Data Science - COVID-19

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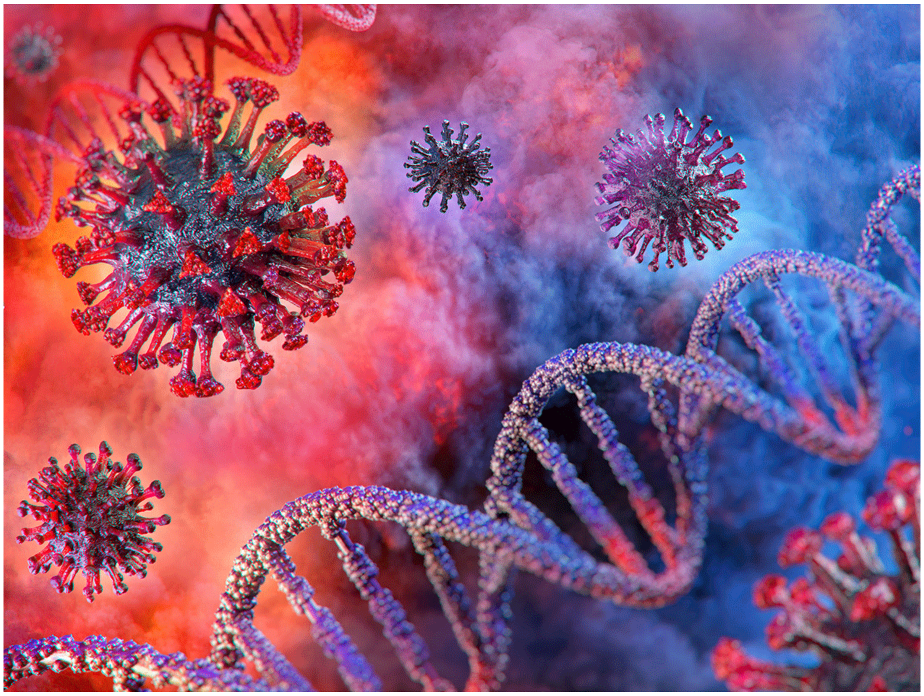


Analysis coronavirus disease (COVID-19).

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
```

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

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

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

```r
# 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')
```

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

```
## [1] 254  73
```

Below we check the time frame of data set

```
# 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" "2020-03-30"
```

```
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
```

```
# 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
## 60   Spain 2020-03-21     25374   1375      2125
## 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
```

```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"    "Belgium"        "Netherlands"    "Turkey"
## [13] "Korea, South"   "Austria"        "Canada"         "Portugal"
## [17] "Israel"         "Brazil"         "Norway"         "Australia"
```

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

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

```r
## 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

```r
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))
```

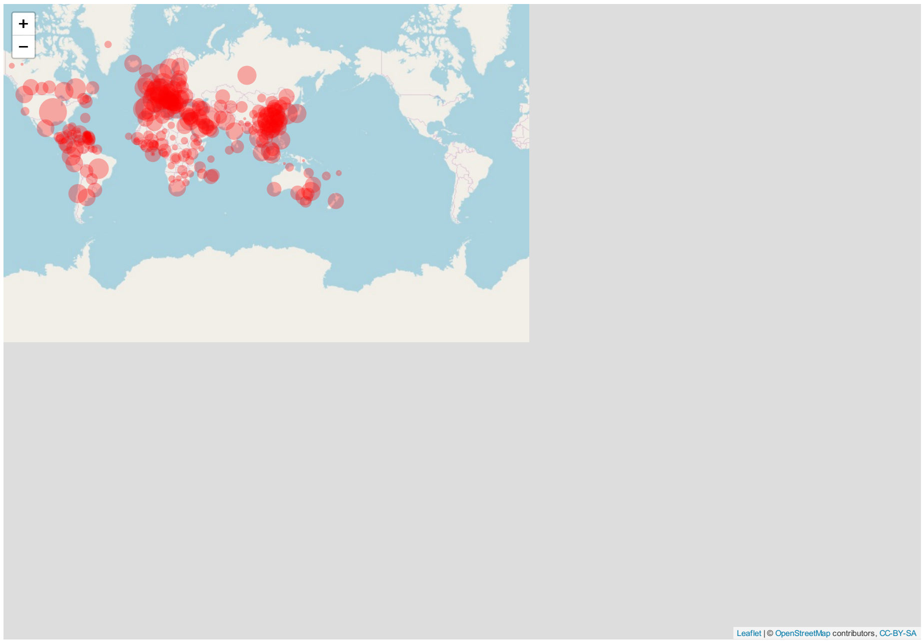
```
##                         Country.Region               Province.State        Lat
## 1                          Afghanistan                               33.000000
## 2                              Albania                               41.153300
## 3                              Algeria                               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 - 30 Mar 2020.

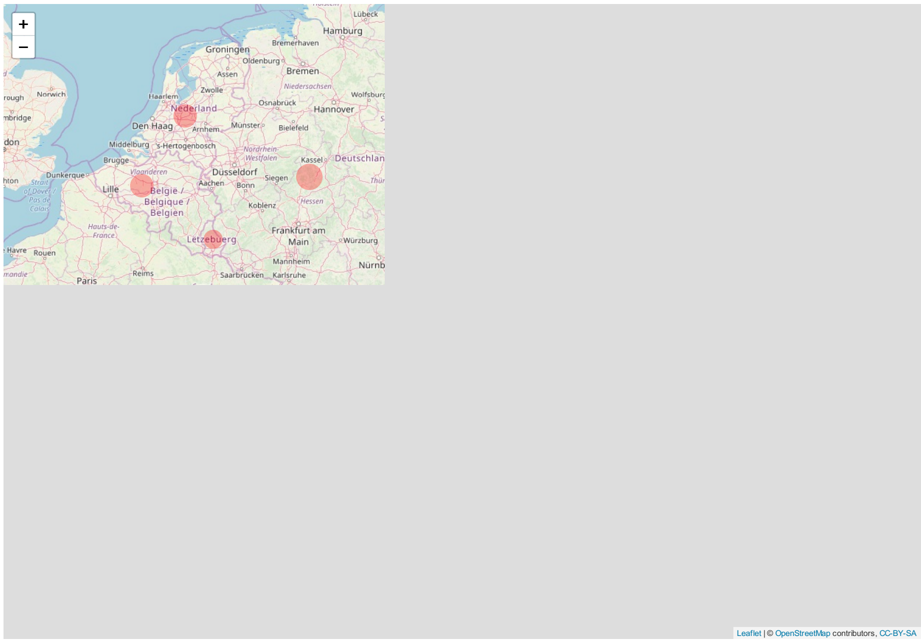
	country	confirmed	deaths	death.rate	confirmed.new	deaths.new	remaining.confirmed
1	World	782,365	37,582	4.8%	62,248	3,657	580,217
2	US	161,807	2,978	1.8%	20,921	511	153,185
3	Italy	101,739	11,591	11.4%	4,050	812	75,528
4	Spain	87,956	7,716	8.8%	7,846	913	63,460
5	China	82,198	3,308	4.0%	76	4	2,967
6	Germany	66,885	645	1.0%	4,790	112	52,740
7	France	45,170	3,030	6.7%	4,462	419	34,176
8	Iran	41,495	2,757	6.6%	3,186	117	24,827
9	United Kingdom	22,453	1,411	6.3%	2,673	180	20,871
10	Switzerland	15,922	359	2.3%	1,093	59	13,740
11	Belgium	11,899	513	4.3%	1,063	82	9,859
12	Netherlands	11,817	865	7.3%	887	93	10,699
13	Turkey	10,827	168	1.6%	1,610	37	10,497
14	Korea, South	9,661	158	1.6%	78	6	4,275
15	Austria	9,618	108	1.1%	830	22	8,874
16	Canada	7,398	80	1.1%	1,118	16	6,852
17	Portugal	6,408	140	2.2%	446	21	6,225
18	Israel	4,695	16	0.3%	448	1	4,518
19	Brazil	4,579	159	3.5%	323	23	4,300
20	Norway	4,445	32	0.7%	161	7	4,401
21	Australia	4,361	17	0.4%	377	1	4,087
22	Others	71,032	1,531	2.2%	5,810	221	64,136

```
## 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
##             Long confirmed                                       txt
## 1      65.000000       170                          Afghanistan-:170
## 2      20.168300       223                              Albania-:223
## 3       1.659600       584                              Algeria-:584
## 4       1.521800       370                              Andorra-:370
## 5      17.873900         7                                 Angola-:7
## 6     -61.796400         7                    Antigua and Barbuda-:7
## 7   -63.616700   820                            Argentina-:820
## 8    45.038200   482                              Armenia-:482
## 9   149.012400    78 Australia-Australian Capital Territory:78
## 10  151.209300  2032            Australia-New South Wales:2032
## 11  130.845600    15           Australia-Northern Territory:15
## 12  153.400000   689                  Australia-Queensland:689
## 13  138.600700   305             Australia-South Australia:305
## 14  145.970700    66                     Australia-Tasmania:66
## 15  144.963100   821                    Australia-Victoria:821
## 16  115.860500   355           Australia-Western Australia:355
## 17   14.550100  9618                             Austria-:9618
## 18   47.576900   273                           Azerbaijan-:273
## 19  -77.396300    14                               Bahamas-:14
## 20   50.550000   515                              Bahrain-:515
## 21   90.356300    49                            Bangladesh-:49
## 22  -59.543200    33                              Barbados-:33
## 23   27.953400   152                              Belarus-:152
## 24    4.000000 11899                            Belgium-:11899
## 25    2.315800     6                                  Benin-:6
## 26   90.433600     4                                 Bhutan-:4
## 27  -63.588700    97                               Bolivia-:97
## 28   17.679100   368               Bosnia and Herzegovina-:368
## 29  -51.925300  4579                              Brazil-:4579
## 30  114.727700   127                               Brunei-:127
## 31   25.485800   359                             Bulgaria-:359
## 32   -1.561600   246                         Burkina Faso-:246
## 33  -23.041800     6                             Cabo Verde-:6
## 34  104.916700   107                             Cambodia-:107
## 35   11.502100   139                             Cameroon-:139
## 36 -116.576500   661                        Canada-Alberta:661
## 37 -123.120700   970               Canada-British Columbia:970
## 38 -122.665500    13                  Canada-Grand Princess:13
## 39  -98.813900    96                        Canada-Manitoba:96
## 40  -66.461900    68                   Canada-New Brunswick:68
## 41  -57.660400   148      Canada-Newfoundland and Labrador:148
## 42  -63.744300   127                    Canada-Nova Scotia:127
## 43  -85.323200  1706                       Canada-Ontario:1706
## 44  -63.416800    18            Canada-Prince Edward Island:18
## 45  -73.549100  3430                        Canada-Quebec:3430
## 46 -106.450900   156                   Canada-Saskatchewan:156
## 47   20.939400     3               Central African Republic-:3
## 48   18.732200     5                                   Chad-:5
## 49  -71.543000  2449                               Chile-:2449
## 50  117.226400   990                           China-Anhui:990
## 51  116.414200   577                         China-Beijing:577
## 52  107.874000   579                       China-Chongqing:579
## 53   117.987400       340                          China-Fujian:340
## 54   101.058300       138                           China-Gansu:138
## 55   113.424400      1484                      China-Guangdong:1484
## 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       682                       China-Hong Kong:682
## 63   112.270700     67801                         China-Hubei:67801
## 64   111.708800      1018                          China-Hunan:1018
## 65   113.944800        97                   China-Inner Mongolia:97
## 66   119.455000       645                         China-Jiangsu:645
## 67   115.722100       937                         China-Jiangxi:937
## 68   126.192300        98                            China-Jilin:98
## 69   122.608500       136                        China-Liaoning:136
## 70   113.550000        38                            China-Macau:38
## 71   106.165500        75                          China-Ningxia:75
## 72    95.995600        18                          China-Qinghai:18
## 73   108.870100       253                         China-Shaanxi:253
## 74   118.149800       773                        China-Shandong:773
## 75   121.449100       498                        China-Shanghai:498
## 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       180                          China-Yunnan:180
## 82   120.093400      1255                       China-Zhejiang:1255
## 83   -74.297300       798                              Colombia-:798
## 84    21.758700        19                   Congo (Brazzaville)-:19
## 85    21.758700        81                      Congo (Kinshasa)-:81
## 86   -83.753400       330                           Costa Rica-:330
## 87    -5.547100       168                        Cote d'Ivoire-:168
## 88    15.200000       790                              Croatia-:790
## 89     0.000000       712                     Diamond Princess-:712
## 90   -80.000000       170                                 Cuba-:170
## 91    33.429900       230                               Cyprus-:230
## 92    15.473000      3001                             Czechia-:3001
## 93    -6.911800       168                 Denmark-Faroe Islands:168
## 94   -42.604300        10                      Denmark-Greenland:10
## 95     9.501800      2577                             Denmark-:2577
## 96    42.590300        18                              Djibouti-:18
## 97   -70.162700       901                   Dominican Republic-:901
## 98   -78.183400      1962                             Ecuador-:1962
## 99    30.000000       656                                Egypt-:656
## 100  -88.896500        30                           El Salvador-:30
## 101   10.000000        12                     Equatorial Guinea-:12
## 102   39.782300        12                               Eritrea-:12
## 103   25.013600       715                              Estonia-:715
## 104   31.465900         9                               Eswatini-:9
## 105   40.489700        23                              Ethiopia-:23
## 106  178.065000         5                                   Fiji-:5
## 107   26.000000      1352                             Finland-:1352
## 108  -53.125800        43                   France-French Guiana:43
## 109  149.406800        36                France-French Polynesia:36
## 110  -61.583300       106                     France-Guadeloupe:106
## 111   45.166200        82                         France-Mayotte:82
## 112  165.618000        15                   France-New Caledonia:15
## 113   55.247100       224                        France-Reunion:224
## 114  -62.833300         6                 France-Saint Barthelemy:6
## 115  -63.050100        15                       France-St Martin:15
## 116  -61.024200        93                      France-Martinique:93
## 117    2.213700     44550                             France-:44550
## 118   11.609400         7                                  Gabon-:7
## 119  -15.310100         4                                 Gambia-:4
## 120   43.356900       103                              Georgia-:103
## 121    9.000000     66885                            Germany-:66885
## 122   -1.023200       152                                Ghana-:152
## 123   21.824300      1212                              Greece-:1212
## 124  -90.230800        36                             Guatemala-:36
## 125   -9.696600        22                                Guinea-:22
## 126  -58.750000         8                                 Guyana-:8
## 127  -72.285200        15                                 Haiti-:15
## 128   12.453400         6                               Holy See-:6
## 129  -86.241900       139                             Honduras-:139
## 130   19.503300       447                              Hungary-:447
## 131  -19.020800      1086                             Iceland-:1086
## 132   78.000000      1251                               India-:1251
## 133  113.921300      1414                           Indonesia-:1414
## 134   53.000000     41495                               Iran-:41495
## 135   44.000000       630                                 Iraq-:630
## 136   -7.692100      2910                             Ireland-:2910
## 137   35.000000      4695                              Israel-:4695
## 138   12.000000    101739                             Italy-:101739
## 139  -77.297500        36                               Jamaica-:36
## 140  138.000000      1866                               Japan-:1866
## 141   36.510000       268                               Jordan-:268
## 142   66.923700       302                           Kazakhstan-:302
## 143   37.906200        50                                 Kenya-:50
## 144  128.000000      9661                        Korea, South-:9661
## 145   47.750000       266                               Kuwait-:266
## 146   74.766100        94                            Kyrgyzstan-:94
## 147   24.603200       376                               Latvia-:376
## 148   35.862300       446                              Lebanon-:446
## 149   -9.429500         3                                Liberia-:3
## 150    9.550000        62                         Liechtenstein-:62
## 151   23.881300       491                            Lithuania-:491
## 152    6.129600      1988                          Luxembourg-:1988
## 153   46.869100        43                            Madagascar-:43
## 154  112.500000      2626                            Malaysia-:2626
## 155   73.220700        17                              Maldives-:17
## 156   14.375400       156                                Malta-:156
## 157   10.940800         5                             Mauritania-:5
## 158   57.500000       128                            Mauritius-:128
## 159 -102.552800       993                               Mexico-:993
## 160   28.369900       298                              Moldova-:298
## 161    7.416700        49                                Monaco-:49
## 162  103.846700        12                              Mongolia-:12
## 163   19.300000        91                            Montenegro-:91
## 164   -7.092600       556                              Morocco-:556
## 165   18.490400        11                               Namibia-:11
## 166   84.250000         5                                  Nepal-:5
## 167  -70.035800        50                      Netherlands-Aruba:50
## 168  -68.990000        11                    Netherlands-Curacao:11
## 169  -63.054800         6                Netherlands-Sint Maarten:6
## 170    5.291300     11750                        Netherlands-:11750
## 171  174.886000       589                          New Zealand-:589
## 172  -85.207200         4                              Nicaragua-:4
## 173    8.081700        27                                 Niger-:27
## 174    8.675300       131                              Nigeria-:131
## 175   21.745300       285                      North Macedonia-:285
## 176    8.468900      4445                              Norway-:4445
## 177   57.000000       179                                 Oman-:179
## 178   69.345100      1717                            Pakistan-:1717
## 179  -80.782100       989                               Panama-:989
## 180  143.955500         1                       Papua New Guinea-:1
## 181  -58.443800        64                              Paraguay-:64
## 182  -75.015200       950                                 Peru-:950
## 183  122.000000      1546                         Philippines-:1546
## 184   19.145100      2055                              Poland-:2055
## 185   -8.224500      6408                            Portugal-:6408
## 186   51.183900       693                                Qatar-:693
## 187   24.966800      2109                             Romania-:2109
## 188   90.000000      1836                              Russia-:1836
## 189   29.873900        70                                Rwanda-:70
## 190  -60.978900         9                            Saint Lucia-:9
## 191  -61.287200         1       Saint Vincent and the Grenadines-:1
## 192   12.457800       230                           San Marino-:230
## 193   45.000000      1453                        Saudi Arabia-:1453
## 194  -14.452400       162                              Senegal-:162
## 195   21.005900       785                               Serbia-:785
## 196   55.492000         8                             Seychelles-:8
## 197  103.833300       879                            Singapore-:879
## 198   19.699000       336                             Slovakia-:336
## 199   14.995500       756                             Slovenia-:756
## 200   46.199600         3                                Somalia-:3
## 201   22.937500      1326                        South Africa-:1326
## 202   -4.000000     87956                              Spain-:87956
## 203   81.000000       122                            Sri Lanka-:122
## 204   30.217600         6                                  Sudan-:6
## 205  -56.027800         8                               Suriname-:8
## 206   16.000000      4028                              Sweden-:4028
## 207    8.227500     15922                        Switzerland-:15922
## 208  121.000000       306                              Taiwan*-:306
## 209   34.888800        19                              Tanzania-:19
## 210  101.000000      1524                            Thailand-:1524
## 211    0.824800        30                                  Togo-:30
## 212  -61.222500        82                   Trinidad and Tobago-:82
## 213    9.000000       312                              Tunisia-:312
## 214   35.243300     10827                             Turkey-:10827
## 215   32.000000        33                                Uganda-:33
## 216   31.165600       548                              Ukraine-:548
## 217   54.000000       611                 United Arab Emirates-:611
## 218  -64.750500        27                 United Kingdom-Bermuda:27
## 219  -81.254600        12          United Kingdom-Cayman Islands:12
## 220   -2.364400       141        United Kingdom-Channel Islands:141
## 221   -5.353600        69               United Kingdom-Gibraltar:69
## 222   -4.548100        49             United Kingdom-Isle of Man:49
## 223  -62.187400         5               United Kingdom-Montserrat:5
## 224   -3.436000     22141                     United Kingdom-:22141
## 225  -55.765800       310                              Uruguay-:310
## 226  -95.712900    161807                                US-:161807
## 227   64.585300       149                           Uzbekistan-:149
## 228  -66.589700       135                            Venezuela-:135
## 229  108.000000       203                              Vietnam-:203
## 230   28.283300        35                                Zambia-:35
## 231   30.000000         7                               Zimbabwe-:7
## 232    0.000000         0                 Canada-Diamond Princess:0
## 233  -61.371000        11                              Dominica-:11
## 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         8                                   Laos-:8
## 241   17.228331         8                                  Libya-:8
## 242   35.233200       116                   West Bank and Gaza-:116
## 243  -15.180400         8                          Guinea-Bissau-:8
## 244   -3.996166        25                                  Mali-:25
## 245  -62.782998         7                  Saint Kitts and Nevis-:7
## 246 -124.845700         1            Canada-Northwest Territories:1
## 247 -135.000000         4                            Canada-Yukon:4
## 248   20.902977        94                                Kosovo-:94
## 249   95.956000        14                                 Burma-:14
## 250  -63.068600         2                 United Kingdom-Anguilla:2
## 251  -64.640000         2   United Kingdom-British Virgin Islands:2
## 252  -71.797900         5 United Kingdom-Turks and Caicos Islands:5
## 253    0.000000         2                             MS Zaandam-:2
## 254   24.684900         3                               Botswana-:3
```

```r
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
```



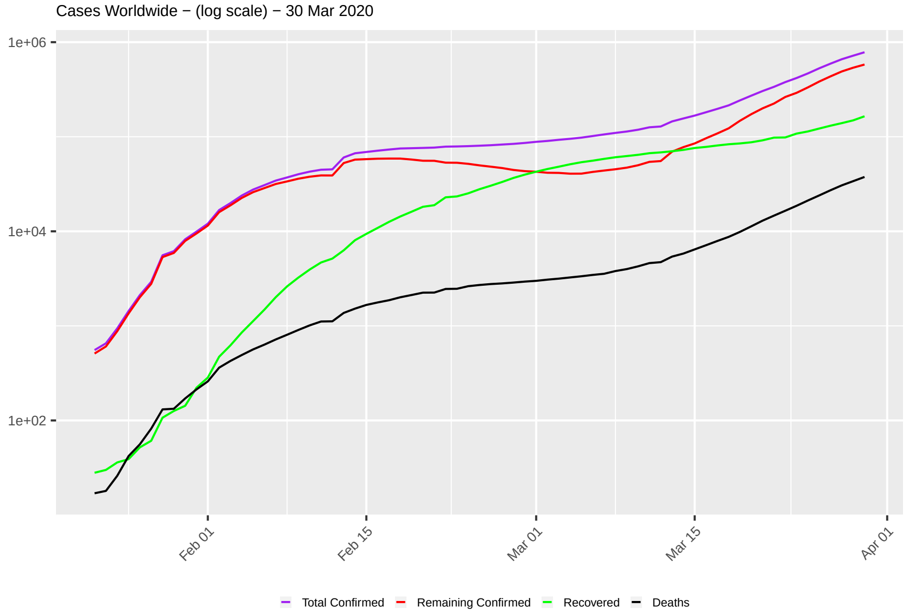
```
map %>% setView(5, 52,zoom = 6)
```



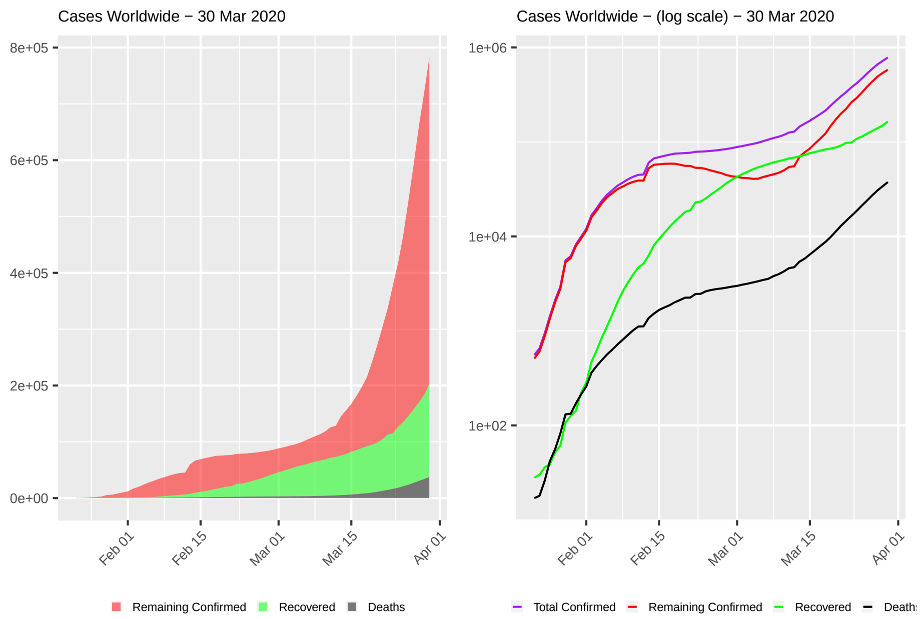
Number of cases:

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

```
# 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:

```
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))
```

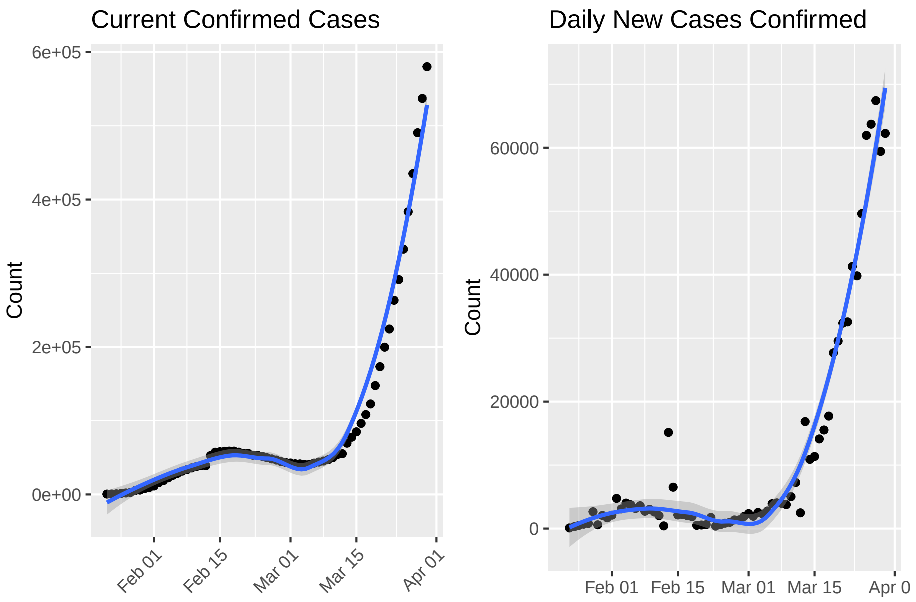
```
## List of 1
##  $ axis.text.x:List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : NULL
##   ..$ angle        : num 45
##   ..$ lineheight   : NULL
##   ..$ margin       : 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
```

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

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

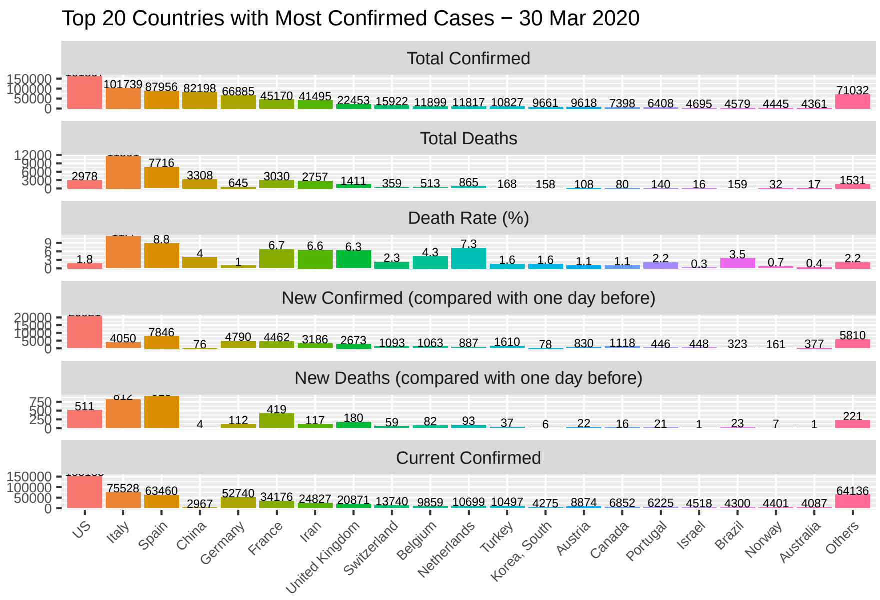
```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

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

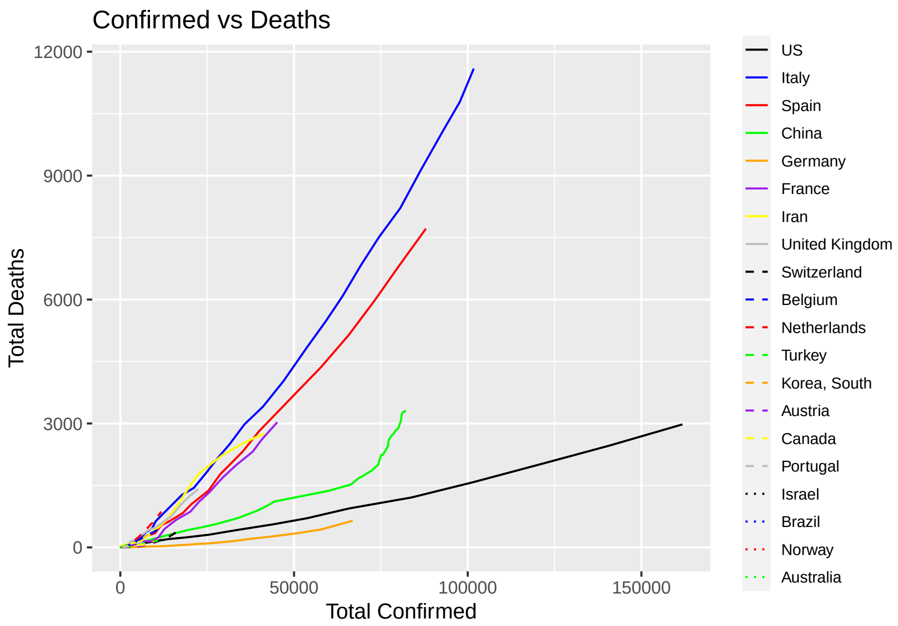


Bar Chart

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


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
```

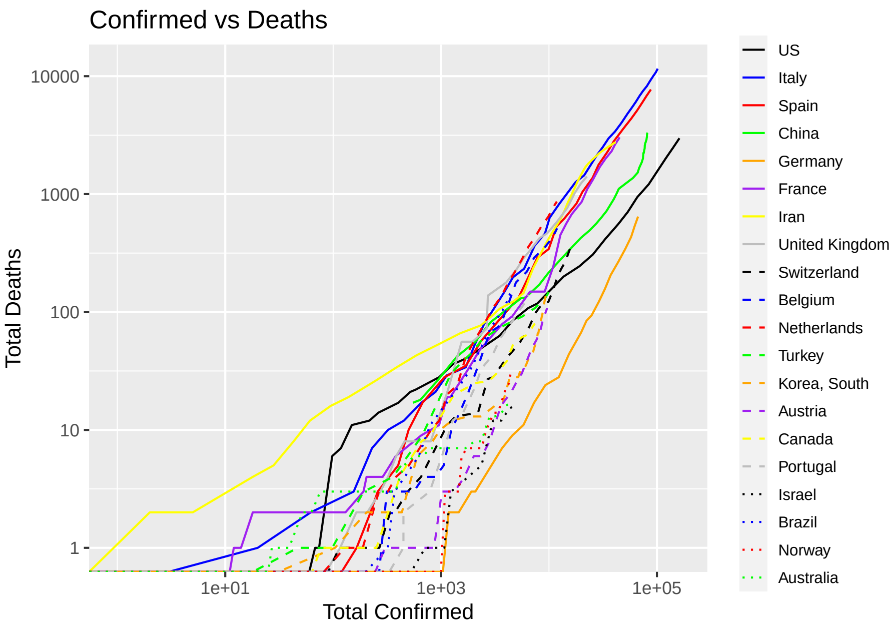


```
# Confirmed versus Deaths
linetypes <- rep(c("solid", "dashed", "dotted"), each=8)
colors <- rep(c('black', 'blue', 'red', 'green', 'orange', 'purple', 'yellow', 'grey'), 3)
df <- data %>% filter(country %in% setdiff(top.countries, c('World', 'Others'))) %>%
mutate(country=country %>% factor(levels=c(top.countries)))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



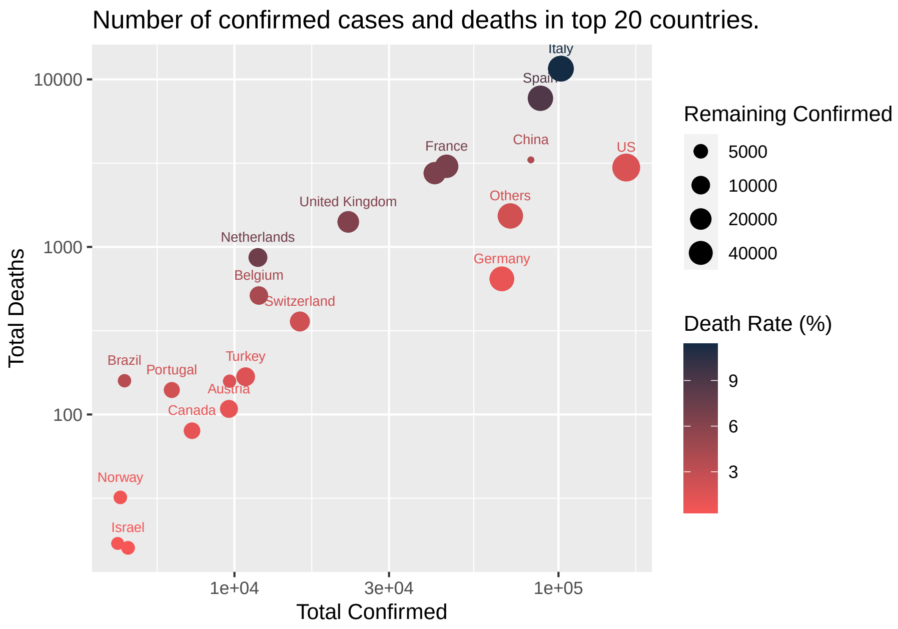
```
vs + scale_x_log10() + scale_y_log10()
```

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

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



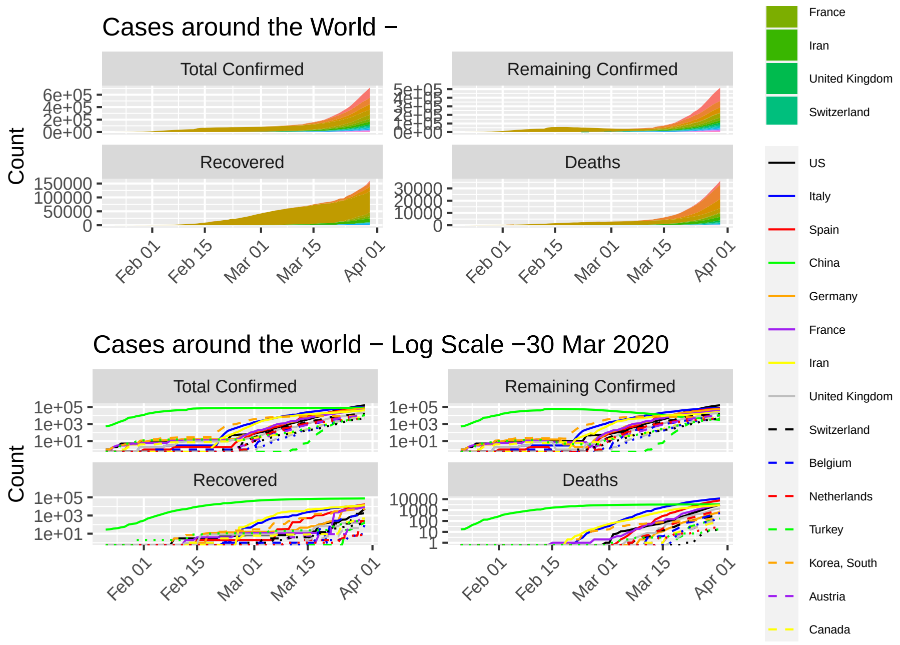
Number of confirmed cases and deaths in top 20 countries.

```
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
```

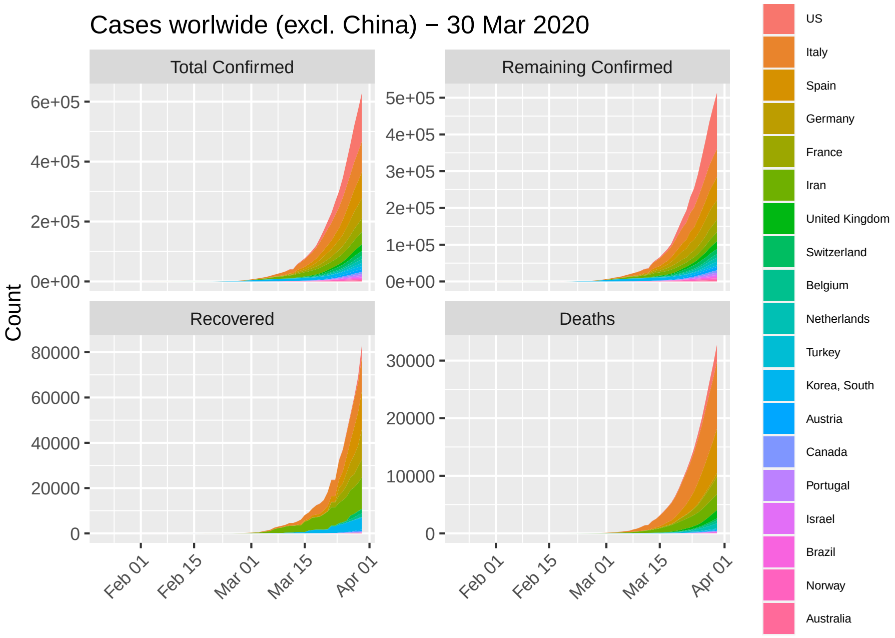


```
df <- data.long %>% filter(country %in% top.countries) %<>% mutate(country=country %>% facto

### 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)
```

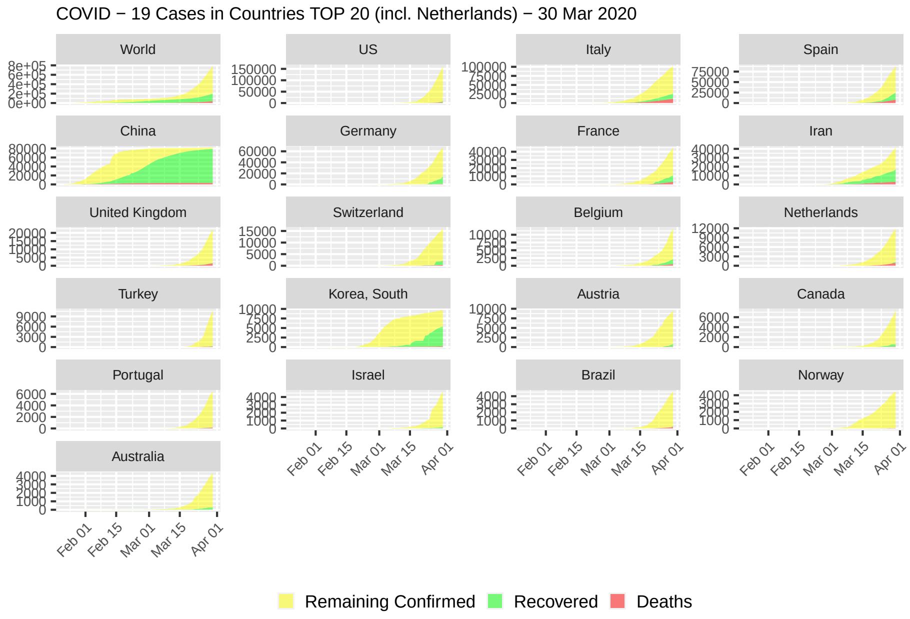
```
## Warning: Transformation introduced infinite values in continuous y-axis
```



```r
# 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))
```



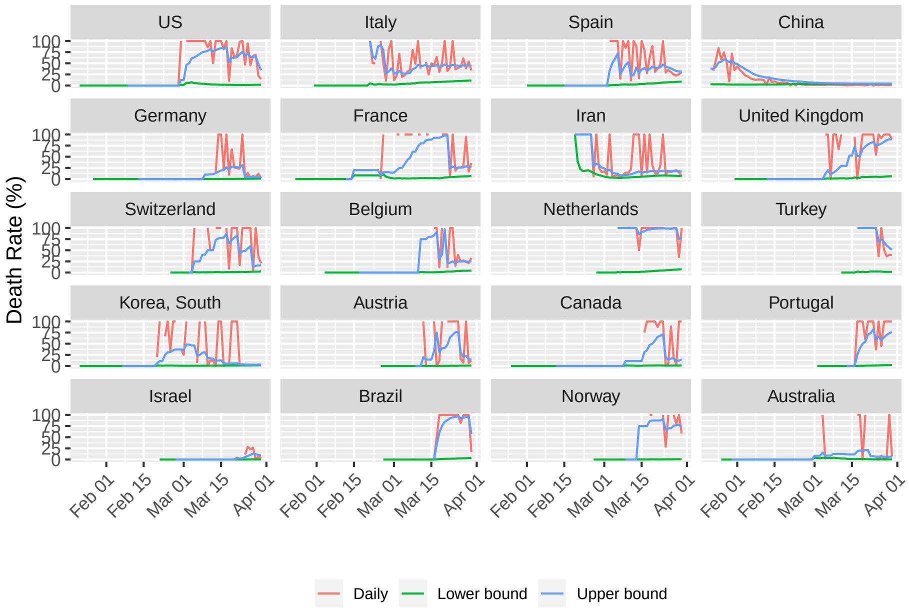
```
# # # list(countries) == 'Netherlands'

## 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 - 30 Mar 2020

	country	confirmed	confirmed.new	remaining.confirmed	recovered	deaths	deaths.new	death.rate
1	Italy	101,739	4,050	75,528	14,620	11,591	812	11.4%
2	San Marino	230	6	192	13	25	3	10.9%
3	Spain	87,956	7,846	63,460	16,780	7,716	913	8.8%
4	Indonesia	1,414	129	1,217	75	122	8	8.6%
5	Iraq	630	83	432	152	46	4	7.3%
6	Netherlands	11,817	887	10,699	253	865	93	7.3%
7	France	45,170	4,462	34,176	7,964	3,030	419	6.7%
8	Iran	41,495	3,186	24,827	13,911	2,757	117	6.6%
9	United Kingdom	22,453	2,673	20,871	171	1,411	180	6.3%
10	Egypt	656	47	465	150	41	1	6.2%
11	Algeria	584	73	512	37	35	4	6.0%
12	Morocco	556	77	508	15	33	7	5.9%
13	Honduras	139	29	129	3	7	4	5.0%
14	Philippines	1,546	128	1,426	42	78	7	5.0%
15	Albania	223	11	168	44	11	1	4.9%
16	Burkina Faso	246	24	203	31	12	0	4.9%
17	Dominican Republic	901	42	855	4	42	3	4.7%
18	Belgium	11,899	1,063	9,859	1,527	513	82	4.3%
19	Cameroon	139	0	128	5	6	0	4.3%
20	China	82,198	76	2,967	75,923	3,308	4	4.0%