Visualizing Covid-19 Data

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TLDR

- Covid-19 has been spreading globally with over 700,000 people infected. Over 150,000 people are infected by Covid-19 in the US. Disease containment efforts are relatively more effective in some Asian countries and regions.
- The growth in the number of cases has become slower recently, which is more likely to be a sign of inadequate tests instead of the effectiveness of social distancing efforts.Positive rate of Covid-19 tests can be used to measure whether sufficient tests has been performed relative to the spread of the disease. It grows from 10% to 17% in the past 10 days.
- Dispite the variation in testing policies, we argue that rough comparisons in the severity of the spread could be made between states with similar numbers of tests per million population. We have found, for example, that the spread is more severe in NJ than DC, MI than IN and MA than VT.

Introduction

The goal of this report is to visualize the spread of Covid-19 and to understand the current situation in terms of where we are in the dynamics of the spread. We begin by a brief overview of the spread of Covid-19 across the globe and in the US. We then move onto the closer scrutiny at the US data at state-level. In particular we visualize the trajectory of the spread across time for individual states as well as make some qualititive attempts to compare the state of the spread across states.

However, due to the different testing policies across the globe and across the states in the US, comparisons among the countries and states may be misleading. After all, no one can be confirmed to be infected with Covid-19 if no test is performed. As such, the use of the figures in this report as means of prediction is discouraged. Comparisons among countries and states should also be made cautiously.

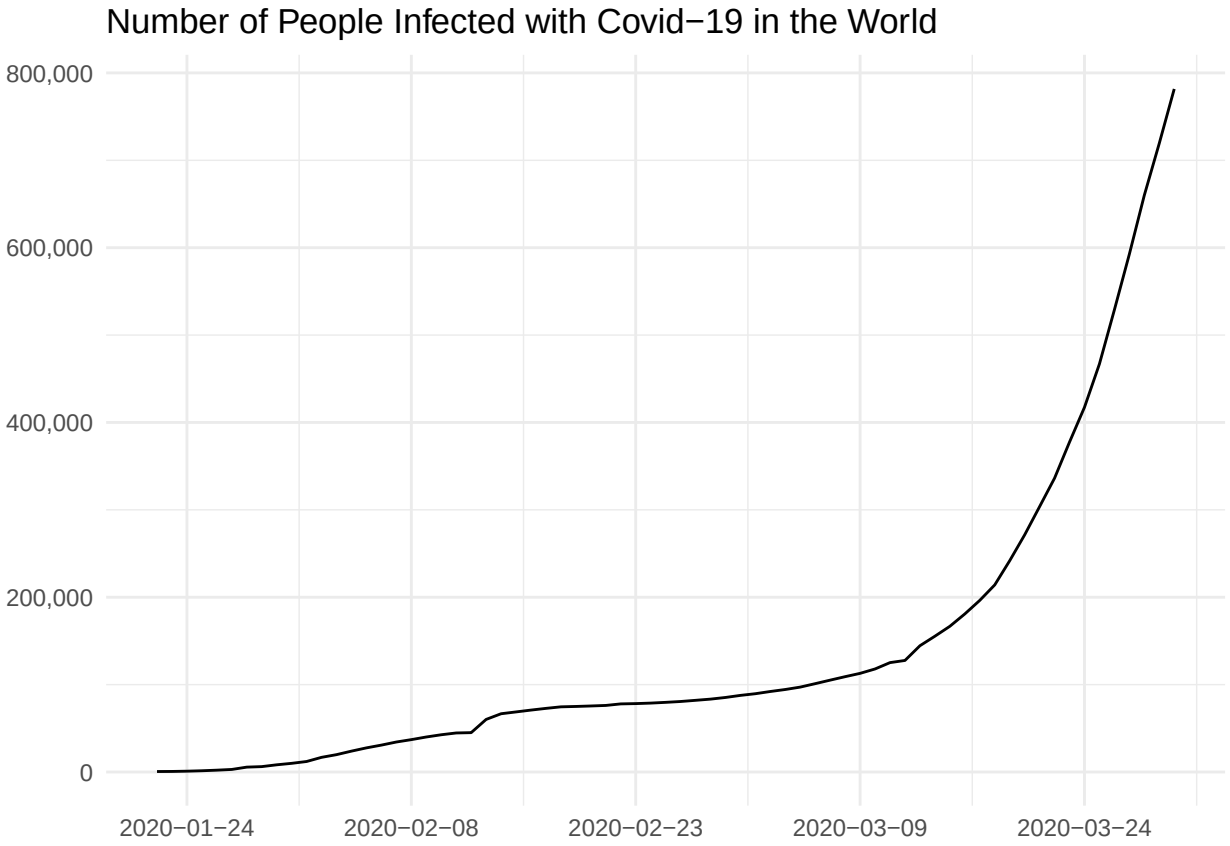
In this report, we use the data from Johns Hopkins dataset (also uploaded in the current repository) for the global overview and the data from The COVID Tracking Project for understanding the development in the US. We also use US states population data (uploaded in this repository) in order to understand the spread and testing of the virus from the per capita perspective.

This report is written with the data as of March 30th, 2020.

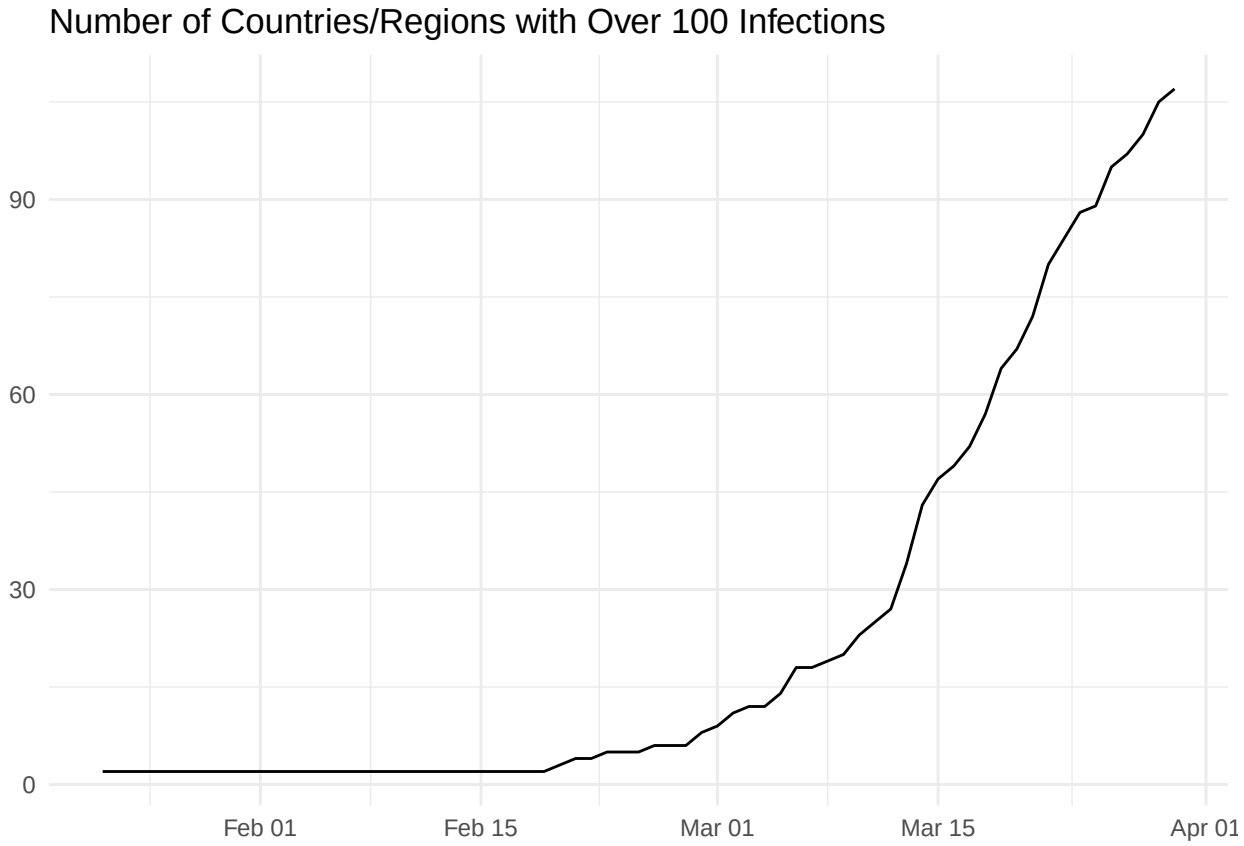
Overview of the Spread of Covid-19

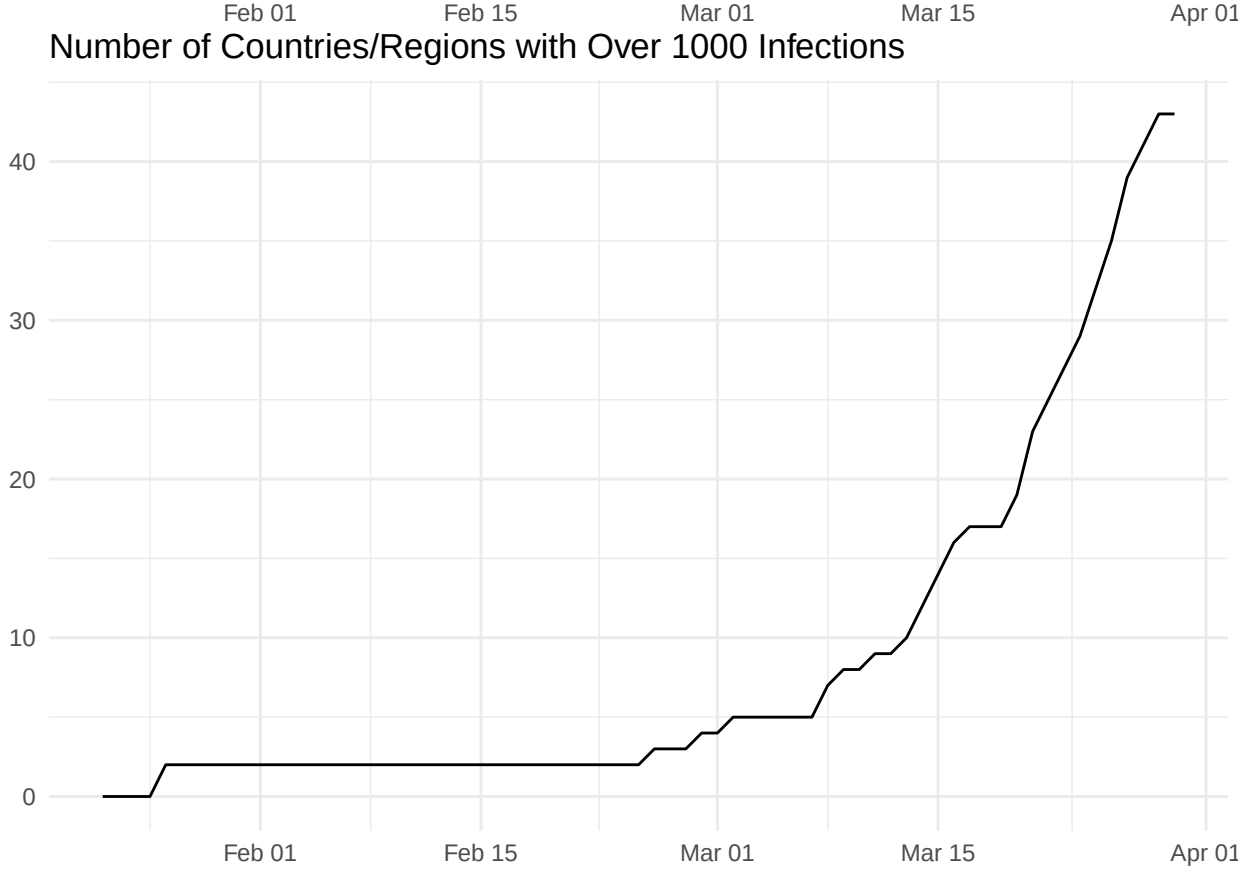
Covid-19 is a Global Pandemic

Covid-19 began spreading in China around the beginning of 2020 and continued to spread globally with around 782,000 people infected with the disease. The figure belows



The disease has been spreading in 178 countries and regions. Currently, there are 107 countries and regions with over 100 confirmed cases of Covid-19, and 43 countries and regions with over 1,000 confirmed cases. These numbers are growing rapidly. Most countries and regions have reached the 100 and 1000 thresholds around mid-March.


Number of Countries/Regions with Over 100 Infections
90
60
30
0
Feb 01
Feb 15
Mar 01
Mar 15
Apr 01


Number of Countries/Regions with Over 1000 Infections
40
30
20
10
0
Feb 01
Feb 15
Mar 01
Mar 15
Apr 01

Among these countries and regions, the following are the hardest-hit places. [1]

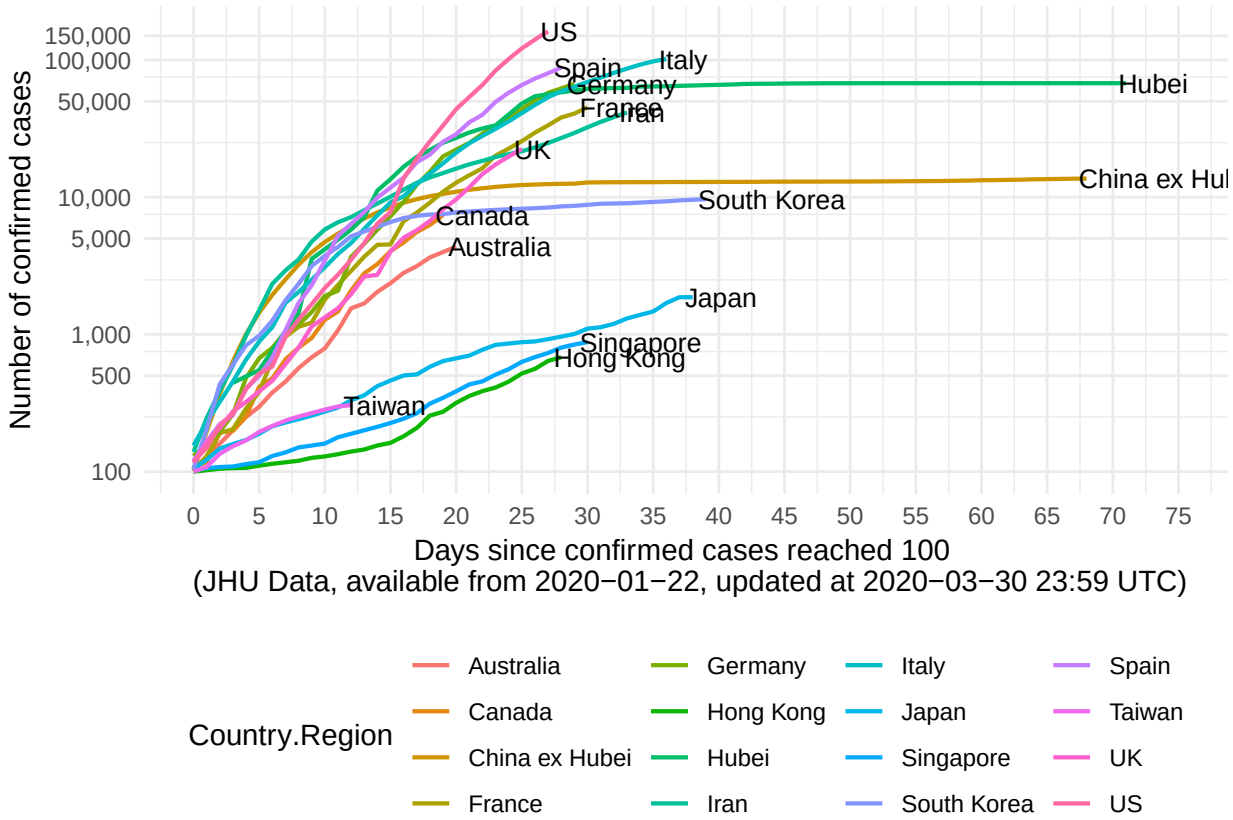
```
## # A tibble: 10 x 2
##    `Country/Region` `Number of Confirmed Cases`
##    <chr>                                 <dbl>
##  1 US                                   161807
##  2 Italy                                101739
##  3 Spain                                 87956
##  4 Hubei                                 67801
##  5 Germany                               66885
##  6 France                                45170
##  7 Iran                                  41495
##  8 UK                                    22453
##  9 Switzerland                           15922
## 10 China ex Hubei                        13677
```

The following figure visualizes the trajectory of the spread of Covid-19 in some of the countries and regions. In particular, for each country or region, we define the date when the number of confirmed cases of Covid-19 reached 100 as the date of the "outbreak" and plot how the cumulative number of confirmed cases evolves after the outbreak.[2]

It seems that China (both Hubei Province and the rest of China) and South Korea has controlled the spread with very limited daily growth in the number of confirmed cases roughly a month after their outbreaks (day 30). The disease is growing at a somewhat controlable rate after the outbreak in some of the other Asian countries and regions, including Japan, Singapre Hong Kong and Taiwan. The spread in rest of the countries in the figure is concerning: the numbers of people infected are growing rapidly at a "close-to-exponential" rate.

[1] Notice that we treat Hubei Province and the rest of China separatedly in our report.

[2] We set the outbreak of Hubei Provence as Jan 19. While data is not available from JHU before Jan 22, we have checked from other data source that the number of confirmed cases has reached 100 for Hubei on that day.



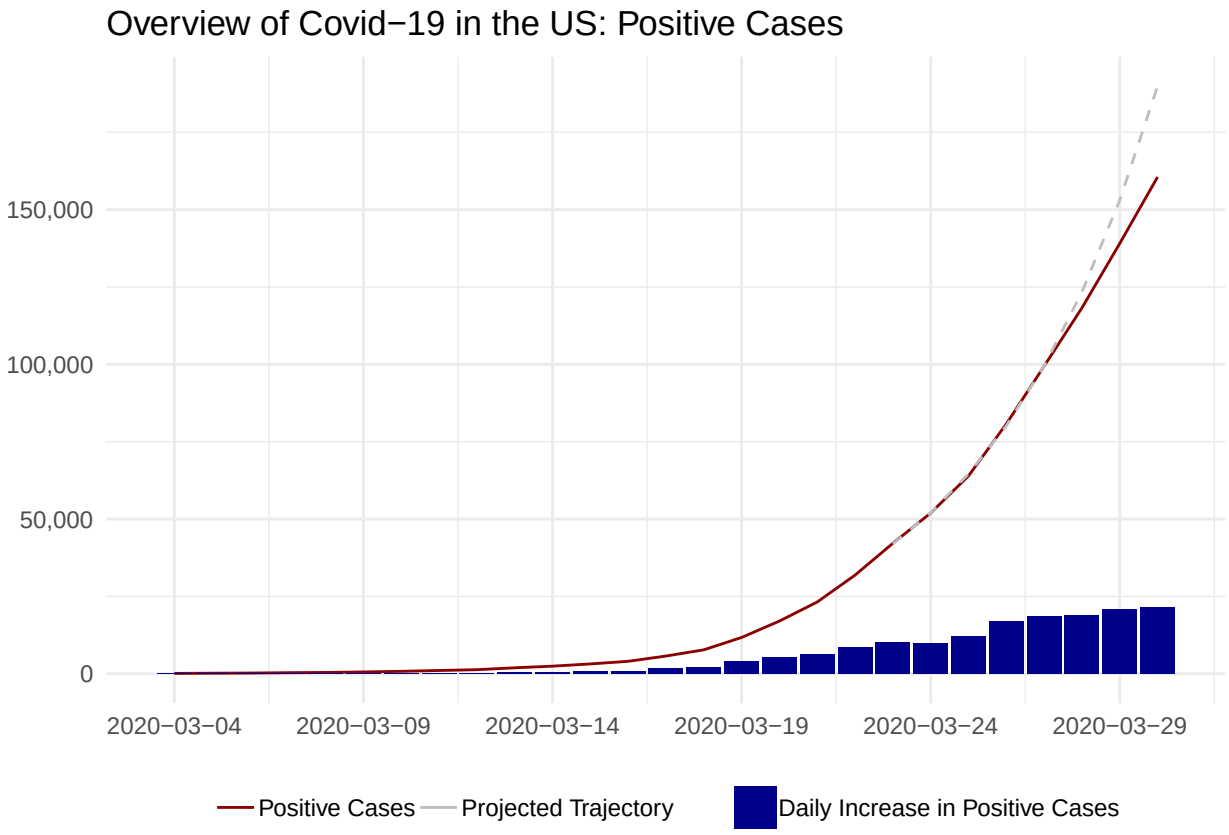
We emphasize again that the number of confirmed cases in each country is affected by its testing policy and capacity, which are not uniform across the world. Moreover, countries with similar total number of confirmed cases may differ in the severity of the spread of Covid-19, due to the difference in total population. As such, while it is tempting to argue a country is more efficient in containing the virus than another country, this argument is unfortunately inaccurate.

Spread of Covid-19 in the US

Now we move onto US data. Currently, there are about NA,000 confirmed cases of Covid-19 in the US.

The figure below show the dynamics of the spread in the US. The situation worsens extremely rapidly in late-March, with the number of cases doubling every 3 days. It also shows the number of incremental cases reported after the outbreak of Covid-19 in the US. Recently, the number of cases grows by about 20,000 everyday.

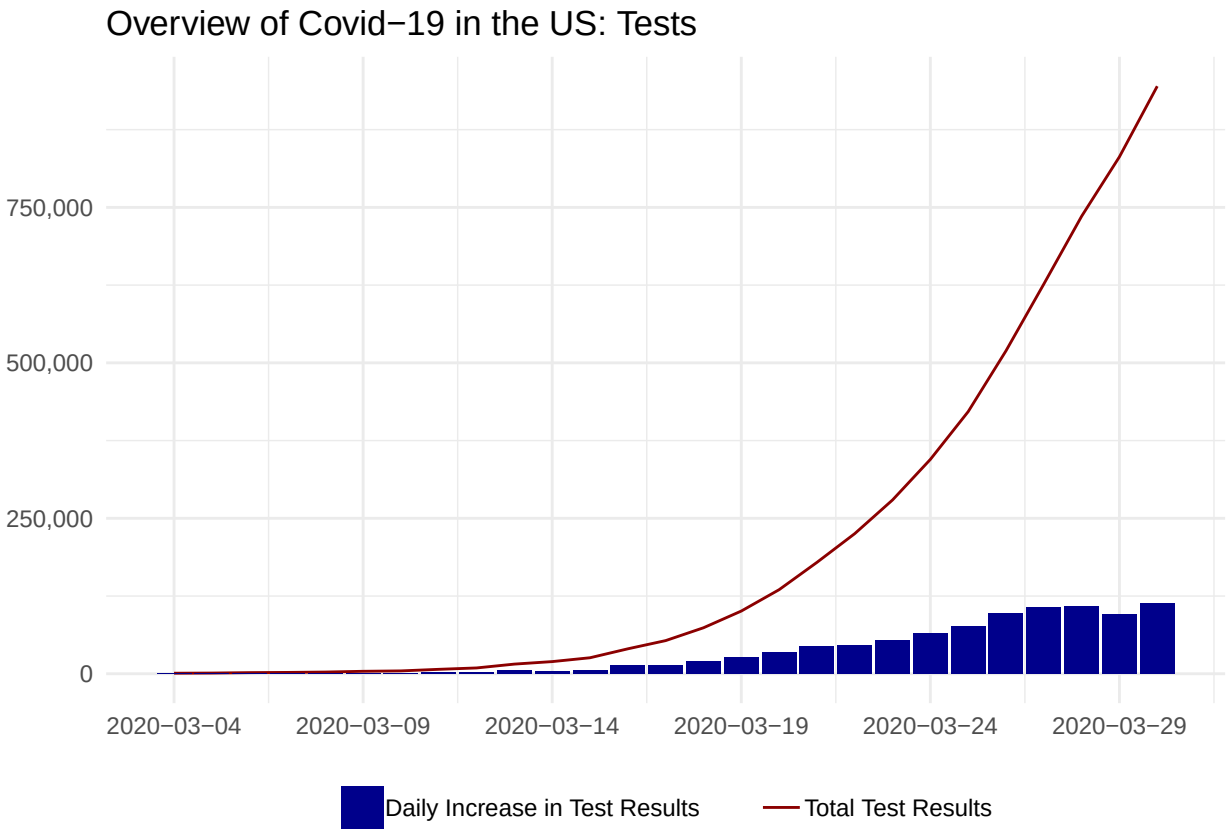
Massive social distancing practices as well as stay-at-home order have been implemented recently across the nation. While it might still be too early to carefully analyze their effectiveness, we estimated the average growth rate in the timeframe between 3 and 7 days from today and use the estimated rate to "project" the number of cases for the recent 3 days. A lower actual number of cases then the projected number **might** indicate a slower growth rate in the most recent days. One can see from the figure that the "projected" trajectory (grey dashed curve) indeed lies above the actual trajectory.



However, one should not be too optimistic about the current situation after observing this pattern. It is equally likely that the pattern is attributed to the inadequate growth in the testing capacity. As we argued before, the number of cases are constrained by the testing capacity.

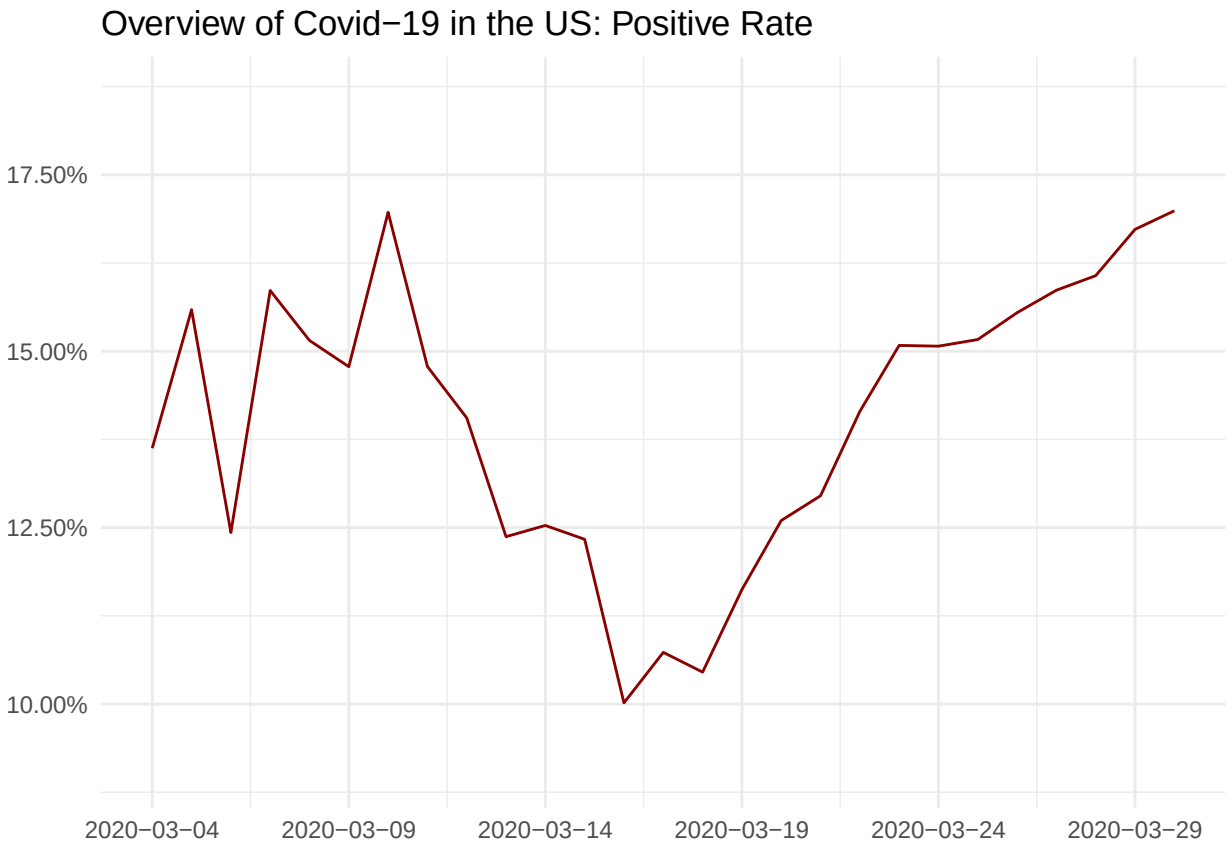
The figure below shows the cumulative number of Covid-19 tests performed in the US from the outbreak, together with its daily increments.[3] The ability to test Covid-19 infection is foundamental in containing the virus, as carriers of the virus may be asymptomatic. One can roughly see that the number of tests grows at the exponential rate from mid-March, followed by the linear rate in the few week. Therefore, attributing the slower growth rate in the spread of disease to effective social distancing measure might be unwarrented.

[3]Tests with pending results are excluded.



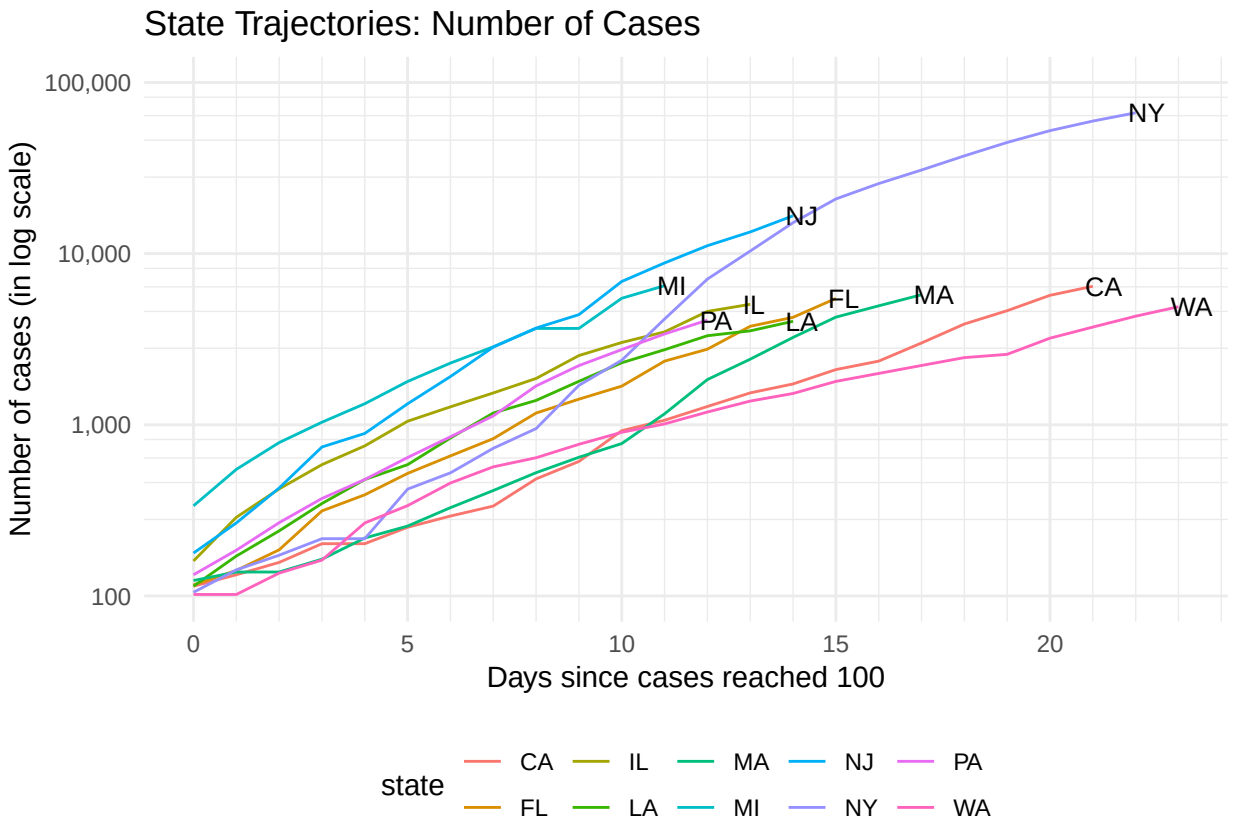
One metric, while it is not a perfect one, to measure if there are enough tests performed relative to the severity of the spread of disease is the positive rate, which is the percentage of people with positive test result among those tested for the virus. Persumably, only those who have symptoms similar to Covid-19 and the close contacts of infected people are tested for the virus. Fixing the relative sizes of these two groups, positive rate is higher when tests are reserved for people with more severe symptioms or when contact tracing is performed less agressively. Therefore, higher positive rate suggests insufficient testing capacity relative to the spread of the disease.

The figure below shows how the positive rate varies in the US after the outbreak. It starts from about 15% and decreases to the lowest level of 10% in mid-March. After that, the positive rate grows up to the current level of about 17%. This suggests that the testing capacity of the US is still inadequate relative to the spread of Covid-19 in the past 10 days. It also suggests that the slower growth rate in the number of cases in the recent days, which we noted earlier, may not be attributed to the effectiveness of social distancing efforts. At least there is not enough evidence to make this statement.



US State-Level Analysis

We visualize the trajectory of the spread of Covid-19 for the top 10 states in terms of total number of cases in the figure below. Observe from the figure that WA, NY and CA are the first three states where the outbreak started: The outbreak occurred more than 20 days ago in these state. NY, which is the state with the most cases of Covid-19, has 66497, 16636, 6498, 6447, 5752, 5473, 5057, 4896, 4087, 4025, 2877, 2809, 2627, 2571, 1933, 1834, 1786, 1413, 1307, 1221, 1157, 1031, 1020, 1008, 925, 859, 847, 806, 606, 576, 481, 473, 439, 424, 408, 401, 368, 314, 310, 275, 264, 256, 237, 175, 174, 171, 145, 126, 114, 109, 101, 94, 58, 30, 2, NA people contracting the virus. Covid-19 has been spreading rapidly in NJ and MI: No other state has seen more cases of Covid-19 than NJ and MI ten days after the outbreak.

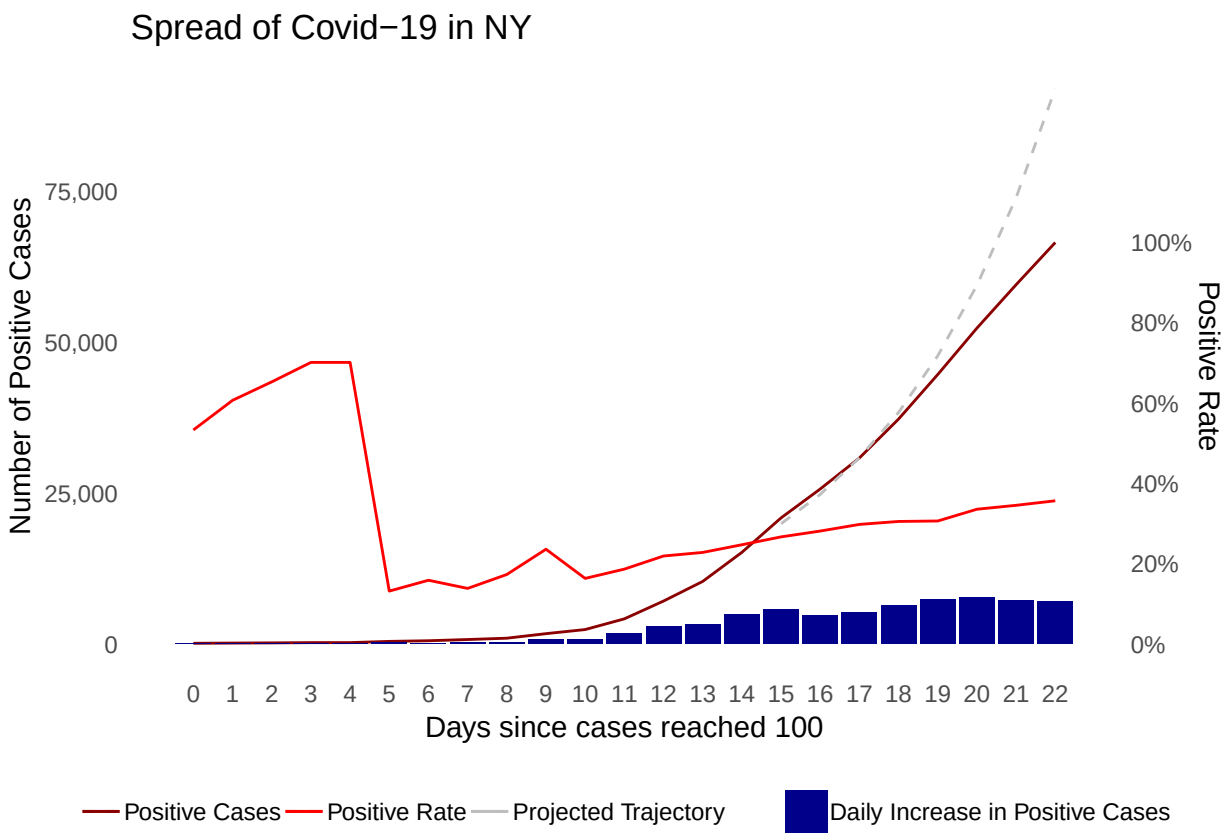


We study the trajectories of the following states in more details.

New York

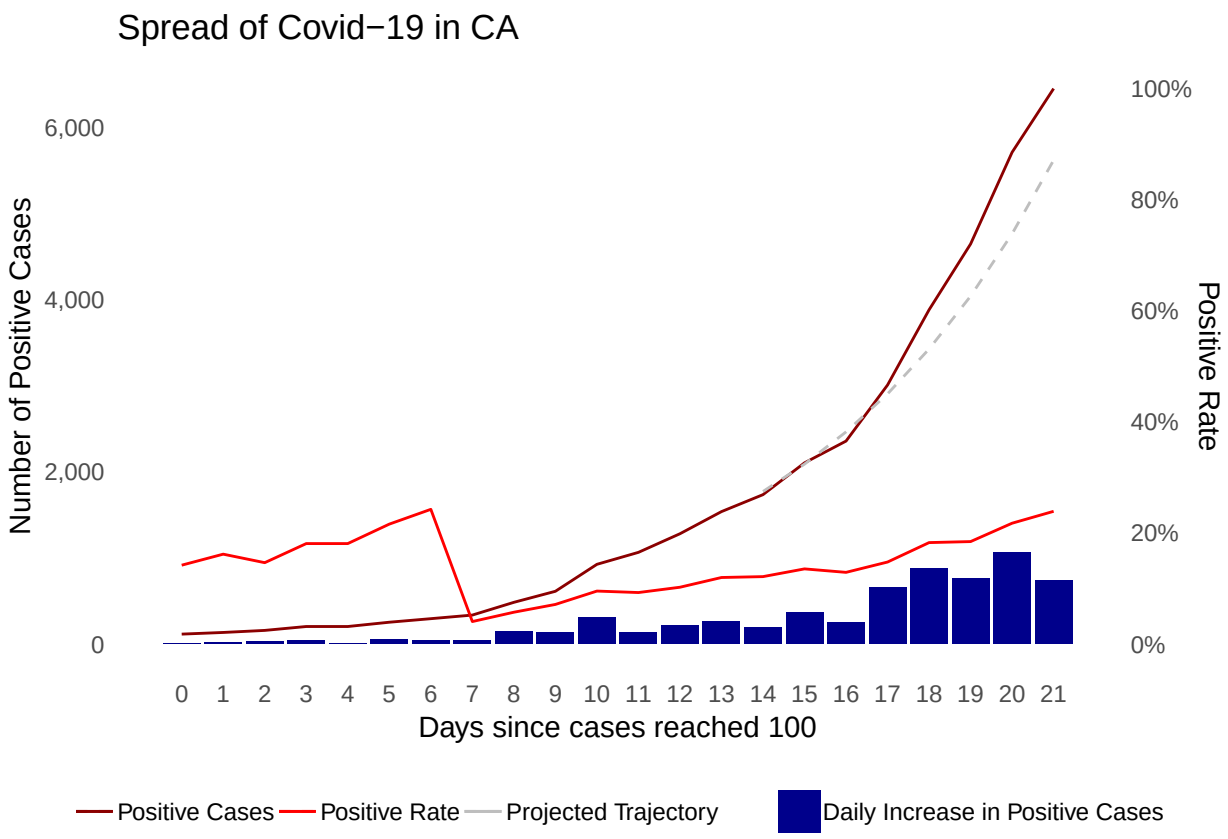
New York is the state that is hit the hardest by Coronavirus. The figure below displays the dynamics of the spread of Covid-19 in NY after its outbreak. The dark red curve represents the number of positive cases while the grey dashed curve is the projected number based on the average growth rate in a 5-day window between 3 and 7 days ago. The dark blue bars captures the daily increments in the number of positive cases. The light red curve represents the trajectory of NY's positive rate. Recall that we have argued that the positive rate of Covid-19 tests measures the testing capacity relative to the severity of the spread.

The situation in NY is qualitively similar to the overall situation in the US. This is natural since roughly41% of the positive cases are contributed by NY. In US, the growth rate seems to become slower in recent days. Again, this cannot be attributed to the effectiveness of social distancing policies: It could be alternatively casued by the limited testing capaicity. Indeed, the positive rate in NY doubles from 10% to 20% in the past 10 days, indicating that tests are insufficient relative to the spread of the disease.



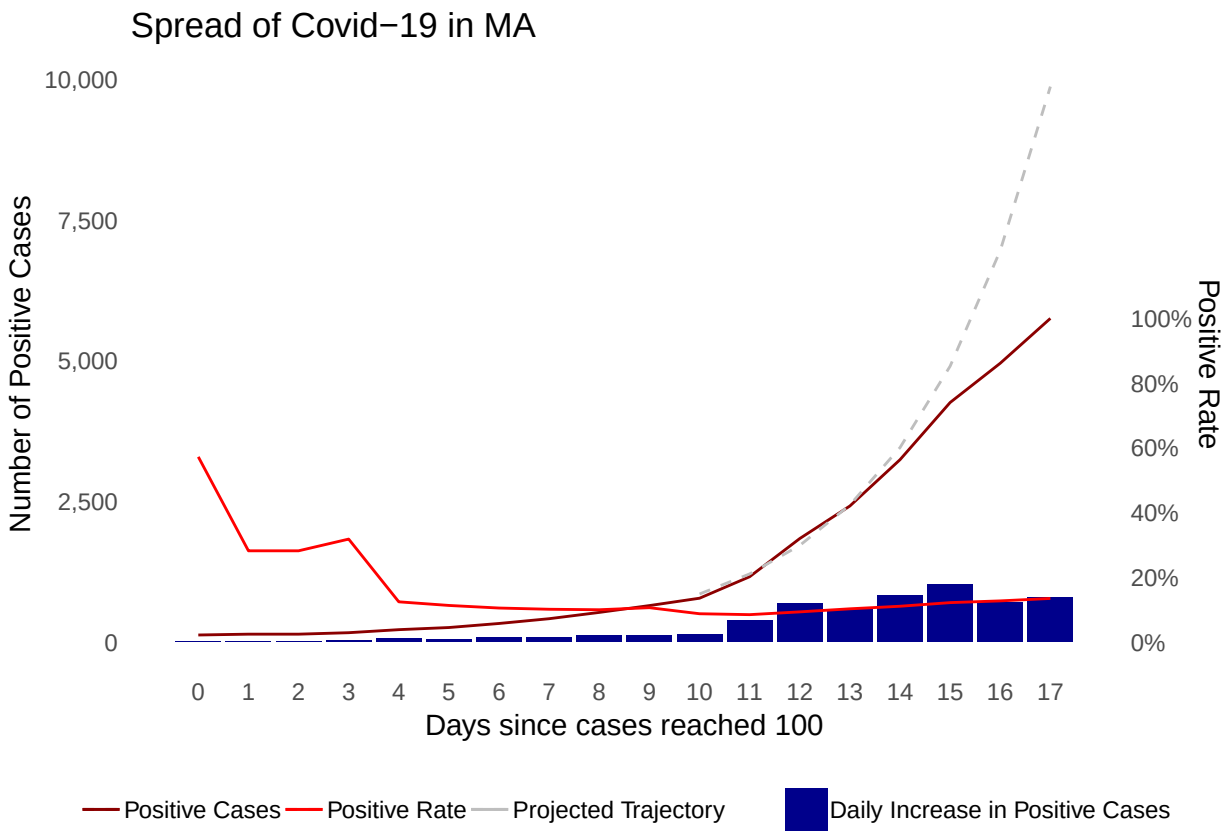
California

The situation in CA might be even worse. Testing capacity is not growing fast enough: Positive rate of Covid-19 test rises from about 10% to over 20% in the past 10 days. Despite the constraining testing capacity, the growth rate in the number of positive cases accelerates, with the actual trajectory above the projected trajectory based on the average growth rate in the past few days.



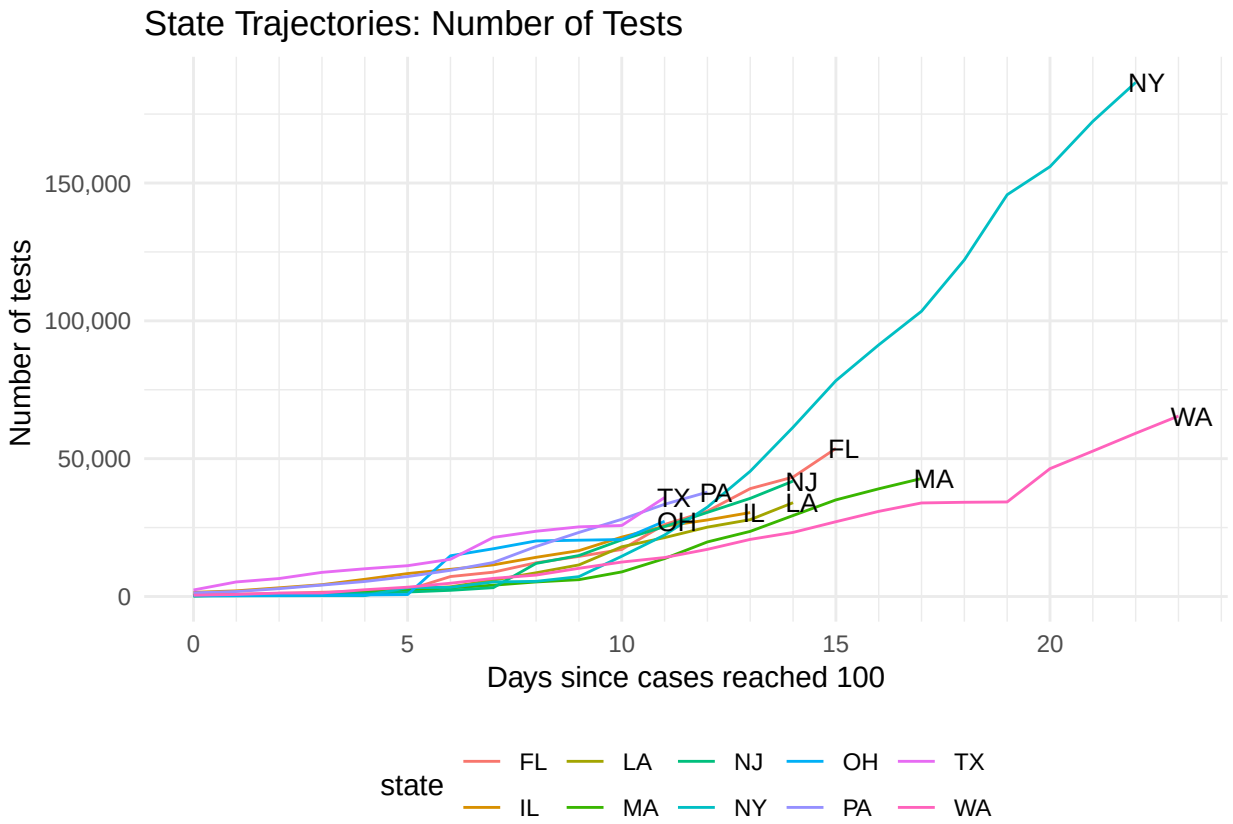
Massachusett

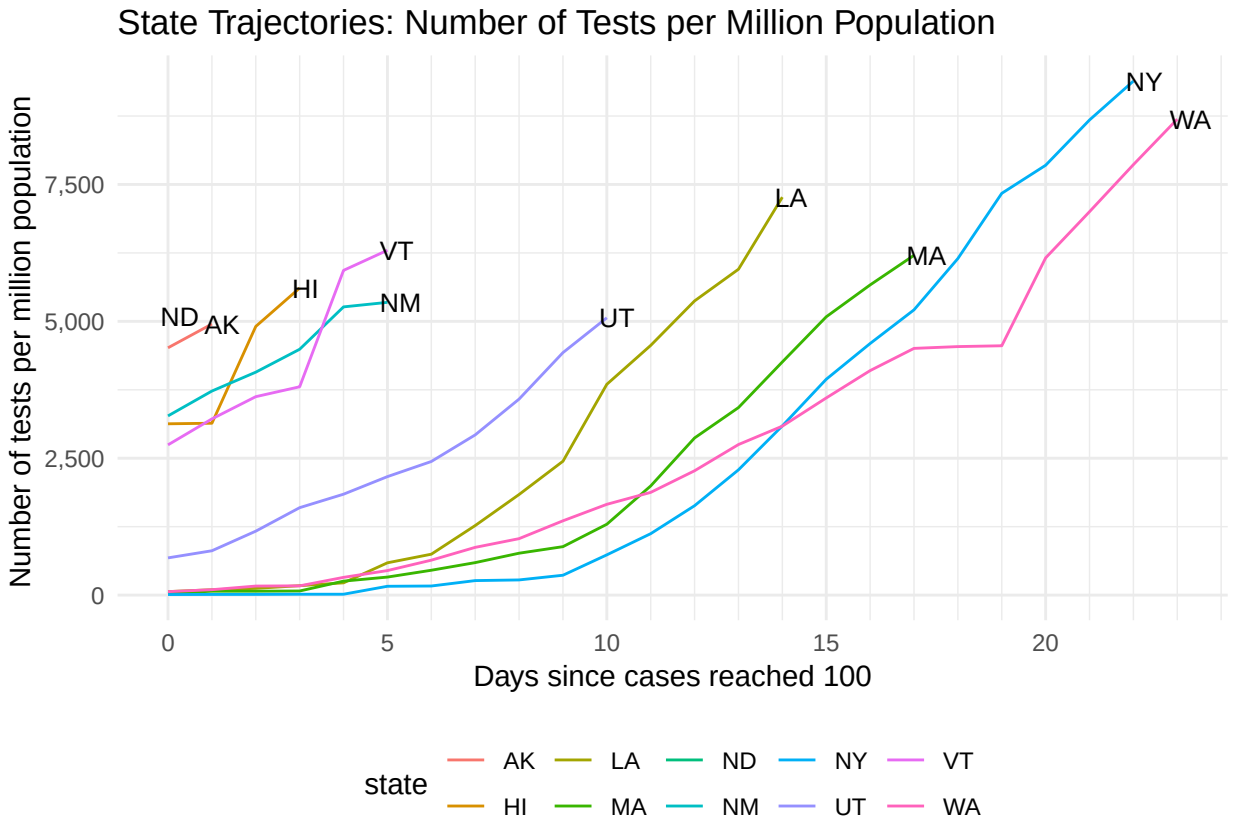
There could be good news in MA. The curve of positive rate suggests that testing capacity is not becoming more constraining. Yet, the growth rate in the number of positive cases decreases. This might suggest that social distancing measures are effective in MA.



Testing of Covid-19 at State Level

Testing of Covid-19 is essential since it is the first step to isolating the infected people and containing the virus. We have already seen a rapid growthing in the number of tests implemented in the US, and we break it down at the state level. The following two figures shows the number of tests and the number of tests per million population performed in the top 10 states according to the metrics, respectively. While we have argued that testing capacity is not sufficient relative to the severity of spread, we also want to point out that the states are making great effort to catch up.


State Trajectories: Number of Tests
Number of tests
150,000
100,000
50,000
0
0
5
10
15
20
Days since cases reached 100
NY
WA
FL
NJ
MA
TX
PA
LA
IL
OH
state
FL
LA
NJ
OH
TX
IL
MA
NY
PA
WA

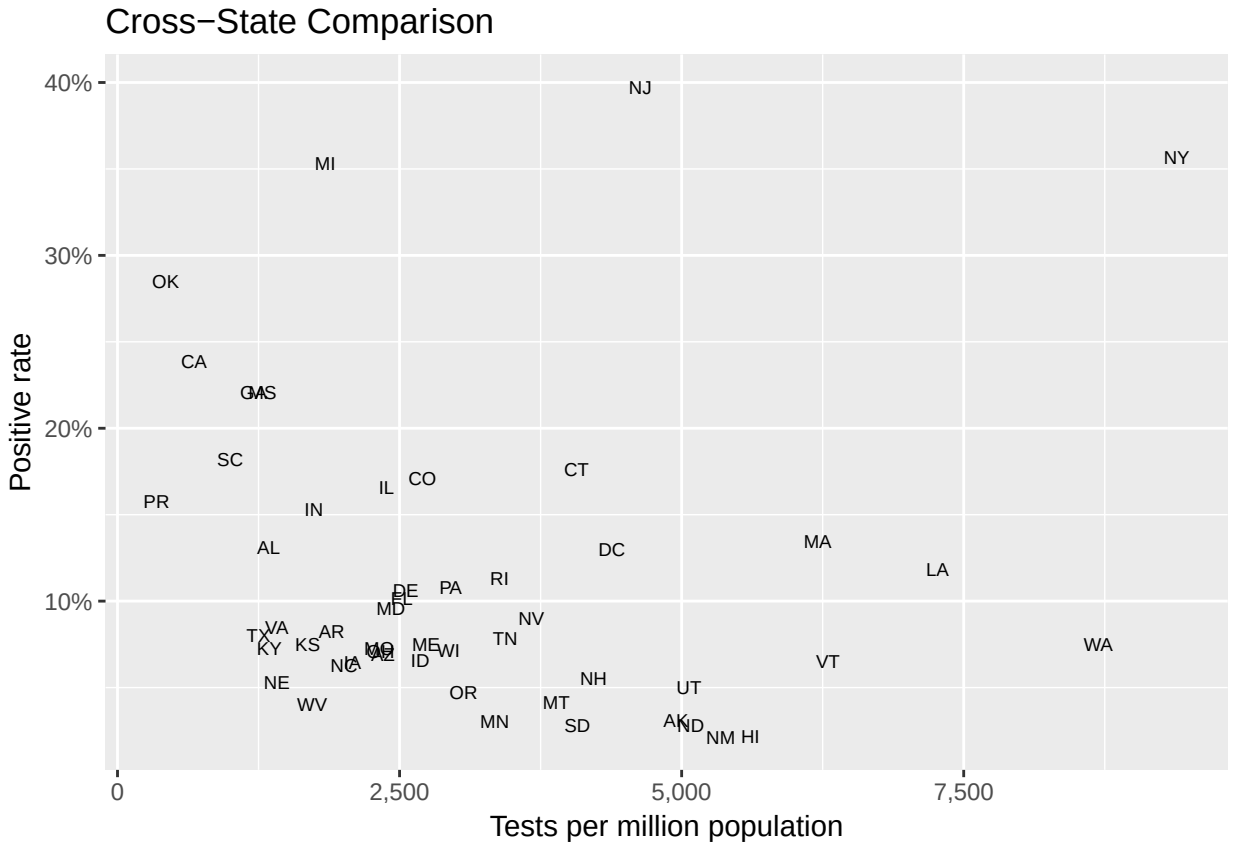

State Trajectories: Number of Tests per Million Population
Number of tests per million population
7,500
5,000
2,500
0
0
5
10
15
20
Days since cases reached 100
NY
WA
LA
MA
VT
HI
ND
AK
NM
UT
state
AK
LA
ND
NY
VT
HI
MA
NM
UT
WA

Cross-State Comparison

We have used another metric to measure the adequacy of testing capacity in the analysis above, which is the number of tests per million population. It measures whether the number of tests performed is sufficient relative to the population. The advantage of this metric, compared with the positive rate, is that it is not affected by the testing policies that varies across states. However, the disadvantage is that it is not linked to the scale of the spread of the disease: We need more tests when the spread is more severe.

We propose the following way to make cross-state comparison, which is demonstrated by the figure below. We conjecture that each state prioritizes testing those who are more likely to be infected by Covid-19, including symptomatic patients as well as close contacts of infected people. When two states have performed the same number of tests per million population, their tests should cover the groups of people who are equaly likely to be infected. Therefore, the comparison of the positive rate of Covid-19 tests between such two states should coincide with the relative severities of the spreads among the people with high risk, which is closely related to the relative severities of the spreads in the states.

Based on this logic and the figure below, we can argue, for example, that the spread is more severe in NY than WA, that it is more severe in NJ than DC, and that it is more severe in MI than IN.




```
## List of 59
##  $ line                :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ lineend      : chr "butt"
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
```

```
##  $ rect                 :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ text                 :List of 11
##   ..$ family       : chr ""
##   ..$ face         : chr "plain"
##   ..$ colour       : chr "black"
##   ..$ size         : num 11
##   ..$ hjust        : num 0.5
##   ..$ vjust        : num 0.5
##   ..$ angle        : num 0
##   ..$ lineheight   : num 0.9
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 2.75pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
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##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
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##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y         :List of 11
##   ..$ family       : NULL
```

```
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 2.75pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y.right   :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.75pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
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##   ..$ face         : NULL
##   ..$ colour       : chr "grey30"
##   ..$ size         : 'rel' num 0.8
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##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x          :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 2.2pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
```

```
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##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 2.2pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
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##   ..$ inherit.blank: logi TRUE
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##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 2.2pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.y.right    :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.2pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
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##   ..- attr(*, "unit")= chr "pt"
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```

```
##  $ axis.line.x          : NULL
##  $ axis.line.y          : NULL
##  $ legend.background    : list()
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##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ legend.spacing       : 'unit' num 11pt
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##   ..- attr(*, "unit")= chr "pt"
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##  $ legend.spacing.y     : NULL
##  $ legend.key           : list()
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##  $ legend.text          :List of 11
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##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 0.8
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##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ legend.title.align   : NULL
##  $ legend.position      : chr "right"
##  $ legend.direction     : NULL
##  $ legend.justification : chr "center"
##  $ legend.box           : NULL
##  $ legend.box.margin    : 'margin' num [1:4] 0cm 0cm 0cm 0cm
##   ..- attr(*, "valid.unit")= int 1
##   ..- attr(*, "unit")= chr "cm"
```

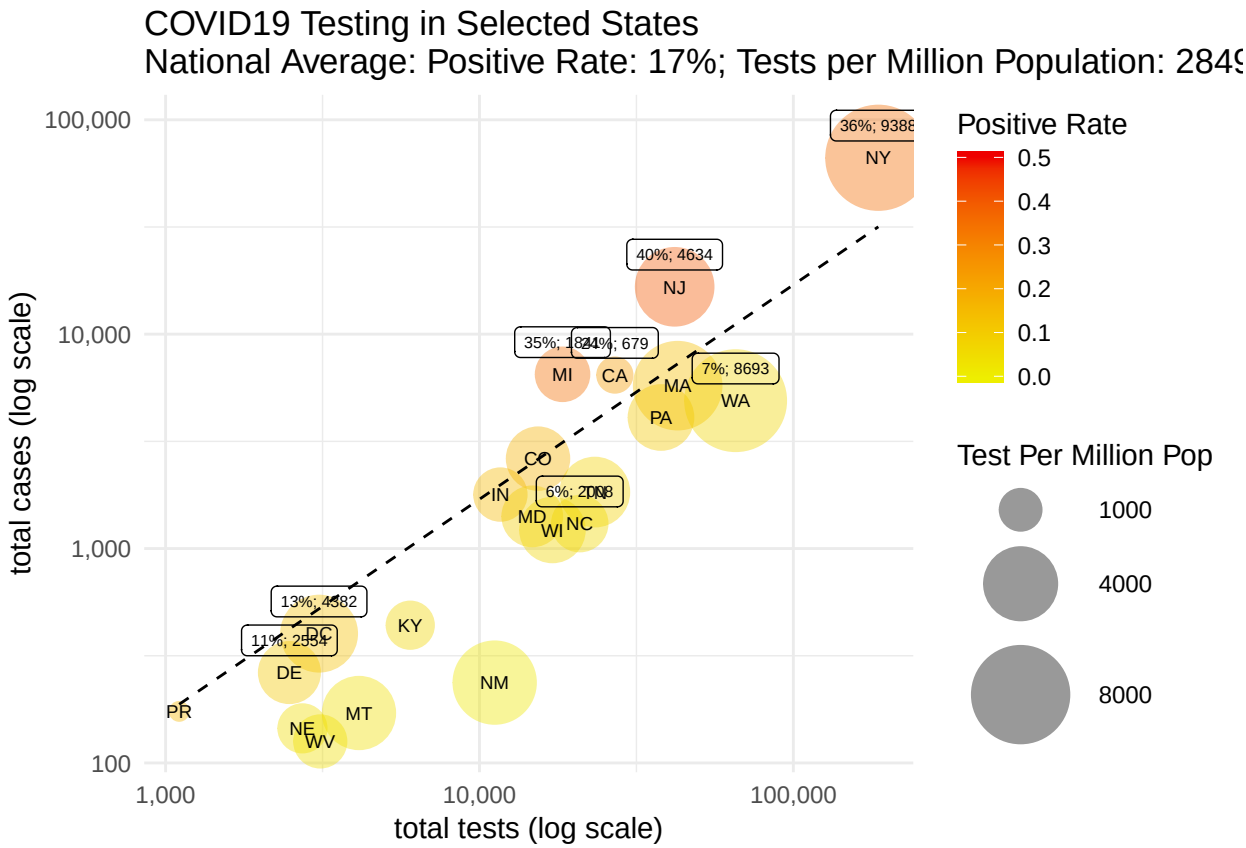
```
##  $ legend.box.background: list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.box.spacing   : 'unit' num 11pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ panel.background     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.border         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.spacing        : 'unit' num 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ panel.spacing.x      : NULL
##  $ panel.spacing.y      : NULL
##  $ panel.grid           :List of 6
##   ..$ colour       : chr "grey92"
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ panel.grid.minor     :List of 6
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 0.5
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ panel.ontop          : logi FALSE
##  $ plot.background      : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ plot.title           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 1.2
##   ..$ hjust        : num 0
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.subtitle        :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
```

```
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.caption         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 0.8
##   ..$ hjust        : num 1
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 5.5pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.tag             :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 1.2
##   ..$ hjust        : num 0.5
##   ..$ vjust        : num 0.5
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.tag.position    : chr "topleft"
##  $ plot.margin          : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ strip.background     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ strip.placement      : chr "inside"
##  $ strip.text           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey10"
##   ..$ size         : 'rel' num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 4.4pt 4.4pt 4.4pt 4.4pt
```

```
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.text.x         : NULL
##  $ strip.text.y         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.switch.pad.grid: 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ strip.switch.pad.wrap: 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi TRUE
##  - attr(*, "validate")= logi TRUE
```

One Figure with Rich Information

We finally provide a figure that converys the latests Covid-19 data of each state in the US. The dashed line represents the national average positive rate: about 17 people are infected by the Coronavirus our of every hundred people tested. Each "bubble" in the figure represents a state and is placed according to the number of tests and number of cases of Covid-19 (in log-scale). The color of a "bubble" captures the positive rate of the tests performed by the state and the size of a "bubble" captures the number of tests performed per million population. We only visualize the data for a selected set of states given the limited size of figure, but more states could be added to the figure.


COVID19 Testing in Selected States
National Average: Positive Rate: 17%; Tests per Million Population: 284
total cases (log scale)
100,000
10,000
1,000
100
1,000
10,000
100,000
total tests (log scale)
36%; 9388
NY
40%; 4634
NJ
35%; 1824
24%; 679
MI
CA
7%; 8693
MA
WA
PA
CO
IN
6%; 2
MD
WI
NC
13%; 4382
11%; 2554
DE
KY
NM
PR
MT
NE
WV
Positive Rate
0.5
0.4
0.3
0.2
0.1
0.0
Test Per Million Pop
1000
4000
8000