Covid19 PT Report

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Synopsis

This is a data analysis report of the **public available** data about Covid19 in Portugal. The report demonstrates how to download and process data, ranks Portugal by cases and deaths and demonstrates the pandemic evolution in this country. Some final remarks are made about the limited availability of the data provided.

This report is also an example of reproducible research in data analysis making it possible to anyone to reproduce or adapt for any country.

Raw Data

World Data Source

The primarily data source used for this work was available by the **European Centre for Disease Prevention and Control**. By analyzing this data we can get a gist of the evolution of covid19 in the world. Some information were added trough time to this data, such as new formats. I choose the JSON format.

```
library(jsonlite)
library(dplyr)
url <- "https://opendata.ecdc.europa.eu/covid19/casedistribution/json"
dataRaw <- read_json(url, simplifyVector = TRUE)
data <- as_tibble(dataRaw$records)
str(data)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    15490 obs. of  11 variables:
##  $ dateRep                : chr  "07/05/2020" "06/05/2020" "05/05/2020" "04/05/2020" ...
##  $ day                    : chr  "7" "6" "5" "4" ...
##  $ month                  : chr  "5" "5" "5" "5" ...
##  $ year                   : chr  "2020" "2020" "2020" "2020" ...
##  $ cases                  : chr  "168" "330" "190" "235" ...
##  $ deaths                 : chr  "9" "5" "5" "13" ...
##  $ countriesAndTerritories: chr  "Afghanistan" "Afghanistan" "Afghanistan" "Afghanistan" ...
##  $ geoId                  : chr  "AF" "AF" "AF" "AF" ...
##  $ countryterritoryCode   : chr  "AFG" "AFG" "AFG" "AFG" ...
##  $ popData2018            : chr  "37172386" "37172386" "37172386" "37172386" ...
##  $ continentExp           : chr  "Asia" "Asia" "Asia" "Asia" ...
```

World Data Pre-Processing - getting Tiddy

Since all available variables are in character format I transformed the numeric values and date values into their respective formats.

```
library(lubridate)
data$dateRep <- dmy(data$dateRep)
data$day <- as.numeric(data$day)
data$month <- as.numeric(data$month)
data$year <- as.numeric(data$year)
data$cases <- as.numeric(data$cases)
data$deaths <- as.numeric(data$deaths)
data$popData2018 <- as.numeric(data$popData2018)
str(data)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    15490 obs. of  11 variables:
##  $ dateRep                : Date, format: "2020-05-07" "2020-05-06" ...
##  $ day                    : num  7 6 5 4 3 2 1 30 29 28 ...
##  $ month                  : num  5 5 5 5 5 5 5 4 4 4 ...
##  $ year                   : num  2020 2020 2020 2020 2020 2020 2020 2020 2020 2020 ...
##  $ cases                  : num  168 330 190 235 134 164 222 122 124 172 ...
##  $ deaths                 : num  9 5 5 13 4 4 4 0 3 0 ...
##  $ countriesAndTerritories: chr  "Afghanistan" "Afghanistan" "Afghanistan" "Afghanistan" ...
##  $ geoId                  : chr  "AF" "AF" "AF" "AF" ...
##  $ countryterritoryCode   : chr  "AFG" "AFG" "AFG" "AFG" ...
##  $ popData2018            : num  37172386 37172386 37172386 37172386 37172386 ...
##  $ continentExp           : chr  "Asia" "Asia" "Asia" "Asia" ...
```

Now we can work with these numbers and make some exploratory analysis. Let's check out a summary of our data:

```
summary(data)
```

```
##     dateRep                day              month             year     
##  Min.   :2019-12-31   Min.   : 1.00   Min.   : 1.000   Min.   :2019  
##  1st Qu.:2020-02-26   1st Qu.: 7.00   1st Qu.: 2.000   1st Qu.:2020  
##  Median :2020-03-31   Median :16.00   Median : 3.000   Median :2020  
##  Mean   :2020-03-21   Mean   :15.62   Mean   : 3.228   Mean   :2020  
##  3rd Qu.:2020-04-19   3rd Qu.:24.00   3rd Qu.: 4.000   3rd Qu.:2020  
##  Max.   :2020-05-07   Max.   :31.00   Max.   :12.000   Max.   :2020  
##                                                                      
##      cases             deaths      countriesAndTerritories    geoId          
##  Min.   :-2461.0   Min.   :   0   Length:15490            Length:15490      
##  1st Qu.:    0.0   1st Qu.:   0   Class :character        Class :character  
##  Median :    2.0   Median :   0   Mode  :character        Mode  :character  
##  Mean   :  239.8   Mean   :  17                                            
##  3rd Qu.:   32.0   3rd Qu.:   1                                            
##  Max.   :48529.0   Max.   :4928                                            
##                                                                            
##  countryterritoryCode  popData2018        continentExp      
##  Length:15490         Min.   :1.000e+03   Length:15490      
##  Class :character     1st Qu.:2.782e+06   Class :character  
##  Mode  :character     Median :9.769e+06   Mode  :character
```

```
##                       Mean   :5.376e+07
##                       3rd Qu.:3.706e+07
##                       Max.   :1.393e+09
##                       NA's   :171
```

Ok, something awkward is going on. The **new cases** variable have negative values, because, as one may notice, the minimum value is **-2461**. There shouldn't be negative cases, and there is not an explanation available anywhere for this observations.
>I tried to address this issue with European Centre for Disease Prevention and Control without response.

One thing to always have in mind is the source of the data: our source must be **reliable and trustworthy**.

I will consider this some sort of correction to the number of reported cases and not mess with this awkward input values for the sake of a globally cohesive information.

Now that I have a **somewhat** tidy data, I can think a bit about the variables available:

```
names(data)
```

```
##  [1] "dateRep"                "day"
##  [3] "month"                  "year"
##  [5] "cases"                  "deaths"
##  [7] "countriesAndTerritories" "geoId"
##  [9] "countryterritoryCode"    "popData2018"
## [11] "continentExp"
```

The most interesting data I will address will be the number of detected **cases** and **deaths**, by **date reported**.

Portugal in the World

How is Portugal rated in death and cases counts? There is some social media discussion about how to address this rates. Let us compare absolute numbers with percentages related to country population:

```
CasesRank <- data %>%
        group_by(countriesAndTerritories) %>%
        summarise("TotalCases" = sum(cases)) %>%
        arrange(desc(TotalCases))

PTrankCases <- grep("Portugal", CasesRank$countriesAndTerritories)

numberofCases <- CasesRank %>% filter(countriesAndTerritories == "Portugal")
numberofCases <- as.integer(numberofCases[2])

knitr::kable(head(CasesRank, 10))
```

countriesAndTerritories	TotalCases
United_States_of_America	1228603
Spain	220325
Italy	214457
United_Kingdom	201201
Germany	166091
Russia	165929
France	137150
Turkey	131744
Brazil	125218
Iran	101650

The above table reflects the ranked 10 worst countries in COVID-19 diagnosed cases. Portugal is ranked **21**, with **26182** total cases.

```r
DeathsRank <- data %>%
        group_by(countriesAndTerritories) %>%
        summarise("TotalDeaths" = sum(deaths)) %>%
        arrange(desc(TotalDeaths))

PTrankDeaths <- grep("Portugal", DeathsRank$countriesAndTerritories)

numberofDeaths <- DeathsRank %>% filter(countriesAndTerritories == "Portugal")
numberofDeaths <- as.integer(numberofDeaths[2])

knitr::kable(head(DeathsRank, 10))
```

countriesAndTerritories	TotalDeaths
United_States_of_America	73431
United_Kingdom	30076
Italy	29684
Spain	25857
France	25809
Brazil	8536
Belgium	8339
Germany	7119
Iran	6418
Netherlands	5204

The above table reflects the ranked 10 worst countries in COVID-19 deaths. Portugal is ranked **22**, with **1089** total deaths.

Let us now check the same rates in percentage.

```
CasesPerRank <- data %>%
        group_by(countriesAndTerritories) %>%
        summarise("TotalCases" = sum(cases), "Pop" = unique(popData2018)) %>%
        mutate("PercentageCases" = TotalCases/Pop * 100) %>%
        arrange(desc(PercentageCases))

DeathsPerRank <- data %>%
        group_by(countriesAndTerritories) %>%
        summarise("TotalDeaths" = sum(deaths), "Pop" = unique(popData2018)) %>%
        mutate("PercentageDeaths" = TotalDeaths/Pop * 100) %>%
        arrange(desc(PercentageDeaths))


PTPerRankCases <- grep("Portugal", CasesPerRank$countriesAndTerritories)
PTPerRankDeaths <- grep("Portugal", CasesPerRank$countriesAndTerritories)

knitr::kable(head(CasesPerRank, 10))
```

countriesAndTerritories	TotalCases	Pop	PercentageCases
Cases_on_an_international_conveyance_Japan	696	3000	23.2000000
San_Marino	608	33785	1.7996152
Holy_See	12	1000	1.2000000
Andorra	751	77006	0.9752487
Qatar	17972	2781677	0.6460851
Luxembourg	3851	607728	0.6336716
Iceland	1799	353574	0.5088044
Spain	220325	46723749	0.4715482
Ireland	22248	4853506	0.4583903
Belgium	50781	11422068	0.4445867

```
knitr::kable(head(DeathsPerRank, 10))
```

countriesAndTerritories	TotalDeaths	Pop	PercentageDeaths
Cases_on_an_international_conveyance_Japan	7	3000	0.2333333
San_Marino	41	33785	0.1213556
Belgium	8339	11422068	0.0730078
Andorra	46	77006	0.0597356
Spain	25857	46723749	0.0553402
Italy	29684	60431283	0.0491203
United_Kingdom	30076	66488991	0.0452346
France	25809	66987244	0.0385282
Sint_Maarten	14	41486	0.0337463
Netherlands	5204	17231017	0.0302014

There are evident differences from percentage to absolute numbers in the extremes (but in fact Portugal doesn't change much at the time of this report writing). In percentage Portugal is in **21** place for cases and **21** for deaths. Is this a fair comparison? There may be missing variables to understand our data: some index of number of urban centers per country for example, and also the predominance of respiratory

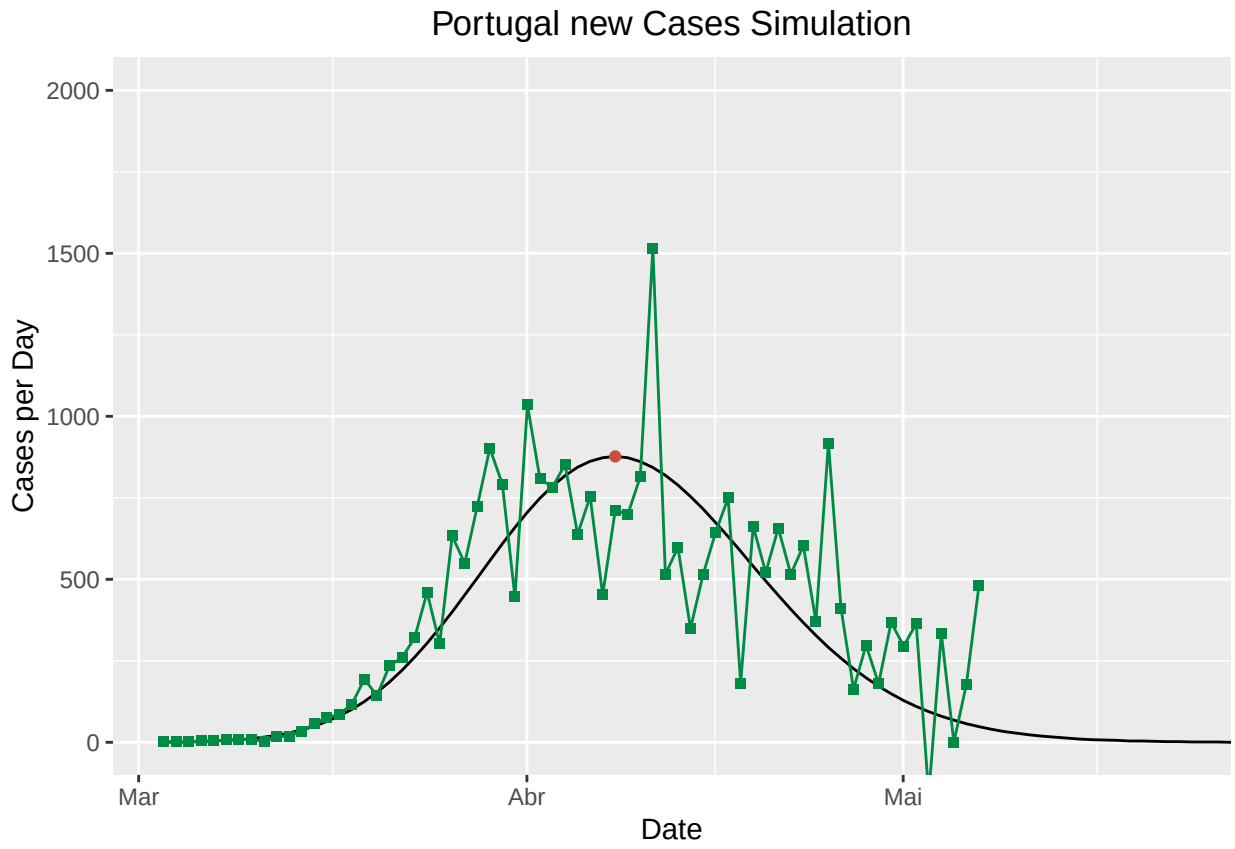
diseases, atmospheric pollution and elderly people percentage. Also, the number of tests each country do highly influence the reported cases. All this summed together can cause a great impact at the political level for managing the emergency states of each countries and interpreting the results. With too many unknown factors the effectiveness of some policies may result only by chance.

Since there are just too many unknown factors in the percentage rate maybe the fairest way to compare is the absolute numbers (aware of not being ideal as well).

Evolution of the Disease in Portugal and Simulations

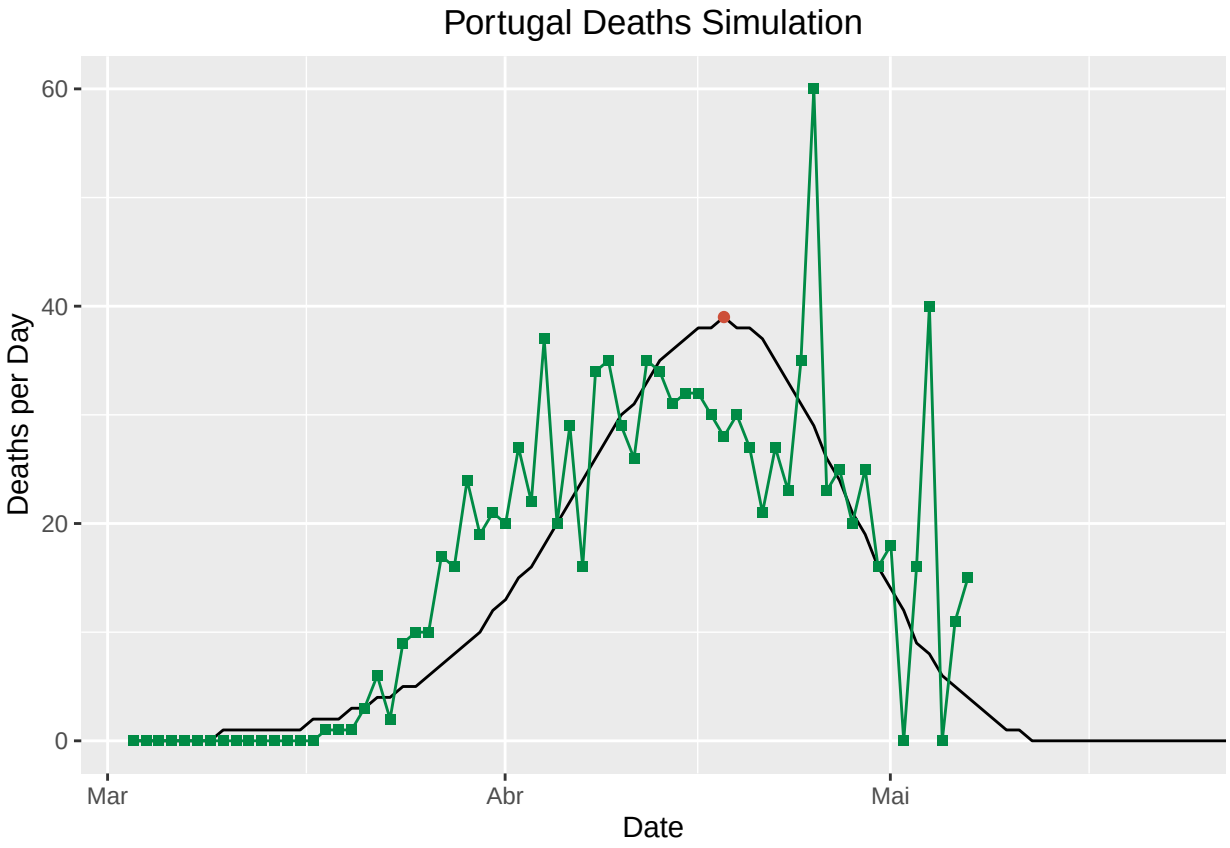
In the next lines I try to simulate new cases and deaths from COVID-19 in Portugal with a 15 day advance from the last data reported and to identify a peak, where we could consider a turning point for the pandemic in Portugal, meaning that the contingency politics are taking effect.

```
PTdata <- filter(data, geoId == "PT")
PTdataArranged <- arrange(PTdata, dateRep)

library(ggpmisc)

x <- 1:length(PTdataArranged$dateRep)
y <- log10(PTdataArranged$cases)
y <- gsub("[-InfNaN]", 0, y)

xsq <- x^2
xcub <- x^3

fit <- lm(y~x+xsq+xcub)

xv <- seq(min(x), 100, 1)
yv <- predict(fit, list(x = xv, xsq = xv^2, xcub = xv^3))

#Prediction <- tibble(Day = xv, logCases = yv)
PredictionCases <- tibble(Day = as.Date("2020-03-02")+xv,
                          SimCases = as.integer(10^yv),
                          RealCases = c(PTdataArranged$cases, rep(NA,
                                                                  100-length(PTdataArranged$cases))))
PredictionCases$Day <- as.POSIXct(PredictionCases$Day)

CasesMaxDay <- as.Date(PredictionCases$Day[
        grep(max(PredictionCases$SimCases[1:length(PTdataArranged$cases)]),
             PredictionCases$SimCases)])

curvePredict <- ggplot(PredictionCases, aes(Day, SimCases))
PTgSimCasesNEW <- curvePredict + geom_line() +
                geom_point(aes(Day, RealCases), col = "springgreen4", pch = 15) +
                geom_line(aes(Day, RealCases), col = "springgreen4") +
                labs(y = "Cases per Day", x = "Date",
                     title = "Portugal new Cases Simulation") +
                stat_peaks(col = "tomato3", ignore_threshold = .9) +
                theme(plot.title = element_text(hjust = 0.5)) +
                coord_cartesian(xlim = c(PredictionCases$Day[1], as.POSIXct(Sys.Date() + 15)),
                                ylim = c(0, 2000))
PTgSimCasesNEW
```




```
z <- log10(PTdataArranged$deaths)
z <- sub("-Inf", "0", z)

fitD <- lm(z~x+xsq+xcub)

xv <- seq(min(x), 100, 1)
zv <- predict(fitD, list(x = xv, xsq = xv^2, xcub = xv^3))

PredictionDeaths <- tibble(Day = as.Date("2020-03-02")+xv,
                           SimDeaths = as.integer(10^zv),
                           RealDeaths = c(PTdataArranged$deaths, rep(NA,
                                                  100-length(PTdataArranged$deaths))))

PredictionDeaths$Day <- as.POSIXct(PredictionDeaths$Day)

DeathsMaxDay <- as.Date(PredictionDeaths$Day[
        grep(max(PredictionDeaths$SimDeaths[1:length(PTdataArranged$deaths)]),
             PredictionDeaths$SimDeaths)])

curvePredictDeaths <- ggplot(PredictionDeaths, aes(Day, SimDeaths))
PTgSimDeaths <- curvePredictDeaths + geom_line() +
                geom_point(aes(Day, RealDeaths), col = "springgreen4", pch = 15) +
                geom_line(aes(Day, RealDeaths), col = "springgreen4") +
                labs(y = "Deaths per Day", x = "Date",
                     title = "Portugal Deaths Simulation") +
                stat_peaks(col = "tomato3", ignore_threshold = .7) +
```

```
                theme(plot.title = element_text(hjust = 0.5)) +
                coord_cartesian(xlim = c(PredictionDeaths$Day[1], as.POSIXct(Sys.Date() + 15)))
PTgSimDeaths
```



As we can observe from the graphs, the worst seems to have passed. The peak for new cases detected was in **2020-04-08** and the peak for deaths in Portugal was in **2020-04-18**.

Conclusions

- Cases: Portugal is ranked **21** in 207 countries, with **26182** total cases. Portugal had the peak of cases in **2020-04-08**.

- Deaths: Portugal is ranked **22** in 207 countries, with **1089** total deaths. Portugal had the peak of deaths in **2020-04-18**.

The fact that the "peaks" have passed for the cases and deaths in Portugal doesn't mean that the problem is over. For example, the peaks are always moving around because every day the simulations are iterated with the new information available, and new policies and the end of the confinement may produce more peaks for new cases and deaths.
From comparing our country with the others, we are quite better than most countries. This is due to several factors, not only policies but also with our peripheric geo-location. Also, it must be observed the predominance of the disease in the north hemisphere of the planet - so our rank my improve greatly for the next months (our rank in the end of April is about 18th to 19th place), if there is some influence with the flu-season.

Final Considerations

There is a lack of trustworthy data sources that would complement this data and give us detailed information about the **how's** and **why's** of SARS-CoV-2 behavior. Interesting variables that I would consider worth studying would be: **Active Cases**, **Recovered Cases**, **ICU Cases**, **Non-ICU Hospitalized Cases**, and also some information about patients, like: **Known Diseases**, a logical or more informative **IfSmoker** variable and **Air Pollution Exposure**.

Some of this information is retained by the "Sistema nacional de vigilância epidemiológica" **SINAVE**

I've applied for access in 2020-04-27 from an institutional e-mail but not a reply until today.