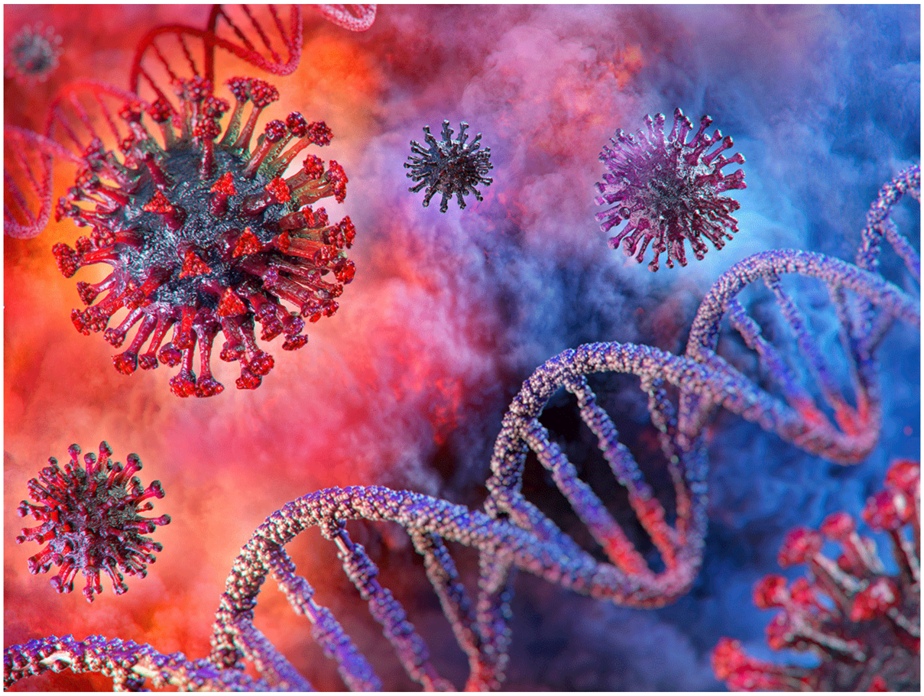
Data Science - COVID-19

Carlos Utrilla Guerrero

3/26/2020



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] 249  70
```

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" "2020-03-27"
```

```
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
## 57   Spain 2020-03-18     13910    623      1081
## 58   Spain 2020-03-19     17963    830      1107
## 59   Spain 2020-03-20     20410   1043      1588
## 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
```

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

```
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))
```

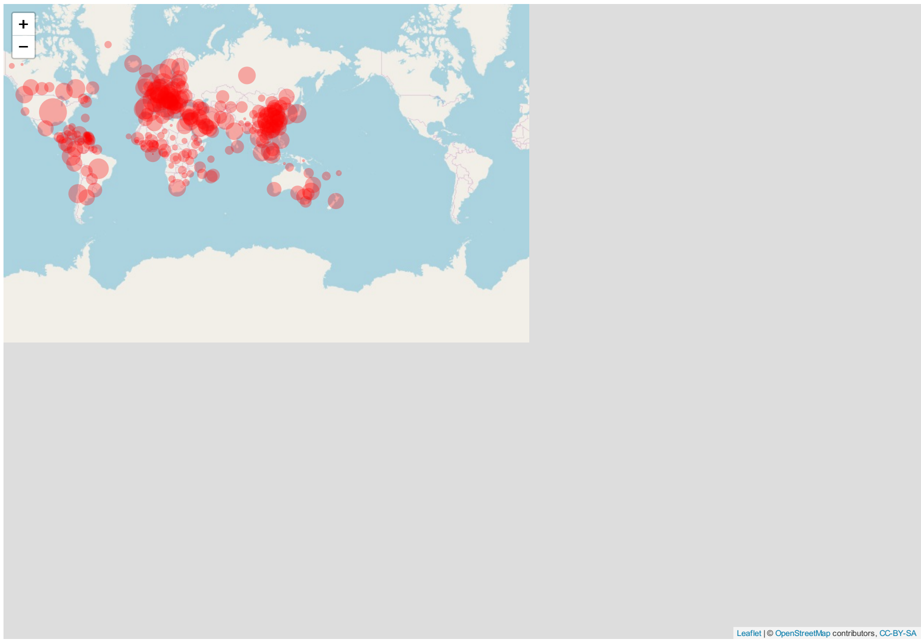
```
##                       Country.Region               Province.State        Lat
## 1                        Afghanistan                               33.000000
## 2                            Albania                               41.153300
## 3                            Algeria                               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 - 27 Mar 2020.

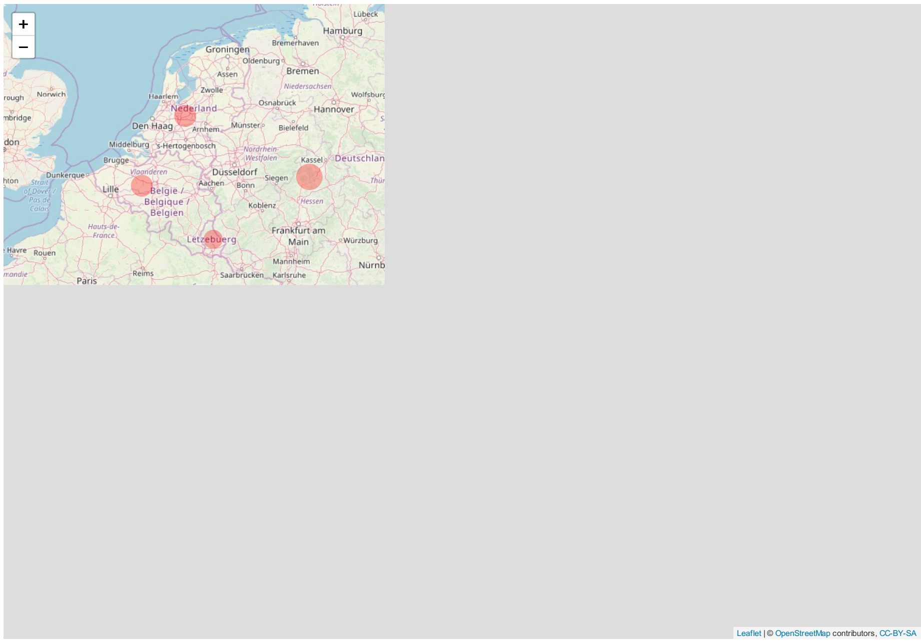
	country	confirmed	deaths	death.rate	confirmed.new	deaths.new	remaining.confirmed
1	World	593,291	27,198	4.6%	63,700	3,228	435,178
2	US	101,657	1,581	1.6%	17,821	372	99,207
3	Italy	86,498	9,134	10.6%	5,909	919	66,414
4	China	81,897	3,296	4.0%	115	5	3,881
5	Spain	65,719	5,138	7.8%	7,933	773	51,224
6	Germany	50,871	342	0.7%	6,933	75	43,871
7	France	33,402	1,997	6.0%	3,851	299	25,698
8	Iran	32,332	2,378	7.4%	2,926	144	18,821
9	United Kingdom	14,745	761	5.2%	2,933	181	13,833
10	Switzerland	12,928	231	1.8%	1,117	40	11,167
11	Korea, South	9,332	139	1.5%	91	8	4,665
12	Netherlands	8,647	547	6.3%	1,179	112	8,094
13	Austria	7,657	58	0.8%	748	9	7,374
14	Belgium	7,284	289	4.0%	1,049	69	6,137
15	Turkey	5,698	92	1.6%	2,069	17	5,564
16	Canada	4,682	54	1.2%	640	16	4,372
17	Portugal	4,268	76	1.8%	724	16	4,149
18	Norway	3,755	19	0.5%	386	5	3,730
19	Brazil	3,417	92	2.7%	432	15	3,319
20	Australia	3,143	13	0.4%	333	0	2,936
21	Sweden	3,069	105	3.4%	229	28	2,948
22	Others	52,290	856	1.6%	6,282	125	47,774

```
## 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
##            Long confirmed                                       txt
## 1     65.000000       110                          Afghanistan-:110
## 2     20.168300       186                              Albania-:186
## 3      1.659600       409                              Algeria-:409
## 4      1.521800       267                              Andorra-:267
## 5     17.873900         4                                 Angola-:4
## 6    -61.796400         7                    Antigua and Barbuda-:7
## 7    -63.616700       589                            Argentina-:589
## 8     45.038200       329                              Armenia-:329
## 9    149.012400        62 Australia-Australian Capital Territory:62
## 10   151.209300      1405            Australia-New South Wales:1405
## 11   130.845600        12           Australia-Northern Territory:12
## 12   153.400000       555                  Australia-Queensland:555
## 13   138.600700       257             Australia-South Australia:257
## 14   145.970700        47                     Australia-Tasmania:47
## 15   144.963100       574                    Australia-Victoria:574
## 16   115.860500       231           Australia-Western Australia:231
## 17    14.550100      7657                             Austria-:7657
## 18    47.576900       165                           Azerbaijan-:165
## 19   -77.396300        10                               Bahamas-:10
## 20    50.550000       466                              Bahrain-:466
## 21    90.356300        48                            Bangladesh-:48
## 22   -59.543200        24                              Barbados-:24
## 23    27.953400        94                               Belarus-:94
## 24     4.000000      7284                             Belgium-:7284
## 25     2.315800         6                                  Benin-:6
## 26    90.433600         3                                 Bhutan-:3
## 27   -63.588700        61                               Bolivia-:61
## 28    17.679100       237               Bosnia and Herzegovina-:237
## 29   -51.925300      3417                              Brazil-:3417
## 30   114.727700       115                               Brunei-:115
## 31    25.485800       293                             Bulgaria-:293
## 32    -1.561600       180                         Burkina Faso-:180
## 33   -23.041800         5                             Cabo Verde-:5
## 34   104.916700        99                              Cambodia-:99
## 35    11.502100        91                              Cameroon-:91
## 36  -116.576500       542                        Canada-Alberta:542
## 37  -123.120700       725               Canada-British Columbia:725
## 38  -122.665500        13                  Canada-Grand Princess:13
## 39   -98.813900        39                        Canada-Manitoba:39
## 40   -66.461900        45                   Canada-New Brunswick:45
## 41   -57.660400       102      Canada-Newfoundland and Labrador:102
## 42   -63.744300        90                     Canada-Nova Scotia:90
## 43   -85.323200       994                        Canada-Ontario:994
## 44   -63.416800         9             Canada-Prince Edward Island:9
## 45   -73.549100      2024                        Canada-Quebec:2024
## 46  -106.450900        95                    Canada-Saskatchewan:95
## 47    20.939400         3               Central African Republic-:3
## 48    18.732200         3                                   Chad-:3
## 49   -71.543000      1610                               Chile-:1610
## 50   117.226400       990                           China-Anhui:990
## 51   116.414200       569                         China-Beijing:569
## 52   107.874000       578                       China-Chongqing:578
## 53   117.987400       331                          China-Fujian:331
## 54   101.058300       136                           China-Gansu:136
## 55   113.424400      1456                      China-Guangdong:1456
## 56   108.788100       254                         China-Guangxi:254
## 57   106.874800       146                         China-Guizhou:146
## 58   109.745300       168                          China-Hainan:168
## 59   116.130600       319                           China-Hebei:319
## 60   127.761500       484                    China-Heilongjiang:484
## 61   113.614000      1275                          China-Henan:1275
## 62   114.200000       519                       China-Hong Kong:519
## 63   112.270700     67801                         China-Hubei:67801
## 64   111.708800      1018                          China-Hunan:1018
## 65   113.944800        92                   China-Inner Mongolia:92
## 66   119.455000       641                         China-Jiangsu:641
## 67   115.722100       936                         China-Jiangxi:936
## 68   126.192300        95                            China-Jilin:95
## 69   122.608500       128                        China-Liaoning:128
## 70   113.550000        33                            China-Macau:33
## 71   106.165500        75                          China-Ningxia:75
## 72    95.995600        18                          China-Qinghai:18
## 73   108.870100       253                         China-Shaanxi:253
## 74   118.149800       772                        China-Shandong:772
## 75   121.449100       468                        China-Shanghai:468
## 76   112.292200       135                          China-Shanxi:135
## 77   102.710300       548                         China-Sichuan:548
## 78   117.323000       155                         China-Tianjin:155
## 79    88.092400         1                             China-Tibet:1
## 80    85.240100        76                         China-Xinjiang:76
## 81   101.487000       180                          China-Yunnan:180
## 82   120.093400      1247                       China-Zhejiang:1247
## 83   -74.297300       539                              Colombia-:539
## 84    21.758700         4                    Congo (Brazzaville)-:4
## 85    21.758700        51                      Congo (Kinshasa)-:51
## 86   -83.753400       263                           Costa Rica-:263
## 87    -5.547100       101                        Cote d'Ivoire-:101
## 88    15.200000       586                              Croatia-:586
## 89     0.000000       712                     Diamond Princess-:712
## 90   -80.000000        80                                  Cuba-:80
## 91    33.429900       162                               Cyprus-:162
## 92    15.473000      2279                             Czechia-:2279
## 93    -6.911800       144                 Denmark-Faroe Islands:144
## 94   -42.604300        10                      Denmark-Greenland:10
## 95     9.501800      2046                             Denmark-:2046
## 96    42.590300        12                              Djibouti-:12
## 97   -70.162700       581                   Dominican Republic-:581
## 98   -78.183400      1595                             Ecuador-:1595
## 99    30.000000       536                                Egypt-:536
## 100  -88.896500        13                            El Salvador-:13
## 101   10.000000        12                      Equatorial Guinea-:12
## 102   39.782300         6                                Eritrea-:6
## 103   25.013600       575                              Estonia-:575
## 104   31.465900         9                               Eswatini-:9
## 105   40.489700        16                              Ethiopia-:16
## 106  178.065000         5                                   Fiji-:5
## 107   26.000000      1041                             Finland-:1041
## 108  -53.125800        28                   France-French Guiana:28
## 109  149.406800        30                France-French Polynesia:30
## 110  -61.583300        73                      France-Guadeloupe:73
## 111   45.166200        50                         France-Mayotte:50
## 112  165.618000        15                   France-New Caledonia:15
## 113   55.247100       145                        France-Reunion:145
## 114  -62.833300         5                 France-Saint Barthelemy:5
## 115  -63.050100        11                       France-St Martin:11
## 116  -61.024200        81                      France-Martinique:81
## 117    2.213700     32964                             France-:32964
## 118   11.609400         7                                  Gabon-:7
## 119  -15.310100         3                                 Gambia-:3
## 120   43.356900        83                               Georgia-:83
## 121    9.000000     50871                            Germany-:50871
## 122   -1.023200       137                                Ghana-:137
## 123   21.824300       966                               Greece-:966
## 124  -90.230800        28                             Guatemala-:28
## 125   -9.696600         8                                 Guinea-:8
## 126  -58.750000         5                                 Guyana-:5
## 127  -72.285200         8                                  Haiti-:8
## 128   12.453400         4                               Holy See-:4
## 129  -86.241900        68                              Honduras-:68
## 130   19.503300       300                              Hungary-:300
## 131  -19.020800       890                              Iceland-:890
## 132   78.000000       887                                India-:887
## 133  113.921300      1046                           Indonesia-:1046
## 134   53.000000     32332                               Iran-:32332
## 135   44.000000       458                                 Iraq-:458
## 136   -7.692100      2121                             Ireland-:2121
## 137   35.000000      3035                              Israel-:3035
## 138   12.000000     86498                              Italy-:86498
## 139  -77.297500        26                               Jamaica-:26
## 140  138.000000      1468                               Japan-:1468
## 141   36.510000       235                               Jordan-:235
## 142   66.923700       150                           Kazakhstan-:150
## 143   37.906200        31                                 Kenya-:31
## 144  128.000000      9332                        Korea, South-:9332
## 145   47.750000       225                               Kuwait-:225
## 146   74.766100        58                            Kyrgyzstan-:58
## 147   24.603200       280                               Latvia-:280
## 148   35.862300       391                              Lebanon-:391
## 149   -9.429500         3                                Liberia-:3
## 150    9.550000        56                         Liechtenstein-:56
## 151   23.881300       358                            Lithuania-:358
## 152    6.129600      1605                          Luxembourg-:1605
## 153   46.869100        26                            Madagascar-:26
## 154  112.500000      2161                            Malaysia-:2161
## 155   73.220700        16                              Maldives-:16
## 156   14.375400       139                                Malta-:139
## 157   10.940800         3                             Mauritania-:3
## 158   57.500000        94                             Mauritius-:94
## 159 -102.552800       585                               Mexico-:585
## 160   28.369900       199                              Moldova-:199
## 161    7.416700        42                                Monaco-:42
## 162  103.846700        11                              Mongolia-:11
## 163   19.300000        82                            Montenegro-:82
## 164   -7.092600       345                              Morocco-:345
## 165   18.490400         8                                Namibia-:8
## 166   84.250000         4                                  Nepal-:4
## 167  -70.035800        33                      Netherlands-Aruba:33
## 168  -68.990000         8                     Netherlands-Curacao:8
## 169  -63.054800         3                Netherlands-Sint Maarten:3
## 170    5.291300      8603                         Netherlands-:8603
## 171  174.886000       368                          New Zealand-:368
## 172  -85.207200         2                              Nicaragua-:2
## 173    8.081700        10                                 Niger-:10
## 174    8.675300        70                               Nigeria-:70
## 175   21.745300       219                      North Macedonia-:219
## 176    8.468900      3755                              Norway-:3755
## 177   57.000000       131                                 Oman-:131
## 178   69.345100      1373                            Pakistan-:1373
## 179  -80.782100       674                               Panama-:674
## 180  143.955500         1                       Papua New Guinea-:1
## 181  -58.443800        52                              Paraguay-:52
## 182  -75.015200       635                                 Peru-:635
## 183  122.000000       803                          Philippines-:803
## 184   19.145100      1389                              Poland-:1389
## 185   -8.224500      4268                            Portugal-:4268
## 186   51.183900       562                                Qatar-:562
## 187   24.966800      1292                             Romania-:1292
## 188   90.000000      1036                              Russia-:1036
## 189   29.873900        54                                Rwanda-:54
## 190  -60.978900         3                            Saint Lucia-:3
## 191  -61.287200         1       Saint Vincent and the Grenadines-:1
## 192   12.457800       223                           San Marino-:223
## 193   45.000000      1104                        Saudi Arabia-:1104
## 194  -14.452400       119                              Senegal-:119
## 195   21.005900       457                               Serbia-:457
## 196   55.492000         7                             Seychelles-:7
## 197  103.833300       732                            Singapore-:732
## 198   19.699000       269                             Slovakia-:269
## 199   14.995500       632                             Slovenia-:632
## 200   46.199600         3                                Somalia-:3
## 201   22.937500      1170                        South Africa-:1170
## 202   -4.000000     65719                              Spain-:65719
## 203   81.000000       106                            Sri Lanka-:106
## 204   30.217600         3                                  Sudan-:3
## 205  -56.027800         8                               Suriname-:8
## 206   16.000000      3069                              Sweden-:3069
## 207    8.227500     12928                        Switzerland-:12928
## 208  121.000000       267                              Taiwan*-:267
## 209   34.888800        13                              Tanzania-:13
## 210  101.000000      1136                            Thailand-:1136
## 211    0.824800        25                                  Togo-:25
## 212  -61.222500        66                   Trinidad and Tobago-:66
## 213    9.000000       227                              Tunisia-:227
## 214   35.243300      5698                              Turkey-:5698
## 215   32.000000        23                                Uganda-:23
## 216   31.165600       310                              Ukraine-:310
## 217   54.000000       405                 United Arab Emirates-:405
## 218  -64.750500        17                 United Kingdom-Bermuda:17
## 219  -81.254600         8           United Kingdom-Cayman Islands:8
## 220   -2.364400        88         United Kingdom-Channel Islands:88
## 221   -5.353600        55               United Kingdom-Gibraltar:55
## 222   -4.548100        29             United Kingdom-Isle of Man:29
## 223  -62.187400         5               United Kingdom-Montserrat:5
## 224   -3.436000     14543                     United Kingdom-:14543
## 225  -55.765800       238                              Uruguay-:238
## 226  -95.712900    101657                                US-:101657
## 227   64.585300        88                            Uzbekistan-:88
## 228  -66.589700       107                            Venezuela-:107
## 229  108.000000       163                              Vietnam-:163
## 230   28.283300        22                                Zambia-:22
## 231   30.000000         5                               Zimbabwe-:5
## 232    0.000000         0                 Canada-Diamond Princess:0
## 233  -61.371000        11                              Dominica-:11
## 234  -61.679000         7                                Grenada-:7
## 235   35.529562         7                             Mozambique-:7
## 236   38.996815         5                                  Syria-:5
## 237  125.727539         1                            Timor-Leste-:1
## 238  -59.543200         2                                 Belize-:2
## 239    0.000000         0                        Canada-Recovered:0
## 240  102.495496         6                                   Laos-:6
## 241   17.228331         1                                  Libya-:1
## 242   35.233200        91                    West Bank and Gaza-:91
## 243  -15.180400         2                          Guinea-Bissau-:2
## 244   -3.996166        11                                  Mali-:11
## 245  -62.782998         2                   Saint Kitts and Nevis-:2
## 246 -124.845700         1             Canada-Northwest Territories:1
## 247 -135.000000         3                             Canada-Yukon:3
## 248   20.902977        86                                Kosovo-:86
## 249   95.956000         8                                  Burma-:8
```

```
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
```



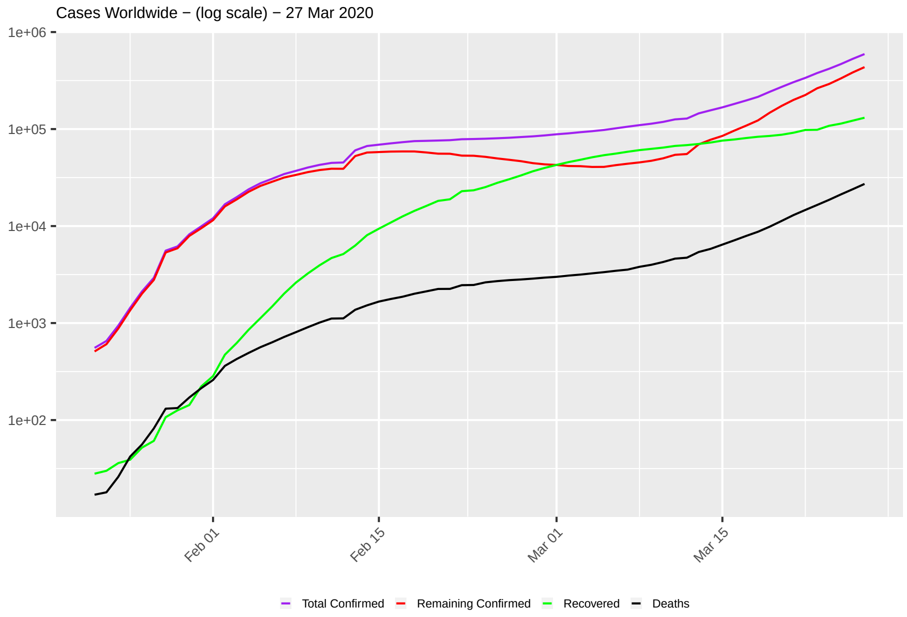
```
map %>% setView(5, 52,zoom = 6)
```



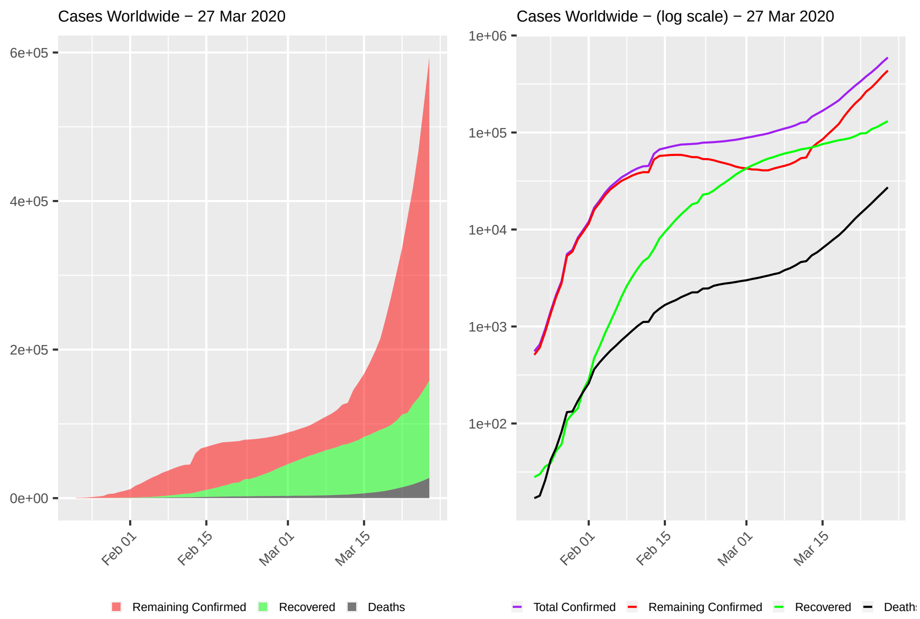
Number of cases:

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

```r
# 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))
```

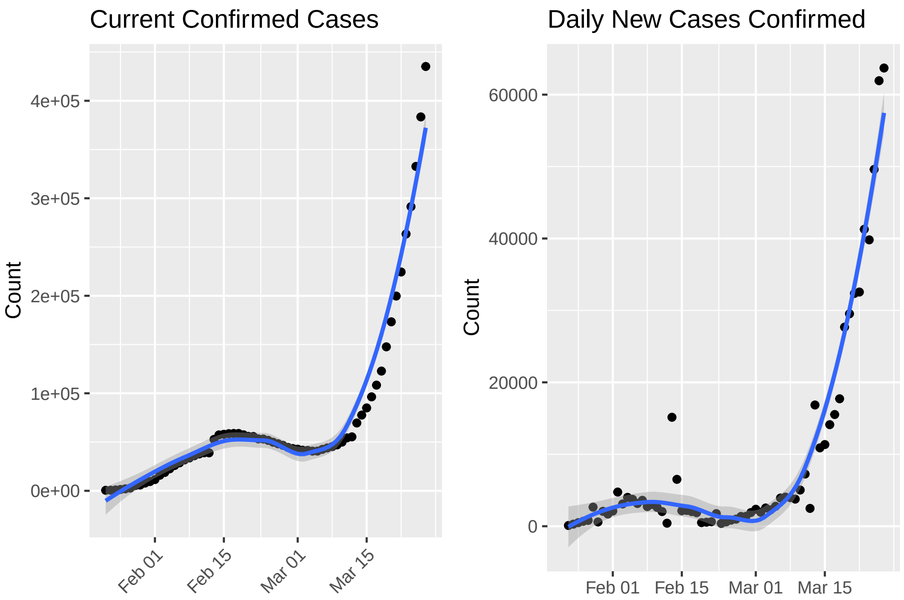
```
## List of 1
##  $ axis.text.x:List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : NULL
##   ..$ angle        : num 45
##   ..$ lineheight   : NULL
##   ..$ margin    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

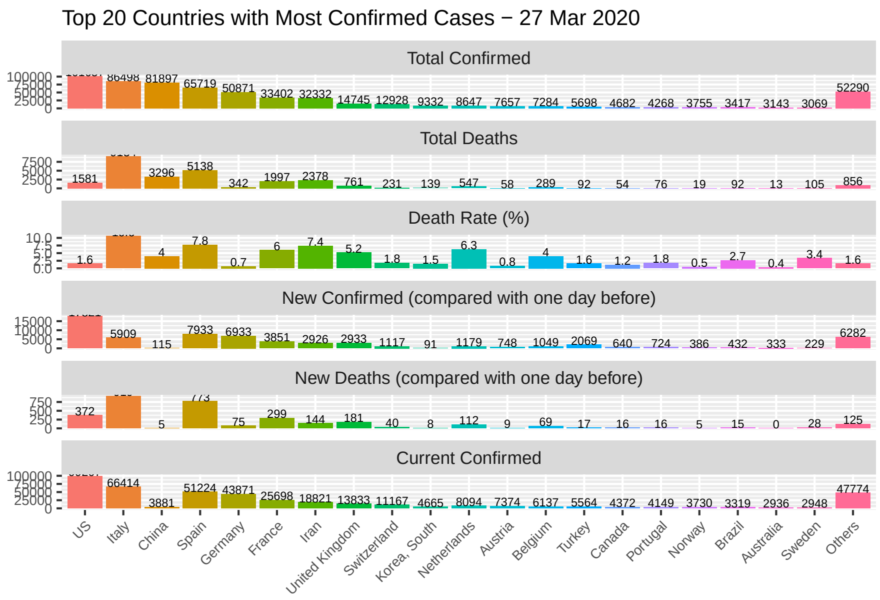
```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

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

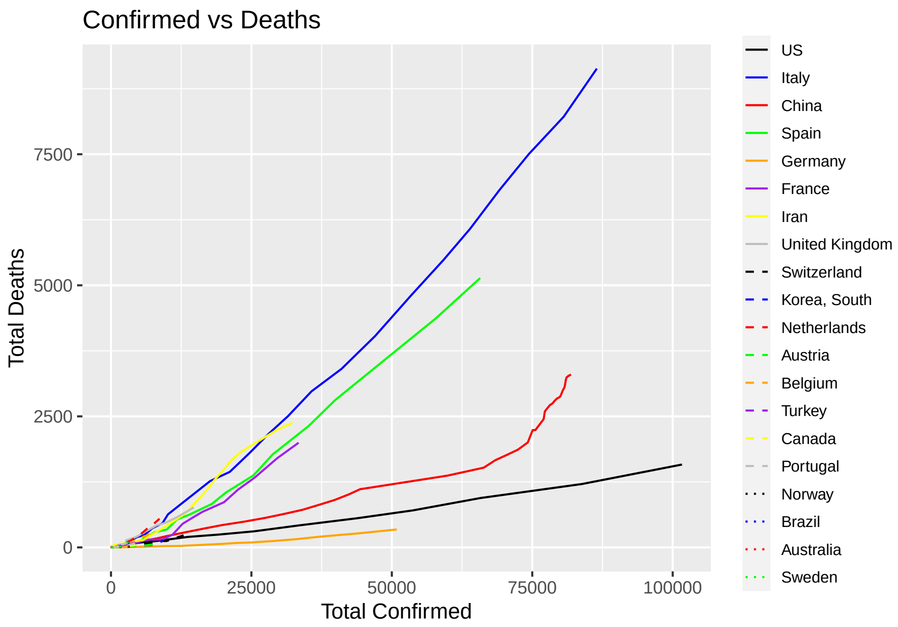


Bar Chart

```
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
```

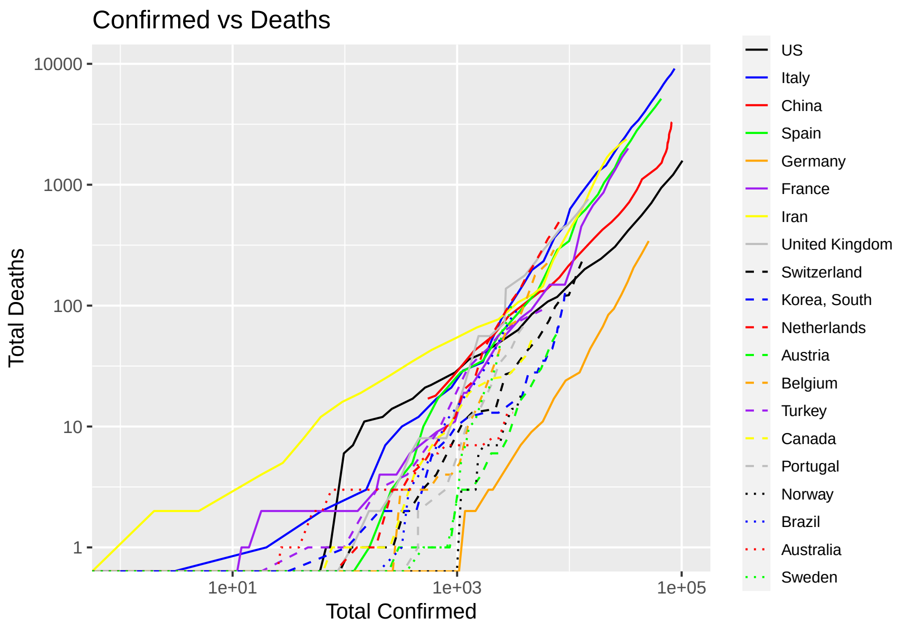


```
# Confirmed versus Deaths
linetypes <- rep(c("solid", "dashed", "dotted"), each=8)
colors <- rep(c('black', 'blue', 'red', 'green', 'orange', 'purple', 'yellow', 'grey'), 3)
df <- data %>% filter(country %in% setdiff(top.countries, c('World', 'Others'))) %>%
mutate(country=country %>% factor(levels=c(top.countries)))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



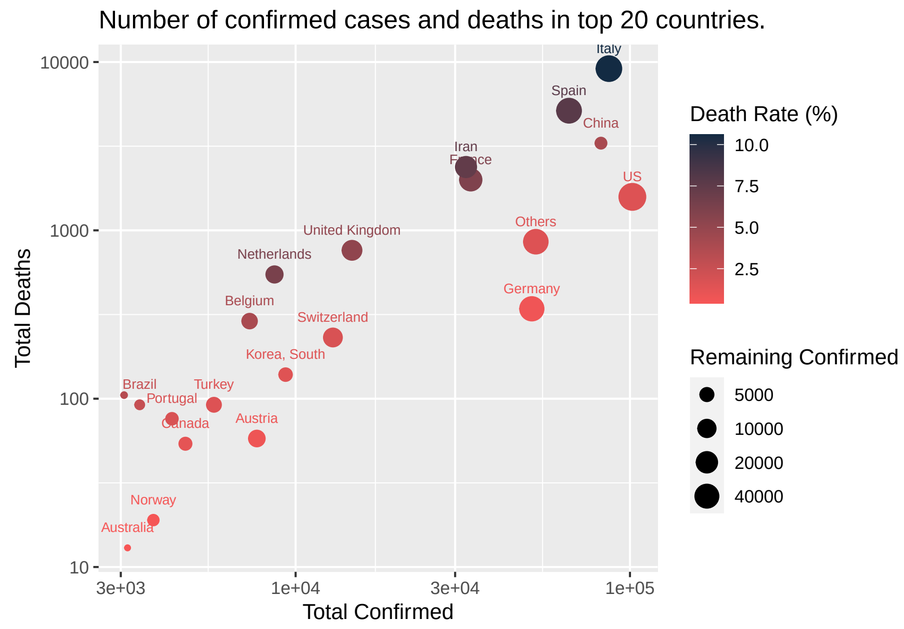
```
vs + scale_x_log10() + scale_y_log10()
```

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

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



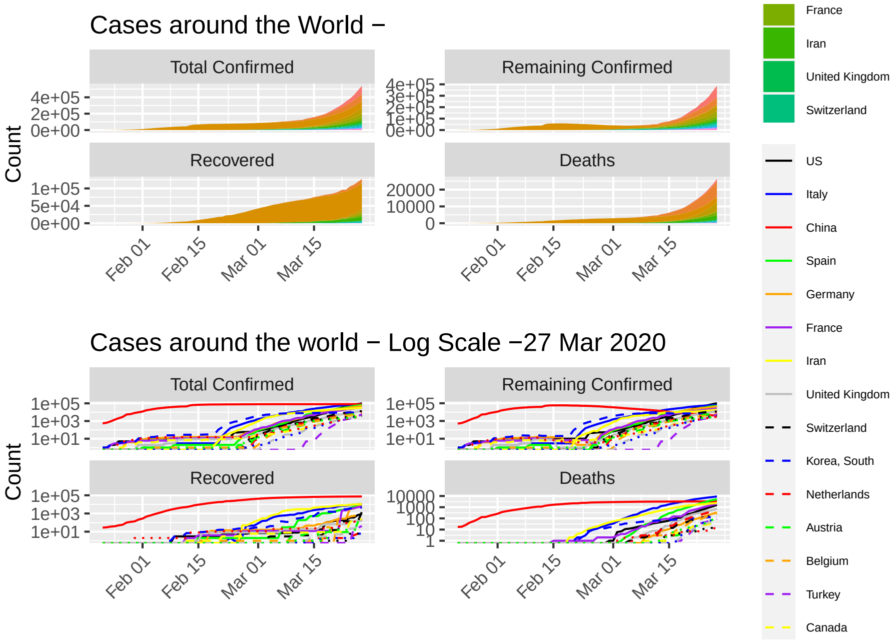
Number of confirmed cases and deaths in top 20 countries.

```
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
```

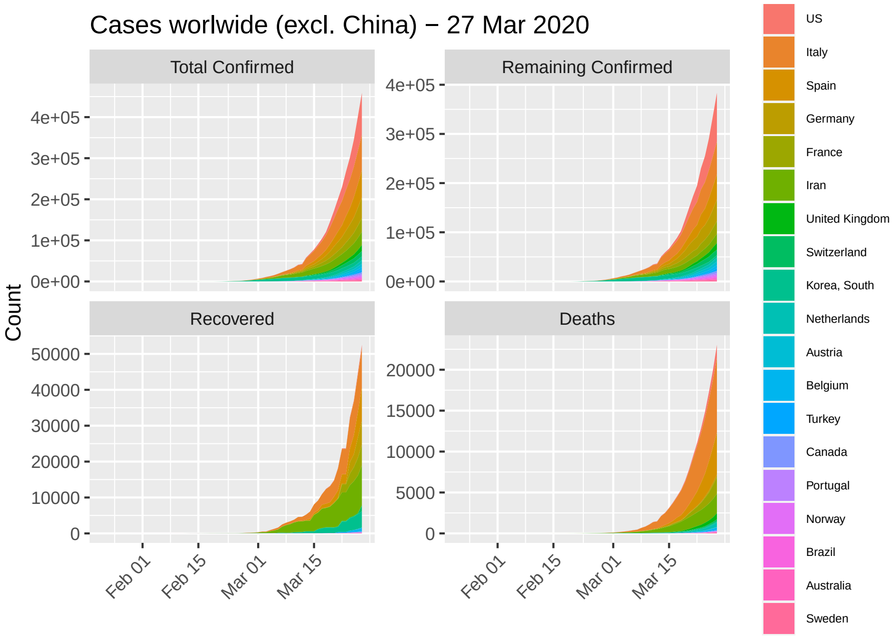


```
df <- data.long %>% filter(country %in% top.countries) %<>% mutate(country=country %>% facto

### 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)
```

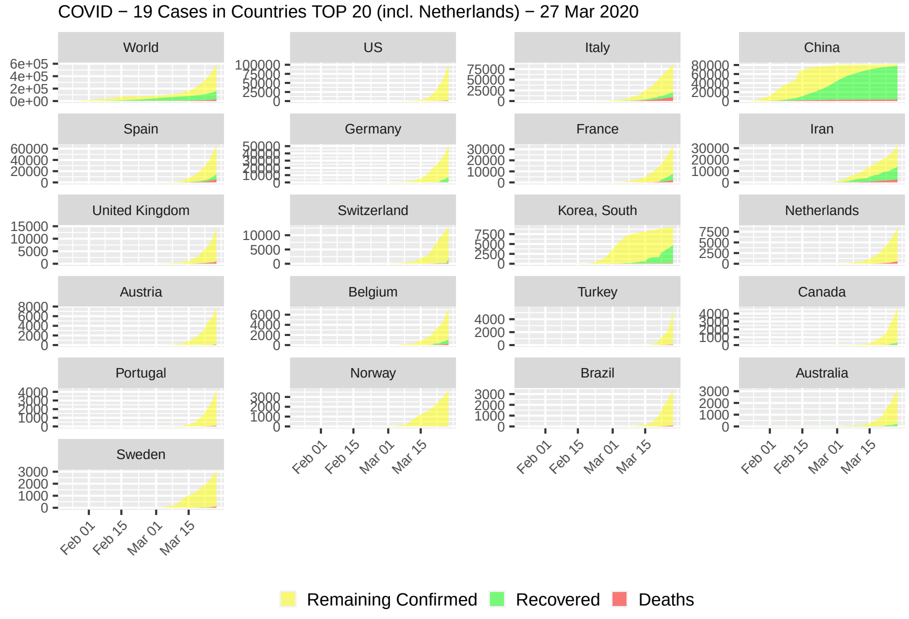
```
## Warning: Transformation introduced infinite values in continuous y-axis
```



```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))
```



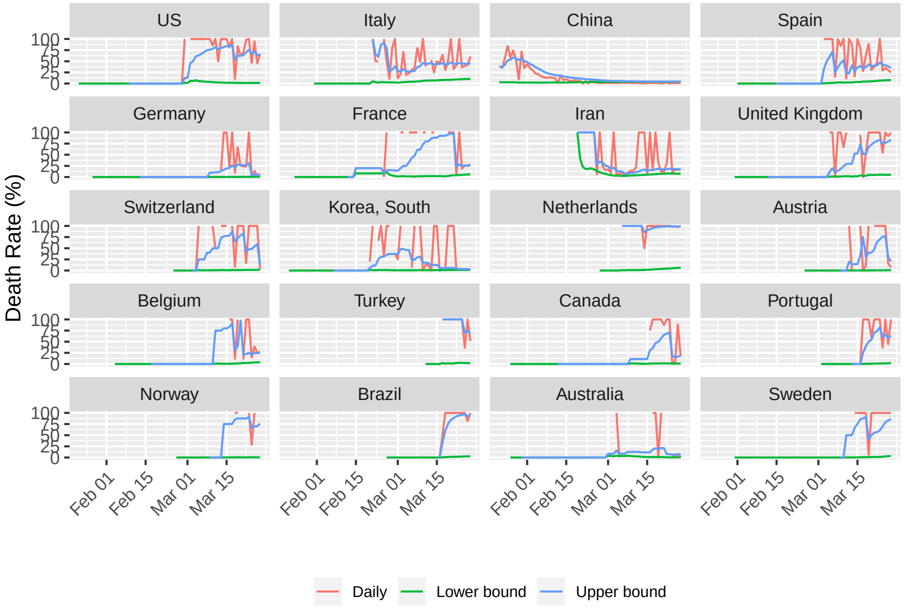
```
# # # list(countries) == 'Netherlands'

## 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:

```r
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 - 27 Mar 2020

	country	confirmed	confirmed.new	remaining.confirmed	recovered	deaths	deaths.new	death.rate
1	Italy	86,498	5,909	66,414	10,950	9,134	919	10.6%
2	San Marino	223	15	198	4	21	0	9.4%
3	Iraq	458	76	296	122	40	4	8.7%
4	Indonesia	1,046	153	913	46	87	9	8.3%
5	Spain	65,719	7,933	51,224	9,357	5,138	773	7.8%
6	Iran	32,332	2,926	18,821	11,133	2,378	144	7.4%
7	Morocco	345	70	311	11	23	12	6.7%
8	Philippines	803	96	718	31	54	9	6.7%
9	Algeria	409	42	354	29	26	1	6.4%
10	Netherlands	8,647	1,179	8,094	6	547	112	6.3%
11	France	33,402	3,851	25,698	5,707	1,997	299	6.0%
12	Egypt	536	41	390	116	30	6	5.6%
13	United Kingdom	14,745	2,933	13,833	151	761	181	5.2%
14	Burkina Faso	180	28	159	12	9	2	5.0%
15	Albania	186	12	147	31	8	2	4.3%
16	Belgium	7,284	1,049	6,137	858	289	69	4.0%
17	China	81,897	115	3,881	74,720	3,296	5	4.0%
18	Afghanistan	110	16	104	2	4	0	3.6%
19	Dominican Republic	581	93	558	3	20	10	3.4%
20	Sweden	3,069	229	2,948	16	105	28	3.4%