COVID19 Time Series Analysis, Worldwide and U.S.

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21 April 2020

Contents

Source data: 2019 Novel Coronavirus COVID-19 (2019-nCoV) Data Repository by Johns Hopkins CSSE; https://github.com/CSSEGISandData/COVID-19

Source code: https://github.com/opencedar/covid19

The visualizations in this document are heavily indebted to Edward Tufte and his use of sparklines—small, clutter-free time series lines—to show how many different panels or categories of data are changing through time; check out https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001OR.

Worldwide

Worldwide Summary

Sorted by total number of cases. Percent growth in total cases in the past seven days is last column.

Table 1: Worldwide Summary

Country_Region	days_100	conf	deaths	new_conf	conf_lag7	l7_rate
US	50	784326	42094	25240	580619	36%
Spain	50	200210	20852	1536	170099	16%
Italy	58	181228	24114	2256	159516	12%
France	52	156480	20292	2383	137875	12%
Germany	51	147065	4862	1881	130072	12%
United Kingdom	41	125856	16550	4684	89570	40%
Turkey	33	90980	2140	4674	61049	48%

Country_Region	days_100	conf	deaths	new_conf	conf_lag7	l7_rate
China	90	83817	4636	12	83213	0%
Iran	55	83505	5209	1294	73303	12%
Russia	35	47121	405	4268	18328	156%
Brazil	39	40743	2587	2089	23430	72%
Belgium	46	39983	5828	1487	30589	32%
Canada	41	37658	1726	2025	25680	48%
Netherlands	46	33588	3764	750	26710	24%
Switzerland	47	27944	1429	204	25688	8%
Portugal	39	20863	735	657	16934	24%
India	38	18539	592	924	10453	76%
Peru	35	16325	445	697	9784	68%
Ireland	38	15652	687	401	10647	48%
Austria	44	14795	470	46	14041	4%
Sweden	46	14777	1580	392	10948	36%
Israel	41	13713	177	222	11586	20%
Japan	60	10797	236	0	7370	48%
Korea, South	61	10674	236	13	10537	0%
Chile	36	10507	139	419	7525	40%
Saudi Arabia	38	10484	103	1122	4934	112%
Ecuador	34	10128	507	660	7529	36%
Poland	38	9593	380	306	6934	40%
Romania	38	8936	478	190	6633	36%
Pakistan	36	8418	176	70	5496	52%
Mexico	33	8261	686	764	4661	76%
Singapore	52	8014	11	1426	2918	176%
Denmark	42	7711	364	131	6513	20%
United Arab Emirates	34	7265	43	484	4521	60%
Norway	46	7156	181	78	6603	8%
Czechia	39	6900	194	154	6059	12%
Indonesia	37	6760	590	185	4557	48%
Serbia	33	6630	125	312	4054	64%
Australia	42	6547	67	0	6351	4%
Philippines	38	6459	428	200	4932	32%
Belarus	22	6264	51	1485	2919	116%
Qatar	41	6015	9	567	3231	88%
Ukraine	27	5710	151	261	3102	84%
Malaysia	43	5425	89	36	4817	12%
Dominican Republic	31	4964	235	284	3167	56%
Panama	33	4467	126	194	3400	32%
Colombia	33	3977	189	185	2852	40%
Finland	39	3868	98	85	3064	28%
Luxembourg	35	3558	75	8	3292	8%
Egypt	38	3333	250	189	2190	52%
South Africa	34	3300	58	142	2272	44%
Morocco	30	3046	143	191	1763	72%
Bangladesh	15	2948	101	492	803	268%
Argentina	32	2941	136	102	2208	32%
Thailand	37	2792	47	27	2579	8%
Algeria	31	2718	384	89	1983	36%
Moldova	29	2548	70	76	1712	48%
Greece	39	2245	116	10	2145	4%
Kuwait	38	1995	9	80	1300	52%

Country_Region	days_100	conf	deaths	new_conf	conf_lag7	l7_rate
Hungary	31	1984	199	68	1458	36%
Bahrain	42	1907	7	26	1361	40%
Croatia	33	1881	47	10	1650	12%
Kazakhstan	26	1852	19	176	1091	68%
Iceland	40	1773	10	2	1711	4%
Uzbekistan	24	1627	5	62	998	64%
Iraq	39	1574	82	35	1378	16%
Estonia	38	1535	40	7	1332	16%
New Zealand	30	1440	12	9	1349	8%
Azerbaijan	26	1436	19	38	1148	24%
Oman	26	1410	7	144	727	92%
Armenia	33	1339	22	48	1039	28%
Slovenia	39	1335	77	5	1212	12%
Lithuania	30	1326	37	28	1062	24%
Bosnia and Herzegovina	30	1309	49	24	1037	28%
North Macedonia	30	1225	54	18	854	44%
Slovakia	34	1173	13	12	769	52%
Cameroon	23	1163	42	146	820	40%
Cuba	24	1087	36	52	726	48%
Ghana	26	1042	9	0	566	84%
Afghanistan	25	1026	36	30	665	56%
World	38	2448966	169277	70079	1900013	28%

Ln (Seven-Day-Moving-Average New Cases) Impact on Ln (New Cases)

In other words, elasticity. How does this elasticity change through time, from days since the 100th case?

An elasticity under 1 indicates that over a seven-day period, new cases are decreasing.

The black line shows the best curve fit for elasticity changing over time. All countries generally are moving to cap the rate of exponential growth. Countries above the line are doing worse than average, and those below the line are doing better than average. A rate below 1 indicates that new cases are declining over an average 7-day period.

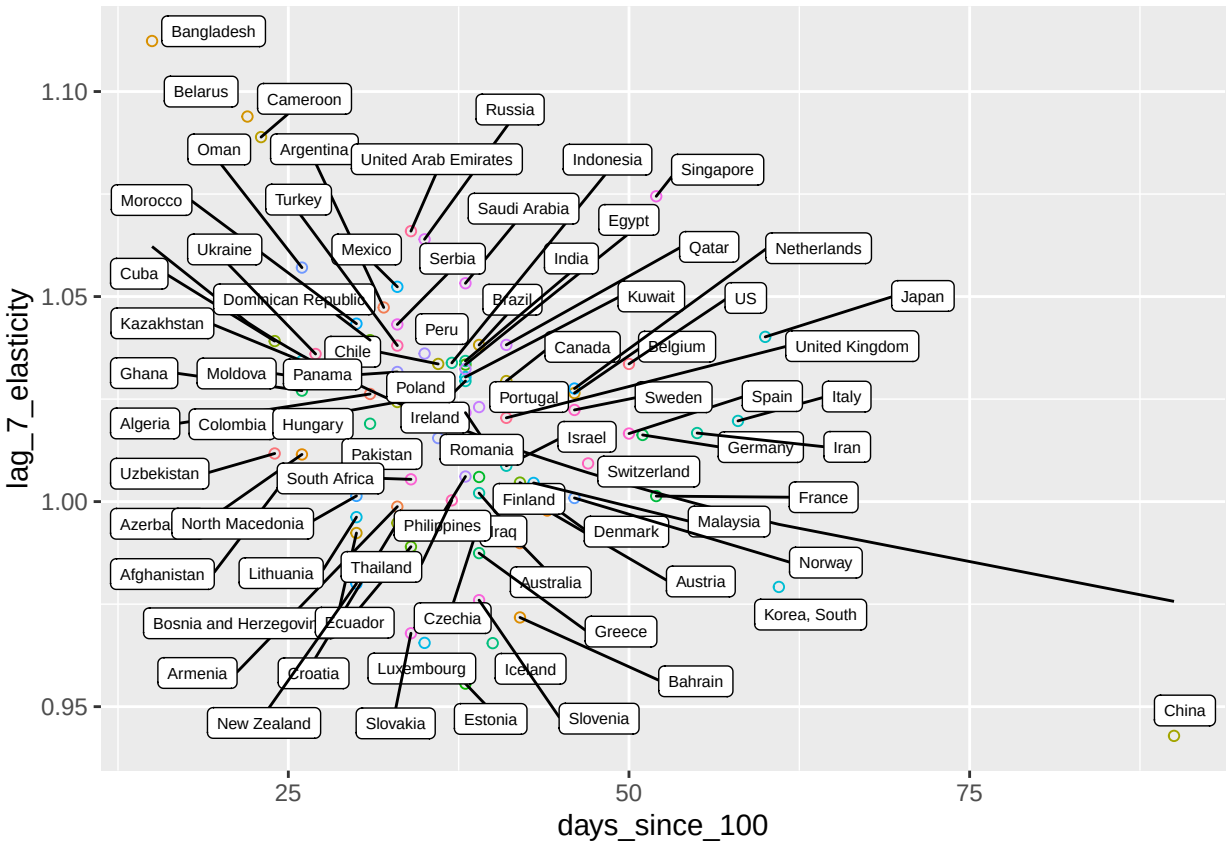


Table 2: Countries by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

country	days_since_100	lag_7_elasticity	prediction	residual
Bangladesh	15	1.11	1.06	0.05
Belarus	22	1.09	1.04	0.05
Cameroon	23	1.09	1.04	0.05
Uzbekistan	24	1.01	1.04	-0.03
Cuba	24	1.04	1.04	0.00
Afghanistan	25	1.01	1.04	-0.03
Azerbaijan	26	1.01	1.04	-0.02
Ghana	26	1.03	1.04	-0.01
Kazakhstan	26	1.03	1.04	0.00
Oman	26	1.06	1.04	0.02
Ukraine	27	1.04	1.03	0.00
Moldova	29	1.03	1.03	0.00
New Zealand	30	0.98	1.03	-0.05
Bosnia and Herzegovina	30	0.99	1.03	-0.04
Lithuania	30	1.00	1.03	-0.03
North Macedonia	30	1.00	1.03	-0.03
Morocco	30	1.04	1.03	0.01
Hungary	31	1.02	1.03	-0.01
Algeria	31	1.03	1.03	0.00
Dominican Republic	31	1.04	1.03	0.01
Argentina	32	1.05	1.03	0.02
Croatia	33	0.99	1.02	-0.03

country	days_since_100	lag_7_elasticity	prediction	residual
Armenia	33	1.00	1.02	-0.03
Colombia	33	1.02	1.02	0.00
Panama	33	1.03	1.02	0.01
Turkey	33	1.04	1.02	0.01
Serbia	33	1.04	1.02	0.02
Mexico	33	1.05	1.02	0.03
Slovakia	34	0.97	1.02	-0.05
Ecuador	34	0.99	1.02	-0.03
South Africa	34	1.01	1.02	-0.02
United Arab Emirates	34	1.07	1.02	0.04
Luxembourg	35	0.97	1.02	-0.06
Peru	35	1.04	1.02	0.01
Russia	35	1.06	1.02	0.04
Pakistan	36	1.02	1.02	0.00
Chile	36	1.03	1.02	0.01
Thailand	37	1.00	1.02	-0.02
Indonesia	37	1.03	1.02	0.02
Estonia	38	0.96	1.02	-0.06
Philippines	38	1.01	1.02	-0.01
Romania	38	1.02	1.02	0.00
Ireland	38	1.03	1.02	0.01
Kuwait	38	1.03	1.02	0.01
Poland	38	1.03	1.02	0.02
Egypt	38	1.03	1.02	0.02
India	38	1.03	1.02	0.02
Saudi Arabia	38	1.05	1.02	0.04
Slovenia	39	0.98	1.02	-0.04
Greece	39	0.99	1.02	-0.03
Czechia	39	0.99	1.02	-0.02
Iraq	39	1.00	1.02	-0.01
Finland	39	1.01	1.02	-0.01
Portugal	39	1.02	1.02	0.01
Brazil	39	1.04	1.02	0.02
Iceland	40	0.97	1.01	-0.05
Israel	41	1.01	1.01	0.00
United Kingdom	41	1.02	1.01	0.01
Canada	41	1.03	1.01	0.02
Qatar	41	1.04	1.01	0.02
Bahrain	42	0.97	1.01	-0.04
Australia	42	0.99	1.01	-0.02
Denmark	42	1.00	1.01	-0.01
Malaysia	43	1.00	1.01	-0.01
Austria	44	1.00	1.01	-0.01
Norway	46	1.00	1.01	-0.01
Sweden	46	1.02	1.01	0.01
Belgium	46	1.03	1.01	0.02
Netherlands	46	1.03	1.01	0.02
Switzerland	47	1.01	1.01	0.00
Spain	50	1.02	1.00	0.01
US	50	1.03	1.00	0.03
Germany	51	1.02	1.00	0.01
France	52	1.00	1.00	0.00

country	days_since_100	lag_7_elasticity	prediction	residual
Singapore	52	1.07	1.00	0.07
Iran	55	1.02	1.00	0.02
Italy	58	1.02	1.00	0.02
Japan	60	1.04	1.00	0.04
Korea, South	61	0.98	0.99	-0.02
China	90	0.94	0.98	-0.03

Comparisons with averages

Table 3: Countries by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

country	days_since_100	lag_7_elasticity	prediction	ww_residual
Bangladesh	15	1.11	1.06	0.05
Belarus	22	1.09	1.04	0.05
Cameroon	23	1.09	1.04	0.05
Uzbekistan	24	1.01	1.04	-0.03
Cuba	24	1.04	1.04	0.00
Afghanistan	25	1.01	1.04	-0.03
Azerbaijan	26	1.01	1.04	-0.02
Ghana	26	1.03	1.04	-0.01
Kazakhstan	26	1.03	1.04	0.00
Oman	26	1.06	1.04	0.02
Ukraine	27	1.04	1.03	0.00
Moldova	29	1.03	1.03	0.00
New Zealand	30	0.98	1.03	-0.05
Bosnia and Herzegovina	30	0.99	1.03	-0.04
Lithuania	30	1.00	1.03	-0.03
North Macedonia	30	1.00	1.03	-0.03
Morocco	30	1.04	1.03	0.01
Hungary	31	1.02	1.03	-0.01
Algeria	31	1.03	1.03	0.00
Dominican Republic	31	1.04	1.03	0.01
Argentina	32	1.05	1.03	0.02
Croatia	33	0.99	1.02	-0.03
Armenia	33	1.00	1.02	-0.03
Colombia	33	1.02	1.02	0.00
Panama	33	1.03	1.02	0.01
Turkey	33	1.04	1.02	0.01
Serbia	33	1.04	1.02	0.02
Mexico	33	1.05	1.02	0.03
Slovakia	34	0.97	1.02	-0.05
Ecuador	34	0.99	1.02	-0.03
South Africa	34	1.01	1.02	-0.02
United Arab Emirates	34	1.07	1.02	0.04
Luxembourg	35	0.97	1.02	-0.06
Peru	35	1.04	1.02	0.01
Russia	35	1.06	1.02	0.04
Pakistan	36	1.02	1.02	0.00
Chile	36	1.03	1.02	0.01
Thailand	37	1.00	1.02	-0.02

country	days_since_100	lag_7_elasticity	prediction	ww_residual
Indonesia	37	1.03	1.02	0.02
Estonia	38	0.96	1.02	-0.06
Philippines	38	1.01	1.02	-0.01
Romania	38	1.02	1.02	0.00
Ireland	38	1.03	1.02	0.01
Kuwait	38	1.03	1.02	0.01
Poland	38	1.03	1.02	0.02
Egypt	38	1.03	1.02	0.02
India	38	1.03	1.02	0.02
Saudi Arabia	38	1.05	1.02	0.04
Slovenia	39	0.98	1.02	-0.04
Greece	39	0.99	1.02	-0.03
Czechia	39	0.99	1.02	-0.02
Iraq	39	1.00	1.02	-0.01
Finland	39	1.01	1.02	-0.01
Portugal	39	1.02	1.02	0.01
Brazil	39	1.04	1.02	0.02
Iceland	40	0.97	1.01	-0.05
Israel	41	1.01	1.01	0.00
United Kingdom	41	1.02	1.01	0.01
Canada	41	1.03	1.01	0.02
Qatar	41	1.04	1.01	0.02
Bahrain	42	0.97	1.01	-0.04
Australia	42	0.99	1.01	-0.02
Denmark	42	1.00	1.01	-0.01
Malaysia	43	1.00	1.01	-0.01
Austria	44	1.00	1.01	-0.01
Norway	46	1.00	1.01	-0.01
Sweden	46	1.02	1.01	0.01
Belgium	46	1.03	1.01	0.02
Netherlands	46	1.03	1.01	0.02
Switzerland	47	1.01	1.01	0.00
Spain	50	1.02	1.00	0.01
US	50	1.03	1.00	0.03
Germany	51	1.02	1.00	0.01
France	52	1.00	1.00	0.00
Singapore	52	1.07	1.00	0.07
Iran	55	1.02	1.00	0.02
Italy	58	1.02	1.00	0.02
Japan	60	1.04	1.00	0.04
Korea, South	61	0.98	0.99	-0.02
China	90	0.94	0.98	-0.03

Forecast New Cases by Country

We estimate new cases by date, to see when countries will peak, based on the worldwide curve fit.

Table 4: Forecast Peak New Cases by Country

country	total_cases	peak_new_cases	date	population	perc_pop_infected
China	84,343	15,133	2020-02-13	1,378,665,000	0.0%
Italy	244,260	6,557	2020-03-21	60,627,498	0.4%

country	total_cases	peak_new_cases	date	population	perc_pop_infected
Thailand	3,847	188	2020-03-22	68,971,331	0.0%
Switzerland	34,535	1,321	2020-03-23	8,373,338	0.4%
Luxembourg	4,259	234	2020-03-25	582,014	0.7%
Spain	268,569	9,630	2020-03-25	46,484,062	0.6%
Austria	16,912	1,321	2020-03-26	8,736,668	0.2%
Estonia	2,120	134	2020-03-26	1,315,790	0.2%
Malaysia	7,464	235	2020-03-26	30,684,804	0.0%
Germany	192,526	6,933	2020-03-27	82,348,669	0.2%
Norway	9,205	386	2020-03-27	5,234,519	0.2%
Slovenia	1,882	70	2020-03-27	2,065,042	0.1%
Australia	7,259	497	2020-03-28	24,190,907	0.0%
Argentina	9,689	234	2020-03-31	43,590,368	0.0%
Philippines	11,030	538	2020-03-31	103,663,927	0.0%
Croatia	2,781	96	2020-04-01	4,174,349	0.1%
Armenia	2,629	92	2020-04-02	2,936,146	0.1%
Greece	2,737	129	2020-04-02	10,775,971	0.0%
Iceland	2,127	99	2020-04-02	335,439	0.6%
Israel	19,483	765	2020-04-02	8,546,000	0.2%
New Zealand	1,942	89	2020-04-02	4,693,200	0.0%
Algeria	6,594	185	2020-04-03	40,551,404	0.0%
Finland	6,850	267	2020-04-04	5,495,303	0.1%
France	197,006	25,646	2020-04-04	66,721,256	0.3%
Canada	87,691	2,778	2020-04-05	36,109,487	0.2%
Bosnia and Herzegovina	2,307	90	2020-04-07	3,386,267	0.1%
Denmark	11,377	391	2020-04-07	5,728,010	0.2%
Iraq	2,688	91	2020-04-07	36,610,632	0.0%
Azerbaijan	2,746	105	2020-04-08	9,757,812	0.0%
Sweden	29,603	726	2020-04-08	9,923,085	0.3%
Panama	10,661	279	2020-04-09	4,037,078	0.3%
Ecuador	16,123	2,196	2020-04-10	16,491,115	0.1%
Hungary	4,604	210	2020-04-10	9,814,023	0.0%
Ireland	33,534	1,515	2020-04-10	4,755,335	0.7%
Netherlands	62,532	1,346	2020-04-10	17,030,314	0.4%
Portugal	35,457	1,516	2020-04-10	10,325,452	0.3%
United Kingdom	221,296	8,733	2020-04-10	65,611,593	0.3%
US	1,570,279	35,098	2020-04-10	322,941,311	0.5%
Romania	18,002	523	2020-04-11	19,702,468	0.1%
Turkey	229,693	5,138	2020-04-11	79,821,724	0.3%
Bahrain	3,038	225	2020-04-13	1,425,791	0.2%
Peru	51,134	2,265	2020-04-13	30,926,032	0.2%
Moldova	6,353	222	2020-04-14	2,802,170	0.2%
Uzbekistan	3,725	167	2020-04-14	31,847,900	0.0%
Afghanistan	2,445	70	2020-04-15	35,383,128	0.0%
Belgium	74,161	2,454	2020-04-15	11,331,422	0.7%
Chile	26,409	534	2020-04-16	18,209,068	0.1%
North Macedonia	2,542	107	2020-04-16	2,080,745	0.1%
Serbia	23,586	445	2020-04-16	7,058,322	0.3%
Brazil	138,996	3,257	2020-04-17	206,163,058	0.1%
Dominican Republic	17,090	371	2020-04-17	10,397,743	0.2%
Indonesia	19,220	407	2020-04-17	261,554,226	0.0%
Japan	41,480	1,161	2020-04-17	126,994,511	0.0%
Morocco	12,884	281	2020-04-17	35,126,296	0.0%

country	total_cases	peak_new_cases	date	population	perc_pop_infected
Ukraine	19,091	501	2020-04-17	45,004,645	0.0%
Cuba	3,794	63	2020-04-18	11,335,109	0.0%
Lithuania	2,542	90	2020-04-18	2,868,231	0.1%
South Africa	6,845	251	2020-04-18	56,203,654	0.0%
Colombia	9,725	353	2020-04-19	48,171,392	0.0%
Ghana	4,051	208	2020-04-19	28,481,946	0.0%
India	62,710	1,893	2020-04-19	1,324,509,589	0.0%
Kuwait	6,646	164	2020-04-19	3,956,873	0.2%
Pakistan	17,897	710	2020-04-19	203,627,284	0.0%
Poland	24,539	545	2020-04-19	37,970,087	0.1%
Kazakhstan	6,361	176	2020-04-20	17,794,055	0.0%
Oman	9,473	144	2020-04-20	4,479,219	0.2%
Qatar	23,951	567	2020-04-20	2,654,374	0.9%
Mexico	51,079	769	2020-05-07	123,333,376	0.0%
Saudi Arabia	87,281	1,342	2020-05-09	32,442,572	0.3%
United Arab Emirates	62,869	826	2020-05-20	9,360,980	0.7%
Singapore	206,777	3,631	2020-05-25	5,607,283	3.7%
Belarus	234,475	4,175	2020-05-30	9,501,534	2.5%
Cameroon	20,760	213	2020-06-08	23,926,539	0.1%
Bangladesh	719,198	10,582	2020-06-20	157,970,840	0.5%

Forecast New Cases WW Total

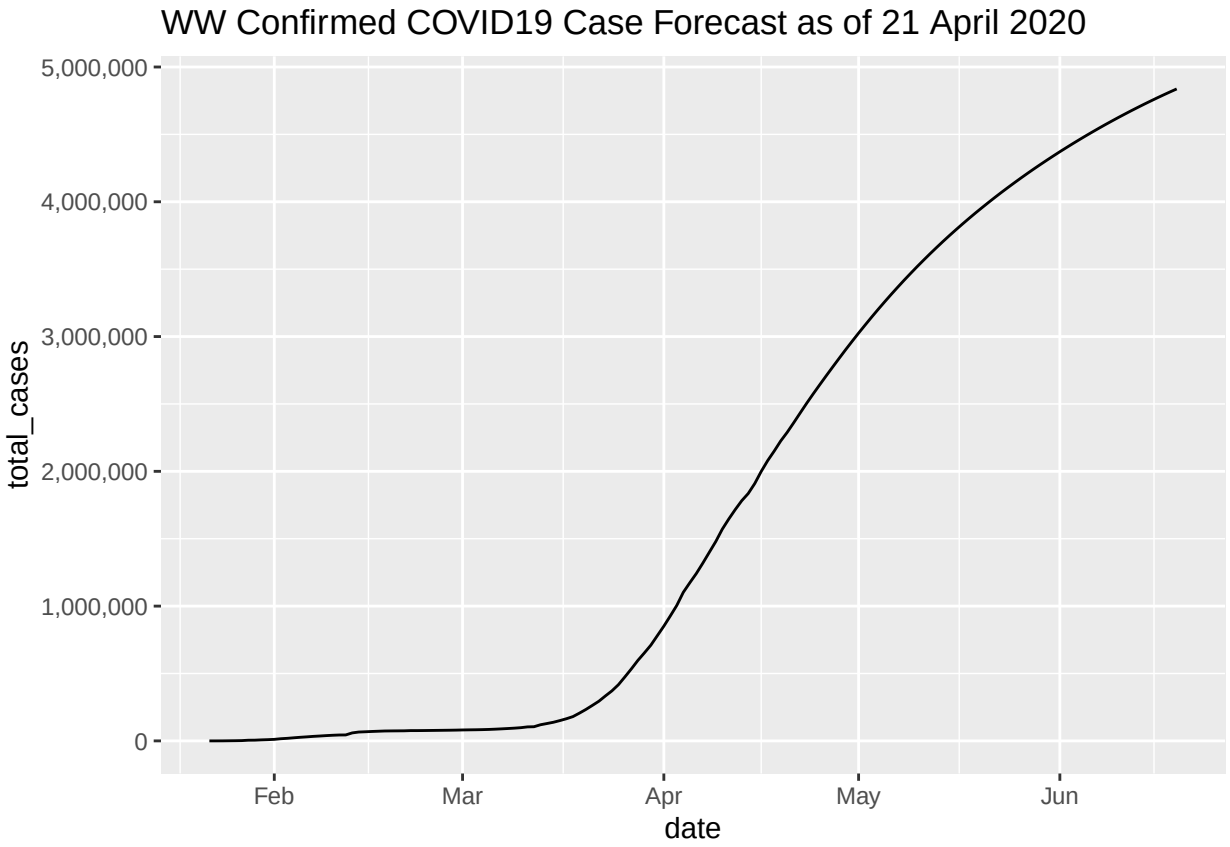
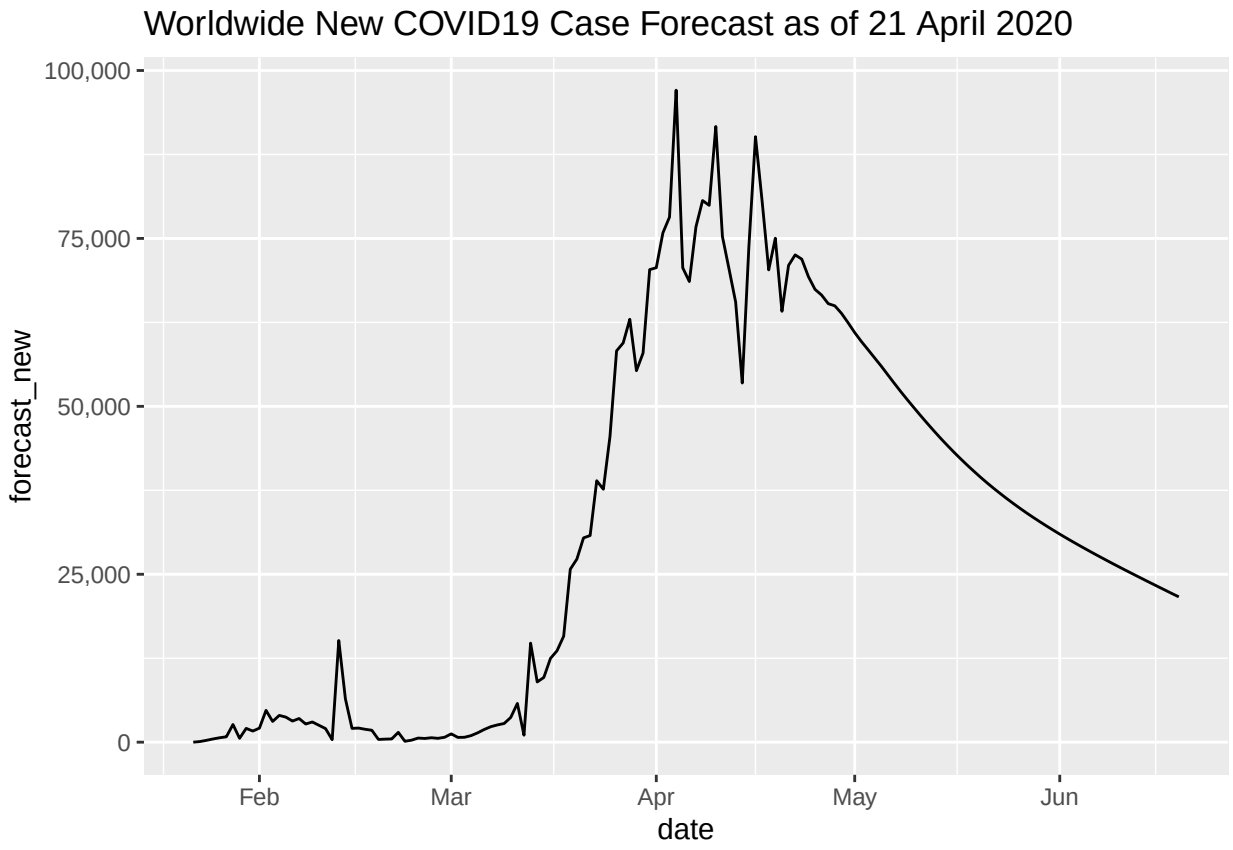


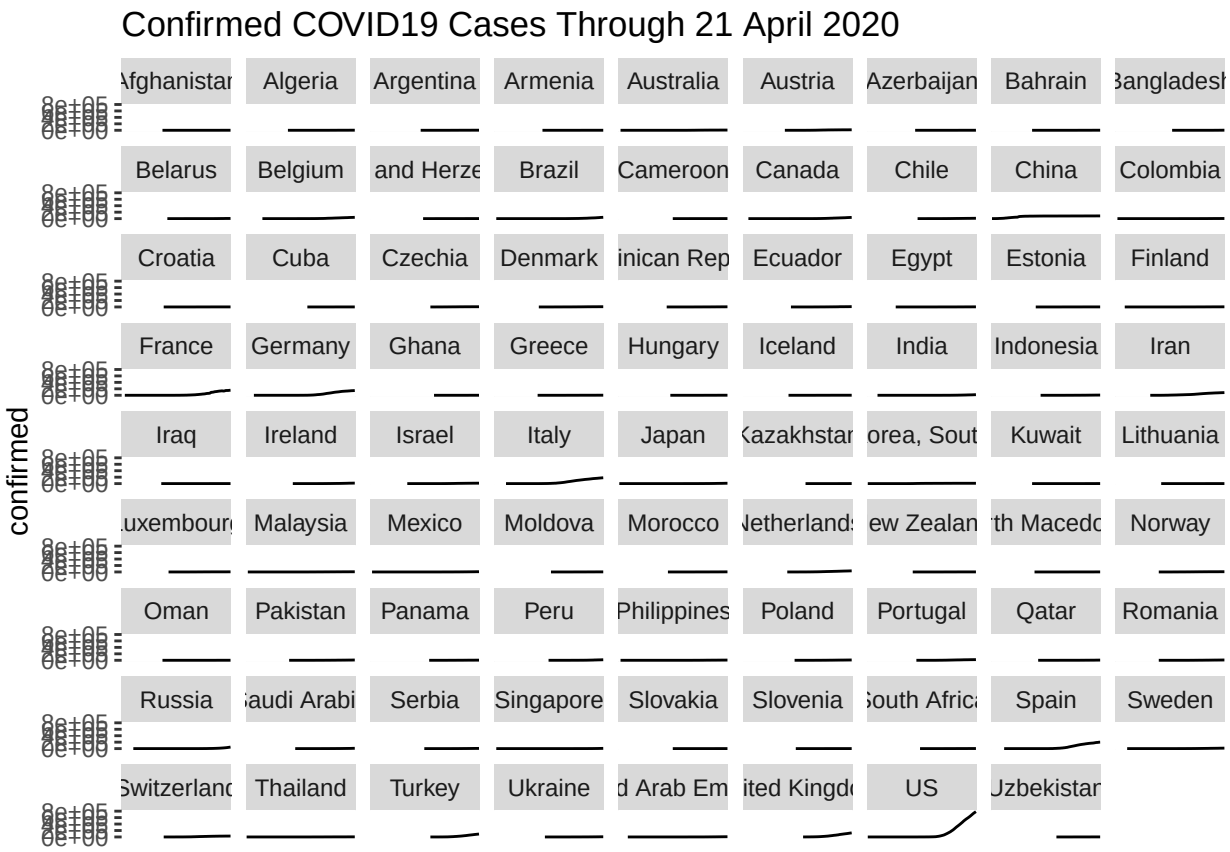
Table 5: Peak Daily New Cases Worldwide and Total on That Day

date	forecast_new	total_cases
2020-04-04	97,067	1,102,531



Sparklines

Confirmed Cases



Deaths


Cumulative COVID19 Deaths Through 21 April 2020
deaths
Afghanistan
Algeria
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahrain
Bangladesh
Belarus
Belgium
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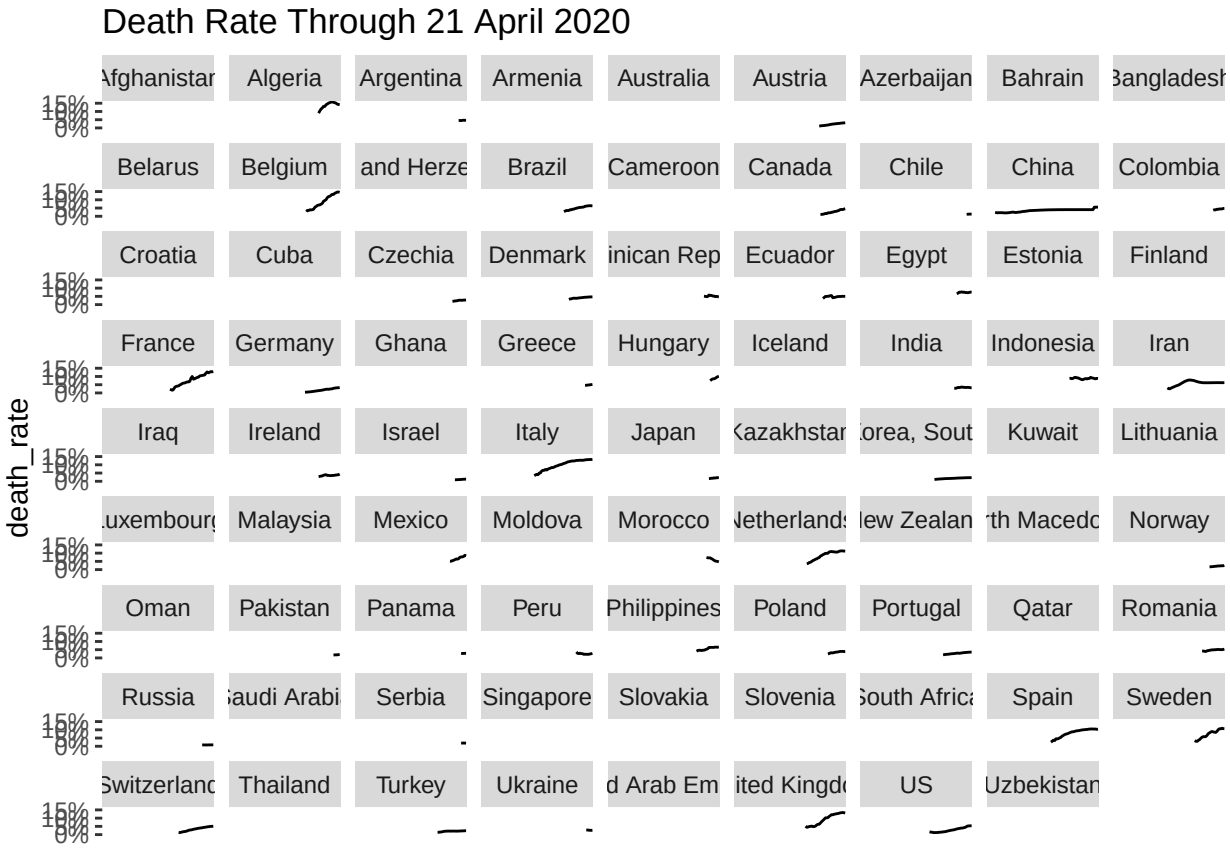
Confirmed Growth Rate 5-Day Moving Average

Death Rate



U.S. Analysis

State Summary

Sorted by total number of cases. Percent growth in total cases in the past seven days is last column.

Table 6: State-by-State Summary

Province_State	days_100	conf	deaths	new_conf	conf_lag7	l7_rate	death_rate
New York	44	253060	18611	5245	195749	29%	7.35%
New Jersey	36	88722	4496	3421	64584	37%	5.07%
Massachusetts	40	38077	1706	0	26867	42%	4.48%
Pennsylvania	35	33914	1348	1012	24292	40%	3.97%
California	43	33686	1225	2255	23931	41%	3.64%
Michigan	33	32000	2468	576	25635	25%	7.71%
Illinois	36	31513	1349	1156	22025	43%	4.28%
Florida	37	27059	822	745	21019	29%	3.04%
Louisiana	36	24523	1328	595	21016	17%	5.42%
Connecticut	33	19815	1331	1853	13381	48%	6.72%
Texas	35	19751	507	491	14275	38%	2.57%
Georgia	36	19407	775	1106	13315	46%	3.99%
Maryland	33	13684	582	837	8936	53%	4.25%
Ohio	33	12919	509	1317	6975	85%	3.94%
Washington	45	12114	643	-141	10635	14%	5.31%

Province_State	days_100	conf	deaths	new_conf	conf_lag7	l7_rate	death_rate
Indiana	31	11688	577	477	8359	40%	4.94%
Colorado	38	9730	420	0	7691	27%	4.32%
Virginia	32	8990	300	448	5747	56%	3.34%
Tennessee	33	7238	152	168	5610	29%	2.10%
North Carolina	33	6895	218	294	4886	41%	3.16%
Missouri	29	5890	200	147	4515	30%	3.40%
Rhode Island	29	5090	155	384	2665	91%	3.05%
Alabama	31	5079	163	191	3734	36%	3.21%
Arizona	31	5068	191	135	3705	37%	3.77%
Mississippi	31	4512	169	238	2942	53%	3.75%
Wisconsin	33	4499	230	153	3428	31%	5.11%
South Carolina	32	4446	123	69	3391	31%	2.77%
Nevada	32	3830	159	102	2990	28%	4.15%
Utah	31	3213	28	144	2363	36%	0.87%
Iowa	29	3159	79	257	1710	85%	2.50%
Kentucky	30	3050	154	90	2018	51%	5.05%
District of Columbia	30	2927	105	134	1955	50%	3.59%
Delaware	28	2745	72	207	1758	56%	2.62%
Oklahoma	28	2680	143	113	2069	30%	5.34%
Minnesota	32	2470	143	114	1621	52%	5.79%
Kansas	28	2048	102	143	1390	47%	4.98%
Arkansas	31	1973	41	192	1410	40%	2.08%
New Mexico	28	1971	58	126	1262	56%	2.94%
Oregon	32	1957	75	47	1584	24%	3.83%
South Dakota	22	1685	7	50	868	94%	0.42%
Idaho	26	1672	45	4	1426	17%	2.69%
Nebraska	23	1648	33	174	814	102%	2.00%
New Hampshire	29	1447	42	57	985	47%	2.90%
Puerto Rico	24	1252	63	39	903	39%	5.03%
West Virginia	23	902	24	12	611	48%	2.66%
Maine	29	875	35	8	698	25%	4.00%
Vermont	27	816	38	3	748	9%	4.66%
North Dakota	22	627	9	42	331	89%	1.44%
Hawaii	25	584	10	4	504	16%	1.71%
Montana	25	433	10	0	394	10%	2.31%
Alaska	23	321	9	2	277	16%	2.80%
Wyoming	21	317	2	4	275	15%	0.63%
Guam	16	136	5	0	133	2%	3.68%
US	31	784107	42089	25240	580405	35%	5.37%

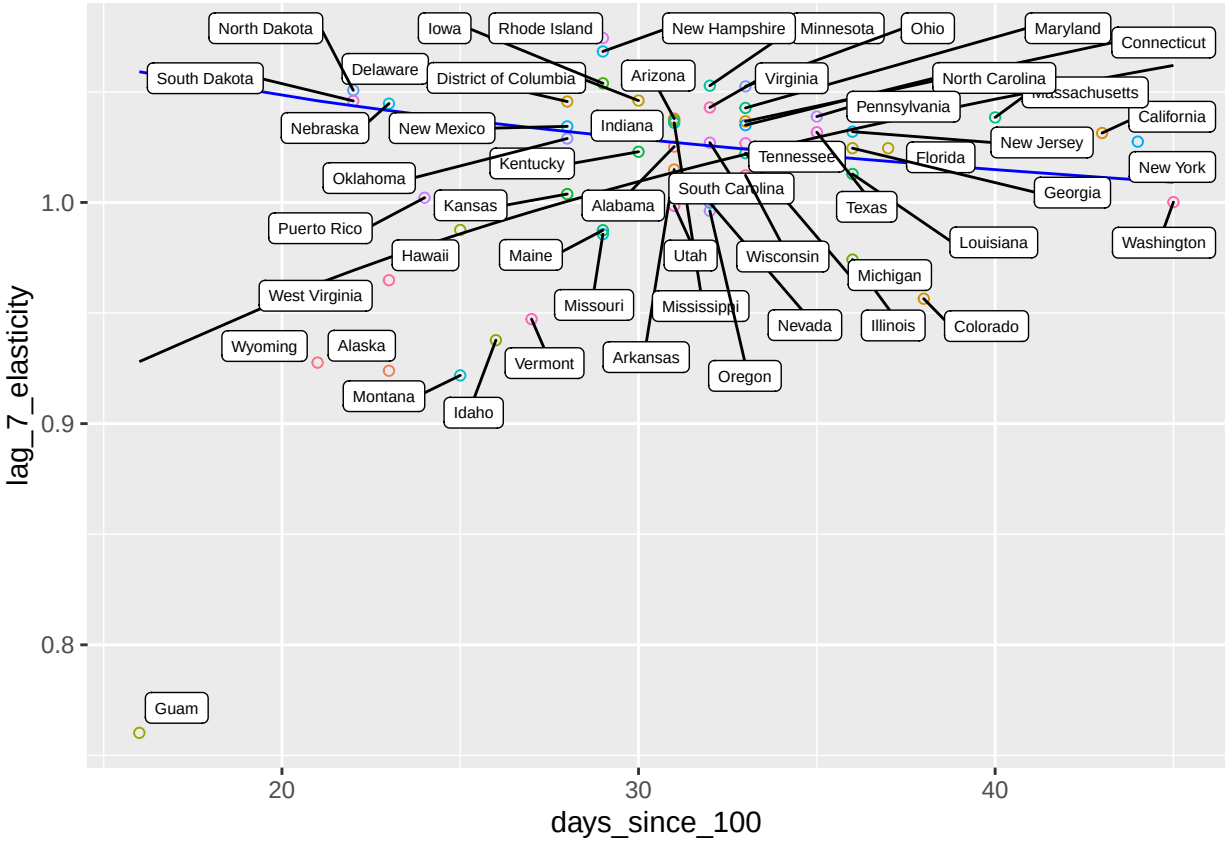
Ln (Seven-Day-Moving-Average New Cases) Impact on Ln (New Cases)

In other words, elasticity. How does this elasticity change through time, from days since the 50th case?

An elasticity under 1 indicates that over a seven-day period, new cases are decreasing.

The black line is the best fit for elasticity for the states that have had 100 cases as they progress. Above the line: worse than average; below-the-line: better than average.

The blue line is the best fit for elasticity for countries across the world. It's apparent that the U.S. is not doing as well as the rest of the world in containing exponential growth–probably due to initial testing failures.



Comparisons with U.S. and worldwide averages

Some states are doing better than worldwide averages when taking into account days since 100th case. Most are doing worse.

Table 7: States by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

state	days_since_100	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Guam	16	0.76	0.93	1.06	-0.17	-0.30
Wyoming	21	0.93	0.96	1.05	-0.04	-0.12
South Dakota	22	1.05	0.97	1.04	0.08	0.00
North Dakota	22	1.05	0.97	1.04	0.08	0.01
Alaska	23	0.92	0.98	1.04	-0.05	-0.12
West Virginia	23	0.96	0.98	1.04	-0.01	-0.08
Nebraska	23	1.04	0.98	1.04	0.07	0.00
Puerto Rico	24	1.00	0.98	1.04	0.02	-0.04
Montana	25	0.92	0.99	1.04	-0.06	-0.12
Hawaii	25	0.99	0.99	1.04	0.00	-0.05
Idaho	26	0.94	0.99	1.04	-0.05	-0.10
Vermont	27	0.95	1.00	1.03	-0.05	-0.09
Kansas	28	1.00	1.00	1.03	0.00	-0.03
Oklahoma	28	1.03	1.00	1.03	0.03	0.00
New Mexico	28	1.03	1.00	1.03	0.03	0.00
Delaware	28	1.05	1.00	1.03	0.05	0.01
Missouri	29	0.99	1.01	1.03	-0.02	-0.04
Maine	29	0.99	1.01	1.03	-0.02	-0.04

state	days_since_100	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Iowa	29	1.05	1.01	1.03	0.05	0.02
New Hampshire	29	1.07	1.01	1.03	0.06	0.04
Rhode Island	29	1.07	1.01	1.03	0.07	0.04
Kentucky	30	1.02	1.01	1.03	0.01	-0.01
District of Columbia	30	1.05	1.01	1.03	0.04	0.02
Utah	31	1.00	1.01	1.03	-0.02	-0.03
Arkansas	31	1.01	1.01	1.03	0.00	-0.01
Alabama	31	1.03	1.01	1.03	0.01	0.00
Mississippi	31	1.04	1.01	1.03	0.02	0.01
Indiana	31	1.04	1.01	1.03	0.02	0.01
Arizona	31	1.04	1.01	1.03	0.02	0.01
Oregon	32	1.00	1.02	1.03	-0.02	-0.03
Nevada	32	1.00	1.02	1.03	-0.02	-0.03
South Carolina	32	1.03	1.02	1.03	0.01	0.00
Virginia	32	1.04	1.02	1.03	0.03	0.02
Minnesota	32	1.05	1.02	1.03	0.03	0.03
Wisconsin	33	1.01	1.02	1.02	-0.01	-0.01
Michigan	33	1.02	1.02	1.02	0.00	0.00
Tennessee	33	1.03	1.02	1.02	0.00	0.00
North Carolina	33	1.03	1.02	1.02	0.01	0.01
Connecticut	33	1.04	1.02	1.02	0.01	0.01
Maryland	33	1.04	1.02	1.02	0.02	0.02
Ohio	33	1.05	1.02	1.02	0.03	0.03
Texas	35	1.03	1.03	1.02	0.00	0.01
Pennsylvania	35	1.04	1.03	1.02	0.01	0.02
Illinois	36	0.97	1.03	1.02	-0.06	-0.05
Louisiana	36	1.01	1.03	1.02	-0.02	-0.01
Georgia	36	1.02	1.03	1.02	-0.01	0.00
New Jersey	36	1.03	1.03	1.02	0.00	0.01
Florida	37	1.02	1.04	1.02	-0.01	0.01
Colorado	38	0.96	1.04	1.02	-0.08	-0.06
Massachusetts	40	1.04	1.05	1.01	-0.01	0.02
California	43	1.03	1.06	1.01	-0.02	0.02
New York	44	1.03	1.06	1.01	-0.03	0.02
Washington	45	1.00	1.06	1.01	-0.06	-0.01

Forecast New Cases by State

We estimate new cases by date, to see when states will peak, based on the worldwide curve fit. The reasoning is that testing rates increasing wildly recently in the U.S. have falsely inflated elasticity.

Table 8: Forecast Peak New Cases by State

State	Peak Cases	Peak Deaths	Max Case Date	Max Death Date	Population
Florida	2,052	82	2020-04-02	2020-04-05	19,552,860
Idaho	210	8	2020-04-02	2020-04-05	1,612,136
Louisiana	2,725	109	2020-04-02	2020-04-05	4,625,470
Maine	73	3	2020-04-02	2020-04-05	1,328,302
Montana	33	1	2020-04-02	2020-04-05	1,015,165
Washington	781	31	2020-04-02	2020-04-05	6,971,406
Hawaii	63	3	2020-04-03	2020-04-06	1,404,054
Michigan	1,953	78	2020-04-03	2020-04-06	9,895,622

State	Peak Cases	Peak Deaths	Max Case Date	Max Death Date	Population
New Jersey	4,305	172	2020-04-03	2020-04-06	8,899,339
Oklahoma	171	7	2020-04-04	2020-04-07	3,850,568
Pennsylvania	1,874	75	2020-04-04	2020-04-07	12,773,801
Vermont	72	3	2020-04-04	2020-04-07	626,630
Wyoming	25	1	2020-04-04	2020-04-07	582,658
Arizona	299	12	2020-04-05	2020-04-08	6,626,624
Oregon	169	7	2020-04-05	2020-04-08	3,930,065
Wisconsin	290	12	2020-04-05	2020-04-08	5,742,713
Alaska	23	1	2020-04-07	2020-04-10	735,132
District of Columbia	229	9	2020-04-08	2020-04-11	646,449
Maryland	1,158	46	2020-04-08	2020-04-11	5,928,814
Alabama	375	15	2020-04-09	2020-04-12	4,833,722
Connecticut	2,003	80	2020-04-09	2020-04-12	3,596,080
South Carolina	376	15	2020-04-09	2020-04-12	4,774,839
Texas	1,431	57	2020-04-09	2020-04-12	26,448,193
Illinois	2,808	112	2020-04-10	2020-04-13	12,882,135
Kentucky	352	14	2020-04-10	2020-04-13	4,395,295
Missouri	465	19	2020-04-10	2020-04-13	6,044,171
New Mexico	216	9	2020-04-10	2020-04-13	2,085,287
Utah	247	10	2020-04-10	2020-04-13	2,900,872
Kansas	158	6	2020-04-11	2020-04-14	2,893,957
Colorado	794	32	2020-04-12	2020-04-15	5,268,367
Massachusetts	2,615	105	2020-04-12	2020-04-15	6,692,824
New Hampshire	217	9	2020-04-15	2020-04-18	1,323,459
New York	11,434	457	2020-04-15	2020-04-18	19,651,127
South Dakota	180	7	2020-04-15	2020-04-18	844,877
Tennessee	548	22	2020-04-16	2020-04-19	6,495,978
Delaware	247	10	2020-04-17	2020-04-20	925,749
Georgia	1,525	61	2020-04-17	2020-04-20	9,992,167
Indiana	612	24	2020-04-17	2020-04-20	6,570,902
Minnesota	261	10	2020-04-17	2020-04-20	5,420,380
Nevada	310	12	2020-04-17	2020-04-20	2,790,136
North Carolina	406	16	2020-04-17	2020-04-20	9,848,060
Rhode Island	648	26	2020-04-17	2020-04-20	1,051,511
Virginia	602	24	2020-04-17	2020-04-20	8,260,405
North Dakota	135	5	2020-04-18	2020-04-21	723,393
Iowa	389	16	2020-04-19	2020-04-22	3,090,416
Mississippi	300	12	2020-04-19	2020-04-22	2,991,207
Nebraska	225	9	2020-04-19	2020-04-22	1,868,516
Ohio	1,380	55	2020-04-19	2020-04-22	11,570,808
West Virginia	105	4	2020-04-19	2020-04-22	1,854,304
Arkansas	192	8	2020-04-20	2020-04-23	2,959,373
California	2,255	90	2020-04-20	2020-04-23	38,332,521

Table 9: Forecast Total New Cases by State

State	Total Cases	Total Deaths	Population	% Population Infected
Florida	49,015	1,960	19,552,860	0.3%
Idaho	2,145	86	1,612,136	0.1%
Louisiana	33,690	1,347	4,625,470	0.7%
Maine	1,510	60	1,328,302	0.1%

State	Total Cases	Total Deaths	Population	% Population Infected
Montana	621	25	1,015,165	0.1%
Washington	16,865	674	6,971,406	0.2%
Hawaii	1,018	41	1,404,054	0.1%
Michigan	49,354	1,974	9,895,622	0.5%
New Jersey	153,501	6,140	8,899,339	1.7%
Oklahoma	5,852	234	3,850,568	0.2%
Pennsylvania	81,205	3,248	12,773,801	0.6%
Vermont	1,106	44	626,630	0.2%
Wyoming	513	20	582,658	0.1%
Arizona	13,628	545	6,626,624	0.2%
Oregon	3,314	132	3,930,065	0.1%
Wisconsin	8,293	331	5,742,713	0.1%
Alaska	522	21	735,132	0.1%
District of Columbia	9,409	376	646,449	1.5%
Maryland	42,549	1,702	5,928,814	0.7%
Alabama	10,823	433	4,833,722	0.2%
Connecticut	47,645	1,906	3,596,080	1.3%
South Carolina	9,181	367	4,774,839	0.2%
Texas	43,237	1,729	26,448,193	0.2%
Illinois	42,276	1,691	12,882,135	0.3%
Kentucky	7,760	310	4,395,295	0.2%
Missouri	8,658	346	6,044,171	0.1%
New Mexico	6,251	250	2,085,287	0.3%
Utah	5,814	232	2,900,872	0.2%
Kansas	4,381	175	2,893,957	0.2%
Colorado	12,541	502	5,268,367	0.2%
Massachusetts	83,392	3,335	6,692,824	1.2%
New Hampshire	10,417	416	1,323,459	0.8%
New York	368,268	14,730	19,651,127	1.9%
South Dakota	6,341	253	844,877	0.8%
Tennessee	15,558	622	6,495,978	0.2%
Delaware	9,449	378	925,749	1.0%
Georgia	40,329	1,613	9,992,167	0.4%
Indiana	29,798	1,192	6,570,902	0.5%
Minnesota	12,485	499	5,420,380	0.2%
Nevada	6,325	253	2,790,136	0.2%
North Carolina	18,294	731	9,848,060	0.2%
Rhode Island	35,986	1,439	1,051,511	3.4%
Virginia	30,808	1,232	8,260,405	0.4%
North Dakota	3,633	145	723,393	0.5%
Iowa	18,554	742	3,090,416	0.6%
Mississippi	13,331	533	2,991,207	0.4%
Nebraska	8,213	328	1,868,516	0.4%
Ohio	77,195	3,087	11,570,808	0.7%
West Virginia	1,639	65	1,854,304	0.1%
Arkansas	4,512	180	2,959,373	0.2%
California	80,561	3,222	38,332,521	0.2%

Forecast New Cases U.S. Total

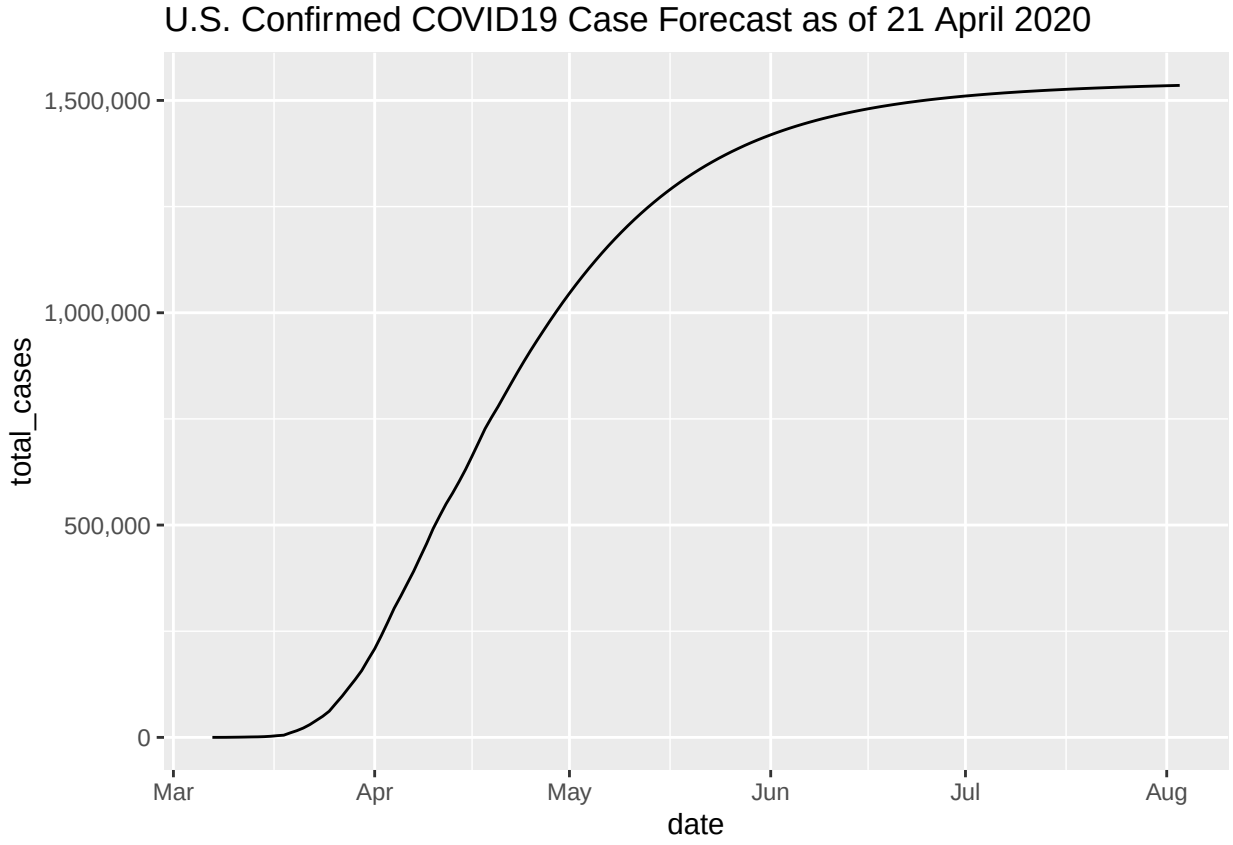


Table 10: Peak Daily New Cases in U.S. and Total on That Day

date	forecast_new	deaths_new	total_cases	total_deaths
2020-04-10	35,049	1179.52	491,329	15645.32

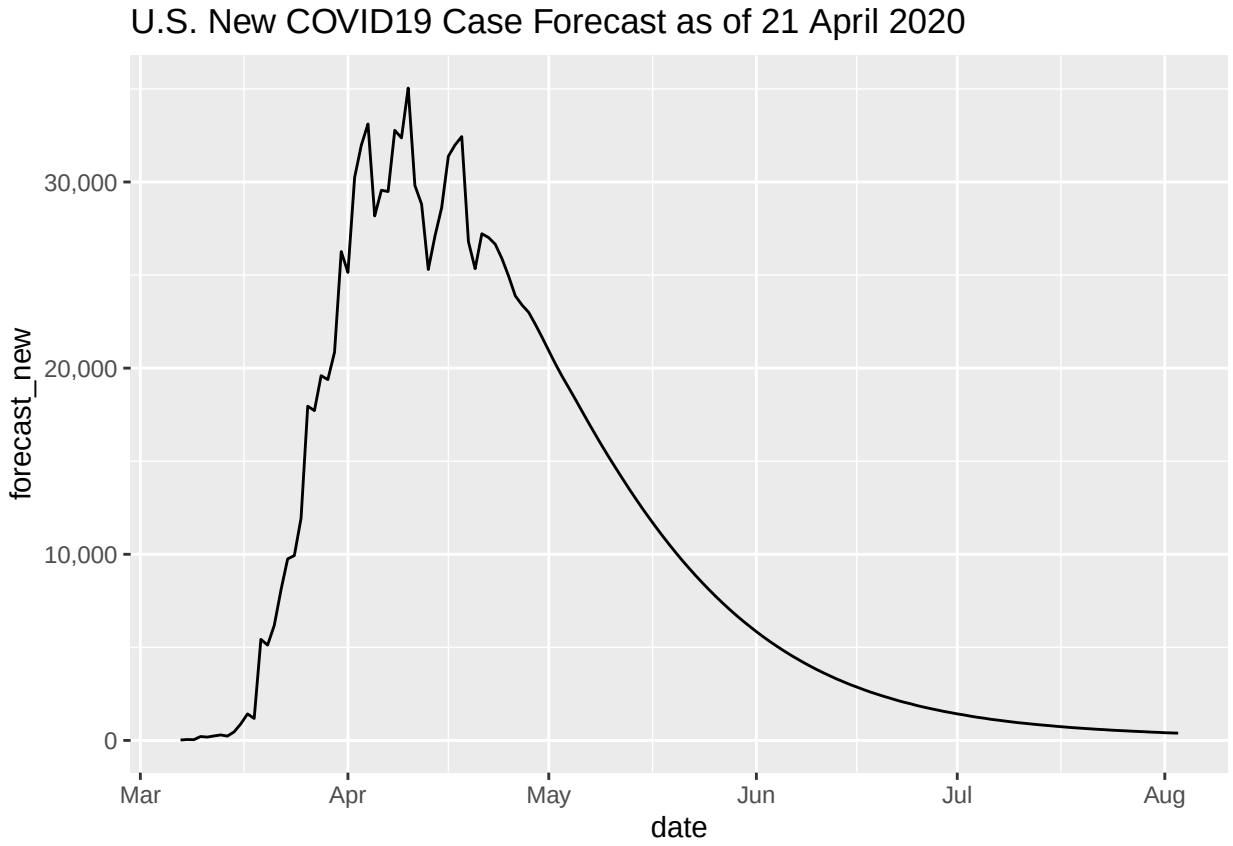
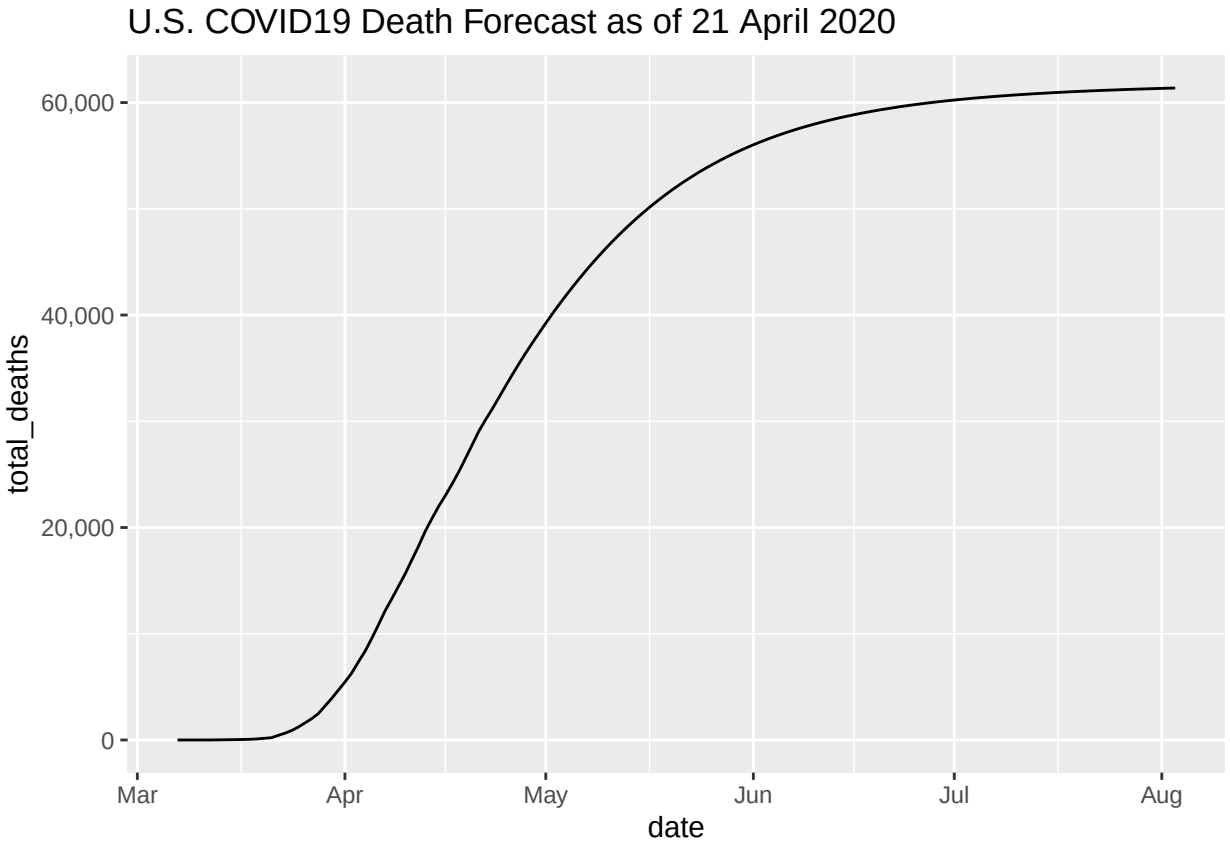


Table 11: Peak Daily Deaths in U.S. and Total on That Day

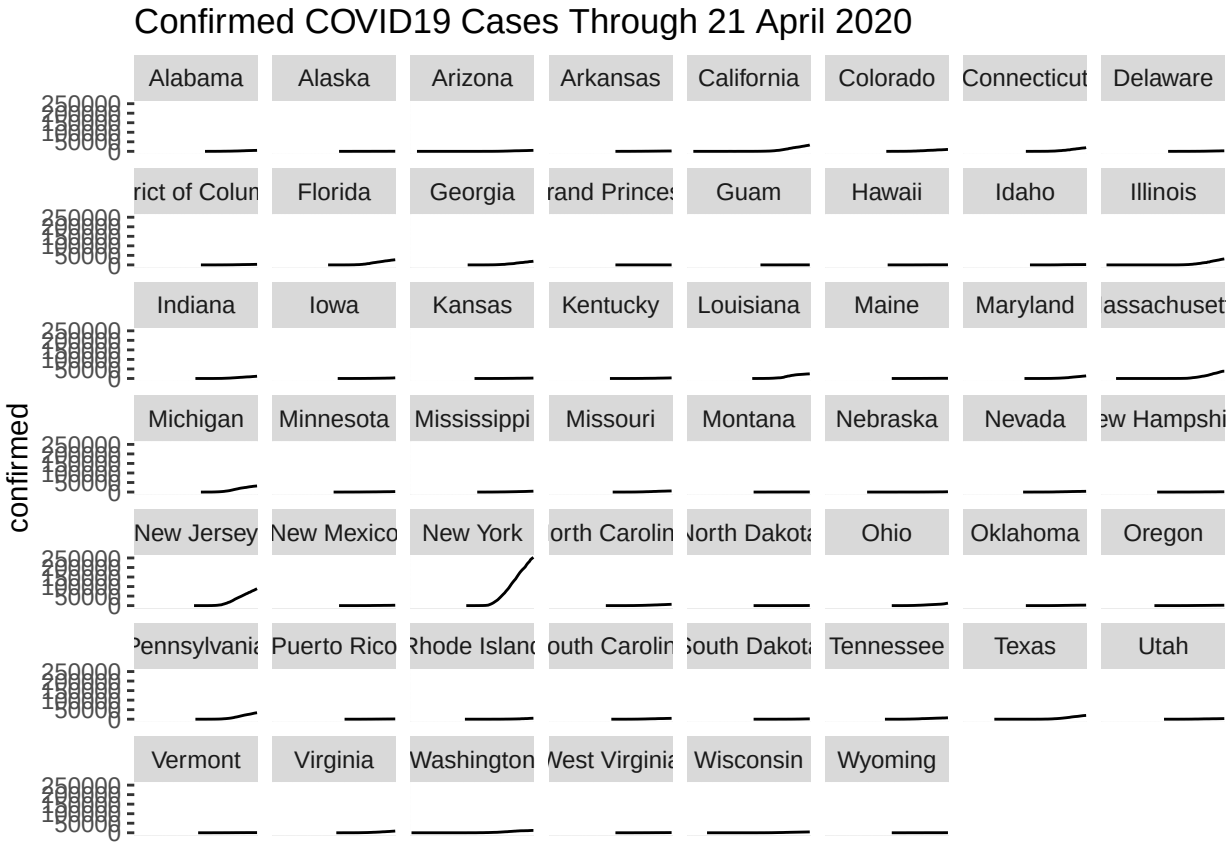
date	forecast_new	deaths_new	total_cases	total_deaths
2020-04-13	25300	1,402	575,251	19653.16



Sparklines

We only look at states with more than one hundred cases today. For moving average growth rates, we only look at states with deaths and recoveries over 25.

Confirmed Cases



Deaths


Cumulative COVID19 Deaths Through 21 April 2020
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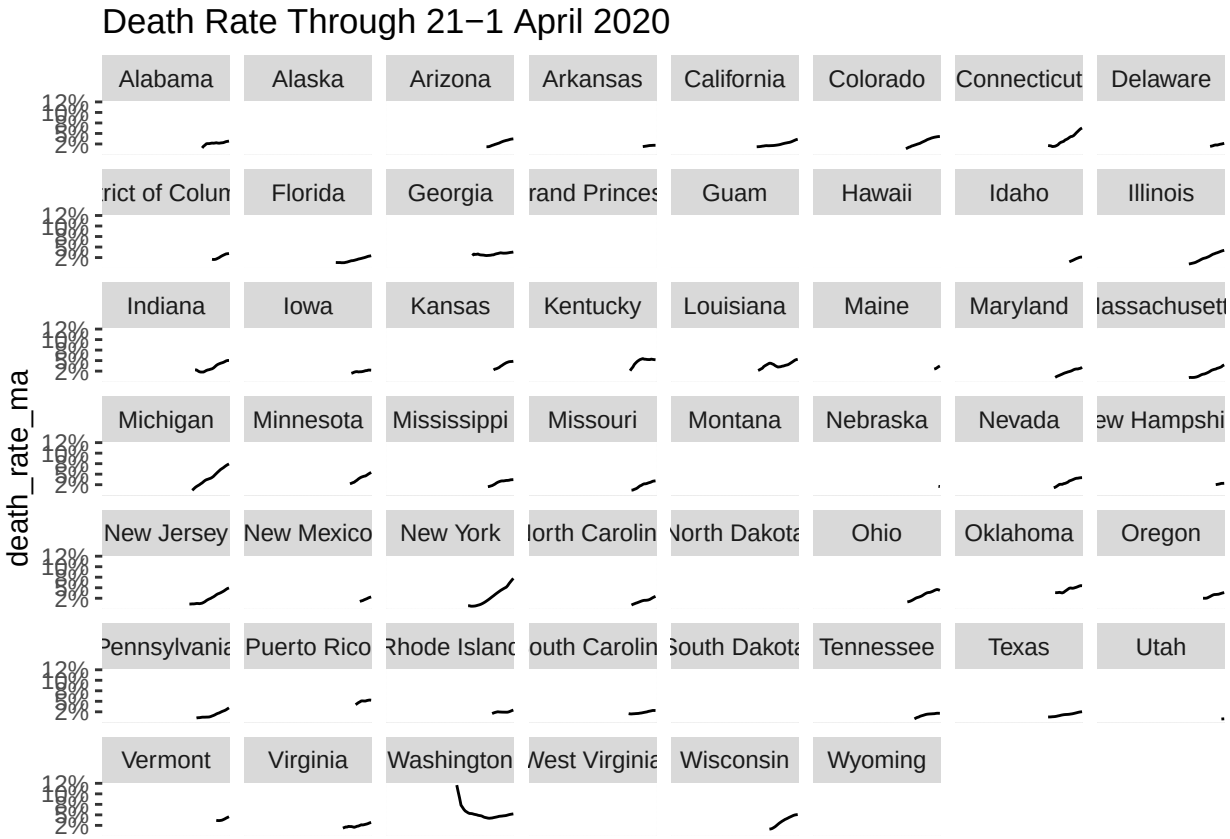
Confirmed Growth Rate 5-Day Moving Average

Death Rate 5-Day Moving Average

Only states with >25 deaths are shown


Death Rate Through 21−1 April 2020
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Wisconsin
Wyoming
12%
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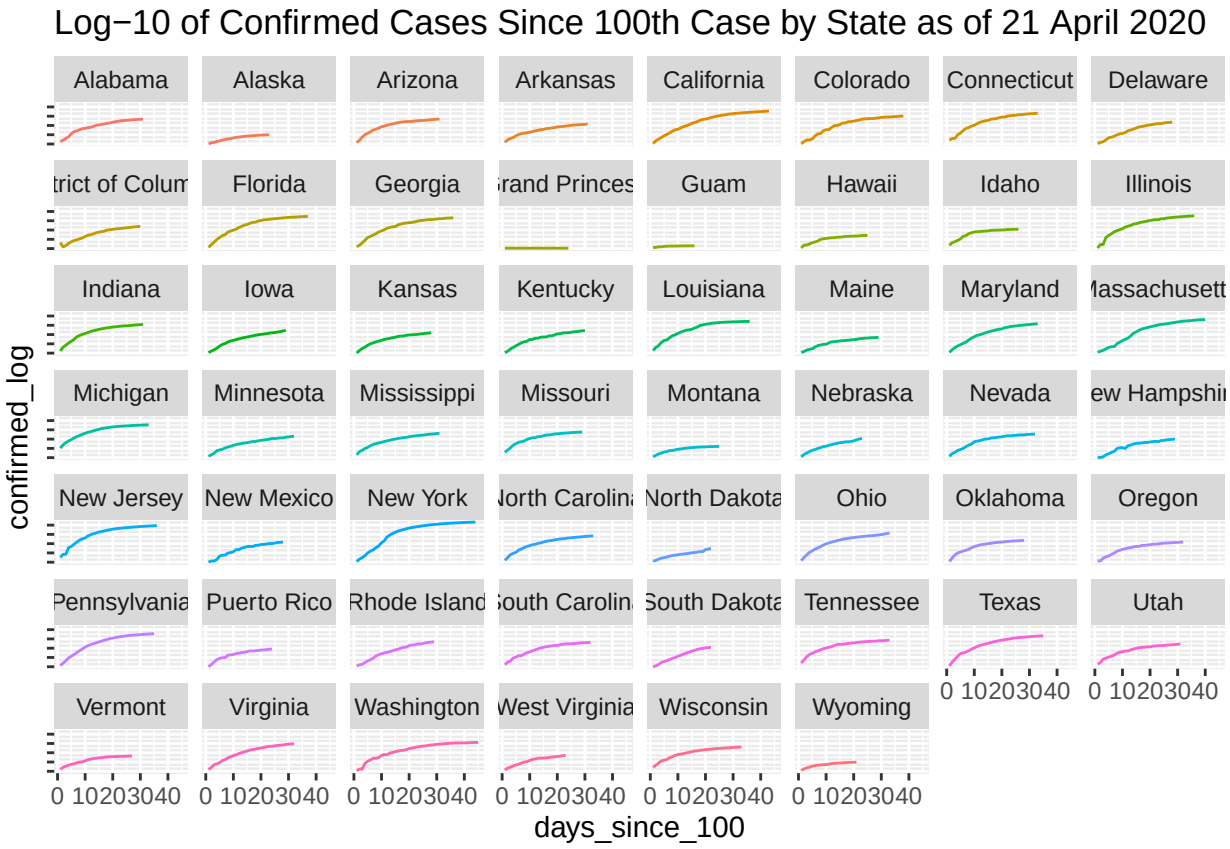
6%
4%
2%

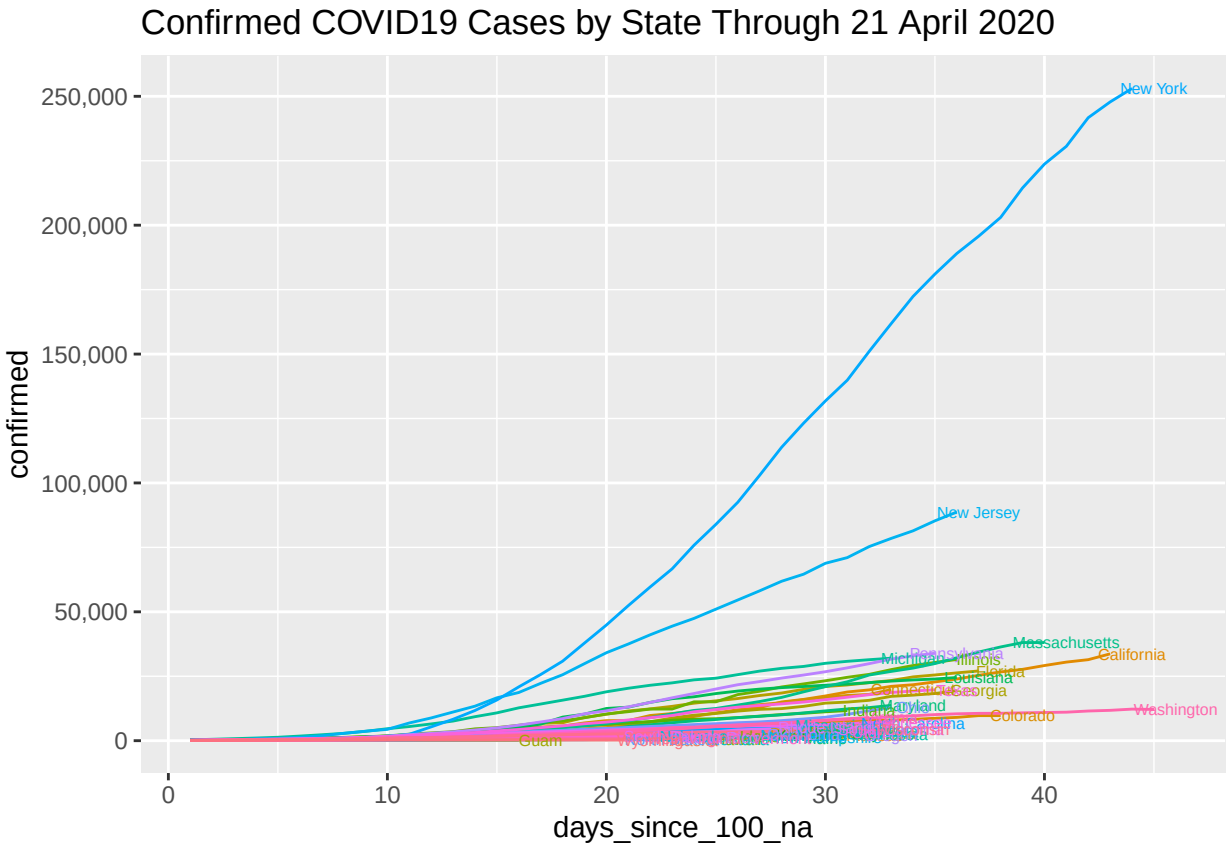
Log / Time for States After 100th Case

Log-10 by States: Confirmed Cases by Day After 50th Confirmed Case



Zero at Fifty Cases

Confirmed Cases



Testing Data

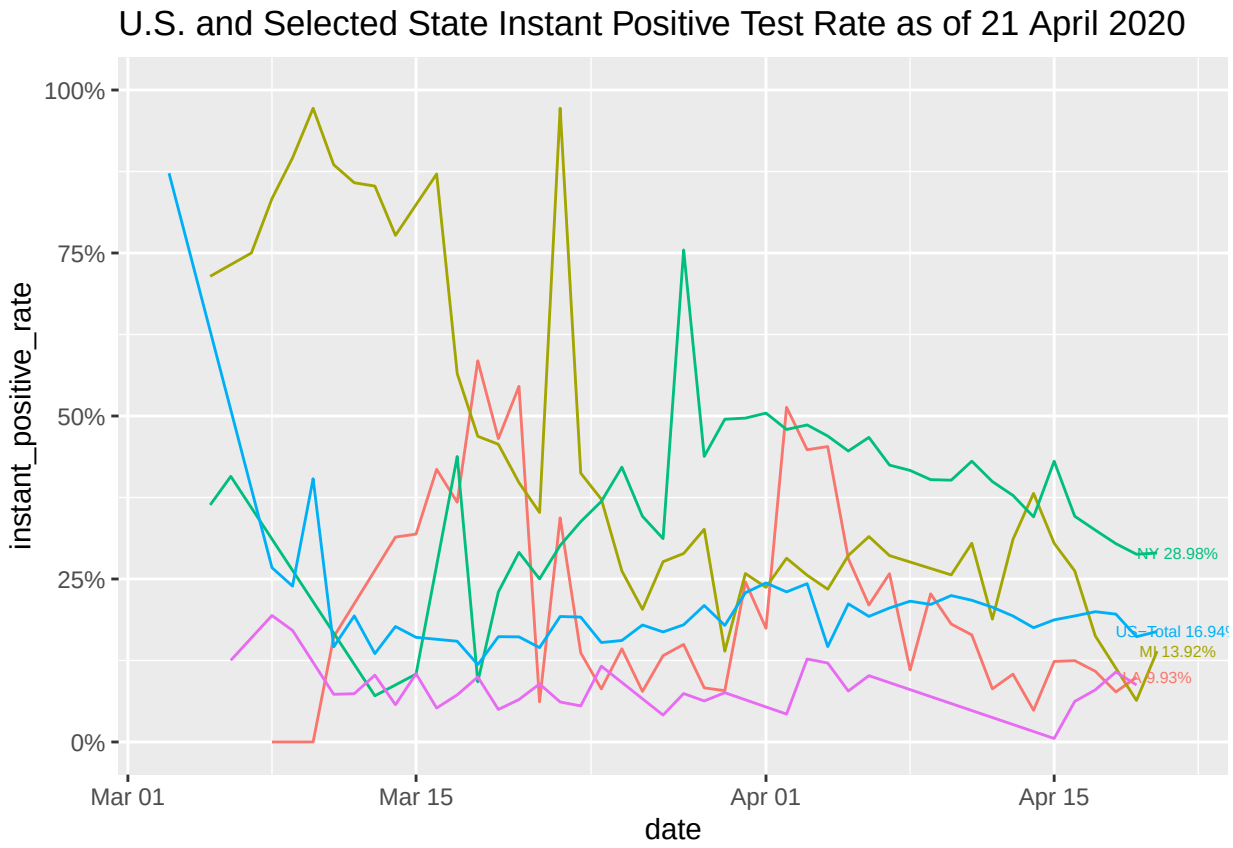
State-by-State Testing Summary

States are sorted descending by total tested. Cum Pos Rate is the cumulative positive rate since the pandemic began; instant positive rate is the current daily testing rate. Instant positive trend is instant positive rate / cumulative positive rate.

Table 12: State-by-State Testing Summary

State	Pos	Cum Tested	Cum Pos Rate	Pos Increase	Tested Increase	Instant Pos Rate	Instant Pos Trend
NY	247,512	633,861	39.0%	4,726	16,306	29.0%	-25.8%
CA	30,978	290,500	10.7%	645	9,600	6.7%	-37.0%
FL	26,660	266,225	10.0%	664	10,146	6.5%	-34.6%
TX	19,458	190,394	10.2%	535	7,684	7.0%	-31.9%
NJ	88,806	178,057	49.9%	3,505	7,369	47.6%	-4.6%
PA	33,232	162,952	20.4%	948	4,098	23.1%	13.4%
MA	38,077	162,241	23.5%	0	0	NaN%	NaN%
IL	31,508	148,358	21.2%	1,151	5,040	22.8%	7.5%
LA	24,523	142,099	17.3%	595	595	100.0%	479.5%
WA	11,790	138,642	8.5%	-12	2,936	-0.4%	-104.8%
MI	32,000	113,798	28.1%	576	4,137	13.9%	-50.5%
TN	7,238	100,689	7.2%	168	3,591	4.7%	-34.9%

State	Pos	Cum Tested	Cum Pos Rate	Pos Increase	Tested Increase	Instant Pos Rate	Instant Pos Trend
OH	12,516	90,436	13.8%	1,224	3,447	35.5%	156.6%
GA	18,947	84,328	22.5%	646	4,395	14.7%	-34.6%
NC	6,764	79,484	8.5%	271	712	38.1%	347.3%
MD	13,684	71,397	19.2%	854	3,506	24.4%	27.1%
UT	3,213	68,311	4.7%	144	4,756	3.0%	-35.6%
IN	11,686	64,639	18.1%	476	3,497	13.6%	-24.7%
CT	19,815	62,806	31.5%	2,265	4,593	49.3%	56.3%
VA	8,990	56,735	15.8%	453	2,002	22.6%	42.8%
MO	5,807	56,013	10.4%	140	2,104	6.7%	-35.8%
AZ	5,064	54,500	9.3%	135	1,510	8.9%	-3.8%
MS	4,512	51,434	8.8%	238	12,369	1.9%	-78.1%
WI	4,499	51,102	8.8%	153	1,433	10.7%	21.3%
MN	2,470	46,850	5.3%	114	1,134	10.1%	90.7%
CO	9,730	46,195	21.1%	297	1,589	18.7%	-11.3%
AL	5,025	45,900	10.9%	188	188	100.0%	813.4%
SC	4,377	40,480	10.8%	0	0	NaN%	NaN%
OR	1,956	40,045	4.9%	46	1,007	4.6%	-6.5%
RI	5,090	37,080	13.7%	384	2,381	16.1%	17.5%
NM	1,845	37,042	5.0%	47	410	11.5%	130.2%
OK	2,680	35,646	7.5%	81	81	100.0%	1 230.1%
KY	2,960	32,572	9.1%	253	347	72.9%	702.3%
NV	3,830	32,347	11.8%	102	749	13.6%	15.0%
AR	1,923	26,553	7.2%	142	2,344	6.1%	-16.4%
IA	3,159	25,820	12.2%	257	1,270	20.2%	65.4%
HI	580	24,175	2.4%	6	705	0.9%	-64.5%
WV	902	22,155	4.1%	39	2,124	1.8%	-54.9%
KS	1,986	18,761	10.6%	137	631	21.7%	105.1%
ID	1,672	17,445	9.6%	4	576	0.7%	-92.8%
DE	2,745	16,470	16.7%	207	1,676	12.4%	-25.9%
NE	1,474	15,680	9.4%	187	1,105	16.9%	80.0%
ME	875	14,951	5.9%	8	8	100.0%	1 608.7%
ND	627	14,747	4.3%	42	1,117	3.8%	-11.6%
NH	1,392	14,118	9.9%	50	694	7.2%	-26.9%
DC	2,927	14,113	20.7%	134	414	32.4%	56.1%
VT	816	12,981	6.3%	4	255	1.6%	-75.0%
SD	1,685	12,326	13.7%	50	264	18.9%	38.5%
MT	433	11,051	3.9%	0	153	0.0%	-100.0%
AK	321	10,124	3.2%	2	229	0.9%	-72.5%
PR	1,252	9,738	12.9%	39	245	15.9%	23.8%
WY	313	7,386	4.2%	4	105	3.8%	-10.1%
GU	133	1,124	11.8%	-3	45	-6.7%	-156.3%
VI	53	607	8.7%	0	6	0.0%	-100.0%
MP	14	65	21.5%	0	9	0.0%	-100.0%
AS	0	3	0.0%	0	0	NaN%	NaN%



Hospitalization Summary

State-by-state hospitalization data are still VERY spotty as of April 5th. Most states are not reporting.

Table 13: State-by-State Hospitalization and ICU Data

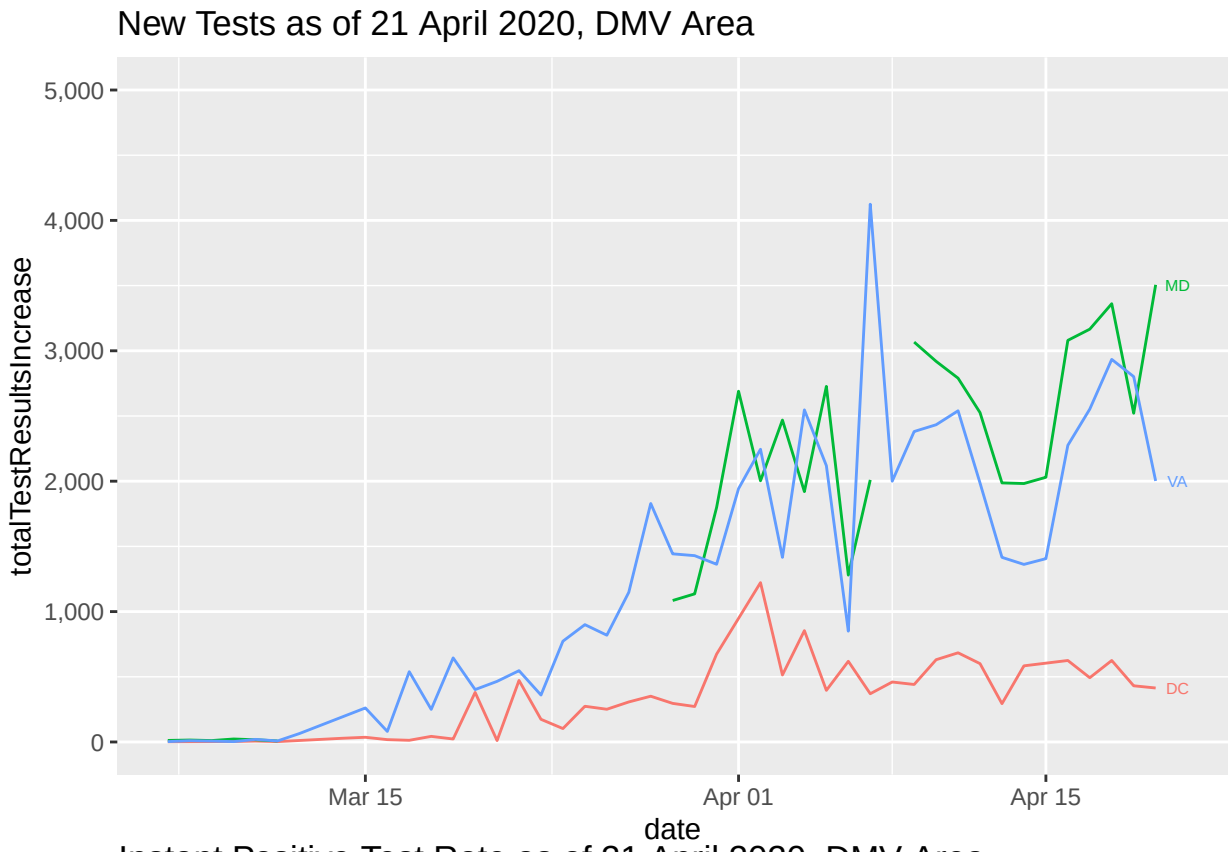
State	Positive	Hospitalized	In ICU	Recovered	Dead	% Hospitalized	% ICU (of Hospitalized)	% Recovered
NY	247,512	16,103	5,016	23,887	14,347	6.5%	31.1%	9.7%
NJ	88,806	6,986	2,018	NA	4,377	7.9%	28.9%	NA%
CA	30,978	4,674	1,480	NA	1,208	15.1%	31.7%	NA%
IL	31,508	4,599	1,239	NA	1,349	14.6%	26.9%	NA%
MA	39,643	3,804	1,017	NA	1,809	9.6%	26.7%	NA%
MI	32,000	3,374	1,346	3,237	2,468	10.5%	39.9%	10.1%
PA	33,232	2,701	NA	NA	1,204	8.1%	NA%	NA%
CT	19,815	1,919	NA	NA	1,331	9.7%	NA%	NA%
LA	24,523	1,794	NA	NA	1,328	7.3%	NA%	NA%
TX	19,458	1,411	NA	5,706	495	7.3%	NA%	29.3%
VA	8,990	1,296	396	1,324	300	14.4%	30.6%	14.7%
MO	5,807	873	NA	NA	177	15.0%	NA%	NA%
CO	10,106	861	NA	NA	449	8.5%	NA%	NA%
AZ	5,064	637	285	1,155	187	12.6%	44.7%	22.8%
MS	4,512	548	146	NA	169	12.1%	26.6%	NA%
WA	12,085	503	161	NA	652	4.2%	32.0%	NA%
WI	4,499	406	168	NA	230	9.0%	41.4%	NA%
DC	2,927	402	120	630	105	13.7%	29.9%	21.5%
NC	6,764	373	NA	NA	179	5.5%	NA%	NA%
OK	2,680	307	136	1,614	143	11.5%	44.3%	60.2%

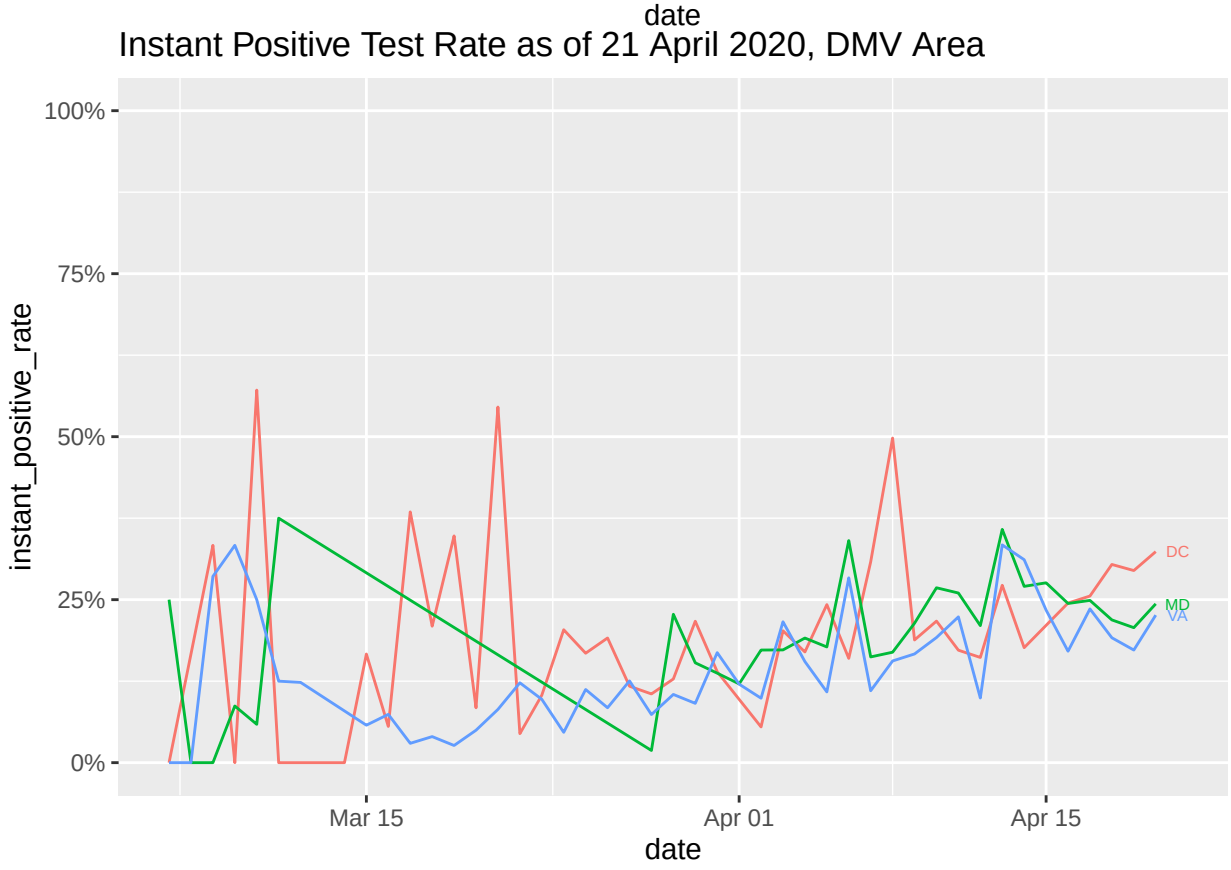
State	Positive	Hospitalized	In ICU	Recovered	Dead	% Hospitalized	% ICU (of Hospitalized)	% Recovered
OR	1,956	303	74	NA	75	15.5%	24.4%	NA%
RI	5,090	272	62	267	155	5.3%	22.8%	5.2%
KY	3,050	263	147	1,174	154	8.6%	55.9%	38.5%
DE	2,745	256	NA	495	72	9.3%	NA%	18.0%
MN	2,470	237	126	1,202	143	9.6%	53.2%	48.7%
IA	3,159	214	91	1,235	79	6.8%	42.5%	39.1%
NM	1,971	116	NA	501	58	5.9%	NA%	25.4%
AR	1,923	93	NA	749	42	4.8%	NA%	38.9%
NH	1,447	78	NA	521	42	5.4%	NA%	36.0%
WV	908	77	37	290	26	8.5%	48.1%	31.9%
VT	816	49	NA	15	38	6.0%	NA%	1.8%
AK	321	46	NA	161	9	14.3%	NA%	50.2%
ME	875	39	16	414	35	4.5%	41.0%	47.3%
MT	433	19	NA	243	10	4.4%	NA%	56.1%
WY	317	19	NA	237	2	6.0%	NA%	74.8%
ND	627	17	NA	189	13	2.7%	NA%	30.1%
GU	133	3	2	114	5	2.3%	66.7%	85.7%
AL	5,078	NA	NA	NA	164	NA%	NA%	NA%
FL	27,058	NA	NA	NA	840	NA%	NA%	NA%
GA	19,398	NA	NA	NA	774	NA%	NA%	NA%
HI	578	NA	NA	423	10	NA%	NA%	73.2%
ID	1,638	NA	NA	660	48	NA%	NA%	40.3%
IN	11,686	NA	669	NA	569	NA%	NA%	NA%
KS	1,986	NA	NA	NA	100	NA%	NA%	NA%
MD	13,684	NA	NA	917	516	NA%	NA%	6.7%
NE	1,648	NA	NA	NA	33	NA%	NA%	NA%
NV	3,830	NA	NA	NA	163	NA%	NA%	NA%
OH	12,516	NA	NA	NA	509	NA%	NA%	NA%
SC	4,439	NA	NA	2,063	124	NA%	NA%	46.5%
SD	1,755	NA	NA	824	7	NA%	NA%	47.0%
TN	7,238	NA	NA	3,575	152	NA%	NA%	49.4%
UT	3,213	NA	NA	776	28	NA%	NA%	24.2%
PR	1,252	NA	NA	NA	63	NA%	NA%	NA%
AS	0	NA	NA	NA	NA	NA%	NA%	NA%
MP	14	NA	NA	11	2	NA%	NA%	78.6%
VI	54	NA	NA	48	3	NA%	NA%	88.9%

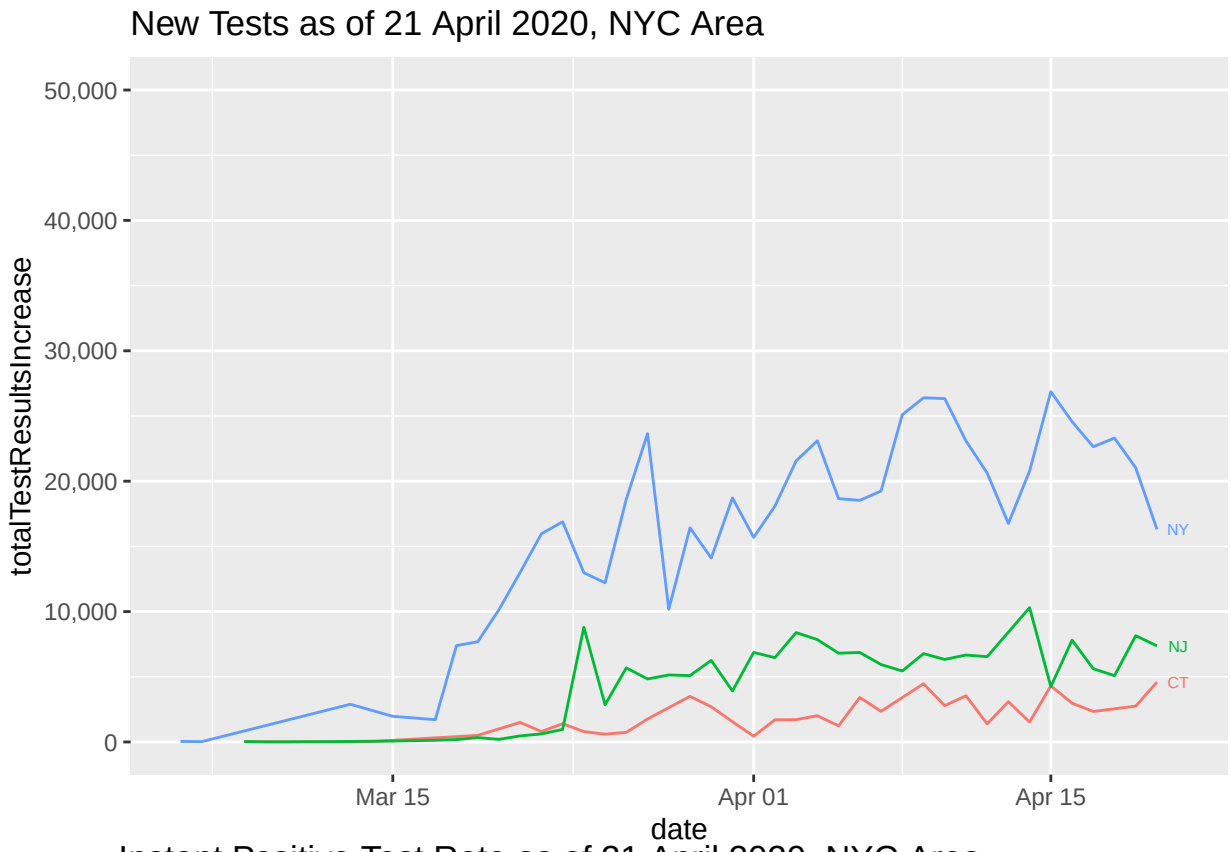
Selected States Drill-Down

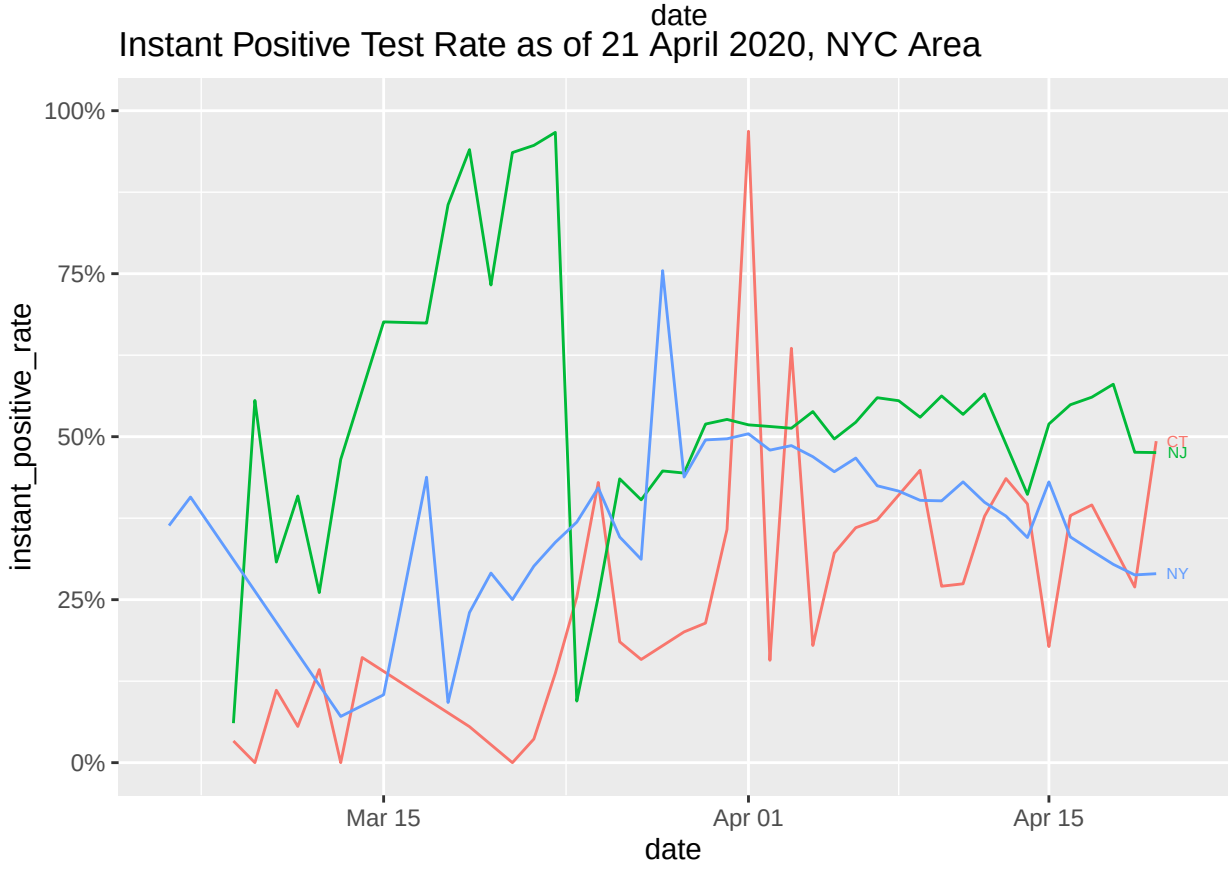
New York State has been the U.S. epicenter so far. New York is also testing much more than most states, but at the same time, its positive rate is very high (around 50% as of early March), indicating that people being tested are high-likelihood cases; as such it should be assumed that there remain a very large population of untested positive patients.

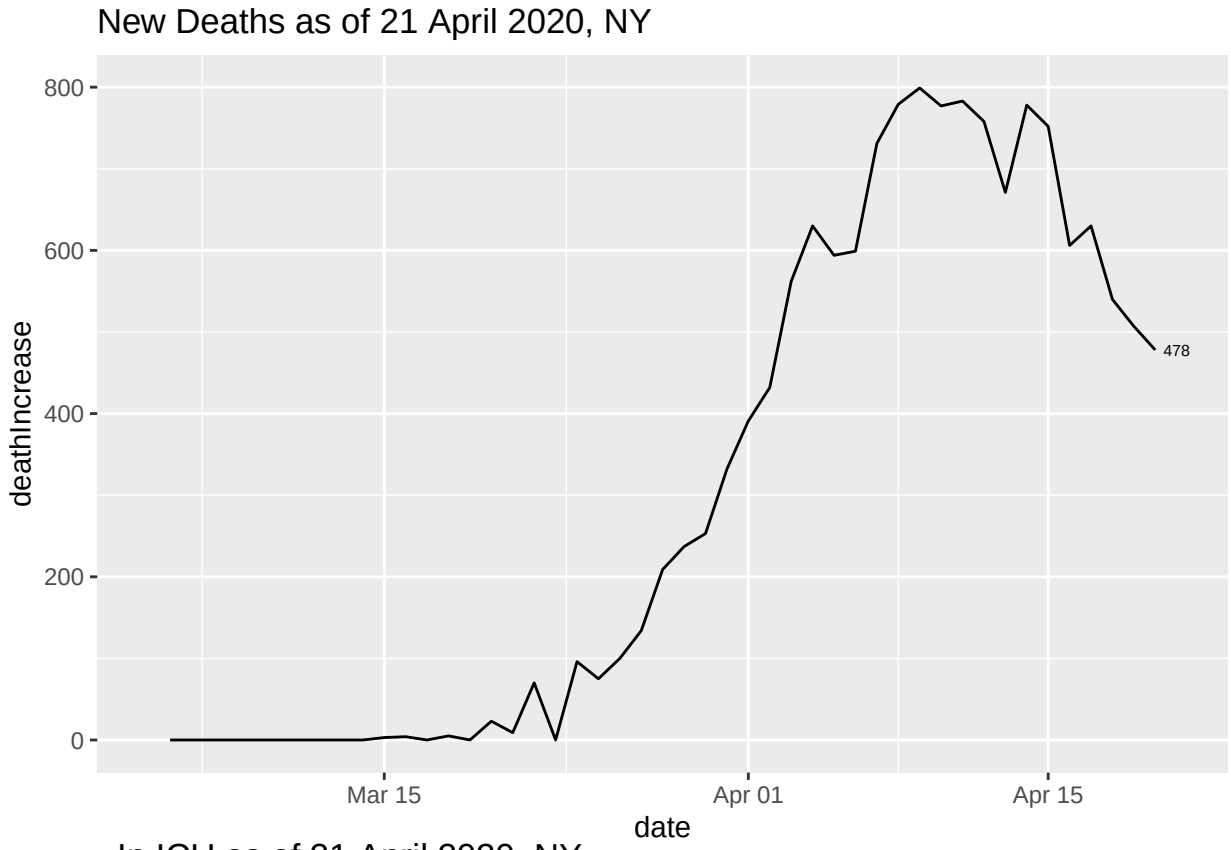
The DMV (D.C., Maryland, Virginia) might be a coming hotspot. Watching instant positive test rates will be a key leading indicator of hospitalizations and ICU beds in the coming week.

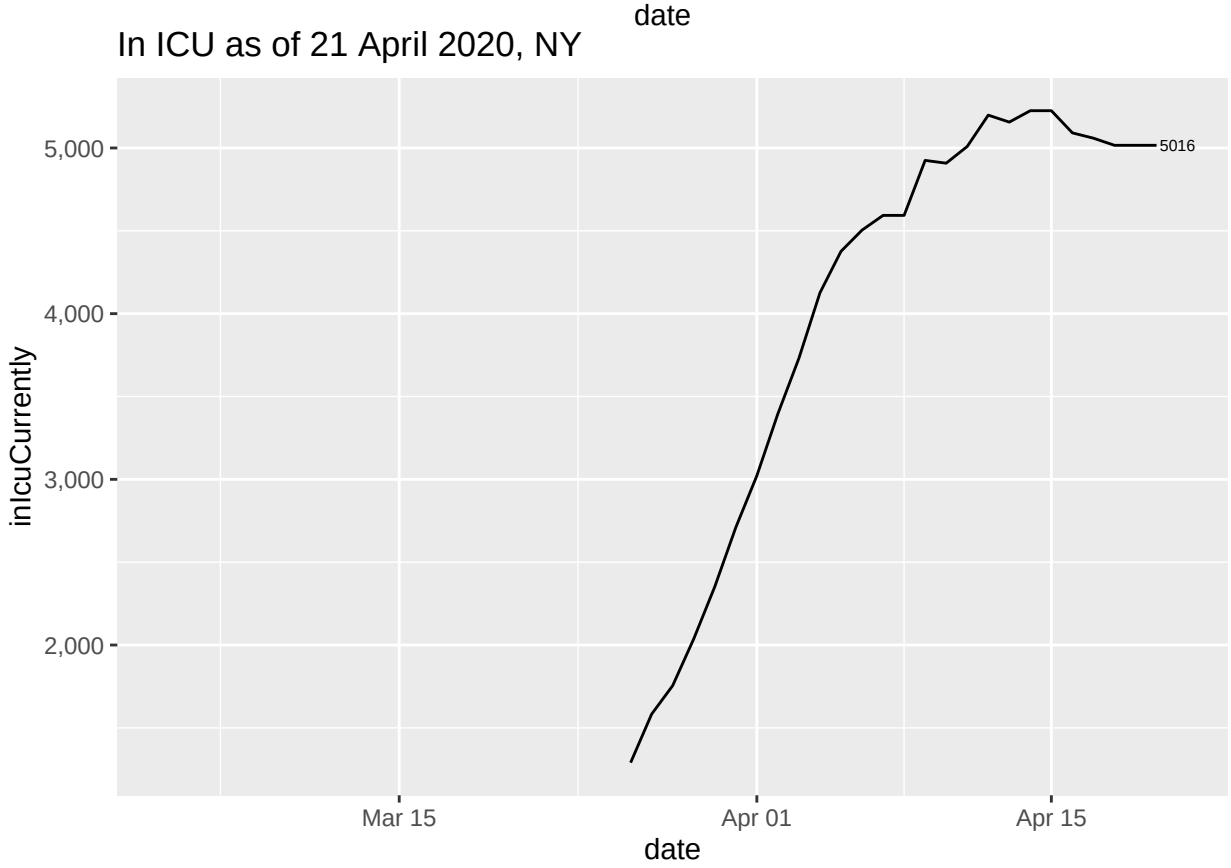

New Tests as of 21 April 2020, DMV Area
totalTestResultsIncrease
5,000
4,000
3,000
2,000
1,000
0
Mar 15
Apr 01
Apr 15
date
MD
VA
DC

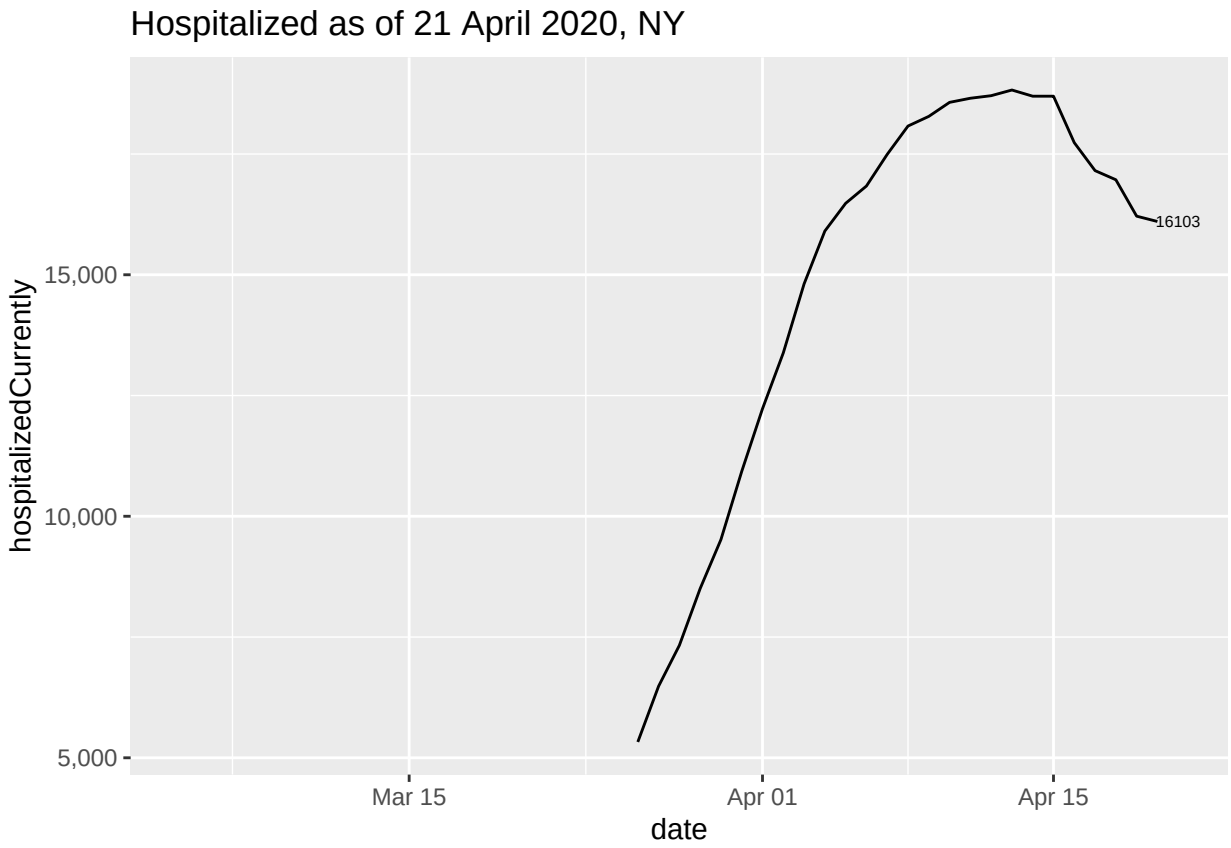

Instant Positive Test Rate as of 21 April 2020, DMV Area
instant_positive_rate
100%
75%
50%
25%
0%
Mar 15
Apr 01
Apr 15
date
DC
MD
VA


New Tests as of 21 April 2020, NYC Area
totalTestResultsIncrease
50,000
40,000
30,000
20,000
10,000
0
Mar 15
Apr 01
Apr 15
date
NY
NJ
CT


Instant Positive Test Rate as of 21 April 2020, NYC Area
instant_positive_rate
100%
75%
50%
25%
0%
Mar 15
Apr 01
Apr 15
date
CT
NJ
NY


New Deaths as of 21 April 2020, NY
800
600
400
200
0
deathIncrease
478
Mar 15
Apr 01
Apr 15
date


In ICU as of 21 April 2020, NY
5,000
4,000
3,000
2,000
inIcuCurrently
5016
Mar 15
Apr 01
Apr 15
date



Relationship between instant positive test rate and weather

```
write.csv(state_historical_testing_df %>%
  group_by(state) %>%
  filter(date == max(date)) %>%
  mutate(instant_positive_rate = positiveIncrease / totalTestResultsIncrease,
         positive_rate = positive/  totalTestResults,
         instant_positive_trend = (instant_positive_rate / positive_rate) -1) %>%
  select(state, positive, totalTestResults, positive_rate, positiveIncrease, totalTestResultsIncrease, i
         instant_positive_trend) %>%
  filter(totalTestResultsIncrease > 100, instant_positive_rate < .75) %>%
  arrange(desc(instant_positive_rate))
, "state_testing.csv")
```