COVID19 Time Series Analysis, Worldwide and U.S.

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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	29	161807	2978	20921	43667	272%
Italy	37	101739	11591	4050	63927	60%
Spain	29	87956	7716	7846	35136	152%
China	69	82198	3308	76	81496	0%
Germany	30	66885	645	4790	29056	132%
France	31	45170	3030	4462	20123	124%
Iran	34	41495	2757	3186	23049	80%
United Kingdom	20	22453	1411	2673	6726	232%
Switzerland	26	15922	359	1093	8795	80%
Belgium	25	11899	513	1063	3743	216%
Netherlands	25	11817	865	887	4764	148%
Turkey	12	10827	168	1610	1529	608%
Korea, South	40	9661	158	78	8961	8%
Austria	23	9618	108	830	4474	116%
Canada	20	7398	80	1118	2088	256%
Portugal	18	6408	140	446	2060	212%
Israel	20	4695	16	448	1442	224%
Brazil	18	4579	159	323	1924	136%
Norway	25	4445	32	161	2621	68%
Australia	21	4361	17	377	1682	160%
Sweden	25	4028	146	328	2046	96%
Czechia	18	3001	23	184	1236	144%
Ireland	17	2910	54	295	1125	160%
Denmark	21	2755	77	191	1572	76%
Malaysia	22	2626	37	156	1518	72%
Chile	15	2449	8	310	746	228%
Romania	17	2109	65	294	576	268%
Poland	17	2055	31	193	749	176%
Luxembourg	14	1988	22	38	875	128%

Country_Region	days_100	conf	deaths	new_conf	conf_lag7	l7_rate
Ecuador	13	1962	60	38	981	100%
Japan	39	1866	54	0	1128	64%
Russia	14	1836	9	302	438	320%
Pakistan	15	1717	21	120	875	96%
Philippines	17	1546	78	128	462	236%
Thailand	16	1524	9	136	721	112%
Saudi Arabia	17	1453	8	154	562	160%
Indonesia	16	1414	122	129	579	144%
Finland	18	1352	13	112	700	92%
South Africa	13	1326	3	46	402	228%
India	17	1251	32	227	499	152%
Greece	18	1212	43	56	695	76%
Iceland	19	1086	2	66	588	84%
World	23	754799	36968	59941	366336	108%

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.

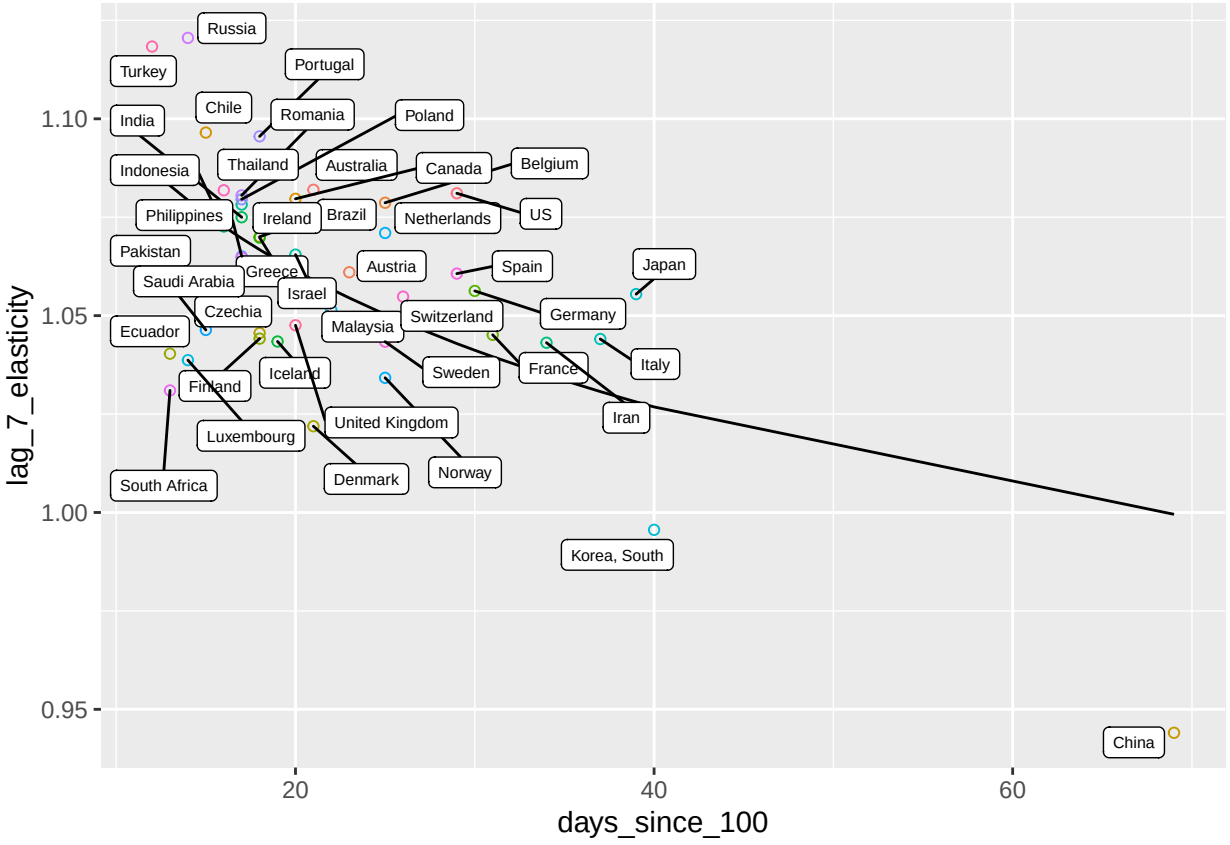


Table 2: Countries by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

country	days_since_100	lag_7_elasticity	prediction	residual
Turkey	12	1.12	1.09	0.03
South Africa	13	1.03	1.08	-0.05
Ecuador	13	1.04	1.08	-0.04
Luxembourg	14	1.04	1.08	-0.04
Russia	14	1.12	1.08	0.04
Pakistan	15	1.05	1.08	-0.03
Chile	15	1.10	1.08	0.02
Indonesia	16	1.07	1.07	0.00
Thailand	16	1.08	1.07	0.01
Saudi Arabia	17	1.06	1.07	0.00
Philippines	17	1.07	1.07	0.00
India	17	1.07	1.07	0.01
Ireland	17	1.08	1.07	0.01
Poland	17	1.08	1.07	0.01
Romania	17	1.08	1.07	0.01
Finland	18	1.04	1.07	-0.02
Czechia	18	1.05	1.07	-0.02
Greece	18	1.07	1.07	0.00
Brazil	18	1.07	1.07	0.00
Portugal	18	1.10	1.07	0.03
Iceland	19	1.04	1.06	-0.02
United Kingdom	20	1.05	1.06	-0.01
Israel	20	1.07	1.06	0.00
Canada	20	1.08	1.06	0.02
Denmark	21	1.02	1.06	-0.04
Australia	21	1.08	1.06	0.02
Malaysia	22	1.05	1.06	-0.01
Austria	23	1.06	1.05	0.01
Norway	25	1.03	1.05	-0.02
Sweden	25	1.04	1.05	-0.01
Netherlands	25	1.07	1.05	0.02
Belgium	25	1.08	1.05	0.03
Switzerland	26	1.05	1.05	0.01
Spain	29	1.06	1.04	0.02
US	29	1.08	1.04	0.04
Germany	30	1.06	1.04	0.02
France	31	1.05	1.04	0.01
Iran	34	1.04	1.03	0.01
Italy	37	1.04	1.03	0.01
Japan	39	1.06	1.03	0.03
Korea, South	40	1.00	1.03	-0.03
China	69	0.94	1.00	-0.06

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
Turkey	12	1.12	1.09	0.03
South Africa	13	1.03	1.08	-0.05
Ecuador	13	1.04	1.08	-0.04
Luxembourg	14	1.04	1.08	-0.04
Russia	14	1.12	1.08	0.04
Pakistan	15	1.05	1.08	-0.03
Chile	15	1.10	1.08	0.02
Indonesia	16	1.07	1.07	0.00
Thailand	16	1.08	1.07	0.01
Saudi Arabia	17	1.06	1.07	0.00
Philippines	17	1.07	1.07	0.00
India	17	1.07	1.07	0.01
Ireland	17	1.08	1.07	0.01
Poland	17	1.08	1.07	0.01
Romania	17	1.08	1.07	0.01
Finland	18	1.04	1.07	-0.02
Czechia	18	1.05	1.07	-0.02
Greece	18	1.07	1.07	0.00
Brazil	18	1.07	1.07	0.00
Portugal	18	1.10	1.07	0.03
Iceland	19	1.04	1.06	-0.02
United Kingdom	20	1.05	1.06	-0.01
Israel	20	1.07	1.06	0.00
Canada	20	1.08	1.06	0.02
Denmark	21	1.02	1.06	-0.04
Australia	21	1.08	1.06	0.02
Malaysia	22	1.05	1.06	-0.01
Austria	23	1.06	1.05	0.01
Norway	25	1.03	1.05	-0.02
Sweden	25	1.04	1.05	-0.01
Netherlands	25	1.07	1.05	0.02
Belgium	25	1.08	1.05	0.03
Switzerland	26	1.05	1.05	0.01
Spain	29	1.06	1.04	0.02
US	29	1.08	1.04	0.04
Germany	30	1.06	1.04	0.02
France	31	1.05	1.04	0.01
Iran	34	1.04	1.03	0.01
Italy	37	1.04	1.03	0.01
Japan	39	1.06	1.03	0.03
Korea, South	40	1.00	1.03	-0.03
China	69	0.94	1.00	-0.06

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	83,498	15,133	2020-02-13	1,378,665,000	0.0%
Pakistan	13,701	229	2020-03-21	193,203,476	0.0%
Ecuador	11,150	283	2020-03-22	16,385,068	0.1%
Luxembourg	9,344	234	2020-03-25	582,972	1.6%
South Africa	7,235	243	2020-03-27	55,908,865	0.0%
Denmark	11,943	202	2020-04-05	5,731,118	0.2%
Iceland	6,685	99	2020-04-15	334,252	2.0%
Norway	27,031	394	2020-04-18	5,232,929	0.5%
Finland	11,351	157	2020-04-20	5,495,096	0.2%
Spain	2,328,442	64,731	2020-04-25	46,443,959	5.0%
United Kingdom	408,764	7,771	2020-04-25	65,637,239	0.6%
US	27,495,813	1,222,159	2020-04-25	323,127,513	8.5%
Sweden	47,508	679	2020-04-28	9,903,122	0.5%
Switzerland	232,296	4,375	2020-04-29	8,372,098	2.8%
Belgium	784,947	23,216	2020-04-30	11,348,159	6.9%
Turkey	7,504,404	342,441	2020-04-30	79,512,426	9.4%
Italy	1,336,088	25,007	2020-05-01	60,600,590	2.2%
France	964,129	17,617	2020-05-02	66,896,109	1.4%
Austria	231,467	4,343	2020-05-03	8,747,358	2.6%
Germany	2,617,710	59,492	2020-05-03	82,667,685	3.2%
Portugal	789,521	25,083	2020-05-03	10,324,611	7.6%
Malaysia	35,806	458	2020-05-04	31,187,265	0.1%
Israel	182,374	3,251	2020-05-07	8,547,100	2.1%
Netherlands	754,418	17,555	2020-05-07	17,018,408	4.4%
Ireland	144,053	2,667	2020-05-10	4,773,095	3.0%
Saudi Arabia	37,481	486	2020-05-10	32,275,687	0.1%
Philippines	64,029	875	2020-05-11	103,320,222	0.1%
Canada	1,317,266	29,642	2020-05-14	36,286,425	3.6%
Greece	34,167	408	2020-05-18	10,746,740	0.3%
Indonesia	63,987	820	2020-05-18	261,115,456	0.0%
Brazil	313,349	4,500	2020-05-20	207,652,865	0.2%
Chile	719,523	15,871	2020-05-20	17,909,754	4.0%
Australia	851,792	17,583	2020-05-21	24,127,159	3.5%
Romania	296,406	4,745	2020-05-23	19,705,301	1.5%
India	92,125	1,150	2020-05-25	1,324,171,354	0.0%
Poland	259,254	3,693	2020-05-28	37,948,016	0.7%
Thailand	147,156	1,883	2020-05-31	68,863,514	0.2%
Japan	115,023	1,171	2020-06-13	126,994,511	0.1%

Forecast New Cases WW Total

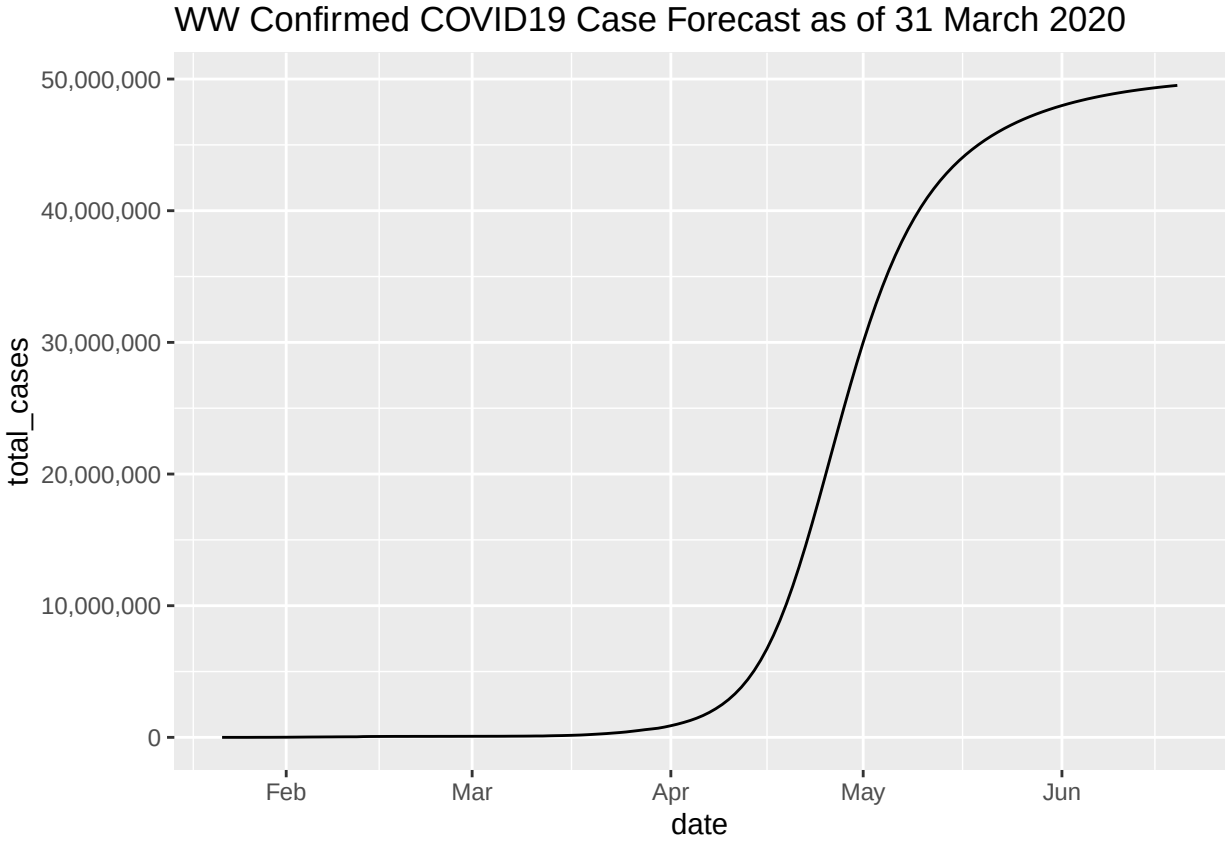
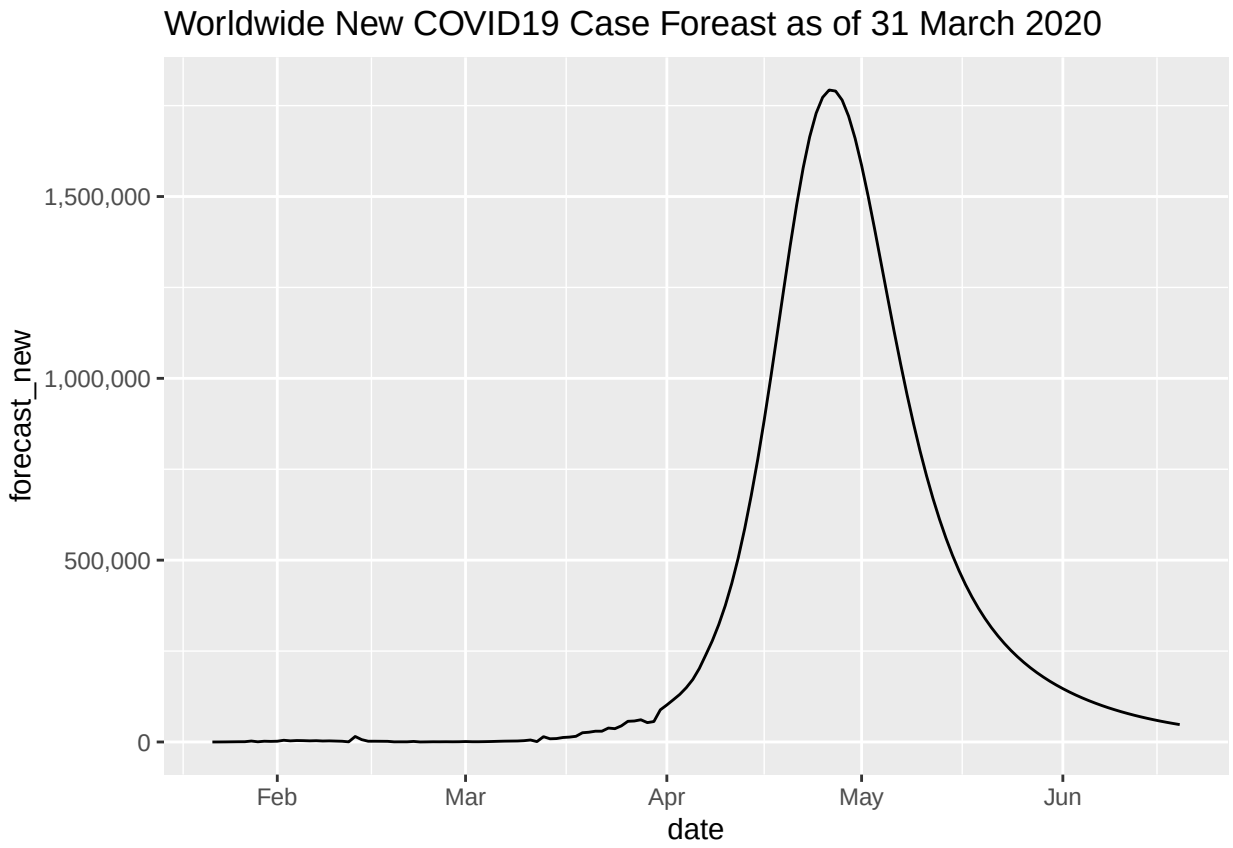


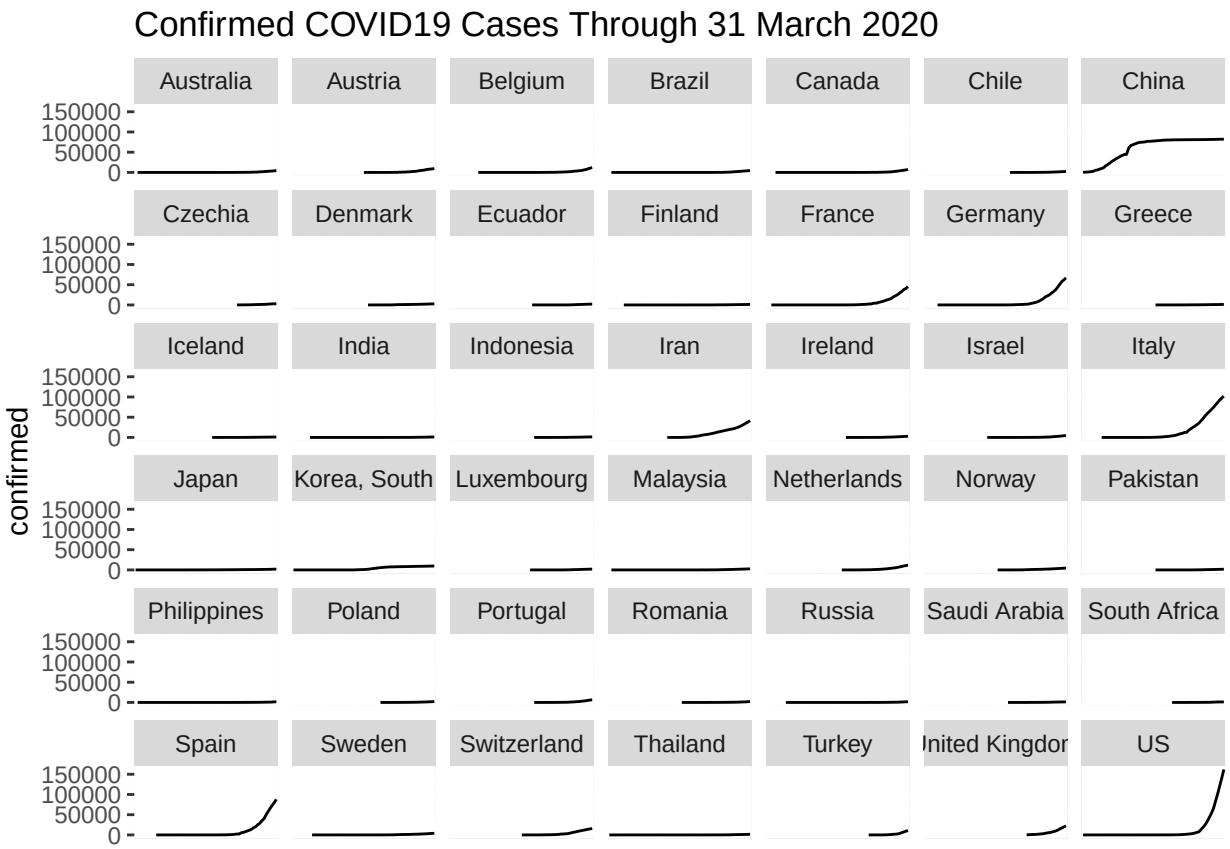
Table 5: Peak Daily New Cases Worldwide and Total on That Day

date	forecast_new	total_cases
2020-04-26	1,792,903	21,486,918

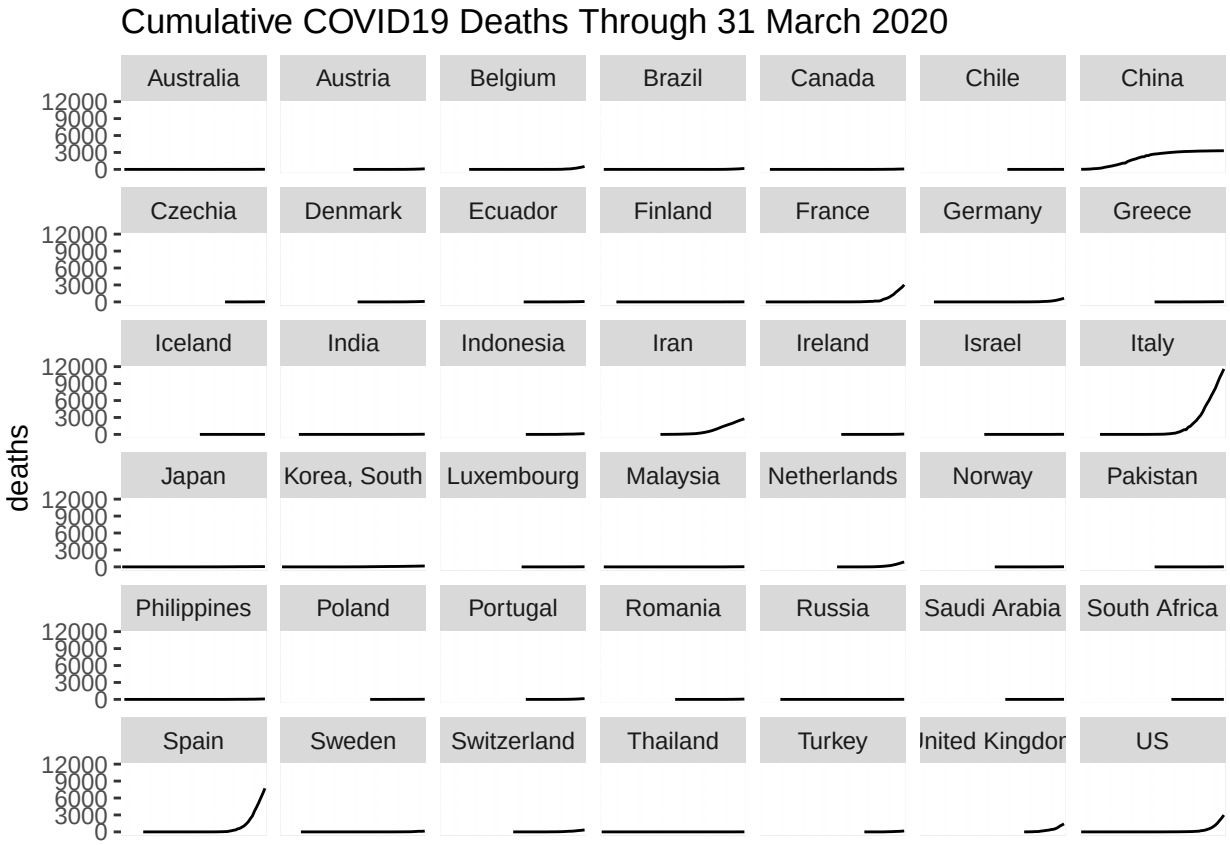

Worldwide New COVID19 Case Foreast as of 31 March 2020
forecast_new
1,500,000
1,000,000
500,000
0
Feb
Mar
Apr
May
Jun
date

Sparklines

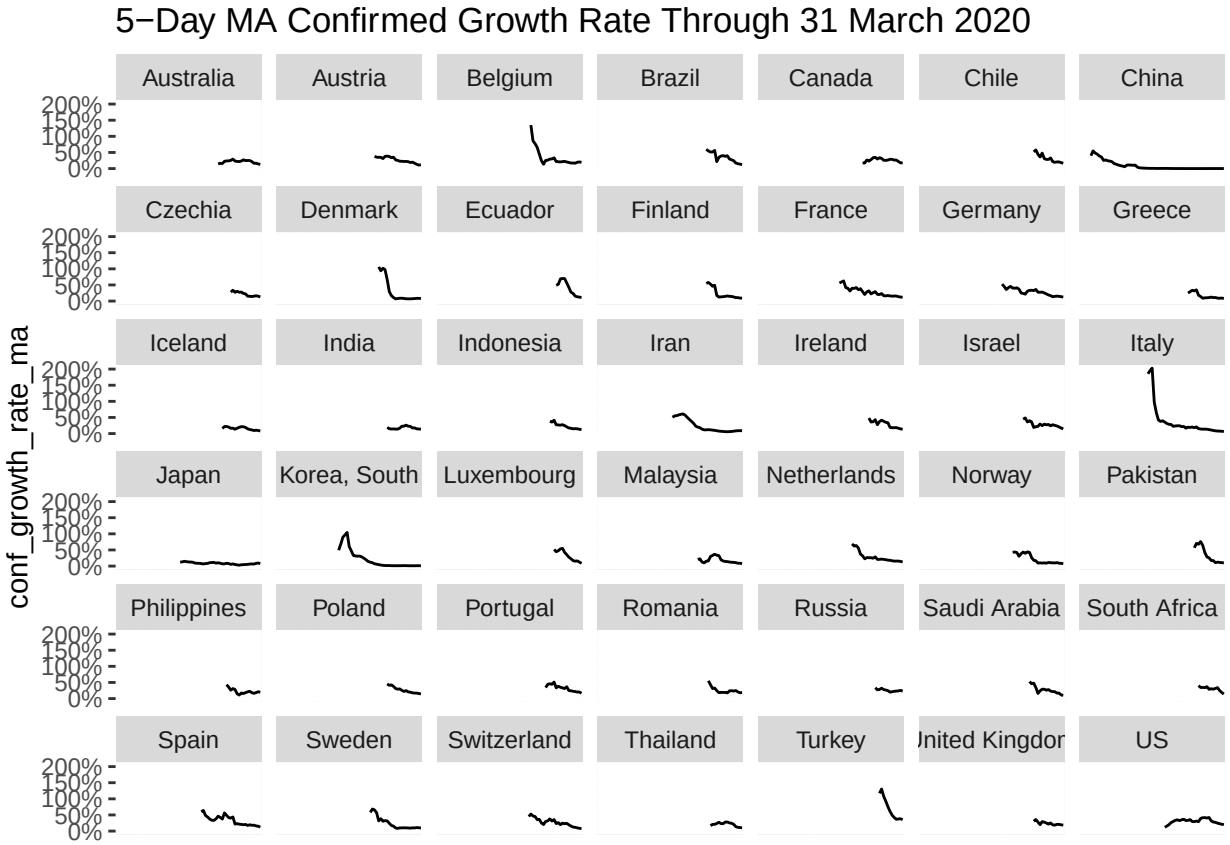
Confirmed Cases



Deaths


Cumulative COVID19 Deaths Through 31 March 2020
deaths
Australia
Austria
Belgium
Brazil
Canada
Chile
China
Czechia
Denmark
Ecuador
Finland
France
Germany
Greece
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Japan
Korea, South
Luxembourg
Malaysia
Netherlands
Norway
Pakistan
Philippines
Poland
Portugal
Romania
Russia
Saudi Arabia
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
United Kingdom
US
0
3000
6000
9000
12000

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
New York	23	66663	1218	7015	20884	220%
New Jersey	15	16636	198	3250	2844	484%
California	22	7138	146	1286	2108	240%
Michigan	12	6498	184	1010	1329	388%
Massachusetts	19	5752	56	797	777	640%
Florida	16	5473	63	1227	1227	348%
Illinois	15	5056	73	460	1285	292%
Washington	24	4923	205	458	2221	120%
Pennsylvania	14	4155	50	723	698	496%
Louisiana	15	4025	185	485	1172	244%
Texas	14	3147	45	355	758	316%
Georgia	15	2808	87	157	772	264%
Connecticut	12	2571	36	578	415	520%
Colorado	17	2311	47	4	704	228%
Ohio	12	1933	40	280	443	336%
Tennessee	12	1917	14	197	614	212%

Province_State	days_100	conf	deaths	new_conf	conf_lag7	l7_rate
Indiana	10	1786	35	273	270	560%
Maryland	12	1413	15	174	290	388%
North Carolina	12	1313	7	122	353	272%
Wisconsin	12	1230	20	66	425	188%
Arizona	10	1157	20	238	235	392%
Missouri	8	1051	13	136	187	464%
Virginia	11	1020	15	130	254	300%
Nevada	11	1012	15	92	245	312%
South Carolina	11	925	18	151	298	212%
Alabama	10	899	10	74	196	360%
Mississippi	10	847	16	88	249	240%
Utah	10	804	4	84	257	212%
Oregon	11	606	16	58	191	216%
Minnesota	11	576	10	73	234	148%
Oklahoma	7	481	16	52	81	492%
Kentucky	9	479	11	41	123	288%
Arkansas	10	473	7	47	192	148%
Iowa	8	424	6	88	105	304%
Rhode Island	8	408	4	114	106	284%
District of Columbia	9	401	9	59	120	236%
Kansas	7	372	8	42	84	344%
Idaho	5	340	6	59	68	400%
New Hampshire	8	314	3	100	101	212%
Maine	8	275	3	22	107	156%
Delaware	7	264	6	32	68	288%
Vermont	6	256	12	21	75	240%
New Mexico	7	237	2	0	83	184%
Hawaii	4	175	0	26	56	212%
Puerto Rico	3	174	6	47	31	460%
Montana	4	171	5	17	34	404%
Nebraska	2	145	2	37	51	184%
West Virginia	2	145	1	32	16	808%
Alaska	2	114	3	12	30	280%
North Dakota	1	109	2	11	30	264%
South Dakota	1	101	1	11	28	260%
US	10	161503	2974	20911	43524	272%

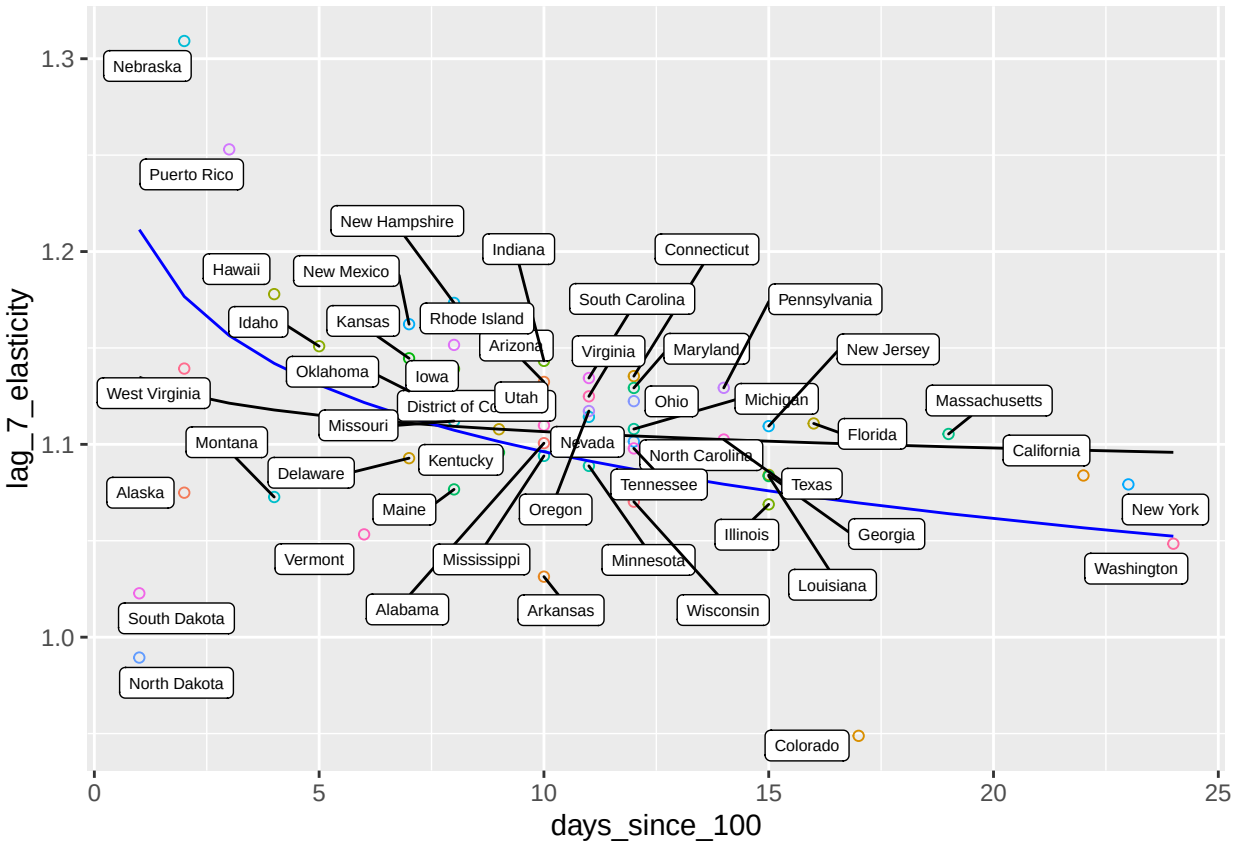
Ln (Seven-Day-Moving-Average New Cases) Impact on Ln (New Cases)

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
North Dakota	1	0.99	1.13	1.21	-0.15	-0.22
South Dakota	1	1.02	1.13	1.21	-0.11	-0.19
Alaska	2	1.07	1.13	1.18	-0.05	-0.10
West Virginia	2	1.14	1.13	1.18	0.01	-0.04
Nebraska	2	1.31	1.13	1.18	0.18	0.13
Puerto Rico	3	1.25	1.12	1.16	0.13	0.10
Montana	4	1.07	1.12	1.14	-0.05	-0.07
Hawaii	4	1.18	1.12	1.14	0.06	0.04
Idaho	5	1.15	1.12	1.13	0.04	0.02
Vermont	6	1.05	1.11	1.12	-0.06	-0.07
Delaware	7	1.09	1.11	1.11	-0.02	-0.02
Oklahoma	7	1.13	1.11	1.11	0.02	0.01
Kansas	7	1.14	1.11	1.11	0.03	0.03
New Mexico	7	1.16	1.11	1.11	0.05	0.05
Maine	8	1.08	1.11	1.11	-0.03	-0.03
Missouri	8	1.11	1.11	1.11	0.00	0.00
Iowa	8	1.14	1.11	1.11	0.03	0.03
Rhode Island	8	1.15	1.11	1.11	0.04	0.04

state	days_since_100	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
New Hampshire	8	1.17	1.11	1.11	0.06	0.07
Kentucky	9	1.10	1.11	1.10	-0.01	-0.01
District of Columbia	9	1.11	1.11	1.10	0.00	0.01
Arkansas	10	1.03	1.11	1.10	-0.08	-0.06
Mississippi	10	1.09	1.11	1.10	-0.01	0.00
Alabama	10	1.10	1.11	1.10	-0.01	0.00
Utah	10	1.11	1.11	1.10	0.00	0.01
Arizona	10	1.13	1.11	1.10	0.03	0.04
Indiana	10	1.14	1.11	1.10	0.04	0.05
Minnesota	11	1.09	1.11	1.09	-0.02	0.00
Nevada	11	1.11	1.11	1.09	0.01	0.02
Oregon	11	1.12	1.11	1.09	0.01	0.03
Virginia	11	1.12	1.11	1.09	0.02	0.03
South Carolina	11	1.13	1.11	1.09	0.03	0.04
Wisconsin	12	1.07	1.10	1.09	-0.03	-0.02
Tennessee	12	1.10	1.10	1.09	-0.01	0.01
North Carolina	12	1.10	1.10	1.09	0.00	0.01
Michigan	12	1.11	1.10	1.09	0.00	0.02
Ohio	12	1.12	1.10	1.09	0.02	0.04
Maryland	12	1.13	1.10	1.09	0.02	0.04
Connecticut	12	1.14	1.10	1.09	0.03	0.05
Texas	14	1.10	1.10	1.08	0.00	0.02
Pennsylvania	14	1.13	1.10	1.08	0.03	0.05
Illinois	15	1.07	1.10	1.08	-0.03	-0.01
Louisiana	15	1.08	1.10	1.08	-0.02	0.01
Georgia	15	1.08	1.10	1.08	-0.02	0.01
New Jersey	15	1.11	1.10	1.08	0.01	0.03
Florida	16	1.11	1.10	1.07	0.01	0.04
Colorado	17	0.95	1.10	1.07	-0.15	-0.12
Massachusetts	19	1.11	1.10	1.06	0.01	0.04
California	22	1.08	1.10	1.06	-0.01	0.03
New York	23	1.08	1.10	1.05	-0.02	0.02
Washington	24	1.05	1.10	1.05	-0.05	0.00

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	total_cases	peak_new_cases	date	population	perc_pop_infected
Arkansas	1,648	61	2020-03-25	2,959,373	0.1%
Washington	16,133	616	2020-03-26	6,971,406	0.2%
Georgia	38,914	475	2020-03-27	9,992,167	0.4%
Wisconsin	8,268	198	2020-03-27	5,742,713	0.1%
Kentucky	12,864	92	2020-03-28	4,395,295	0.3%
Louisiana	44,663	571	2020-03-28	4,625,470	1.0%
Maine	2,644	43	2020-03-28	1,328,302	0.2%
New York	380,880	7,534	2020-03-28	19,651,127	1.9%
Colorado	3,876	567	2020-03-29	5,268,367	0.1%
Illinois	33,742	1,105	2020-03-29	12,882,135	0.3%

state	total_cases	peak_new_cases	date	population	perc_pop_infected
California	134,506	1,286	2020-03-30	38,332,521	0.4%
Minnesota	9,671	73	2020-03-30	5,420,380	0.2%
New Jersey	462,593	8,614	2020-04-30	8,899,339	5.2%
Connecticut	320,987	7,783	2020-05-12	3,596,080	8.9%
Mississippi	18,690	141	2020-05-14	2,991,207	0.6%
Indiana	635,739	17,732	2020-05-18	6,570,902	9.7%
Massachusetts	271,297	3,698	2020-05-18	6,692,824	4.1%
New Hampshire	193,443	6,837	2020-05-19	1,323,459	14.6%
Pennsylvania	983,305	23,416	2020-05-20	12,773,801	7.7%
Michigan	351,791	4,616	2020-05-21	9,895,622	3.6%
Rhode Island	112,346	2,669	2020-05-25	1,051,511	10.7%
Maryland	417,221	8,128	2020-06-02	5,928,814	7.0%
Tennessee	66,267	508	2020-06-02	6,495,978	1.0%
District of Columbia	15,415	120	2020-06-05	646,449	2.4%
Florida	796,211	11,240	2020-06-05	19,552,860	4.1%
Arizona	472,447	9,401	2020-06-06	6,626,624	7.1%
South Carolina	365,528	7,438	2020-06-07	4,774,839	7.7%
Alabama	39,577	279	2020-06-11	4,833,722	0.8%
Nevada	106,442	1,161	2020-06-12	2,790,136	3.8%
Ohio	630,864	10,373	2020-06-13	11,570,808	5.5%
Iowa	236,937	4,508	2020-06-16	3,090,416	7.7%
Virginia	452,712	7,075	2020-06-23	8,260,405	5.5%
Utah	66,263	556	2020-06-26	2,900,872	2.3%
Missouri	127,678	1,102	2020-07-02	6,044,171	2.1%
North Carolina	83,242	599	2020-07-02	9,848,060	0.8%
Texas	353,601	2,945	2020-07-05	26,448,193	1.3%
Oregon	134,389	1,374	2020-07-15	3,930,065	3.4%

Forecast New Cases U.S. Total

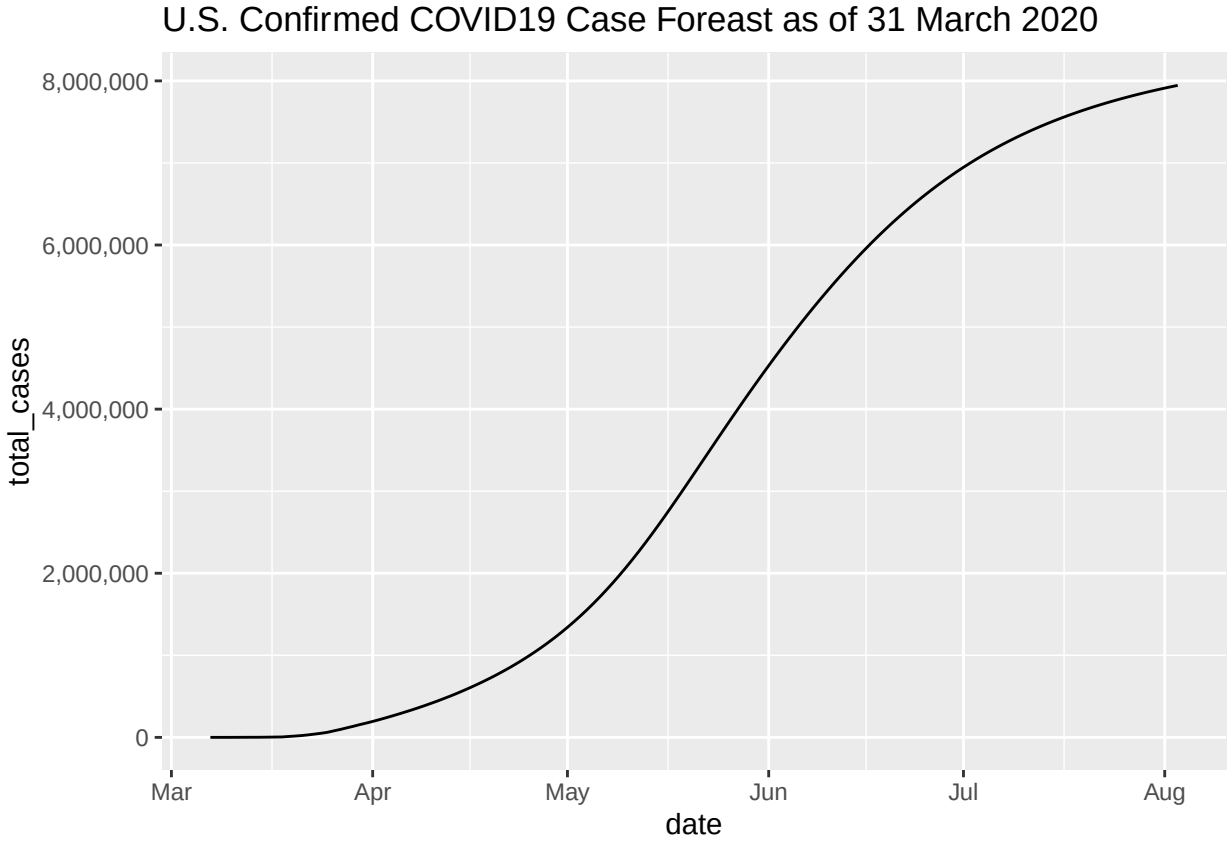
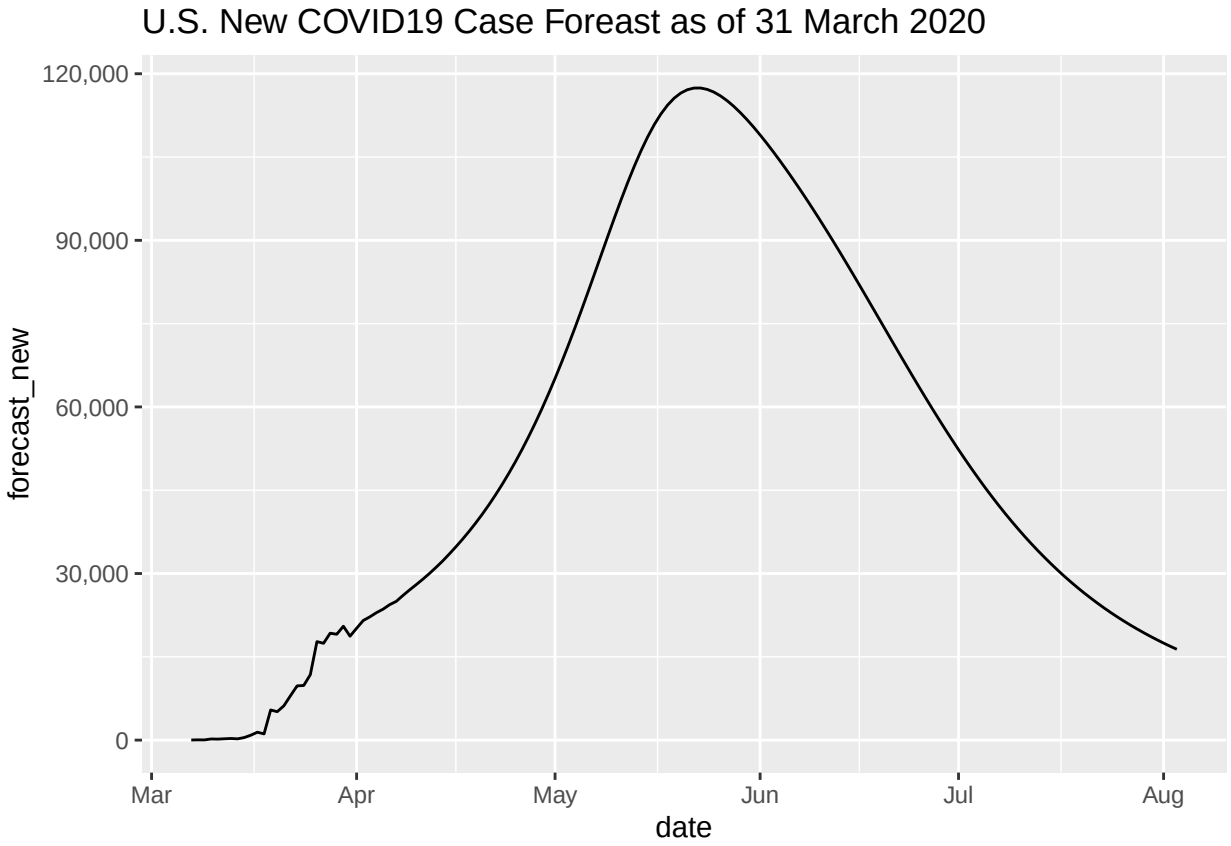


Table 9: Peak Daily New Cases in U.S. and Total on That Day

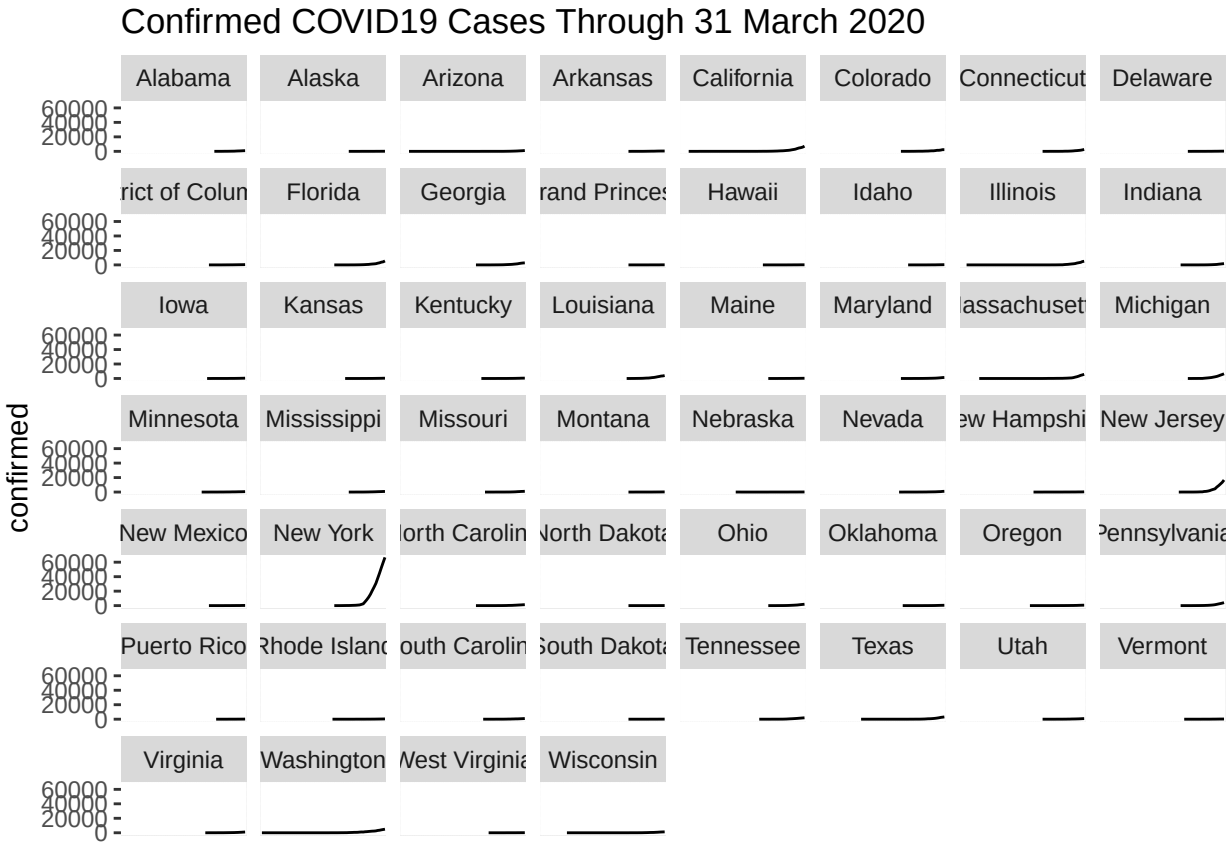
date	forecast_new	total_cases
2020-05-23	117,431	3,506,989



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



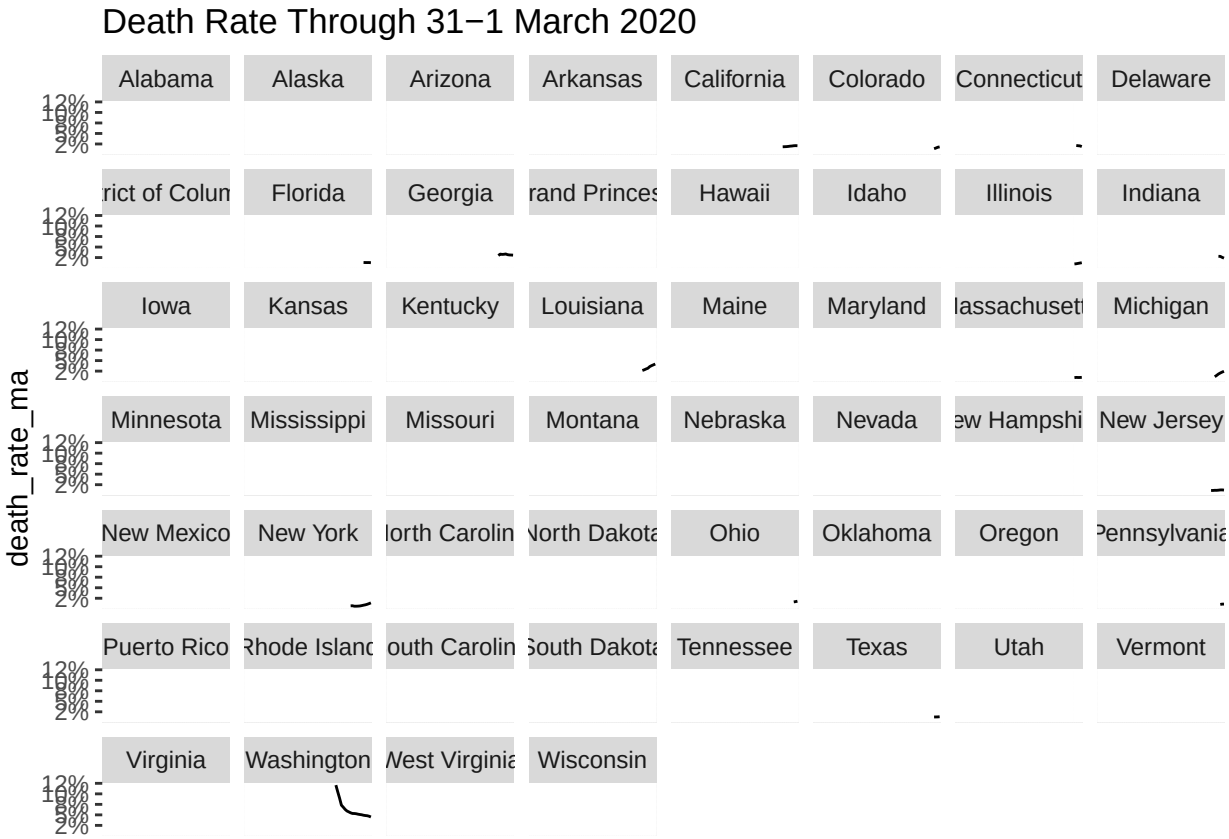
Deaths


Cumulative COVID19 Deaths Through 31 March 2020
deaths
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
rict of Colun
Florida
Georgia
rand Princes
Hawaii
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
lassachusett
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
ew Hampshi
New Jersey
New Mexico
New York
lorth Carolin
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Puerto Rico
Rhode Island
outh Carolin
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
1250
1000
750
500
250
0

Confirmed Growth Rate 5-Day Moving Average

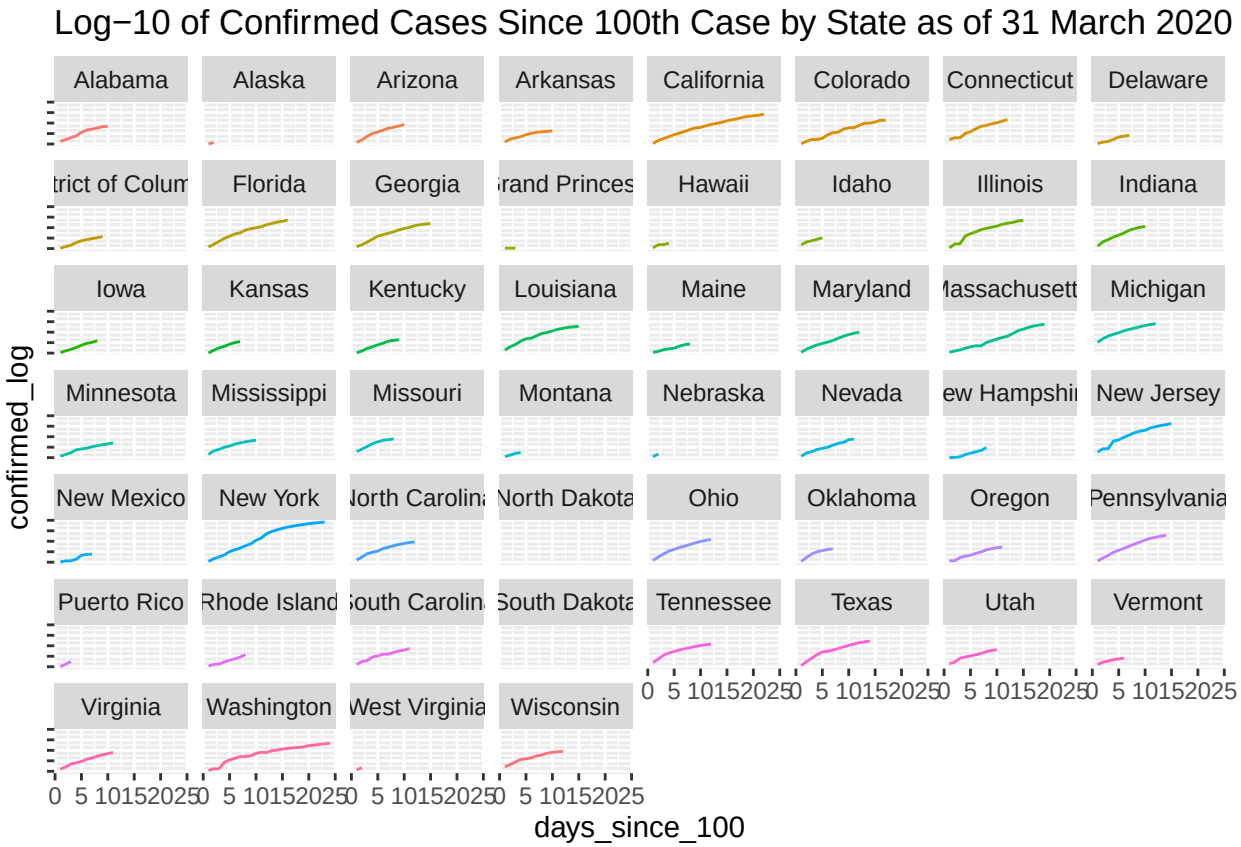
Death Rate 5-Day Moving Average

Only states with >25 deaths are shown


Death Rate Through 31−1 March 2020
death_rate_ma
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
rict of Colun
Florida
Georgia
rand Princes
Hawaii
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
lassachusett
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
ew Hampshi
New Jersey
New Mexico
New York
lorth Carolin
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Puerto Rico
Rhode Island
outh Carolin
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
12%
10%
8%
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