Data Science - COVID-19

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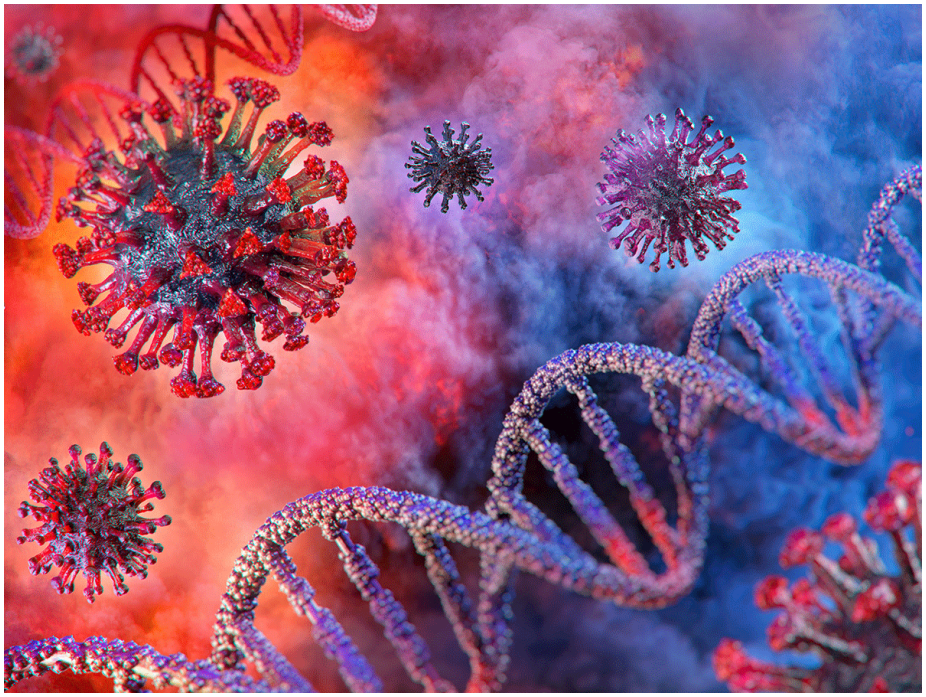


Analysis coronavirus disease (COVID-19).

This is an R Markdown document. It is intented to publicy illustrate how R statistics can help you out to output data science pipeline.

About this data

It changes rapidly

It doesn't include all cases

Confirmed cases aren't all cases. They only include people who tested positive. Testing rules and availability vary by country.

Data Repository: Johns Hopkins University.

```
# This is an analysis report of the Novel Coronavirus (COVID-19)
# Aim for data processing, visualisation and statstics
# Source code: http://yanchang.rdatamining.com/
# set directory
# Data Source: 2019 Data Repository https://github.com/CSSEGISandData/COVID-19
# R Packages:
library(magrittr) # pipline operations
library(lubridate) # date operation
```

```
##
## Attaching package: 'lubridate'
```

```
## The following object is masked from 'package:base':
##
##     date
```

```
library(tidyverse) # data science pips
```

```
## -- Attaching packages ---------------------------------------------------------
```

```
## v ggplot2 3.3.0     v purrr   0.3.3
## v tibble  2.1.3     v dplyr   0.8.5
## v tidyr   1.0.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0
```

```
## -- Conflicts ------------------------------------------------------------------
## x lubridate::as.difftime() masks base::as.difftime()
## x lubridate::date()        masks base::date()
## x tidyr::extract()         masks magrittr::extract()
## x dplyr::filter()          masks stats::filter()
## x lubridate::intersect()   masks base::intersect()
## x dplyr::lag()             masks stats::lag()
## x purrr::set_names()       masks magrittr::set_names()
## x lubridate::setdiff()     masks base::setdiff()
## x lubridate::union()       masks base::union()
```

```
library(gridExtra) # grid based plots
```

```
##
## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(dplyr)
library(leaflet)
library(ggforce)
library(kableExtra)
```

```
##
## Attaching package: 'kableExtra'

## The following object is masked from 'package:dplyr':
##
##     group_rows
```

```
# Loading data
# At first, three CSV files, are downloaded and saved as local files
# and then loaded into R
# source data files changes everytime
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 folder
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
data.confirmed.original <- read.csv('./data/time_series_covid19_confirmed_global.csv')
data.deaths.original <- read.csv('./data/time_series_covid19_deaths_global.csv')
data.recovered.original <- read.csv('./data/time_series_covid19_recovered_global.csv')
```

```r
# check dimension of data confirmed
dim(data.confirmed.original)
```

```
## [1] 256  74
```

Below we check the time frame of data set

```r
# check time frame of the data
n.col <- ncol(data.confirmed.original) # 58 variables
# get dates from column names
dates <- names(data.confirmed.original)[5:n.col] %>% substr(2,8) %>% mdy()
range(dates)
```

```
## [1] "2020-01-22" "2020-03-31"
```

```r
min.date <- min(dates)
max.date <- max(dates)
max.date.txt <- max.date %>% format('%d %b %Y')
min.date.txt <- min.date %>% format('%d %b Y')
# last update on 26 March 2020 max.date
```

```r
# Data Preparation steps:
# 1.From wide to long format
# 2.Aggregate by country
# 3. merge into a signe dataset
# 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)) %>% as.data.frame()
  return(data)
}
# clean the three datasets
data.confirmed <- data.confirmed.original %>% cleanData() %>% rename(confirmed=count)
data.deaths <- data.deaths.original %>% cleanData() %>% rename(deaths=count)
data.recovered <- data.recovered.original %>% cleanData() %>% rename(recovered=count)

# merge above 3 datasets into one, by country and date
```

```r
data <- data.confirmed %>% merge(data.deaths, all = T) %>% merge(data.recovered, all = T)

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

# last 10 records when it first broke out in Spain
data %>% filter(country =='Spain')%>% tail(10)
```

```
##    country       date confirmed deaths recovered
## 61   Spain 2020-03-22     28768   1772      2575
## 62   Spain 2020-03-23     35136   2311      2575
## 63   Spain 2020-03-24     39885   2808      3794
## 64   Spain 2020-03-25     49515   3647      5367
## 65   Spain 2020-03-26     57786   4365      7015
## 66   Spain 2020-03-27     65719   5138      9357
## 67   Spain 2020-03-28     73235   5982     12285
## 68   Spain 2020-03-29     80110   6803     14709
## 69   Spain 2020-03-30     87956   7716     16780
## 70   Spain 2020-03-31     95923   8464     19259
```

```r
# counts for worldwide
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(remaining.confirmed = confirmed - deaths - recovered)
```

```r
# Visualisation
# After preparing the data, we portrait it in various graphs

# TOP Ten Countries
# ranking by confirmed cases
data.latest.all <- data %>% filter(date == max(date)) %>%
  select(country, date,
         confirmed, confirmed.new, remaining.confirmed, recovered, deaths.new, deaths, death
# top 20 countries incl 11 World
k<- 20
top.countries <- data.latest.all %>% filter(ranking <= k+1) %>%
  arrange(ranking) %>% pull(country) %>% as.character()
top.countries %>% setdiff('World') %>% print()
```

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

```
names(data.latest.all)
```

```
##  [1] "country"             "date"                "confirmed"
##  [4] "confirmed.new"       "remaining.confirmed" "recovered"
##  [7] "deaths.new"          "deaths"              "death.rate"
## [10] "ranking"
```

```
## 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), confirmed.new=sum(confirmed.new), remaining.confirmed
              mutate(death.rate=(100*deaths/confirmed) %>% round(1))
data.latest %<>% select(c(country, confirmed, deaths,death.rate, confirmed.new, deaths.new,r

data.latest %>% mutate(death.rate=death.rate %>% format(nsmall=1) %>% paste0('%')) %>% kable
```

Worldmap

```
x <- data.confirmed.original
x$confirmed <- x[, ncol(x)]
x %>% select(c(Country.Region, Province.State, Lat, Long, confirmed)) %>%
  mutate(txt=paste0(Country.Region, '-', Province.State, ':', confirmed))
```

```
##                       Country.Region                Province.State        Lat
## 1                        Afghanistan                                  33.000000
## 2                            Albania                                  41.153300
## 3                            Algeria                                  28.033900
## 4                            Andorra                                  42.506300
## 5                             Angola                                 -11.202700
## 6                Antigua and Barbuda                                  17.060800
## 7                          Argentina                                 -38.416100
## 8                            Armenia                                  40.069100
## 9                          Australia Australian Capital Territory -35.473500
```

Table 1: Cases in Top 20 Countries - 31 Mar 2020.

	country	confirmed	deaths	death.rate	confirmed.new	deaths.new	remaining.confirmed
1	World	857,487	42,107	4.9%	75,122	4,525	637,346
2	US	188,172	3,873	2.1%	26,365	895	177,275
3	Italy	105,792	12,428	11.7%	4,053	837	77,635
4	Spain	95,923	8,464	8.8%	7,967	748	68,200
5	China	82,279	3,309	4.0%	81	1	2,764
6	Germany	71,808	775	1.1%	4,923	130	54,933
7	France	52,827	3,532	6.7%	7,657	502	39,782
8	Iran	44,605	2,898	6.5%	3,110	141	27,051
9	United Kingdom	25,481	1,793	7.0%	3,028	382	23,509
10	Switzerland	16,605	433	2.6%	683	74	14,349
11	Turkey	13,531	214	1.6%	2,704	46	13,074
12	Belgium	12,775	705	5.5%	876	192	10,374
13	Netherlands	12,667	1,040	8.2%	850	175	11,374
14	Austria	10,180	128	1.3%	562	20	8,957
15	Korea, South	9,786	162	1.7%	125	4	4,216
16	Canada	8,527	101	1.2%	1,129	21	6,834
17	Portugal	7,443	160	2.1%	1,035	20	7,240
18	Brazil	5,717	201	3.5%	1,138	42	5,389
19	Israel	5,358	20	0.4%	663	4	5,114
20	Norway	4,641	39	0.8%	196	7	4,589
21	Australia	4,559	18	0.4%	198	1	4,183
22	Others	78,811	1,814	2.3%	7,779	283	70,504

```
## 10                    Australia          New South Wales -33.868800
## 11                    Australia       Northern Territory -12.463400
## 12                    Australia               Queensland -28.016700
## 13                    Australia          South Australia -34.928500
## 14                    Australia                Tasmania -41.454500
## 15                    Australia                Victoria -37.813600
## 16                    Australia       Western Australia -31.950500
## 17                      Austria                          47.516200
## 18                   Azerbaijan                          40.143100
## 19                      Bahamas                          25.034300
## 20                      Bahrain                          26.027500
## 21                   Bangladesh                          23.685000
## 22                     Barbados                          13.193900
## 23                      Belarus                          53.709800
## 24                      Belgium                          50.833300
## 25                        Benin                           9.307700
## 26                       Bhutan                          27.514200
## 27                      Bolivia                         -16.290200
## 28 Bosnia and Herzegovina                          43.915900
## 29                       Brazil                         -14.235000
## 30                       Brunei                           4.535300
## 31                     Bulgaria                          42.733900
```

```
## 32                    Burkina Faso                                12.238300
## 33                      Cabo Verde                                16.538800
## 34                        Cambodia                                11.550000
## 35                        Cameroon                                 3.848000
## 36                          Canada                         Alberta 53.933300
## 37                          Canada                British Columbia 49.282700
## 38                          Canada                  Grand Princess 37.648900
## 39                          Canada                        Manitoba 53.760900
## 40                          Canada                   New Brunswick 46.565300
## 41                          Canada       Newfoundland and Labrador 53.135500
## 42                          Canada                    Nova Scotia 44.682000
## 43                          Canada                         Ontario 51.253800
## 44                          Canada            Prince Edward Island 46.510700
## 45                          Canada                          Quebec 52.939900
## 46                          Canada                    Saskatchewan 52.939900
## 47          Central African Republic                                 6.611100
## 48                            Chad                                15.454200
## 49                           Chile                               -35.675100
## 50                           China                          Anhui 31.825700
## 51                           China                        Beijing 40.182400
## 52                           China                      Chongqing 30.057200
## 53                           China                         Fujian 26.078900
## 54                           China                          Gansu 37.809900
## 55                           China                      Guangdong 23.341700
## 56                           China                         Guangxi 23.829800
## 57                           China                         Guizhou 26.815400
## 58                           China                         Hainan 19.195900
## 59                           China                          Hebei 39.549000
## 60                           China                     Heilongjiang 47.862000
## 61                           China                          Henan 33.882000
## 62                           China                      Hong Kong 22.300000
## 63                           China                          Hubei 30.975600
## 64                           China                          Hunan 27.610400
## 65                           China                  Inner Mongolia 44.093500
## 66                           China                         Jiangsu 32.971100
## 67                           China                         Jiangxi 27.614000
## 68                           China                           Jilin 43.666100
## 69                           China                        Liaoning 41.295600
## 70                           China                           Macau 22.166700
## 71                           China                         Ningxia 37.269200
## 72                           China                         Qinghai 35.745200
## 73                           China                         Shaanxi 35.191700
## 74                           China                        Shandong 36.342700
## 75                           China                        Shanghai 31.202000
## 76                           China                          Shanxi 37.577700
## 77                           China                         Sichuan 30.617100
```

```
## 78                        China                  Tianjin  39.305400
## 79                        China                    Tibet  31.692700
## 80                        China                 Xinjiang  41.112900
## 81                        China                   Yunnan  24.974000
## 82                        China                 Zhejiang  29.183200
## 83                     Colombia                           4.570900
## 84         Congo (Brazzaville)                           -4.038300
## 85            Congo (Kinshasa)                           -4.038300
## 86                   Costa Rica                           9.748900
## 87               Cote d'Ivoire                           7.540000
## 88                      Croatia                          45.100000
## 89               Diamond Princess                           0.000000
## 90                         Cuba                          22.000000
## 91                       Cyprus                          35.126400
## 92                      Czechia                          49.817500
## 93                      Denmark             Faroe Islands  61.892600
## 94                      Denmark                Greenland  71.706900
## 95                      Denmark                          56.263900
## 96                     Djibouti                          11.825100
## 97           Dominican Republic                          18.735700
## 98                      Ecuador                          -1.831200
## 99                        Egypt                          26.000000
## 100                 El Salvador                          13.794200
## 101           Equatorial Guinea                           1.500000
## 102                     Eritrea                          15.179400
## 103                     Estonia                          58.595300
## 104                    Eswatini                         -26.522500
## 105                    Ethiopia                           9.145000
## 106                        Fiji                         -17.713400
## 107                     Finland                          64.000000
## 108                      France             French Guiana   3.933900
## 109                      France           French Polynesia -17.679700
## 110                      France                 Guadeloupe  16.250000
## 111                      France                    Mayotte -12.827500
## 112                      France              New Caledonia -20.904300
## 113                      France                    Reunion -21.135100
## 114                      France           Saint Barthelemy  17.900000
## 115                      France                  St Martin  18.070800
## 116                      France                 Martinique  14.641500
## 117                      France                          46.227600
## 118                       Gabon                          -0.803700
## 119                      Gambia                          13.443200
## 120                     Georgia                          42.315400
## 121                     Germany                          51.000000
## 122                       Ghana                           7.946500
## 123                      Greece                          39.074200
```

```
## 124                Guatemala                        15.783500
## 125                   Guinea                         9.945600
## 126                   Guyana                         5.000000
## 127                    Haiti                        18.971200
## 128                 Holy See                        41.902900
## 129                 Honduras                        15.200000
## 130                  Hungary                        47.162500
## 131                  Iceland                        64.963100
## 132                    India                        21.000000
## 133                Indonesia                        -0.789300
## 134                     Iran                        32.000000
## 135                     Iraq                        33.000000
## 136                  Ireland                        53.142400
## 137                   Israel                        31.000000
## 138                    Italy                        43.000000
## 139                  Jamaica                        18.109600
## 140                    Japan                        36.000000
## 141                   Jordan                        31.240000
## 142               Kazakhstan                        48.019600
## 143                    Kenya                        -0.023600
## 144             Korea, South                        36.000000
## 145                   Kuwait                        29.500000
## 146               Kyrgyzstan                        41.204400
## 147                   Latvia                        56.879600
## 148                  Lebanon                        33.854700
## 149                  Liberia                         6.428100
## 150            Liechtenstein                        47.140000
## 151                Lithuania                        55.169400
## 152               Luxembourg                        49.815300
## 153               Madagascar                       -18.766900
## 154                 Malaysia                         2.500000
## 155                 Maldives                         3.202800
## 156                    Malta                        35.937500
## 157               Mauritania                        21.007900
## 158                Mauritius                       -20.200000
## 159                   Mexico                        23.634500
## 160                  Moldova                        47.411600
## 161                   Monaco                        43.733300
## 162                 Mongolia                        46.862500
## 163               Montenegro                        42.500000
## 164                  Morocco                        31.791700
## 165                  Namibia                       -22.957600
## 166                    Nepal                        28.166700
## 167              Netherlands                Aruba  12.518600
## 168              Netherlands              Curacao  12.169600
## 169              Netherlands          Sint Maarten  18.042500
```

```
## 170                     Netherlands  52.132600
## 171                     New Zealand -40.900600
## 172                       Nicaragua  12.865400
## 173                           Niger  17.607800
## 174                         Nigeria   9.082000
## 175                  North Macedonia  41.608600
## 176                          Norway  60.472000
## 177                            Oman  21.000000
## 178                        Pakistan  30.375300
## 179                          Panama   8.538000
## 180                  Papua New Guinea -6.315000
## 181                        Paraguay -23.442500
## 182                            Peru  -9.190000
## 183                     Philippines  13.000000
## 184                          Poland  51.919400
## 185                        Portugal  39.399900
## 186                           Qatar  25.354800
## 187                         Romania  45.943200
## 188                          Russia  60.000000
## 189                          Rwanda  -1.940300
## 190                     Saint Lucia  13.909400
## 191 Saint Vincent and the Grenadines  12.984300
## 192                      San Marino  43.942400
## 193                    Saudi Arabia  24.000000
## 194                         Senegal  14.497400
## 195                          Serbia  44.016500
## 196                      Seychelles  -4.679600
## 197                       Singapore   1.283300
## 198                        Slovakia  48.669000
## 199                        Slovenia  46.151200
## 200                         Somalia   5.152100
## 201                    South Africa -30.559500
## 202                           Spain  40.000000
## 203                       Sri Lanka   7.000000
## 204                           Sudan  12.862800
## 205                        Suriname   3.919300
## 206                          Sweden  63.000000
## 207                     Switzerland  46.818200
## 208                          Taiwan*  23.700000
## 209                        Tanzania  -6.369000
## 210                        Thailand  15.000000
## 211                            Togo   8.619500
## 212             Trinidad and Tobago  10.691800
## 213                         Tunisia  34.000000
## 214                          Turkey  38.963700
## 215                          Uganda   1.000000
```

```
## 216                         Ukraine                                48.379400
## 217             United Arab Emirates                                24.000000
## 218                  United Kingdom                    Bermuda      32.307800
## 219                  United Kingdom              Cayman Islands     19.313300
## 220                  United Kingdom              Channel Islands    49.372300
## 221                  United Kingdom                   Gibraltar     36.140800
## 222                  United Kingdom                Isle of Man      54.236100
## 223                  United Kingdom                  Montserrat     16.742500
## 224                  United Kingdom                                 55.378100
## 225                         Uruguay                                -32.522800
## 226                              US                                 37.090200
## 227                      Uzbekistan                                 41.377500
## 228                       Venezuela                                  6.423800
## 229                         Vietnam                                 16.000000
## 230                          Zambia                                -15.416700
## 231                        Zimbabwe                                -20.000000
## 232                          Canada             Diamond Princess     0.000000
## 233                        Dominica                                 15.415000
## 234                         Grenada                                 12.116500
## 235                      Mozambique                                -18.665695
## 236                           Syria                                 34.802075
## 237                     Timor-Leste                                 -8.874217
## 238                          Belize                                 13.193900
## 239                          Canada                    Recovered     0.000000
## 240                            Laos                                 19.856270
## 241                           Libya                                 26.335100
## 242              West Bank and Gaza                                 31.952200
## 243                   Guinea-Bissau                                 11.803700
## 244                            Mali                                 17.570692
## 245            Saint Kitts and Nevis                                17.357822
## 246                          Canada        Northwest Territories    64.825500
## 247                          Canada                      Yukon      64.282300
## 248                          Kosovo                                 42.602636
## 249                           Burma                                 21.916200
## 250                  United Kingdom                  Anguilla       18.220600
## 251                  United Kingdom       British Virgin Islands    18.420700
## 252                  United Kingdom     Turks and Caicos Islands    21.694000
## 253                      MS Zaandam                                  0.000000
## 254                        Botswana                                -22.328500
## 255                         Burundi                                 -3.373100
## 256                    Sierra Leone                                  8.460555
##           Long confirmed                                 txt
## 1     65.000000       174                  Afghanistan-:174
## 2     20.168300       243                      Albania-:243
## 3      1.659600       716                      Algeria-:716
## 4      1.521800       376                      Andorra-:376
```

```
## 5     17.873900         7                                Angola-:7
## 6    -61.796400         7                    Antigua and Barbuda-:7
## 7    -63.616700      1054                           Argentina-:1054
## 8     45.038200       532                              Armenia-:532
## 9    149.012400        80 Australia-Australian Capital Territory:80
## 10   151.209300      2032            Australia-New South Wales:2032
## 11   130.845600        17           Australia-Northern Territory:17
## 12   153.400000       743                  Australia-Queensland:743
## 13   138.600700       337             Australia-South Australia:337
## 14   145.970700        69                     Australia-Tasmania:69
## 15   144.963100       917                   Australia-Victoria:917
## 16   115.860500       364           Australia-Western Australia:364
## 17    14.550100     10180                              Austria-:10180
## 18    47.576900       298                            Azerbaijan-:298
## 19   -77.396300        14                                Bahamas-:14
## 20    50.550000       567                               Bahrain-:567
## 21    90.356300        51                             Bangladesh-:51
## 22   -59.543200        34                               Barbados-:34
## 23    27.953400       152                               Belarus-:152
## 24     4.000000     12775                              Belgium-:12775
## 25     2.315800         9                                   Benin-:9
## 26    90.433600         4                                  Bhutan-:4
## 27   -63.588700       107                               Bolivia-:107
## 28    17.679100       420              Bosnia and Herzegovina-:420
## 29   -51.925300      5717                               Brazil-:5717
## 30   114.727700       129                                Brunei-:129
## 31    25.485800       399                              Bulgaria-:399
## 32    -1.561600       261                          Burkina Faso-:261
## 33   -23.041800         6                              Cabo Verde-:6
## 34   104.916700       109                              Cambodia-:109
## 35    11.502100       193                              Cameroon-:193
## 36  -116.576500       690                        Canada-Alberta:690
## 37  -123.120700      1013              Canada-British Columbia:1013
## 38  -122.665500        13                  Canada-Grand Princess:13
## 39   -98.813900       103                       Canada-Manitoba:103
## 40   -66.461900        70                   Canada-New Brunswick:70
## 41   -57.660400       152      Canada-Newfoundland and Labrador:152
## 42   -63.744300       147                    Canada-Nova Scotia:147
## 43   -85.323200      1966                       Canada-Ontario:1966
## 44   -63.416800        21            Canada-Prince Edward Island:21
## 45   -73.549100      4162                         Canada-Quebec:4162
## 46  -106.450900       184                  Canada-Saskatchewan:184
## 47    20.939400         3               Central African Republic-:3
## 48    18.732200         7                                  Chad-:7
## 49   -71.543000      2738                               Chile-:2738
## 50   117.226400       990                          China-Anhui:990
```

```
## 51   116.414200       580                    China-Beijing:580
## 52   107.874000       579                  China-Chongqing:579
## 53   117.987400       343                     China-Fujian:343
## 54   101.058300       138                      China-Gansu:138
## 55   113.424400      1494                   China-Guangdong:1494
## 56   108.788100       254                     China-Guangxi:254
## 57   106.874800       146                     China-Guizhou:146
## 58   109.745300       168                      China-Hainan:168
## 59   116.130600       321                       China-Hebei:321
## 60   127.761500       484                 China-Heilongjiang:484
## 61   113.614000      1276                      China-Henan:1276
## 62   114.200000       714                  China-Hong Kong:714
## 63   112.270700     67801                       China-Hubei:67801
## 64   111.708800      1018                      China-Hunan:1018
## 65   113.944800       107             China-Inner Mongolia:107
## 66   119.455000       646                     China-Jiangsu:646
## 67   115.722100       937                     China-Jiangxi:937
## 68   126.192300        98                        China-Jilin:98
## 69   122.608500       139                    China-Liaoning:139
## 70   113.550000        41                        China-Macau:41
## 71   106.165500        75                      China-Ningxia:75
## 72    95.995600        18                      China-Qinghai:18
## 73   108.870100       253                     China-Shaanxi:253
## 74   118.149800       774                    China-Shandong:774
## 75   121.449100       509                    China-Shanghai:509
## 76   112.292200       136                      China-Shanxi:136
## 77   102.710300       550                     China-Sichuan:550
## 78   117.323000       174                     China-Tianjin:174
## 79    88.092400         1                         China-Tibet:1
## 80    85.240100        76                     China-Xinjiang:76
## 81   101.487000       182                      China-Yunnan:182
## 82   120.093400      1257                    China-Zhejiang:1257
## 83   -74.297300       906                          Colombia-:906
## 84    21.758700        19               Congo (Brazzaville)-:19
## 85    21.758700        98                  Congo (Kinshasa)-:98
## 86   -83.753400       347                       Costa Rica-:347
## 87    -5.547100       179                   Cote d'Ivoire-:179
## 88    15.200000       867                          Croatia-:867
## 89     0.000000       712              Diamond Princess-:712
## 90   -80.000000       186                           Cuba-:186
## 91    33.429900       262                         Cyprus-:262
## 92    15.473000      3308                        Czechia-:3308
## 93    -6.911800       169          Denmark-Faroe Islands:169
## 94   -42.604300        10               Denmark-Greenland:10
## 95     9.501800      2860                        Denmark-:2860
## 96    42.590300        30                       Djibouti-:30
```

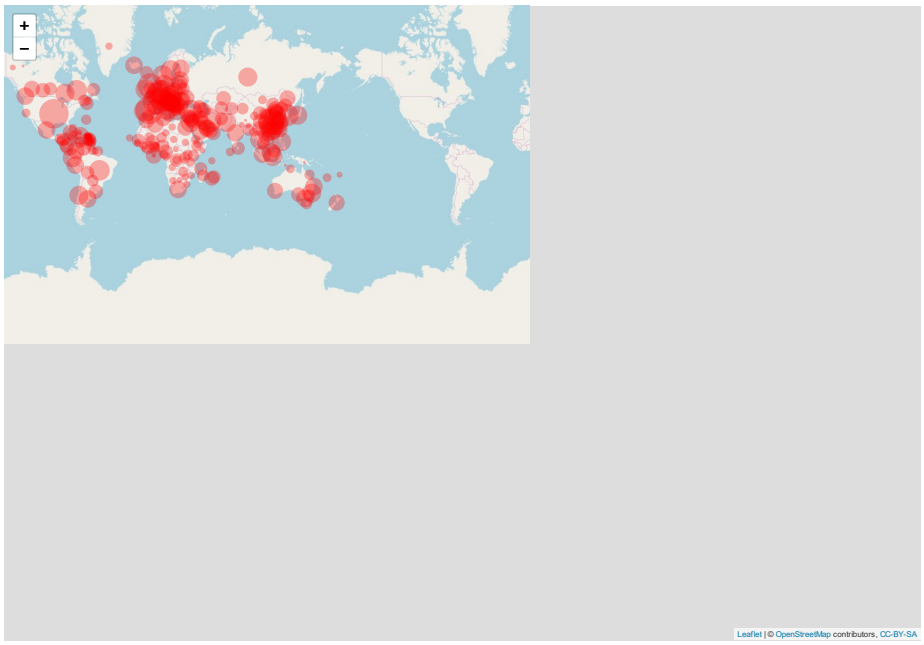
```
## 97   -70.162700      1109                Dominican Republic-:1109
## 98   -78.183400      2240                           Ecuador-:2240
## 99    30.000000       710                              Egypt-:710
## 100  -88.896500        32                        El Salvador-:32
## 101   10.000000        12                   Equatorial Guinea-:12
## 102   39.782300        15                            Eritrea-:15
## 103   25.013600       745                           Estonia-:745
## 104   31.465900         9                            Eswatini-:9
## 105   40.489700        26                           Ethiopia-:26
## 106  178.065000         5                                Fiji-:5
## 107   26.000000      1418                          Finland-:1418
## 108  -53.125800        43              France-French Guiana:43
## 109  149.406800        36           France-French Polynesia:36
## 110  -61.583300       114                France-Guadeloupe:114
## 111   45.166200        94                    France-Mayotte:94
## 112  165.618000        16              France-New Caledonia:16
## 113   55.247100       247                   France-Reunion:247
## 114  -62.833300         6           France-Saint Barthelemy:6
## 115  -63.050100        15                 France-St Martin:15
## 116  -61.024200       128                France-Martinique:128
## 117    2.213700     52128                          France-:52128
## 118   11.609400        16                              Gabon-:16
## 119  -15.310100         4                             Gambia-:4
## 120   43.356900       110                           Georgia-:110
## 121    9.000000     71808                         Germany-:71808
## 122   -1.023200       161                             Ghana-:161
## 123   21.824300      1314                           Greece-:1314
## 124  -90.230800        38                         Guatemala-:38
## 125   -9.696600        22                            Guinea-:22
## 126  -58.750000        12                            Guyana-:12
## 127  -72.285200        15                             Haiti-:15
## 128   12.453400         6                           Holy See-:6
## 129  -86.241900       141                          Honduras-:141
## 130   19.503300       492                           Hungary-:492
## 131  -19.020800      1135                          Iceland-:1135
## 132   78.000000      1397                            India-:1397
## 133  113.921300      1528                        Indonesia-:1528
## 134   53.000000     44605                             Iran-:44605
## 135   44.000000       694                              Iraq-:694
## 136   -7.692100      3235                          Ireland-:3235
## 137   35.000000      5358                           Israel-:5358
## 138   12.000000    105792                          Italy-:105792
## 139  -77.297500        36                           Jamaica-:36
## 140  138.000000      1953                            Japan-:1953
## 141   36.510000       274                           Jordan-:274
## 142   66.923700       343                       Kazakhstan-:343
```

```
## 143   37.906200        59                          Kenya-:59
## 144  128.000000      9786                 Korea, South-:9786
## 145   47.750000       289                        Kuwait-:289
## 146   74.766100       107                     Kyrgyzstan-:107
## 147   24.603200       398                        Latvia-:398
## 148   35.862300       470                       Lebanon-:470
## 149   -9.429500         3                        Liberia-:3
## 150    9.550000        68                   Liechtenstein-:68
## 151   23.881300       537                      Lithuania-:537
## 152    6.129600      2178                    Luxembourg-:2178
## 153   46.869100        57                     Madagascar-:57
## 154  112.500000      2766                      Malaysia-:2766
## 155   73.220700        18                       Maldives-:18
## 156   14.375400       169                          Malta-:169
## 157   10.940800         6                      Mauritania-:6
## 158   57.500000       143                      Mauritius-:143
## 159 -102.552800      1094                        Mexico-:1094
## 160   28.369900       353                       Moldova-:353
## 161    7.416700        52                         Monaco-:52
## 162  103.846700        12                       Mongolia-:12
## 163   19.300000       109                    Montenegro-:109
## 164   -7.092600       617                       Morocco-:617
## 165   18.490400        11                        Namibia-:11
## 166   84.250000         5                           Nepal-:5
## 167  -70.035800        55              Netherlands-Aruba:55
## 168  -68.990000        11           Netherlands-Curacao:11
## 169  -63.054800         6        Netherlands-Sint Maarten:6
## 170    5.291300     12595                Netherlands-:12595
## 171  174.886000       647                  New Zealand-:647
## 172  -85.207200         5                       Nicaragua-:5
## 173    8.081700        27                          Niger-:27
## 174    8.675300       135                       Nigeria-:135
## 175   21.745300       329              North Macedonia-:329
## 176    8.468900      4641                       Norway-:4641
## 177   57.000000       192                          Oman-:192
## 178   69.345100      1938                     Pakistan-:1938
## 179  -80.782100      1181                       Panama-:1181
## 180  143.955500         1                  Papua New Guinea-:1
## 181  -58.443800        65                       Paraguay-:65
## 182  -75.015200      1065                         Peru-:1065
## 183  122.000000      2084                   Philippines-:2084
## 184   19.145100      2311                        Poland-:2311
## 185   -8.224500      7443                      Portugal-:7443
## 186   51.183900       781                          Qatar-:781
## 187   24.966800      2245                       Romania-:2245
## 188   90.000000      2337                        Russia-:2337
```

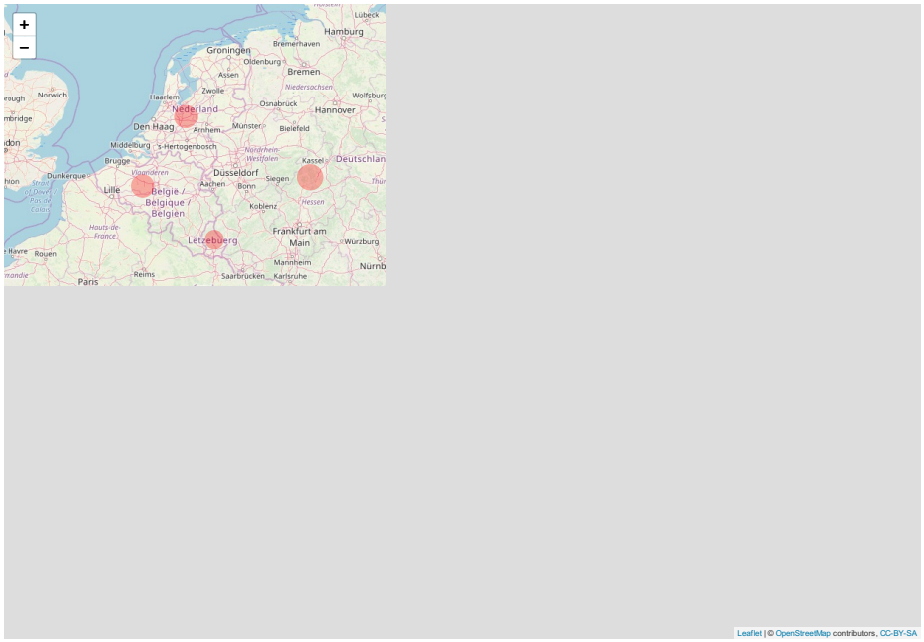
```
## 189   29.873900        75                              Rwanda-:75
## 190  -60.978900        13                         Saint Lucia-:13
## 191  -61.287200         1       Saint Vincent and the Grenadines-:1
## 192   12.457800       236                         San Marino-:236
## 193   45.000000      1563                       Saudi Arabia-:1563
## 194  -14.452400       175                             Senegal-:175
## 195   21.005900       900                              Serbia-:900
## 196   55.492000        10                          Seychelles-:10
## 197  103.833300       926                          Singapore-:926
## 198   19.699000       363                           Slovakia-:363
## 199   14.995500       802                           Slovenia-:802
## 200   46.199600         5                              Somalia-:5
## 201   22.937500      1353                       South Africa-:1353
## 202   -4.000000     95923                             Spain-:95923
## 203   81.000000       143                          Sri Lanka-:143
## 204   30.217600         7                                Sudan-:7
## 205  -56.027800         9                            Suriname-:9
## 206   16.000000      4435                            Sweden-:4435
## 207    8.227500     16605                       Switzerland-:16605
## 208  121.000000       322                             Taiwan*-:322
## 209   34.888800        19                            Tanzania-:19
## 210  101.000000      1651                          Thailand-:1651
## 211    0.824800        34                                Togo-:34
## 212  -61.222500        87                  Trinidad and Tobago-:87
## 213    9.000000       394                            Tunisia-:394
## 214   35.243300     13531                           Turkey-:13531
## 215   32.000000        44                              Uganda-:44
## 216   31.165600       645                           Ukraine-:645
## 217   54.000000       664                 United Arab Emirates-:664
## 218  -64.750500        32                 United Kingdom-Bermuda:32
## 219  -81.254600        14          United Kingdom-Cayman Islands:14
## 220   -2.364400       141        United Kingdom-Channel Islands:141
## 221   -5.353600        69               United Kingdom-Gibraltar:69
## 222   -4.548100        60            United Kingdom-Isle of Man:60
## 223  -62.187400         5              United Kingdom-Montserrat:5
## 224   -3.436000     25150                    United Kingdom-:25150
## 225  -55.765800       338                             Uruguay-:338
## 226  -95.712900    188172                               US-:188172
## 227   64.585300       172                          Uzbekistan-:172
## 228  -66.589700       135                           Venezuela-:135
## 229  108.000000       212                             Vietnam-:212
## 230   28.283300        35                              Zambia-:35
## 231   30.000000         8                             Zimbabwe-:8
## 232    0.000000         0                 Canada-Diamond Princess:0
## 233  -61.371000        12                           Dominica-:12
## 234  -61.679000         9                              Grenada-:9
```

```
## 235   35.529562         8                              Mozambique-:8
## 236   38.996815        10                                  Syria-:10
## 237  125.727539         1                             Timor-Leste-:1
## 238  -59.543200         3                                  Belize-:3
## 239    0.000000         0                        Canada-Recovered:0
## 240  102.495496         9                                    Laos-:9
## 241   17.228331        10                                  Libya-:10
## 242   35.233200       119                    West Bank and Gaza-:119
## 243  -15.180400         8                           Guinea-Bissau-:8
## 244   -3.996166        28                                    Mali-:28
## 245  -62.782998         8                  Saint Kitts and Nevis-:8
## 246 -124.845700         1            Canada-Northwest Territories:1
## 247 -135.000000         5                              Canada-Yukon:5
## 248   20.902977       112                                 Kosovo-:112
## 249   95.956000        15                                  Burma-:15
## 250  -63.068600         2                 United Kingdom-Anguilla:2
## 251  -64.640000         3   United Kingdom-British Virgin Islands:3
## 252  -71.797900         5 United Kingdom-Turks and Caicos Islands:5
## 253    0.000000         2                               MS Zaandam-:2
## 254   24.684900         4                                 Botswana-:4
## 255   29.918900         2                                  Burundi-:2
## 256  -11.779889         1                            Sierra Leone-:1
```

```
map <- leaflet() %>% addTiles()
#marker
map %<>% addCircleMarkers(x$Long, x$Lat, radius = 2+log2(x$confirmed), stroke = F,
                          color = 'red', fillOpacity = 0.3, popup = x$txt)
map
```

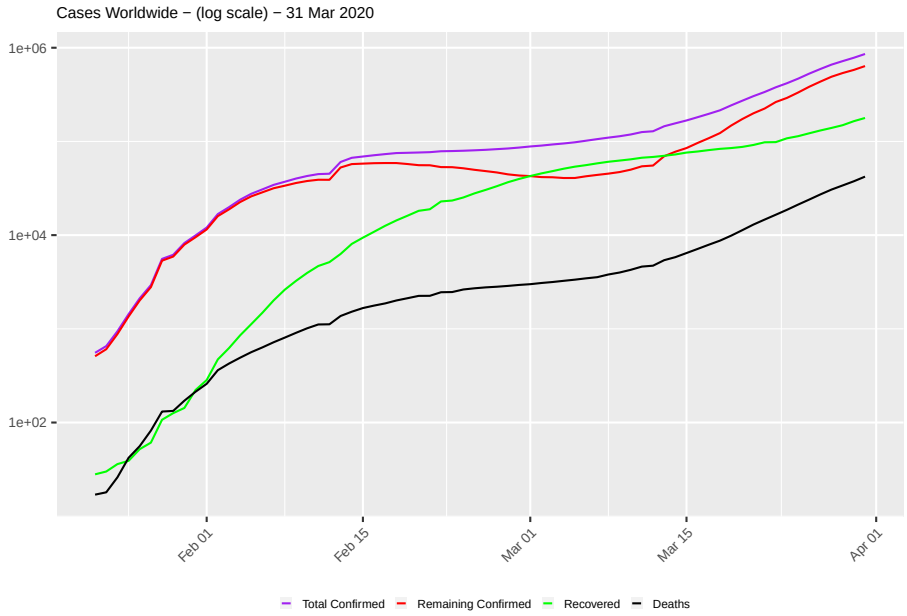



```
map %>% setView(5, 52,zoom = 6)
```

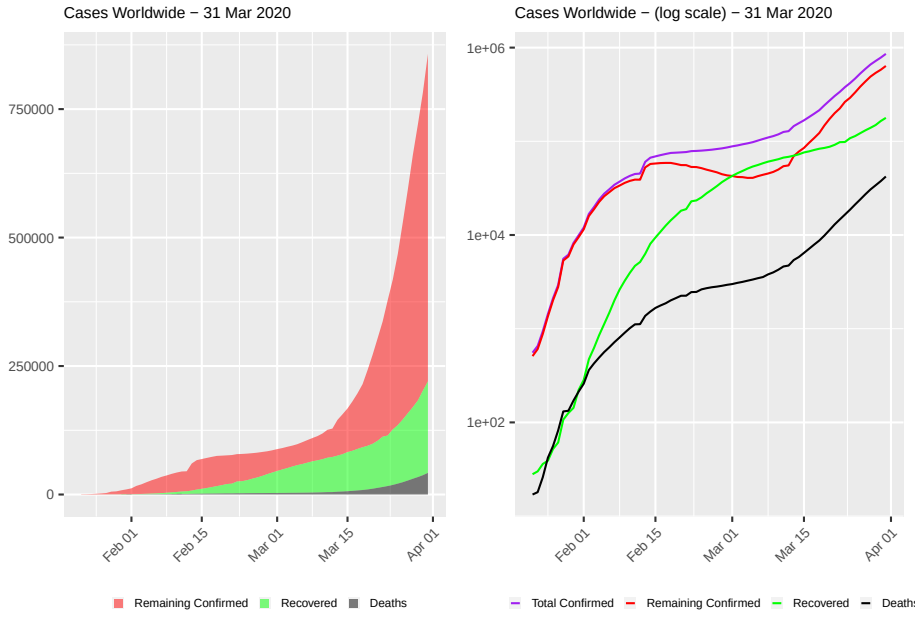


Number of cases:

```r
world.long <- data.long %>% filter(country =='World') # can be also filtered for different c

# 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('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('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')

plot2
```




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



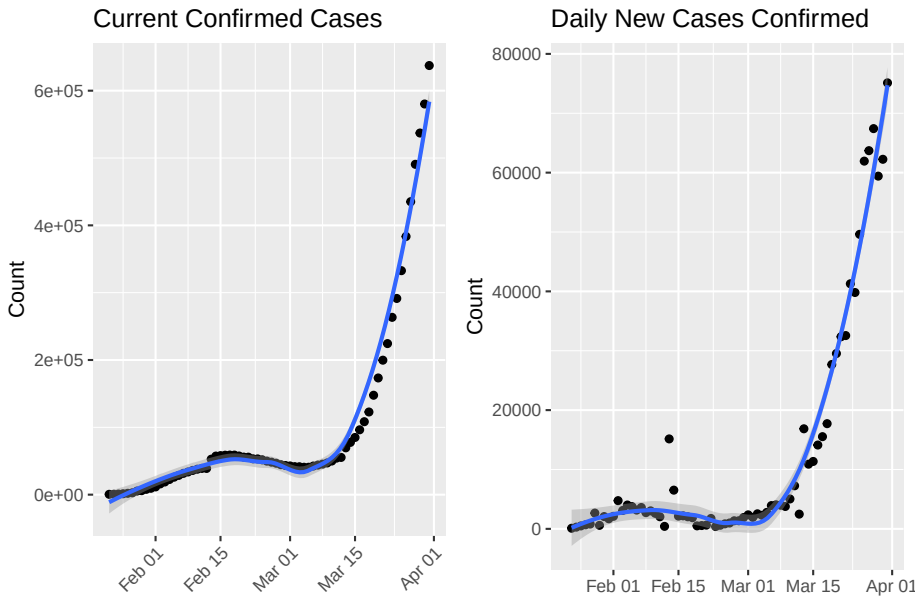
Current confirmed Cases:

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

##current confirmed and daily new confirmed
plot1 <- ggplot(data.world, aes(x=date, y=remaining.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=confirmed.new))+ geom_point() + geom_smooth() + xl
  theme(axis.text.x = element_text(angle =45, hjust=1))
```

```
## List of 1
##  $ axis.text.x:List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : NULL
##   ..$ angle        : num 45
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi FALSE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi FALSE
##  - attr(*, "validate")= logi TRUE
```

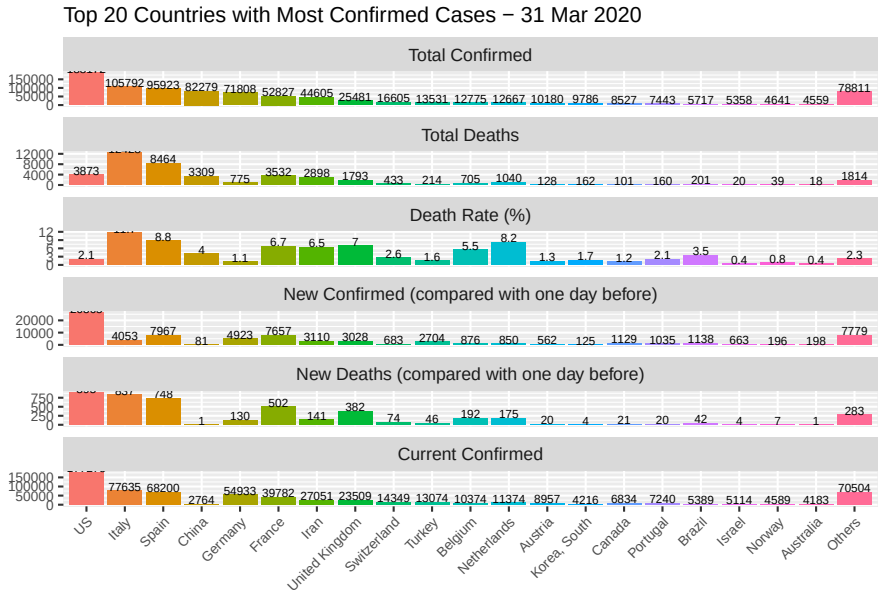
```r
grid.arrange(plot1, plot2, ncol=2)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'

## Warning: Removed 1 rows containing non-finite values (stat_smooth).

## Warning: Removed 1 rows containing missing values (geom_point).
```

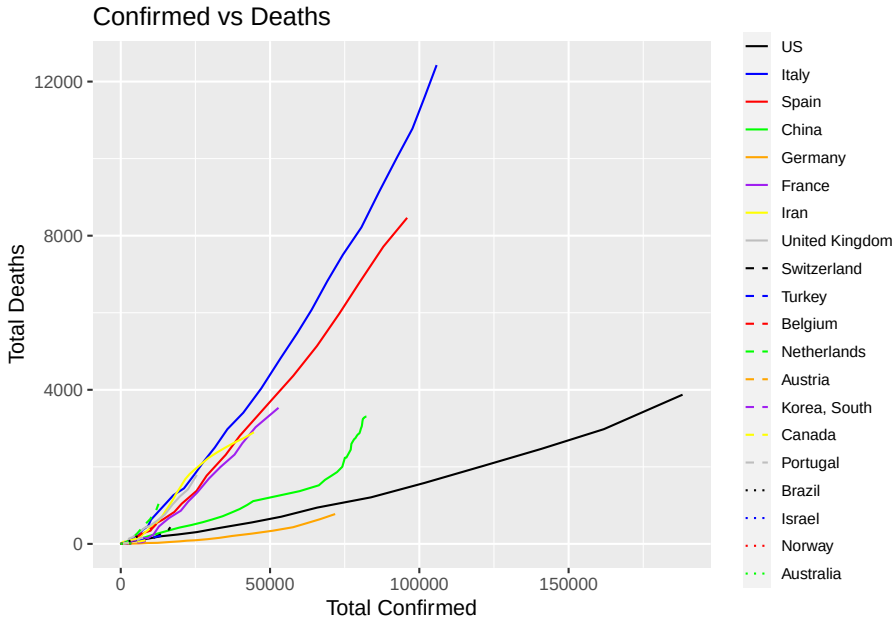


Bar Chart

```
data.latest.long <- data.latest %>% filter(country!='World') %>% gather(key=type, value=cou


data.latest.long %<>% mutate(type=recode_factor(type, confirmed='Total Confirmed', deaths='T

## 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_f
  theme(legend.title=element_blank(),
        legend.position='none',
        plot.title=element_text(size=11),axis.text=element_text(size=7), axis.text.x=element
```



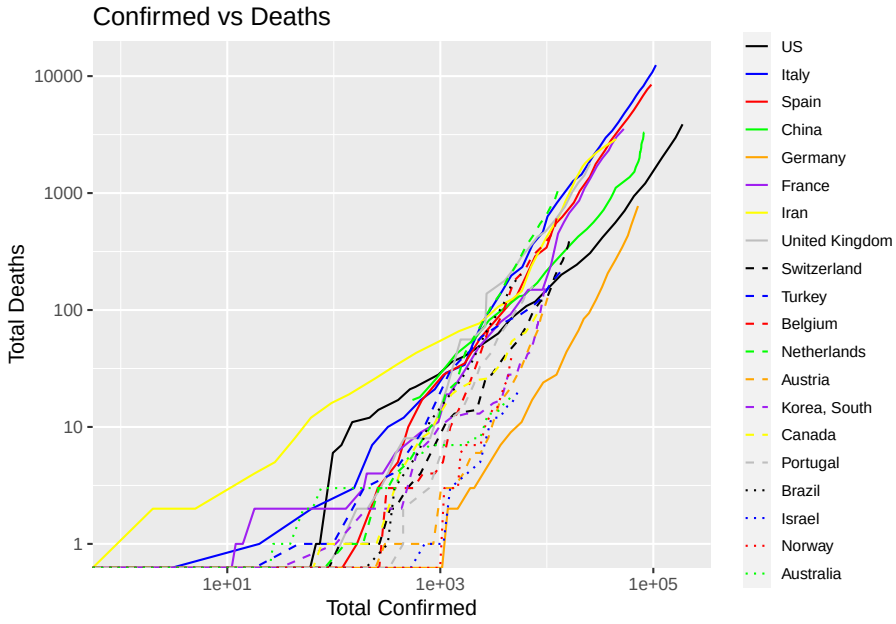

```
# Confirmed versus Deaths
linetypes <- rep(c("solid", "dashed", "dotted"), each=8)
colors <- rep(c('black', 'blue', 'red', 'green', 'orange', 'purple', 'yellow', 'grey'), 3)
df <- data %>% filter(country %in% setdiff(top.countries, c('World', 'Others'))) %>%
mutate(country=country %>% factor(levels=c(top.countries)))
vs <- 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')) + ggtitle('Confirmed vs Deaths')
vs
```




```
vs + scale_x_log10() + scale_y_log10()
```

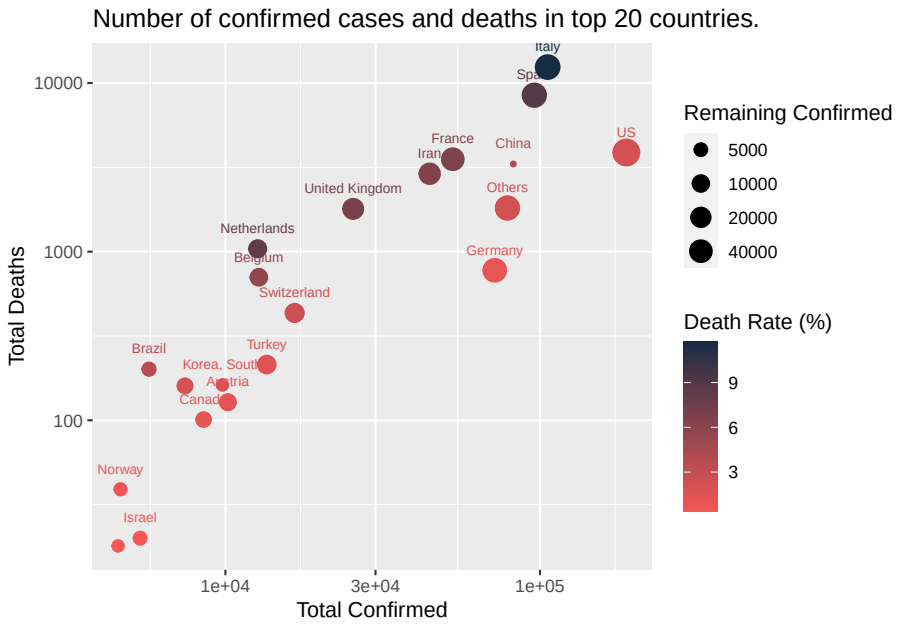
```
## Warning: Transformation introduced infinite values in continuous x-axis
```

```
## Warning: Transformation introduced infinite values in continuous y-axis
```



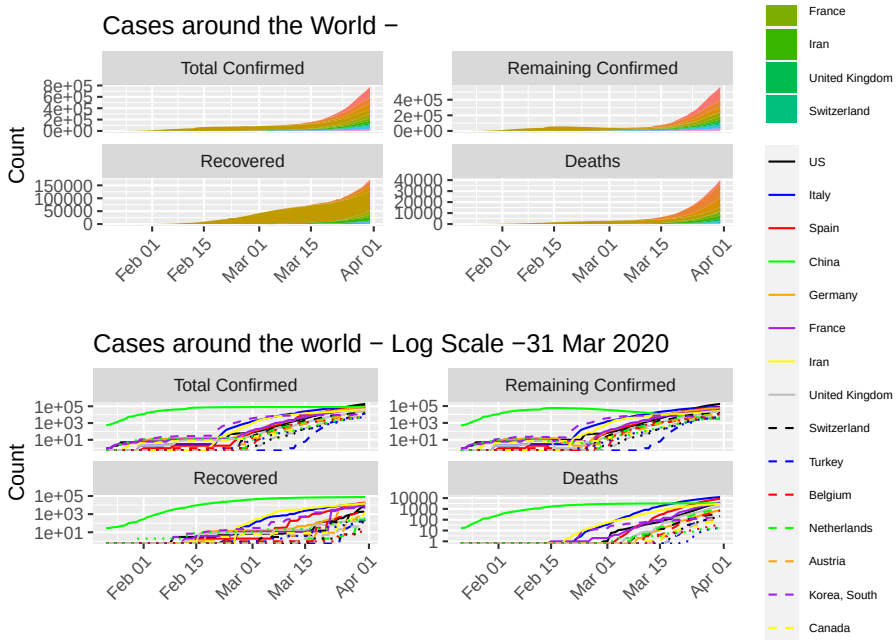
Number of confirmed cases and deaths in top 20 countries.

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

plot1 <- df %>% ggplot(aes(x=confirmed, y=deaths, col=death.rate, size=remaining.confirmed))
scale_size(name='Remaining 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='#f75656', high='#132B43') +
scale_x_log10() + scale_y_log10()
plot1
```

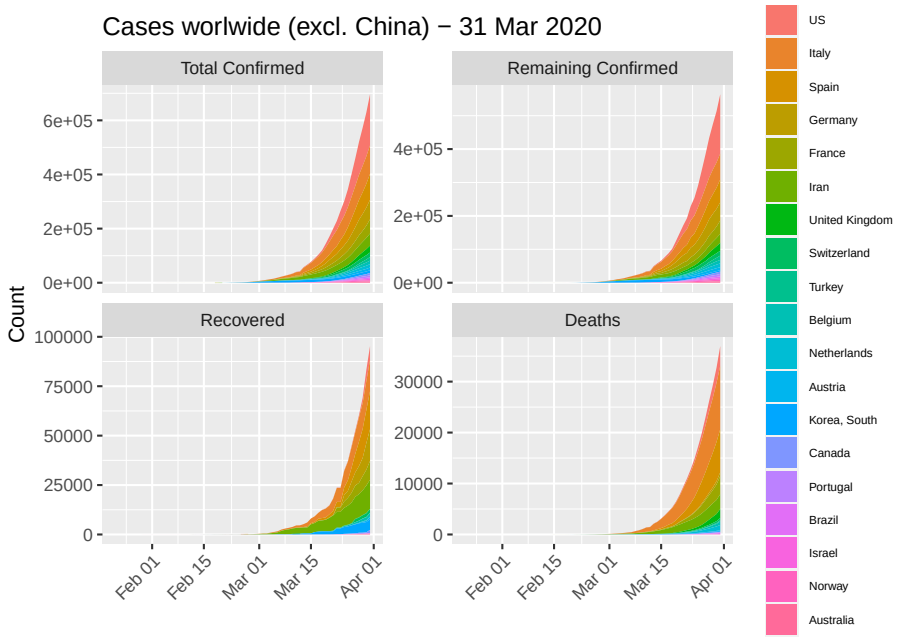



```
df <- data.long %>% filter(country %in% top.countries) %<>% mutate(country=country %>% facto

### CASES AROUND WORLD
p <- df%>% filter(country !='World') %>%
  ggplot(aes(x=date, y=count)) + xlab('') + ylab('Count') +
  theme(legend.title=element_blank(),
        legend.text = element_text(size=6),
        legend.key.size=unit(0.6, 'cm'),
        axis.text.x=element_text(angle = 45, hjust=1)) +
  facet_wrap(~type, ncol = 2, scale='free_y')
# area plot
plot1 <- p + geom_area(aes(fill=country)) +
  labs(title='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)
```

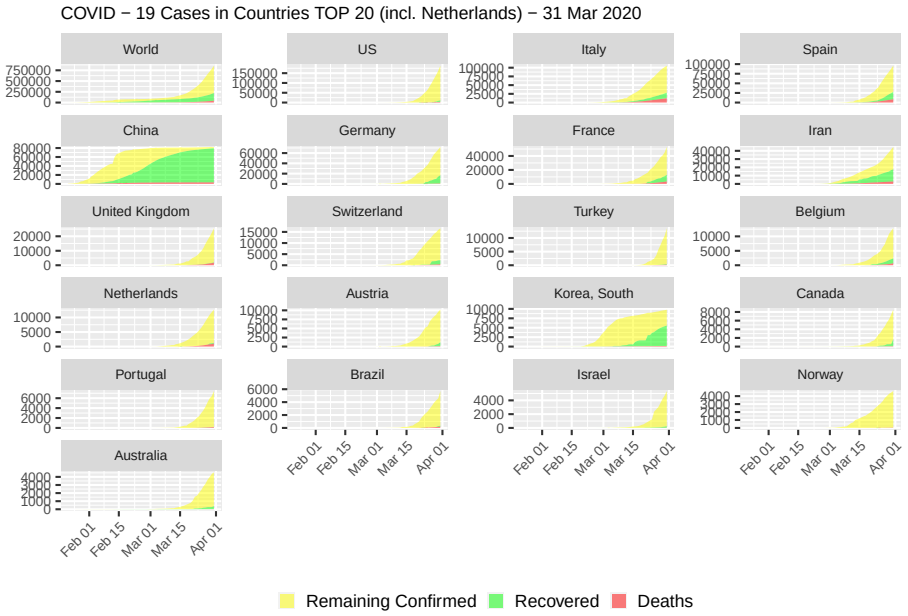
```
## Warning: Transformation introduced infinite values in continuous y-axis
```




```
# 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=6),
        legend.key.size=unit(0.6, 'cm'),
        axis.text.x=element_text(angle = 45, hjust=1)) +
  facet_wrap(~type, ncol = 2, scale='free_y')
p + geom_area(aes(fill=country)) +
  labs(title=paste0('Cases worlwide (excl. China) - ', max.date.txt))
```




```
# # # list(countries) == 'Netherlands'

## If The Netherland is not top 20, add it in and remove 'Others'
if(!('Netherlands' %in% top.countries)) {
  top.countries %<>% setdiff('Others') %>% c('Netherlands')
  df <- data.long %>% filter(country %in% top.countries) %>%
    mutate(country=country %>% factor(levels = c(top.countries)))
}

# cases by country - area plot
df %>% filter(type != 'World' & type !='Total Confirmed') %>%
  ggplot(aes(x=date, y=count, fill=type)) +
  geom_area(alpha=0.5) +
  labs(title = paste0('COVID - 19 Cases in Countries TOP 20 (incl. Netherlands) - ', max.dat
  scale_fill_manual(values=c('yellow','green','red')) +
  theme(legend.title=element_blank(), legend.position='bottom',
        plot.title= element_text(size = 9),
        axis.title.x=element_blank(),
        axis.title.y = element_blank(),
        legend.key.size = unit(0.3, 'cm'),
        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, scale='free_y') + facet_wrap(~country, ncol=4, scales = 'free
```



Deaths rate:

```
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)
```

```
## Warning: Removed 36 row(s) containing missing values (geom_path).
```

Countries with Highest Death Rates

```
## 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, confirmed.new, remaining.confirmed,
         recovered, deaths, deaths.new, 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
kable_styling(font_size=7, latex_options=c('striped', 'hold_position', 'repeat_header'))
```

Note that this is an developing story. Check back for updates.

Table 2: Top 20 Countries with Highest Death Rates - 31 Mar 2020

	country	confirmed	confirmed.new	remaining.confirmed	recovered	deaths	deaths.new	death.rate
1	Italy	105,792	4,053	77,635	15,729	12,428	837	11.7%
2	San Marino	236	6	197	13	26	1	11.0%
3	Indonesia	1,528	114	1,311	81	136	14	8.9%
4	Spain	95,923	7,967	68,200	19,259	8,464	748	8.8%
5	Netherlands	12,667	850	11,374	253	1,040	175	8.2%
6	Iraq	694	64	474	170	50	4	7.2%
7	United Kingdom	25,481	3,028	23,509	179	1,793	382	7.0%
8	France	52,827	7,657	39,782	9,513	3,532	502	6.7%
9	Egypt	710	54	507	157	46	5	6.5%
10	Iran	44,605	3,110	27,051	14,656	2,898	141	6.5%
11	Albania	243	20	176	52	15	4	6.2%
12	Algeria	716	132	626	46	44	9	6.1%
13	Morocco	617	61	557	24	36	3	5.8%
14	Bolivia	107	10	101	0	6	2	5.6%
15	Belgium	12,775	876	10,374	1,696	705	192	5.5%
16	Burkina Faso	261	15	215	32	14	2	5.4%
17	Honduras	141	2	131	3	7	0	5.0%
18	Dominican Republic	1,109	208	1,053	5	51	9	4.6%
19	Philippines	2,084	538	1,947	49	88	10	4.2%
20	Sweden	4,435	407	4,239	16	180	34	4.1%