Exploration of COVID-19 tracking data from multiple resources

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Contents

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by a new type of coronavirus: severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The outbreak first started in Wuhan, China in December 2019. The first kown case of COVID-19 in the U.S. was confirmed on January 20, 2020, in a 35-year-old man who teturned to Washington State on January 15 after traveling to Wuhan. Starting around the end of Feburary, evidence emerge for community spread in the US.

We, as all of us, are indebted to the heros who fight COVID-19 across the whole world in different ways. For this data exploration, I am grateful to many data science groups who have collected detailed COVID-19 outbreak data, including the number of tests, confirmed cases, and deaths, across countries/regions, states/provnices (administrative division level 1, or admin1), and counties (admin2). Specifically, I used the data from these three resources:

- JHU (https://coronavirus.jhu.edu/)
  - The Center for Systems Science and Engineering (CSSE) at John Hopkins University.
  - World-wide counts of coronavirus cases, deaths, and recovered ones.
  - https://github.com/CSSEGISandData/COVID-19
- NY Times (https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html)
  - The New York Times
  - "cumulative counts of coronavirus cases in the United States, at the state and county level, over time"
  - https://github.com/nytimes/covid-19-data

- COVID Trackng (https://covidtracking.com/)
  - COVID Tracking Project
  - "collects information from 50 US states, the District of Columbia, and 5 other US territories to provide the most comprehensive testing data"
  - https://github.com/COVID19Tracking/covid-tracking-data

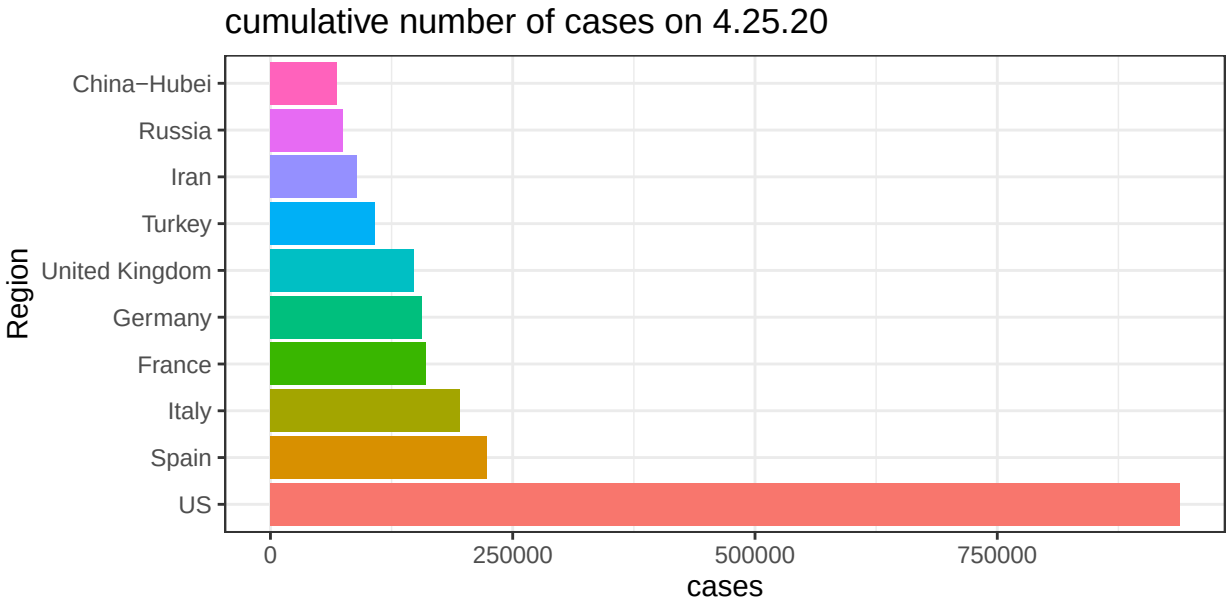
JHU

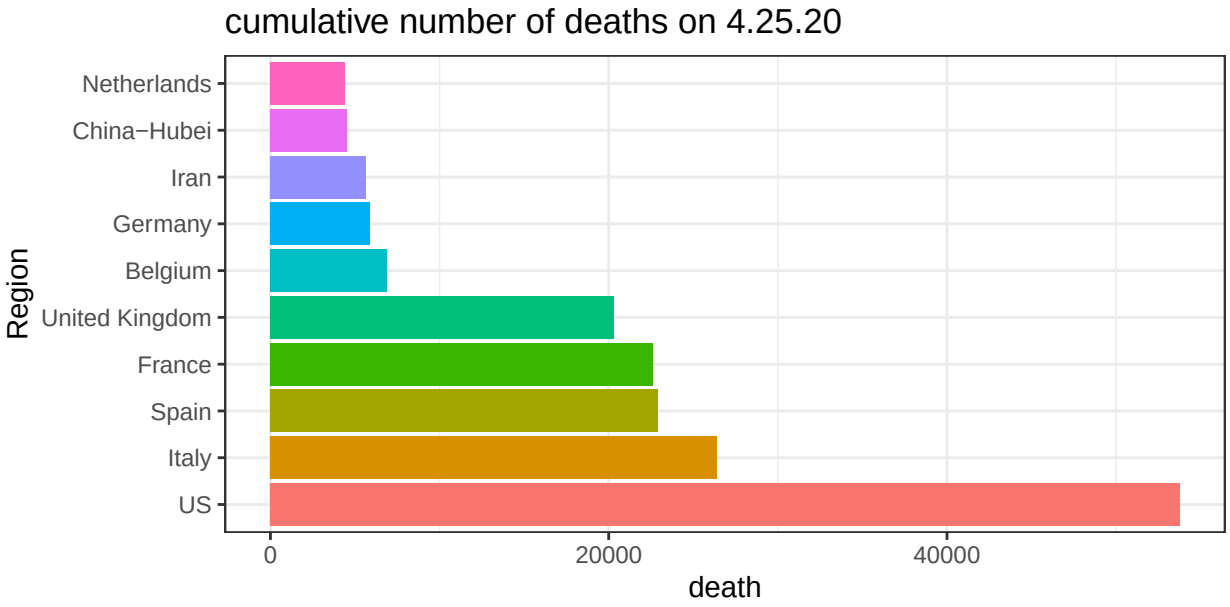
Assume you have cloned the JHU Github repository on your local machine at "../COVID-19".

time series data

The time series provide counts (e.g., confirmed cases, deaths) starting from Jan 22nd, 2020 for 253 locations. Currently there is no data of individual US state in these time series data files.

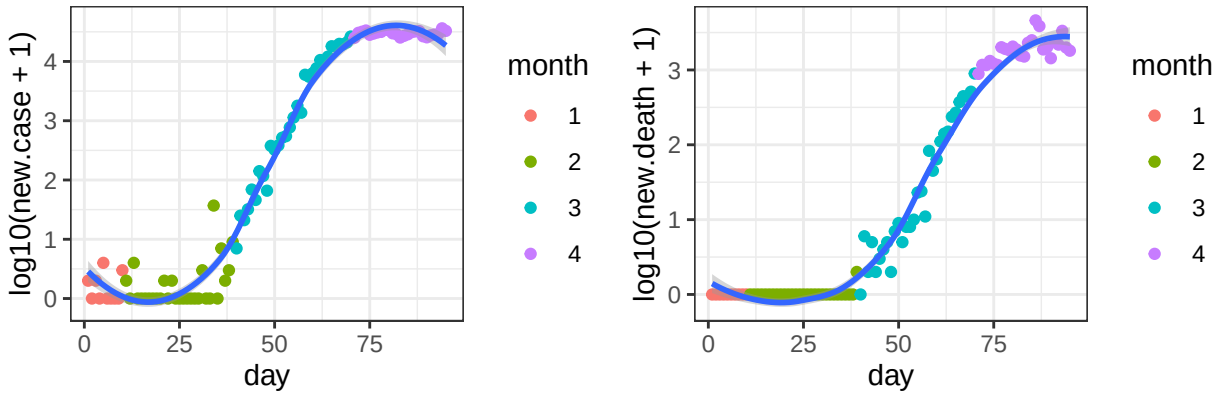
Here is the list of 10 records with the largest number of cases or deaths on the most recent date.





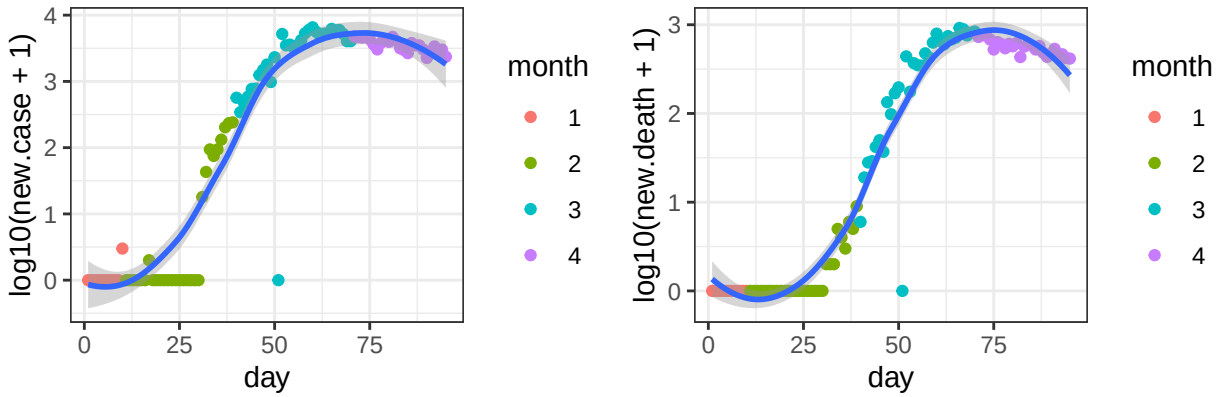
Next, I check for each country/region, what is the number of new cases/deaths? This data is important to understand what is the trend under different situations, e.g., population density, social distance policies etc. Here I checked the top 10 countries/regions with the highest number of deaths.

US



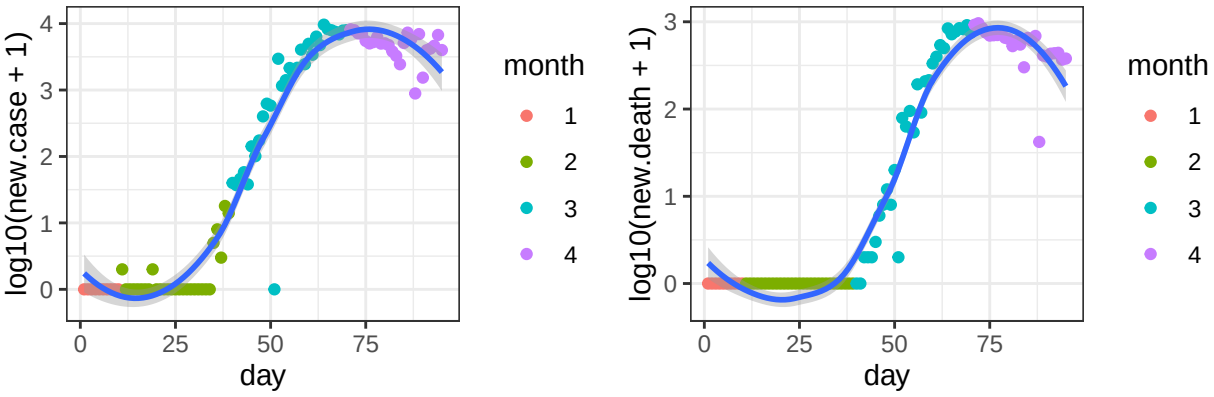
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

Italy



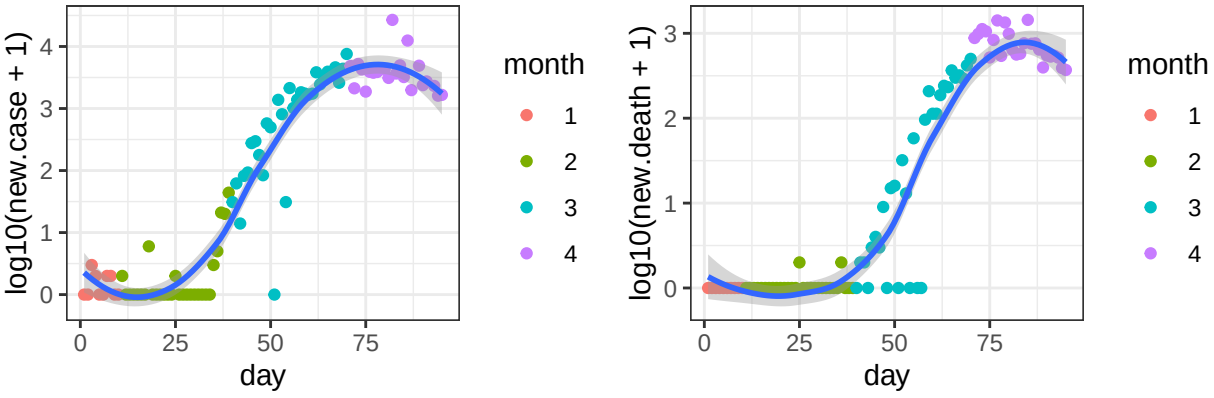
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

Spain



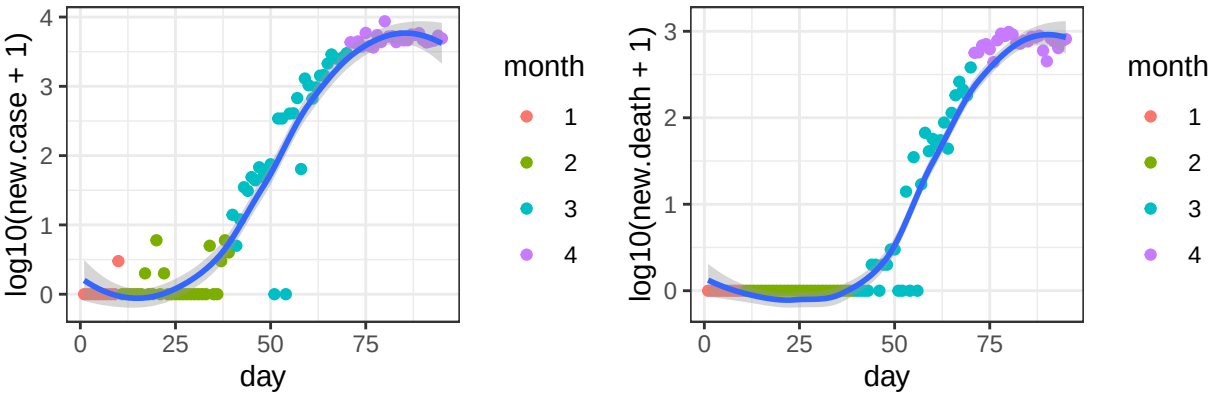
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

France



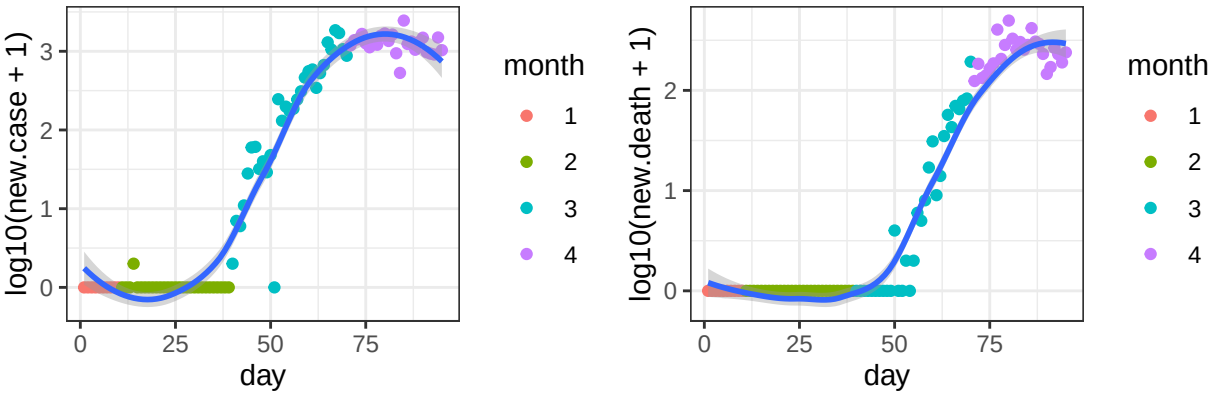
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

United Kingdom



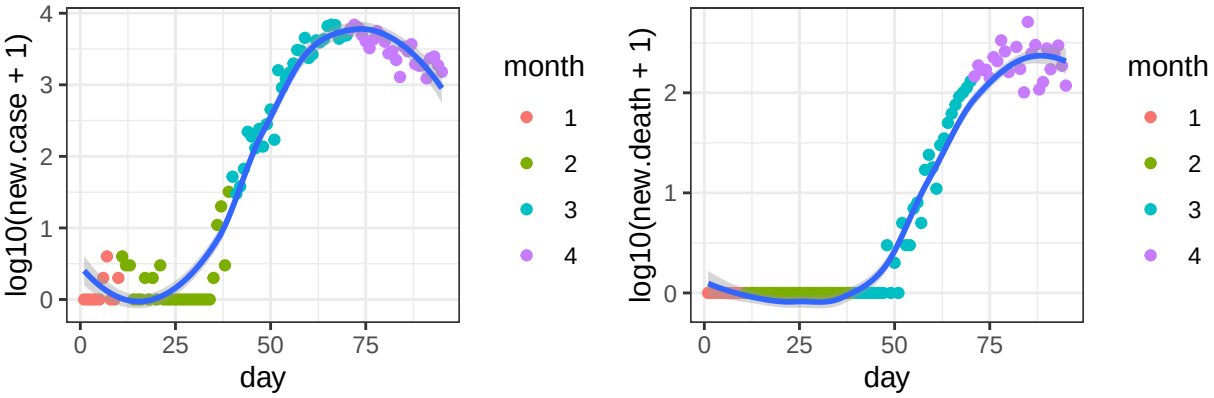
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

Belgium



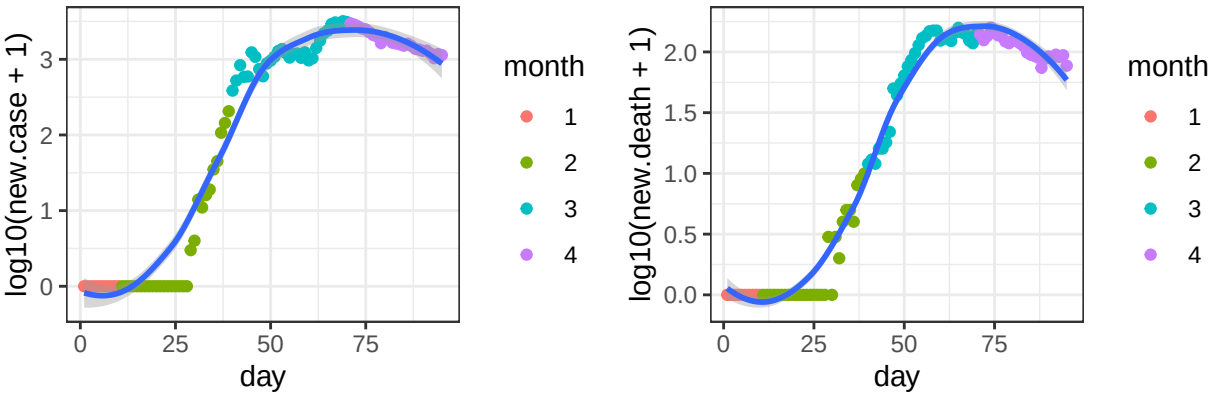
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

Germany



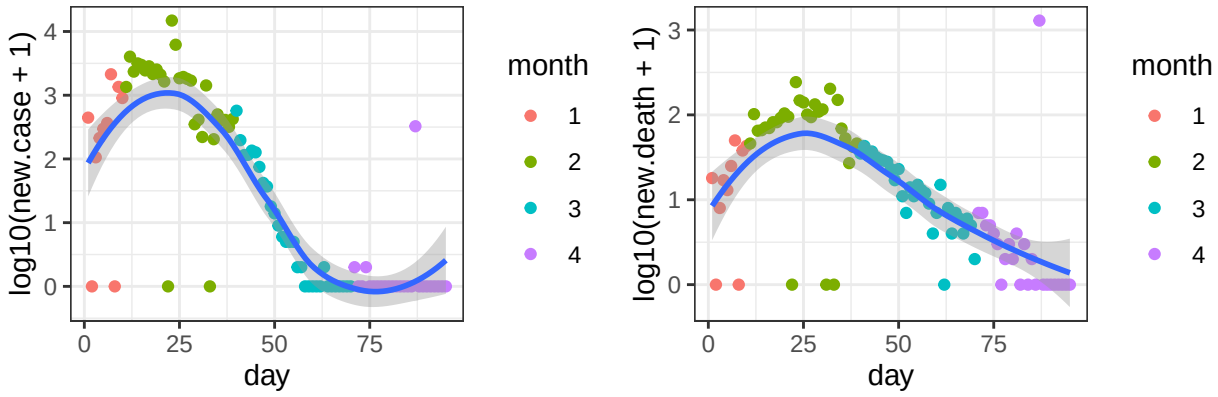
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

Iran



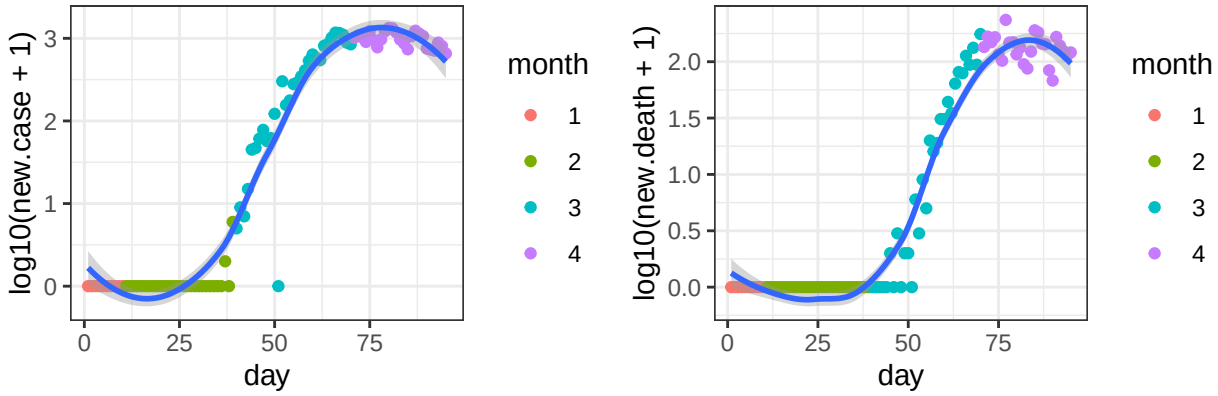
data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

China−Hubei



data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

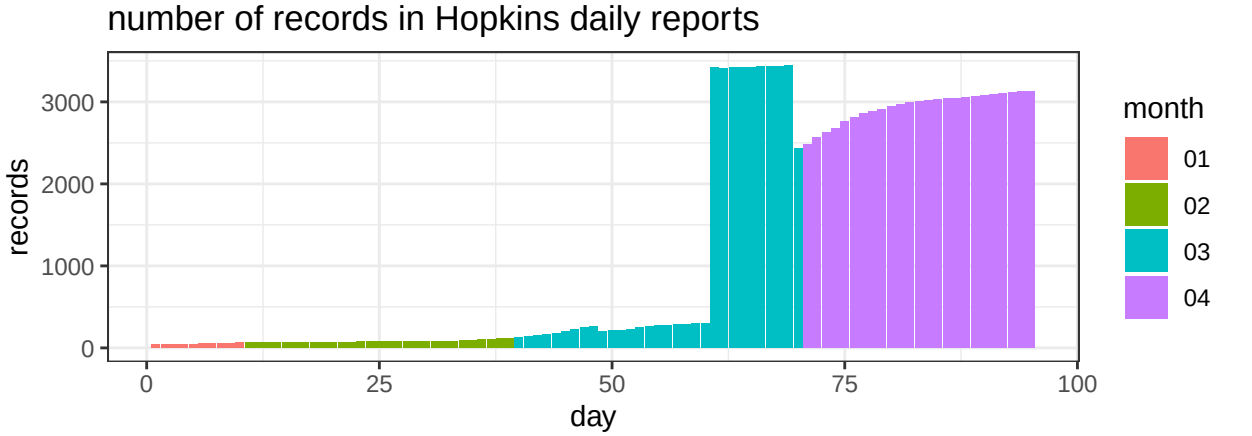
Netherlands



data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

daily reports data

The raw data from Hopkins are in the format of daily reports with one file per day. More recent files (since March 22nd) inlcude information from individual states of US or individual counties, as shown in the following figure. So I turn to NY Times data for informatoin of individual states or counties.



data source: https://github.com/CSSEGISandData/COVID−19, day 1 is 1/22/2020

NY Times

The data from NY Times are saved in two text files, one for state level information and the other one for county level information.

The currente date is

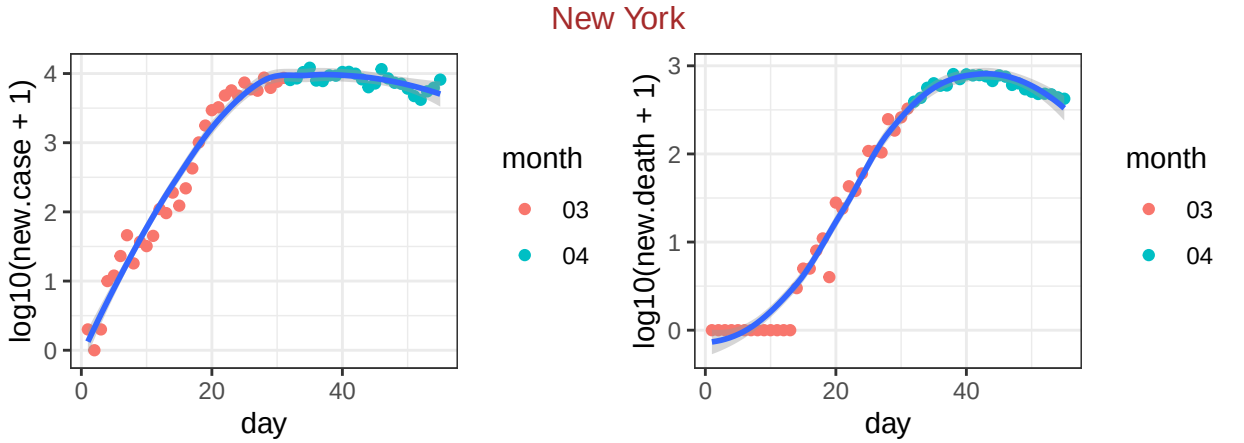
```
## [1] "2020-04-24"
```

state level data

First check the 20 states with the largest number of deaths.

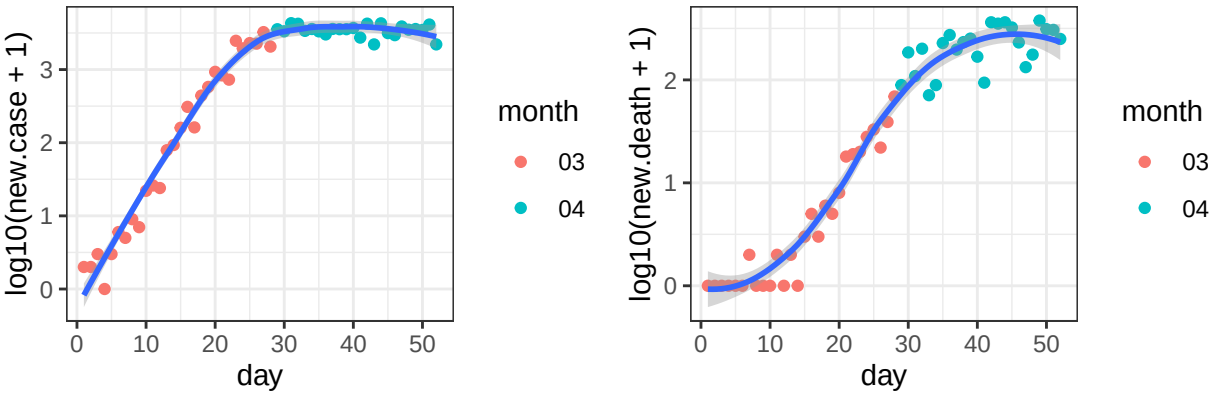
```
##            date          state fips  cases deaths
## 2908 2020-04-24       New York   36 271621  16162
## 2906 2020-04-24     New Jersey   34 102196   5617
## 2898 2020-04-24       Michigan   26  36627   3084
## 2897 2020-04-24  Massachusetts   25  50969   2556
## 2889 2020-04-24       Illinois   17  39658   1804
## 2915 2020-04-24   Pennsylvania   42  40298   1786
## 2881 2020-04-24    Connecticut    9  23921   1764
## 2879 2020-04-24     California    6  41368   1619
## 2894 2020-04-24      Louisiana   22  26140   1601
## 2884 2020-04-24        Florida   12  30525   1045
## 2885 2020-04-24        Georgia   13  21575    889
## 2890 2020-04-24        Indiana   18  13680    741
## 2926 2020-04-24     Washington   53  13120    731
## 2896 2020-04-24       Maryland   24  16618    723
## 2912 2020-04-24           Ohio   39  15169    690
## 2880 2020-04-24       Colorado    8  12255    672
## 2921 2020-04-24          Texas   48  23650    625
## 2925 2020-04-24       Virginia   51  11596    413
## 2909 2020-04-24 North Carolina   37   8052    270
## 2877 2020-04-24        Arizona    4   6045    268
```

For these 20 states, I check the number of new cases and the number of new deaths. Part of the reason for such checking is to identify whether there is any similarity on such patterns. For example, could you use the pattern seen from Italy to predict what happen in an individual state, and what are the similarities and differences across states.



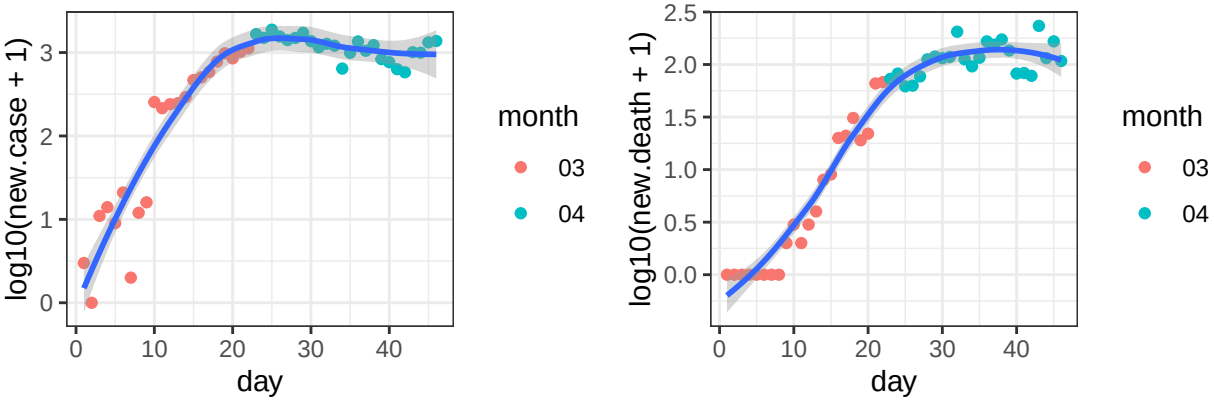
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−01

New Jersey



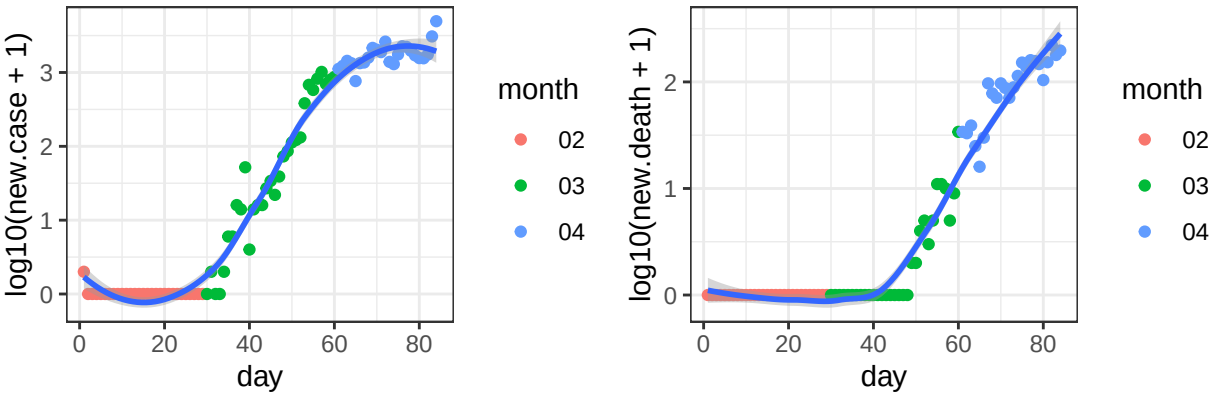
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−04

Michigan



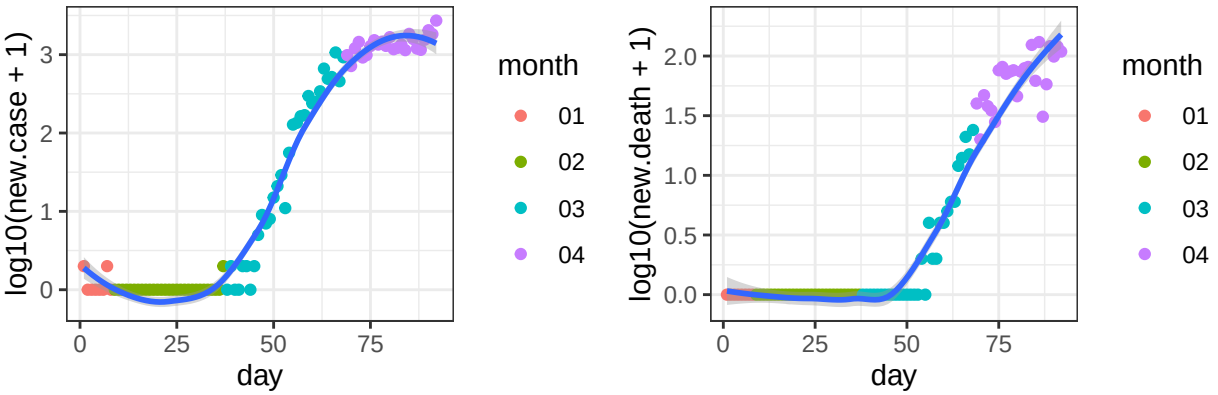
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−10

Massachusetts



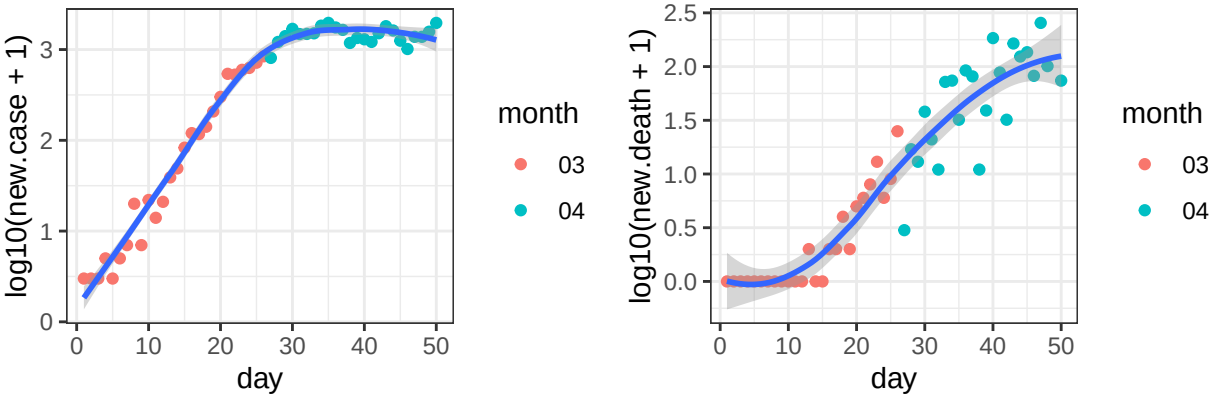
data source: https://github.com/nytimes/covid−19−data, day 1 is 02−01

Illinois



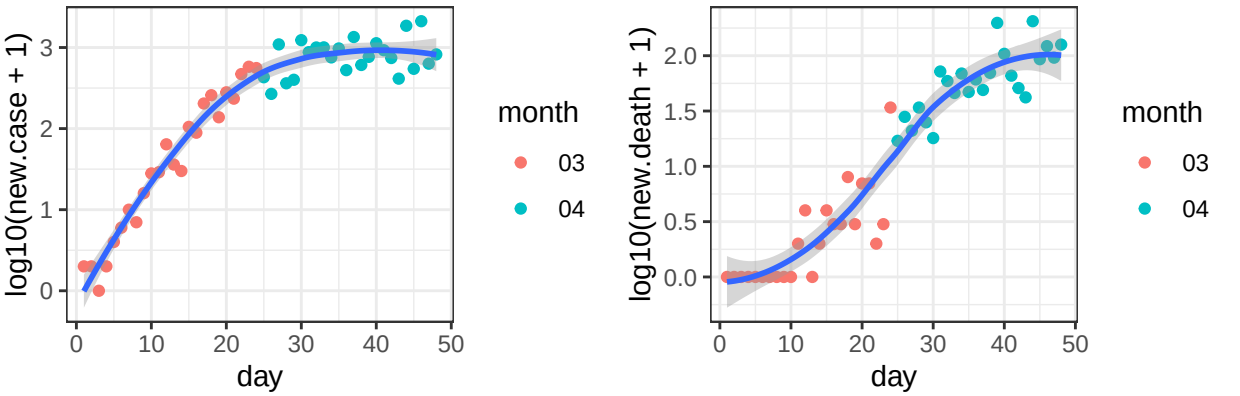
data source: https://github.com/nytimes/covid−19−data, day 1 is 01−24

Pennsylvania



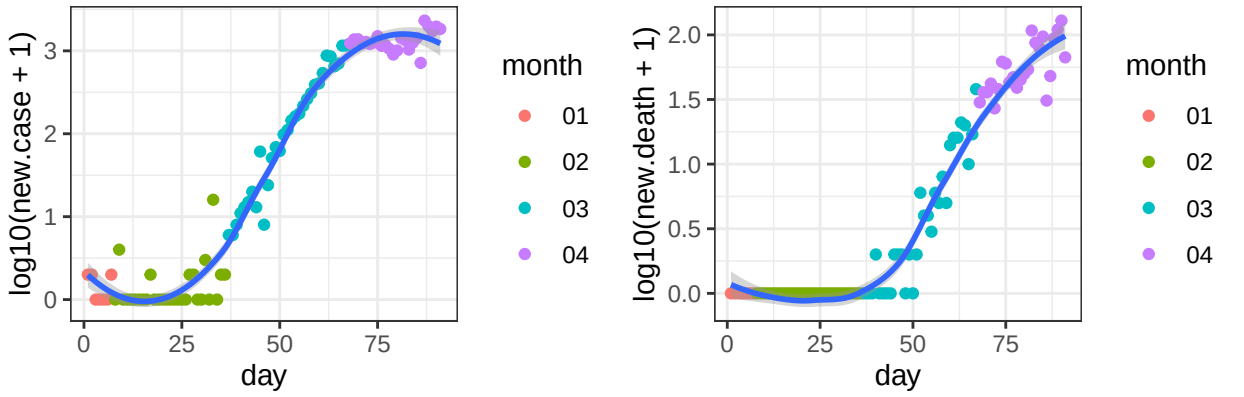
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−06

Connecticut



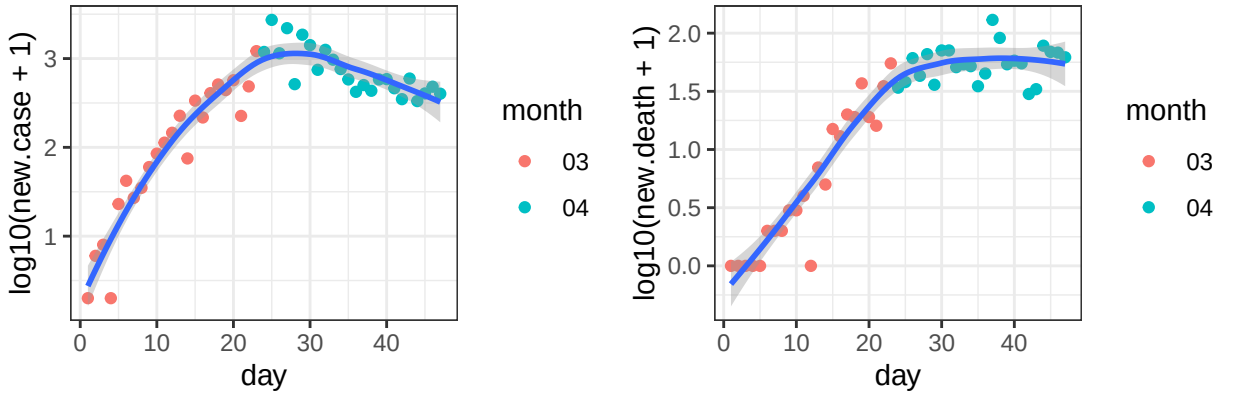
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−08

California



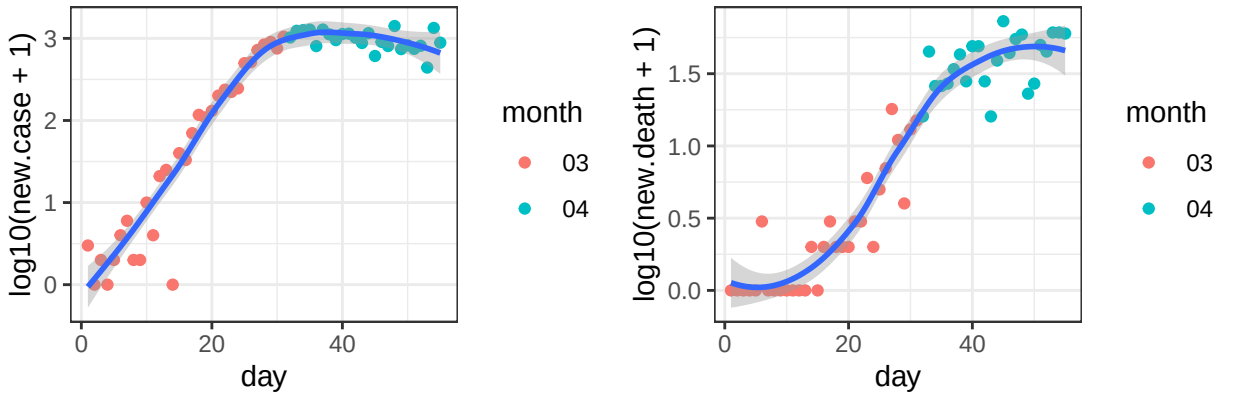
data source: https://github.com/nytimes/covid−19−data, day 1 is 01−25

Louisiana



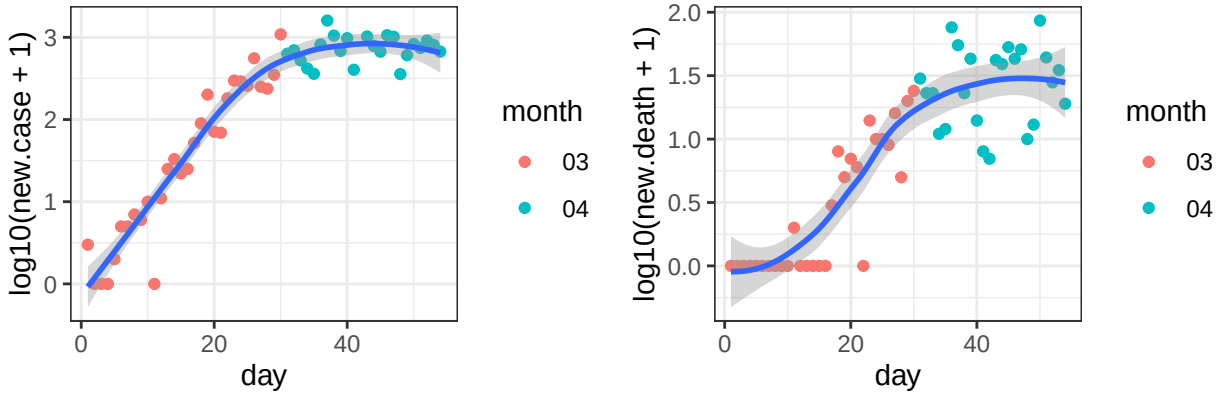
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−09

Florida



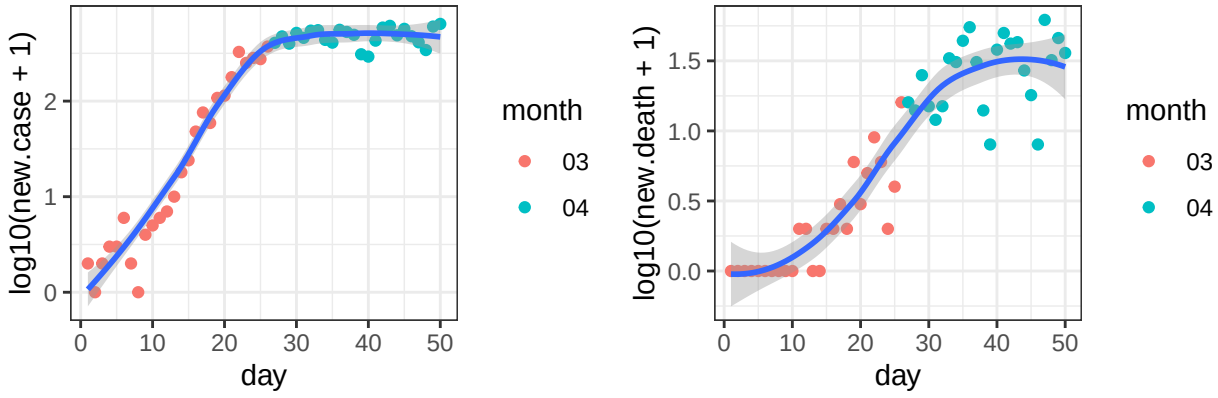
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−01

Georgia



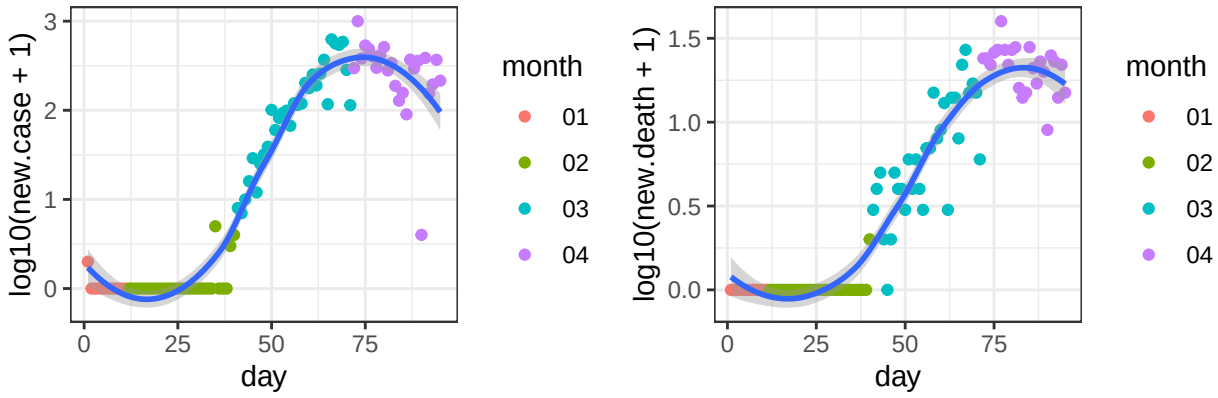
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−02

Indiana



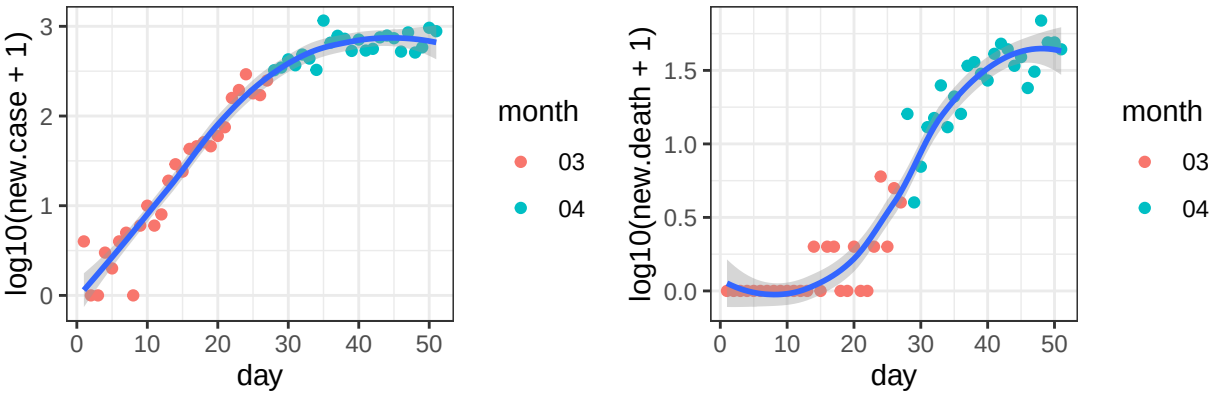
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−06

Washington



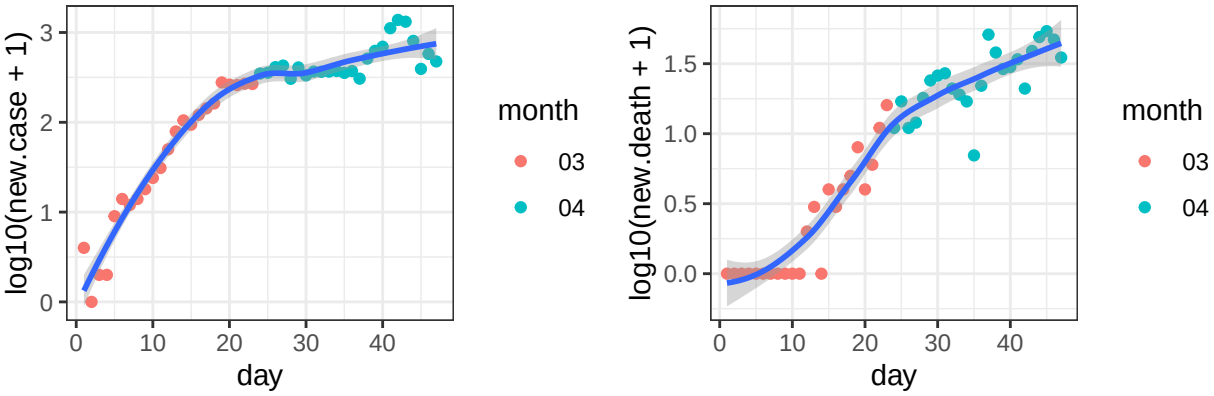
data source: https://github.com/nytimes/covid−19−data, day 1 is 01−21

Maryland



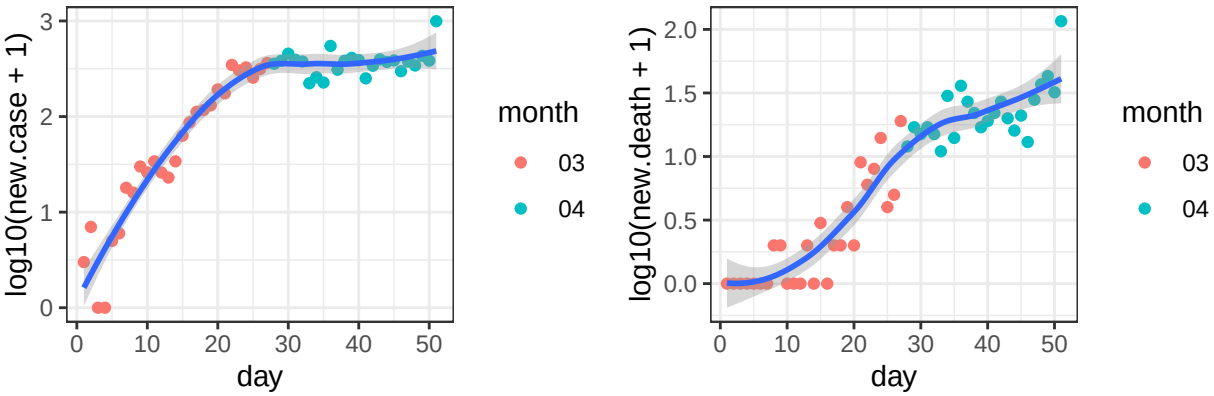
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−05

Ohio



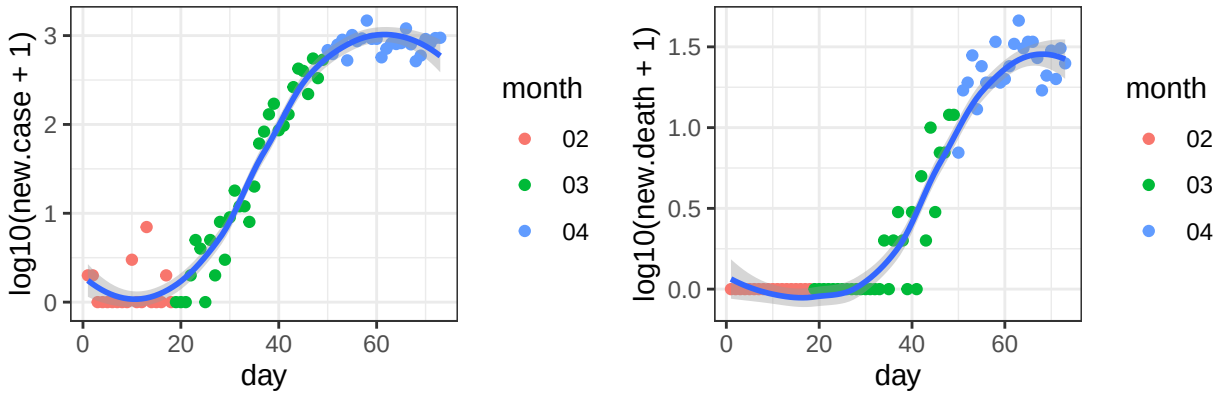
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−09

Colorado



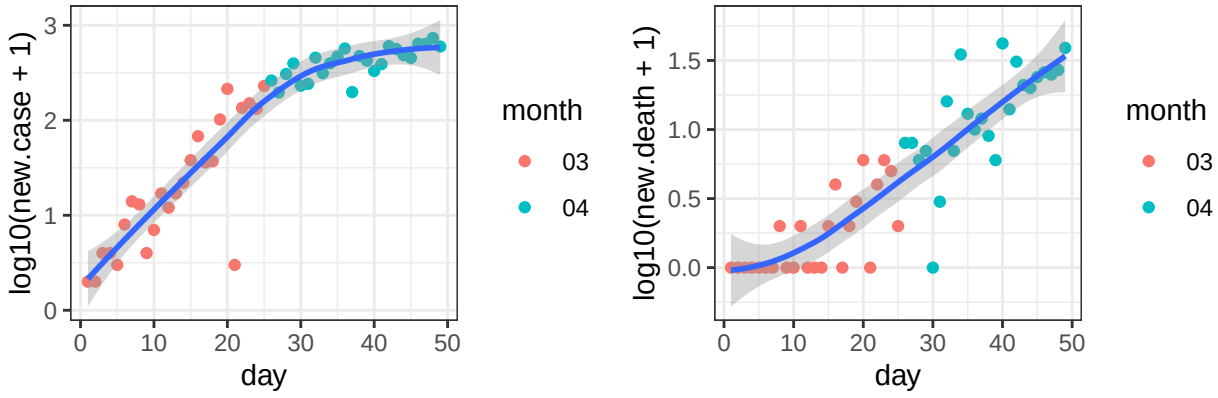
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−05

Texas



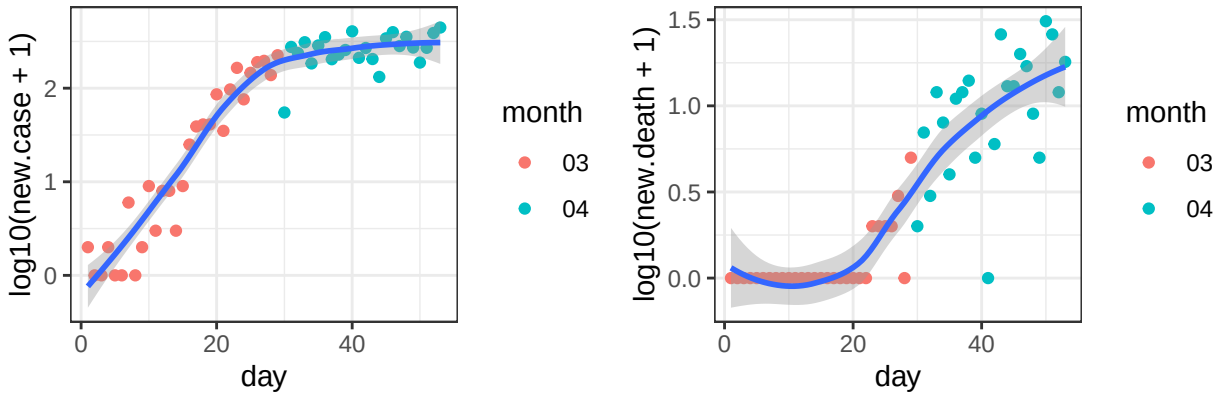
data source: https://github.com/nytimes/covid−19−data, day 1 is 02−12

Virginia

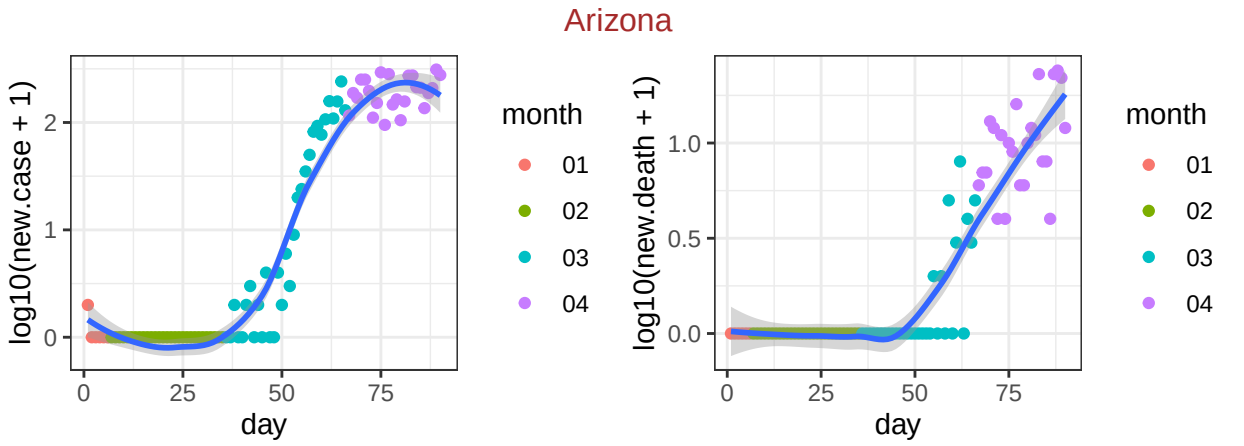


data source: https://github.com/nytimes/covid−19−data, day 1 is 03−07

North Carolina

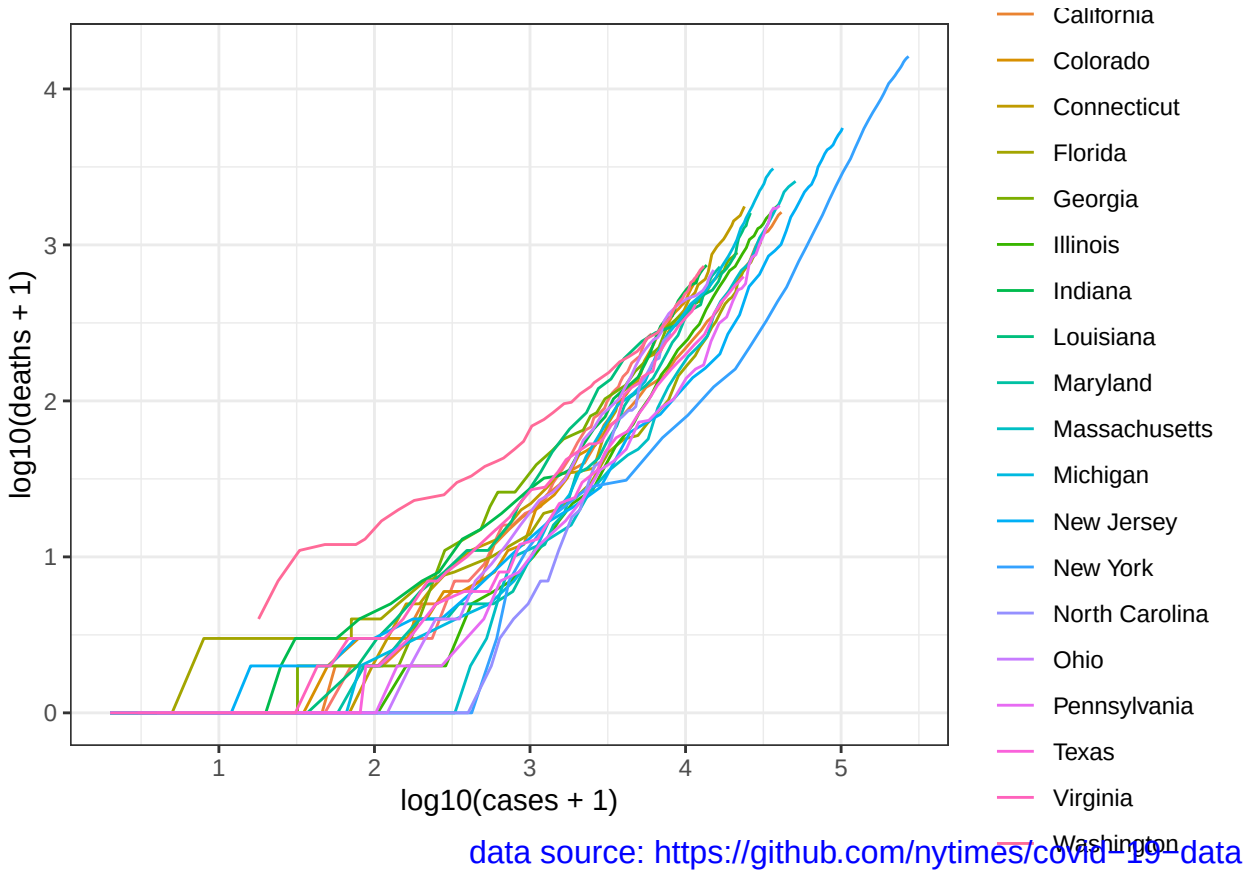


data source: https://github.com/nytimes/covid−19−data, day 1 is 03−03



data source: https://github.com/nytimes/covid−19−data, day 1 is 01−26

Next I check the relation between the **cumulative** number of cases and deaths for these 10 states, starting on March



data source: https://github.com/nytimes/covid−19−data

county level data

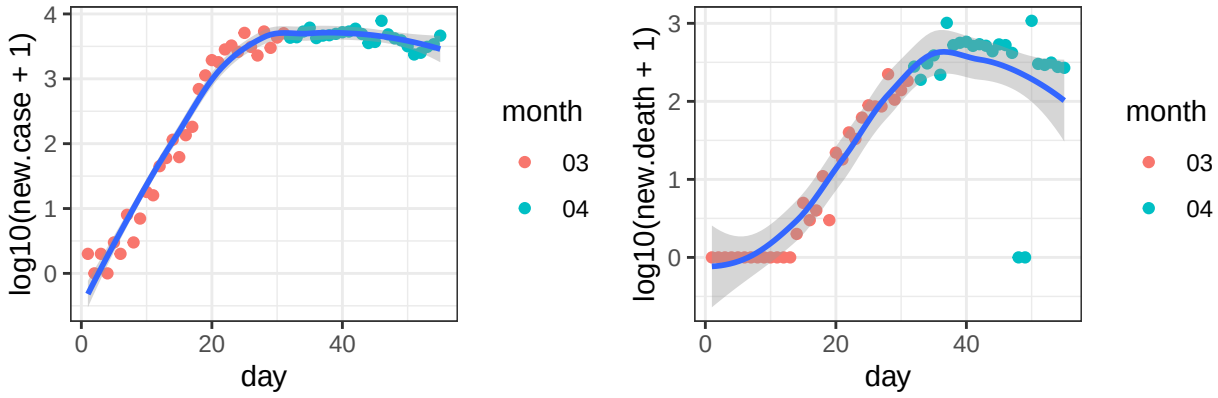
First check the 20 counties with the largest number of deaths.

```
##            date        county       state  fips  cases deaths
## 85808 2020-04-24 New York City    New York    NA 150484  11157
## 85807 2020-04-24        Nassau    New York 36059  32765   1867
## 85359 2020-04-24         Wayne    Michigan 26163  15407   1443
```

```
## 84712 2020-04-24          Cook      Illinois 17031  27616    1220
## 85827 2020-04-24       Suffolk      New York 36103  30606    1035
## 85835 2020-04-24   Westchester      New York 36119  26632     989
## 85736 2020-04-24         Essex    New Jersey 34013  12110     975
## 85731 2020-04-24        Bergen    New Jersey 34003  14363     934
## 84329 2020-04-24   Los Angeles    California  6037  18545     850
## 84422 2020-04-24     Fairfield   Connecticut  9001  10227     662
## 85738 2020-04-24        Hudson    New Jersey 34017  13011     640
## 85274 2020-04-24     Middlesex Massachusetts 25017  11681     585
## 85340 2020-04-24       Oakland      Michigan 26125   6804     585
## 85749 2020-04-24         Union    New Jersey 34039  11208     542
## 84423 2020-04-24      Hartford   Connecticut  9003   4570     511
## 85327 2020-04-24        Macomb      Michigan 26099   5022     504
## 86203 2020-04-24  Philadelphia  Pennsylvania 42101  11877     449
## 85741 2020-04-24     Middlesex    New Jersey 34023   9789     413
## 84426 2020-04-24     New Haven   Connecticut  9009   6286     396
## 86795 2020-04-24          King    Washington 53033   5691     393
```

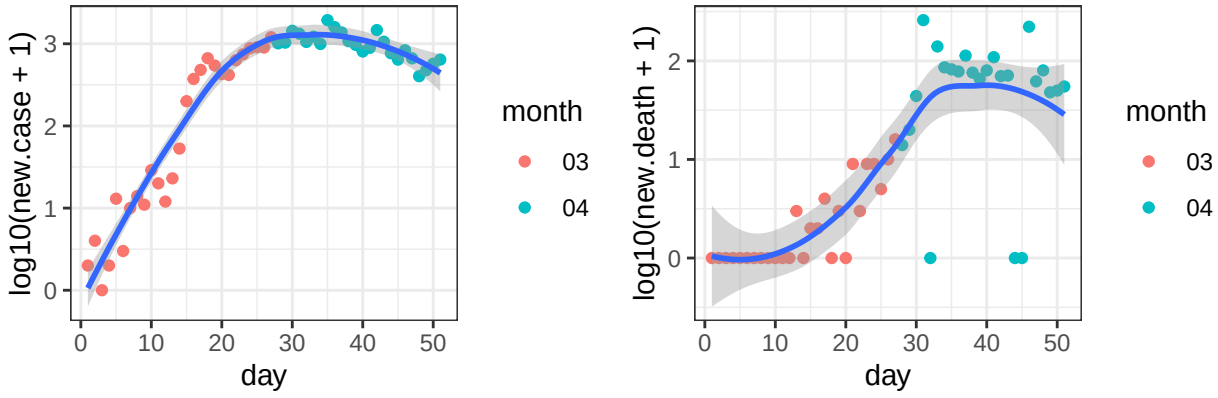
For these 20 counties, I check the number of new cases and the number of new deaths.

New York City_New York



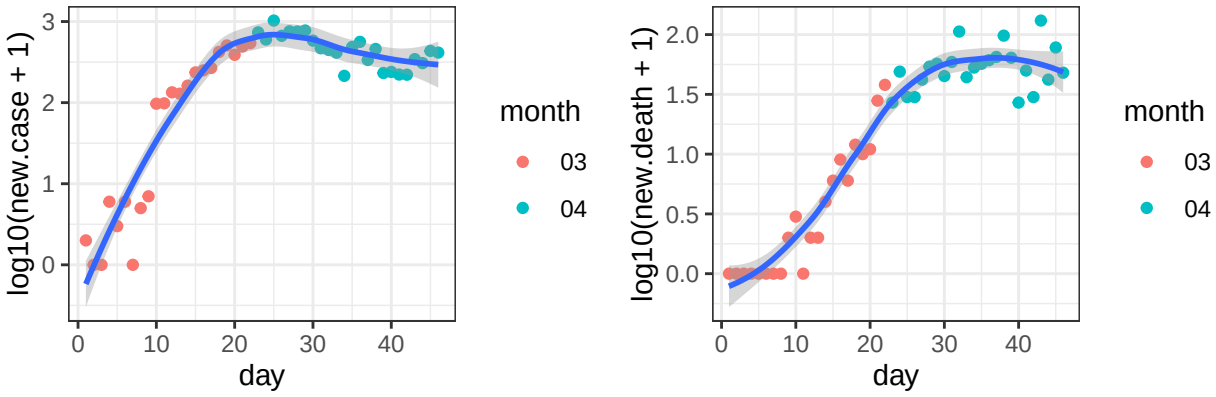
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−01

Nassau_New York



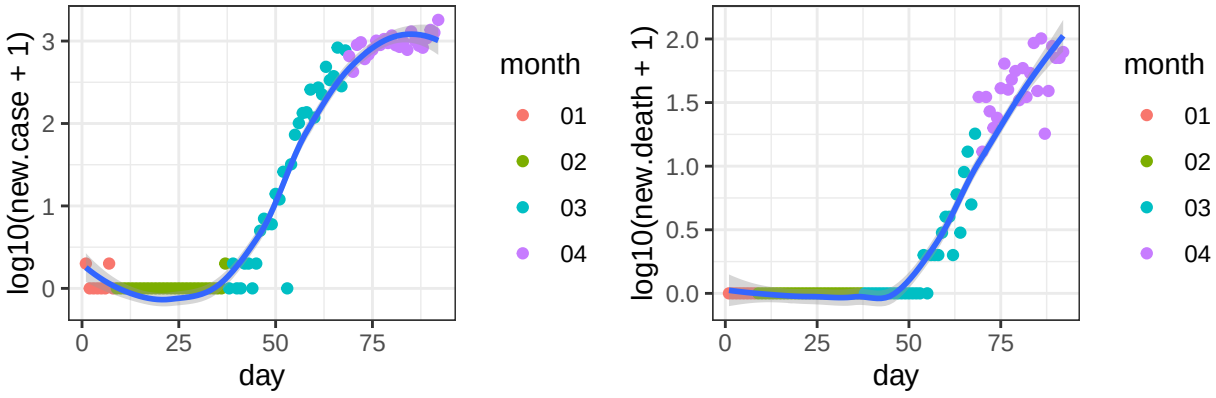
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−05

Wayne_Michigan



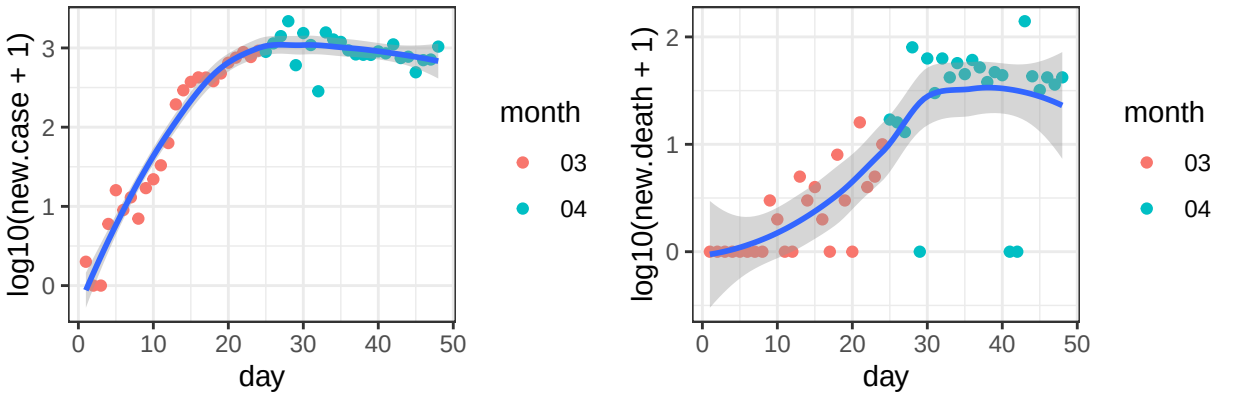
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−10

Cook_Illinois



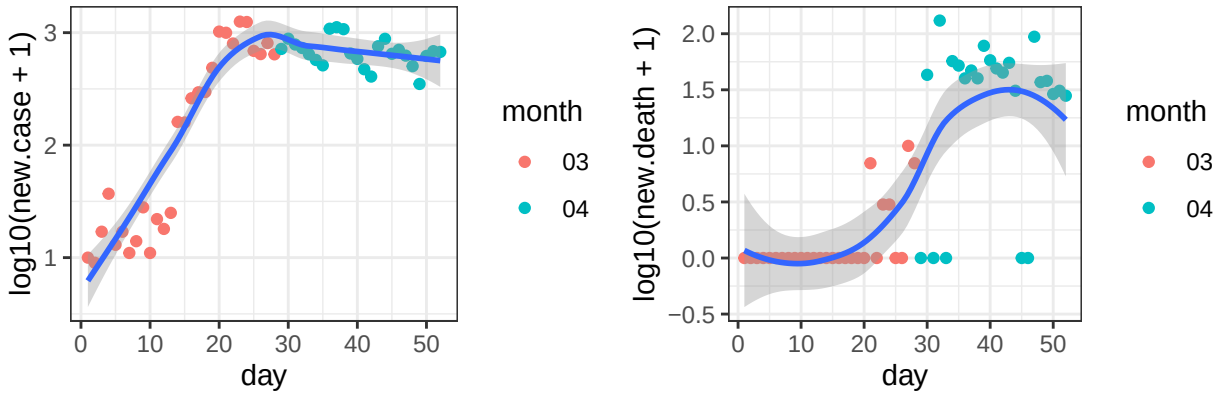
data source: https://github.com/nytimes/covid−19−data, day 1 is 01−24

Suffolk_New York



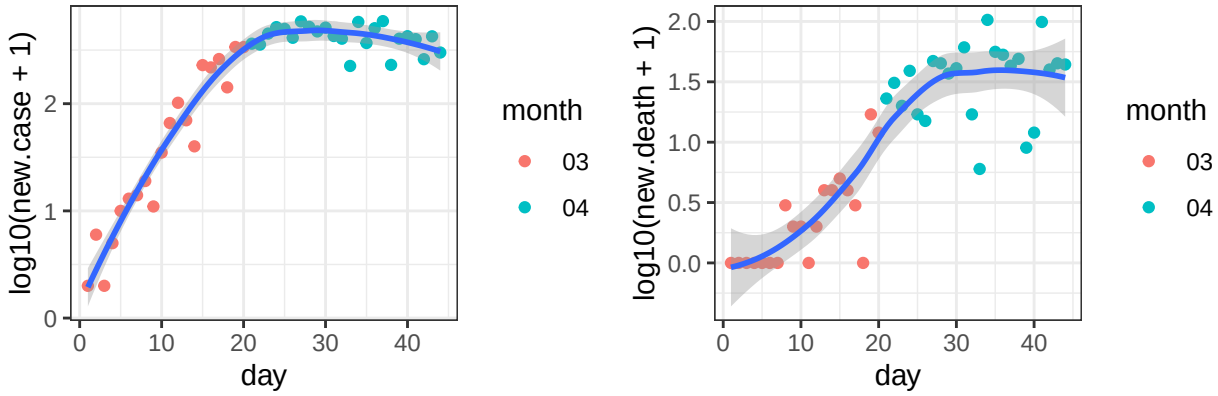
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−08

Westchester_New York



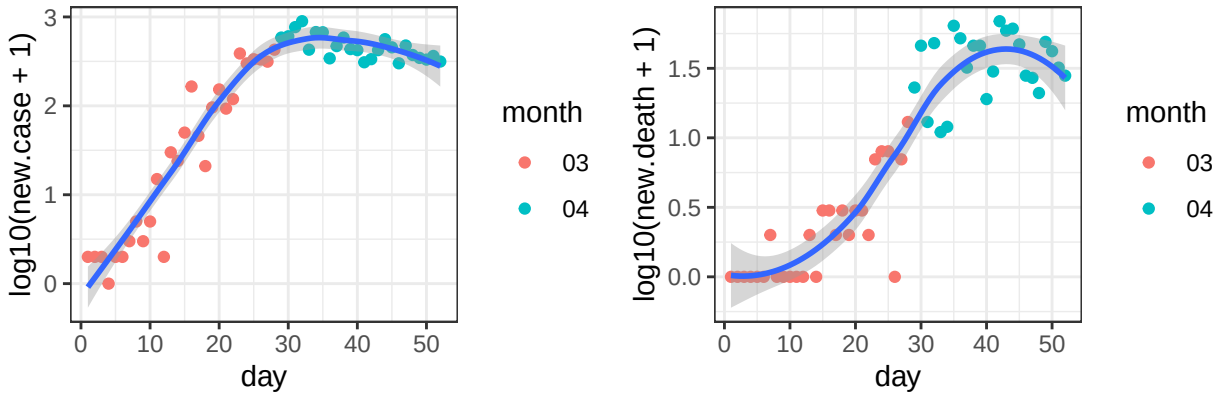
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−04

Essex_New Jersey



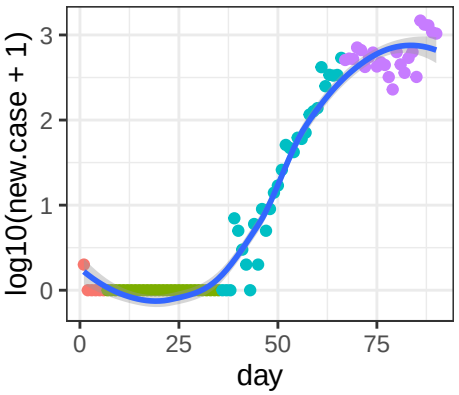
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−12

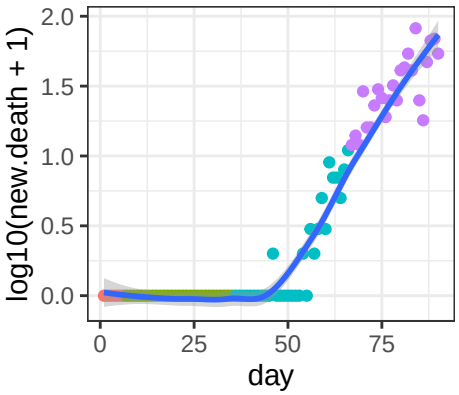
Bergen_New Jersey



data source: https://github.com/nytimes/covid−19−data, day 1 is 03−04

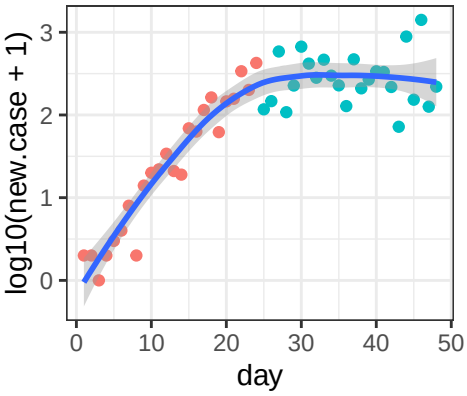
Los Angeles_California

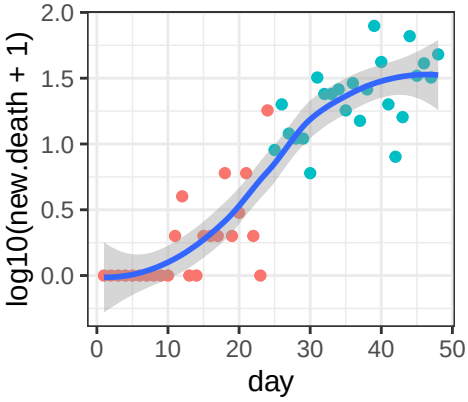




data source: https://github.com/nytimes/covid−19−data, day 1 is 01−26

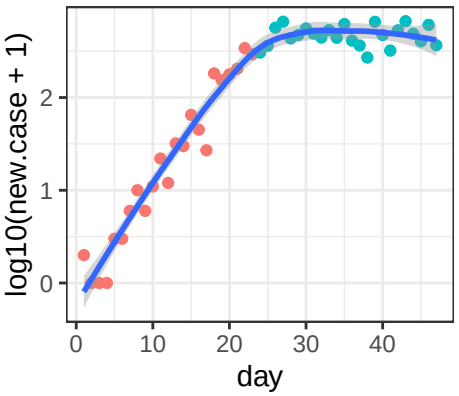
Fairfield_Connecticut

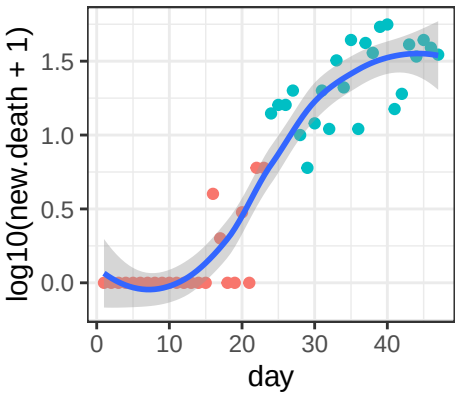




data source: https://github.com/nytimes/covid−19−data, day 1 is 03−08

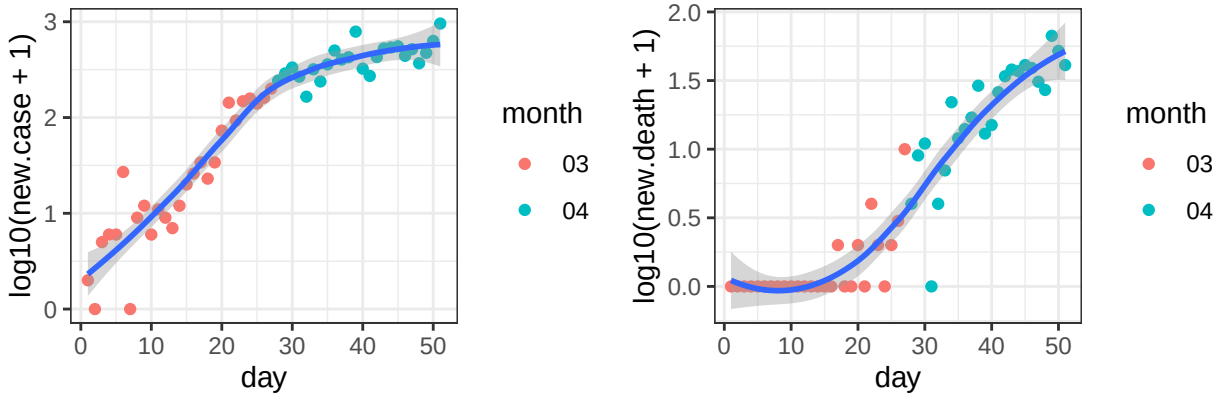
Hudson_New Jersey





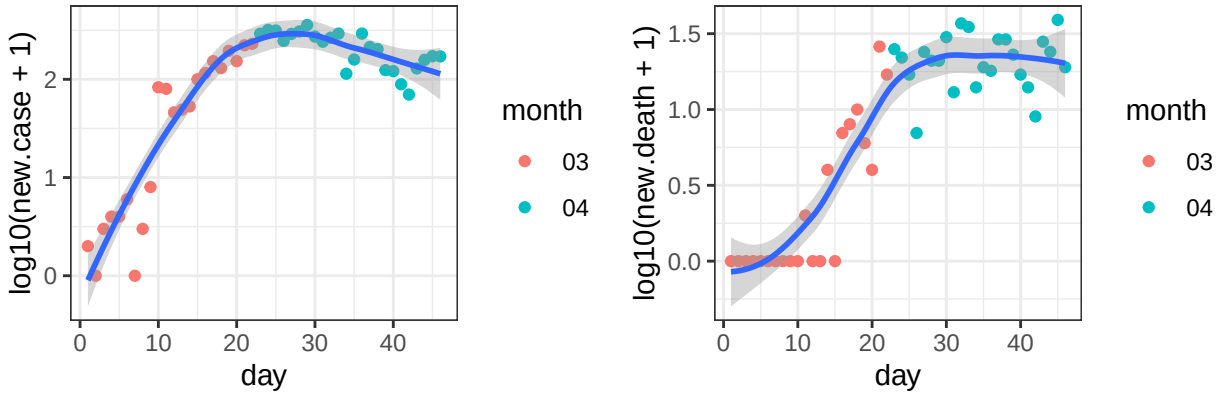
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−09

Middlesex_Massachusetts



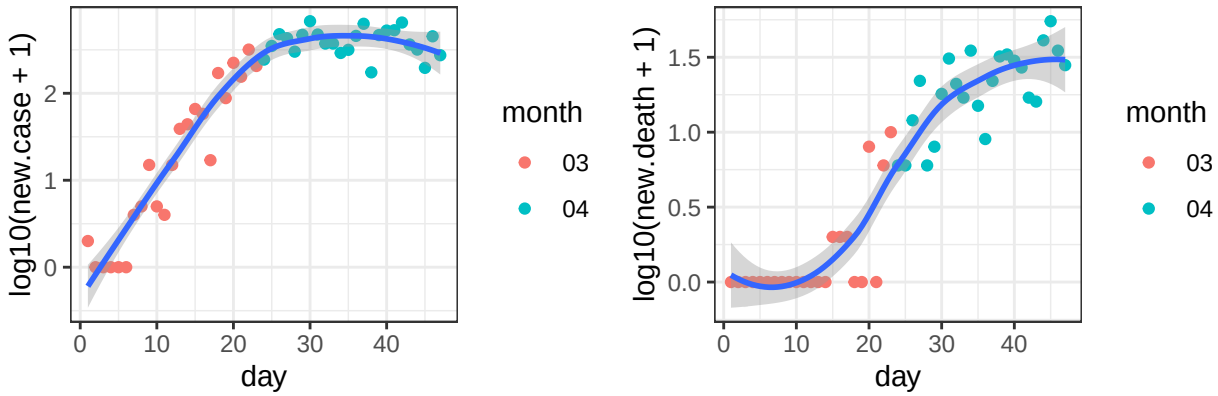
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−05

Oakland_Michigan



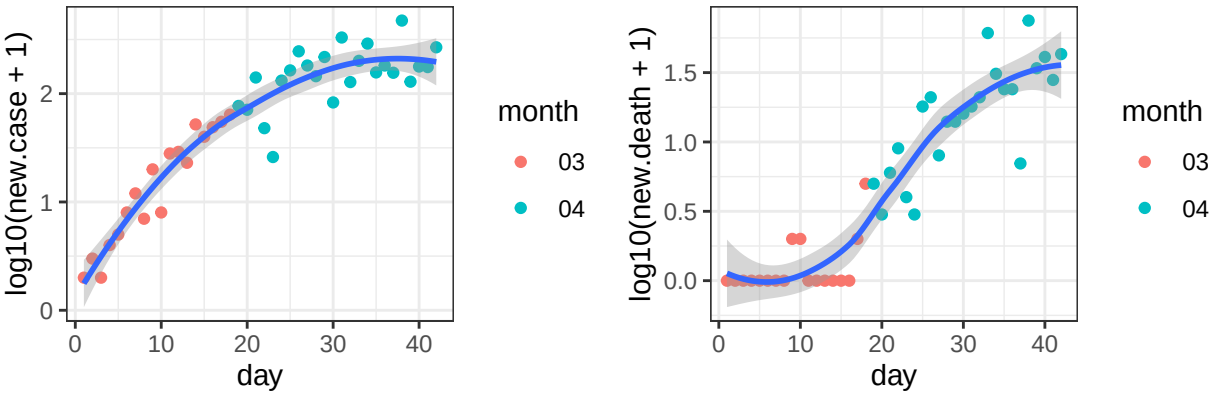
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−10

Union_New Jersey



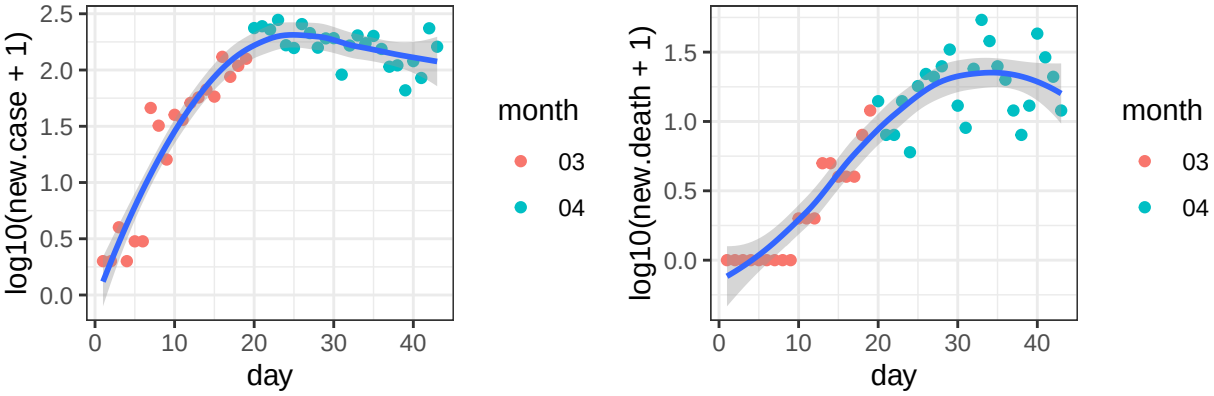
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−09

Hartford_Connecticut



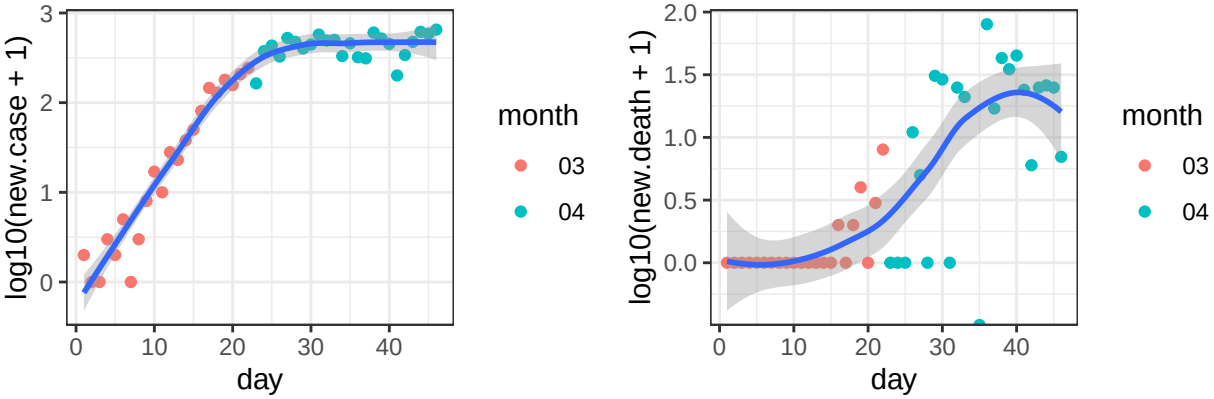
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−14

Macomb_Michigan



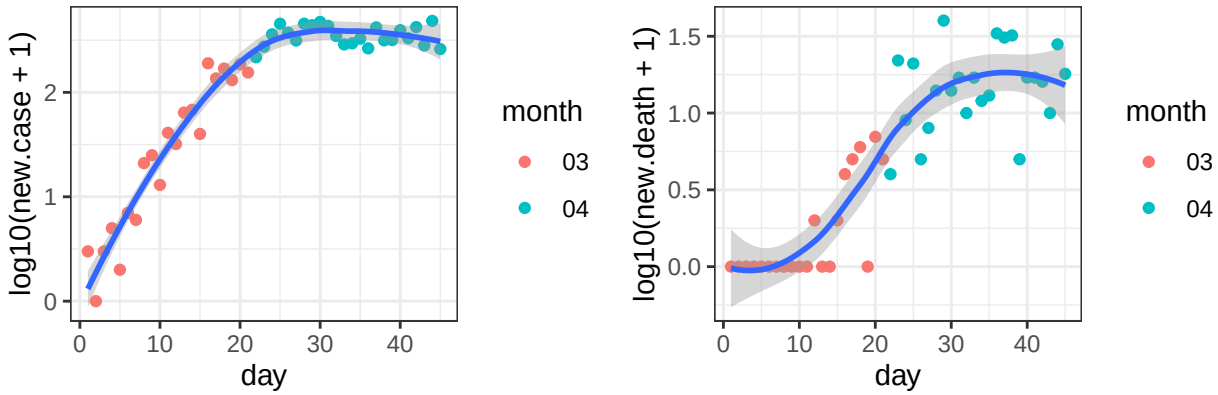
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−13

Philadelphia_Pennsylvania



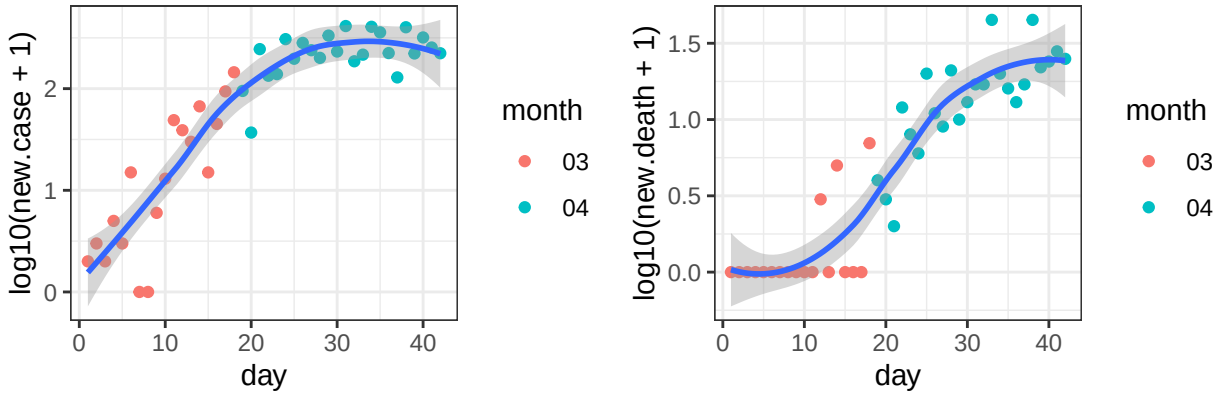
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−10

Middlesex_New Jersey



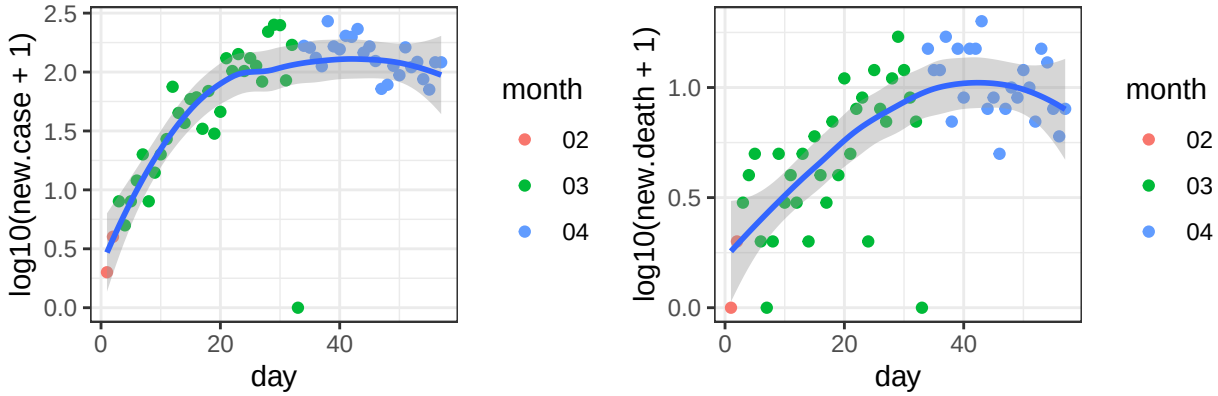
data source: https://github.com/nytimes/covid−19−data, day 1 is 03−11

New Haven_Connecticut



data source: https://github.com/nytimes/covid−19−data, day 1 is 03−14

King_Washington



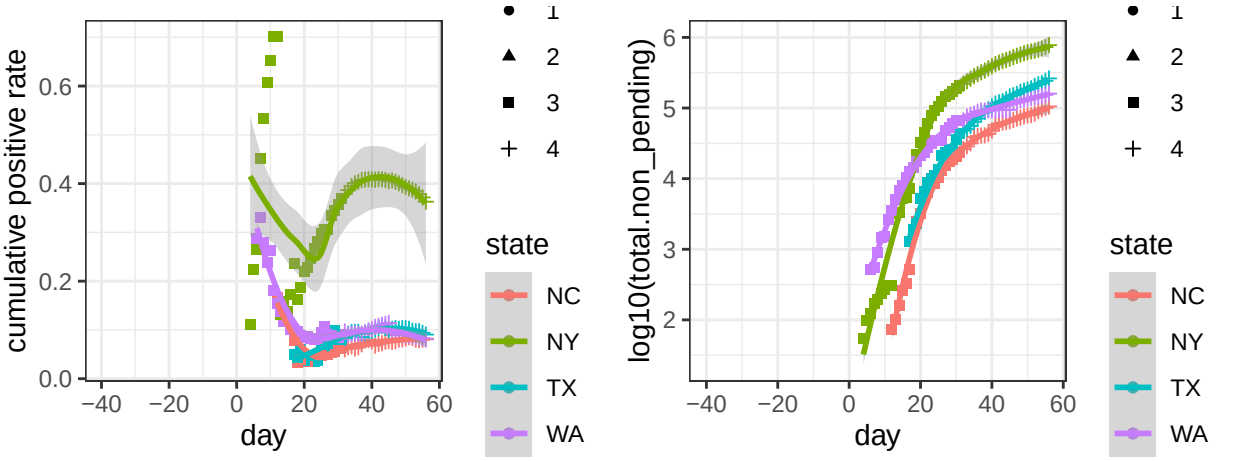
data source: https://github.com/nytimes/covid−19−data, day 1 is 02−28

COVID Trackng

The positive rates of testing can be an indicator on how much the COVID-19 has spread. However, they are more noisy data since the negative testing resutls are often not reported and the tests are almost surely taken on a non-representative random sample of the population. The COVID traking project proides a grade per state: “If you are calculating positive rates, it should only be with states that have an A grade. And be

careful going back in time because almost all the states have changed their level of reporting at different times." (https://covidtracking.com/about-tracker/). The data are also availalbe for both counties and states, here I only look at state level data.

Since the daily postive rate can fluctuate a lot, here I only illustrae the cumulative positave rate across time, for four states with grade A data. Of course since this is an R markdown file, you can modify the source code and check for other states.



github.com/COVID19Tracking/, cumulative positive rate on 0425: 0.08(WA) 0.09(TX) 0.36(NY) 0.08(NC)

Session information

```
sessionInfo()
```

```
## R version 3.6.2 (2019-12-12)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS Catalina 10.15.4
##
## Matrix products: default
## BLAS:   /Library/Frameworks/R.framework/Versions/3.6/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/3.6/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] httr_1.4.1    ggpubr_0.2.5  magrittr_1.5  ggplot2_3.2.1
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.3       pillar_1.4.3     compiler_3.6.2   tools_3.6.2
##  [5] digest_0.6.23    evaluate_0.14    lifecycle_0.1.0  tibble_2.1.3
##  [9] gtable_0.3.0     pkgconfig_2.0.3  rlang_0.4.4      yaml_2.2.1
## [13] xfun_0.12        gridExtra_2.3    withr_2.1.2      dplyr_0.8.4
## [17] stringr_1.4.0    knitr_1.28       grid_3.6.2       tidyselect_1.0.0
## [21] cowplot_1.0.0    glue_1.3.1       R6_2.4.1         rmarkdown_2.1
## [25] purrr_0.3.3      farver_2.0.3     scales_1.1.0     htmltools_0.4.0
```

```
## [29] assertthat_0.2.1 colorspace_1.4-1 ggsignif_0.6.0   labeling_0.3
## [33] stringi_1.4.5    lazyeval_0.2.2   munsell_0.5.0    crayon_1.3.4
```