COVID-19 Data Analysis with R - Worldwide*

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13 November 2020

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1 Introduction

This is an analysis report of the Novel Coronavirus (COVID-19) around the world, to demonstrate data processing and visualisation with R, *tidyverse* and *ggplot2*. This report will be updated from time to time, with new data and more analysis. Please find its latest version at http://www.rdatamining.com/docs/Coronavirus-data-analysis-world.pdf.

A similar COVID-19 analysis report for China is available at http://www.rdatamining.com/docs/Coronavirus-data-analysis-china.pdf, if you are particually interested what has happened in China.

1.1 Data Source

The data source used for this analysis is *the 2019 Novel Coronavirus COVID-19 (2019-nCoV) Data Repository*[1] built by the Center for Systems Science and Engineering, Johns Hopkins University.

1.2 R Packages

Blow is a list of R packages used for this analysis. Package *magrittr* is for pipe operations like `%>%` and `%<>%` and *lubridate* for date operations. Package *tidyverse* is a collection of R packages for data science, including *dplyr* and *tidyr* for data processing and *ggplot2* for graphics. Package *gridExtra* is for arranging multiple grid-based plots on a page and *kableExtra* works together with `kable()` from *knitr* to build complex HTML or LaTeX tables.

```
library(magrittr) # pipe operations
library(lubridate) # date operations
library(tidyverse) # ggplot2, tidyr, dplyr...
library(gridExtra) # multiple grid-based plots on a page
library(ggforce) # accelerating ggplot2
library(kableExtra) # complex tables
library(leaflet) # map
```

2 Loading Data

At first, the datasets, which are three CSV files, are downloaded and saved as local files and then are loaded into R.

```
## source data files
filenames <- c('time_series_covid19_confirmed_global.csv',
               'time_series_covid19_deaths_global.csv',
               'time_series_covid19_recovered_global.csv')
url.path <- paste0('https://raw.githubusercontent.com/CSSEGISandData/COVID-19/',
                   'master/csse_covid_19_data/csse_covid_19_time_series/')

## download files to local
download <- function(filename) {
  url <- file.path(url.path, filename)
  dest <- file.path('./data', filename)
  download.file(url, dest)
}
bin <- lapply(filenames, download)

## load data into R
raw.data.confirmed <- read.csv('./data/time_series_covid19_confirmed_global.csv')
raw.data.deaths <- read.csv('./data/time_series_covid19_deaths_global.csv')
```

[1] https://github.com/CSSEGISandData/COVID-19

```
raw.data.recovered <- read.csv('./data/time_series_covid19_recovered_global.csv')

dim(raw.data.confirmed)
```

```
## [1] 269 300
```

Each dataset has 269 rows, corresponding to country/region/province/state. It has 300 columns. Starting from column 5, each column corresponds to a single day. Here we have a look at the first 10 rows and the first 10 columns.

```
raw.data.confirmed[1:10, 1:10] %>%
  kable('latex', booktabs=T, caption='Raw Data (Confirmed, First 10 Columns only)') %>%
  kable_styling(font_size=5, latex_options = c('striped', 'hold_position', 'repeat_header'))
```

Table 1: Raw Data (Confirmed, First 10 Columns only)

Province.State	Country.Region	Lat	Long	X1.22.20	X1.23.20	X1.24.20	X1.25.20	X1.26.20	X1.27.20
	Afghanistan	33.93911	67.70995	0	0	0	0	0	0
	Albania	41.15330	20.16830	0	0	0	0	0	0
	Algeria	28.03390	1.65960	0	0	0	0	0	0
	Andorra	42.50630	1.52180	0	0	0	0	0	0
	Angola	-11.20270	17.87390	0	0	0	0	0	0
	Antigua and Barbuda	17.06080	-61.79640	0	0	0	0	0	0
	Argentina	-38.41610	-63.61670	0	0	0	0	0	0
	Armenia	40.06910	45.03820	0	0	0	0	0	0
Australian Capital Territory	Australia	-35.47350	149.01240	0	0	0	0	0	0
New South Wales	Australia	-33.86880	151.20930	0	0	0	0	3	4

Below we check the time frame of the data.

```
n.col <- ncol(raw.data.confirmed)
## get dates from column names
dates <- names(raw.data.confirmed)[5:n.col] %>% str_replace('X', '') %>% mdy()
range(dates)
```

```
## [1] "2020-01-22" "2020-11-12"
```

```
min.date <- min(dates)
max.date <- max(dates)
min.date.txt <- min.date %>% format('%d %b %Y')
max.date.txt <- max.date %>% format('%d %b %Y') %>% paste('UTC')
```

It shows that the data was last updated on 12 Nov 2020 UTC and all the stats and charts in this report are based on that data.

3 Data Preparation

3.1 Data Cleaning

The three datesets are converted from wide to long format and then are aggregated by country. After that, they are merged into one single dataset.

```
## data cleaning and transformation
cleanData <- function(data) {
  ## remove some columns
  data %<>% select(-c(Province.State, Lat, Long)) %>% rename(country=Country.Region)
  ## convert from wide to long format
  data %<>% gather(key=date, value=count, -country)
  ## convert from character to date
  data %<>% mutate(date = date %>% str_replace('X', '') %>% mdy())
```

```
  ## aggregate by country
  data %<>% group_by(country, date) %>% summarise(count=sum(count, na.rm=T)) %>% as.data.frame()
  return(data)
}

## clean the three datasets
data.confirmed <- raw.data.confirmed %>% cleanData() %>% rename(confirmed=count)
data.deaths <- raw.data.deaths %>% cleanData() %>% rename(deaths=count)
data.recovered <- raw.data.recovered %>% cleanData() %>% rename(recovered=count)

## merge above 3 datasets into one, by country and date
data <- data.confirmed %>% merge(data.deaths, all=T) %>% merge(data.recovered, all=T)
# data %<>% mutate(recovered = ifelse(is.na(recovered), lag(recovered, 1), recovered))

## countries/regions with confirmed cases, excl. cruise ships
countries <- data %>% pull(country) %>% setdiff('Cruise Ship')

## latest 10 records in US
data %>% filter(country=='US') %>% tail(10) %>%
  kable('latex', row.names=F, booktabs=T,
        caption='Raw Data (with first 10 Columns Only)',
        format.args=list(big.mark=',')) %>%
  kable_styling(latex_options = c('striped', 'hold_position', 'repeat_header'))
```

Table 2: Raw Data (with first 10 Columns Only)

country	date	confirmed	deaths	recovered
US	2020-11-03	9,404,058	233,189	3,705,130
US	2020-11-04	9,507,004	234,264	3,743,527
US	2020-11-05	9,632,704	235,424	3,781,751
US	2020-11-06	9,757,612	236,553	3,810,791
US	2020-11-07	9,886,080	237,564	3,851,465
US	2020-11-08	9,995,860	238,037	3,881,491
US	2020-11-09	10,115,804	238,735	3,928,845
US	2020-11-10	10,256,094	240,123	3,961,873
US	2020-11-11	10,399,325	241,504	3,997,175
US	2020-11-12	10,552,821	242,423	4,051,256

There are 191 countries with confirmed COVID-19 cases, as of 12 Nov 2020 UTC.

3.2 Worldwide Cases

The raw data provide the daily number of cases in every country. They are aggregated below to derive the daily stats of the whole world.

```
## counts for the whole world
data.world <- data %>% group_by(date) %>%
  summarise(country='World',
            confirmed = sum(confirmed, na.rm=T),
            deaths = sum(deaths, na.rm=T),
            recovered = sum(recovered, na.rm=T))
```

```r
data %<>% rbind(data.world)

## active confirmed cases
data %<>% mutate(active.confirmed = confirmed - deaths - recovered)
```

3.3 Daily Increases and Death Rates

After that, the daily increases of death and recovered cases and the death rates are calculated.

`rate.upper` is caculated with the total dead and recovered cases. It is the upper bound of death rate and the reasons are

1) there were much more deaths than recovered cases when the coronavirus broke out and when it was not contained, and
2) the daily number of death will decrease and that of recovered will increase as it becomes contained and more effective measures and treatments are used.

`rate.lower` is caculated with total dead and confirmed cases. It is a lower bound of death rate, because there are and will be new deaths from the active confirmed cases. The final death rate is expected to be in between of the above two rates.

`rate.daily` is caculated with the daily dead and recovered cases and therefore is more volatile than the above two. However, it can give us a clue of the current situlation: whether it is very serious or is getting better.

```r
## sort by country and date
data %<>% arrange(country, date)

## daily increases of deaths and recovered cases
## set NA to the increases on day1
n <- nrow(data)
day1 <- min(data$date)
data %<>% mutate(new.confirmed = ifelse(date == day1, NA, confirmed - lag(confirmed, n=1)),
                 new.deaths = ifelse(date == day1, NA, deaths - lag(deaths, n=1)),
                 new.recovered = ifelse(date == day1, NA, recovered - lag(recovered, n=1)))

## change negative number of new cases to zero
data %<>% mutate(new.confirmed = ifelse(new.confirmed < 0, 0, new.confirmed),
                 new.deaths = ifelse(new.deaths < 0, 0, new.deaths),
                 new.recovered = ifelse(new.recovered < 0, 0, new.recovered))

## death rate based on total deaths and recovered cases
data %<>% mutate(rate.upper = (100 * deaths / (deaths + recovered)) %>% round(1))
## lower bound: death rate based on total confirmed cases
data %<>% mutate(rate.lower = (100 * deaths / confirmed) %>% round(1))
## death rate based on the number of death/recovered on every single day
data %<>% mutate(rate.daily = (100 * new.deaths / (new.deaths + new.recovered)) %>% round(1))


## convert from wide to long format, for drawing area plots
data.long <- data %>%
  select(c(country, date, confirmed, active.confirmed, recovered, deaths)) %>%
  gather(key=type, value=count, -c(country, date))
## set factor levels to show them in a desirable order
data.long %<>% mutate(type=recode_factor(type, confirmed='Total Confirmed',
                                         active.confirmed='Active Confirmed',
```

```
                                        recovered='Recovered',
                                        deaths='Deaths'))


## convert from wide to long format, for drawing area plots
rates.long <- data %>%
  # filter(country %in% top.countries) %>%
  select(c(country, date, rate.upper, rate.lower, rate.daily)) %>%
  # mutate(country=factor(country, levels=top.countries)) %>%
  gather(key=type, value=count, -c(country, date))
# set factor levels to show them in a desirable order
rates.long %<>% mutate(type=recode_factor(type, rate.daily='Daily',
                                          rate.lower='Lower bound',
                                          rate.upper='Upper bound'))
```

4 Worldwide Cases

After tidying up the data, we visualise it with various charts.

4.1 World Map

Below is a world map of vconfirmed cases. An interactive map can be created if running the code in R or RStudio, or knitting it into a HTML file.

```
## select last column, which is the number of latest confirmed cases
x <- raw.data.confirmed
x$confirmed <- x[, ncol(x)]
x %<>% select(c(Country.Region, Province.State, Lat, Long, confirmed)) %>%
  mutate(txt=paste0(Country.Region, ' - ', Province.State, ': ', confirmed))

m <- leaflet(width=1200, height=800) %>% addTiles()
# circle marker (units in pixels)
m %<>% addCircleMarkers(x$Long, x$Lat,
                        # radius=2+log2(x$confirmed),
                        radius=0.03*sqrt(x$confirmed),
                        stroke=F,
                        color='red', fillOpacity=0.3,
                        popup=x$txt)

# world
m
```

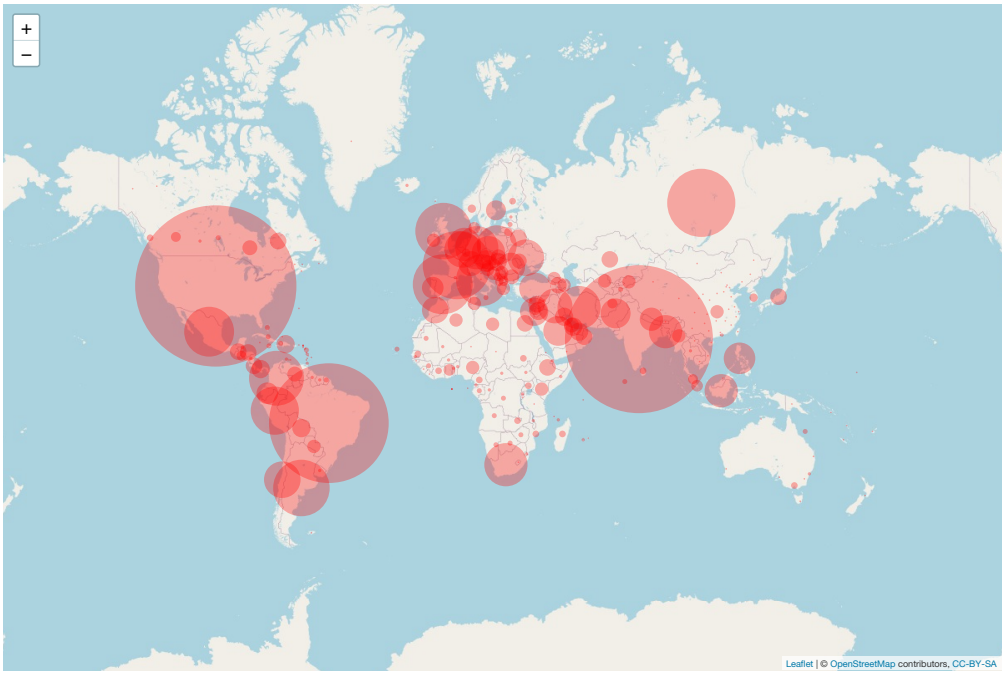


Figure 1: World Map

Views of some specific countries or regions can be produced with the script below.

```
## China
m %>% setView(95, 35, zoom=4)
## Australia and New Zealand
m %>% setView(135, -27, zoom=4)
## US and Canada
m %>% setView(-105, 40, zoom=4)
## Europe
m %>% setView(10, 50, zoom=4)
```

4.2 Number of Cases

In the rest of this section, we will focuse on the cases worldwide. Similar analysis for a single country can be done by filter the data with the corresponding country name.

```
# data %<>% filter(country=='China')
# data %<>% filter(country=='Australia')
world.long <- data.long %>% filter(country == 'World')

## cases - area plot
plot1 <- world.long %>% filter(type != 'Total Confirmed') %>%
  ggplot(aes(x=date, y=count)) +
  geom_area(aes(fill=type), alpha=0.5) +
  labs(title=paste0('Numbers of Cases Worldwide - ', max.date.txt)) +
  scale_fill_manual(values=c('red', 'green', 'black')) +
  theme(legend.title=element_blank(), legend.position='bottom',
        plot.title = element_text(size=7),
        axis.title.x=element_blank(),
        axis.title.y=element_blank(),
```

```
        legend.key.size=unit(0.2, 'cm'),
        legend.text=element_text(size=6),
        axis.text=element_text(size=7),
        axis.text.x=element_text(angle=45, hjust=1))

plot2 <- world.long %>%
  ggplot(aes(x=date, y=count)) +
  geom_line(aes(color=type)) +
  labs(title=paste0('Numbers of Cases Worldwide (log scale) - ', max.date.txt)) +
  scale_color_manual(values=c('purple', 'red', 'green', 'black')) +
  theme(legend.title=element_blank(), legend.position='bottom',
        plot.title = element_text(size=7),
        axis.title.x=element_blank(),
        axis.title.y=element_blank(),
        legend.key.size=unit(0.2, 'cm'),
        legend.text=element_text(size=6),
        axis.text=element_text(size=7),
        axis.text.x=element_text(angle=45, hjust=1)) +
  scale_y_continuous(trans='log10')
## show two plots side by side
grid.arrange(plot1, plot2, ncol=2)
```

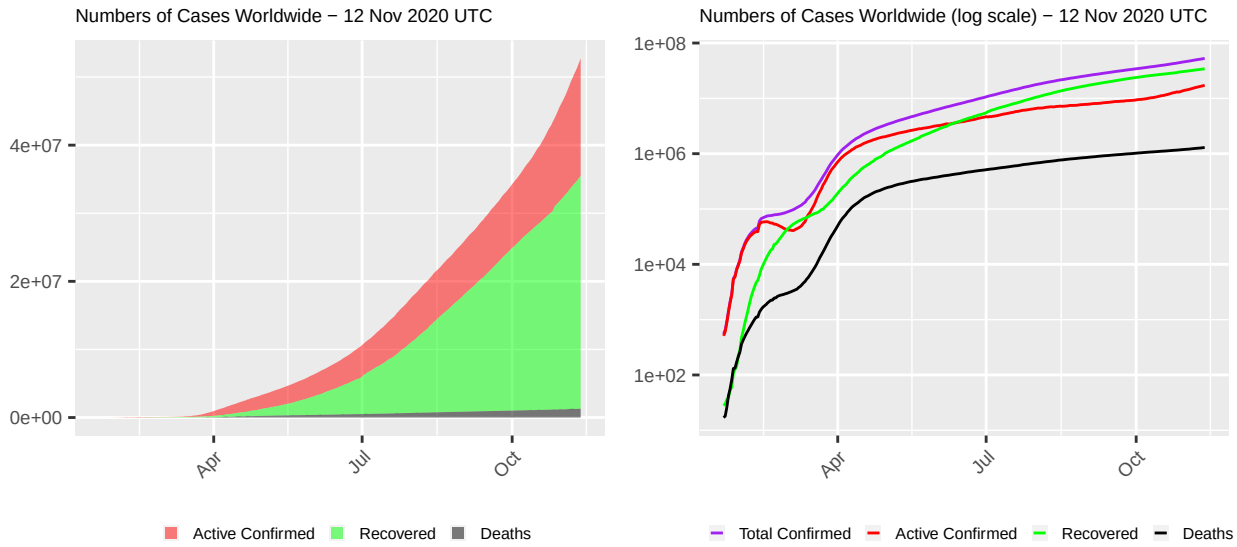


Figure 2: COVID-19 Cases Worldwide

4.3 Active Confirmed Cases

```
data.world <- data %>% filter(country=='World')
n <- nrow(data.world)
```

```
## active confirmed and daily new confirmed
plot1 <- ggplot(data.world, aes(x=date, y=active.confirmed)) +
  geom_point() + geom_smooth() +
  xlab('') + ylab('Count') + labs(title='Active Confirmed Cases') +
  theme(axis.text.x=element_text(angle=45, hjust=1))
plot2 <- ggplot(data.world, aes(x=date, y=new.confirmed)) +
```

```
  geom_point() + geom_smooth() +
  xlab('') + ylab('Count') + labs(title='Daily New Confirmed Cases') +
  theme(axis.text.x=element_text(angle=45, hjust=1))
## show two plots side by side
grid.arrange(plot1, plot2, ncol=2)
```

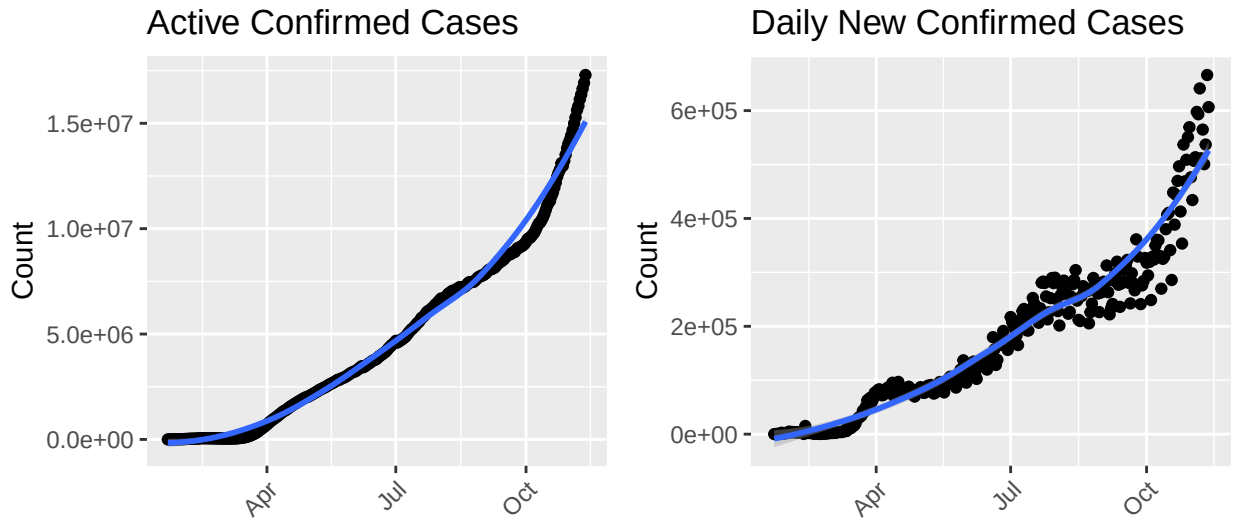


Figure 3: Active Confirmed Cases

Figure 3 shows the numbers of active (see left chart) and new (see right chart) confirmed cases. The blue lines are smoothed conditional means and the grey band around them show the 95% confidence interval.

4.4 Deaths and Recovered Cases

```
## a scatter plot with a smoothed line and vertical x-axis labels
plot1 <- ggplot(data.world, aes(x=date, y=deaths)) +
  geom_point() + geom_smooth() +
  xlab('') + ylab('Count') + labs(title='Accumulative Deaths') +
  theme(axis.text.x=element_text(angle=45, hjust=1))
plot2 <- ggplot(data.world, aes(x=date, y=recovered)) +
  geom_point() + geom_smooth() +
  xlab('') + ylab('Count') + labs(title='Accumulative Recovered Cases') +
  theme(axis.text.x=element_text(angle=45, hjust=1))
plot3 <- ggplot(data.world, aes(x=date, y=new.deaths))  +
  geom_point() + geom_smooth()  +
  xlab('') + ylab('Count') + labs(title='New Deaths') +
  theme(axis.text.x=element_text(angle=45, hjust=1))
plot4 <- ggplot(data.world, aes(x=date, y=new.recovered)) +
  geom_point() + geom_smooth()  +
  xlab('') + ylab('Count') + labs(title='New Recovered Cases') +
  theme(axis.text.x=element_text(angle=45, hjust=1))
## show four plots together, with 2 plots in each row
grid.arrange(plot1, plot2, plot3, plot4, nrow=2)
```

Figure 4: Deaths and Recovered Cases

4.5 Death Rates

Figure 5 shows death rates caculated in three different ways (see Section 3.3 for details). The left chart shows the death rates from 22 Jan 2020 to 12 Nov 2020 UTC and the right one is a zoom-in view of the rates in last two weeks.

In the right chart, the upper bound (in blue) is decreasing, as there will be more recovered cases and fewer dead ones daily as time goes on. However, the lower bound (in green) keeps going up, as there are and will be new deaths from the active confirmed cases. Therefore, the final death rate is expected to be in-between of those two rates, and based on the latest data retrieved as of 12 Nov 2020 UTC, it will be between 2.5% and 3.6%.

A surge in the daily death rate (in red) in late March suggests that the situlation is changing dramatically (actually, getting worse) and that above lower/upper bounds are likely to increase shortly. A likely reason of that surge is the outbreak of coronavirus in Iran, Europe and US.

```
## three death rates
plot1 <- ggplot(data.world, aes(x=date)) +
```

```
  geom_line(aes(y=rate.upper, colour='Upper bound')) +
  geom_line(aes(y=rate.lower, colour='Lower bound')) +
  geom_line(aes(y=rate.daily, colour='Daily')) +
  xlab('') + ylab('Death Rate (%)') + labs(title='Overall') +
  theme(legend.position='bottom', legend.title=element_blank(),
        legend.text=element_text(size=8),
        legend.key.size=unit(0.5, 'cm'),
        axis.text.x=element_text(angle=45, hjust=1)) +
  ylim(c(0, 99))
## focusing on last 2 weeks
# y.max <- data.world[n-(14:0), ] %>% select(rate.upper, rate.lower, rate.daily) %>% max()
plot2 <- ggplot(data.world[n-(14:0),], aes(x=date)) +
  geom_line(aes(y=rate.upper, colour='Upper bound')) +
  geom_line(aes(y=rate.lower, colour='Lower bound')) +
  geom_line(aes(y=rate.daily, colour='Daily')) +
  xlab('') + ylab('Death Rate (%)') + labs(title='Last two weeks') +
  theme(legend.position='bottom', legend.title=element_blank(),
        legend.text=element_text(size=8),
        legend.key.size=unit(0.5, 'cm'),
        axis.text.x=element_text(angle=45, hjust=1)) +
  ylim(c(0, 20))
grid.arrange(plot1, plot2, ncol=2)
```

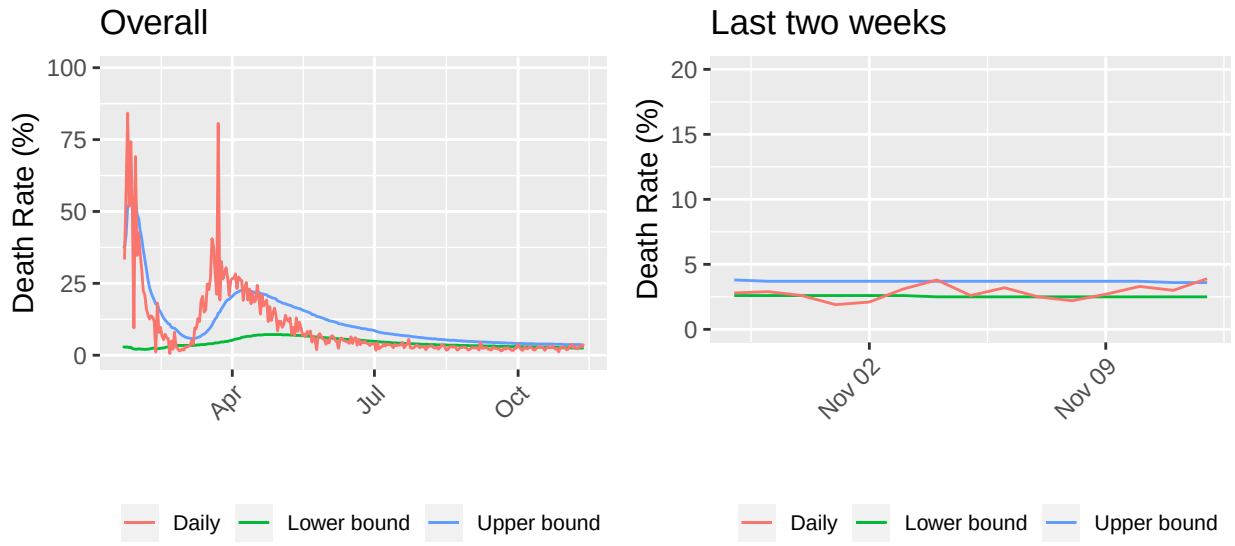


Figure 5: Death Rate

5 Top Twenty Countries

Next, we will have a look at the top 20 countries in total confirmed cases.

```
## ranking by confirmed cases
data.latest.all <- data %>% filter(date == max(date)) %>%
  select(country, date,
         confirmed, new.confirmed, active.confirmed,
         recovered, deaths, new.deaths, death.rate=rate.lower) %>%
  mutate(ranking = dense_rank(desc(confirmed)))
```

```
k <- 20
## top 20 countries: 21 incl. 'World'
top.countries <- data.latest.all %>% filter(ranking <= k + 1) %>%
  arrange(ranking) %>% pull(country) %>% as.character()
top.countries %>% setdiff('World') %>% print()
```

```
##  [1] "US"             "India"          "Brazil"         "France"
##  [5] "Russia"         "Spain"          "United Kingdom" "Argentina"
##  [9] "Colombia"       "Italy"          "Mexico"         "Peru"
## [13] "Germany"        "South Africa"   "Iran"           "Poland"
## [17] "Chile"          "Belgium"        "Ukraine"        "Iraq"
```

```
## add 'Others'
# top.countries %<>% c('Others')
## put all others in a single group of 'Others'
data.latest <- data.latest.all %>% filter(!is.na(country)) %>%
  mutate(country=ifelse(ranking <= k + 1, as.character(country), 'Others')) %>%
  mutate(country=country %>% factor(levels=c(top.countries, 'Others')))
data.latest %<>% group_by(country) %>%
  summarise(confirmed=sum(confirmed), new.confirmed=sum(new.confirmed),
            active.confirmed=sum(active.confirmed),
            recovered=sum(recovered), deaths=sum(deaths), new.deaths=sum(new.deaths)) %>%
  mutate(death.rate=(100 * deaths/confirmed) %>% round(1))
data.latest %<>% select(c(country, confirmed, deaths, death.rate,
                 new.confirmed, new.deaths, active.confirmed))
```

```
data.latest %>% mutate(death.rate=death.rate %>% format(nsmall=1) %>% paste0('%')) %>%
  kable('latex', booktabs=T, row.names=T, align=c('l', rep('r', 6)),
        caption=paste0('Cases in Top 20 Countries - ', max.date.txt,
                       '. See a complete list of all infected countries at the end of this report.'),
        format.args=list(big.mark=',')) %>%
  kable_styling(font_size=7, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

```
## convert from wide to long format, for drawing area plots
data.latest.long <- data.latest %>% filter(country!='World') %>%
  gather(key=type, value=count, -country)
## set factor levels to show them with proper text and in a desirable order
data.latest.long %<>% mutate(type=recode_factor(type,
                                      confirmed='Total Confirmed',
                                      deaths='Total Deaths',
                                      death.rate='Death Rate (%)',
                                      new.confirmed='New Confirmed (compared with one day before)',
                                      new.deaths='New Deaths (compared with one day before)',
                                      active.confirmed='Active Confirmed'))
```

```
## bar chart
data.latest.long %>% ggplot(aes(x=country, y=count, fill=country, group=country)) +
  geom_bar(stat='identity') +
  geom_text(aes(label=count, y=count), size=2, vjust=0) +
  xlab('') + ylab('') +
  labs(title=paste0('Top 20 Countries with Most Confirmed Cases - ', max.date.txt)) +
  scale_fill_discrete(name='Country', labels=aes(count)) +
  theme(legend.title=element_blank(),
        legend.position='none',
        plot.title=element_text(size=11),
```

Table 3: Cases in Top 20 Countries - 12 Nov 2020 UTC. See a complete list of all infected countries at the end of this report.

	country	confirmed	deaths	death.rate	new.confirmed	new.deaths	active.confirmed
1	World	52,733,290	1,293,183	2.5%	606,497	9,020	17,290,884
2	US	10,552,821	242,423	2.3%	153,496	919	6,259,142
3	India	8,728,795	128,668	1.5%	44,879	547	484,547
4	Brazil	5,781,582	164,281	2.8%	33,922	913	362,844
5	France	1,915,282	42,599	2.2%	364	0	1,733,471
6	Russia	1,843,678	31,755	1.7%	21,333	429	433,460
7	Spain	1,437,220	40,461	2.8%	19,511	356	1,246,383
8	United Kingdom	1,293,715	51,020	3.9%	33,517	563	1,239,664
9	Argentina	1,284,519	34,782	2.7%	11,163	251	149,557
10	Colombia	1,174,012	33,491	2.9%	8,686	179	58,830
11	Italy	1,066,401	43,589	4.1%	37,977	636	635,054
12	Mexico	991,835	97,056	9.8%	5,658	626	158,582
13	Peru	928,006	35,031	3.8%	2,575	39	39,767
14	Germany	762,832	12,216	1.6%	24,738	222	276,408
15	South Africa	744,732	20,076	2.7%	2,338	65	33,753
16	Iran	726,585	40,121	5.5%	11,517	457	144,898
17	Poland	641,496	9,080	1.4%	22,683	275	378,067
18	Chile	526,438	14,699	2.8%	1,634	66	9,264
19	Belgium	520,393	13,891	2.7%	5,002	133	506,502
20	Ukraine	515,755	9,422	1.8%	11,332	208	268,934
21	Iraq	511,806	11,532	2.3%	3,298	50	61,046
22	Others	10,785,387	216,990	2.0%	150,874	2,086	2,810,711

```
      axis.text=element_text(size=7),
      axis.text.x=element_text(angle=45, hjust=1)) +
facet_wrap(~type, ncol=1, scales='free_y')
```

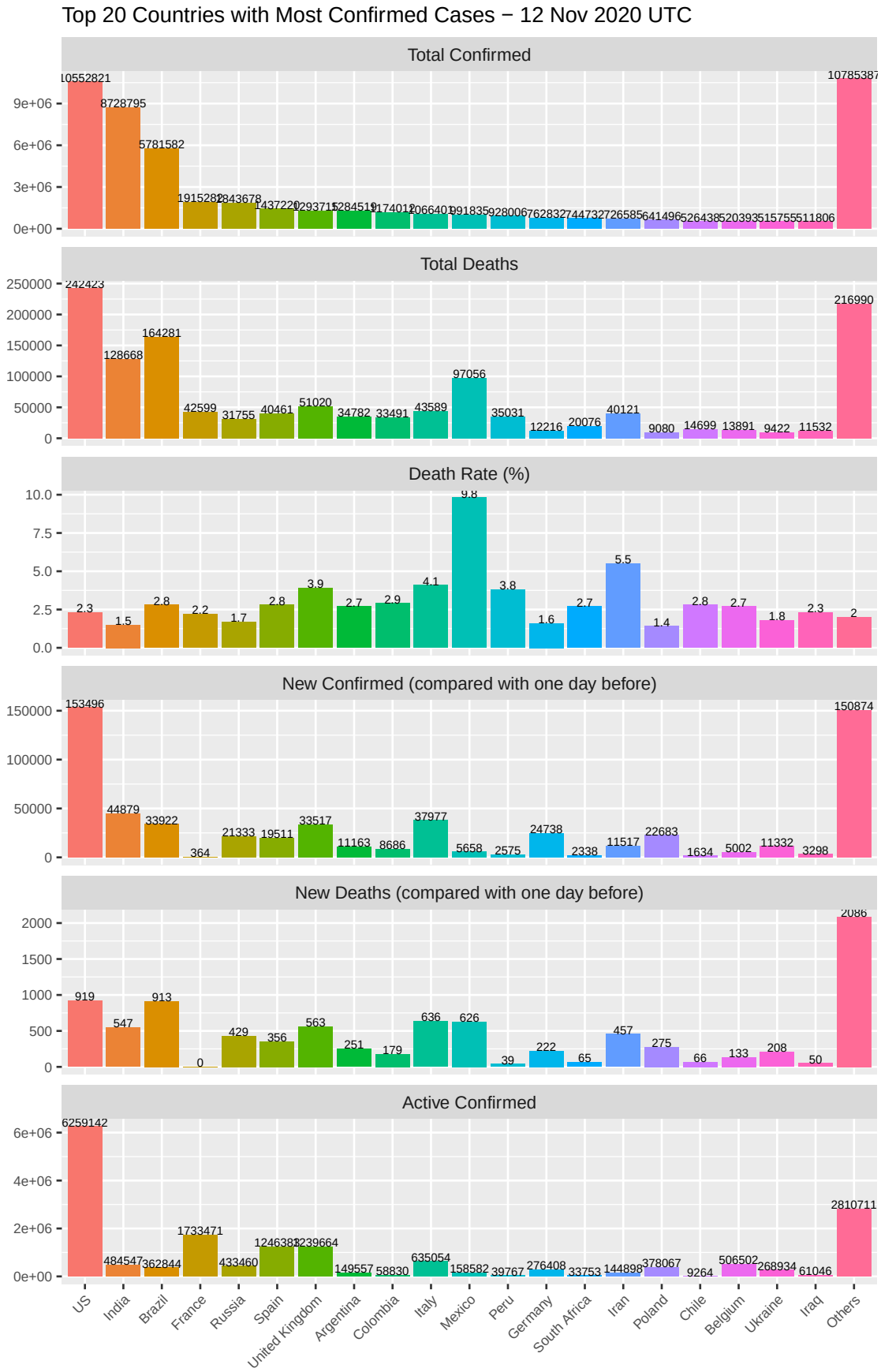
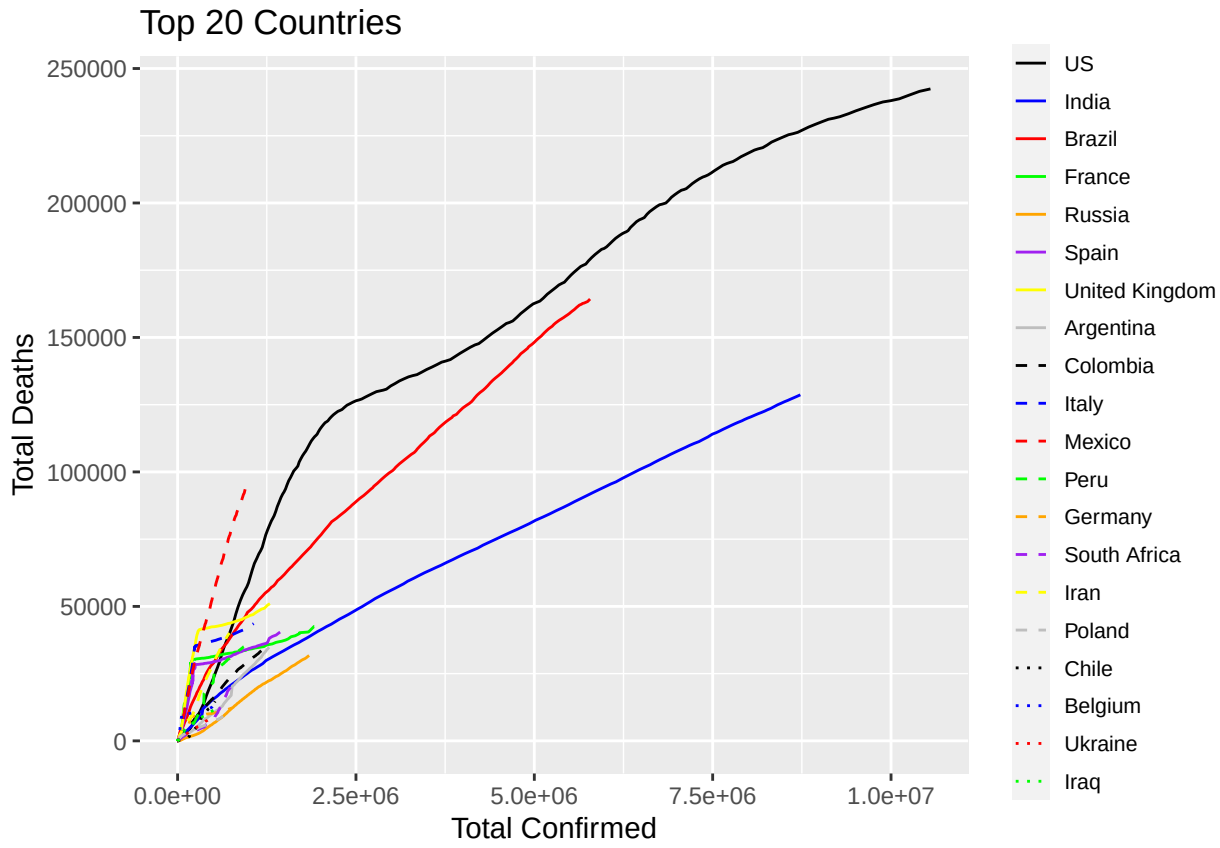


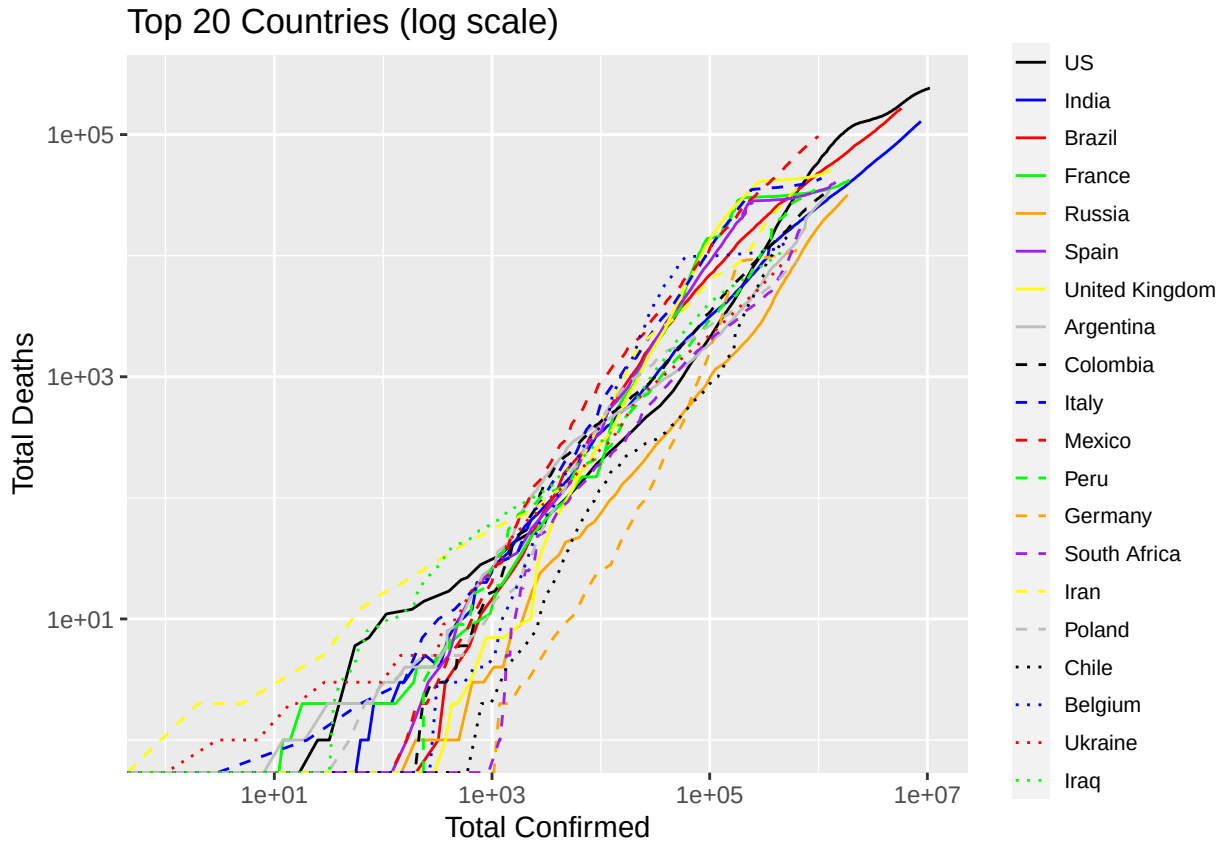
Figure 6: Top 20 Countries with Most Confirmed Cases

5.1 Confirmed vs Deaths

```
# linetypes <- rep(c("dotted", "dashed", "solid"), each=8)
# colors <- rep(c('grey', 'yellow', 'purple', 'orange', 'green', 'red', 'blue', 'black'), 3)
linetypes <- rep(c("solid", "dashed", "dotted"), each=8)
colors <- rep(c('black', 'blue', 'red', 'green', 'orange', 'purple', 'yellow', 'grey'), 3)
df <- data %>% filter(country %in% setdiff(top.countries, c('World'))) %>%
  mutate(country=country %>% factor(levels=c(top.countries)))
p <- df %>% ggplot(aes(x=confirmed, y=deaths, group=country)) +
  geom_line(aes(color=country, linetype=country)) +
  xlab('Total Confirmed') + ylab('Total Deaths') +
  scale_linetype_manual(values=linetypes) +
  scale_color_manual(values=colors) +
  theme(legend.title=element_blank(),
        legend.text=element_text(size=8),
        legend.key.size=unit(0.5, 'cm'))
p + labs(title=paste0('Top 20 Countries'))
```




```
p + scale_x_log10() + scale_y_log10() +
  labs(title=paste0('Top 20 Countries (log scale)'))
```



The two figures below show the numbers of confirmed cases and deaths of top 20 countries, as well as the death rates up to 12 Nov 2020 UTC.

```
df <- data.latest %>% filter(country %in% setdiff(top.countries, 'World'))
## breaks for circle size in legend; needs to be adjusted accordingly when the number of total confirme
breaks.confirmed <- c(5e3, 1e4, 2e4, 5e4, 1e5, 2e5, 5e5, 1e6, 2e6, 5e6, 1e7)

plot1 <- df %>% ggplot(aes(x=confirmed, y=deaths, col=death.rate, size=active.confirmed)) +
  scale_size(name='Active Confirmed', trans='log2', breaks=breaks.confirmed) +
  geom_text(aes(label=country), size=2.5, check_overlap=T, vjust=-1.6) +
  geom_point() +
  xlab('Total Confirmed') + ylab('Total Deaths') +
  labs(col="Death Rate (%)") +
  scale_color_gradient(low='#56B1F7', high='#132B43') +
  scale_x_log10() + scale_y_log10() +
  labs(title=paste0('Top 20 Countries - Confirmed vs Deaths (log scale)'))

plot2 <- df %>% ggplot(aes(x=new.confirmed, y=new.deaths, col=death.rate, size=active.confirmed)) +
  scale_size(name='Active Confirmed', trans='log2', breaks=breaks.confirmed) +
  geom_text(aes(label=country), size=2.5, check_overlap=T, vjust=-1.6) +
  geom_point() +
  xlab('New Confirmed') + ylab('New Deaths') +
  labs(col="Death Rate (%)") +
  scale_color_gradient(low='#56B1F7', high='#132B43') +
  scale_x_log10() + scale_y_log10() +
  labs(title=paste0('Top 20 Countries - New Confirmed vs New Deaths (log scale)'))
```

```
grid.arrange(plot1, plot2, ncol=1)
```

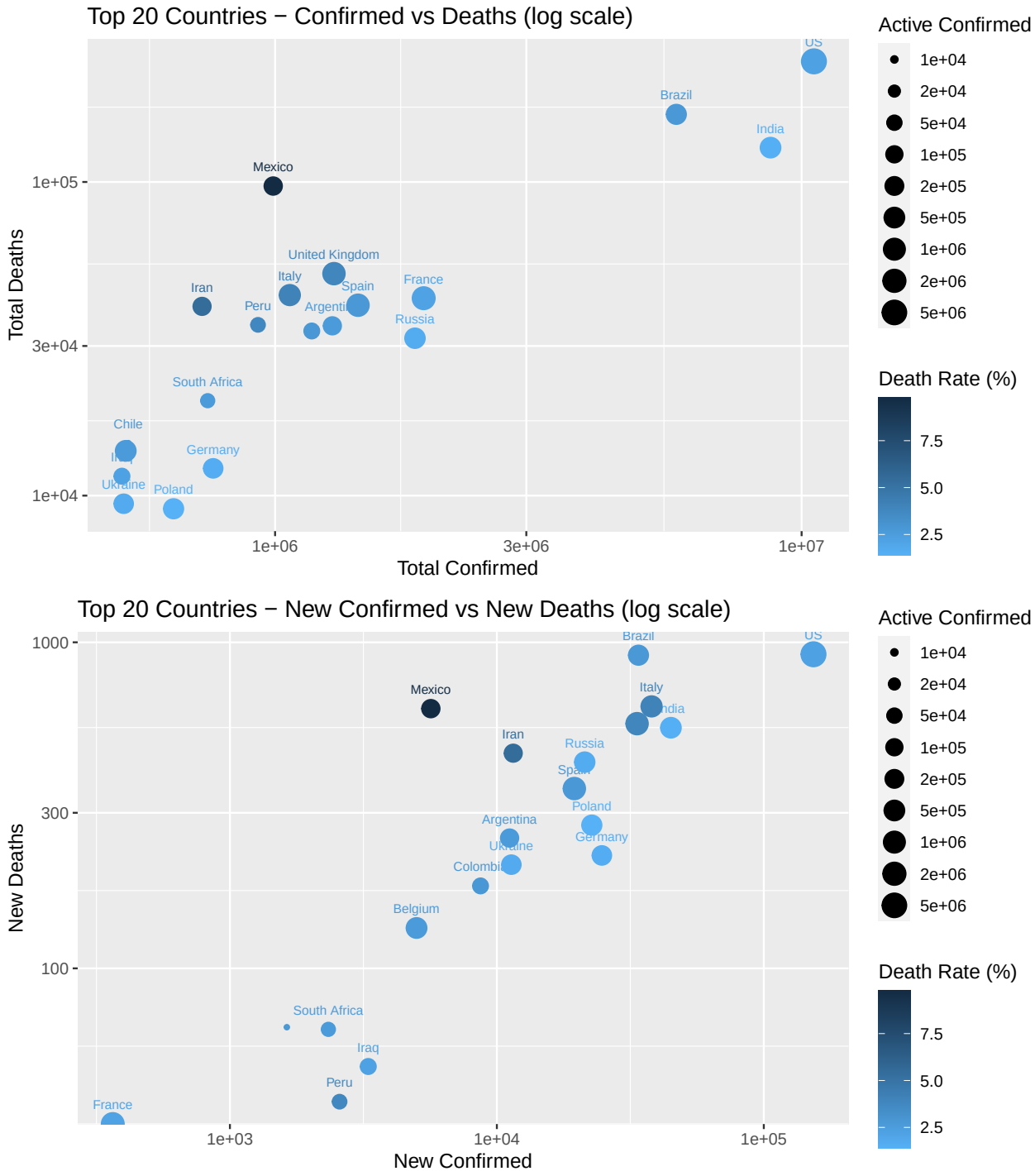


Figure 7: Top 20 Countries

5.2 Comparison across Countries

The area plots blow show the numbers of dead, recovered, total and active confimed cases. Note that, in the area plot, the total number of total confirmed cases is represented by the total areas of active confirmed,

recovered and dead.

```
## plot: cases by type
df <- data.long %>% filter(country %in% top.countries) %<>%
  mutate(country=country %>% factor(levels=c(top.countries)))

p <- df %>% filter(country != 'World') %>%
  ggplot(aes(x=date, y=count)) + xlab('') + ylab('Count')  +
  theme(legend.title=element_blank(),
        legend.text=element_text(size=8),
        legend.key.size=unit(0.5, 'cm'),
        plot.title=element_text(size=11),
        axis.text.x=element_text(angle=45, hjust=1)) +
  facet_wrap(~type, ncol=2, scales='free_y')

## area plot
plot1 <- p + geom_area(aes(fill=country)) +
  labs(title=paste0('Cases around the World - ', max.date.txt))

## line plot and in log scale
# linetypes <- rep(c("solid", "dashed", "dotted"), each=8)
# colors <- rep(c('black', 'blue', 'red', 'green', 'orange', 'purple', 'yellow', 'grey'), 3)
plot2 <- p + geom_line(aes(color=country, linetype=country)) +
  scale_linetype_manual(values=linetypes) +
  scale_color_manual(values=colors) +
  labs(title=paste0('Cases around the World - Log Scale - ', max.date.txt)) +
  scale_y_continuous(trans='log10')

grid.arrange(plot1, plot2, ncol=1)
```

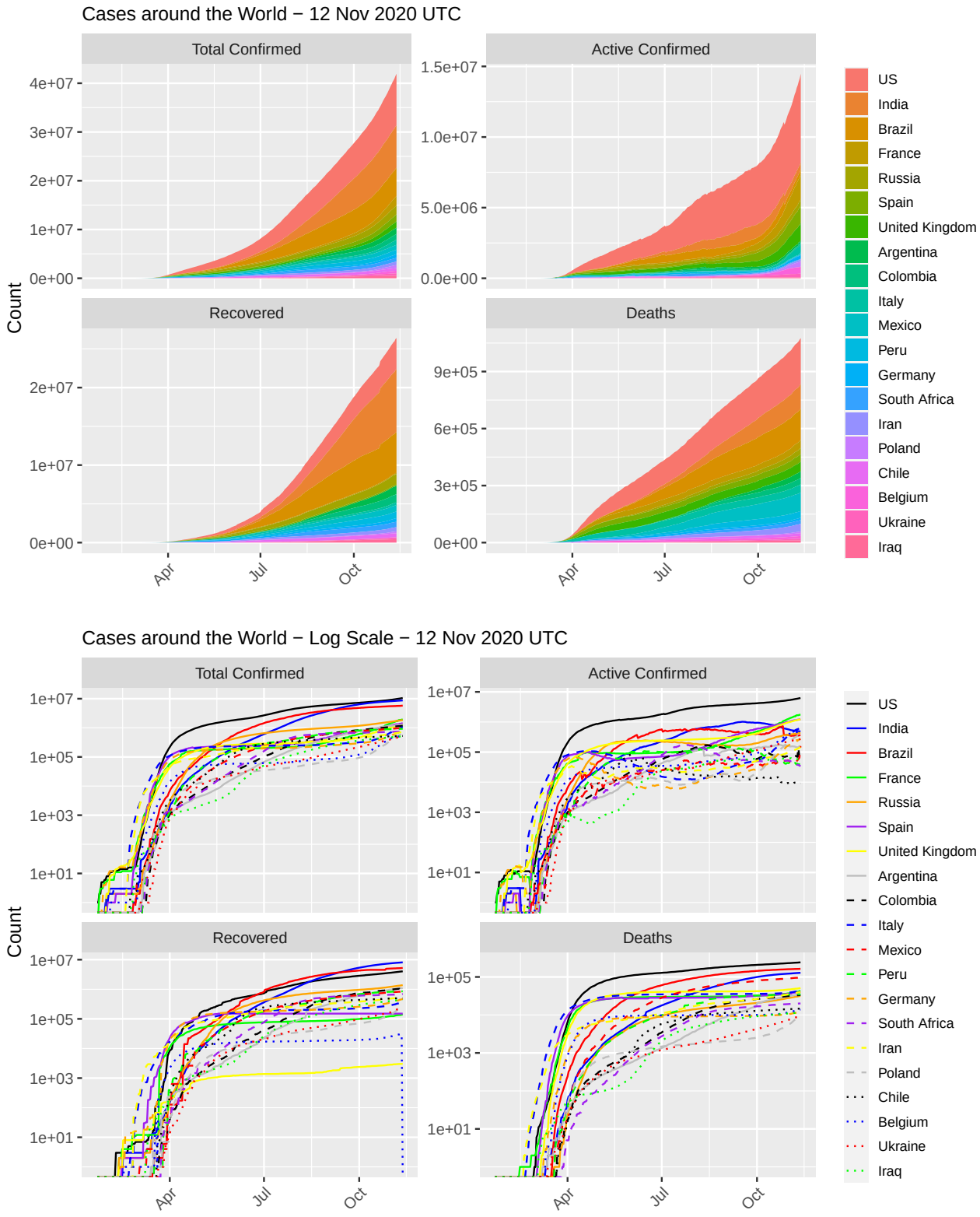


Figure 8: Cases around the World

```
## plot: excluding China
p <- df %>% filter(!(country %in% c('World', 'China'))) %>%
```

```
  ggplot(aes(x=date, y=count)) + xlab('') + ylab('Count') +
  theme(legend.title=element_blank(),
        legend.text=element_text(size=8),
        legend.key.size=unit(0.5, 'cm'),
        plot.title=element_text(size=11),
        axis.text.x=element_text(angle=45, hjust=1)) +
  facet_wrap(~type, ncol=2, scales='free_y')
p + geom_area(aes(fill=country)) +
  labs(title=paste0('Cases around the World (excl. China) - ', max.date.txt))
```

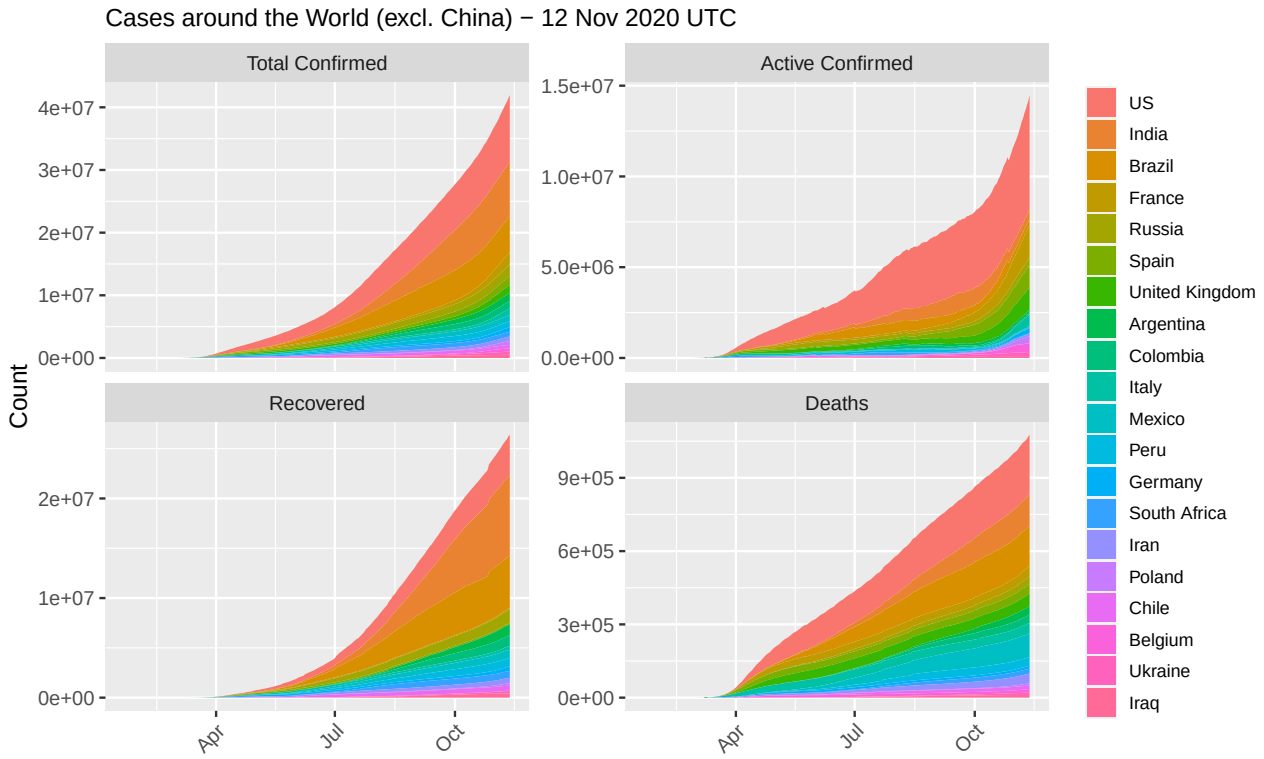


Figure 9: Cases around the World (excl. China)

```
## remove 'Others'
top.countries %<>% setdiff('Others')
## if China or Australia not in top 20, add them in
if(!('China' %in% top.countries)) {
  top.countries %<>% c('China')
}
if(!('Australia' %in% top.countries)) {
  top.countries %<>% c('Australia')
}
df <- data.long %>% filter(country %in% top.countries) %<>%
  mutate(country=country %>% factor(levels=c(top.countries)))

## cases by country - area plot
df %>% filter(country != 'World' & type != 'Total Confirmed') %>%
  ggplot(aes(x=date, y=count, fill=type)) +
  geom_area(alpha=0.5) +
```

```
  # xlab('') + ylab('') +
  labs(title=paste0('Numbers of COVID-19 Cases in Top 20 Countries - ',
                    max.date.txt)) +
  scale_fill_manual(values=c('red', 'green', 'black')) +
  theme(legend.title=element_blank(), legend.position='bottom',
        plot.title = element_text(size=12),
        axis.title.x=element_blank(),
        axis.title.y=element_blank(),
        legend.key.size=unit(0.4, 'cm'),
        # legend.text=element_text(size=7),
        strip.text.x=element_text(size=7),
        axis.text=element_text(size=7),
        axis.text.x=element_text(angle=45, hjust=1)) +
  facet_wrap(~country, ncol=4, scales='free_y')
```

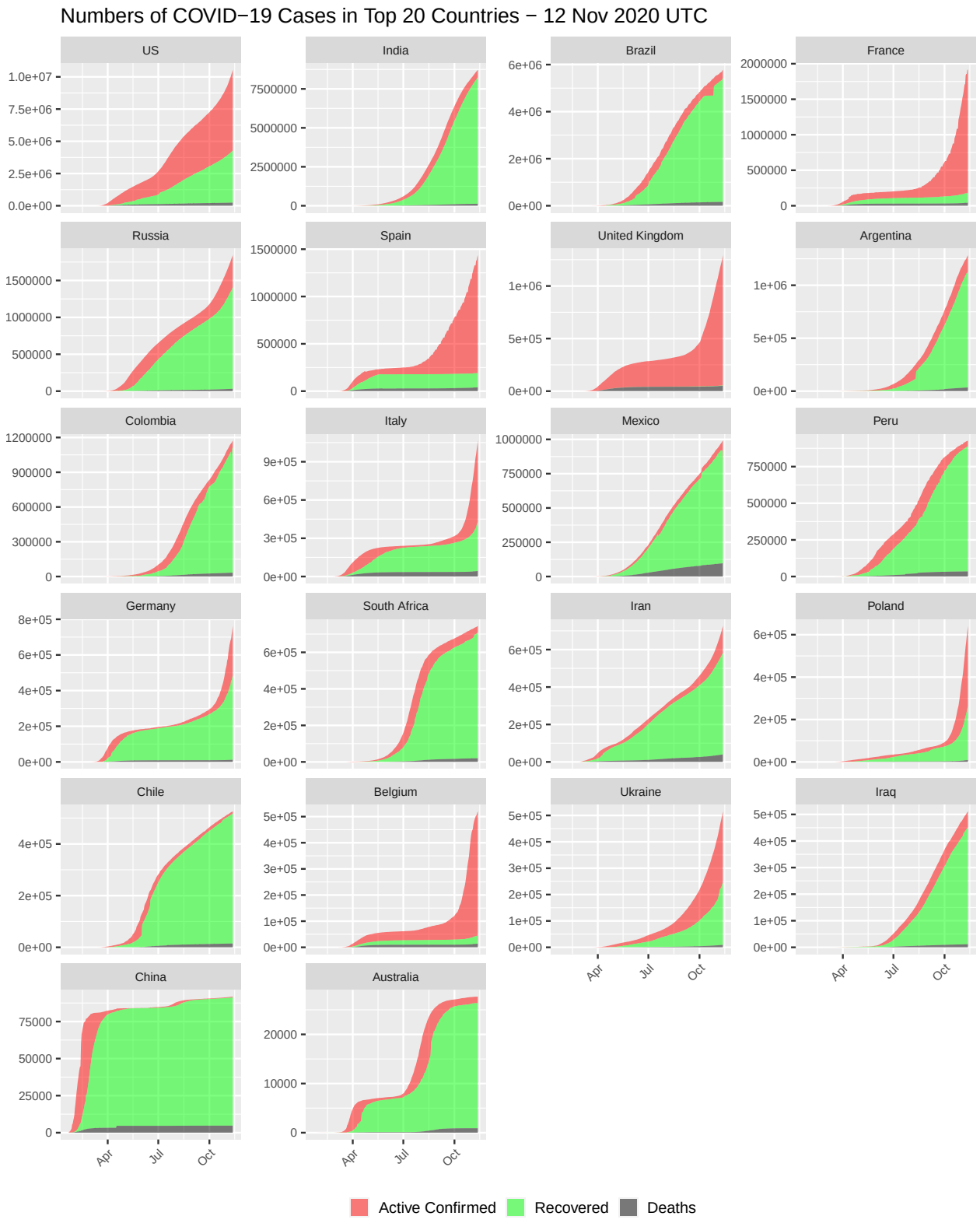


Figure 10: COVID-19 Cases in Top 20 Countries. Ordered descendingly by number of confirmed cases.

```r
## cases by country - line plot - log scale
p <- df %>% filter(country != 'World') %>%
  ggplot(aes(x=date, y=count, color=type)) +
  geom_line() +
  labs(title=paste0('Numbers of COVID-19 Cases in Top 20 Countries (log scale) - ',
                    max.date.txt)) +
  scale_color_manual(values=c('purple', 'red', 'green', 'black')) +
  theme(legend.title=element_blank(), legend.position='bottom',
        plot.title = element_text(size=12),
        axis.title.x=element_blank(),
        axis.title.y=element_blank(),
        legend.key.size=unit(0.4, 'cm'),
        # legend.text=element_text(size=7),
        strip.text.x=element_text(size=7),
        axis.text=element_text(size=7),
        axis.text.x=element_text(angle=45, hjust=1)) +
  scale_y_continuous(trans='log10')
p + facet_wrap(~country, ncol=4, scales='free_y')
```

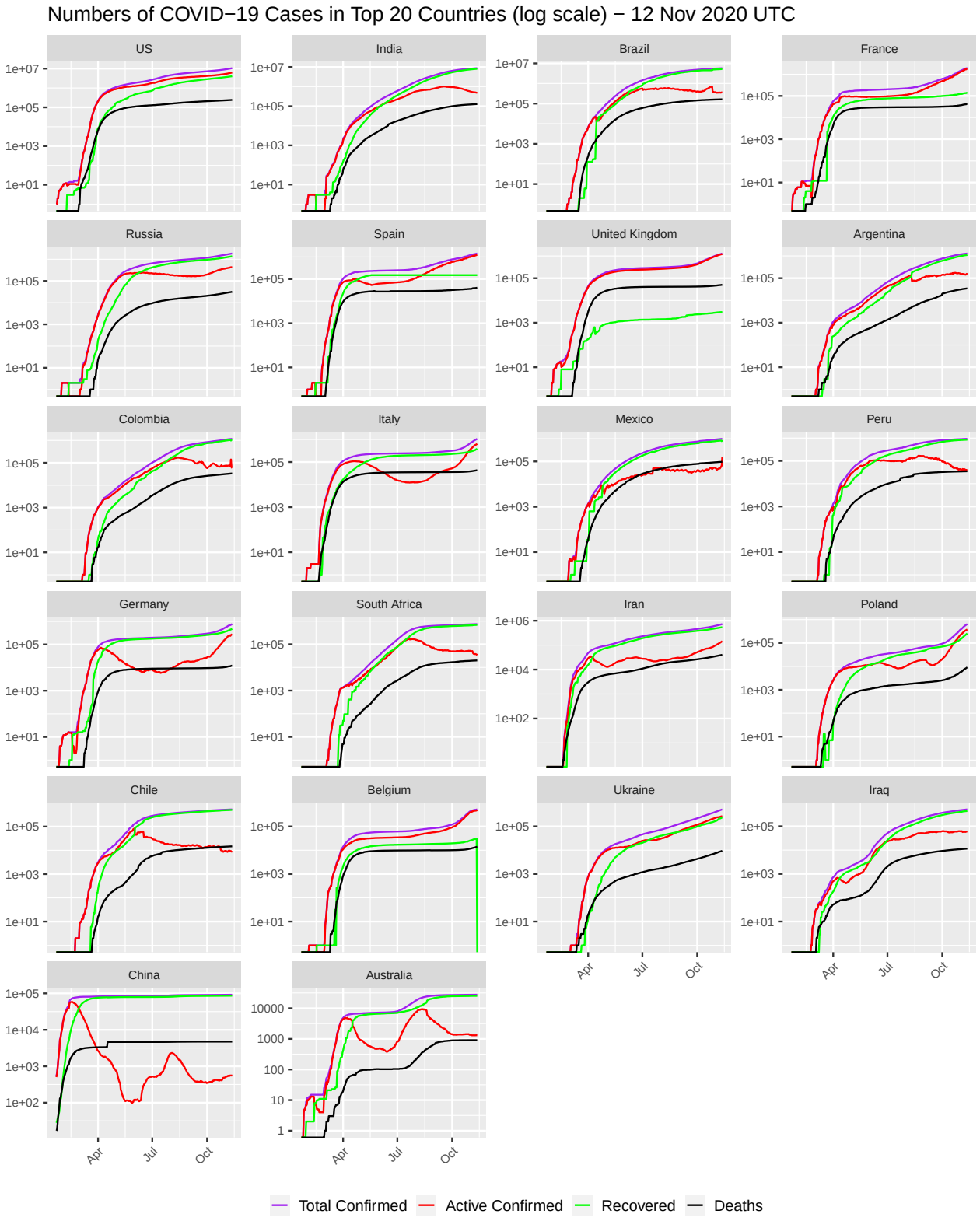


Figure 11: COVID-19 Cases Top 20 Countries (log scale). Ordered descendingly by number of confirmed cases.

```
## plot over multiple pages
# p + facet_wrap_paginate(~country, nrow=4, ncol=3, page=1, scales='free_y')
# p + facet_wrap_paginate(~country, nrow=4, ncol=3, page=2, scales='free_y')
```

Figures 10 and 11 show that China has entered a post-epidemic phase, followed by Australia and Germany, with an increase of recovered cases (in green) every day and a shrinking of the active confirmed cases (in red). In contrast, there are sharp surges in Russia, South America (incl. Brazil, Peru, Chile and Mexico) and West/South Asia (incl. Saudi Arabia, India and Pakistan), which suggests that the virus spread is accerelating there.

5.3 Death Rates

```
## three death rates
rate.max <- rates.long$count %>% max(na.rm=T)
df <- rates.long %>% filter(country %in% setdiff(top.countries, 'World')) %>%
  mutate(country=factor(country, levels=top.countries))
df %>% ggplot(aes(x=date, y=count, color=type)) +
  geom_line() +
  xlab('') + ylab('Death Rate (%)') +
  theme(legend.position='bottom', legend.title=element_blank(),
        legend.text=element_text(size=8),
        legend.key.size=unit(0.5, 'cm'),
        axis.text.x=element_text(angle=45, hjust=1)) +
  ylim(c(0, 99)) +
  facet_wrap(~country, ncol=4)
```

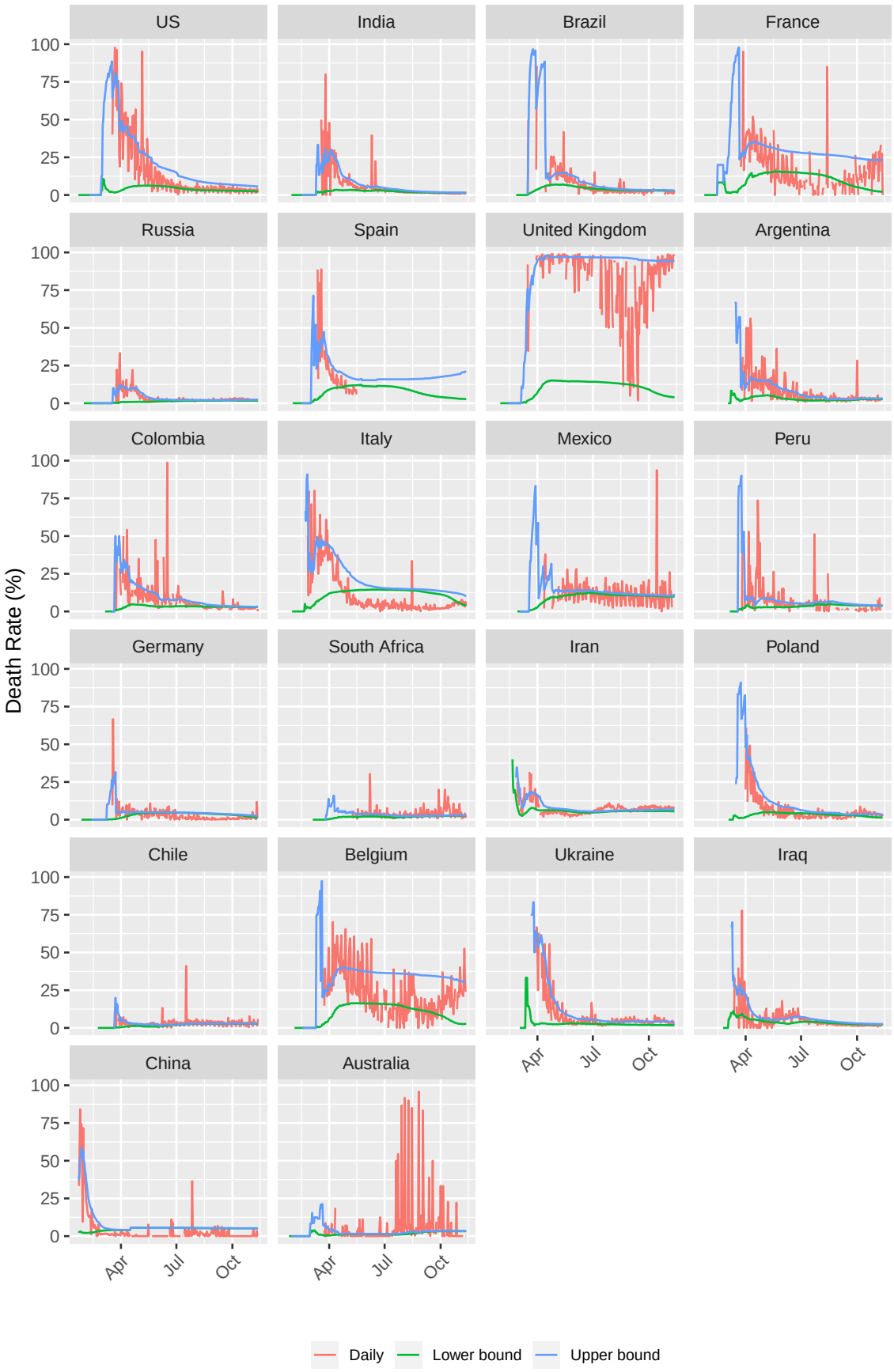


Figure 12: Death Rates

5.4 Countries with Highest Death Rates

Below are a list of top 20 countries with the highest death rates out of countries having 2000+ confirmed cases.

```
## sort the latest data by death rate, and if tie, by confirmed
df <- data %>% filter(date == max(date) & country != 'World' & confirmed >= 2000) %>%
  select(country, confirmed, new.confirmed, active.confirmed,
         recovered, deaths, new.deaths, death.rate=rate.lower) %>%
  arrange(desc(death.rate, confirmed))

df %>% head(20) %>%
  mutate(death.rate=death.rate %>% format(nsmall=1) %>% paste0('%')) %>%
  kable('latex', booktabs=T, row.names=T, align=c('l', rep('r', 7)),
        caption=paste0('Top 20 Countries with Highest Death Rates - ', max.date.txt),
        format.args=list(big.mark=',')) %>%
  kable_styling(font_size=7, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

Table 4: Top 20 Countries with Highest Death Rates - 12 Nov 2020 UTC

	country	confirmed	new.confirmed	active.confirmed	recovered	deaths	new.deaths	death.rate
1	Yemen	2,071	0	72	1,394	605	0	29.2%
2	Mexico	991,835	5,658	158,582	736,197	97,056	626	9.8%
3	Sudan	14,401	55	3,750	9,535	1,116	0	7.7%
4	Ecuador	177,513	883	9,611	154,956	12,946	26	7.3%
5	Bolivia	142,889	113	17,927	116,137	8,825	7	6.2%
6	Egypt	110,095	214	2,918	100,760	6,417	12	5.8%
7	Iran	726,585	11,517	144,898	541,566	40,121	457	5.5%
8	China	91,783	31	553	86,488	4,742	0	5.2%
9	Syria	6,486	65	3,595	2,558	333	4	5.1%
10	Italy	1,066,401	37,977	635,054	387,758	43,589	636	4.1%
11	United Kingdom	1,293,715	33,517	1,239,664	3,031	51,020	563	3.9%
12	Canada	285,936	5,474	44,679	230,429	10,828	80	3.8%
13	Peru	928,006	2,575	39,767	853,208	35,031	39	3.8%
14	Afghanistan	42,795	186	6,180	35,024	1,591	10	3.7%
15	Mali	3,792	39	731	2,923	138	0	3.6%
16	Sweden	171,365	4,658	165,243	0	6,122	40	3.6%
17	Guatemala	113,543	732	6,511	103,174	3,858	13	3.4%
18	Australia	27,676	1	1,310	25,459	907	0	3.3%
19	Gambia	3,697	0	19	3,556	122	0	3.3%
20	Indonesia	452,291	4,173	55,274	382,084	14,933	97	3.3%

6 Conclusions

As of 12 Nov 2020 UTC, there are 191 countries with confirmed COVID-19 cases. It seems to be contained in China, but starts to break out in rest of the world. The current death rate is in between 2.5% and 3.6%, but it is likely to change dramatically with the breakout in many countries, such as European countries.

Appendix A. Processed Data

Blow is the processed data for this analysis.

Appendix A.1 COVID-19 Cases Worldwide

```
## sort by date descendingly and re-order columns
data.world %<>% arrange(desc(date)) %>%
```

```r
  select(c(date, confirmed, deaths, recovered, active.confirmed,
           new.confirmed, new.deaths, new.recovered, rate.lower, rate.upper, rate.daily))
## output as a table
data.world %>%
  mutate(rate.upper = rate.upper %>% format(nsmall=1) %>% paste0('\\%'),
         rate.lower = rate.lower %>% format(nsmall=1) %>% paste0('\\%'),
         rate.daily = rate.daily %>% format(nsmall=1) %>% paste0('\\%')) %>%
  kable('latex', escape=F, booktabs=T, longtable=T,
        caption='Cases in the Whole World',
        format.args=list(big.mark=','),
        align=c('l', rep('r', 10))) %>%
  kable_styling(font_size=4, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

Table 5: Cases in the Whole World

date	confirmed	deaths	recovered	active.confirmed	new.confirmed	new.deaths	new.recovered	rate.lower	rate.upper	rate.daily
2020-11-12	52,733,290	1,293,183	34,149,223	17,290,884	606,497	9,020	222,872	2.5%	3.6%	3.9%
2020-11-11	52,126,793	1,284,163	33,926,351	16,916,279	666,053	11,617	382,115	2.5%	3.6%	3.0%
2020-11-10	51,460,740	1,272,546	33,544,236	16,643,958	537,077	8,775	254,832	2.5%	3.7%	3.3%
2020-11-09	50,923,663	1,263,771	33,289,404	16,370,488	500,644	7,125	256,642	2.5%	3.7%	2.7%
2020-11-08	50,423,019	1,256,646	33,032,762	16,133,611	564,822	5,749	253,221	2.5%	3.7%	2.2%
2020-11-07	49,858,197	1,250,897	32,779,541	15,827,759	511,574	7,549	298,915	2.5%	3.7%	2.5%
2020-11-06	49,346,623	1,243,348	32,480,626	15,622,649	641,152	9,538	288,161	2.5%	3.7%	3.2%
2020-11-05	48,705,471	1,233,810	32,192,465	15,279,196	593,225	8,061	303,435	2.5%	3.7%	2.6%
2020-11-04	48,112,246	1,225,749	31,889,030	14,997,467	597,627	11,002	279,788	2.5%	3.7%	3.8%
2020-11-03	47,514,619	1,214,747	31,609,242	14,690,630	513,543	8,001	251,356	2.6%	3.7%	3.1%
2020-11-02	47,001,076	1,206,746	31,357,886	14,436,444	506,857	6,115	279,626	2.6%	3.7%	2.1%
2020-11-01	46,494,219	1,200,631	31,078,260	14,215,328	434,135	4,923	257,734	2.6%	3.7%	1.9%
2020-10-31	46,060,084	1,195,708	30,820,526	14,043,850	476,330	6,545	245,017	2.6%	3.7%	2.6%
2020-10-30	45,583,754	1,189,163	30,575,509	13,819,082	569,234	7,543	255,026	2.6%	3.7%	2.9%
2020-10-29	45,014,520	1,181,620	30,320,483	13,512,417	550,788	7,059	246,547	2.6%	3.8%	2.8%
2020-10-28	44,463,732	1,174,561	30,073,936	13,215,235	508,935	7,082	265,967	2.6%	3.8%	2.6%
2020-10-27	43,954,797	1,167,479	29,807,969	12,979,349	468,908	7,414	590,521	2.7%	3.8%	1.2%
2020-10-26	43,485,889	1,160,065	29,217,448	13,108,376	537,063	5,647	239,426	2.7%	3.8%	2.3%
2020-10-25	42,948,826	1,154,418	28,978,022	12,816,386	353,478	4,140	196,355	2.7%	3.8%	2.1%
2020-10-24	42,595,348	1,150,278	28,781,667	12,663,403	412,833	5,694	211,267	2.7%	3.8%	2.6%
2020-10-23	42,182,515	1,144,584	28,570,400	12,467,531	496,765	6,921	206,123	2.7%	3.9%	3.2%
2020-10-22	41,685,750	1,137,663	28,364,277	12,183,810	469,645	5,904	226,404	2.7%	3.9%	2.5%
2020-10-21	41,216,105	1,131,759	28,137,873	11,946,473	443,650	6,557	211,138	2.7%	3.9%	3.0%
2020-10-20	40,772,455	1,125,202	27,926,735	11,720,518	388,522	6,593	213,727	2.8%	3.9%	3.0%
2020-10-19	40,383,933	1,118,609	27,713,008	11,552,316	448,086	5,001	210,302	2.8%	3.9%	2.3%
2020-10-18	39,935,847	1,113,608	27,502,706	11,319,533	285,938	3,385	198,996	2.8%	3.9%	1.7%
2020-10-17	39,649,909	1,110,223	27,303,710	11,235,976	341,242	5,513	198,680	2.8%	3.9%	2.7%
2020-10-16	39,308,667	1,104,710	27,105,030	11,098,927	410,443	6,124	204,654	2.8%	3.9%	2.9%
2020-10-15	38,898,224	1,098,586	26,900,376	10,899,262	407,271	6,120	207,181	2.8%	3.9%	2.9%
2020-10-14	38,490,953	1,092,466	26,693,195	10,705,292	380,052	5,999	211,949	2.8%	3.9%	2.8%
2020-10-13	38,110,901	1,086,467	26,481,246	10,543,188	329,004	5,456	193,683	2.9%	3.9%	2.7%
2020-10-12	37,781,897	1,081,011	26,287,563	10,413,323	325,119	3,940	204,353	2.9%	3.9%	1.9%
2020-10-11	37,456,778	1,077,071	26,083,210	10,296,497	269,754	3,917	217,826	2.9%	4.0%	1.8%
2020-10-10	37,187,024	1,073,154	25,865,384	10,248,486	330,405	4,831	192,046	2.9%	4.0%	2.5%
2020-10-09	36,856,619	1,068,323	25,673,338	10,114,958	359,678	6,095	205,297	2.9%	4.0%	2.9%
2020-10-08	36,496,941	1,062,228	25,468,041	9,966,672	360,464	6,259	219,492	2.9%	4.0%	2.8%
2020-10-07	36,136,477	1,055,969	25,248,549	9,831,959	349,825	5,822	255,400	2.9%	4.0%	2.2%
2020-10-06	35,786,652	1,050,147	24,993,149	9,743,356	323,875	5,782	233,092	2.9%	4.0%	2.4%
2020-10-05	35,462,777	1,044,365	24,760,057	9,658,355	329,116	7,019	238,887	2.9%	4.0%	2.9%
2020-10-04	35,133,661	1,037,346	24,521,170	9,575,145	248,696	3,775	218,201	3.0%	4.1%	1.7%
2020-10-03	34,884,965	1,033,571	24,302,969	9,548,425	319,471	5,348	258,186	3.0%	4.1%	2.0%
2020-10-02	34,565,494	1,028,223	24,044,783	9,492,488	294,425	4,982	171,897	3.0%	4.1%	2.8%
2020-10-01	34,271,069	1,023,241	23,872,886	9,374,942	317,982	8,694	220,615	3.0%	4.1%	3.8%
2020-09-30	33,953,087	1,014,547	23,652,271	9,286,269	326,721	6,397	249,536	3.0%	4.1%	2.5%
2020-09-29	33,626,366	1,008,150	23,402,735	9,215,481	284,049	6,093	237,926	3.0%	4.1%	2.5%
2020-09-28	33,342,317	1,002,057	23,164,809	9,175,451	275,883	3,928	225,556	3.0%	4.1%	1.7%
2020-09-27	33,066,434	998,129	22,939,253	9,129,052	241,169	3,616	210,400	3.0%	4.2%	1.7%
2020-09-26	32,825,265	994,513	22,728,853	9,101,899	277,050	5,283	243,351	3.0%	4.2%	2.1%
2020-09-25	32,548,215	989,230	22,485,502	9,073,483	329,316	5,903	239,727	3.0%	4.2%	2.4%
2020-09-24	32,218,899	983,327	22,245,775	8,989,797	361,264	6,720	254,751	3.1%	4.2%	2.6%
2020-09-23	31,857,635	976,607	21,991,024	8,890,004	266,732	5,615	263,721	3.1%	4.3%	2.1%
2020-09-22	31,590,903	970,992	21,727,303	8,892,608	279,898	5,983	219,855	3.1%	4.3%	2.6%
2020-09-21	31,311,005	965,009	21,507,448	8,838,548	298,376	4,121	243,350	3.1%	4.3%	1.7%
2020-09-20	31,012,629	960,888	21,264,098	8,787,643	242,441	3,706	236,133	3.1%	4.3%	1.5%
2020-09-19	30,770,188	957,182	21,027,965	8,785,041	280,556	5,237	237,937	3.1%	4.4%	2.2%
2020-09-18	30,489,632	951,945	20,790,028	8,747,659	323,167	5,706	251,942	3.1%	4.4%	2.2%
2020-09-17	30,166,465	946,239	20,538,086	8,682,140	313,586	5,462	219,486	3.1%	4.4%	2.4%
2020-09-16	29,852,879	940,777	20,318,600	8,593,502	304,971	5,752	229,124	3.2%	4.4%	2.4%
2020-09-15	29,547,908	935,025	20,089,476	8,523,407	283,682	6,548	226,370	3.2%	4.4%	2.8%
2020-09-14	29,264,226	928,477	19,863,106	8,472,643	279,594	4,438	229,607	3.2%	4.5%	1.9%
2020-09-13	28,984,632	924,039	19,633,499	8,427,094	236,080	3,655	185,941	3.2%	4.5%	1.9%
2020-09-12	28,748,552	920,384	19,447,558	8,380,610	277,007	4,873	223,479	3.2%	4.5%	2.1%
2020-09-11	28,471,545	915,511	19,224,079	8,331,955	319,858	5,885	223,534	3.2%	4.5%	2.6%
2020-09-10	28,151,687	909,626	19,000,545	8,241,516	298,981	5,799	215,767	3.2%	4.6%	2.6%
2020-09-09	27,852,706	903,827	18,784,778	8,164,101	284,435	6,077	240,031	3.2%	4.6%	2.5%
2020-09-08	27,568,271	897,750	18,544,747	8,125,774	241,376	4,945	201,639	3.3%	4.6%	2.4%

Table 5: Cases in the Whole World *(continued)*

date	confirmed	deaths	recovered	active.confirmed	new.confirmed	new.deaths	new.recovered	rate.lower	rate.upper	rate.daily
2020-09-07	27,326,895	892,805	18,343,108	8,090,982	233,388	9,321	198,899	3.3%	4.6%	4.5%
2020-09-06	27,093,507	883,484	18,144,209	8,065,814	222,128	3,775	210,230	3.3%	4.6%	1.8%
2020-09-05	26,871,379	879,709	17,933,979	8,057,691	263,226	4,931	200,990	3.3%	4.7%	2.4%
2020-09-04	26,608,153	874,778	17,732,989	8,000,386	312,834	5,911	213,938	3.3%	4.7%	2.7%
2020-09-03	26,295,319	868,867	17,519,051	7,907,401	280,856	5,712	220,901	3.3%	4.7%	2.5%
2020-09-02	26,014,463	863,155	17,298,150	7,853,158	282,754	6,014	218,769	3.3%	4.8%	2.7%
2020-09-01	25,731,709	857,141	17,079,381	7,795,187	264,189	6,486	257,679	3.3%	4.8%	2.5%
2020-08-31	25,467,520	850,655	16,821,702	7,795,163	262,432	4,214	201,563	3.3%	4.8%	2.0%
2020-08-30	25,205,088	846,441	16,620,139	7,738,508	226,342	3,910	208,554	3.4%	4.8%	1.8%
2020-08-29	24,978,746	842,531	16,411,585	7,724,630	260,696	5,384	211,741	3.4%	4.9%	2.5%
2020-08-28	24,718,050	837,147	16,199,844	7,681,059	281,330	5,520	200,578	3.4%	4.9%	2.7%
2020-08-27	24,436,720	831,627	15,999,266	7,605,827	279,074	5,884	201,706	3.4%	4.9%	2.8%
2020-08-26	24,157,646	825,743	15,797,560	7,534,343	289,697	6,292	224,503	3.4%	5.0%	2.7%
2020-08-25	23,867,949	819,451	15,573,057	7,475,441	241,958	6,376	232,787	3.4%	5.0%	2.7%
2020-08-24	23,625,991	813,075	15,340,270	7,472,646	226,136	4,365	200,201	3.4%	5.0%	2.1%
2020-08-23	23,399,855	808,710	15,140,069	7,451,076	205,504	3,856	215,236	3.5%	5.1%	1.8%
2020-08-22	23,194,351	804,854	14,924,833	7,464,664	265,034	5,572	210,122	3.5%	5.1%	2.6%
2020-08-21	22,929,317	799,282	14,714,711	7,415,324	269,595	5,498	170,093	3.5%	5.2%	3.1%
2020-08-20	22,659,722	793,784	14,544,618	7,321,320	267,251	6,038	207,904	3.5%	5.2%	2.8%
2020-08-19	22,392,471	787,746	14,336,714	7,268,011	274,459	6,740	217,585	3.5%	5.2%	3.0%
2020-08-18	22,118,012	781,006	14,119,129	7,217,877	256,074	6,882	227,987	3.5%	5.2%	2.9%
2020-08-17	21,861,938	774,124	13,891,142	7,196,672	209,769	4,144	211,585	3.5%	5.3%	1.9%
2020-08-16	21,652,169	769,980	13,679,557	7,202,632	211,928	4,203	231,256	3.6%	5.3%	1.8%
2020-08-15	21,440,241	765,777	13,448,301	7,226,163	247,638	5,345	169,013	3.6%	5.4%	3.1%
2020-08-14	21,192,603	760,432	13,279,288	7,152,883	304,229	10,127	284,450	3.6%	5.4%	3.4%
2020-08-13	20,888,374	750,305	12,994,838	7,143,231	285,951	6,214	165,213	3.6%	5.5%	3.6%
2020-08-12	20,602,423	744,091	12,829,625	7,028,707	277,973	6,621	241,505	3.6%	5.5%	2.7%
2020-08-11	20,324,450	737,470	12,588,120	6,998,860	254,808	6,431	305,143	3.6%	5.5%	2.1%
2020-08-10	20,069,642	731,039	12,282,977	7,055,626	227,025	4,913	164,231	3.6%	5.6%	2.9%
2020-08-09	19,842,617	726,126	12,118,746	6,997,745	223,292	4,556	176,885	3.7%	5.7%	2.5%
2020-08-08	19,619,325	721,570	11,941,861	6,955,894	259,051	5,435	201,379	3.7%	5.7%	2.6%
2020-08-07	19,360,274	716,135	11,740,482	6,903,657	280,739	6,296	192,651	3.7%	5.7%	3.2%
2020-08-06	19,079,535	709,839	11,547,831	6,821,865	284,745	6,494	188,970	3.7%	5.8%	3.3%
2020-08-05	18,794,790	703,345	11,358,861	6,732,584	272,239	6,965	221,696	3.7%	5.8%	3.0%
2020-08-04	18,522,551	696,380	11,137,165	6,689,006	258,449	6,917	224,165	3.8%	5.9%	3.0%
2020-08-03	18,264,102	689,463	10,913,000	6,661,639	201,437	4,323	222,445	3.8%	5.9%	1.9%
2020-08-02	18,062,665	685,140	10,690,555	6,686,970	228,200	4,273	136,703	3.8%	6.0%	3.0%
2020-08-01	17,834,465	680,867	10,553,852	6,599,746	250,116	5,482	184,597	3.8%	6.1%	2.9%
2020-07-31	17,584,349	675,385	10,369,255	6,539,709	290,191	6,208	198,605	3.8%	6.1%	3.0%
2020-07-30	17,294,158	669,177	10,170,650	6,454,331	280,130	6,010	222,487	3.9%	6.2%	2.6%
2020-07-29	17,014,028	663,167	9,948,163	6,402,698	289,607	6,573	201,690	3.9%	6.2%	3.2%
2020-07-28	16,724,421	656,594	9,746,473	6,321,354	252,233	6,308	173,854	3.9%	6.3%	3.5%
2020-07-27	16,472,188	650,286	9,572,619	6,249,283	226,198	5,179	169,623	3.9%	6.4%	3.0%
2020-07-26	16,245,990	645,107	9,402,996	6,197,887	212,809	3,667	140,476	4.0%	6.4%	2.5%
2020-07-25	16,033,181	641,440	9,262,520	6,129,221	255,401	5,539	219,317	4.0%	6.5%	2.5%
2020-07-24	15,777,780	635,901	9,043,203	6,098,676	280,321	6,042	229,317	4.0%	6.6%	2.6%
2020-07-23	15,497,459	629,859	8,813,886	6,053,714	282,921	9,892	170,164	4.1%	6.7%	5.5%
2020-07-22	15,214,538	619,967	8,643,722	5,950,849	280,828	6,926	176,387	4.1%	6.7%	3.8%
2020-07-21	14,933,710	613,041	8,467,335	5,853,334	233,407	6,162	174,647	4.1%	6.8%	3.4%
2020-07-20	14,700,303	606,879	8,292,688	5,800,736	206,554	4,175	158,996	4.1%	6.8%	2.6%
2020-07-19	14,493,749	602,704	8,133,692	5,757,353	213,922	4,058	87,877	4.2%	6.9%	4.4%
2020-07-18	14,279,827	598,646	8,045,815	5,635,366	236,756	5,616	150,957	4.2%	6.9%	3.6%
2020-07-17	14,043,071	593,030	7,894,858	5,555,183	241,872	6,660	183,310	4.2%	7.0%	3.5%
2020-07-16	13,801,199	586,370	7,711,548	5,503,281	252,565	5,750	152,370	4.2%	7.1%	3.6%
2020-07-15	13,548,634	580,620	7,559,178	5,408,836	231,110	5,438	159,781	4.3%	7.1%	3.3%
2020-07-14	13,317,524	575,182	7,399,397	5,342,945	221,319	5,590	142,200	4.3%	7.2%	3.8%
2020-07-13	13,096,205	569,592	7,257,197	5,269,416	192,188	3,812	140,344	4.3%	7.3%	2.6%
2020-07-12	12,904,017	565,780	7,116,853	5,221,384	192,505	3,993	111,679	4.4%	7.4%	3.5%
2020-07-11	12,711,512	561,787	7,005,174	5,144,551	216,272	4,787	125,709	4.4%	7.4%	3.7%
2020-07-10	12,495,240	557,000	6,879,465	5,058,775	232,157	5,292	139,392	4.5%	7.5%	3.7%
2020-07-09	12,263,083	551,708	6,740,073	4,971,302	228,065	5,411	134,514	4.5%	7.6%	3.9%
2020-07-08	12,035,018	546,297	6,605,559	4,883,162	212,399	5,273	157,949	4.5%	7.6%	3.2%
2020-07-07	11,822,619	541,024	6,447,610	4,833,985	210,927	6,014	145,025	4.6%	7.7%	4.0%
2020-07-06	11,611,692	535,010	6,302,585	4,774,097	165,205	3,824	123,612	4.6%	7.8%	3.0%
2020-07-05	11,446,487	531,186	6,178,973	4,736,328	182,896	3,474	119,322	4.6%	7.9%	2.8%
2020-07-04	11,263,591	527,712	6,059,651	4,676,228	193,841	4,366	195,833	4.7%	8.0%	2.2%
2020-07-03	11,069,750	523,346	5,863,818	4,682,586	202,685	4,935	109,900	4.7%	8.2%	4.3%
2020-07-02	10,867,065	518,411	5,753,918	4,594,736	208,114	5,063	284,877	4.8%	8.3%	1.7%
2020-07-01	10,658,951	513,348	5,469,041	4,676,562	217,212	4,926	115,926	4.8%	8.6%	4.1%
2020-06-30	10,441,739	508,422	5,353,115	4,580,202	174,108	4,949	117,322	4.9%	8.7%	4.0%
2020-06-29	10,267,631	503,473	5,235,793	4,528,365	156,186	3,725	94,566	4.9%	8.8%	3.8%
2020-06-28	10,111,445	499,748	5,141,227	4,470,470	161,795	3,144	89,120	4.9%	8.9%	3.4%
2020-06-27	9,949,650	496,604	5,052,107	4,400,939	178,460	4,461	106,365	5.0%	8.9%	4.0%
2020-06-26	9,771,190	492,143	4,945,742	4,333,305	191,398	4,701	106,714	5.0%	9.1%	4.2%
2020-06-25	9,579,792	487,442	4,839,028	4,253,322	178,325	4,694	92,856	5.1%	9.2%	4.8%
2020-06-24	9,401,467	482,748	4,746,172	4,172,547	170,862	5,171	115,760	5.1%	9.2%	4.3%
2020-06-23	9,230,605	477,577	4,630,412	4,122,616	165,290	5,222	104,075	5.2%	9.3%	4.8%
2020-06-22	9,065,315	472,355	4,526,337	4,066,623	137,907	3,558	91,626	5.2%	9.4%	3.7%
2020-06-21	8,927,408	468,797	4,434,711	4,023,900	128,288	4,009	68,737	5.3%	9.6%	5.5%
2020-06-20	8,799,120	464,788	4,365,974	3,968,358	157,092	4,204	115,825	5.3%	9.6%	3.5%
2020-06-19	8,642,028	460,584	4,250,149	3,931,295	179,833	6,150	95,015	5.3%	9.8%	6.1%
2020-06-18	8,462,195	454,434	4,155,134	3,852,627	140,305	4,981	81,142	5.4%	9.9%	5.8%
2020-06-17	8,321,890	449,453	4,073,992	3,798,445	142,517	5,090	118,787	5.4%	9.9%	4.1%
2020-06-16	8,179,373	444,363	3,955,205	3,779,805	141,843	6,718	97,840	5.4%	10.1%	6.4%
2020-06-15	8,037,530	437,645	3,857,365	3,742,520	119,745	3,418	80,208	5.4%	10.2%	4.1%
2020-06-14	7,917,785	434,227	3,777,157	3,706,401	132,652	3,412	70,785	5.5%	10.3%	4.6%
2020-06-13	7,785,133	430,815	3,706,372	3,647,946	135,324	4,191	85,934	5.5%	10.4%	4.7%
2020-06-12	7,649,809	426,624	3,620,438	3,602,747	128,472	4,214	79,724	5.6%	10.5%	5.0%
2020-06-11	7,521,337	422,410	3,540,714	3,558,213	138,170	4,682	85,882	5.6%	10.7%	5.2%

Table 5: Cases in the Whole World *(continued)*

date	confirmed	deaths	recovered	active.confirmed	new.confirmed	new.deaths	new.recovered	rate.lower	rate.upper	rate.daily
2020-06-10	7,383,167	417,728	3,454,832	3,510,607	134,447	5,059	79,138	5.7%	10.8%	6.0%
2020-06-09	7,248,720	412,669	3,375,694	3,460,357	124,635	4,836	82,282	5.7%	10.9%	5.6%
2020-06-08	7,124,085	407,833	3,293,412	3,422,840	102,479	3,679	151,563	5.7%	11.0%	2.4%
2020-06-07	7,021,606	404,154	3,141,849	3,475,603	111,904	2,744	55,101	5.8%	11.4%	4.7%
2020-06-06	6,909,702	401,410	3,086,748	3,421,544	134,629	3,850	72,204	5.8%	11.5%	5.1%
2020-06-05	6,775,073	397,560	3,014,544	3,362,969	130,799	4,565	69,159	5.9%	11.7%	6.2%
2020-06-04	6,644,274	392,995	2,945,385	3,305,894	126,827	5,116	70,053	5.9%	11.8%	6.8%
2020-06-03	6,517,447	387,879	2,875,332	3,254,236	118,095	5,436	79,104	6.0%	11.9%	6.4%
2020-06-02	6,399,352	382,443	2,796,228	3,220,681	121,381	4,723	104,123	6.0%	12.0%	4.3%
2020-06-01	6,277,971	377,720	2,692,105	3,208,146	95,503	3,077	54,897	6.0%	12.3%	5.3%
2020-05-31	6,182,468	374,643	2,637,208	3,170,617	106,599	2,976	76,320	6.1%	12.4%	3.8%
2020-05-30	6,075,869	371,667	2,560,888	3,143,314	136,954	4,065	70,453	6.1%	12.7%	5.5%
2020-05-29	5,938,915	367,602	2,490,435	3,080,878	120,895	4,587	77,346	6.2%	12.9%	5.6%
2020-05-28	5,818,020	363,015	2,413,089	3,041,916	119,514	4,623	66,857	6.2%	13.1%	6.5%
2020-05-27	5,698,506	358,392	2,346,232	2,993,882	103,005	5,135	63,393	6.3%	13.3%	7.5%
2020-05-26	5,595,501	353,257	2,282,839	2,959,405	93,251	4,120	55,214	6.3%	13.4%	6.9%
2020-05-25	5,502,250	349,137	2,227,625	2,925,488	86,349	1,202	63,723	6.3%	13.5%	1.9%
2020-05-24	5,415,901	347,935	2,163,902	2,904,064	94,477	3,122	55,440	6.4%	13.9%	5.3%
2020-05-23	5,321,424	344,813	2,108,462	2,868,149	104,626	3,915	54,971	6.5%	14.1%	6.6%
2020-05-22	5,216,798	340,898	2,053,491	2,822,409	105,983	5,195	108,651	6.5%	14.2%	4.6%
2020-05-21	5,110,815	335,703	1,944,840	2,830,272	106,565	4,725	51,265	6.6%	14.7%	8.4%
2020-05-20	5,004,250	330,978	1,893,575	2,779,697	102,753	4,760	58,928	6.6%	14.9%	7.5%
2020-05-19	4,901,497	326,218	1,834,647	2,740,632	97,138	4,720	52,105	6.7%	15.1%	8.3%
2020-05-18	4,804,359	321,498	1,782,542	2,700,319	88,718	3,694	52,921	6.7%	15.3%	6.5%
2020-05-17	4,715,641	317,804	1,729,621	2,668,216	77,405	3,286	40,907	6.7%	15.5%	7.4%
2020-05-16	4,638,236	314,518	1,688,714	2,635,004	94,206	4,175	56,592	6.8%	15.7%	6.9%
2020-05-15	4,544,030	310,343	1,632,122	2,601,565	96,324	5,116	48,008	6.8%	16.0%	9.6%
2020-05-14	4,447,706	305,227	1,584,114	2,558,365	96,682	5,181	39,716	6.9%	16.2%	11.5%
2020-05-13	4,351,024	300,046	1,544,398	2,506,580	84,820	5,077	55,856	6.9%	16.3%	8.3%
2020-05-12	4,266,204	294,969	1,488,542	2,482,693	84,258	5,522	37,021	6.9%	16.5%	13.0%
2020-05-11	4,181,946	289,447	1,451,521	2,440,978	76,875	3,468	46,994	6.9%	16.6%	6.9%
2020-05-10	4,105,071	285,979	1,404,527	2,414,565	75,196	3,594	33,594	7.0%	16.9%	9.7%
2020-05-09	4,029,875	282,385	1,370,933	2,376,557	84,923	4,287	53,550	7.0%	17.1%	7.4%
2020-05-08	3,944,952	278,098	1,317,383	2,349,471	91,171	5,480	36,550	7.0%	17.4%	13.0%
2020-05-07	3,853,781	272,618	1,280,833	2,300,330	89,020	5,292	39,468	7.1%	17.5%	11.8%
2020-05-06	3,764,761	267,326	1,241,365	2,256,070	89,914	6,543	46,006	7.1%	17.7%	12.5%
2020-05-05	3,674,847	260,783	1,195,359	2,218,705	80,455	5,888	36,540	7.1%	17.9%	13.9%
2020-05-04	3,594,392	254,895	1,158,819	2,180,678	77,078	4,099	34,087	7.1%	18.0%	10.7%
2020-05-03	3,517,314	250,796	1,124,732	2,141,786	76,523	3,471	32,316	7.1%	18.2%	9.7%
2020-05-02	3,440,791	247,325	1,092,416	2,101,050	80,047	5,478	40,879	7.2%	18.5%	11.8%
2020-05-01	3,360,744	241,847	1,051,537	2,067,360	87,190	5,149	38,253	7.2%	18.7%	11.9%
2020-04-30	3,273,554	236,698	1,013,284	2,023,572	83,348	5,997	64,966	7.2%	18.9%	8.5%
2020-04-29	3,190,206	230,701	948,318	2,011,187	77,462	6,734	42,182	7.2%	19.6%	13.8%
2020-04-28	3,112,744	223,967	906,136	1,982,641	75,484	6,546	33,271	7.2%	19.8%	16.4%
2020-04-27	3,037,260	217,421	872,865	1,946,974	69,690	4,675	27,769	7.2%	19.9%	14.4%
2020-04-26	2,967,570	212,746	845,096	1,909,728	72,140	3,939	28,605	7.2%	20.1%	12.1%
2020-04-25	2,895,430	208,807	816,491	1,870,132	83,247	5,637	27,779	7.2%	20.4%	16.9%
2020-04-24	2,812,183	203,170	788,712	1,820,301	84,373	6,661	50,051	7.2%	20.5%	11.7%
2020-04-23	2,727,810	196,509	738,661	1,792,640	88,057	6,839	28,780	7.2%	21.0%	19.2%
2020-04-22	2,639,753	189,670	709,881	1,740,202	78,019	6,731	30,425	7.2%	21.1%	18.1%
2020-04-21	2,561,734	182,939	679,456	1,699,339	75,879	7,184	34,843	7.1%	21.2%	17.1%
2020-04-20	2,485,855	175,755	644,613	1,665,487	74,503	5,858	21,990	7.1%	21.4%	21.0%
2020-04-19	2,411,352	169,897	622,623	1,618,832	79,972	5,262	31,655	7.0%	21.4%	14.3%
2020-04-18	2,331,380	164,635	590,968	1,575,777	73,394	6,023	23,919	7.1%	21.8%	20.1%
2020-04-17	2,257,986	158,612	567,049	1,532,325	87,813	8,366	26,123	7.0%	21.9%	24.3%
2020-04-16	2,170,173	150,246	540,926	1,479,001	96,921	7,300	30,820	6.9%	21.7%	19.2%
2020-04-15	2,073,252	142,946	510,106	1,420,200	81,873	8,348	36,670	6.9%	21.9%	18.5%
2020-04-14	1,991,379	134,598	473,436	1,383,345	71,346	6,970	25,089	6.8%	22.1%	21.7%
2020-04-13	1,920,033	127,628	448,347	1,344,058	70,145	5,918	27,167	6.6%	22.2%	17.9%
2020-04-12	1,849,888	121,710	421,180	1,306,998	95,353	5,809	19,414	6.6%	22.4%	23.0%
2020-04-11	1,754,535	115,901	401,766	1,236,868	76,216	6,239	26,257	6.6%	22.4%	19.2%
2020-04-10	1,678,319	109,662	375,509	1,193,148	87,540	7,385	21,802	6.5%	22.6%	25.3%
2020-04-09	1,590,779	102,277	353,707	1,134,795	86,481	7,776	25,348	6.4%	22.4%	23.5%
2020-04-08	1,504,298	94,501	328,359	1,081,438	84,031	6,761	28,716	6.3%	22.3%	19.1%
2020-04-07	1,420,267	87,740	299,643	1,032,884	77,740	8,224	23,391	6.2%	22.6%	26.0%
2020-04-06	1,342,527	79,516	276,252	986,759	73,234	5,947	16,580	5.9%	22.4%	26.4%
2020-04-05	1,269,293	73,569	259,672	936,052	71,977	5,166	13,840	5.8%	22.1%	27.2%
2020-04-04	1,197,316	68,403	245,832	883,081	80,354	6,166	20,417	5.7%	21.8%	23.2%
2020-04-03	1,116,962	62,237	225,415	829,310	83,253	6,107	15,448	5.6%	21.6%	28.3%
2020-04-02	1,033,709	56,130	209,967	767,612	81,331	6,239	17,049	5.4%	21.1%	26.8%
2020-04-01	952,378	49,891	192,918	709,569	76,526	5,505	15,093	5.2%	20.5%	26.7%
2020-03-31	875,852	44,386	177,825	653,641	76,829	4,751	13,488	5.1%	20.0%	26.0%
2020-03-30	799,023	39,635	164,337	595,051	65,237	4,052	15,446	5.0%	19.4%	20.8%
2020-03-29	733,786	35,583	148,891	549,312	59,399	3,476	9,467	4.8%	19.3%	26.9%
2020-03-28	674,387	32,107	139,424	502,856	67,382	3,713	8,503	4.8%	18.7%	30.4%
2020-03-27	607,005	28,394	130,921	447,690	64,991	3,493	8,776	4.7%	17.8%	28.5%
2020-03-26	542,014	24,901	122,145	394,968	62,726	3,020	8,370	4.6%	16.9%	26.5%
2020-03-25	479,288	21,881	113,775	343,632	50,984	2,800	5,783	4.6%	16.1%	32.6%
2020-03-24	428,304	19,081	107,992	301,231	41,472	2,284	9,641	4.5%	15.0%	19.2%
2020-03-23	386,832	16,797	98,351	271,684	43,368	1,942	466	4.3%	14.6%	80.6%
2020-03-22	343,464	14,855	97,885	230,724	34,238	1,674	6,215	4.3%	13.2%	21.2%
2020-03-21	309,226	13,181	91,670	204,375	31,969	1,720	4,267	4.3%	12.6%	28.7%
2020-03-20	277,257	11,461	87,403	178,393	30,635	1,481	2,445	4.1%	11.6%	37.7%
2020-03-19	246,622	9,980	84,958	151,684	27,156	1,113	1,637	4.0%	10.5%	40.5%
2020-03-18	219,466	8,867	83,321	127,278	19,533	903	2,483	4.0%	9.6%	26.7%
2020-03-17	199,933	7,964	80,838	111,131	15,931	811	2,752	4.0%	9.0%	22.8%
2020-03-16	184,002	7,153	78,086	98,763	14,744	678	2,054	3.9%	8.4%	24.8%
2020-03-15	169,258	6,475	76,032	86,751	11,293	641	3,410	3.8%	7.8%	15.8%

Table 5: Cases in the Whole World *(continued)*

date	confirmed	deaths	recovered	active.confirmed	new.confirmed	new.deaths	new.recovered	rate.lower	rate.upper	rate.daily
2020-03-14	157,965	5,834	72,622	79,509	11,078	420	2,371	3.7%	7.4%	15.0%
2020-03-13	146,887	5,414	70,251	71,222	14,381	497	1,927	3.7%	7.2%	20.5%
2020-03-12	132,506	4,917	68,324	59,265	5,789	306	1,322	3.7%	6.7%	18.8%
2020-03-11	126,717	4,611	67,002	55,104	7,681	344	2,598	3.6%	6.4%	11.7%
2020-03-10	119,036	4,267	64,404	50,365	5,011	280	1,911	3.6%	6.2%	12.8%
2020-03-09	114,025	3,987	62,493	47,545	3,963	184	1,799	3.5%	6.0%	9.3%
2020-03-08	110,062	3,803	60,694	45,565	3,960	244	2,335	3.5%	5.9%	9.5%
2020-03-07	106,102	3,559	58,359	44,184	4,062	99	2,494	3.4%	5.7%	3.8%
2020-03-06	102,040	3,460	55,865	42,715	4,000	112	2,069	3.4%	5.8%	5.1%
2020-03-05	98,040	3,348	53,796	40,896	2,764	93	2,626	3.4%	5.9%	3.4%
2020-03-04	95,276	3,255	51,170	40,851	2,317	95	2,942	3.4%	6.0%	3.1%
2020-03-03	92,959	3,160	48,228	41,571	2,584	75	2,626	3.4%	6.1%	2.8%
2020-03-02	90,375	3,085	45,602	41,688	1,978	89	2,886	3.4%	6.3%	3.0%
2020-03-01	88,397	2,996	42,716	42,685	2,383	54	2,934	3.4%	6.6%	1.8%
2020-02-29	86,014	2,942	39,782	43,290	1,893	69	3,071	3.4%	6.9%	2.2%
2020-02-28	84,121	2,873	36,711	44,537	1,385	59	3,434	3.4%	7.3%	1.7%
2020-02-27	82,736	2,814	33,277	46,645	1,360	43	2,893	3.4%	7.8%	1.5%
2020-02-26	81,376	2,771	30,384	48,221	977	61	2,479	3.4%	8.4%	2.4%
2020-02-25	80,399	2,710	27,905	49,784	853	80	2,678	3.4%	8.9%	2.9%
2020-02-24	79,546	2,630	25,227	51,689	564	160	1,833	3.3%	9.4%	8.0%
2020-02-23	78,982	2,470	23,394	53,118	380	11	508	3.1%	9.5%	2.1%
2020-02-22	78,602	2,459	22,886	53,257	1,761	207	3,996	3.1%	9.7%	4.9%
2020-02-21	76,841	2,252	18,890	55,699	629	4	713	2.9%	10.7%	0.6%
2020-02-20	76,212	2,248	18,177	55,787	560	125	2,056	2.9%	11.0%	5.7%
2020-02-19	75,652	2,123	16,121	57,408	500	115	1,769	2.8%	11.6%	6.1%
2020-02-18	75,152	2,008	14,352	58,792	1,882	140	1,769	2.7%	12.3%	7.3%
2020-02-17	73,270	1,868	12,583	58,819	2,035	98	1,718	2.5%	12.9%	5.4%
2020-02-16	71,235	1,770	10,865	58,600	2,184	104	1,470	2.5%	14.0%	6.6%
2020-02-15	69,051	1,666	9,395	57,990	2,142	143	1,337	2.4%	15.1%	9.7%
2020-02-14	66,909	1,523	8,058	57,328	6,527	152	1,763	2.3%	15.9%	7.9%
2020-02-13	60,382	1,371	6,295	52,716	15,153	253	1,145	2.3%	17.9%	18.1%
2020-02-12	45,229	1,118	5,150	38,961	418	5	467	2.5%	17.8%	1.1%
2020-02-11	44,811	1,113	4,683	39,015	2,042	100	737	2.5%	19.2%	11.9%
2020-02-10	42,769	1,013	3,946	37,810	2,609	107	702	2.4%	20.4%	13.2%
2020-02-09	40,160	906	3,244	36,010	3,030	100	628	2.3%	21.8%	13.7%
2020-02-08	37,130	806	2,616	33,708	2,734	87	605	2.2%	23.6%	12.6%
2020-02-07	34,396	719	2,011	31,666	3,593	85	524	2.1%	26.3%	14.0%
2020-02-06	30,803	634	1,487	28,682	3,160	70	363	2.1%	29.9%	16.2%
2020-02-05	27,643	564	1,124	25,955	3,745	72	272	2.0%	33.4%	20.9%
2020-02-04	23,898	492	852	22,554	4,011	66	229	2.1%	36.6%	22.4%
2020-02-03	19,887	426	623	18,838	3,100	64	151	2.1%	40.6%	29.8%
2020-02-02	16,787	362	472	15,953	4,749	103	188	2.2%	43.4%	35.4%
2020-02-01	12,038	259	284	11,495	2,111	46	62	2.2%	47.7%	42.6%
2020-01-31	9,927	213	222	9,492	1,692	42	79	2.1%	49.0%	34.7%
2020-01-30	8,235	171	143	7,921	2,068	38	17	2.1%	54.5%	69.1%
2020-01-29	6,167	133	126	5,908	589	2	19	2.2%	51.4%	9.5%
2020-01-28	5,578	131	107	5,340	2,651	49	46	2.3%	55.0%	51.6%
2020-01-27	2,927	82	61	2,784	809	26	9	2.8%	57.3%	74.3%
2020-01-26	2,118	56	52	2,010	684	14	13	2.6%	51.9%	51.9%
2020-01-25	1,434	42	39	1,353	493	16	3	2.9%	51.9%	84.2%
2020-01-24	941	26	36	879	287	8	6	2.8%	41.9%	57.1%
2020-01-23	654	18	30	606	99	1	2	2.8%	37.5%	33.3%
2020-01-22	555	17	28	510				3.1%	37.8%	NA%

Appendix A.2 Latest Cases by Country

```
## hightlight high death rates (if >= 5%) for those countries with 2000+ confirmed cases
data.latest.all %>% arrange(desc(confirmed)) %>% select(-c(date, ranking)) %>%
  mutate(death.rate=ifelse(confirmed >= 2000 & death.rate >= 5,
                           cell_spec(format(death.rate, big.mark=',') %>% paste0('%'),
                                     "latex", color="red", bold=T),
                           cell_spec(format(death.rate, big.mark=',') %>% paste0('%'),
                                     "latex", color="black", bold=F))) %>%
  kable(format='latex', escape=F, booktabs=T, longtable=T, row.names=T,
        caption=paste0('Cases by Country (', max.date.txt, ')'),
        format.args=list(big.mark=','),
        align=c('l', rep('r', 7))) %>%
  kable_styling(font_size=6, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

Table 6: Cases by Country (12 Nov 2020 UTC)

	country	confirmed	new.confirmed	active.confirmed	recovered	deaths	new.deaths	death.rate
1	World	52,733,290	606,497	17,290,884	34,149,223	1,293,183	9,020	2.5%

Table 6: Cases by Country (12 Nov 2020 UTC) *(continued)*

	country	confirmed	new.confirmed	active.confirmed	recovered	deaths	new.deaths	death.rate
2	US	10,552,821	153,496	6,259,142	4,051,256	242,423	919	2.3%
3	India	8,728,795	44,879	484,547	8,115,580	128,668	547	1.5%
4	Brazil	5,781,582	33,922	362,844	5,254,457	164,281	913	2.8%
5	France	1,915,282	364	1,733,471	139,212	42,599	0	2.2%
6	Russia	1,843,678	21,333	433,460	1,378,463	31,755	429	1.7%
7	Spain	1,437,220	19,511	1,246,383	150,376	40,461	356	2.8%
8	United Kingdom	1,293,715	33,517	1,239,664	3,031	51,020	563	3.9%
9	Argentina	1,284,519	11,163	149,557	1,100,180	34,782	251	2.7%
10	Colombia	1,174,012	8,686	58,830	1,081,691	33,491	179	2.9%
11	Italy	1,066,401	37,977	635,054	387,758	43,589	636	4.1%
12	Mexico	991,835	5,658	158,582	736,197	97,056	626	**9.8%**
13	Peru	928,006	2,575	39,767	853,208	35,031	39	3.8%
14	Germany	762,832	24,738	276,408	474,208	12,216	222	1.6%
15	South Africa	744,732	2,338	33,753	690,903	20,076	65	2.7%
16	Iran	726,585	11,517	144,898	541,566	40,121	457	**5.5%**
17	Poland	641,496	22,683	378,067	254,349	9,080	275	1.4%
18	Chile	526,438	1,634	9,264	502,475	14,699	66	2.8%
19	Belgium	520,393	5,002	506,502	0	13,891	133	2.7%
20	Ukraine	515,755	11,332	268,934	237,399	9,422	208	1.8%
21	Iraq	511,806	3,298	61,046	439,228	11,532	50	2.3%
22	Indonesia	452,291	4,173	55,274	382,084	14,933	97	3.3%
23	Czechia	446,675	7,870	140,201	300,719	5,755	185	1.3%
24	Netherlands	437,376	5,680	422,629	6,372	8,375	89	1.9%
25	Bangladesh	427,198	1,845	76,190	344,868	6,140	13	1.4%
26	Turkey	404,894	2,841	46,867	346,794	11,233	88	2.8%
27	Philippines	402,820	1,404	32,682	362,417	7,721	11	1.9%
28	Pakistan	352,296	2,304	23,641	321,563	7,092	37	2.0%
29	Saudi Arabia	352,160	311	7,441	339,114	5,605	15	1.6%
30	Romania	334,236	10,142	100,810	224,916	8,510	121	2.5%
31	Israel	322,159	833	8,848	310,605	2,706	6	0.8%
32	Canada	285,936	5,474	44,679	230,429	10,828	80	3.8%
33	Morocco	276,821	6,195	46,211	226,040	4,570	64	1.7%
34	Switzerland	250,396	6,924	106,180	141,000	3,216	103	1.3%
35	Nepal	204,242	1,913	38,461	164,592	1,189	15	0.6%
36	Portugal	198,011	5,839	81,141	113,689	3,181	78	1.6%
37	Austria	181,642	9,262	72,159	107,875	1,608	44	0.9%
38	Ecuador	177,513	883	9,611	154,956	12,946	26	**7.3%**
39	Sweden	171,365	4,658	165,243	0	6,122	40	3.6%
40	United Arab Emirates	146,735	1,136	4,997	141,215	523	3	0.4%
41	Panama	143,352	887	18,452	122,070	2,830	7	2.0%
42	Bolivia	142,889	113	17,927	116,137	8,825	7	**6.2%**
43	Qatar	135,132	245	2,745	132,153	234	1	0.2%
44	Kuwait	134,932	773	8,509	125,593	830	4	0.6%
45	Jordan	132,086	5,685	120,975	9,564	1,547	80	1.2%
46	Dominican Republic	131,636	371	20,227	109,135	2,274	2	1.7%
47	Hungary	126,790	3,927	94,704	29,302	2,784	87	2.2%
48	Costa Rica	120,939	1,171	45,157	74,255	1,527	14	1.3%
49	Oman	119,442	256	8,066	110,050	1,326	5	1.1%
50	Kazakhstan	119,129	638	8,272	108,958	1,899	0	1.6%
51	Japan	113,655	1,644	12,519	99,282	1,854	7	1.6%
52	Guatemala	113,543	732	6,511	103,174	3,858	13	3.4%
53	Armenia	112,680	2,132	40,882	70,130	1,668	32	1.5%
54	Belarus	110,455	1,098	16,585	92,843	1,027	5	0.9%
55	Egypt	110,095	214	2,918	100,760	6,417	12	**5.8%**
56	Honduras	101,468	299	54,596	44,068	2,804	7	2.8%
57	Ethiopia	101,248	521	36,426	63,268	1,554	9	1.5%
58	Lebanon	100,703	1,874	44,222	55,706	775	12	0.8%
59	Venezuela	96,140	390	4,158	91,141	841	3	0.9%
60	China	91,783	31	553	86,488	4,742	0	**5.2%**
61	Bulgaria	90,725	3,414	61,168	27,587	1,970	72	2.2%
62	Moldova	86,038	1,331	16,799	67,270	1,969	19	2.3%
63	Bahrain	84,192	150	2,014	81,846	332	0	0.4%
64	Slovakia	81,772	2,591	56,994	24,314	464	50	0.6%
65	Tunisia	76,106	1,584	22,148	51,807	2,151	51	2.8%
66	Croatia	75,922	3,082	16,348	58,649	925	32	1.2%
67	Serbia	73,765	3,341	72,810	0	955	19	1.3%
68	Libya	71,804	919	28,116	42,703	985	15	1.4%
69	Azerbaijan	70,216	1,622	17,325	51,986	905	20	1.3%

Table 6: Cases by Country (12 Nov 2020 UTC) *(continued)*

	country	confirmed	new.confirmed	active.confirmed	recovered	deaths	new.deaths	death.rate
70	Georgia	69,681	3,120	16,913	52,169	599	33	0.9%
71	Paraguay	69,653	547	18,065	50,045	1,543	11	2.2%
72	Uzbekistan	69,560	163	2,153	66,814	593	2	0.9%
73	Bosnia and Herzegovina	68,293	1,728	32,853	33,690	1,750	49	2.6%
74	Kenya	66,723	919	21,480	44,040	1,203	23	1.8%
75	Greece	66,637	3,316	42,604	23,074	959	50	1.4%
76	Ireland	66,632	385	41,303	23,364	1,965	0	2.9%
77	Burma	65,598	1,145	14,527	49,563	1,508	28	2.3%
78	Algeria	65,108	851	20,017	42,980	2,111	18	3.2%
79	Kyrgyzstan	64,887	527	7,870	55,824	1,193	5	1.8%
80	Nigeria	64,728	212	2,776	60,790	1,162	0	1.8%
81	West Bank and Gaza	60,784	719	7,381	52,861	542	4	0.9%
82	Denmark	59,478	1,012	13,519	45,204	755	2	1.3%
83	Singapore	58,102	11	72	58,002	28	0	0.0%
84	Slovenia	50,870	1,931	20,157	30,027	686	41	1.3%
85	Ghana	49,957	655	1,541	48,096	320	0	0.6%
86	North Macedonia	43,835	1,295	16,815	25,782	1,238	26	2.8%
87	Malaysia	43,791	919	11,419	32,069	303	1	0.7%
88	Afghanistan	42,795	186	6,180	35,024	1,591	10	3.7%
89	El Salvador	36,030	885	2,756	32,246	1,028	4	2.9%
90	Lithuania	29,812	1,550	22,472	7,096	244	9	0.8%
91	Korea, South	28,133	191	2,108	25,537	488	1	1.7%
92	Australia	27,676	1	1,310	25,459	907	0	3.3%
93	Norway	27,228	717	15,074	11,863	291	6	1.1%
94	Kosovo	26,888	767	9,418	16,685	785	8	2.9%
95	Albania	26,211	410	13,039	12,574	598	8	2.3%
96	Montenegro	25,509	644	8,357	16,788	364	8	1.4%
97	Luxembourg	25,218	1,508	10,209	14,798	211	13	0.8%
98	Cameroon	22,490	0	547	21,510	433	0	1.9%
99	Cote d'Ivoire	20,882	27	171	20,584	127	0	0.6%
100	Finland	18,542	197	4,177	14,000	365	0	2.0%
101	Madagascar	17,223	0	458	16,516	249	0	1.4%
102	Zambia	17,056	20	604	16,102	350	0	2.1%
103	Senegal	15,744	9	32	15,386	326	0	2.1%
104	Sri Lanka	15,723	373	5,022	10,653	48	2	0.3%
105	Uganda	15,217	224	7,089	7,985	143	4	0.9%
106	Sudan	14,401	55	3,750	9,535	1,116	0	**7.7%**
107	Mozambique	14,094	103	1,856	12,134	104	0	0.7%
108	Namibia	13,345	53	1,022	12,188	135	1	1.0%
109	Angola	13,053	100	6,488	6,250	315	3	2.4%
110	Guinea	12,537	21	1,564	10,899	74	0	0.6%
111	Maldives	12,085	26	819	11,225	41	0	0.3%
112	Congo (Kinshasa)	11,692	36	391	10,983	318	2	2.7%
113	Tajikistan	11,496	40	559	10,853	84	0	0.7%
114	Cabo Verde	9,694	134	588	9,004	102	0	1.1%
115	Jamaica	9,634	53	4,366	5,043	225	0	2.3%
116	Latvia	9,381	533	7,759	1,515	107	2	1.1%
117	Haiti	9,160	8	1,227	7,701	232	0	2.5%
118	Gabon	9,048	0	69	8,922	57	0	0.6%
119	Zimbabwe	8,696	29	381	8,060	255	0	2.9%
120	Botswana	8,225	390	2,639	5,559	27	0	0.3%
121	Mauritania	7,900	15	235	7,500	165	0	2.1%
122	Malta	7,646	109	2,079	5,479	88	0	1.2%
123	Cuba	7,487	58	432	6,924	131	1	1.7%
124	Bahamas	7,124	64	1,777	5,192	155	1	2.2%
125	Estonia	6,881	373	2,352	4,453	76	0	1.1%
126	Cyprus	6,646	185	4,730	1,882	34	1	0.5%
127	Syria	6,486	65	3,595	2,558	333	4	**5.1%**
128	Eswatini	6,060	16	197	5,746	117	0	1.9%
129	Malawi	5,958	3	404	5,369	185	0	3.1%
130	Trinidad and Tobago	5,930	26	502	5,317	111	0	1.9%
131	Nicaragua	5,661	0	1,278	4,225	158	0	2.8%
132	Djibouti	5,641	6	71	5,509	61	0	1.1%
133	Andorra	5,616	49	956	4,585	75	0	1.3%
134	Congo (Brazzaville)	5,379	0	1,400	3,887	92	0	1.7%
135	Rwanda	5,319	7	304	4,974	41	0	0.8%
136	Suriname	5,261	7	21	5,126	114	1	2.2%
137	Iceland	5,160	18	472	4,663	25	1	0.5%

Table 6: Cases by Country (12 Nov 2020 UTC) *(continued)*

	country	confirmed	new.confirmed	active.confirmed	recovered	deaths	new.deaths	death.rate
138	Equatorial Guinea	5,104	2	46	4,973	85	0	1.7%
139	Central African Republic	4,888	4	2,902	1,924	62	0	1.3%
140	Guyana	4,662	44	908	3,616	138	1	3.0%
141	Belize	4,596	76	2,008	2,513	75	0	1.6%
142	Somalia	4,301	0	864	3,330	107	0	2.5%
143	Thailand	3,861	9	104	3,697	60	0	1.6%
144	Uruguay	3,795	95	629	3,103	63	0	1.7%
145	Mali	3,792	39	731	2,923	138	0	3.6%
146	Gambia	3,697	0	19	3,556	122	0	3.3%
147	South Sudan	2,960	0	1,611	1,290	59	0	2.0%
148	Benin	2,844	0	286	2,515	43	0	1.5%
149	Togo	2,605	12	730	1,815	60	1	2.3%
150	Burkina Faso	2,586	0	108	2,411	67	0	2.6%
151	Guinea-Bissau	2,419	0	121	2,255	43	0	1.8%
152	Sierra Leone	2,387	1	497	1,816	74	0	3.1%
153	Yemen	2,071	0	72	1,394	605	0	**29.2%**
154	Lesotho	2,026	0	953	1,029	44	0	2.2%
155	New Zealand	1,995	4	53	1,917	25	0	1.3%
156	Chad	1,578	13	50	1,428	100	1	6.3%
157	Liberia	1,468	7	74	1,312	82	0	5.6%
158	Niger	1,282	19	69	1,144	69	0	5.4%
159	Vietnam	1,253	1	125	1,093	35	0	2.8%
160	San Marino	1,190	0	291	857	42	0	3.5%
161	Sao Tome and Principe	963	1	33	914	16	0	1.7%
162	Liechtenstein	905	28	245	656	4	0	0.4%
163	Diamond Princess	712	0	40	659	13	0	1.8%
164	Burundi	623	3	73	549	1	0	0.2%
165	Papua New Guinea	599	0	6	586	7	0	1.2%
166	Taiwan*	589	5	50	532	7	0	1.2%
167	Comoros	574	5	25	542	7	0	1.2%
168	Monaco	532	8	122	408	2	0	0.4%
169	Tanzania	509	0	305	183	21	0	4.1%
170	Eritrea	493	2	49	444	0	0	0.0%
171	Mauritius	468	15	31	427	10	0	2.1%
172	Mongolia	412	6	95	317	0	0	0.0%
173	Bhutan	369	5	24	345	0	0	0.0%
174	Cambodia	301	0	13	288	0	0	0.0%
175	Barbados	249	0	9	233	7	0	2.8%
176	Seychelles	160	2	3	157	0	0	0.0%
177	Brunei	148	0	0	145	3	0	2.0%
178	Saint Lucia	148	0	100	46	2	0	1.4%
179	Antigua and Barbuda	131	0	4	124	3	0	2.3%
180	Saint Vincent and the Grenadines	77	0	3	74	0	0	0.0%
181	Dominica	68	0	27	41	0	0	0.0%
182	Fiji	35	0	1	32	2	0	5.7%
183	Grenada	32	0	5	27	0	0	0.0%
184	Timor-Leste	30	0	1	29	0	0	0.0%
185	Holy See	27	0	12	15	0	0	0.0%
186	Laos	24	0	1	23	0	0	0.0%
187	Saint Kitts and Nevis	19	0	0	19	0	0	0.0%
188	Solomon Islands	16	0	11	5	0	0	0.0%
189	Western Sahara	10	0	1	8	1	0	10.0%
190	MS Zaandam	9	0	7	0	2	0	22.2%
191	Marshall Islands	1	0	1	0	0	0	0.0%
192	Vanuatu	1	0	1	0	0	0	0.0%

Appendix B. How to Cite This Work

Citation

Yanchang Zhao, COVID-19 Data Analysis with R – Worldwide. RDataMining.com, 2020. URL: http://www.rdatamining.com/docs/Coronavirus-data-analysis-world.pdf.

BibTex

@techreport{Zhao2020Covid19world,

Author = {Yanchang Zhao},
Institution = {RDataMining.com},
Title = {COVID-19 Data Analysis with R – Worldwide},
Url = {http://www.rdatamining.com/docs/Coronavirus-data-analysis-world.pdf},
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Comments and suggestions and welcome. Thanks!