COVID-19 Data Analysis with R - Worldwide

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27 March 2020

Contents

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.

```r
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.

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

dim(raw.data.confirmed)
```

```
## [1] 248  69
```

Each dataset has 248 rows, corresponding to country/region/province/state. It has 69 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.

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

```
raw.data.confirmed[1:10, 1:10] %>%
  kable('latex', booktabs=T, caption='Raw Data (Confirmed, First 10 Columns only)') %>%
  kable_styling(font_size=6, 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	33.0000	65.0000	0	0	0	0	0	0
	Albania	41.1533	20.1683	0	0	0	0	0	0
	Algeria	28.0339	1.6596	0	0	0	0	0	0
	Andorra	42.5063	1.5218	0	0	0	0	0	0
	Angola	-11.2027	17.8739	0	0	0	0	0	0
	Antigua and Barbuda	17.0608	-61.7964	0	0	0	0	0	0
	Argentina	-38.4161	-63.6167	0	0	0	0	0	0
	Armenia	40.0691	45.0382	0	0	0	0	0	0
Australian Capital Territory	Australia	-35.4735	149.0124	0	0	0	0	0	0
New South Wales	Australia	-33.8688	151.2093	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] %>% substr(2,8) %>% mdy()
range(dates)
```

```
## [1] "2020-01-22" "2020-03-26"
```

```
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')
```

It shows that the data was last updated on 26 Mar 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 %>% substr(2,8) %>% 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)
```

```r
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')

## first 10 records when it first broke out in China
data %>% filter(country=='China') %>% head(10) %>%
  kable('latex', 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
China	2020-01-22	548	17	28
China	2020-01-23	643	18	30
China	2020-01-24	920	26	36
China	2020-01-25	1,406	42	39
China	2020-01-26	2,075	56	49
China	2020-01-27	2,877	82	58
China	2020-01-28	5,509	131	101
China	2020-01-29	6,087	133	120
China	2020-01-30	8,141	171	135
China	2020-01-31	9,802	213	214

There are 175 countries with confirmed COVID-19 cases, as of 26 Mar 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.

```r
## 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))

data %<>% rbind(data.world)

## current confirmed cases
data %<>% mutate(current.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 current 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, current.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',
                                       current.confirmed='Current 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$confirmed), stroke=F,
                        color='red', fillOpacity=0.3,
                        popup=x$txt)

# world
m
```

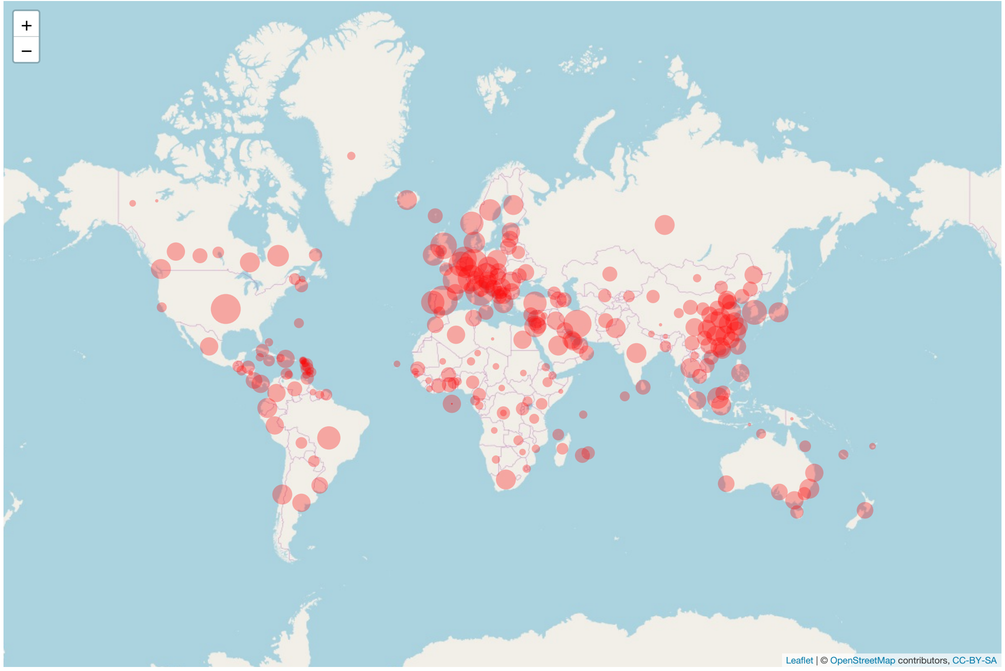


Figure 1: World Map

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=8),
        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=8),
        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')

grid.arrange(plot1, plot2, ncol=2)
```

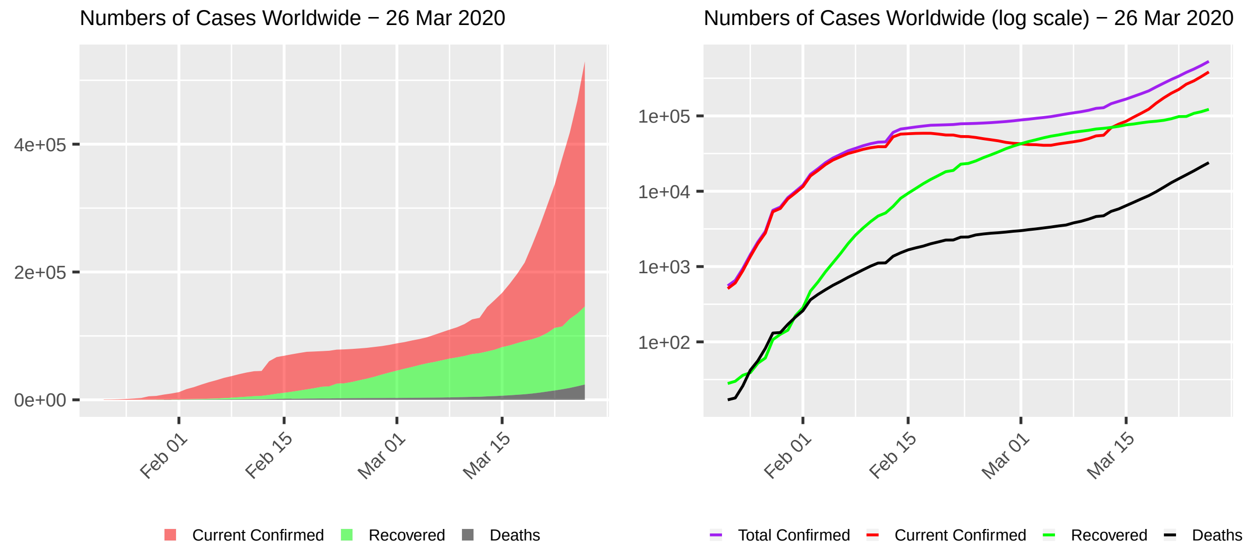


Figure 2: COVID-19 Cases Worldwide

4.3 Current Confirmed Cases

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

```
## current confirmed and daily new confirmed
plot1 <- ggplot(data.world, aes(x=date, y=current.confirmed)) +
  geom_point() + geom_smooth() +
  xlab('') + ylab('Count') + labs(title='Current 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)
```

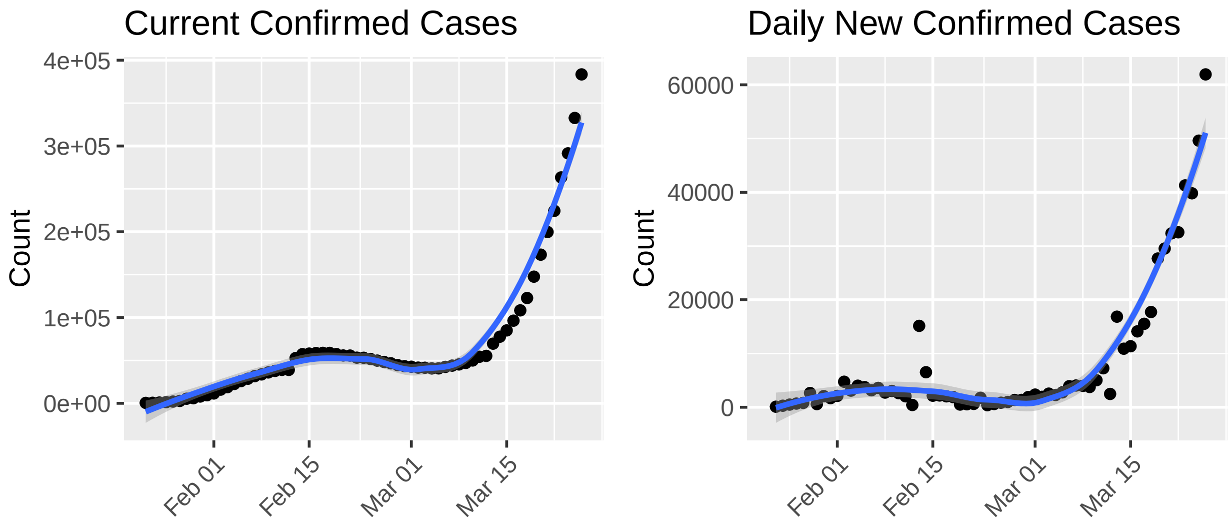


Figure 3: Current Confirmed Cases

Figure 3 shows the numbers of current (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)
```

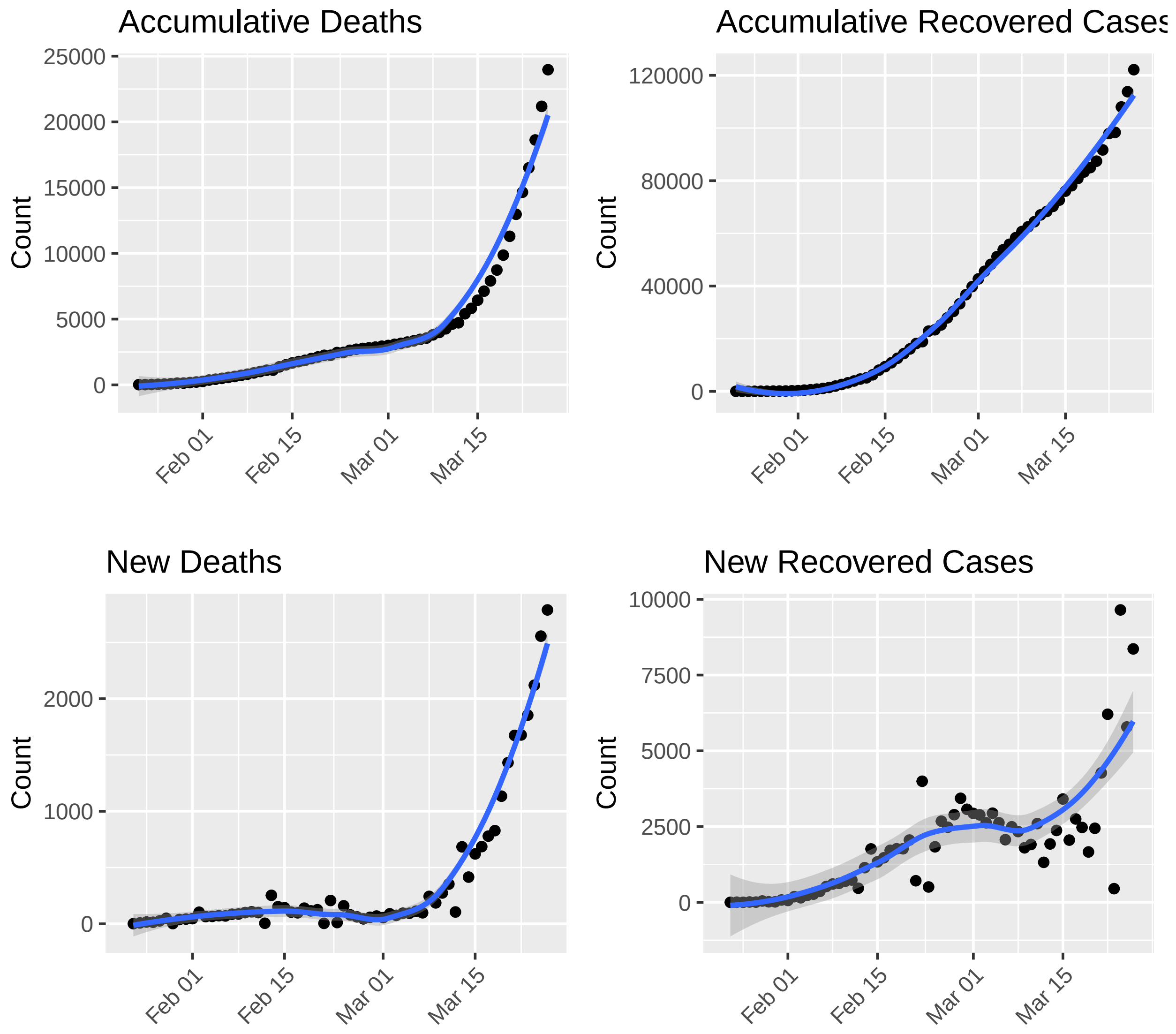


Figure 4: Deaths and Recovered Cases

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 26 Mar 2020 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 current 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 26 Mar 2020 UTC, it will be between 4.5% and 16.4%.

A surge in the daily death rate (in red) 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 recent outbreak of coronavirus in Italy, Iran and some other European countries.

```
## 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))
## 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, y.max))
grid.arrange(plot1, plot2, ncol=2)
```

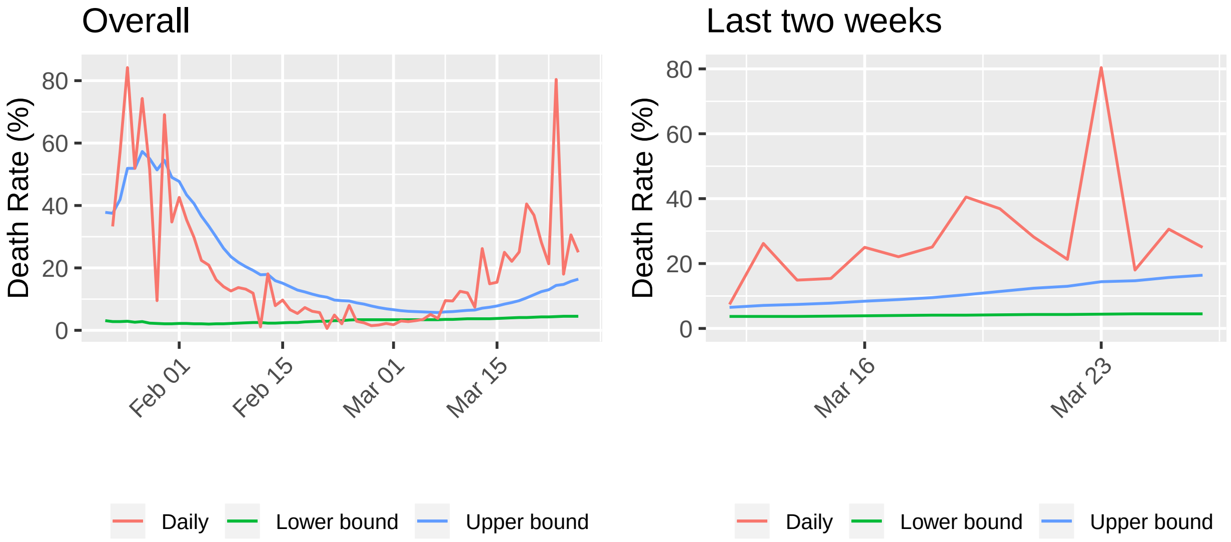


Figure 5: Death Rate

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, current.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"             "China"          "Italy"          "Spain"
##  [5] "Germany"        "France"         "Iran"           "United Kingdom"
##  [9] "Switzerland"    "Korea, South"   "Netherlands"    "Austria"
## [13] "Belgium"        "Canada"         "Turkey"         "Portugal"
## [17] "Norway"         "Brazil"         "Sweden"         "Australia"
```

```
## 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)))
data.latest %<>% group_by(country) %>%
  summarise(confirmed=sum(confirmed), new.confirmed=sum(new.confirmed),
            current.confirmed=sum(current.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, current.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)',
                                               current.confirmed='Current 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 - 26 Mar 2020. See a complete list of all infected countries at the end of this report.

	country	confirmed	deaths	death.rate	new.confirmed	new.deaths	current.confirmed
1	World	529,591	23,970	4.5%	61,938	2,789	383,471
2	US	83,836	1,209	1.4%	18,058	267	81,946
3	China	81,782	3,291	4.0%	121	6	4,310
4	Italy	80,589	8,215	10.2%	6,203	712	62,013
5	Spain	57,786	4,365	7.6%	8,271	718	46,406
6	Germany	43,938	267	0.6%	6,615	61	37,998
7	France	29,551	1,698	5.7%	3,951	365	22,898
8	Iran	29,406	2,234	7.6%	2,389	157	16,715
9	United Kingdom	11,812	580	4.9%	2,172	114	11,082
10	Switzerland	11,811	191	1.6%	914	38	11,489
11	Korea, South	9,241	131	1.4%	104	5	4,966
12	Netherlands	7,468	435	5.8%	1,030	78	7,027
13	Austria	6,909	49	0.7%	1,321	19	6,748
14	Belgium	6,235	220	3.5%	1,298	42	5,340
15	Canada	4,042	38	0.9%	791	8	3,820
16	Turkey	3,629	75	2.1%	1,196	16	3,528
17	Portugal	3,544	60	1.7%	549	17	3,441
18	Norway	3,369	14	0.4%	285	0	3,349
19	Brazil	2,985	77	2.6%	431	18	2,902
20	Sweden	2,840	77	2.7%	314	15	2,747
21	Australia	2,810	13	0.5%	446	5	2,625
22	Others	46,008	731	1.6%	5,479	131	42,121

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

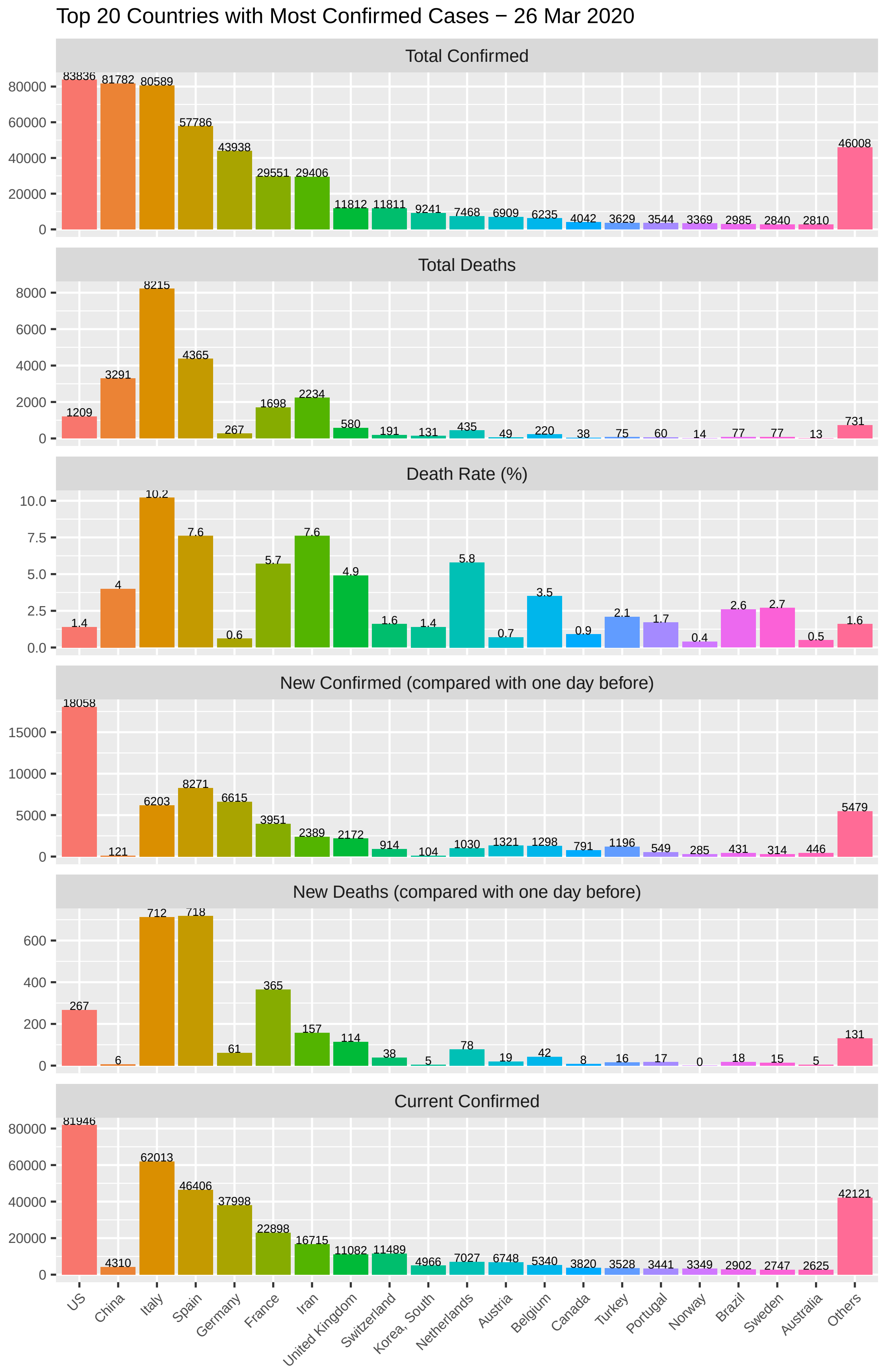
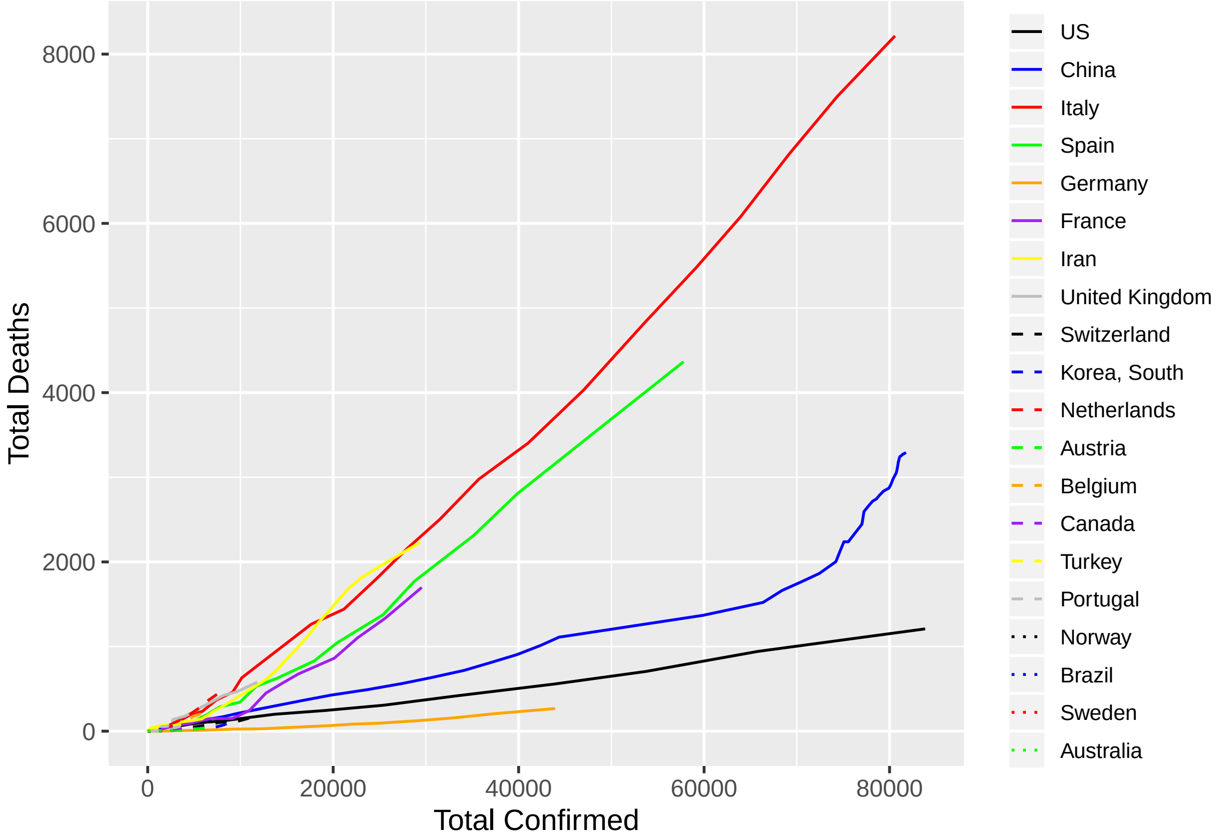


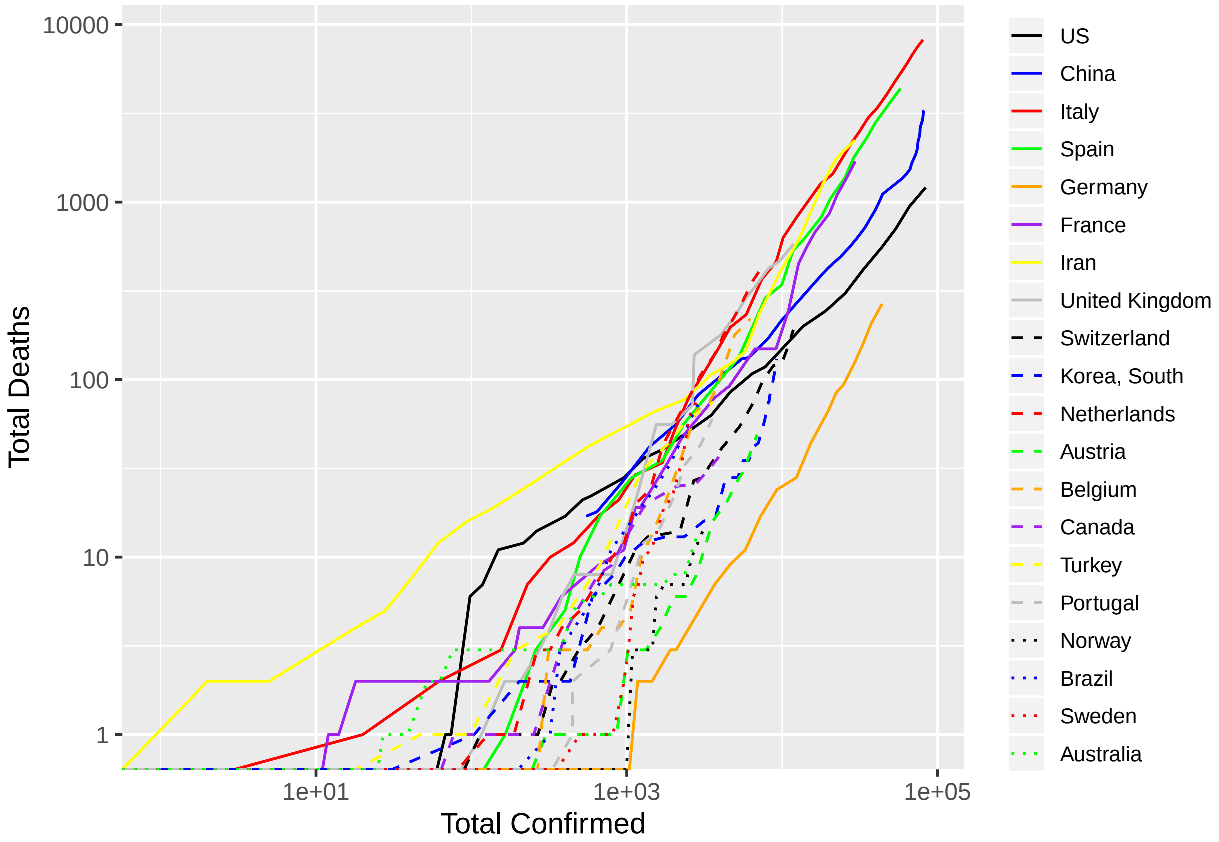
Figure 6: Top 20 Countries with Most Confirmed Cases

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', 'Others'))) %>%
  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
```



```
p + scale_x_log10() + scale_y_log10()
```



The two figures below show the numbers of confirmed cases and deaths of top 20 countries, as well as the death rates up to 26 Mar 2020.

```
df <- data.latest %>% filter(country %in% setdiff(top.countries, 'World'))

plot1 <- df %>% ggplot(aes(x=confirmed, y=deaths, col=death.rate, size=current.confirmed)) +
  scale_size(name='Current Confirmed', trans='log2', breaks=c(1e3, 2e3, 5e3, 1e4, 2e4, 4e4)) +
  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()

plot2 <- df %>% ggplot(aes(x=new.confirmed, y=new.deaths, col=death.rate, size=current.confirmed)) +
  scale_size(name='Current Confirmed', trans='log2', breaks=c(1e3, 2e3, 5e3, 1e4, 2e4, 4e4)) +
  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()

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

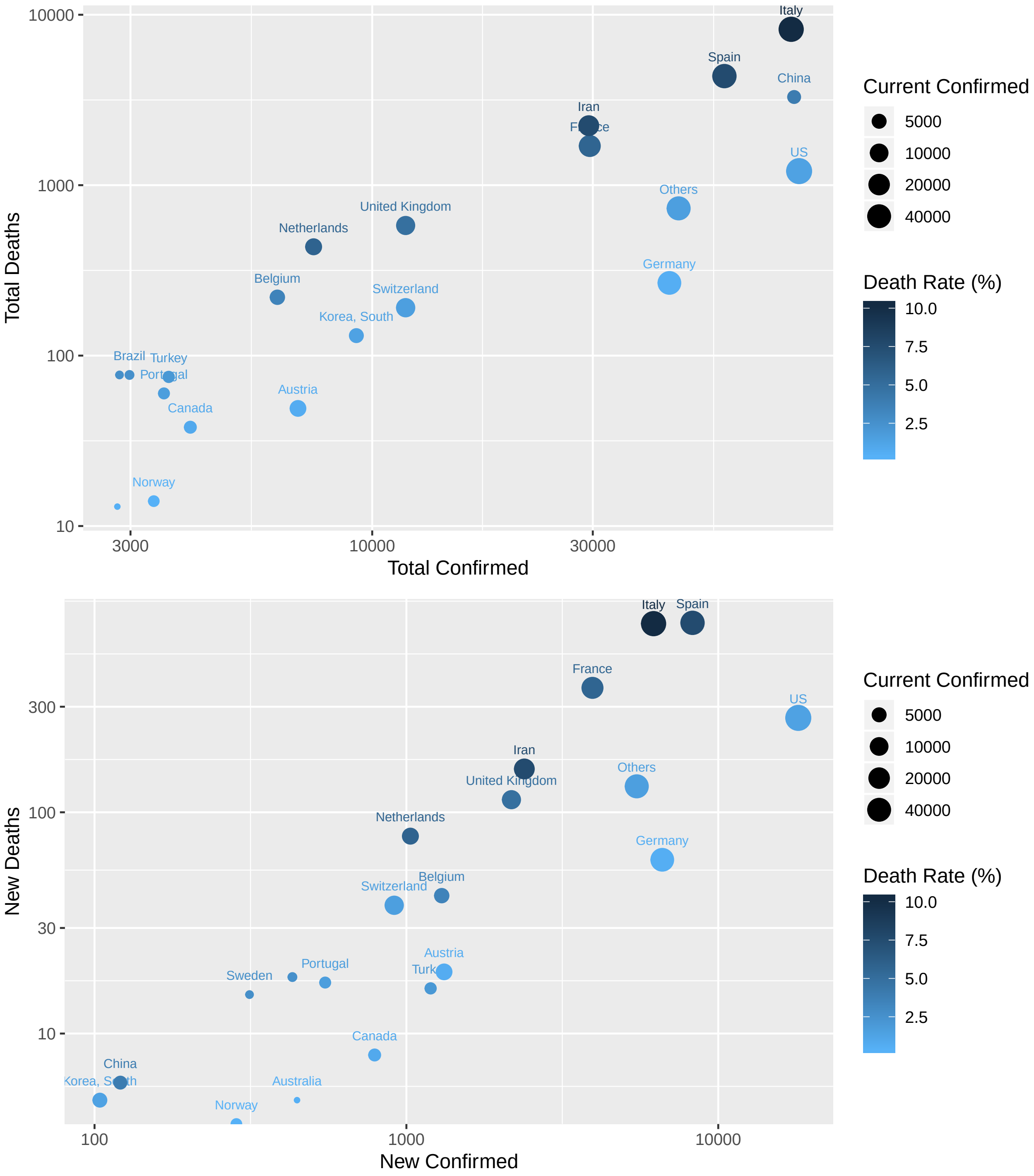


Figure 7: Top 20 Countries

5.2 Comparison across Countries

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

```r
## 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)
```

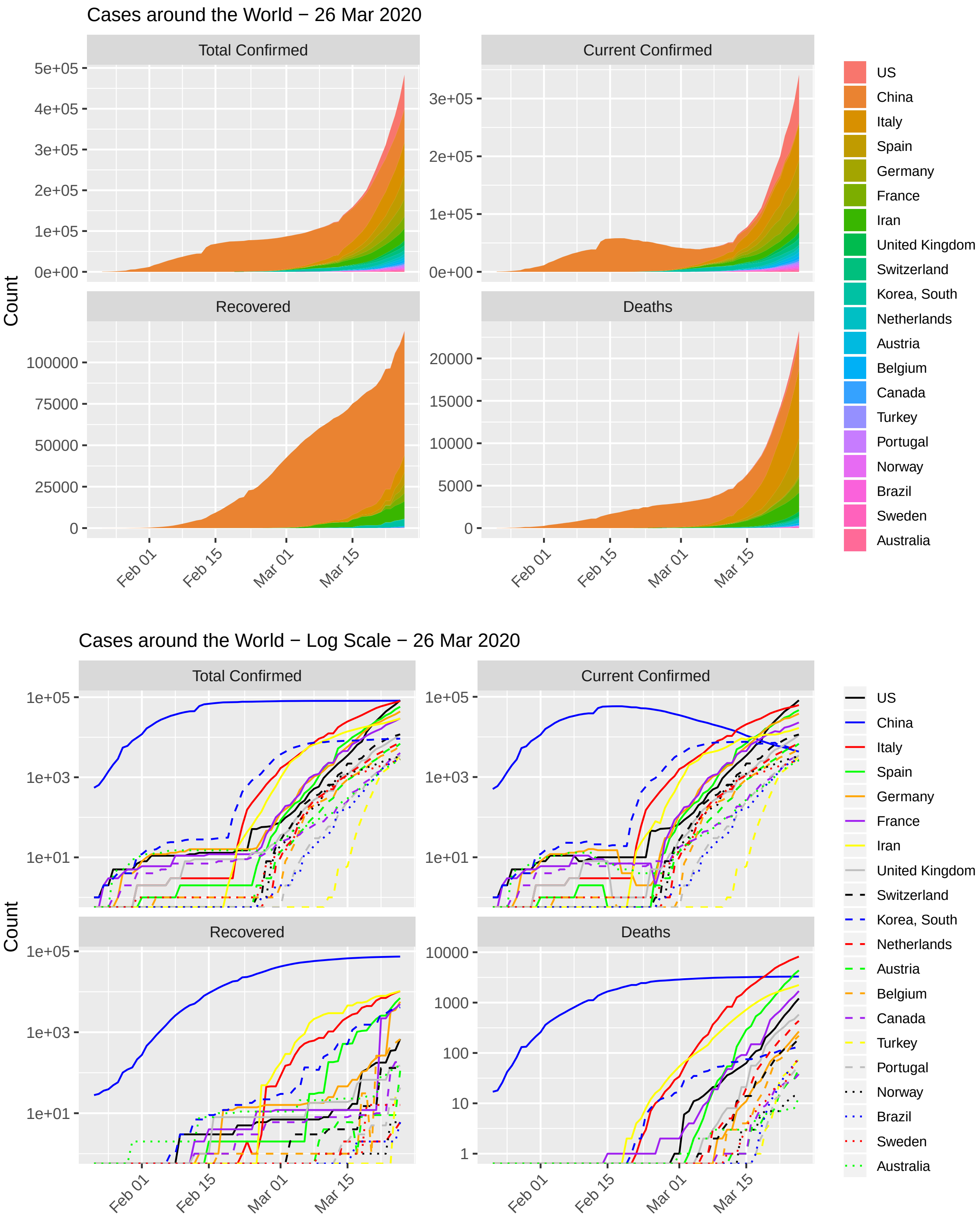


Figure 8: Cases around the World

```
## 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))
```

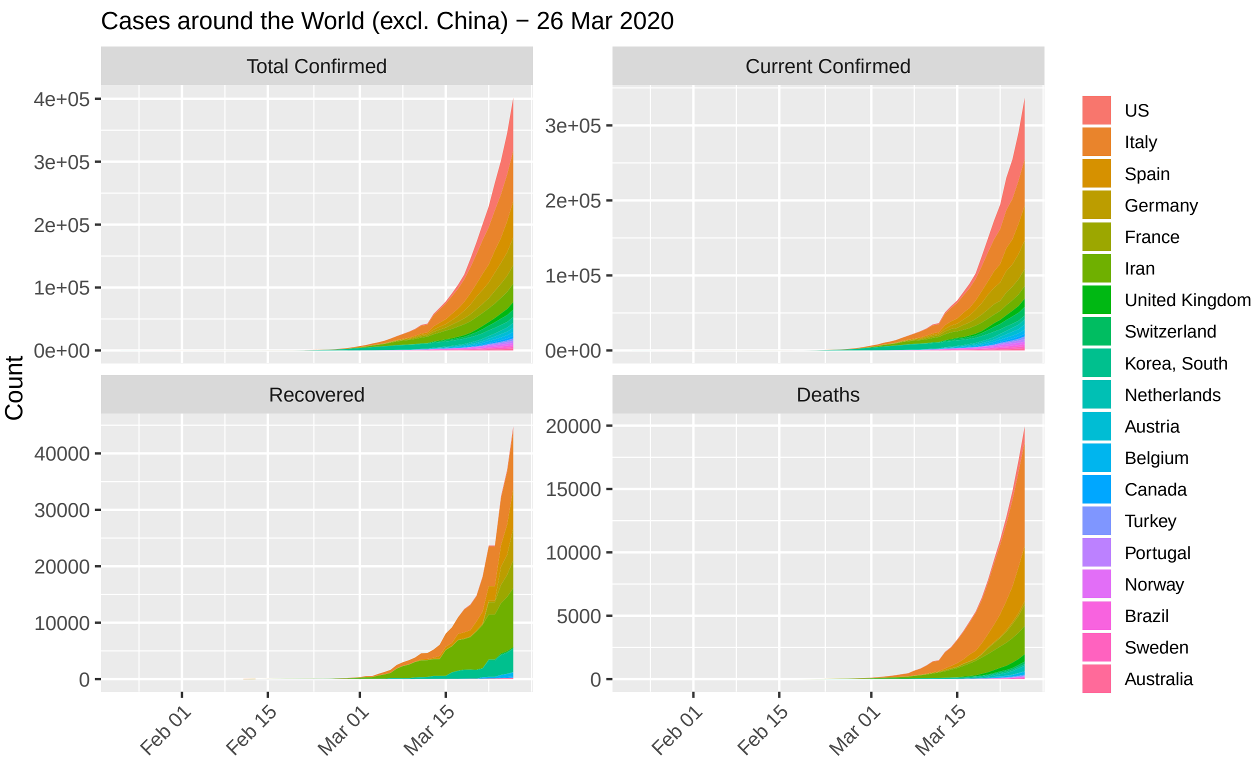


Figure 9: Cases around the World (excl. China)

```
## if Australia in not in top 20, add it in and remove 'Others'
if(!('Australia' %in% top.countries)) {
  top.countries %<>% setdiff('Others') %>% 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')
```

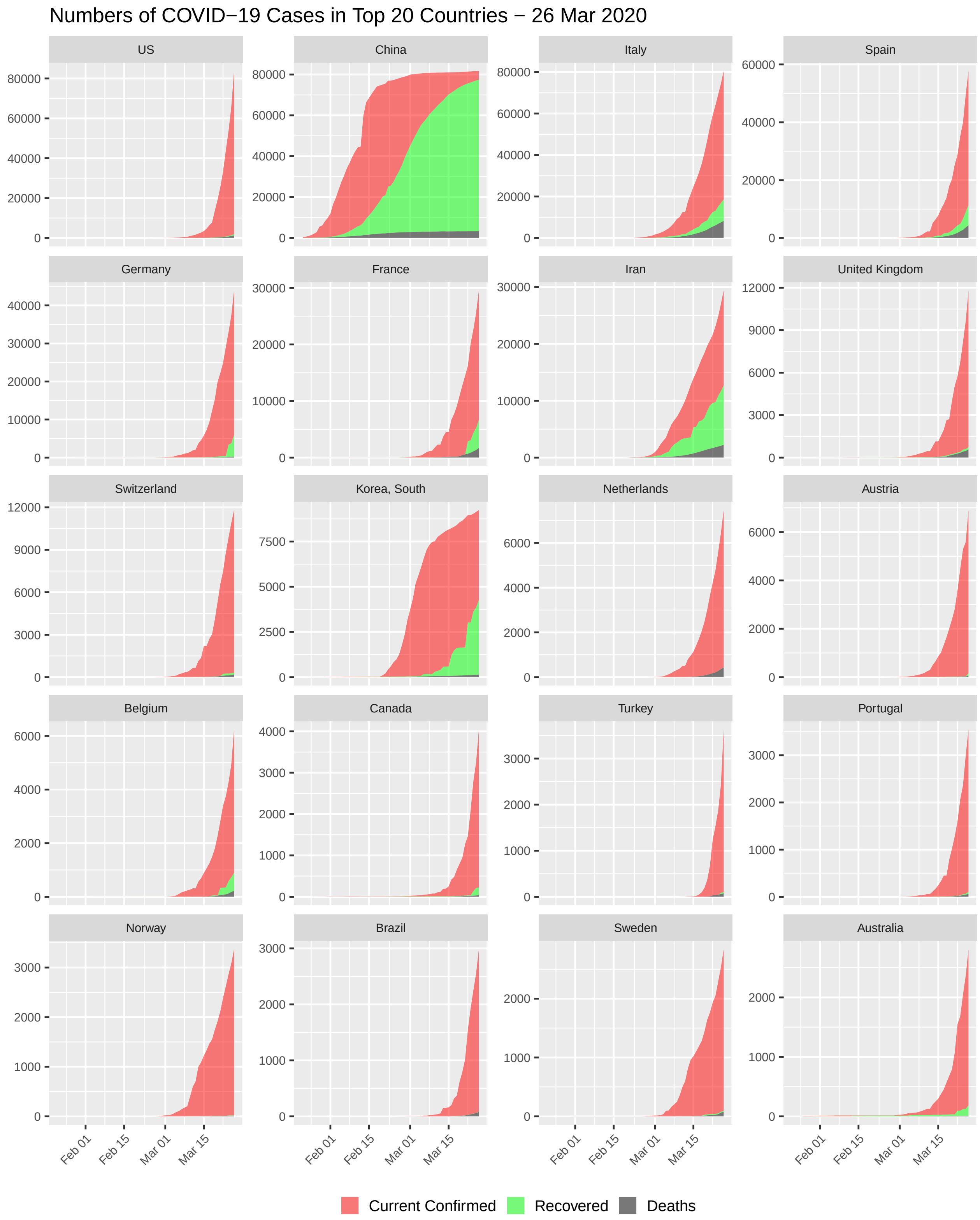


Figure 10: COVID-19 Cases in Top 20 Countries. Ordered descendingly by number of confirmed cases.

```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')
```

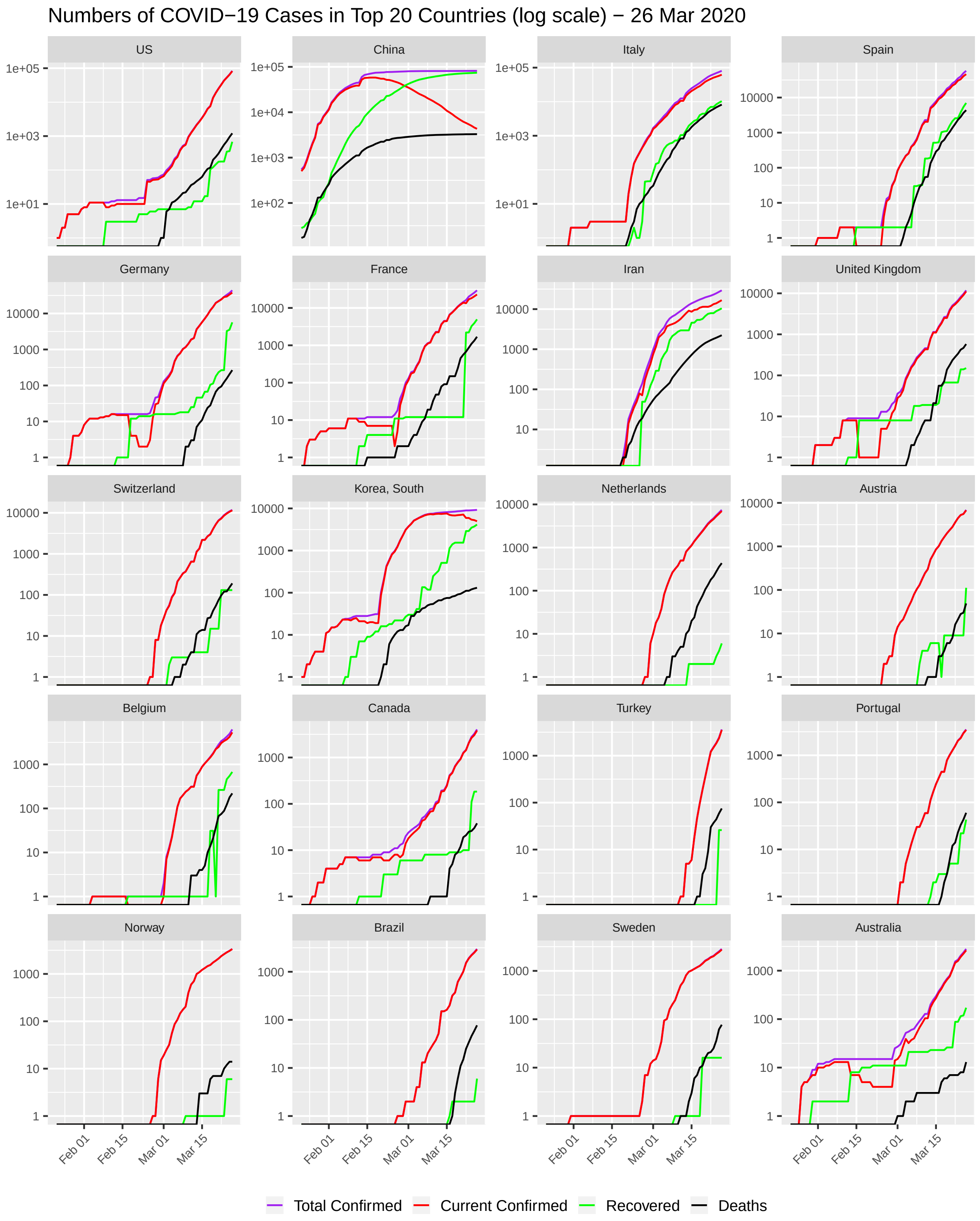


Figure 11: COVID-19 Cases Top 20 Countries (log scale). Ordered descendingly by number of confirmed cases.

```
## 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 the coronavirus seems to be under control in China, with an increase of recovered cases (in green) every day and a shrinking of the current confrimed cases (in red). However, in the rest of the world (i.e., outside of China), the confirmed cases are surging up in many other countries, which suggests that the virus has broken out 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, 100)) +
  facet_wrap(~country, ncol=4)
```

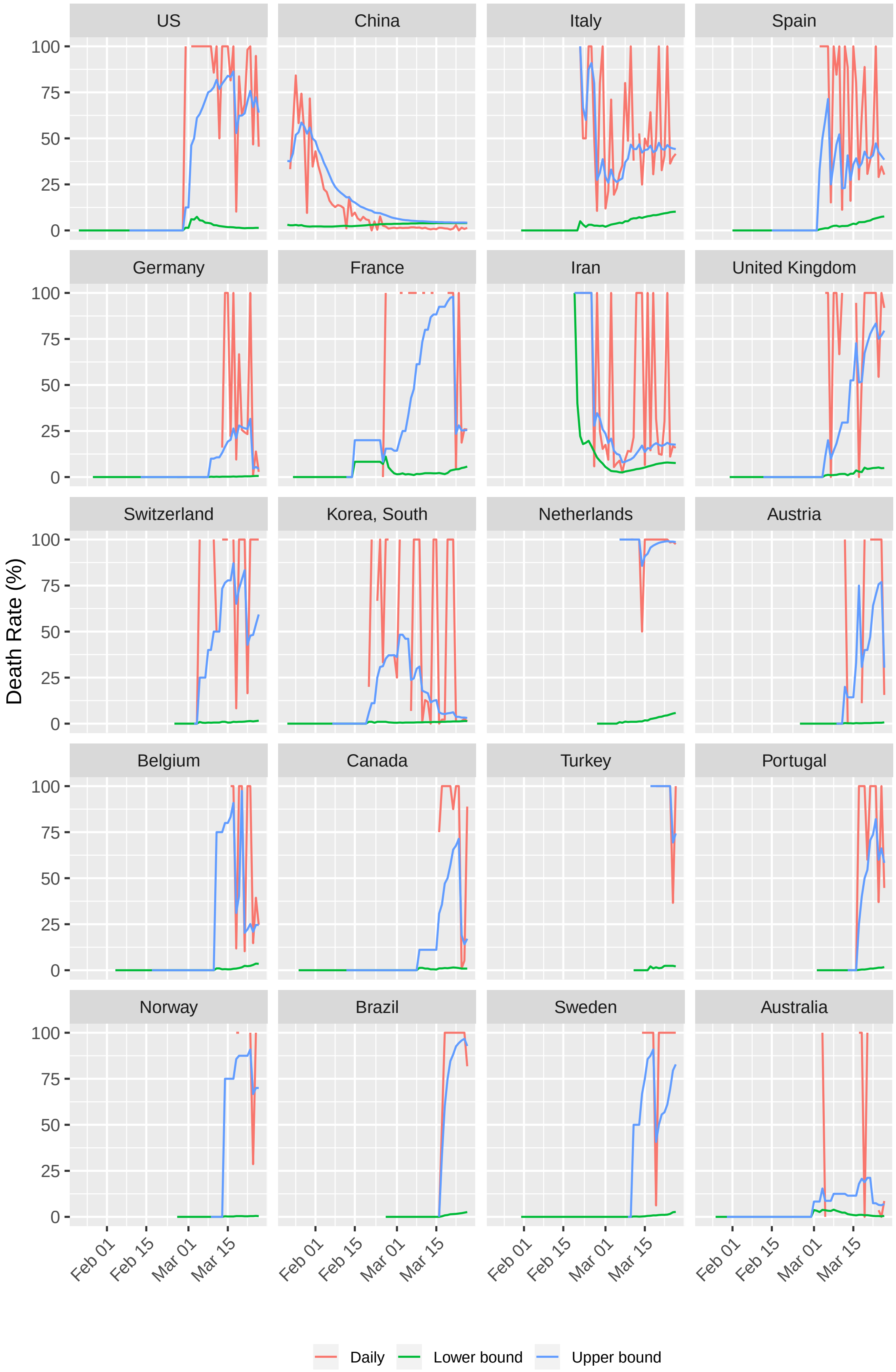


Figure 12: Death Rates

5.4 Countries with Highest Death Rates

Below are a list of top 20 countries of high death rates and with 100+ confirmed cases each.

```
## sort the latest data by death rate, and if tie, by confirmed
df <- data %>% filter(date == max(date) & country != 'World' & confirmed >= 100) %>%
  select(country, confirmed, new.confirmed, current.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 - 26 Mar 2020

	country	confirmed	new.confirmed	current.confirmed	recovered	deaths	new.deaths	death.rate
1	Italy	80,589	6,203	62,013	10,361	8,215	712	10.2%
2	San Marino	208	0	183	4	21	0	10.1%
3	Iraq	382	36	241	105	36	7	9.4%
4	Indonesia	893	103	780	35	78	20	8.7%
5	Iran	29,406	2,389	16,715	10,457	2,234	157	7.6%
6	Spain	57,786	8,271	46,406	7,015	4,365	718	7.6%
7	Algeria	367	65	313	29	25	4	6.8%
8	Philippines	707	71	634	28	45	7	6.4%
9	Netherlands	7,468	1,030	7,027	6	435	78	5.8%
10	France	29,551	3,951	22,898	4,955	1,698	365	5.7%
11	United Kingdom	11,812	2,172	11,082	150	580	114	4.9%
12	Egypt	495	39	369	102	24	3	4.8%
13	Burkina Faso	152	6	135	10	7	3	4.6%
14	China	81,782	121	4,310	74,181	3,291	6	4.0%
15	Morocco	275	50	256	8	11	5	4.0%
16	Hungary	261	35	223	28	10	0	3.8%
17	Belgium	6,235	1,298	5,340	675	220	42	3.5%
18	Albania	174	28	151	17	6	1	3.4%
19	Japan	1,387	80	981	359	47	2	3.4%
20	Ghana	132	39	127	1	4	0	3.0%

6 Conclusions

As of 26 Mar 2020, there are 175 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 4.5% and 16.4%, 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)) %>%
  select(c(date, confirmed, deaths, recovered, current.confirmed,
          new.confirmed, new.deaths, new.recovered, rate.lower, rate.upper, rate.daily))
## output as a table
data.world %>% kable('latex', booktabs=T, longtable=T, caption='Cases in the Whole World',
               format.args=list(big.mark=',')) %>%
    kable_styling(font_size=4, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

Table 5: Cases in the Whole World

date	confirmed	deaths	recovered	current.confirmed	new.confirmed	new.deaths	new.recovered	rate.lower	rate.upper	rate.daily
2020-03-26	529,591	23,970	122,150	383,471	61,938	2,789	8,363	4.5	16.4	25.0
2020-03-25	467,653	21,181	113,787	332,685	49,608	2,556	5,787	4.5	15.7	30.6
2020-03-24	418,045	18,625	108,000	291,420	39,810	2,120	9,649	4.5	14.7	18.0
2020-03-23	378,235	16,505	98,351	263,379	41,282	1,854	452	4.4	14.4	80.4
2020-03-22	336,953	14,651	97,899	224,403	32,557	1,678	6,207	4.3	13.0	21.3
2020-03-21	304,396	12,973	91,692	199,731	32,361	1,674	4,272	4.3	12.4	28.2
2020-03-20	272,035	11,299	87,420	173,316	29,535	1,432	2,445	4.2	11.4	36.9
2020-03-19	242,500	9,867	84,975	147,658	27,679	1,134	1,663	4.1	10.4	40.5
2020-03-18	214,821	8,733	83,312	122,776	17,719	828	2,472	4.1	9.5	25.1
2020-03-17	197,102	7,905	80,840	108,357	15,528	779	2,752	4.0	8.9	22.1
2020-03-16	181,574	7,126	78,088	96,360	14,120	686	2,054	3.9	8.4	25.0
2020-03-15	167,454	6,440	76,034	84,980	11,353	621	3,410	3.8	7.8	15.4
2020-03-14	156,101	5,819	72,624	77,658	10,896	415	2,373	3.7	7.4	14.9
2020-03-13	145,205	5,404	70,251	69,550	16,853	684	1,927	3.7	7.1	26.2
2020-03-12	128,352	4,720	68,324	55,308	2,477	105	1,321	3.7	6.5	7.4
2020-03-11	125,875	4,615	67,003	54,257	7,255	353	2,599	3.7	6.4	12.0
2020-03-10	118,620	4,262	64,404	49,954	5,030	274	1,910	3.6	6.2	12.5
2020-03-09	113,590	3,988	62,494	47,108	3,769	186	1,800	3.5	6.0	9.4
2020-03-08	109,821	3,802	60,694	45,325	3,974	244	2,336	3.5	5.9	9.5
2020-03-07	105,847	3,558	58,358	43,931	4,046	98	2,493	3.4	5.7	3.8
2020-03-06	101,801	3,460	55,865	42,476	3,915	112	2,069	3.4	5.8	5.1
2020-03-05	97,886	3,348	53,796	40,742	2,766	94	2,626	3.4	5.9	3.5
2020-03-04	95,120	3,254	51,170	40,696	2,280	94	2,942	3.4	6.0	3.1
2020-03-03	92,840	3,160	48,228	41,452	2,534	75	2,626	3.4	6.1	2.8
2020-03-02	90,306	3,085	45,602	41,619	1,937	89	2,886	3.4	6.3	3.0
2020-03-01	88,369	2,996	42,716	42,657	2,358	55	2,934	3.4	6.6	1.8
2020-02-29	86,011	2,941	39,782	43,288	1,899	69	3,071	3.4	6.9	2.2
2020-02-28	84,112	2,872	36,711	44,529	1,366	58	3,434	3.4	7.3	1.7
2020-02-27	82,746	2,814	33,277	46,655	1,358	44	2,893	3.4	7.8	1.5
2020-02-26	81,388	2,770	30,384	48,234	982	62	2,479	3.4	8.4	2.4
2020-02-25	80,406	2,708	27,905	49,793	845	79	2,678	3.4	8.8	2.9
2020-02-24	79,561	2,629	25,227	51,705	603	160	1,833	3.3	9.4	8.0
2020-02-23	78,958	2,469	23,394	53,095	386	11	508	3.1	9.5	2.1
2020-02-22	78,572	2,458	22,886	53,228	1,753	207	3,996	3.1	9.7	4.9
2020-02-21	76,819	2,251	18,890	55,678	622	4	713	2.9	10.6	0.6
2020-02-20	76,197	2,247	18,177	55,773	558	125	2,056	2.9	11.0	5.7
2020-02-19	75,639	2,122	16,121	57,396	503	115	1,769	2.8	11.6	6.1
2020-02-18	75,136	2,007	14,352	58,777	1,878	139	1,769	2.7	12.3	7.3
2020-02-17	73,258	1,868	12,583	58,807	2,034	98	1,718	2.5	12.9	5.4
2020-02-16	71,224	1,770	10,865	58,589	2,194	104	1,470	2.5	14.0	6.6
2020-02-15	69,030	1,666	9,395	57,969	2,145	143	1,337	2.4	15.1	9.7
2020-02-14	66,885	1,523	8,058	57,304	6,517	152	1,763	2.3	15.9	7.9
2020-02-13	60,368	1,371	6,295	52,702	15,147	253	1,145	2.3	17.9	18.1
2020-02-12	45,221	1,118	5,150	38,953	419	5	467	2.5	17.8	1.1
2020-02-11	44,802	1,113	4,683	39,006	2,040	100	737	2.5	19.2	11.9
2020-02-10	42,762	1,013	3,946	37,803	2,612	107	702	2.4	20.4	13.2
2020-02-09	40,150	906	3,244	36,000	3,030	100	628	2.3	21.8	13.7
2020-02-08	37,120	806	2,616	33,698	2,729	87	605	2.2	23.6	12.6
2020-02-07	34,391	719	2,011	31,661	3,597	85	524	2.1	26.3	14.0
2020-02-06	30,794	634	1,487	28,673	3,159	70	363	2.1	29.9	16.2
2020-02-05	27,635	564	1,124	25,947	3,743	72	272	2.0	33.4	20.9
2020-02-04	23,892	492	852	22,548	4,011	66	229	2.1	36.6	22.4
2020-02-03	19,881	426	623	18,832	3,094	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	1,693	42	79	2.1	49.0	34.7
2020-01-30	8,234	171	143	7,920	2,068	38	17	2.1	54.5	69.1
2020-01-29	6,166	133	126	5,907	588	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	

Appendix A.2 Latest Cases by Country

```
## hightlight high death rates (if >= 5%) for those countries with 100+ confirmed cases
data.latest.all %>% arrange(desc(confirmed)) %>% select(-c(date, ranking)) %>%
  mutate(death.rate = cell_spec(death.rate, "latex",
                                 color = ifelse(confirmed >= 100 & death.rate >= 5, "red", "black"),
                                 bold = ifelse(confirmed >= 100 & death.rate >= 5, T, 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=',')) %>%
  kable_styling(font_size=6, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

Table 6: Cases by Country (26 Mar 2020)

	country	confirmed	new.confirmed	current.confirmed	recovered	deaths	new.deaths	death.rate
1	World	529,591	61,938	383,471	122,150	23,970	2,789	4.5
2	US	83,836	18,058	81,946	681	1,209	267	1.4
3	China	81,782	121	4,310	74,181	3,291	6	4
4	Italy	80,589	6,203	62,013	10,361	8,215	712	**10.2**
5	Spain	57,786	8,271	46,406	7,015	4,365	718	**7.6**
6	Germany	43,938	6,615	37,998	5,673	267	61	0.6
7	France	29,551	3,951	22,898	4,955	1,698	365	**5.7**
8	Iran	29,406	2,389	16,715	10,457	2,234	157	**7.6**
9	United Kingdom	11,812	2,172	11,082	150	580	114	4.9
10	Switzerland	11,811	914	11,489	131	191	38	1.6
11	Korea, South	9,241	104	4,966	4,144	131	5	1.4
12	Netherlands	7,468	1,030	7,027	6	435	78	**5.8**
13	Austria	6,909	1,321	6,748	112	49	19	0.7
14	Belgium	6,235	1,298	5,340	675	220	42	3.5
15	Canada	4,042	791	3,820	184	38	8	0.9
16	Turkey	3,629	1,196	3,528	26	75	16	2.1
17	Portugal	3,544	549	3,441	43	60	17	1.7
18	Norway	3,369	285	3,349	6	14	0	0.4
19	Brazil	2,985	431	2,902	6	77	18	2.6
20	Sweden	2,840	314	2,747	16	77	15	2.7
21	Australia	2,810	446	2,625	172	13	5	0.5
22	Israel	2,693	324	2,617	68	8	3	0.3
23	Malaysia	2,031	235	1,793	215	23	3	1.1
24	Denmark	2,023	161	1,932	50	41	7	2
25	Czechia	1,925	271	1,906	10	9	3	0.5
26	Ireland	1,819	255	1,795	5	19	10	1
27	Luxembourg	1,453	120	1,438	6	9	1	0.6
28	Ecuador	1,403	230	1,366	3	34	6	2.4
29	Japan	1,387	80	981	359	47	2	3.4
30	Chile	1,306	164	1,280	22	4	1	0.3
31	Poland	1,221	170	1,198	7	16	2	1.3
32	Pakistan	1,201	138	1,171	21	9	1	0.7
33	Thailand	1,045	111	953	88	4	0	0.4
34	Romania	1,029	123	912	94	23	6	2.2
35	Saudi Arabia	1,012	112	976	33	3	1	0.3
36	Finland	958	78	943	10	5	2	0.5
37	South Africa	927	218	915	12	0	0	0
38	Indonesia	893	103	780	35	78	20	**8.7**
39	Greece	892	71	830	36	26	4	2.9
40	Russia	840	182	799	38	3	0	0.4
41	Iceland	802	65	718	82	2	0	0.2
42	India	727	70	662	45	20	8	2.8
43	Diamond Princess	712	0	105	597	10	0	1.4
44	Philippines	707	71	634	28	45	7	**6.4**
45	Singapore	683	52	509	172	2	0	0.3
46	Peru	580	100	557	14	9	0	1.6
47	Slovenia	562	34	546	10	6	1	1.1
48	Panama	558	115	548	2	8	0	1.4
49	Qatar	549	12	506	43	0	0	0
50	Estonia	538	134	529	8	1	0	0.2
51	Argentina	502	115	430	63	9	1	1.8
52	Croatia	495	53	470	22	3	2	0.6
53	Egypt	495	39	369	102	24	3	4.8
54	Colombia	491	21	477	8	6	2	1.2
55	Dominican Republic	488	96	475	3	10	0	2
56	Mexico	475	70	465	4	6	1	1.3
57	Bahrain	458	39	250	204	4	0	0.9
58	Serbia	384	0	383	0	1	0	0.3
59	Iraq	382	36	241	105	36	7	**9.4**
60	Lebanon	368	35	339	23	6	0	1.6

Table 6: Cases by Country (26 Mar 2020) *(continued)*

	country	confirmed	new.confirmed	current.confirmed	recovered	deaths	new.deaths	death.rate
61	Algeria	367	65	313	29	25	4	**6.8**
62	United Arab Emirates	333	0	279	52	2	0	0.6
63	Lithuania	299	25	294	1	4	0	1.3
64	Armenia	290	25	271	18	1	1	0.3
65	New Zealand	283	78	256	27	0	0	0
66	Morocco	275	50	256	8	11	5	4
67	Bulgaria	264	22	253	8	3	0	1.1
68	Hungary	261	35	223	28	10	0	3.8
69	Taiwan*	252	17	221	29	2	0	0.8
70	Latvia	244	23	243	1	0	0	0
71	Costa Rica	231	30	227	2	2	0	0.9
72	Slovakia	226	10	224	2	0	0	0
73	Andorra	224	36	220	1	3	2	1.3
74	Uruguay	217	28	217	0	0	0	0
75	Jordan	212	40	211	1	0	0	0
76	Kuwait	208	13	159	49	0	0	0
77	San Marino	208	0	183	4	21	0	**10.1**
78	North Macedonia	201	24	195	3	3	0	1.5
79	Tunisia	197	24	189	2	6	1	3
80	Ukraine	196	51	190	1	5	0	2.6
81	Bosnia and Herzegovina	191	15	186	2	3	0	1.6
82	Moldova	177	28	174	2	1	0	0.6
83	Albania	174	28	151	17	6	1	3.4
84	Vietnam	153	12	133	20	0	0	0
85	Burkina Faso	152	6	135	10	7	3	4.6
86	Cyprus	146	14	139	4	3	0	2.1
87	Malta	134	5	132	2	0	0	0
88	Ghana	132	39	127	1	4	0	3
89	Azerbaijan	122	29	104	15	3	1	2.5
90	Brunei	114	5	109	5	0	0	0
91	Kazakhstan	111	30	108	2	1	1	0.9
92	Oman	109	10	86	23	0	0	0
93	Venezuela	107	16	92	15	0	0	0
94	Sri Lanka	106	4	99	7	0	0	0
95	Senegal	105	6	96	9	0	0	0
96	Cambodia	96	0	86	10	0	0	0
97	Cote d'Ivoire	96	16	93	3	0	0	0
98	Afghanistan	94	10	88	2	4	2	4.3
99	Belarus	86	0	57	29	0	0	0
100	West Bank and Gaza	84	25	66	17	1	1	1.2
101	Mauritius	81	33	79	0	2	0	2.5
102	Georgia	79	4	68	11	0	0	0
103	Cameroon	75	0	72	2	1	0	1.3
104	Uzbekistan	75	15	75	0	0	0	0
105	Kosovo	71	71	70	0	1	1	1.4
106	Montenegro	69	17	68	0	1	0	1.4
107	Cuba	67	10	64	1	2	1	3
108	Nigeria	65	14	62	2	1	0	1.5
109	Trinidad and Tobago	65	5	64	0	1	0	1.5
110	Liechtenstein	56	5	56	0	0	0	0
111	Honduras	52	16	51	0	1	1	1.9
112	Congo (Kinshasa)	51	3	48	0	3	1	5.9
113	Rwanda	50	9	50	0	0	0	0
114	Bangladesh	44	5	28	11	5	0	11.4
115	Kyrgyzstan	44	0	44	0	0	0	0
116	Bolivia	43	11	43	0	0	0	0
117	Paraguay	41	4	38	0	3	0	7.3
118	Monaco	33	2	32	1	0	0	0
119	Kenya	31	3	29	1	1	1	3.2
120	Jamaica	26	0	23	2	1	0	3.8
121	Guatemala	25	1	20	4	1	0	4
122	Madagascar	23	4	23	0	0	0	0
123	Togo	23	0	22	1	0	0	0
124	Barbados	18	0	18	0	0	0	0
125	Zambia	16	4	16	0	0	0	0
126	Uganda	14	0	14	0	0	0	0
127	El Salvador	13	4	13	0	0	0	0
128	Maldives	13	0	5	8	0	0	0

Table 6: Cases by Country (26 Mar 2020) *(continued)*

	country	confirmed	new.confirmed	current.confirmed	recovered	deaths	new.deaths	death.rate
129	Tanzania	13	1	13	0	0	0	0
130	Equatorial Guinea	12	3	12	0	0	0	0
131	Ethiopia	12	0	12	0	0	0	0
132	Djibouti	11	0	11	0	0	0	0
133	Dominica	11	4	11	0	0	0	0
134	Mongolia	11	1	11	0	0	0	0
135	Niger	10	3	9	0	1	0	10
136	Bahamas	9	4	8	1	0	0	0
137	Haiti	8	0	8	0	0	0	0
138	Namibia	8	1	6	2	0	0	0
139	Suriname	8	0	8	0	0	0	0
140	Antigua and Barbuda	7	4	7	0	0	0	0
141	Gabon	7	1	6	0	1	0	14.3
142	Grenada	7	6	7	0	0	0	0
143	Mozambique	7	2	7	0	0	0	0
144	Seychelles	7	0	7	0	0	0	0
145	Benin	6	0	6	0	0	0	0
146	Eritrea	6	2	6	0	0	0	0
147	Eswatini	6	2	6	0	0	0	0
148	Laos	6	3	6	0	0	0	0
149	Fiji	5	0	5	0	0	0	0
150	Guyana	5	0	4	0	1	0	20
151	Syria	5	0	5	0	0	0	0
152	Angola	4	1	4	0	0	0	0
153	Cabo Verde	4	0	3	0	1	0	25
154	Congo (Brazzaville)	4	0	4	0	0	0	0
155	Guinea	4	0	4	0	0	0	0
156	Holy See	4	0	4	0	0	0	0
157	Mali	4	2	4	0	0	0	0
158	Central African Republic	3	0	3	0	0	0	0
159	Chad	3	0	3	0	0	0	0
160	Gambia	3	0	2	0	1	0	33.3
161	Liberia	3	0	3	0	0	0	0
162	Mauritania	3	1	3	0	0	0	0
163	Nepal	3	0	2	1	0	0	0
164	Saint Lucia	3	0	3	0	0	0	0
165	Sudan	3	0	2	0	1	0	33.3
166	Zimbabwe	3	0	2	0	1	0	33.3
167	Belize	2	0	2	0	0	0	0
168	Bhutan	2	0	2	0	0	0	0
169	Guinea-Bissau	2	0	2	0	0	0	0
170	Nicaragua	2	0	2	0	0	0	0
171	Saint Kitts and Nevis	2	0	2	0	0	0	0
172	Somalia	2	1	2	0	0	0	0
173	Libya	1	0	1	0	0	0	0
174	Papua New Guinea	1	0	1	0	0	0	0
175	Saint Vincent and the Grenadines	1	0	1	0	0	0	0
176	Timor-Leste	1	0	1	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},
Year = {2020}}

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Comments and suggestions and welcome. Thanks!