

Exploration of COVID-19 tracking data from multiple resources

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2020-06-11

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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 Tracking (<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>

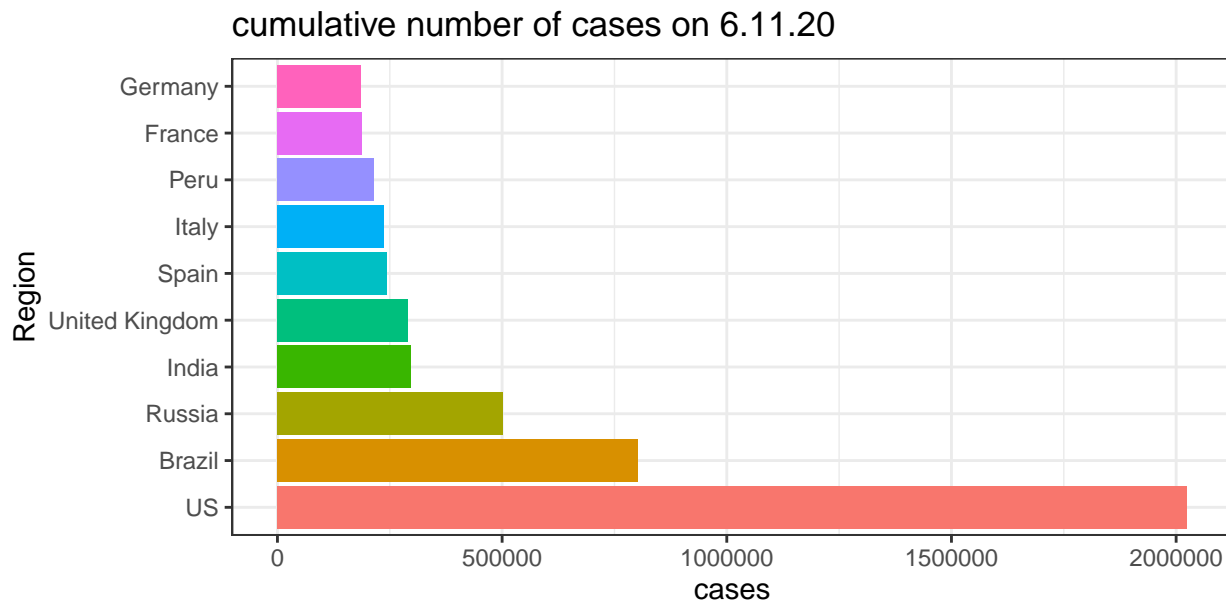
JHU

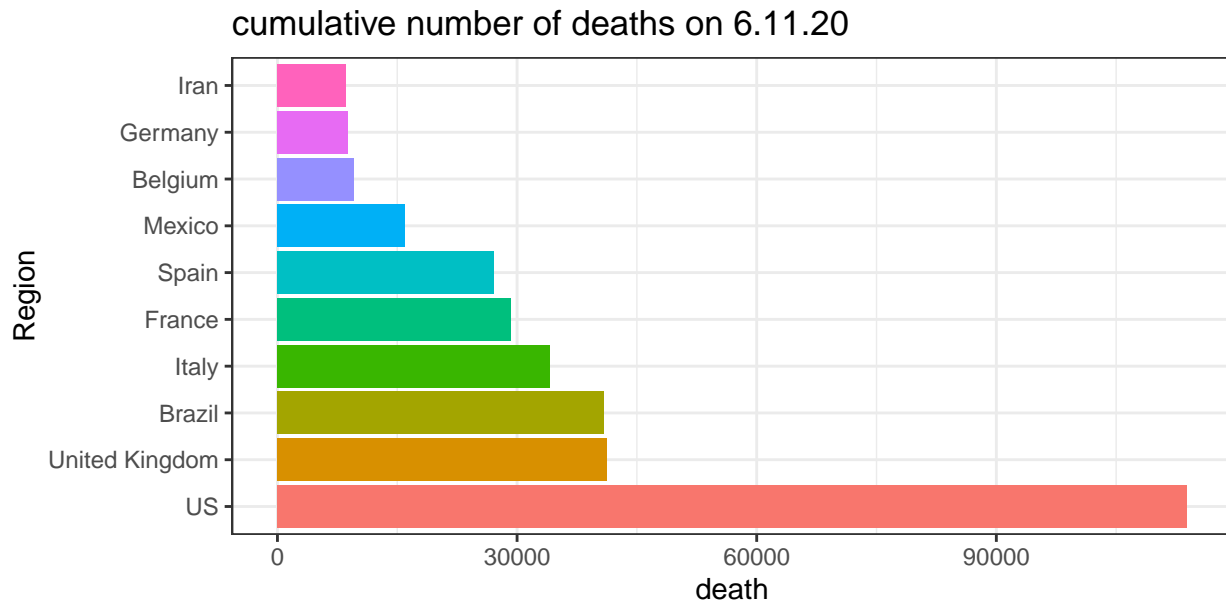
Assume you have cloned the JHU Github repository on your local machine at “../COVID-19”.

time series data

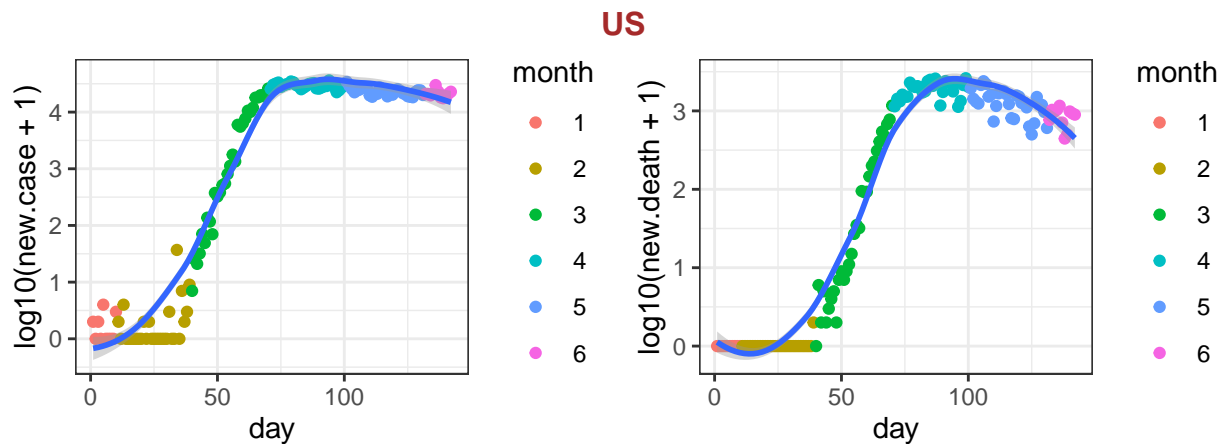
The time series provide counts (e.g., confirmed cases, deaths) starting from Jan 22nd, 2020 for 253 locations. Currently there is no data of individual US state in these time series data files.

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

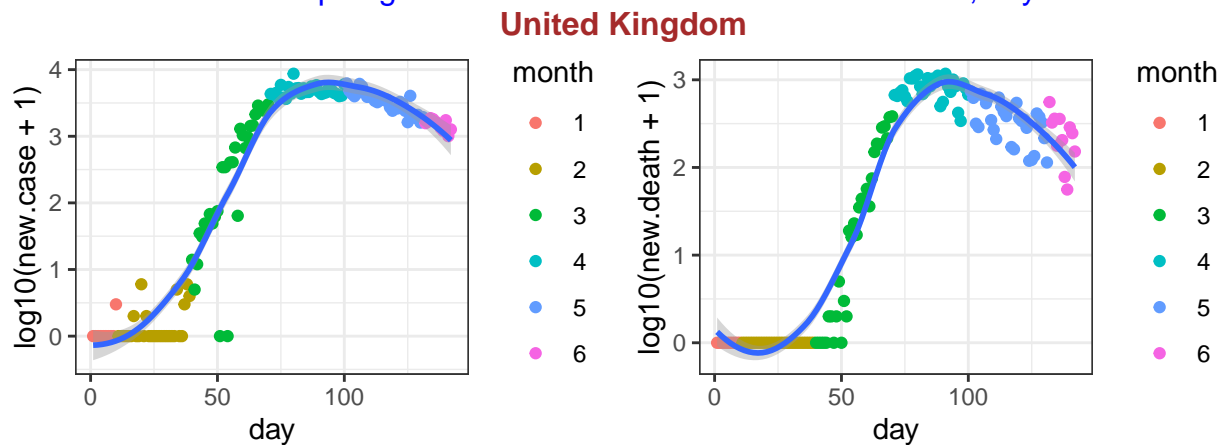




Next, I check for each country/region, what is the number of new cases/deaths? This data is important to understand what is the trend under different situations, e.g., population density, social distance policies etc. Here I checked the top 10 countries/regions with the highest number of deaths.

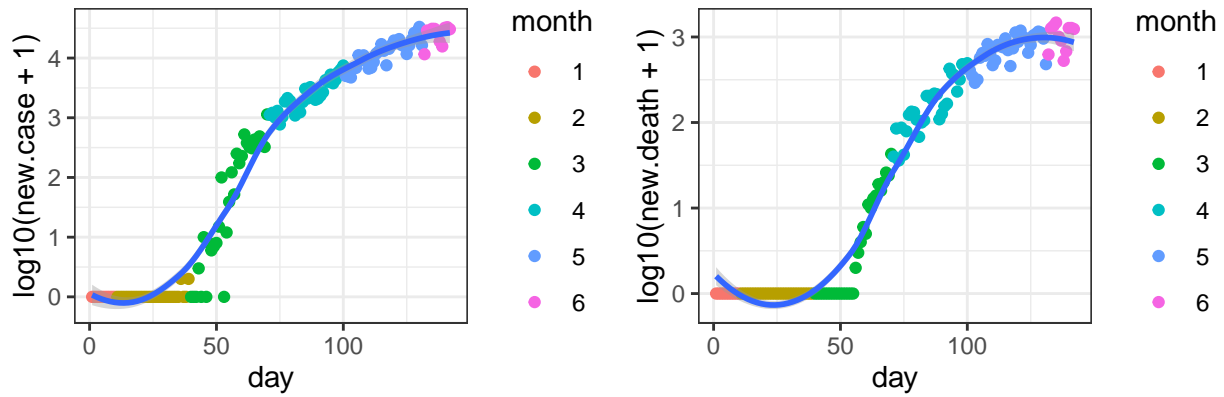


data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020



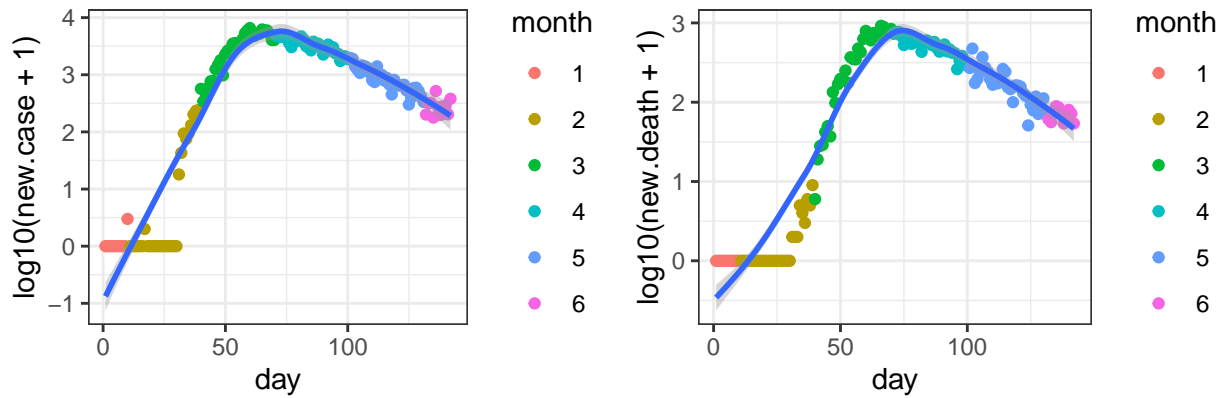
data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020

Brazil



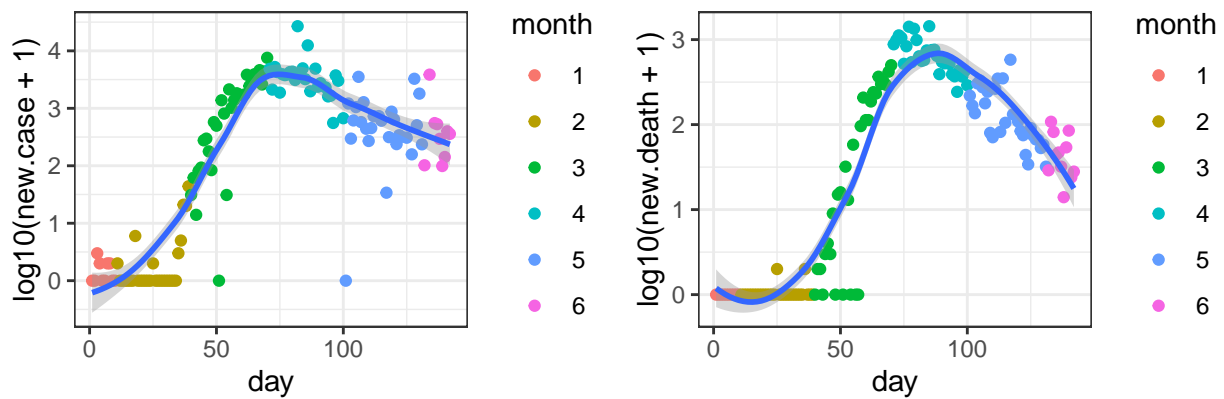
data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020

Italy

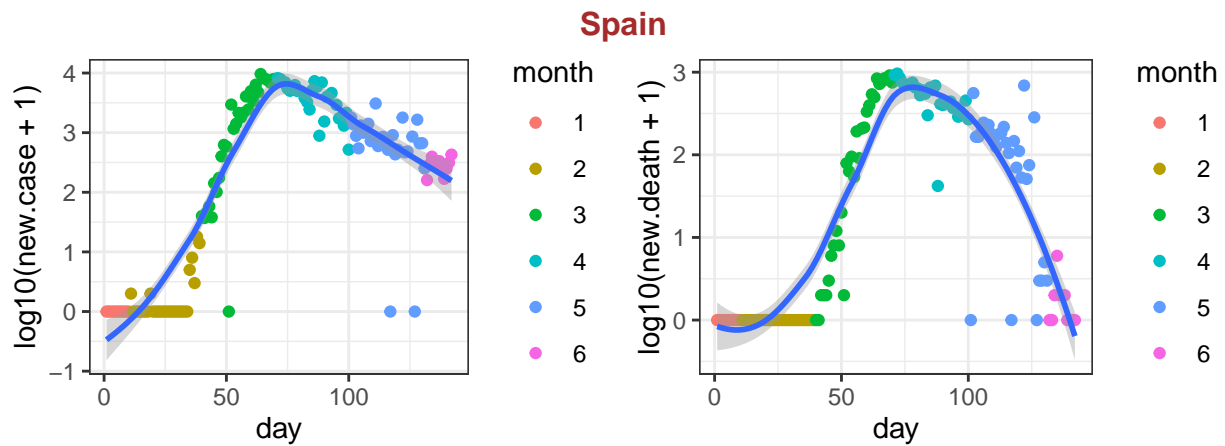


data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020

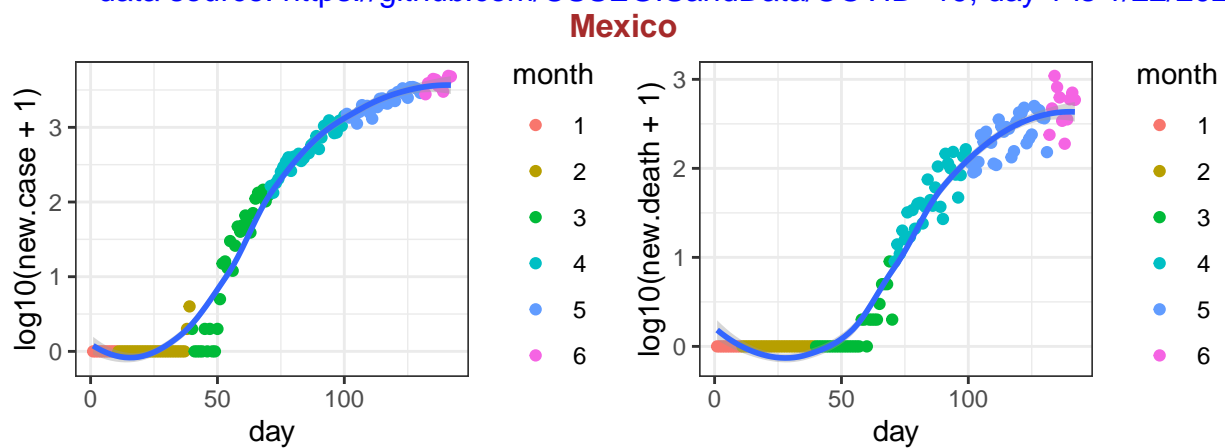
France



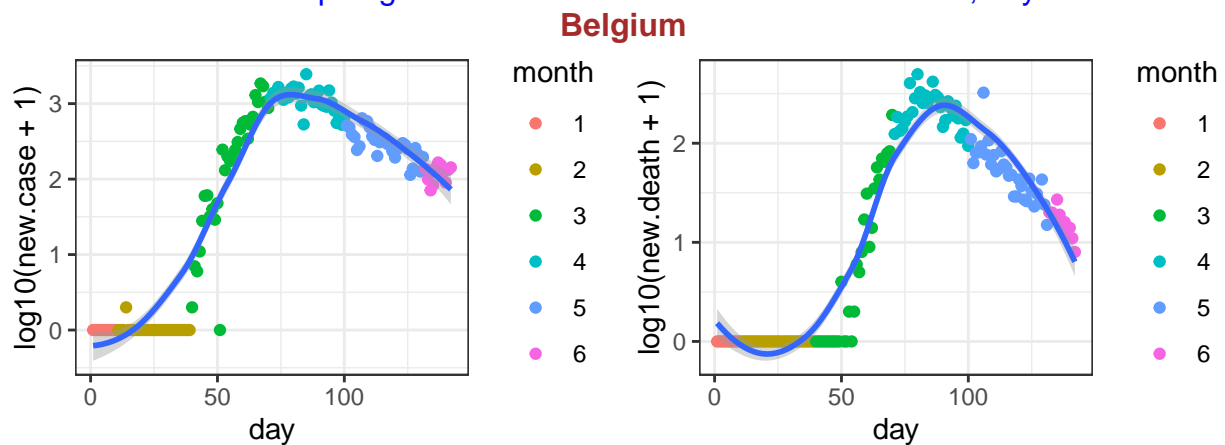
data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020



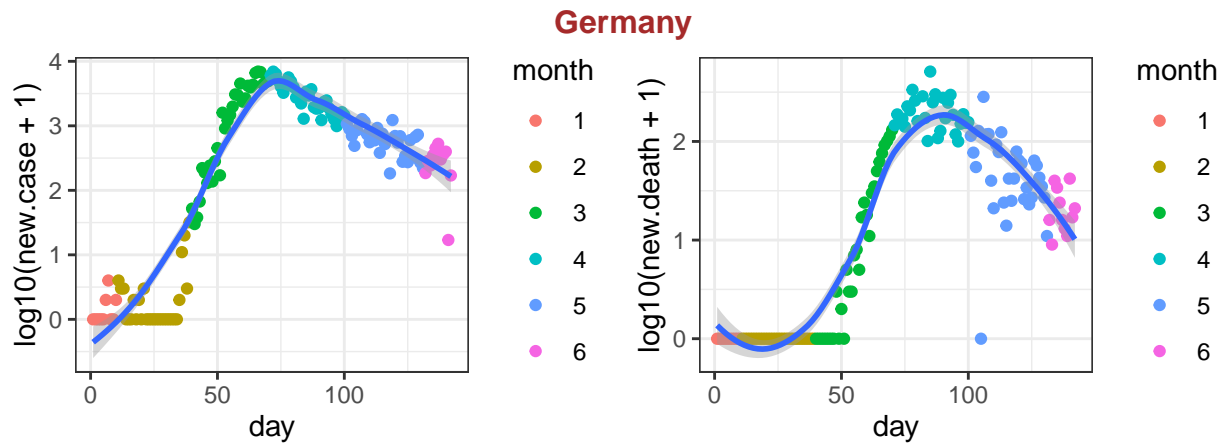
data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020



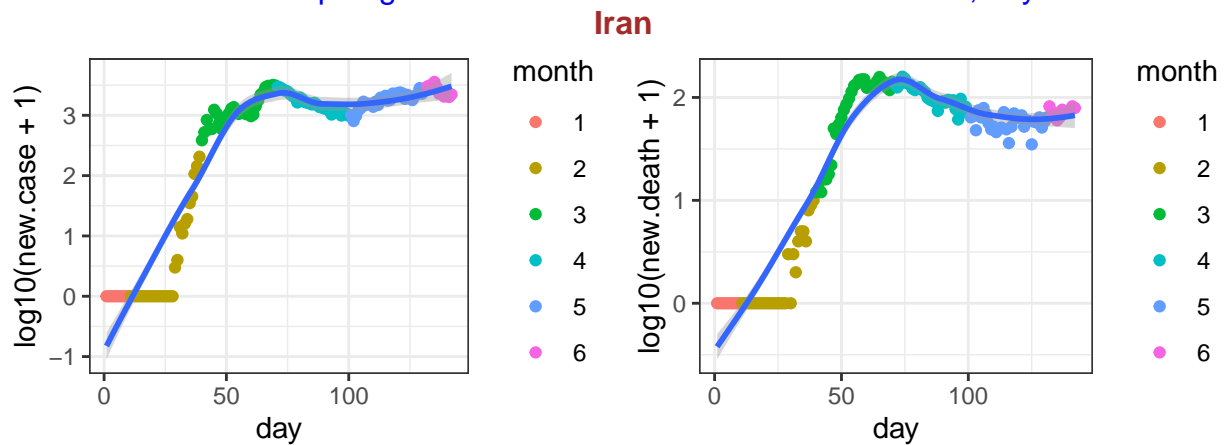
data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020



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



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

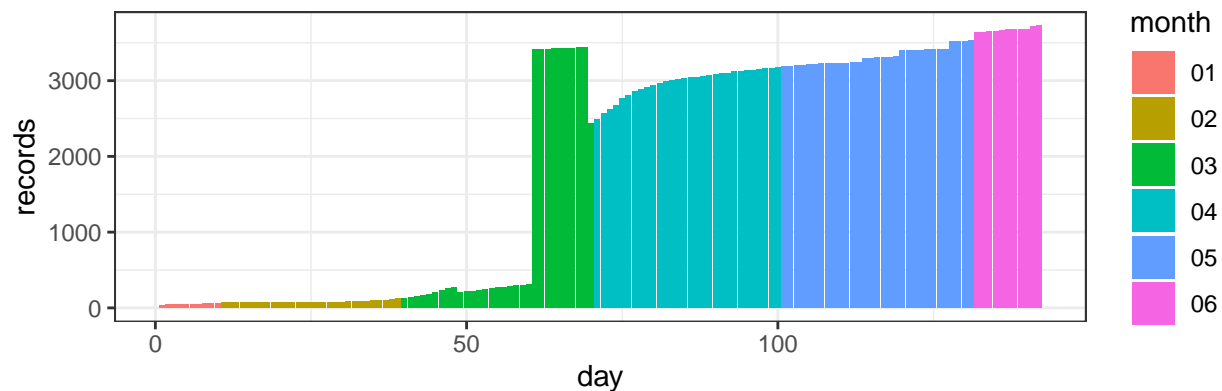


data source: <https://github.com/CSSEGISandData/COVID-19>, day 1 is 1/22/2020

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) include 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.

number of records in Hopkins daily reports



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 current date is

```
## [1] "2020-06-10"
```

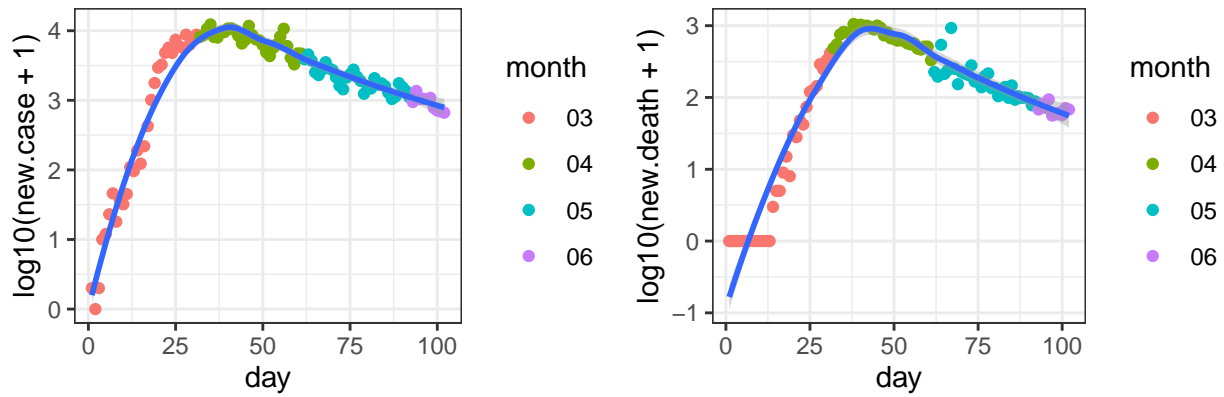
state level data

First check the 30 states with the largest number of deaths.

| ## | date | state | fips | cases | deaths |
|---------|------------|----------------------|------|--------|--------|
| ## 5493 | 2020-06-10 | New York | 36 | 384945 | 30376 |
| ## 5491 | 2020-06-10 | New Jersey | 34 | 165346 | 12377 |
| ## 5482 | 2020-06-10 | Massachusetts | 25 | 104156 | 7454 |
| ## 5474 | 2020-06-10 | Illinois | 17 | 130889 | 6302 |
| ## 5500 | 2020-06-10 | Pennsylvania | 42 | 81410 | 6143 |
| ## 5483 | 2020-06-10 | Michigan | 26 | 65377 | 5958 |
| ## 5464 | 2020-06-10 | California | 6 | 140123 | 4869 |
| ## 5466 | 2020-06-10 | Connecticut | 9 | 44347 | 4120 |
| ## 5479 | 2020-06-10 | Louisiana | 22 | 44143 | 2968 |
| ## 5481 | 2020-06-10 | Maryland | 24 | 60114 | 2844 |
| ## 5469 | 2020-06-10 | Florida | 12 | 67363 | 2800 |
| ## 5497 | 2020-06-10 | Ohio | 39 | 39575 | 2457 |
| ## 5475 | 2020-06-10 | Indiana | 18 | 39297 | 2355 |
| ## 5470 | 2020-06-10 | Georgia | 13 | 51465 | 2292 |
| ## 5506 | 2020-06-10 | Texas | 48 | 81771 | 1916 |
| ## 5465 | 2020-06-10 | Colorado | 8 | 28484 | 1573 |
| ## 5510 | 2020-06-10 | Virginia | 51 | 52177 | 1514 |
| ## 5484 | 2020-06-10 | Minnesota | 27 | 28900 | 1267 |
| ## 5511 | 2020-06-10 | Washington | 53 | 25940 | 1183 |
| ## 5462 | 2020-06-10 | Arizona | 4 | 29981 | 1100 |
| ## 5494 | 2020-06-10 | North Carolina | 37 | 38305 | 1096 |
| ## 5485 | 2020-06-10 | Mississippi | 28 | 18483 | 868 |
| ## 5486 | 2020-06-10 | Missouri | 29 | 15662 | 861 |
| ## 5502 | 2020-06-10 | Rhode Island | 44 | 15756 | 812 |
| ## 5460 | 2020-06-10 | Alabama | 1 | 21989 | 744 |
| ## 5513 | 2020-06-10 | Wisconsin | 55 | 21772 | 673 |
| ## 5476 | 2020-06-10 | Iowa | 19 | 22733 | 638 |
| ## 5503 | 2020-06-10 | South Carolina | 45 | 15759 | 575 |
| ## 5468 | 2020-06-10 | District of Columbia | 11 | 9537 | 499 |
| ## 5478 | 2020-06-10 | Kentucky | 21 | 12029 | 498 |

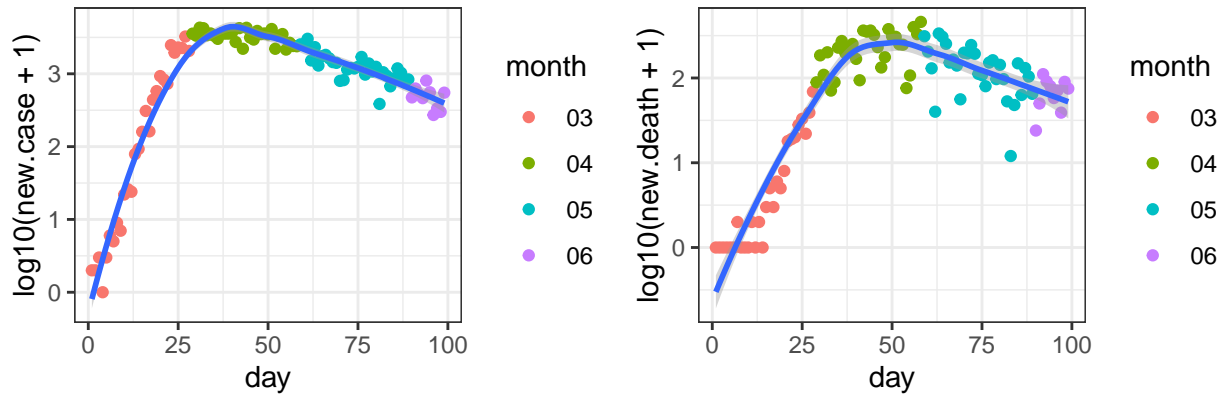
For these 20 states, I check the number of new cases and the number of new deaths. Part of the reason for such checking is to identify whether there is any similarity on such patterns. For example, could you use the pattern seen from Italy to predict what happen in an individual state, and what are the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

New York



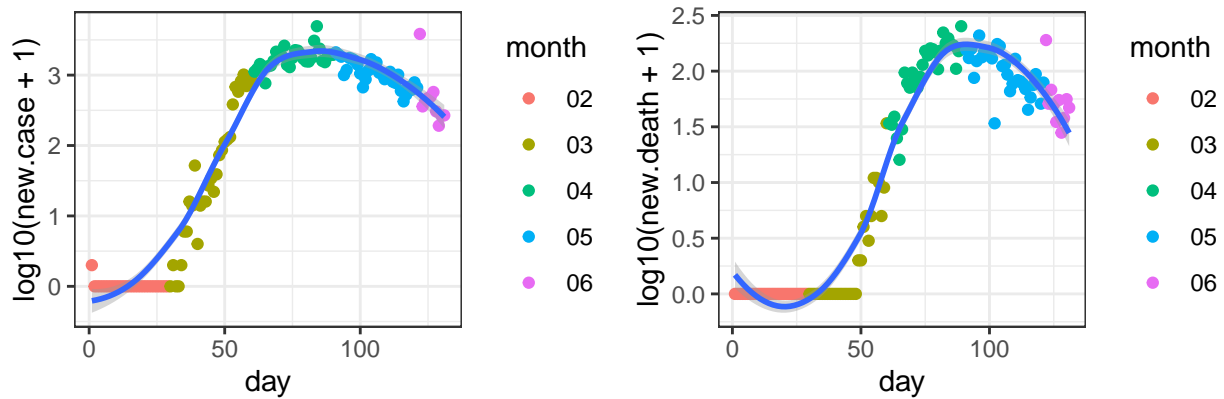
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-01

New Jersey

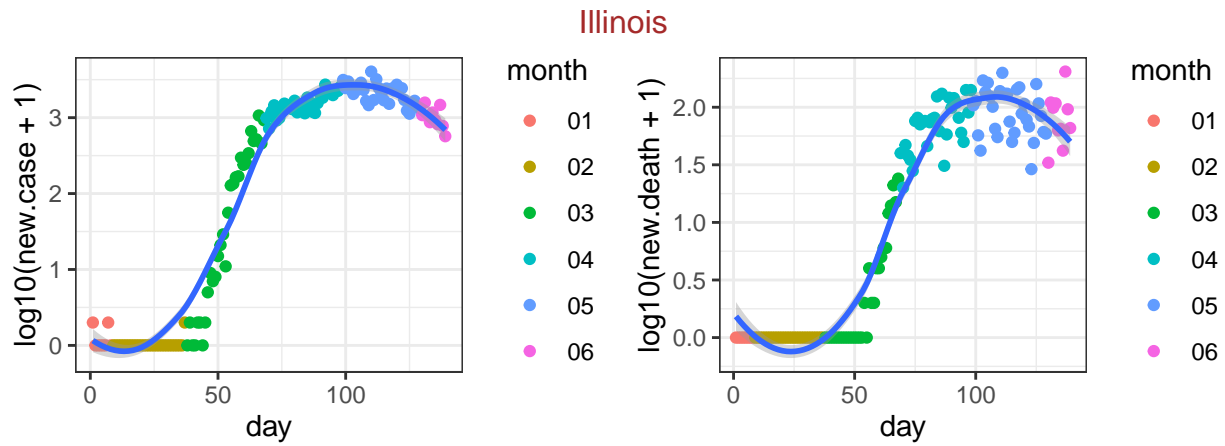


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-04

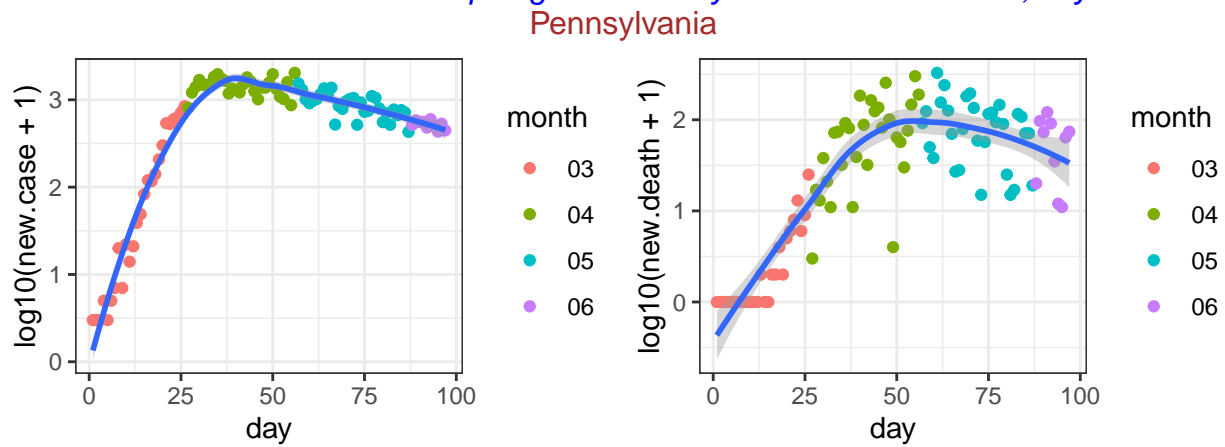
Massachusetts



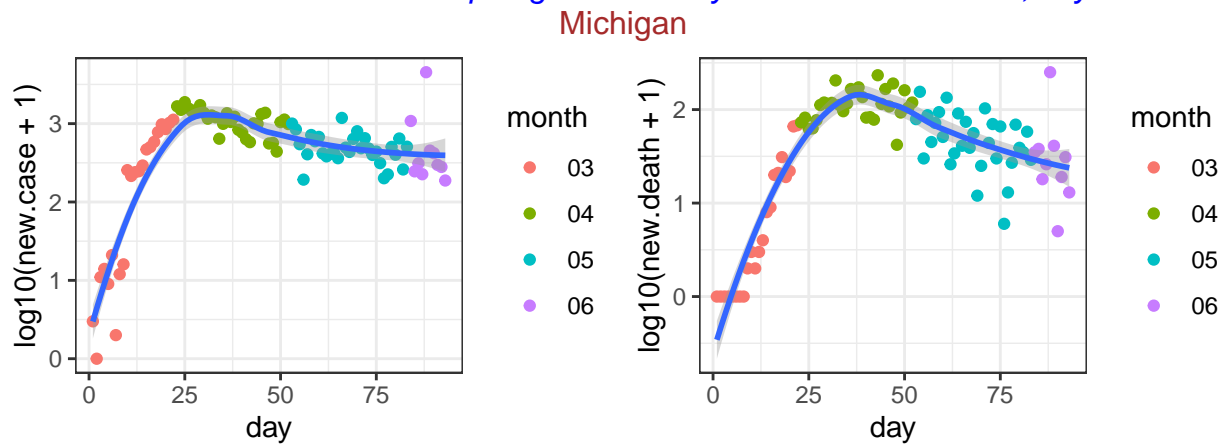
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 02-01



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

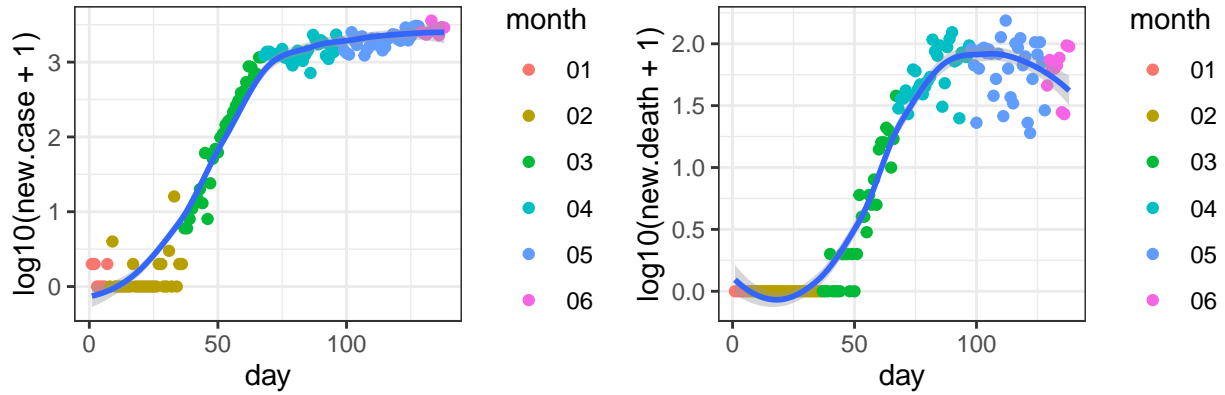


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-06



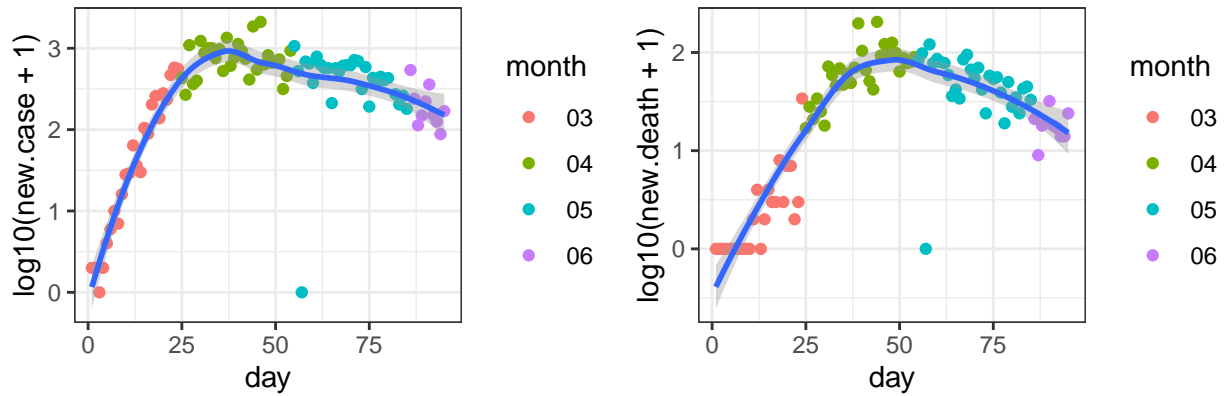
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-10

California



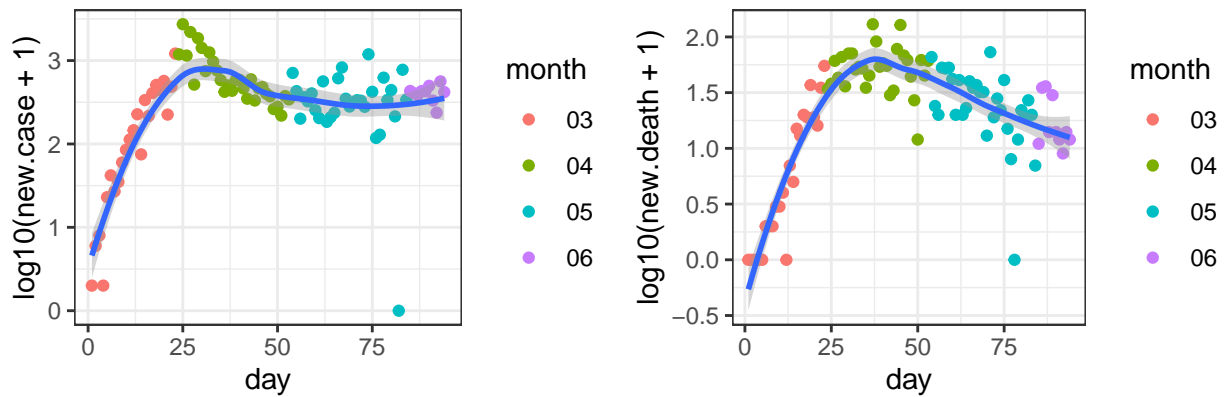
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 01-25

Connecticut



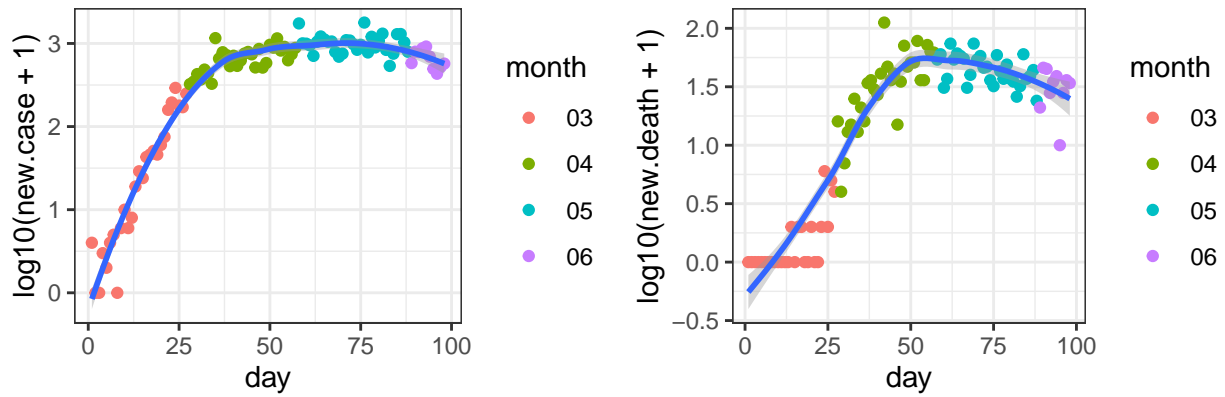
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-08

Louisiana



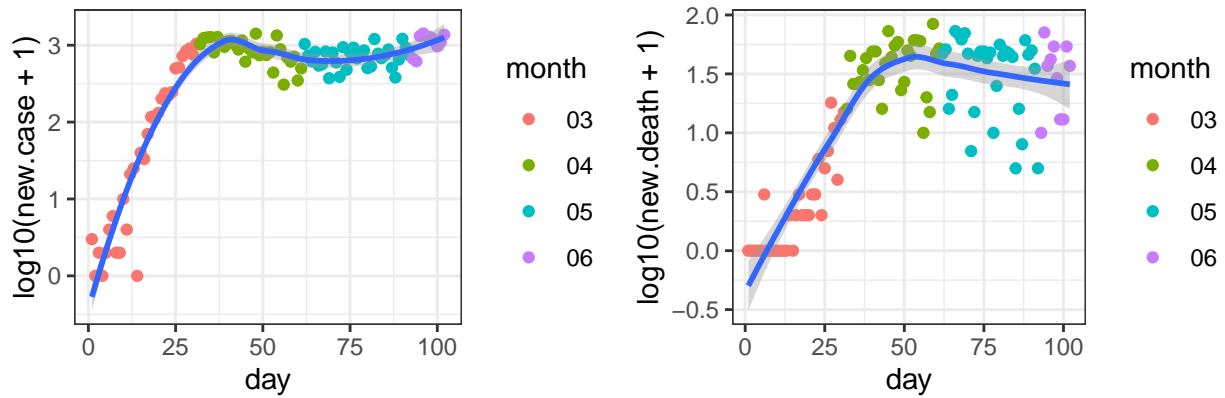
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09

Maryland



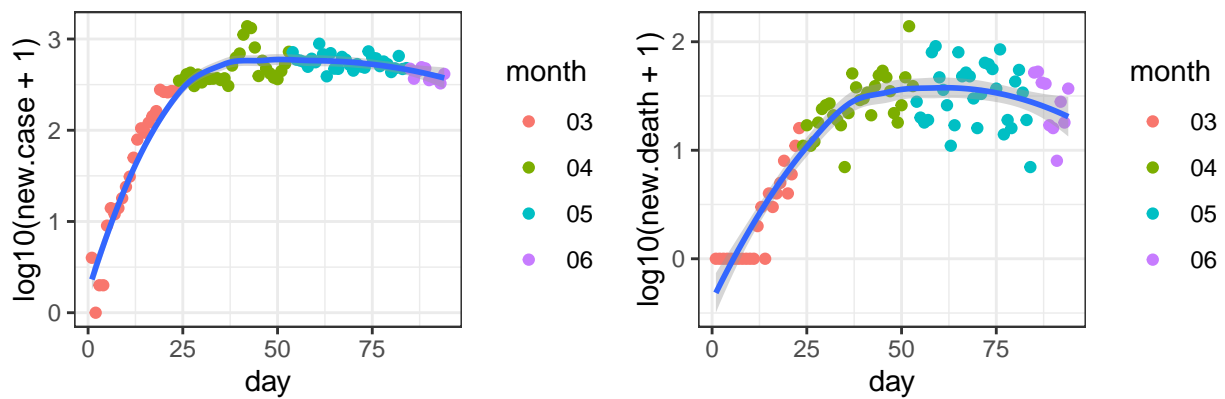
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-05

Florida

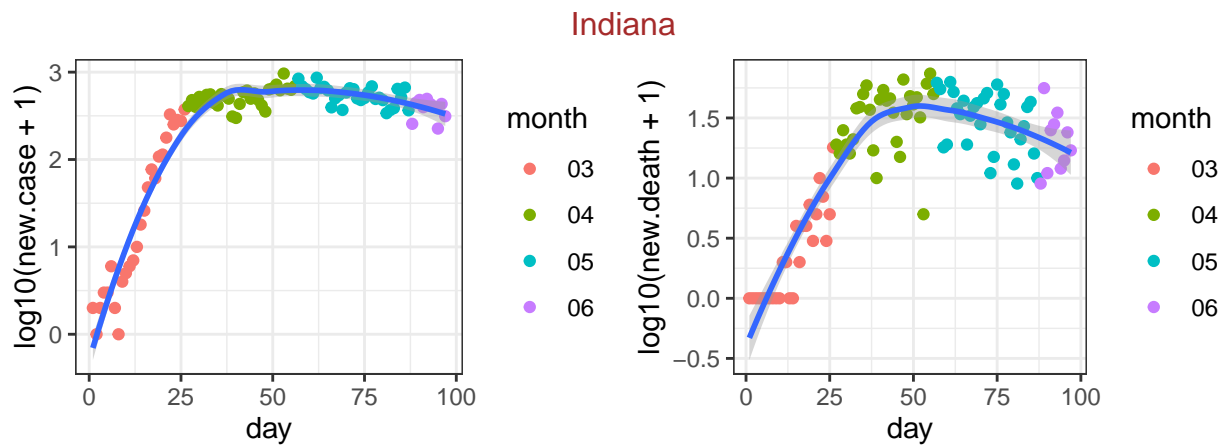


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-01

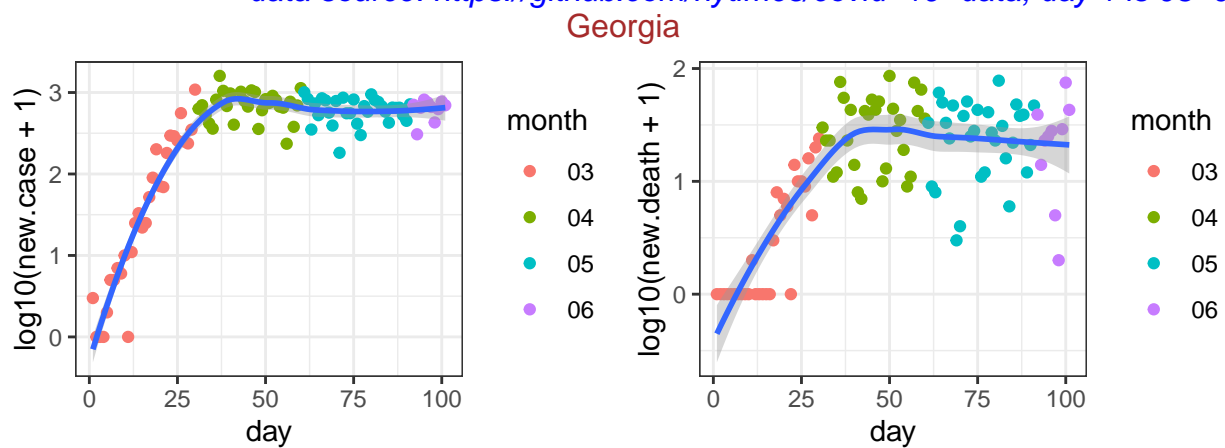
Ohio



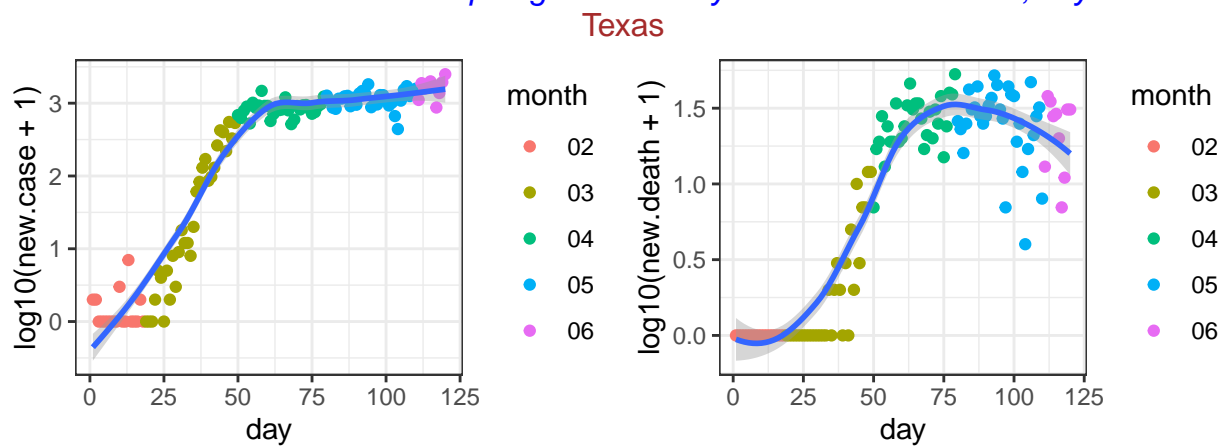
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09



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

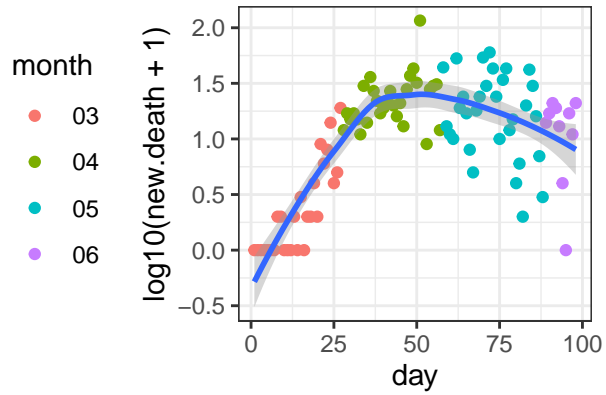
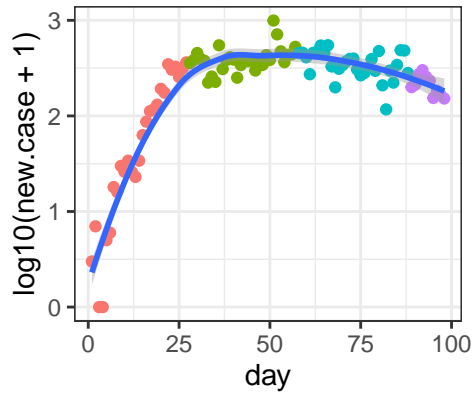


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-02



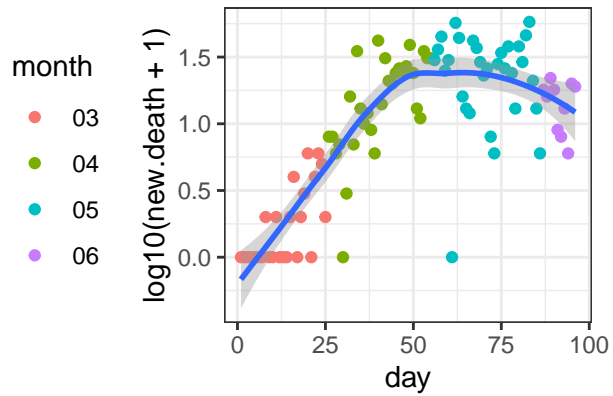
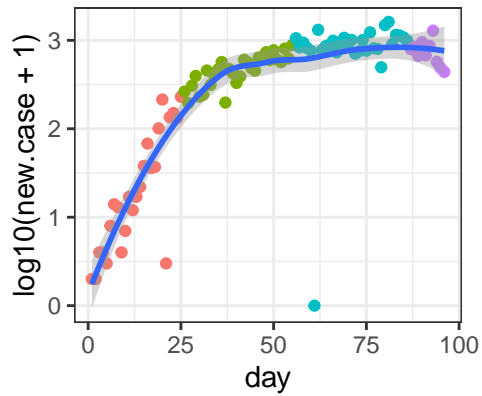
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 02-12

Colorado



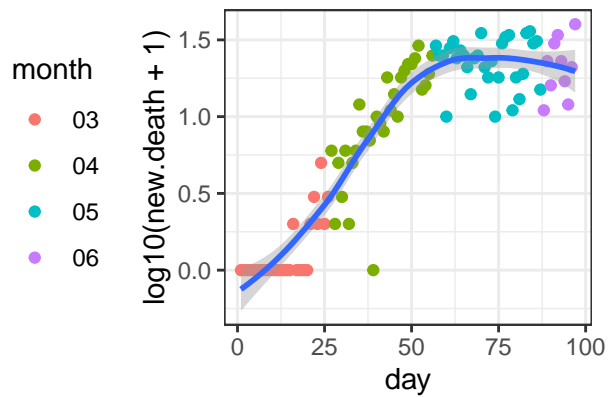
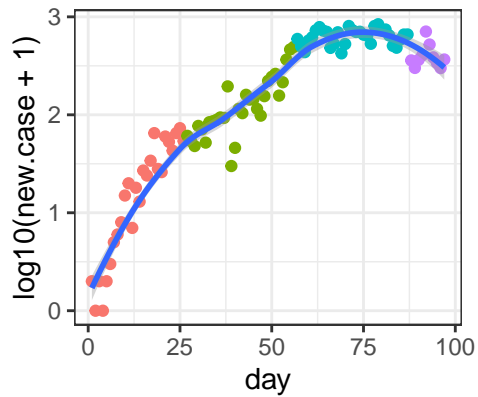
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-05

Virginia

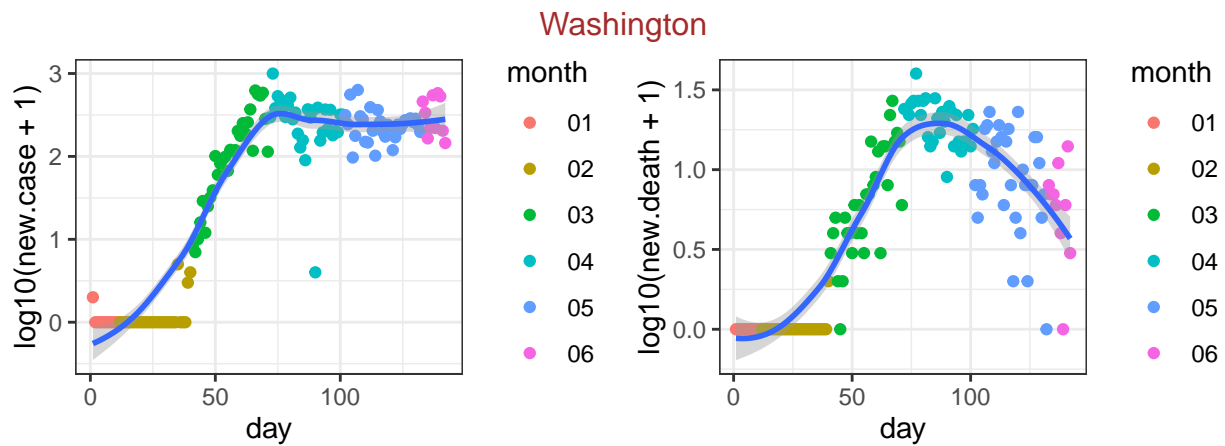


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

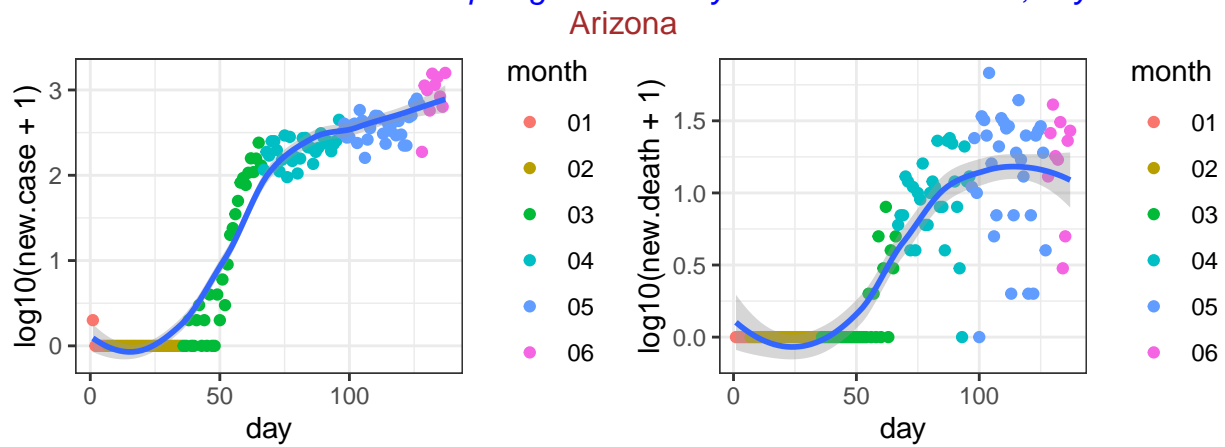
Minnesota



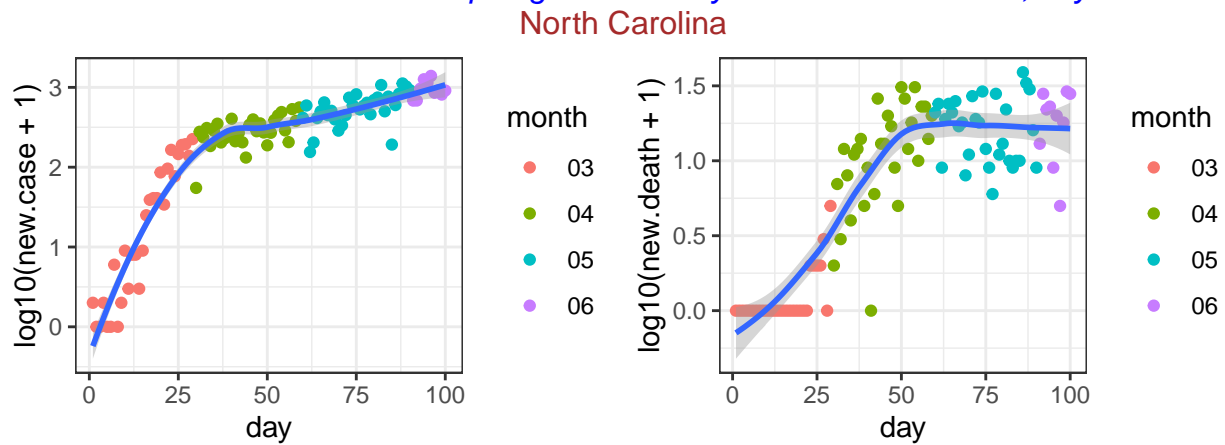
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-06



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

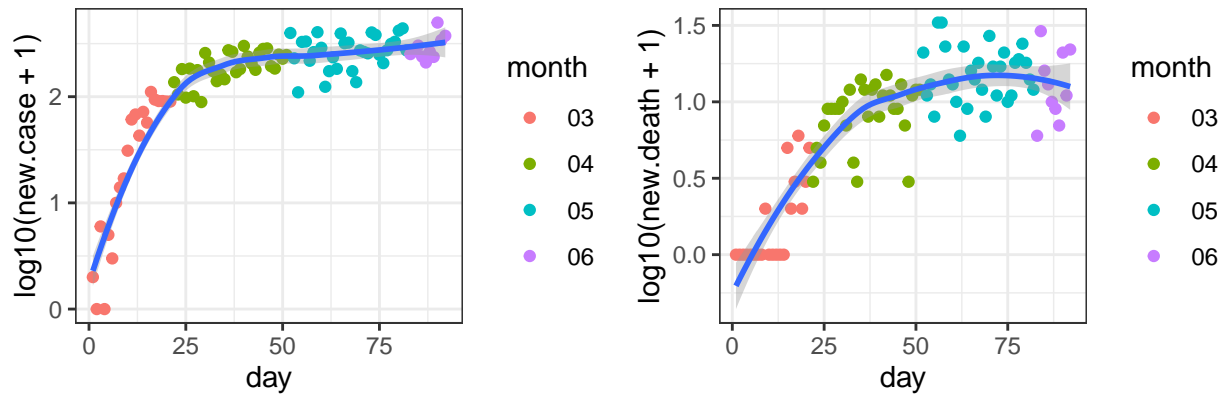


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 01-26



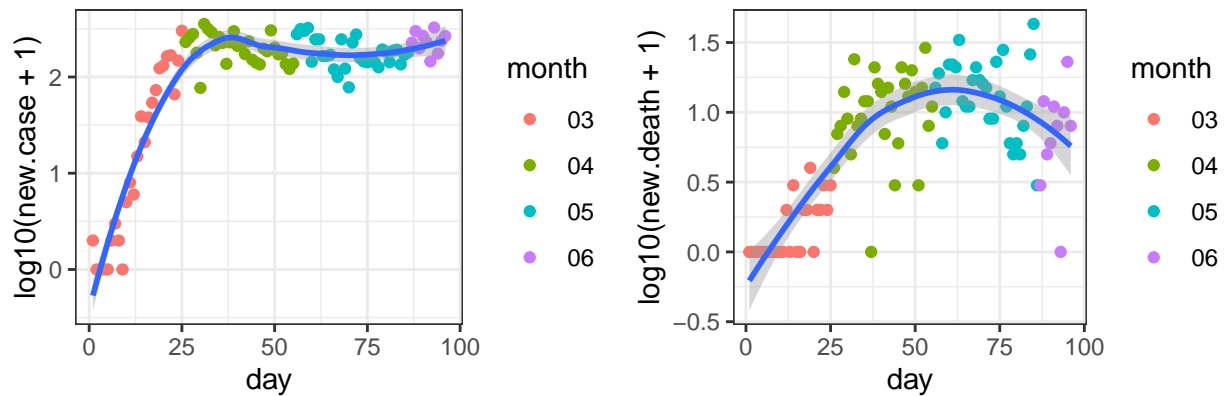
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-03

Mississippi



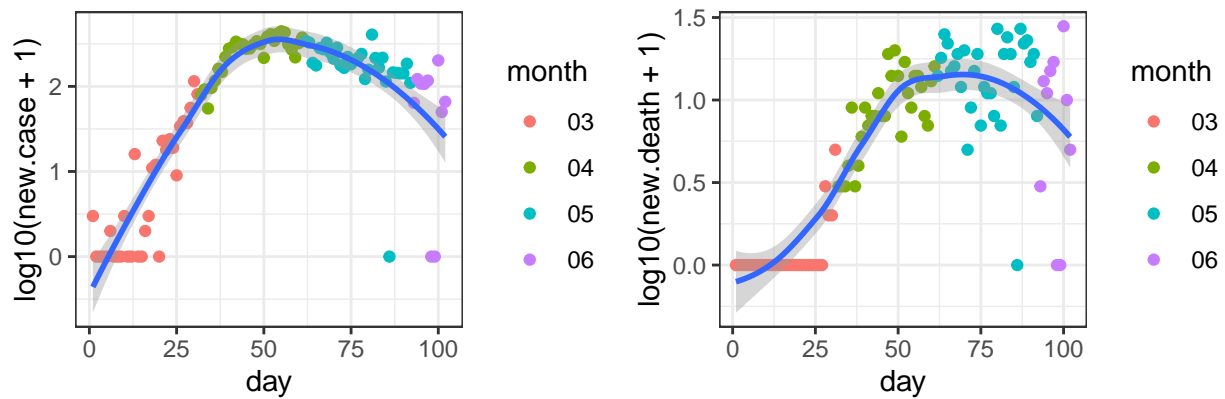
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-11

Missouri



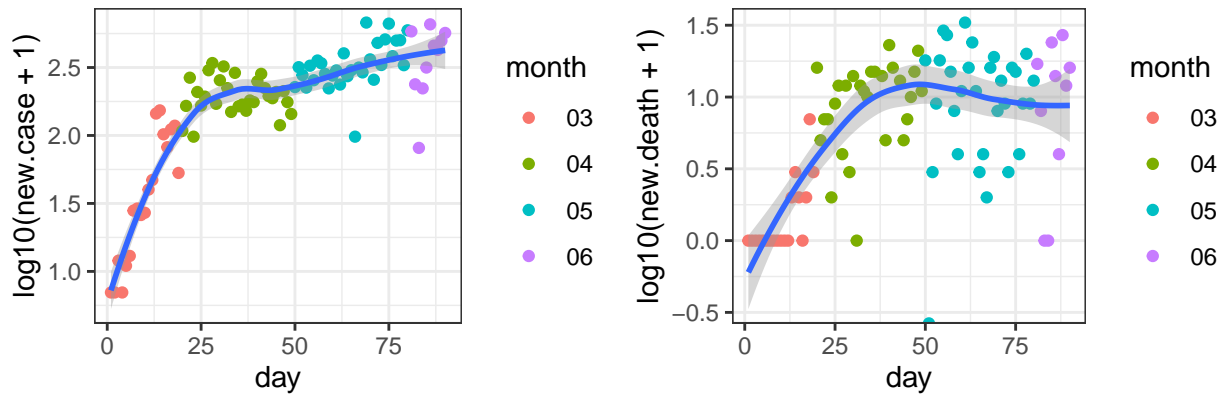
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

Rhode Island



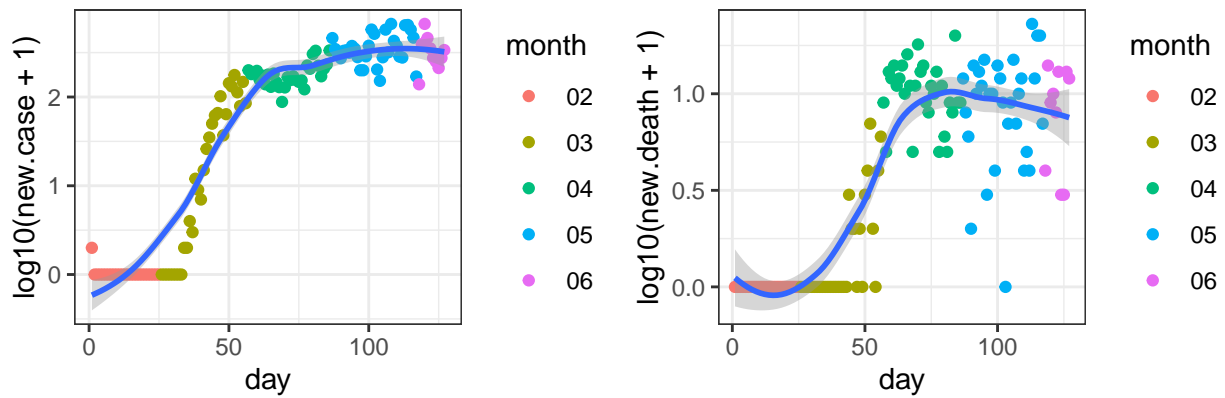
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-01

Alabama



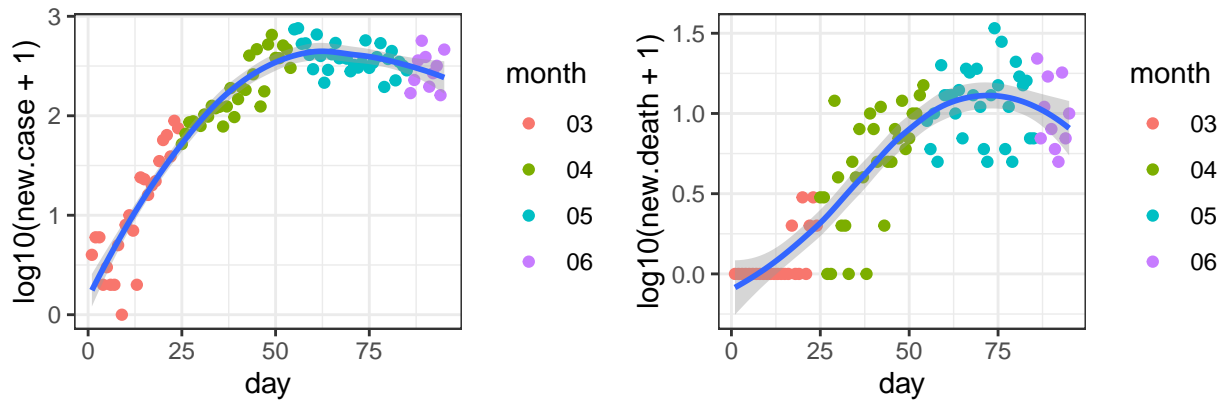
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-13

Wisconsin



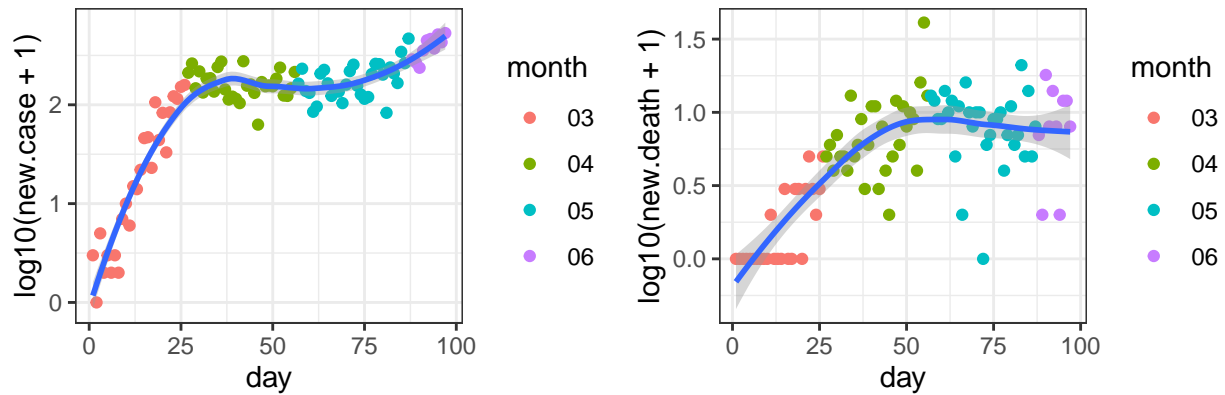
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 02-05

Iowa



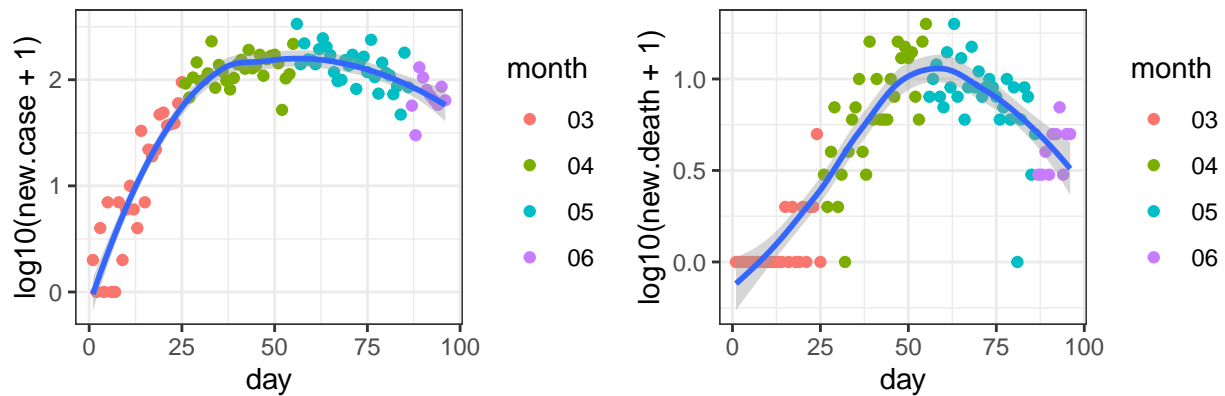
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-08

South Carolina



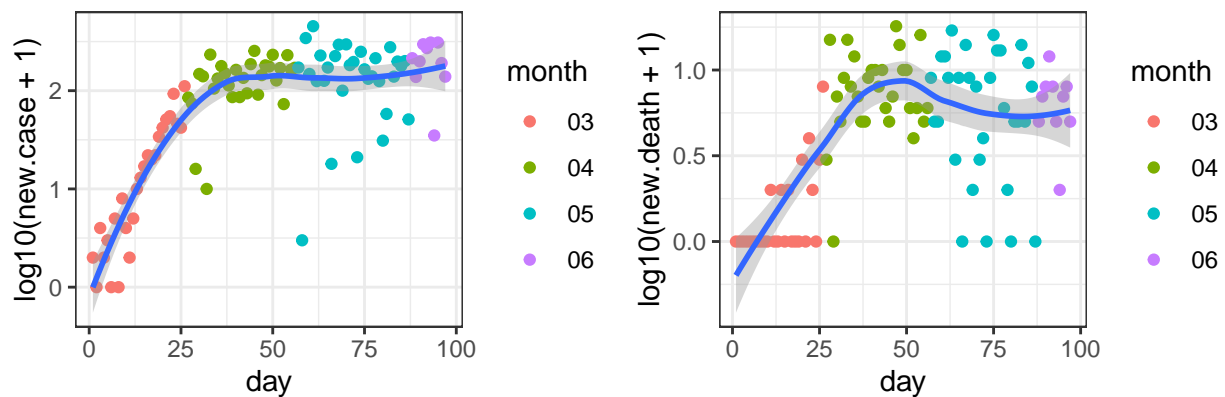
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-06

District of Columbia



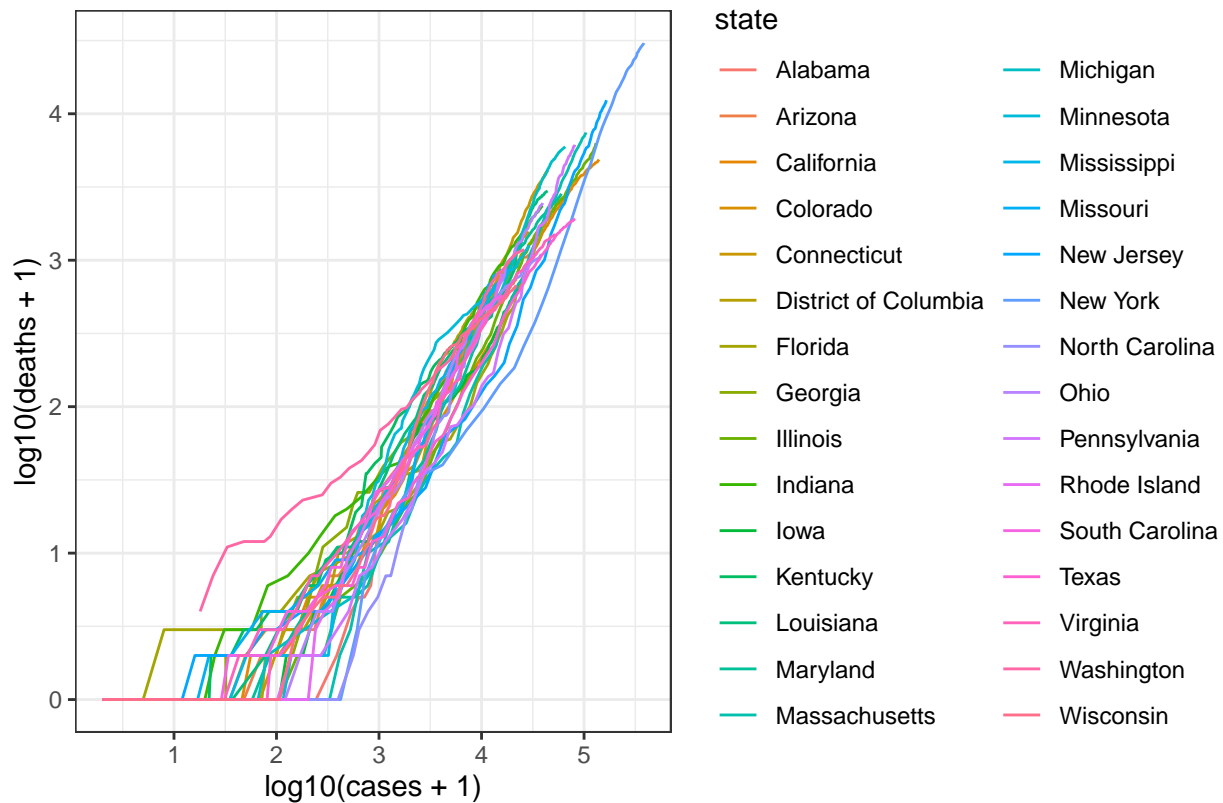
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

Kentucky



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

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

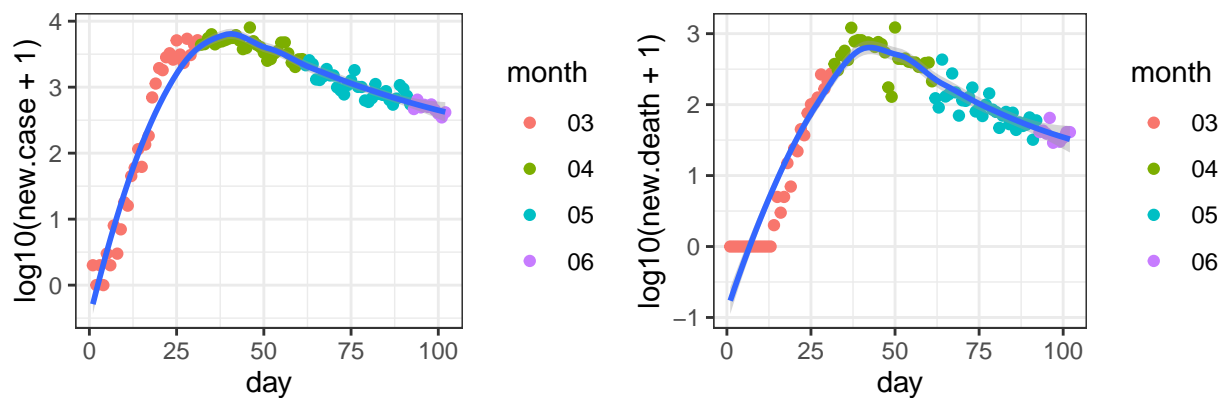
First check the 50 counties with the largest number of deaths.

| ## | date | county | state | fips | cases | deaths |
|-----------|------------|---------------|---------------|-------|--------|--------|
| ## 223426 | 2020-06-10 | New York City | New York | NA | 212884 | 21436 |
| ## 222241 | 2020-06-10 | Cook | Illinois | 17031 | 83585 | 4053 |
| ## 221845 | 2020-06-10 | Los Angeles | California | 6037 | 67064 | 2768 |
| ## 222933 | 2020-06-10 | Wayne | Michigan | 26163 | 21570 | 2653 |
| ## 223425 | 2020-06-10 | Nassau | New York | 36059 | 41015 | 2653 |
| ## 223445 | 2020-06-10 | Suffolk | New York | 36103 | 40464 | 1990 |
| ## 222845 | 2020-06-10 | Middlesex | Massachusetts | 25017 | 22889 | 1725 |
| ## 223351 | 2020-06-10 | Essex | New Jersey | 34013 | 18206 | 1723 |
| ## 223346 | 2020-06-10 | Bergen | New Jersey | 34003 | 18667 | 1635 |
| ## 223453 | 2020-06-10 | Westchester | New York | 36119 | 34075 | 1530 |
| ## 223850 | 2020-06-10 | Philadelphia | Pennsylvania | 42101 | 23951 | 1454 |
| ## 221944 | 2020-06-10 | Fairfield | Connecticut | 9001 | 16134 | 1321 |
| ## 221945 | 2020-06-10 | Hartford | Connecticut | 9003 | 10924 | 1303 |
| ## 223353 | 2020-06-10 | Hudson | New Jersey | 34017 | 18647 | 1242 |
| ## 223364 | 2020-06-10 | Union | New Jersey | 34039 | 16317 | 1103 |
| ## 223356 | 2020-06-10 | Middlesex | New Jersey | 34023 | 16288 | 1064 |
| ## 222914 | 2020-06-10 | Oakland | Michigan | 26125 | 11262 | 1058 |
| ## 221948 | 2020-06-10 | New Haven | Connecticut | 9009 | 11911 | 1024 |
| ## 222841 | 2020-06-10 | Essex | Massachusetts | 25009 | 15365 | 1024 |
| ## 223360 | 2020-06-10 | Passaic | New Jersey | 34031 | 16524 | 982 |
| ## 222849 | 2020-06-10 | Suffolk | Massachusetts | 25025 | 19099 | 936 |
| ## 222901 | 2020-06-10 | Macomb | Michigan | 26099 | 7000 | 876 |

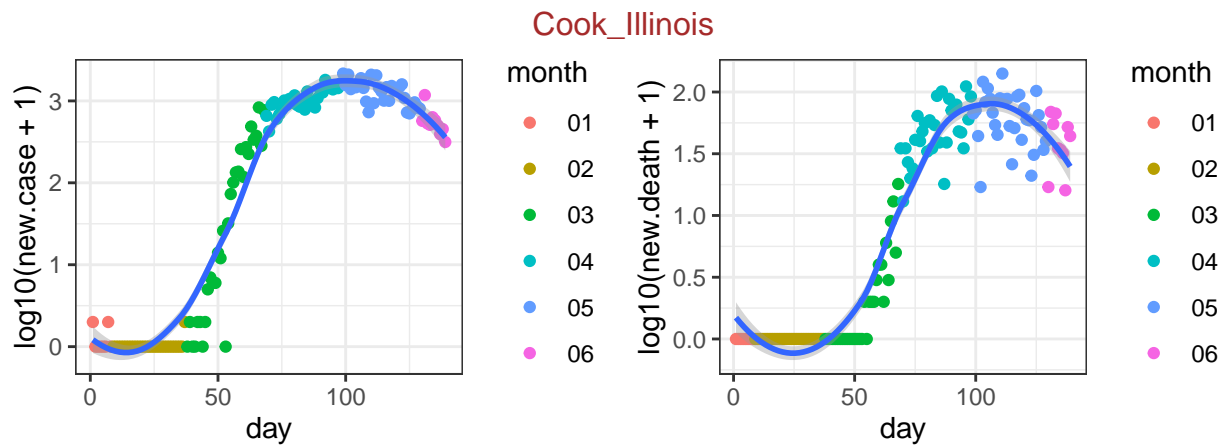
| | | | | | | | |
|----|--------|------------|----------------------|----------------------|-------|-------|-----|
| ## | 222847 | 2020-06-10 | Norfolk | Massachusetts | 25021 | 8774 | 873 |
| ## | 222851 | 2020-06-10 | Worcester | Massachusetts | 25027 | 11820 | 844 |
| ## | 223359 | 2020-06-10 | Ocean | New Jersey | 34029 | 9100 | 792 |
| ## | 222000 | 2020-06-10 | Miami-Dade | Florida | 12086 | 20276 | 784 |
| ## | 223845 | 2020-06-10 | Montgomery | Pennsylvania | 42091 | 7709 | 762 |
| ## | 222960 | 2020-06-10 | Hennepin | Minnesota | 27053 | 9674 | 693 |
| ## | 222376 | 2020-06-10 | Marion | Indiana | 18097 | 10581 | 680 |
| ## | 222827 | 2020-06-10 | Montgomery | Maryland | 24031 | 13163 | 672 |
| ## | 223822 | 2020-06-10 | Delaware | Pennsylvania | 42045 | 6811 | 662 |
| ## | 223357 | 2020-06-10 | Monmouth | New Jersey | 34025 | 8563 | 652 |
| ## | 223871 | 2020-06-10 | Providence | Rhode Island | 44007 | 11959 | 637 |
| ## | 222843 | 2020-06-10 | Hampden | Massachusetts | 25013 | 6395 | 629 |
| ## | 223358 | 2020-06-10 | Morris | New Jersey | 34027 | 6596 | 627 |
| ## | 222828 | 2020-06-10 | Prince George's | Maryland | 24033 | 17305 | 613 |
| ## | 222848 | 2020-06-10 | Plymouth | Massachusetts | 25023 | 8418 | 608 |
| ## | 224496 | 2020-06-10 | King | Washington | 53033 | 8561 | 582 |
| ## | 223411 | 2020-06-10 | Erie | New York | 36029 | 6616 | 563 |
| ## | 223808 | 2020-06-10 | Bucks | Pennsylvania | 42017 | 5340 | 534 |
| ## | 221744 | 2020-06-10 | Maricopa | Arizona | 4013 | 15282 | 519 |
| ## | 222765 | 2020-06-10 | Orleans | Louisiana | 22071 | 7279 | 513 |
| ## | 223355 | 2020-06-10 | Mercer | New Jersey | 34021 | 7245 | 510 |
| ## | 221957 | 2020-06-10 | District of Columbia | District of Columbia | 11001 | 9537 | 499 |
| ## | 222839 | 2020-06-10 | Bristol | Massachusetts | 25005 | 7754 | 487 |
| ## | 223199 | 2020-06-10 | St. Louis | Missouri | 29189 | 5388 | 485 |
| ## | 223437 | 2020-06-10 | Rockland | New York | 36087 | 13372 | 466 |
| ## | 222755 | 2020-06-10 | Jefferson | Louisiana | 22051 | 7971 | 463 |
| ## | 223362 | 2020-06-10 | Somerset | New Jersey | 34035 | 4698 | 431 |
| ## | 224385 | 2020-06-10 | Fairfax | Virginia | 51059 | 12746 | 422 |

For these 50 counties, I check the number of new cases and the number of new deaths.

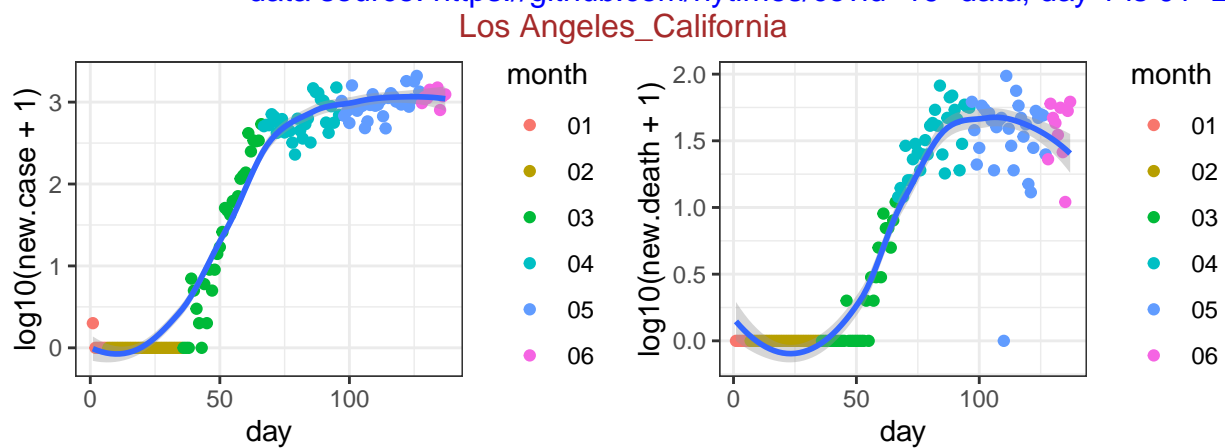
New York City_New York



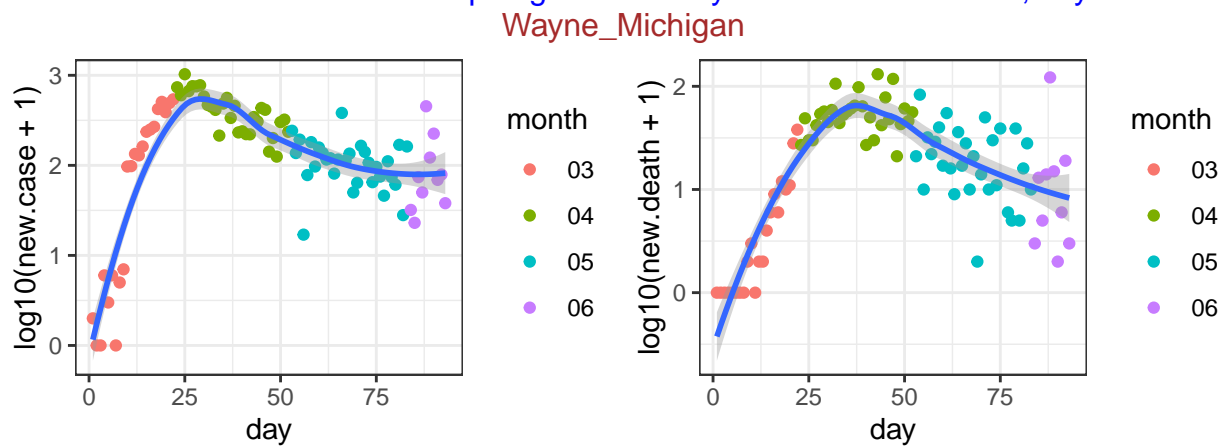
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-01



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

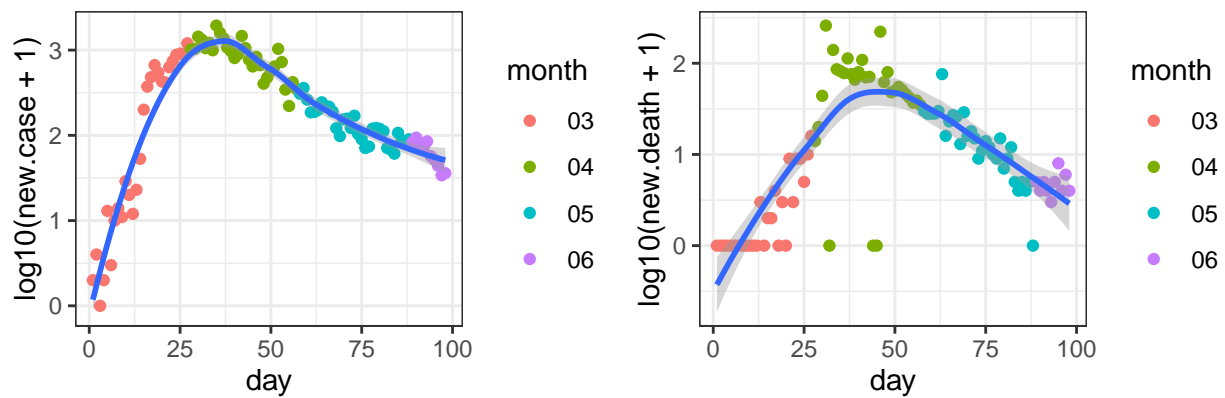


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 01-26



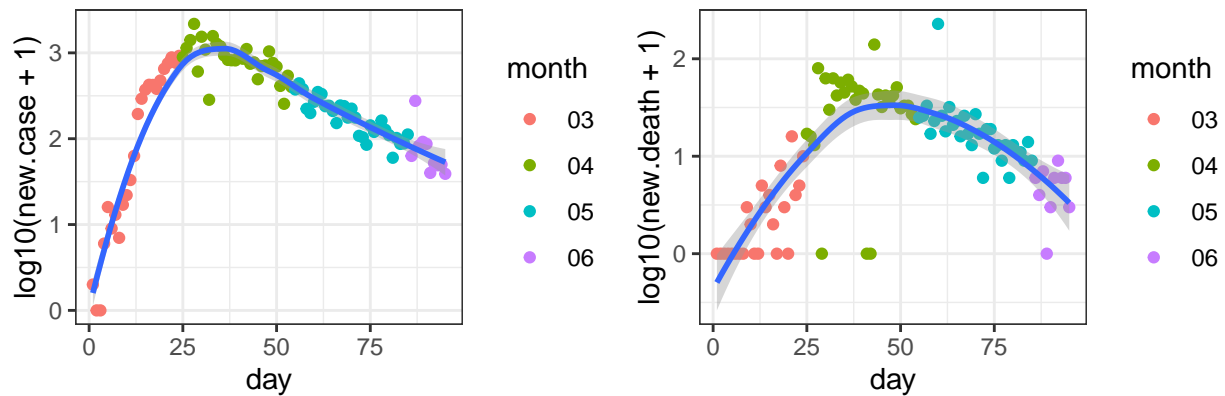
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-10

Nassau_New York



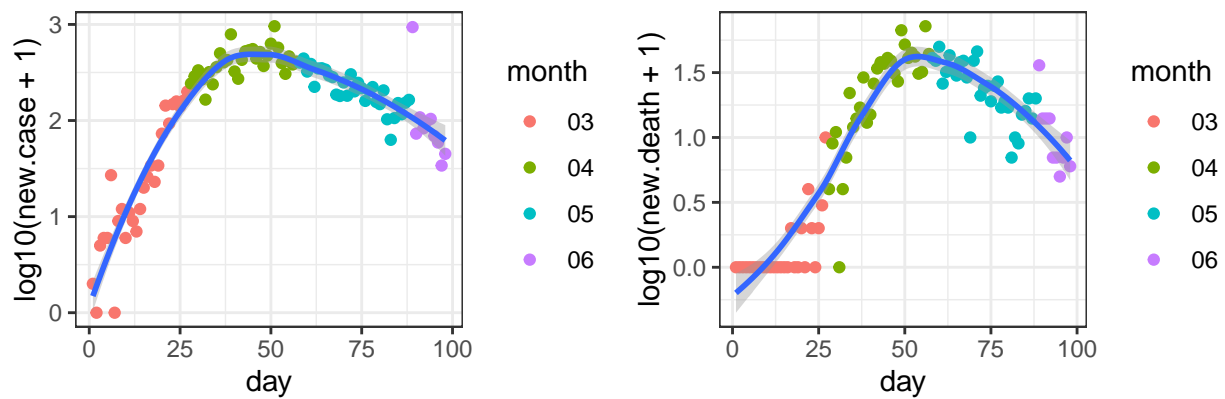
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-05

Suffolk_New York



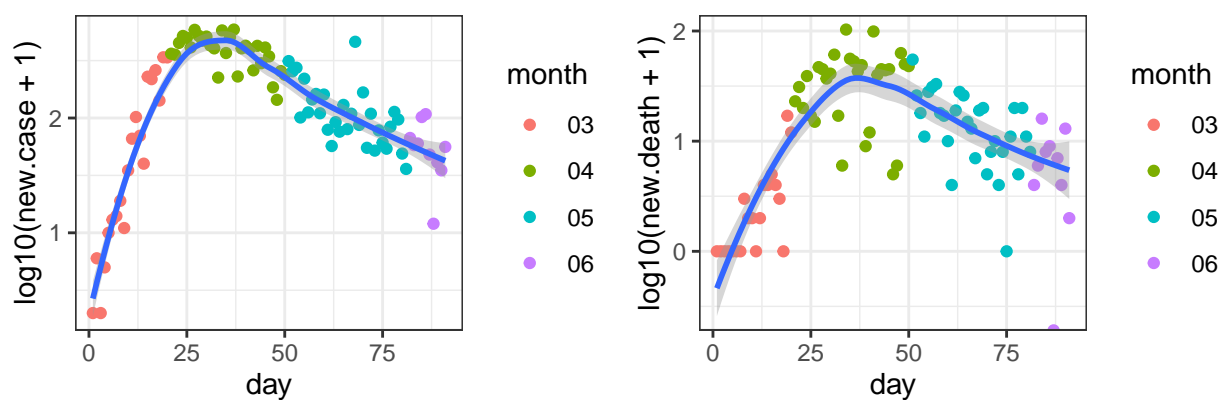
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-08

Middlesex_Massachusetts



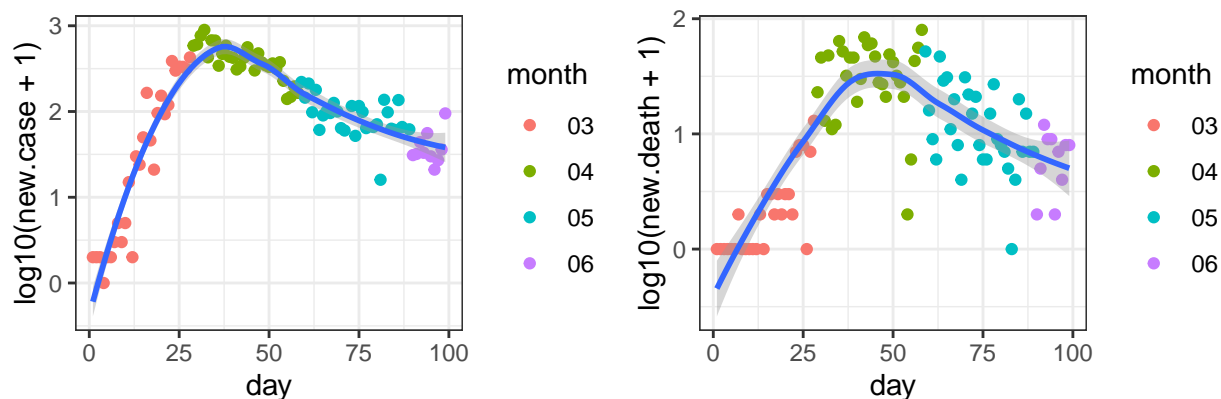
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-05

Essex_New Jersey



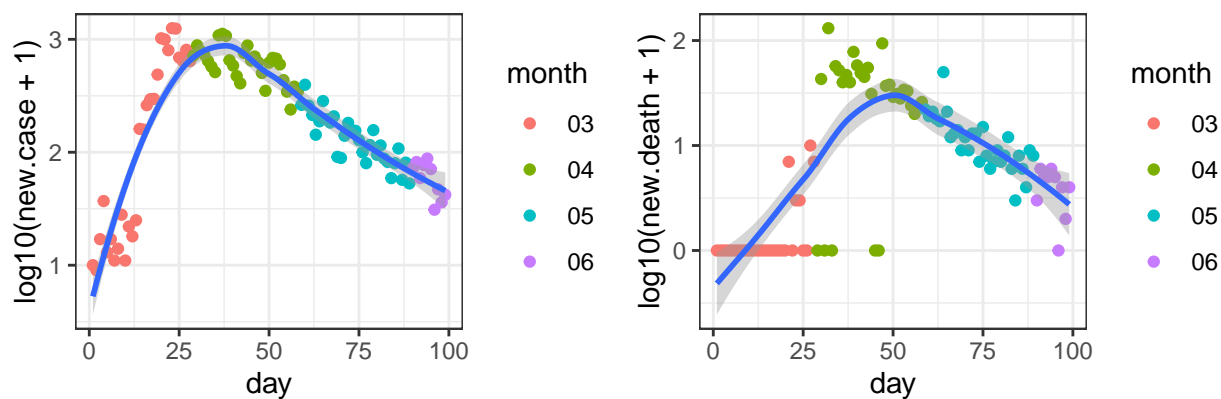
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-12

Bergen_New Jersey



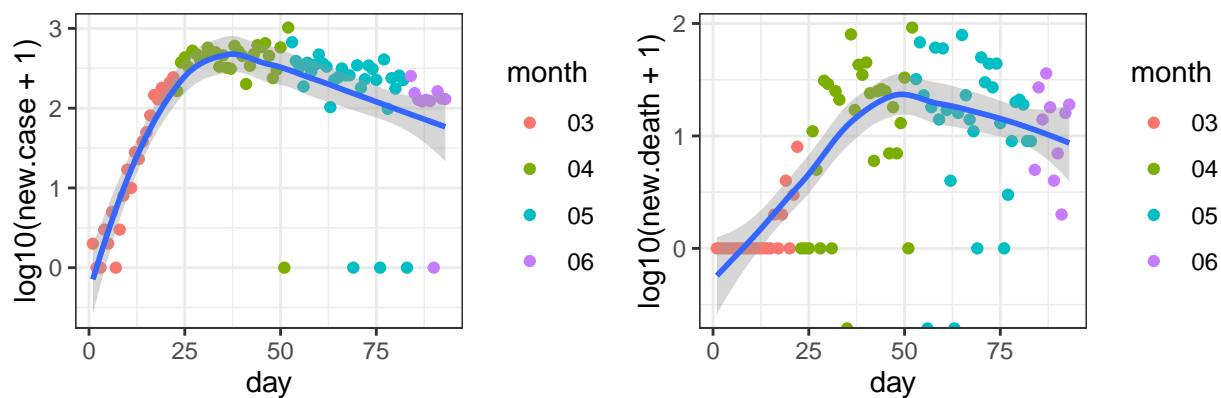
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-04

Westchester_New York



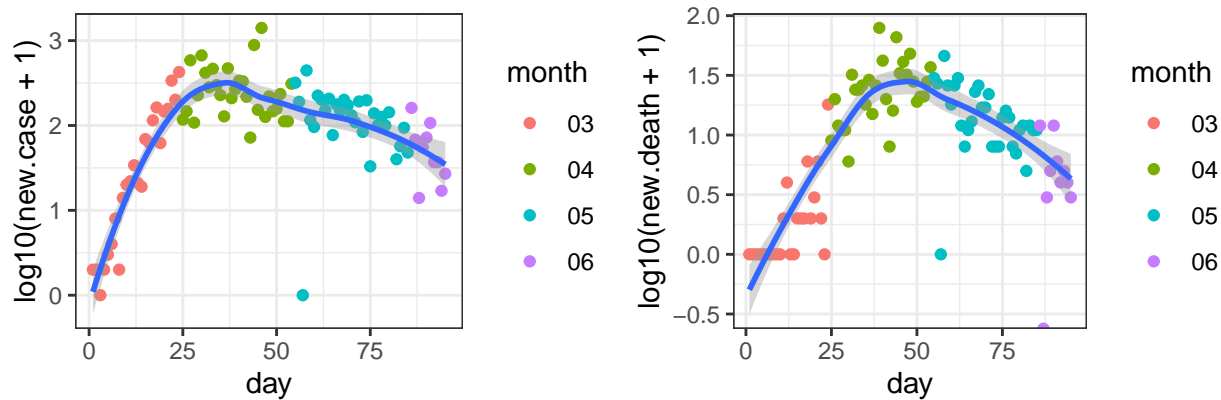
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-04

Philadelphia_Pennsylvania



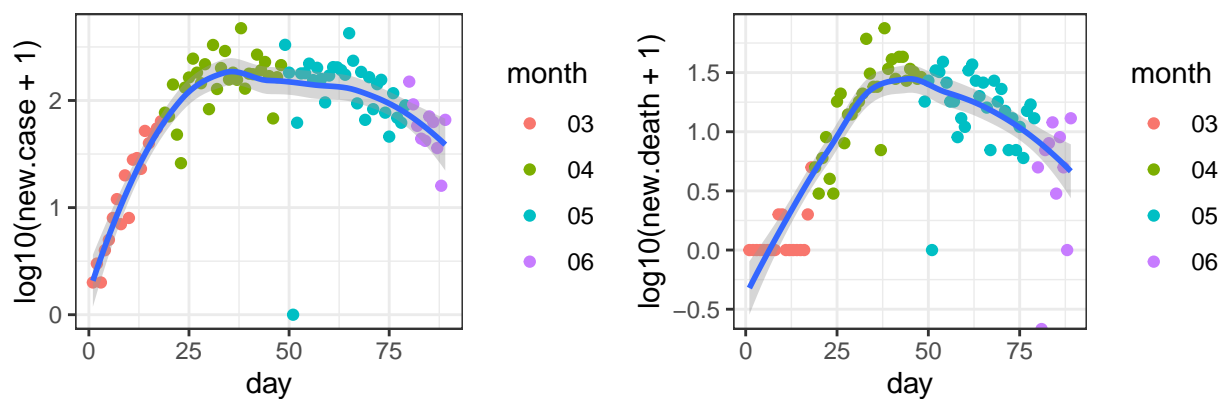
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-10

Fairfield_Connecticut



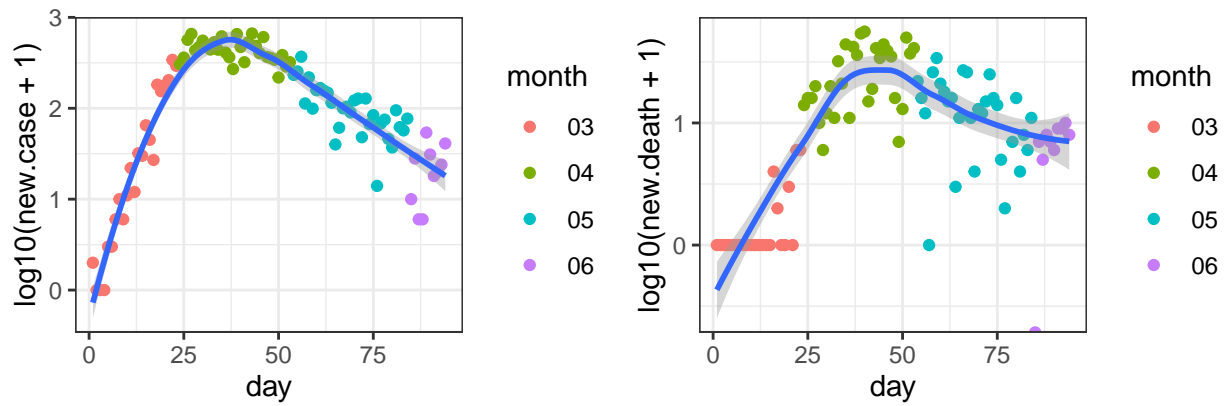
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-08

Hartford_Connecticut



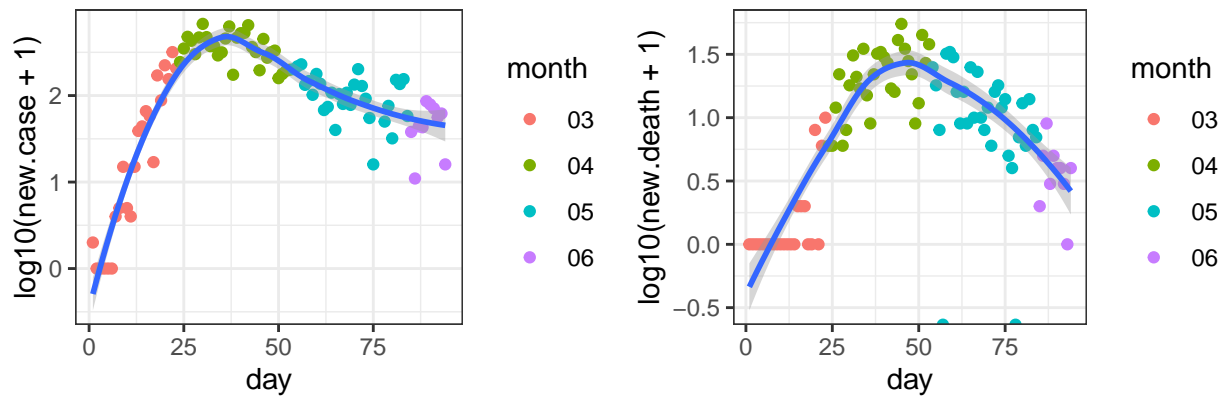
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-14

Hudson_New Jersey



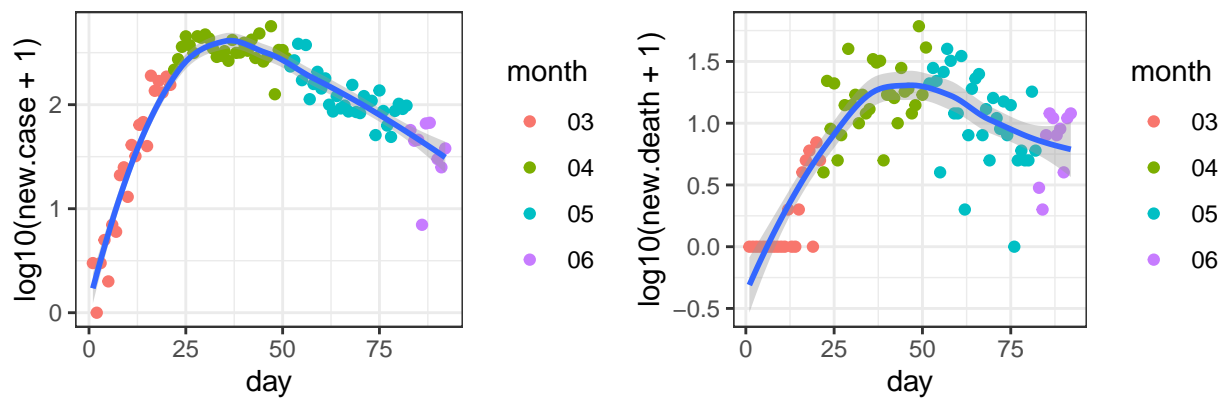
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09

Union_New Jersey



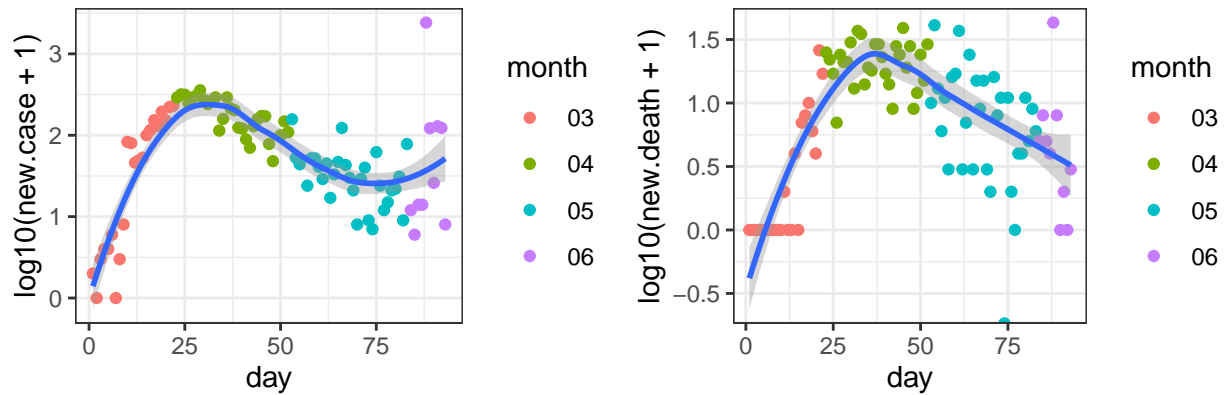
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09

Middlesex_New Jersey



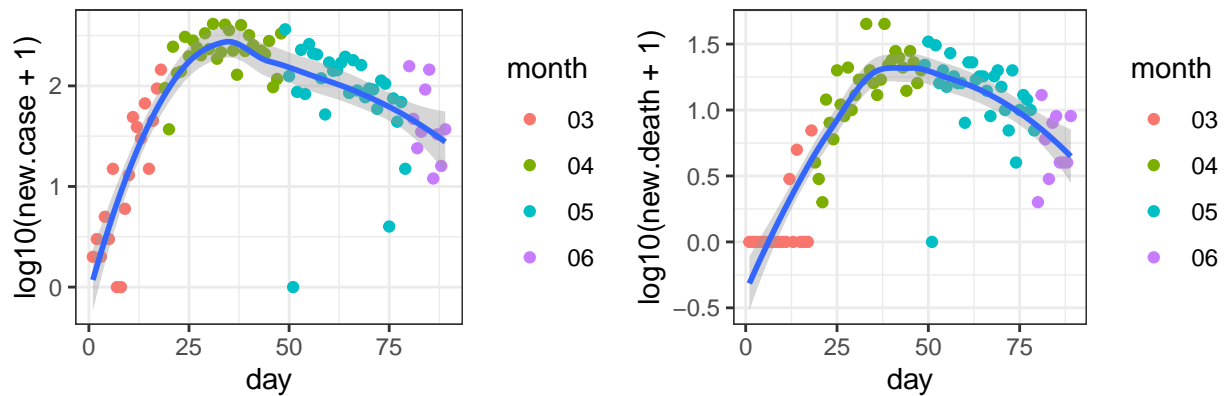
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-11

Oakland_Michigan



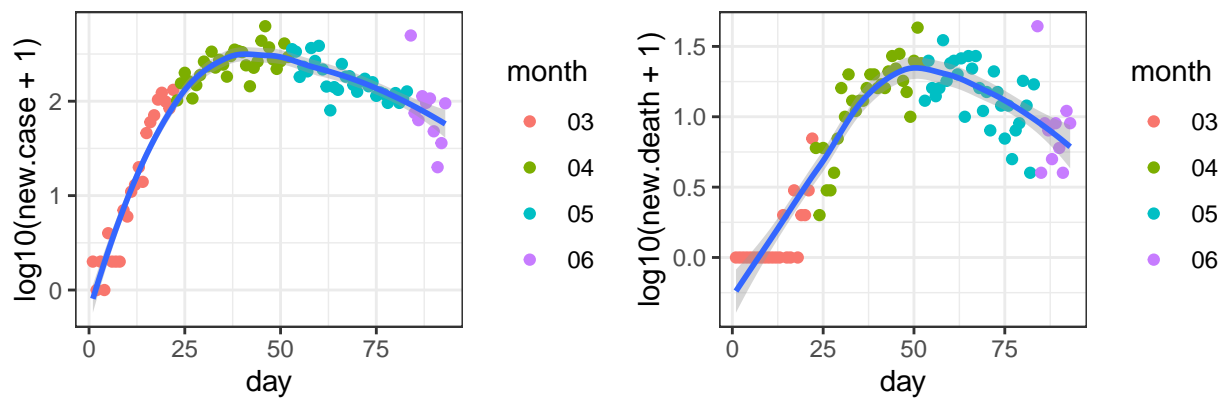
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-10

New Haven_Connecticut



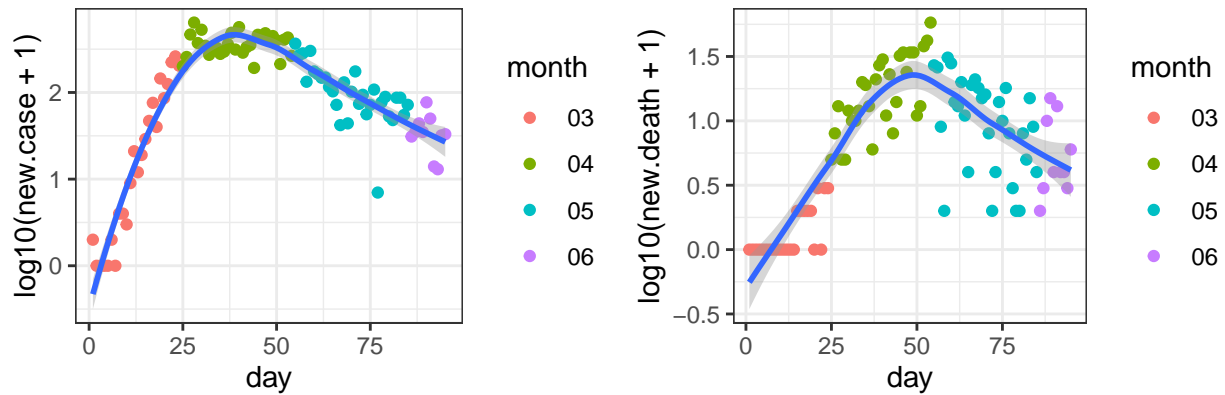
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-14

Essex_Massachusetts



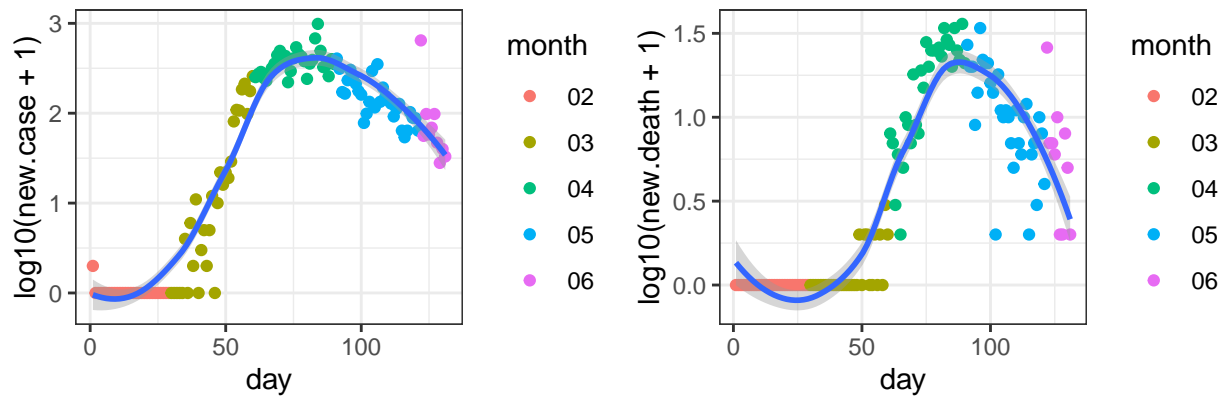
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-10

Passaic_New Jersey



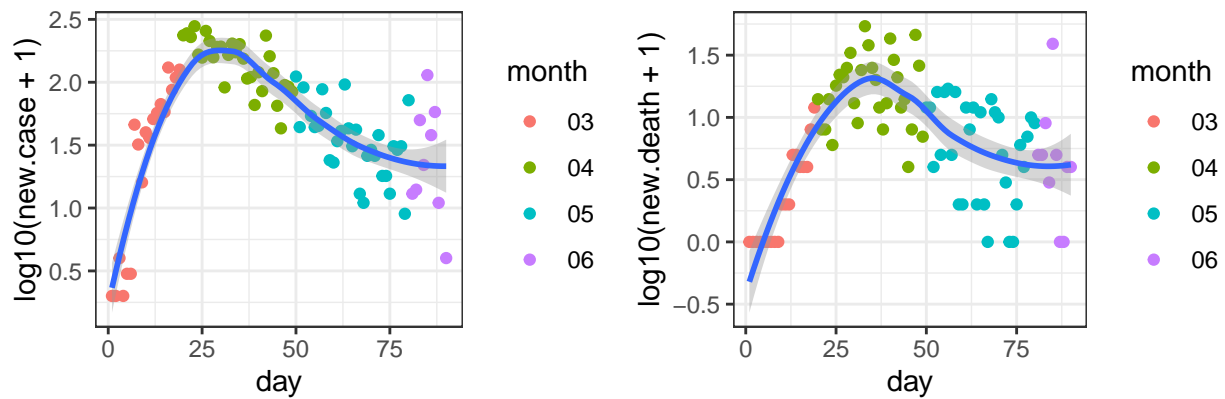
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-08

Suffolk_Massachusetts



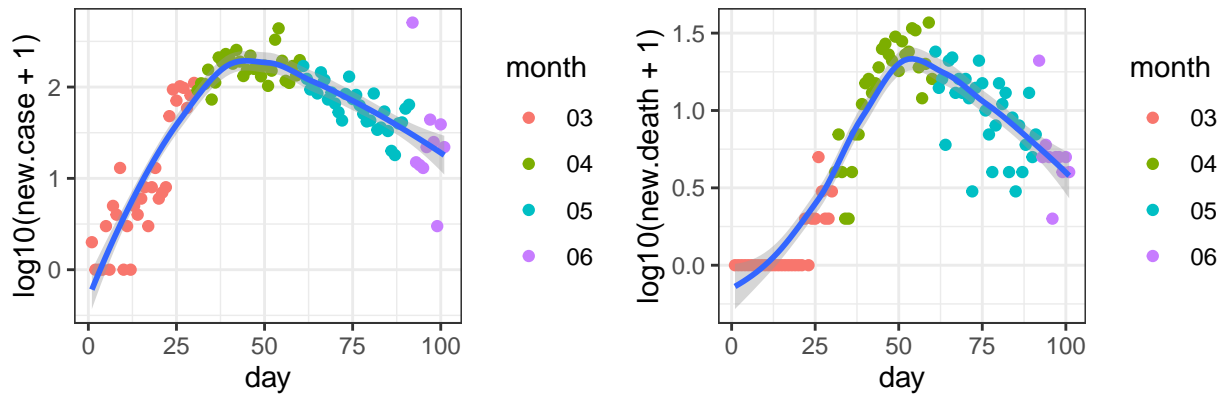
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 02-01

Macomb_Michigan



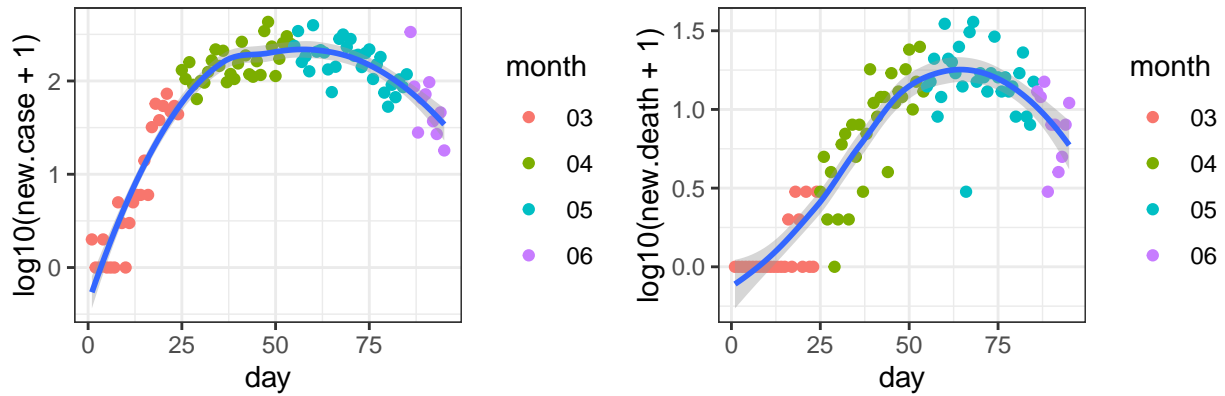
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-13

Norfolk_Massachusetts



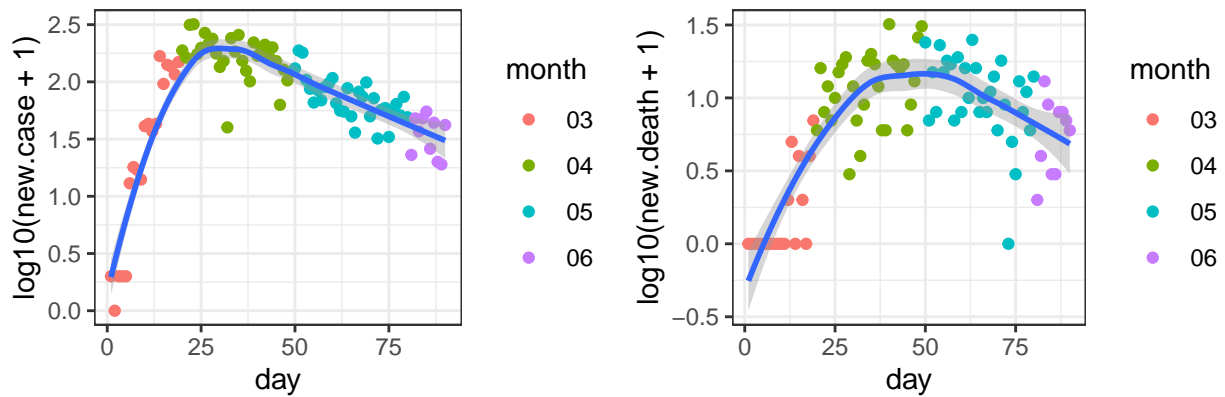
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-02

Worcester_Massachusetts



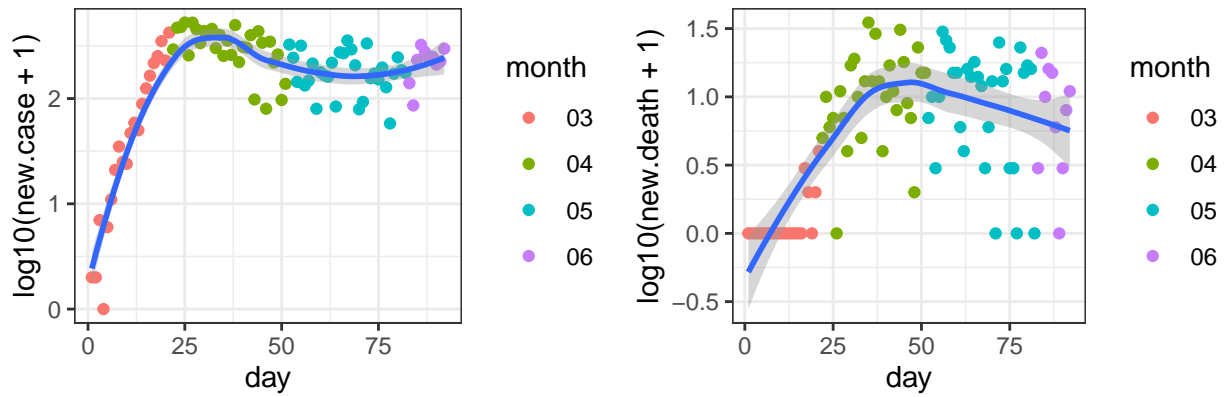
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-08

Ocean_New Jersey



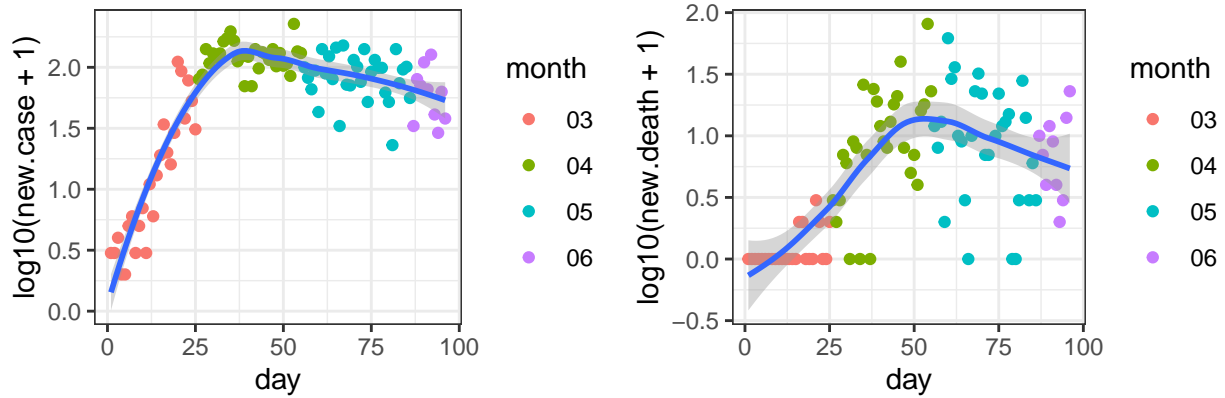
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-13

Miami-Dade_Florida



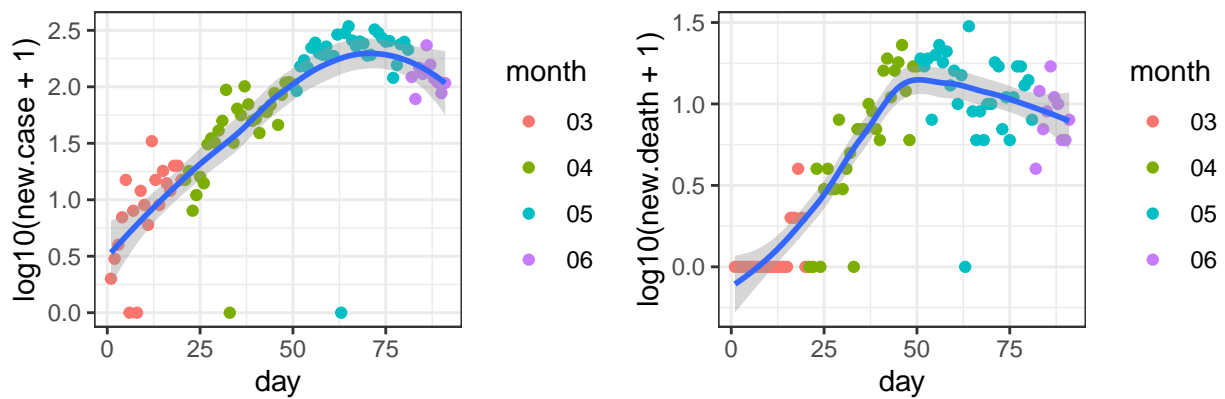
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-11

Montgomery_Pennsylvania



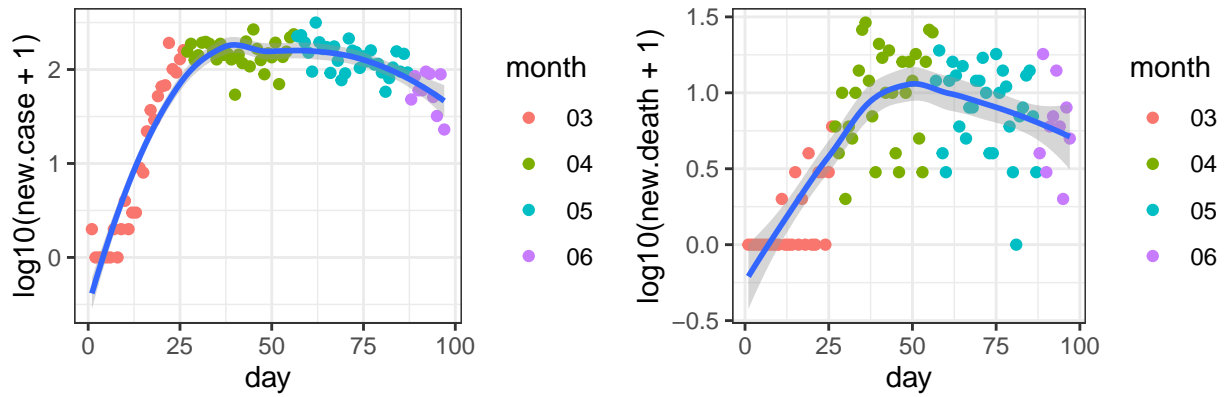
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

Hennepin_Minnesota



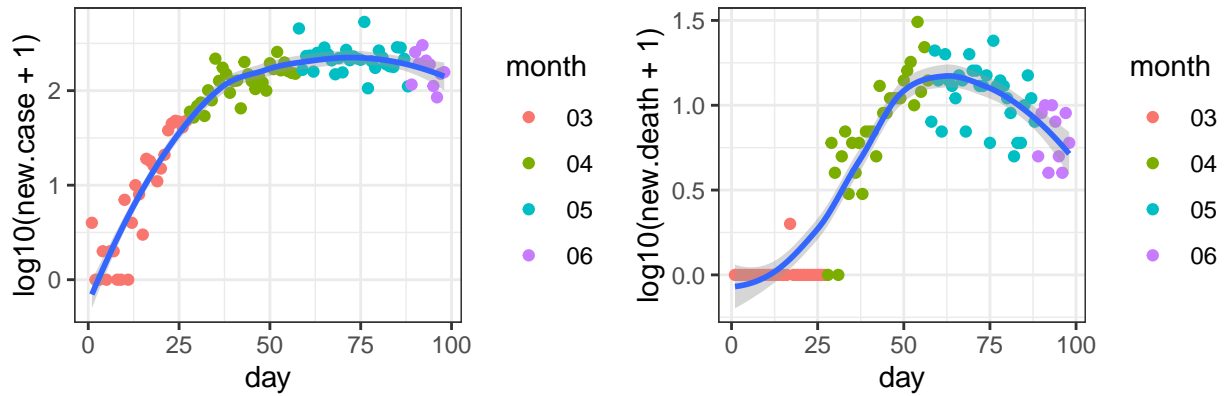
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-12

Marion_Indiana



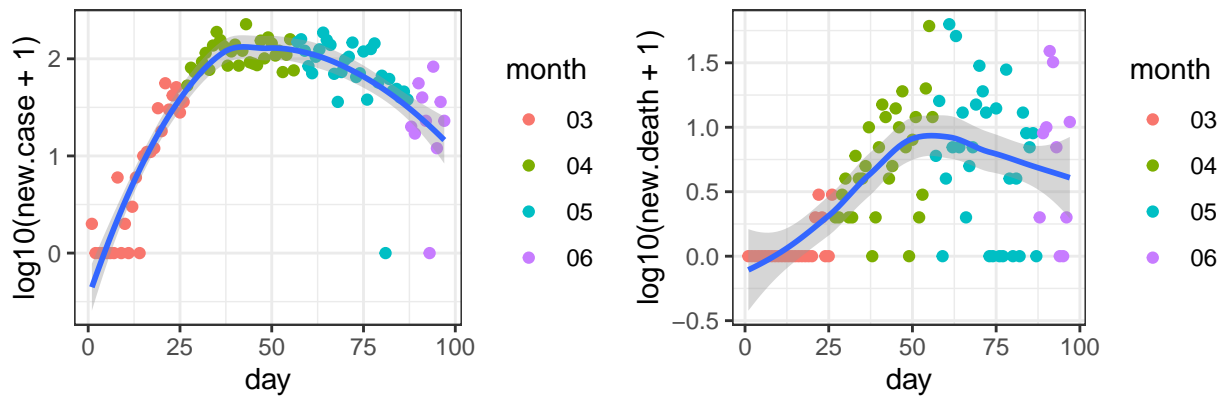
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-06

Montgomery_Maryland



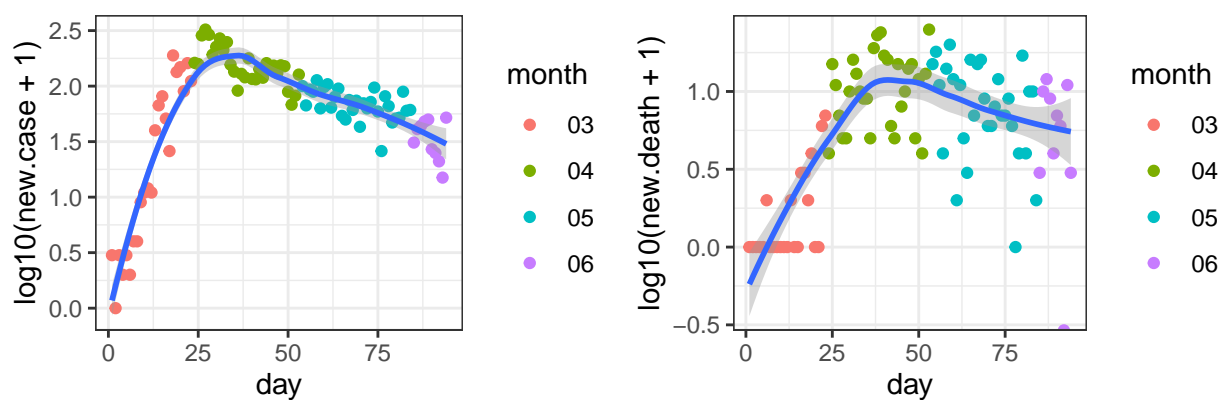
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-05

Delaware_Pennsylvania



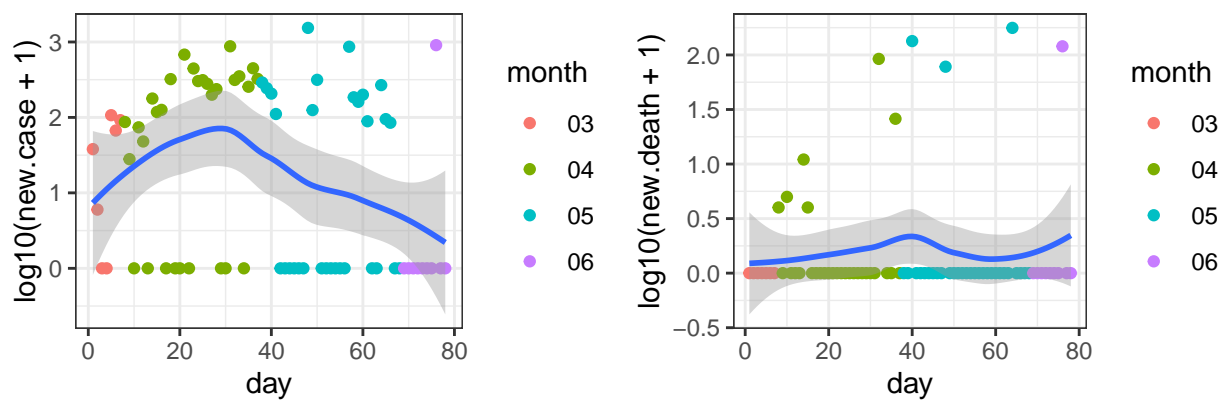
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Monmouth_New Jersey



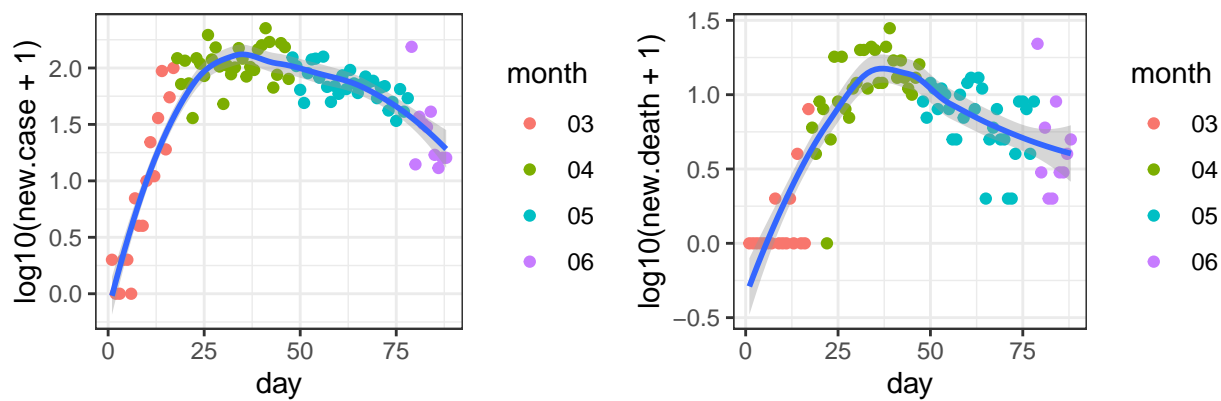
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09

Providence_Rhode Island



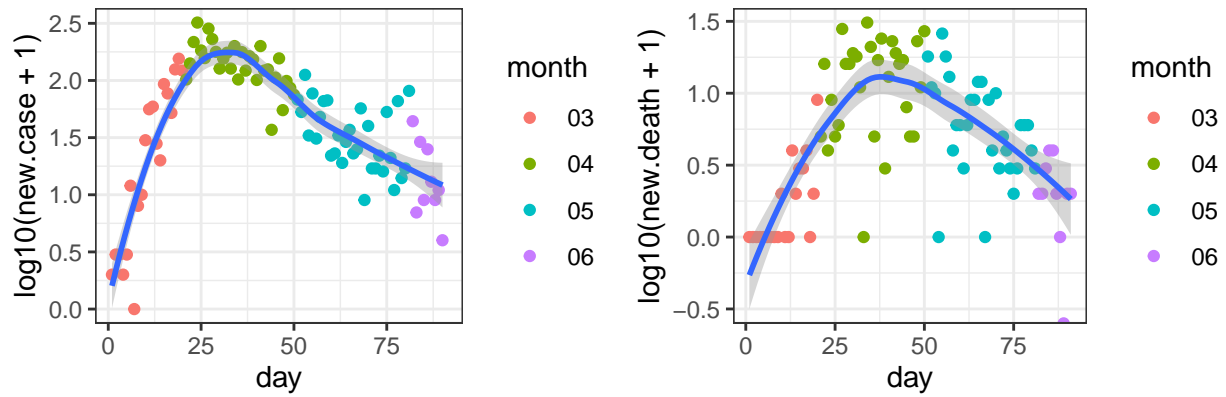
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-25

Hampden_Massachusetts



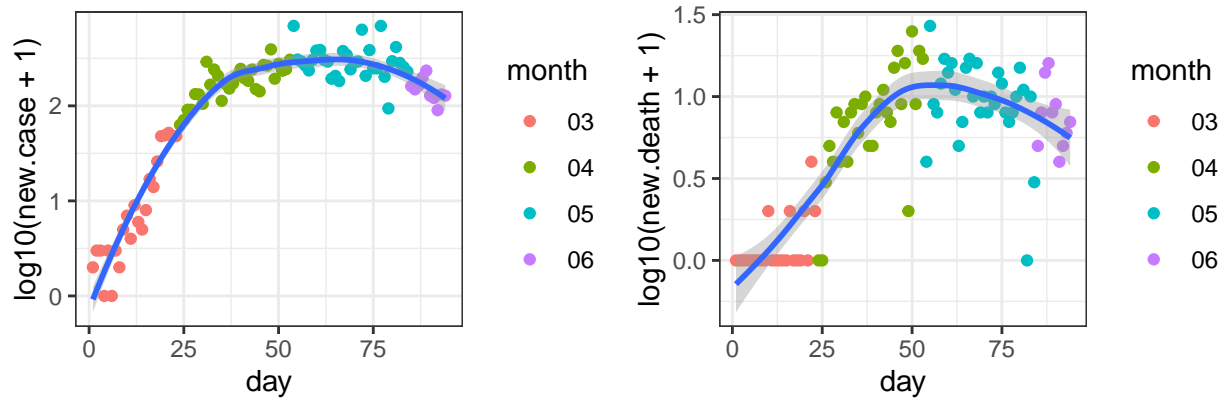
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-15

Morris_New Jersey



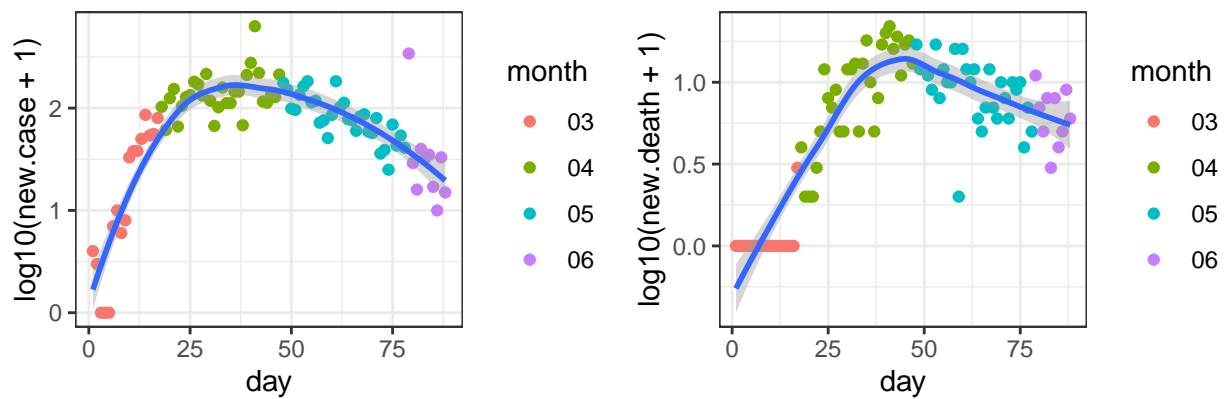
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-12

Prince George's_Maryland



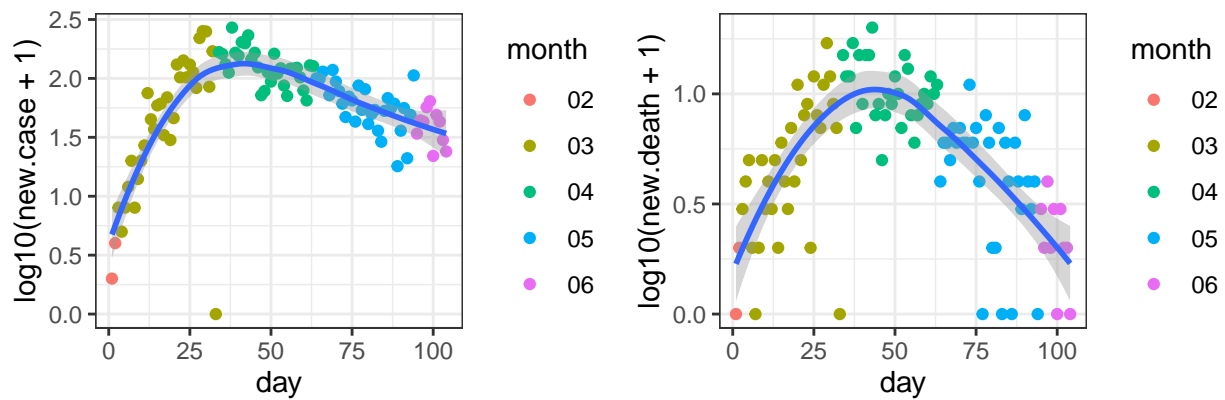
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09

Plymouth_Massachusetts



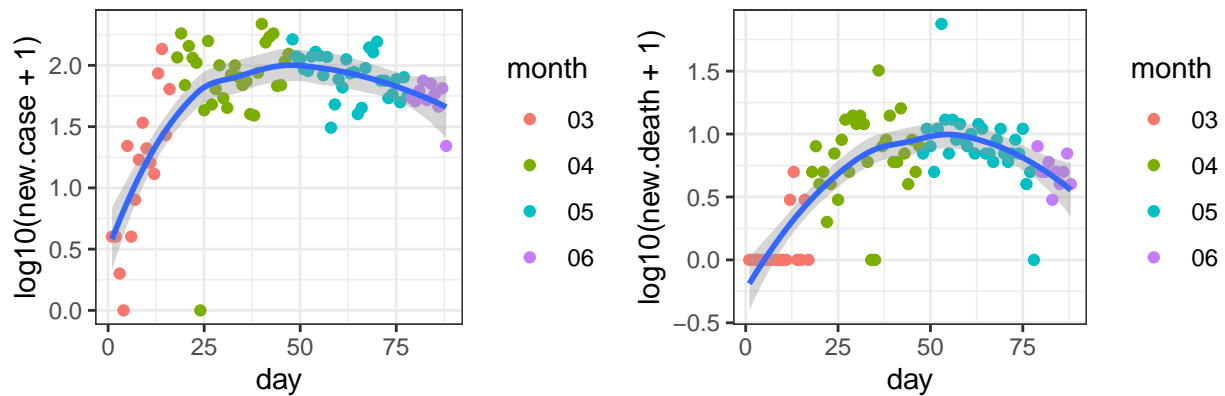
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-15

King_Washington



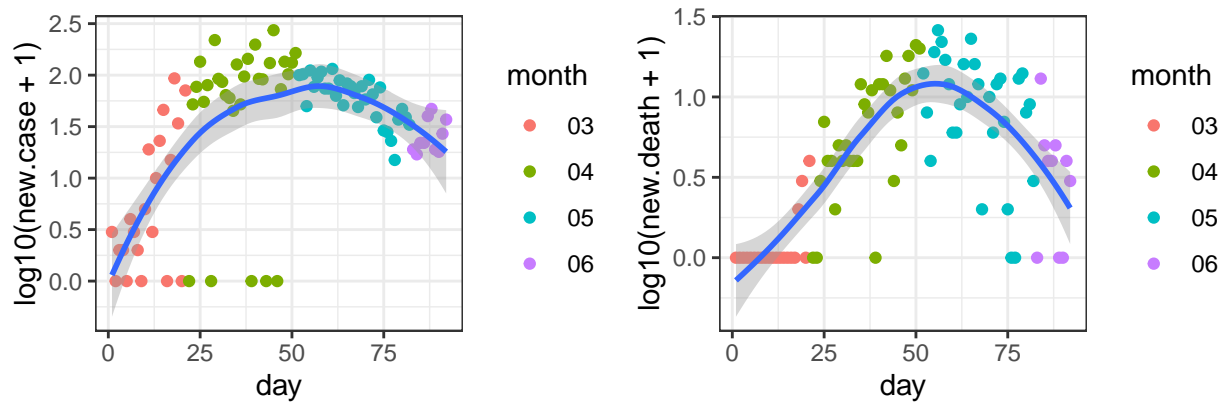
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 02-28

Erie_New York



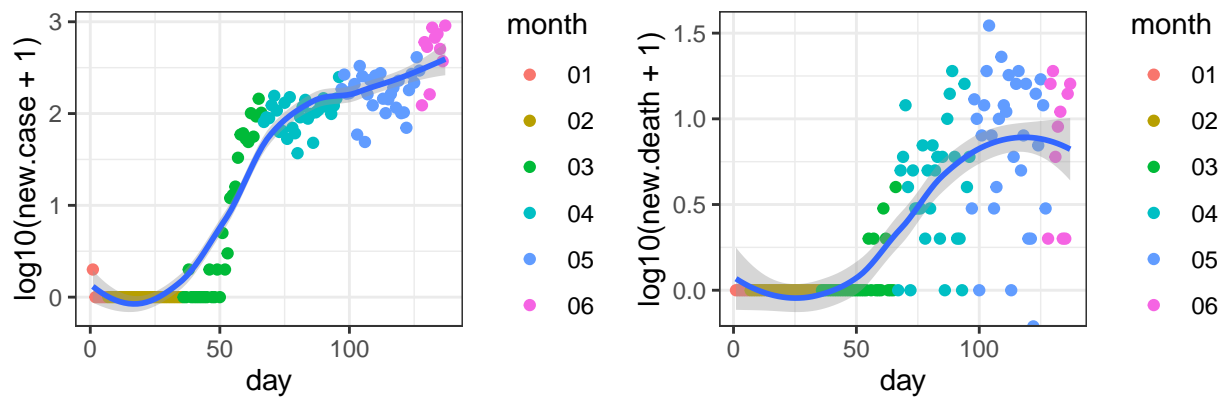
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-15

Bucks_Pennsylvania



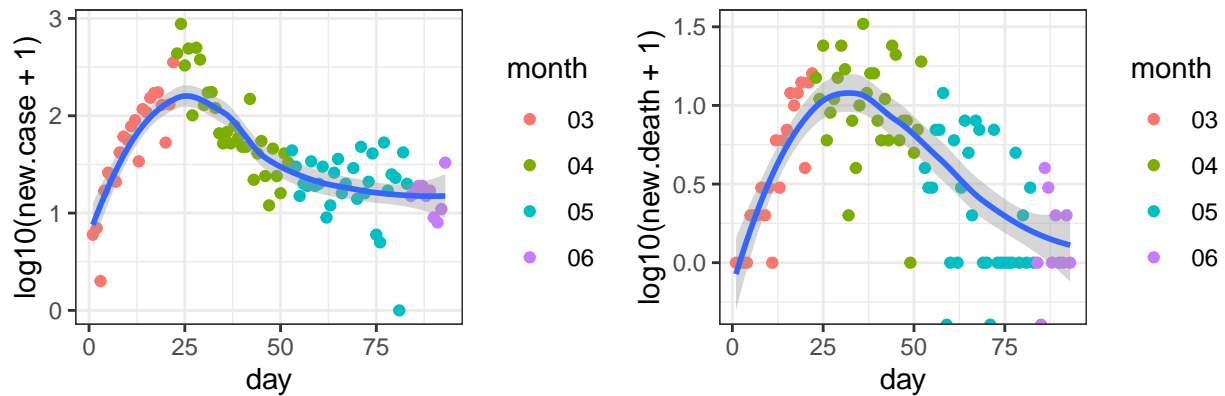
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-11

Maricopa_Arizona



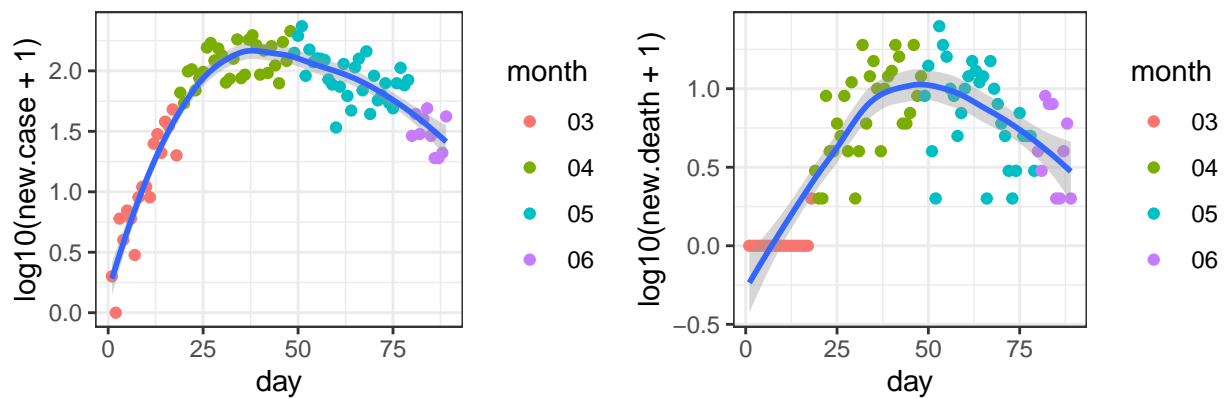
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 01-26

Orleans_Louisiana



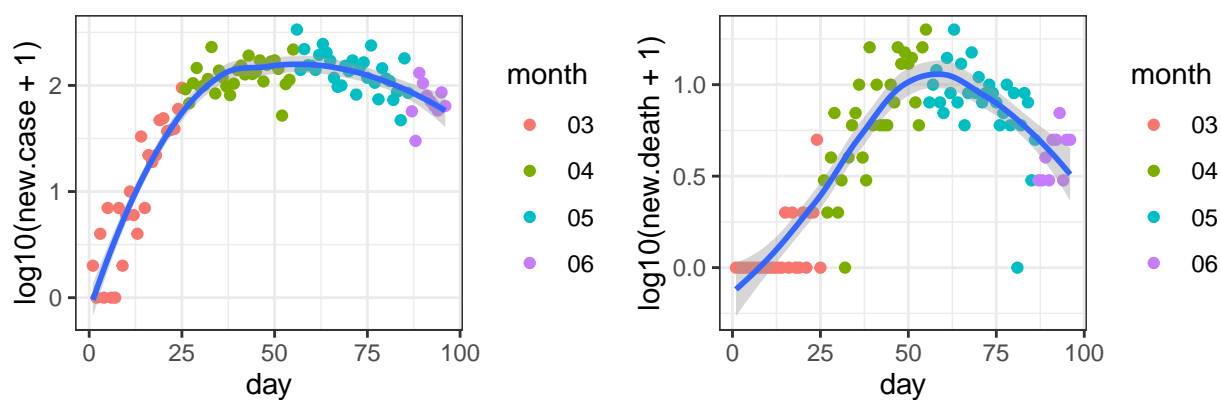
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-10

Mercer_New Jersey



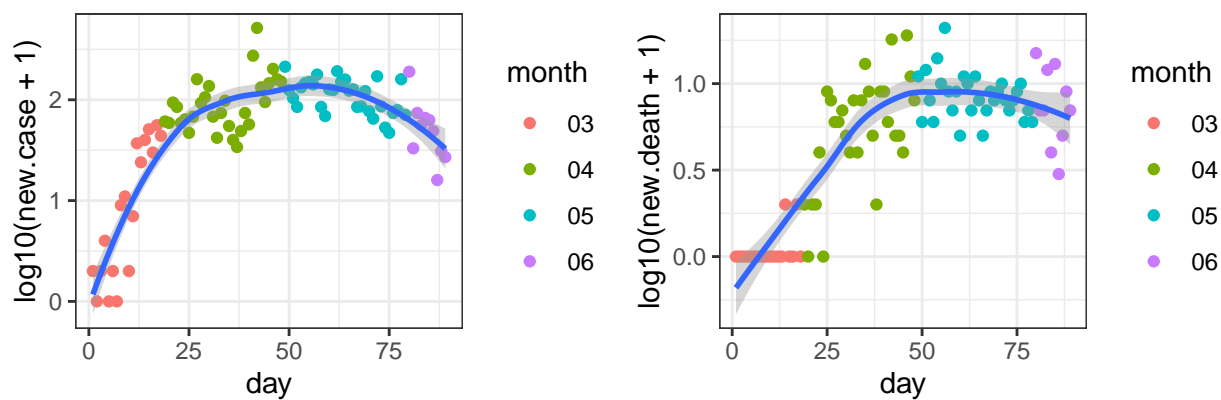
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-14

District of Columbia_District of Columbia



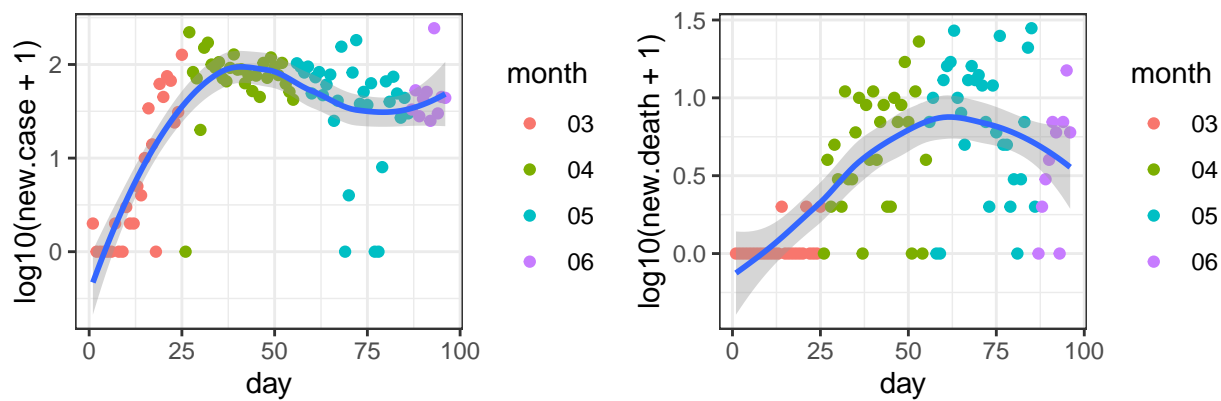
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

Bristol_Massachusetts



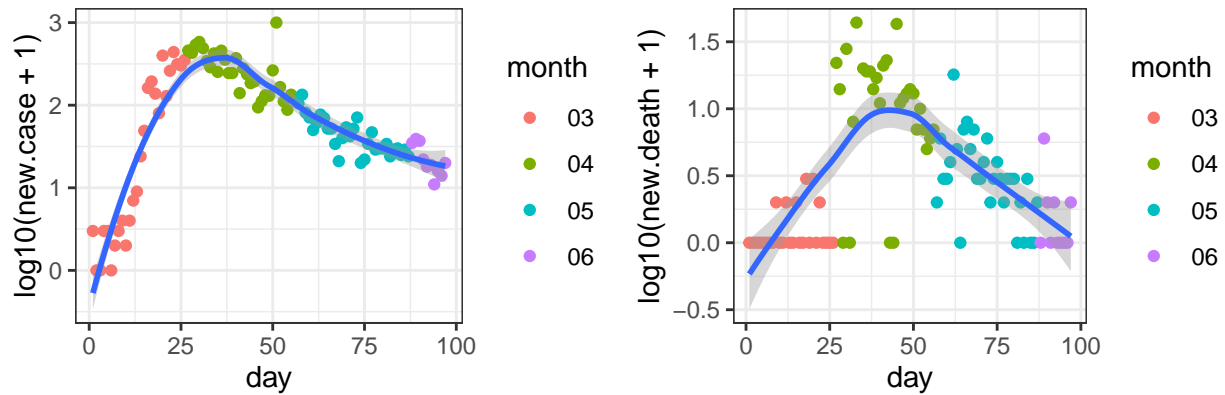
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-14

St. Louis_Missouri



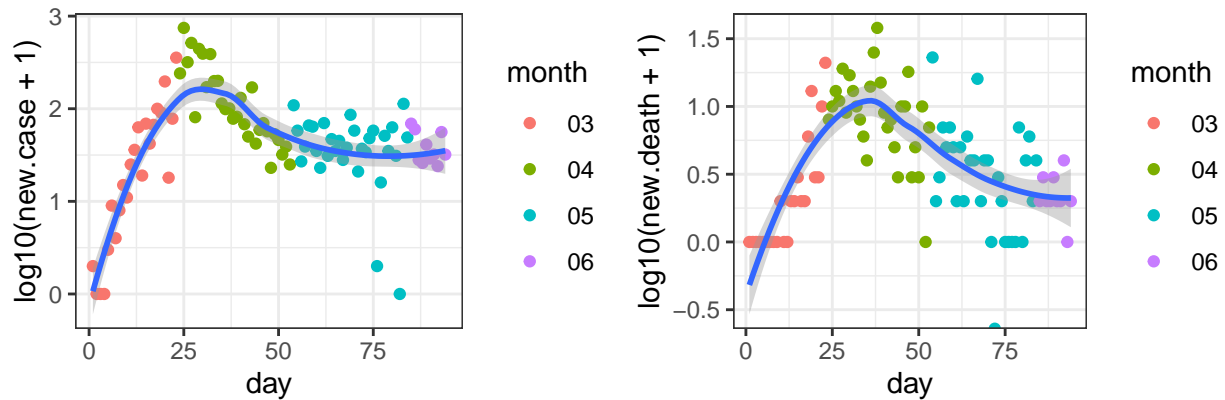
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

Rockland_New York



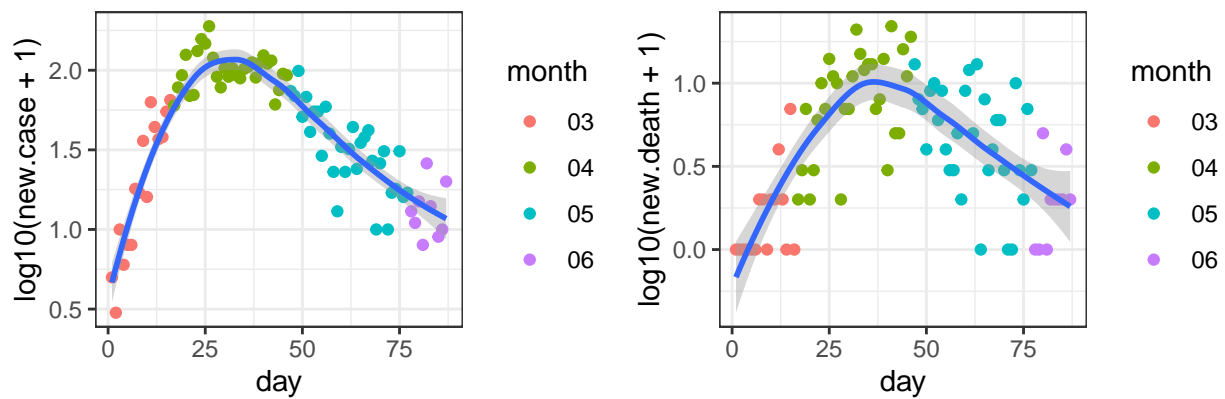
data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-06

Jefferson_Louisiana

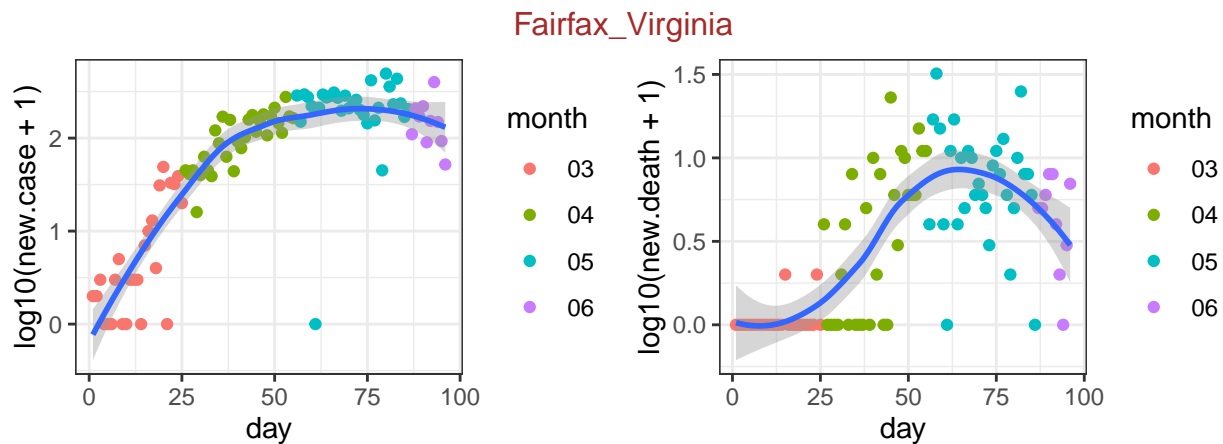


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-09

Somerset_New Jersey



data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-16

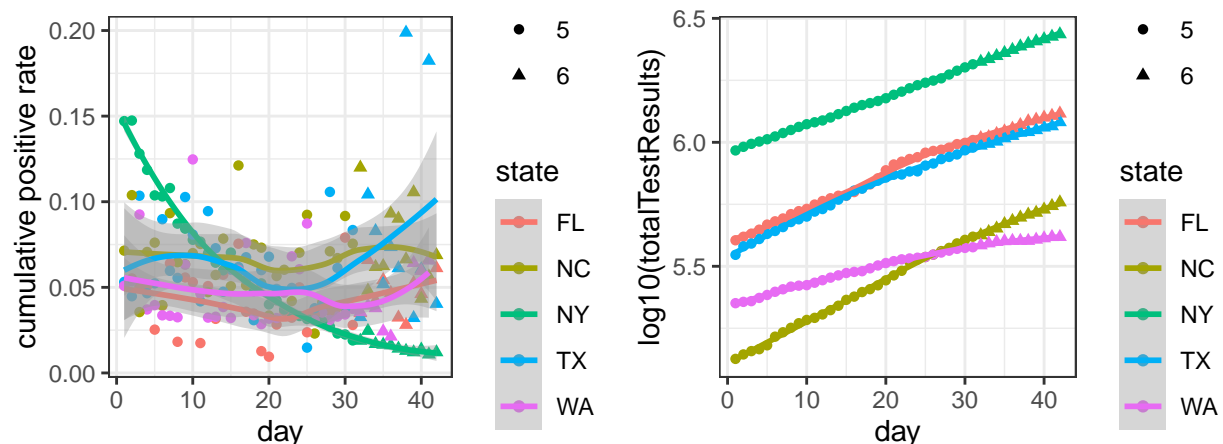


data source: <https://github.com/nytimes/covid-19-data>, day 1 is 03-07

COVID Tracking

The positive rates of testing can be an indicator on how much the COVID-19 has spread. However, they can be much more noisy data since the negative testing results are often not reported and the tests are almost surely taken on a non-representative random sample of the population. The COVID tracking project provides 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 available for both counties and states, here I only look at state level data.

The grades of the states may change over time and I strongly recommend checking their website before putting serious interpretation on the following plot.



github.com/COVID19Tracking/, positive rate on 0611: NA(WA) 0.04(TX) 0.01(NY) 0.07(NC) 0.06(FL)

Session information

```
sessionInfo()
```

```
## R version 3.6.2 (2019-12-12)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS Catalina 10.15.5
```

```

##
## 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_3.3.1
##
## 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   lattice_0.20-38 nlme_3.1-144     evaluate_0.14
## [9] lifecycle_0.2.0 tibble_3.0.1     gtable_0.3.0    mgcv_1.8-31
## [13] pkgconfig_2.0.3 rlang_0.4.6      Matrix_1.2-18   yaml_2.2.1
## [17] xfun_0.12       gridExtra_2.3    withr_2.1.2     stringr_1.4.0
## [21] dplyr_0.8.4     knitr_1.28       vctrs_0.3.0     cowplot_1.0.0
## [25] grid_3.6.2      tidyselect_1.0.0 glue_1.3.1       R6_2.4.1
## [29] rmarkdown_2.1   purrr_0.3.3      farver_2.0.3    splines_3.6.2
## [33] scales_1.1.0    ellipsis_0.3.0   htmltools_0.4.0 assertthat_0.2.1
## [37] colorspace_1.4-1 ggsignif_0.6.0   labeling_0.3     stringi_1.4.5
## [41] munsell_0.5.0   crayon_1.3.4

```