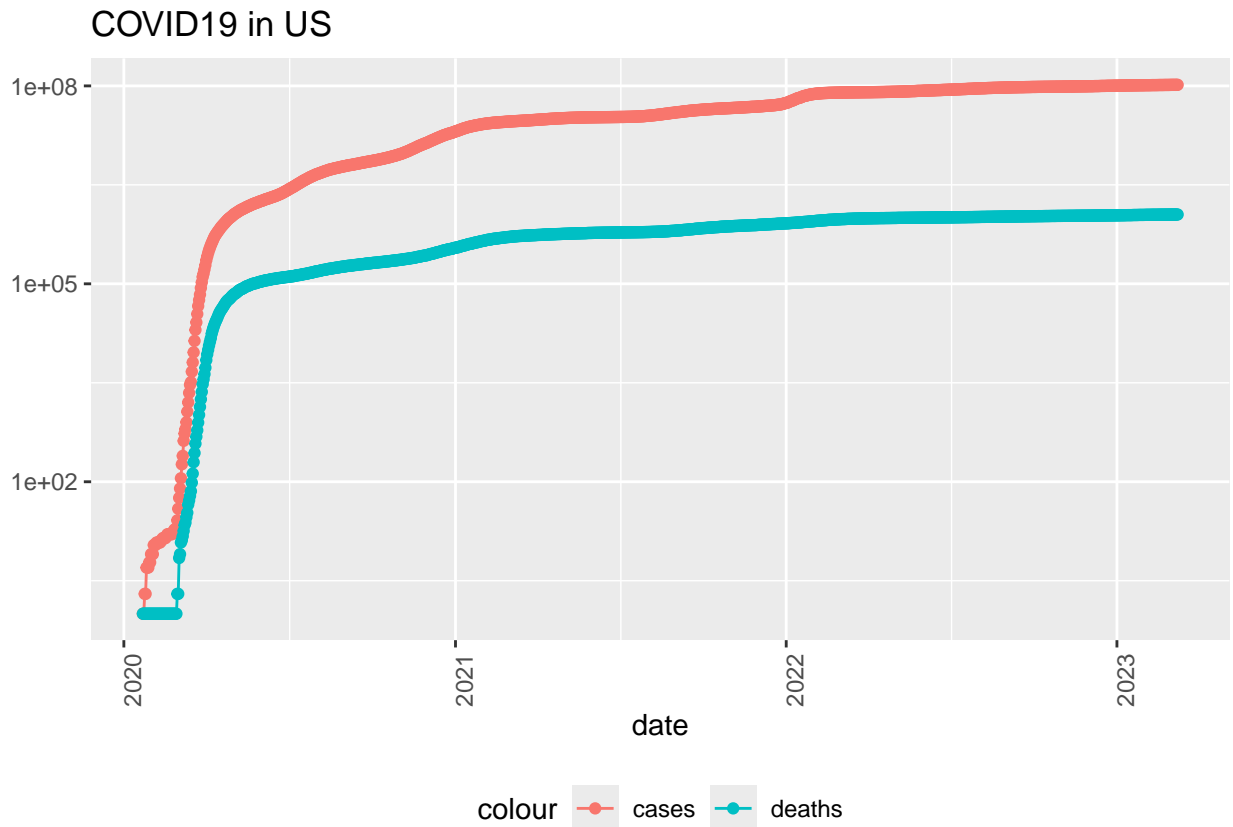
```

```

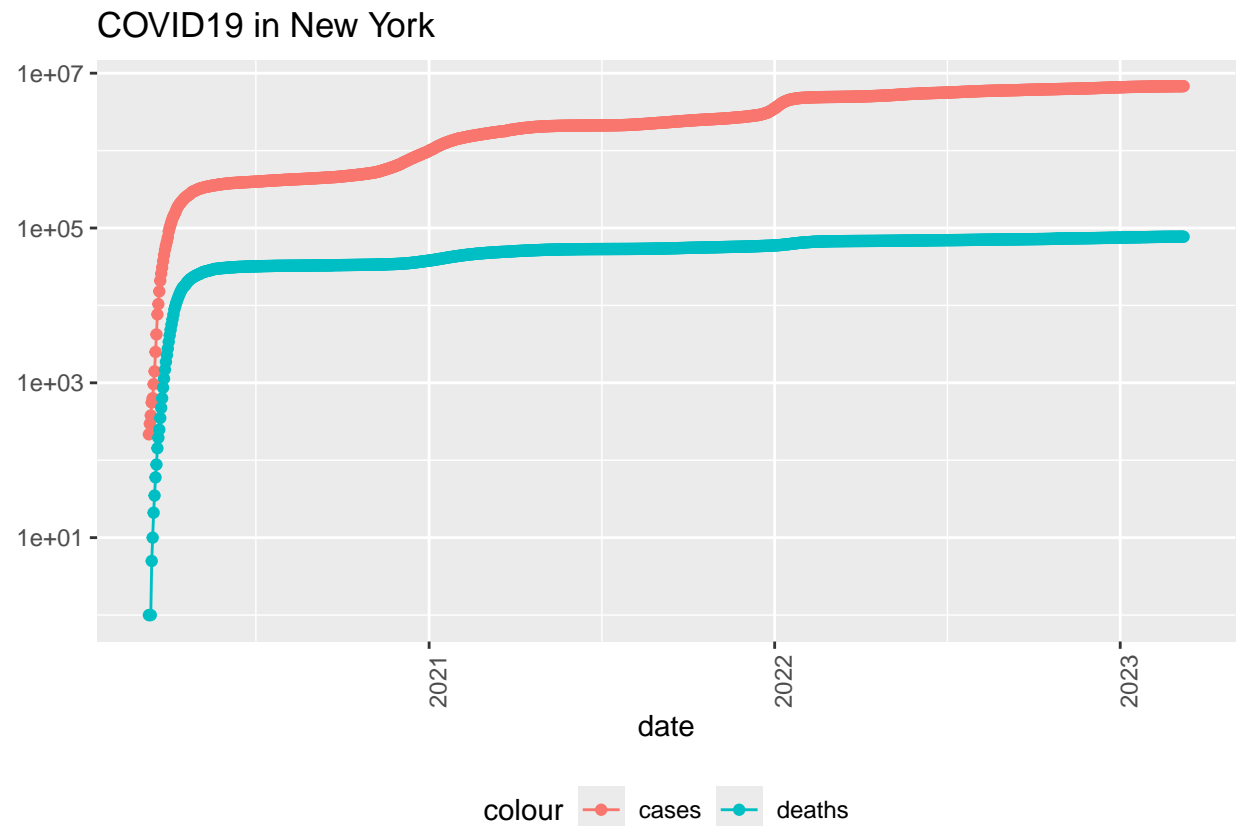
us_totals %>%
  filter(cases > 0) %>%
  ggplot(aes(x = date, y = cases)) +
  geom_line(aes(color = "cases")) +
  geom_point(aes(color = "cases")) +
  geom_line(aes(y = deaths, color = "deaths")) +
  geom_point(aes(y = deaths, color = "deaths")) +
  scale_y_log10() +
  theme(legend.position = "bottom",

```

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



```
state <- "New York"
us_by_state %>%
  filter(Province_State == state) %>%
  filter(cases > 0 & deaths > 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)
```



```
max(us_totals$date)
```

```
## [1] "2023-03-09"
```

```
max(us_totals$deaths)
```

```
## [1] 1123836
```

```
us_by_state <- us_by_state %>%
  mutate(new_cases = cases - lag(cases),
         new_deaths = deaths - lag(deaths))

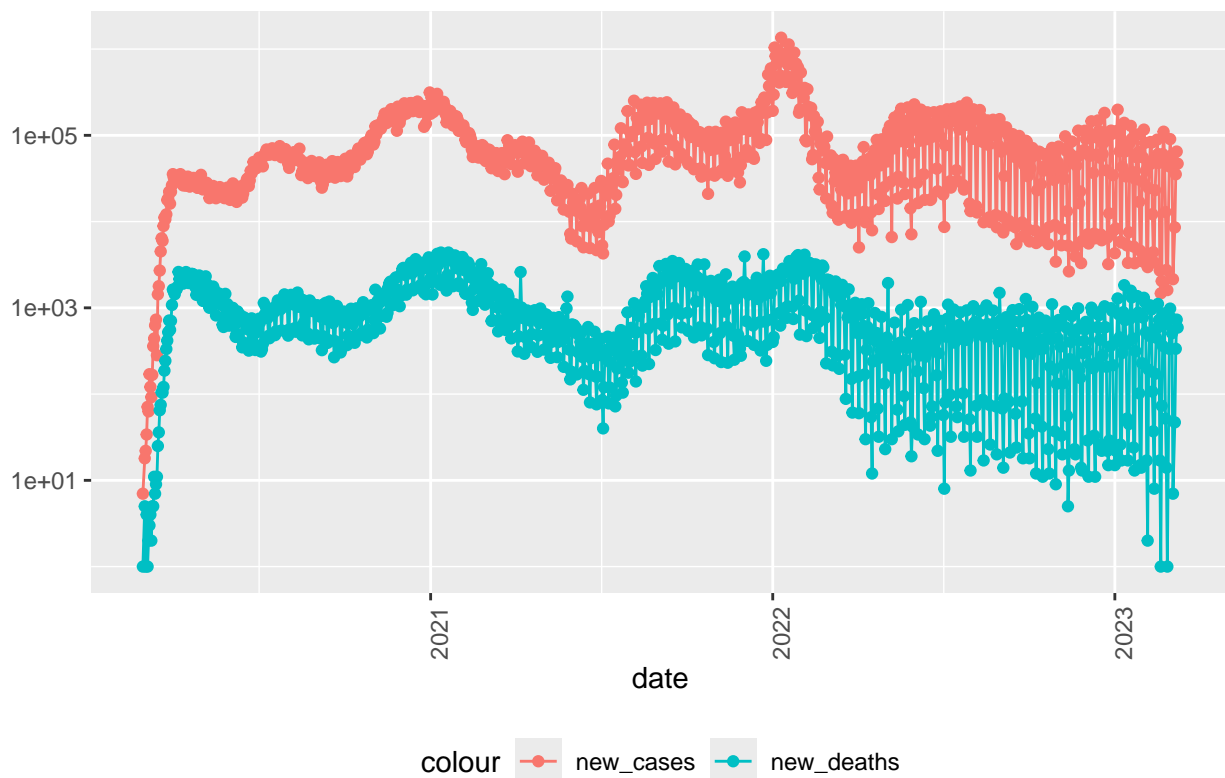
us_totals <- us_totals %>%
  mutate(new_cases = cases - lag(cases),
         new_deaths = deaths - lag(deaths))
tail(us_totals %>% select(new_cases, new_deaths, everything()))
```

```
## # A tibble: 6 x 8
##   new_cases new_deaths Country_Region date      cases deaths deaths_per_mill
##   <dbl>      <dbl> <chr>      <date>      <dbl> <dbl>      <dbl>
## 1      2147         7 US        2023-03-04  1.04e8  1.12e6      3371.
## 2     -3862        -38 US        2023-03-05  1.04e8  1.12e6      3371.
## 3      8564         47 US        2023-03-06  1.04e8  1.12e6      3371.
## 4     35371        335 US        2023-03-07  1.04e8  1.12e6      3372.
```

```
## 5      64861      730 US      2023-03-08      1.04e8 1.12e6      3374.
## 6      46931      590 US      2023-03-09      1.04e8 1.12e6      3376.
## # i 1 more variable: Population <dbl>
```

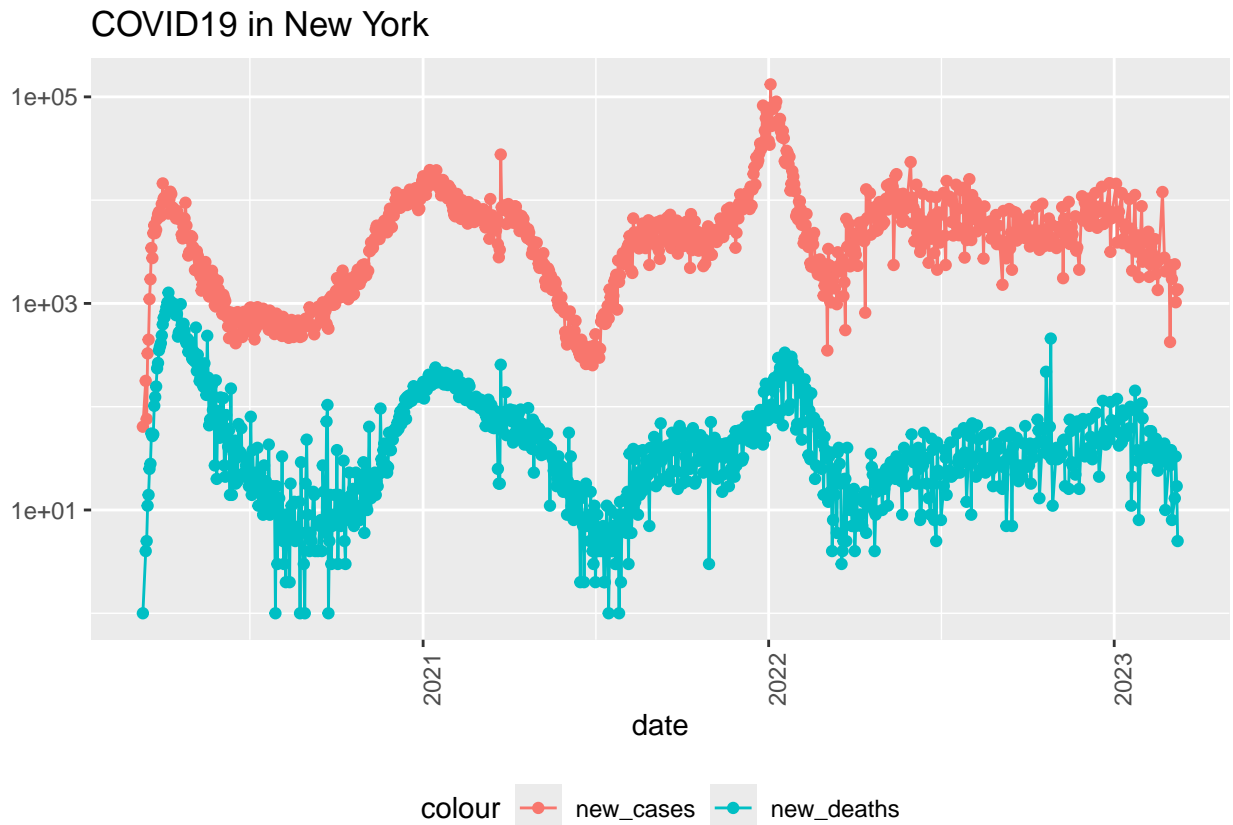
```
us_totals %>%
  filter(new_cases > 0 & new_deaths > 0) %>%
  ggplot(aes(x = date, y = new_cases)) +
  geom_line(aes(color = "new_cases")) +
  geom_point(aes(color = "new_cases")) +
  geom_line(aes(y = new_deaths, color = "new_deaths")) +
  geom_point(aes(y = new_deaths, color = "new_deaths")) +
  scale_y_log10() +
  theme(legend.position = "bottom",
        axis.text.x = element_text(angle = 90)) +
  labs(title = "COVID19 in US", y = NULL)
```

COVID19 in US



```
us_by_state %>%
  filter(Province_State == state) %>%
  filter(new_cases > 0 & new_deaths > 0) %>%
  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 New York", y = NULL)
```



```
us_state_totals <- us_by_state %>%
  group_by(Province_State) %>%
  summarise(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) %>%
  select(deaths_per_thou, cases_per_thou, everything())
```

```
## # A tibble: 10 x 6
##   deaths_per_thou cases_per_thou Province_State deaths cases population
##   <dbl> <dbl> <chr> <dbl> <dbl> <dbl>
## 1 0.611 150. American Samoa 34 8.32e3 55641
## 2 0.744 248. Northern Mariana Isl~ 41 1.37e4 55144
## 3 1.21 231. Virgin Islands 130 2.48e4 107268
## 4 1.30 269. Hawaii 1841 3.81e5 1415872
## 5 1.49 245. Vermont 929 1.53e5 623989
## 6 1.55 293. Puerto Rico 5823 1.10e6 3754939
```

```
## 7          1.65          340. Utah          5298 1.09e6      3205958
## 8          2.01          415. Alaska          1486 3.08e5       740995
## 9          2.03          252. District of Columbia      1432 1.78e5       705749
## 10         2.06          253. Washington      15683 1.93e6      7614893
```

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

```
## # A tibble: 10 x 6
##   deaths_per_thou cases_per_thou Province_State deaths    cases population
##   <dbl>          <dbl> <chr>          <dbl>    <dbl>      <dbl>
## 1          4.55          336. Arizona      33102 2443514    7278717
## 2          4.54          326. Oklahoma      17972 1290929    3956971
## 3          4.49          333. Mississippi    13370  990756    2976149
## 4          4.44          359. West Virginia   7960  642760    1792147
## 5          4.32          320. New Mexico      9061  670929    2096829
## 6          4.31          334. Arkansas      13020 1006883    3017804
## 7          4.29          335. Alabama       21032 1644533    4903185
## 8          4.28          368. Tennessee     29263 2515130    6829174
## 9          4.23          307. Michigan      42205 3064125    9986857
## 10         4.06          385. Kentucky      18130 1718471    4467673
```

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

```
##
## Call:
## lm(formula = deaths_per_thou ~ cases_per_thou, data = us_state_totals)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.3352 -0.5978  0.1491  0.6535  1.2086
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.36167    0.72480  -0.499    0.62
## cases_per_thou  0.01133    0.00232   4.881 9.76e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8615 on 54 degrees of freedom
## Multiple R-squared:  0.3061, Adjusted R-squared:  0.2933
## F-statistic: 23.82 on 1 and 54 DF, p-value: 9.763e-06
```

```
us_state_totals %>% slice_min(cases_per_thou)
```

```
## # A tibble: 1 x 6
##   Province_State deaths cases population cases_per_thou deaths_per_thou
##   <chr>          <dbl> <dbl>      <dbl>          <dbl>      <dbl>
## 1 American Samoa      34  8320    55641          150.          0.611
```



```
us_state_totals %>% slice_max(cases_per_thou)
```

```
## # A tibble: 1 x 6
##   Province_State deaths cases population cases_per_thou deaths_per_thou
##   <chr>          <dbl> <dbl>         <dbl>         <dbl>         <dbl>
## 1 Rhode Island    3870 460697    1059361         435.         3.65
```

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

```
## # A tibble: 56 x 7
##   Province_State deaths cases population cases_per_thou deaths_per_thou pred
##   <chr>          <dbl> <dbl>         <dbl>         <dbl>         <dbl> <dbl>
## 1 Alabama      21032 1.64e6    4903185         335.         4.29    3.44
## 2 Alaska        1486 3.08e5     740995         415.         2.01    4.34
## 3 American Samoa    34 8.32e3     55641         150.         0.611   1.33
## 4 Arizona       33102 2.44e6    7278717         336.         4.55    3.44
## 5 Arkansas       13020 1.01e6    3017804         334.         4.31    3.42
## 6 California     101159 1.21e7    39512223         307.         2.56    3.12
## 7 Colorado       14181 1.76e6    5758736         306.         2.46    3.11
## 8 Connecticut     12220 9.77e5    3565287         274.         3.43    2.74
## 9 Delaware        3324 3.31e5     973764         340.         3.41    3.49
## 10 District of Co~  1432 1.78e5     705749         252.         2.03    2.49
## # i 46 more rows
```

```
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")
```

