

# disCOVIDer19

## A path-guide inside the COVID-19 pandemia

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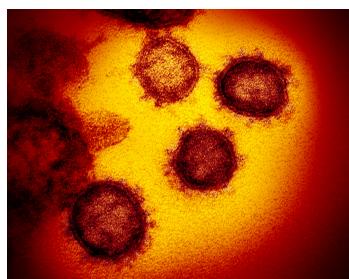
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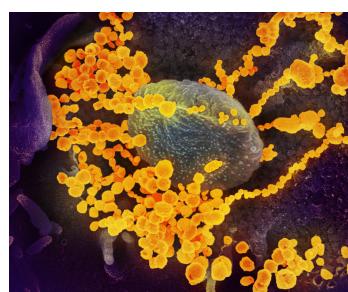
### ABSTRACT

## 1 INTRODUCTION

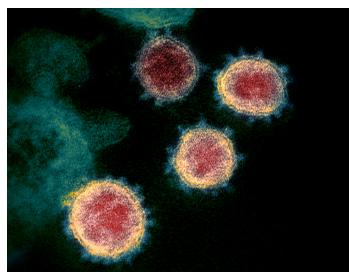
**BACKGROUND** In December 2019 different cases of pneumonia were reported in Wuhan (China) [2]. Their origin was later ascribed to a new virus classified as *Severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2) whose TEM and SEM pictures are reported in the Fig. 1. The origin of this virus is still subject of scientific debate between the scientific community, however one of the most common opinion is that this virus comes from bats, in particular the genus *Rhinolophus* [3]. The most compelling feature of this virus is that is its ability to spread also via coughing and sneezing [4], and also by touching infected surfaces [5]. Differently with respect to the SARS-CoV the virus seems to have a lower mortality rate [6, 7].



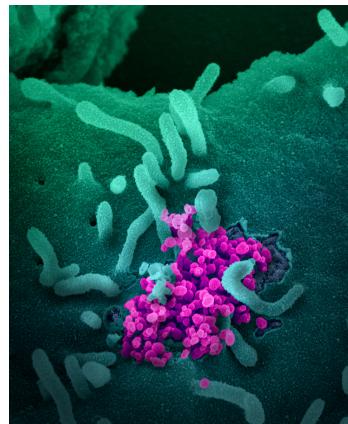
(a) Transmission electron microscope (TEM) image of SARS-CoV-2—also known as 2019-nCoV, emerging from the surface of cells cultured



(b) Scanning electron microscope of the SARS-CoV-2 emerging from the surface of cells cultured



(c) TEM image of SARS-CoV-2. Note the spikes that gives the name coronavirus to the virus



(d) SEM image of the virus

**Figure 1:** Different pictures of the virus as reported by the NIAID's Rocky Mountain Laboratories (RML) in Hamilton, Montana [1]

In January the Chinese government imposed the quarantine for the city of Wuhan (almost 11M people); the quarantine was later expanded to the full province of Hubei (60M people) and then to the neighbour provinces Huanggang, Ezhou and Xianning. The virus then spread in Canada, Germany, Thailand and Japan and then in other different countries included Italy [8]. In Italy the first cases, two

Chinese tourist from Hubei, were reported in Rome [9]; then other cases were reported in Codogno (Lodi,Lombardy). Later the virus spread almost in all regions of Italy with a higher density in Lombardy, Veneto, Emilia-Romagna, Piemonte and Marche. Starting from 22 of February, the Italian government started to impose the quarantine (red-zone) for 11 different municipalities, in particular Codogno, Casalpusterlengo, Lodi (included the neighbour municipalities) and Vo'. Starting from this date different restrictive measures were imposed starting from the regions with the highest number of cases: public entrainment were almost suspended as well as schools and universities. Workers (in public and private sectors) were allowed, when possibile, to work at home (smart-working). Such measures culminated with a decree approved by the Italian government that divided Italy in three areas: the red zones in which the municipalities with highest number of cases in which all the population was subjected to quarantine, the yellow one (Lombardia, Veneto, Emilia Romagna) in which schools, universities and public events ,sports as well cinemas were suspended and the rest of Italy in which no restrictive measures were adopted [10]; however 3 days later all schools and universities were suspended [11]. The restrictive measures were also extend up to all Italy with a further decree [12].

**MOTIVATION** In order to have a better understanding about the spread and the effects on the population of the COVID19 disease, we propose a ShinyApp, called disCOVIDer19 , that gathers the data , mostly provided by the Protezione Civile [13], about the number of infections(current as well cumulative), hospitalized people as well in intensive care, deaths and recovered for Italy, its regions and provinces; more details will be discussed in sections 3 and 4. Furthermore we fitted the cumulative cases for Italy and all its regions and provinces with a logistic curve, in order to get a bird-of-eye view on the trend followed as well on the effectiveness of the restrictive measures imposed by the Italian government. The theoretical foundations of this fit ,as well how to manage and use it, will be discussed in the section 2. Beside the logistic curve, we also considered a statistical approach, largely diffused among economists, that considers the number of cases in each day as a time series: on this basis we were able to make use of a particular tool, which will be briefly introduced in the section 2, that allowed us to make a further forecast about future cases. This latter becomes useful in case of large deviations from logistic distribution.

## 2 THEORETICAL BACKGROUND

Different models were proposed in the literature for modelling the spread of a disease [14], here we are going to consider a relative simple model taken from the growth dynamics of populations.

**POPULATION GROWTH DYNAMICS** The dynamics of population was founded by Thomas Malthus in 1817 [15] with his well known equation:

$$x_{n+1} = x_n(1 + r) \quad (1)$$

Where  $x_n$  stands for the population at time and  $r$  the growth rate. Thus the following discrete progression will be obtained:

$$P_{n+1} = P_0(1 + r)^{n+1} \quad (2)$$

in which  $P_0$  stands for the initial population. This discrete model can be reshaped in to a continuous one in the following way:

$$\dot{P}(t) = rP(t) \quad (3)$$

this is a relative simple differential equation with separable variable. Its integration gives:

$$P(t) = P_0(t) \quad (4)$$

Malthus, of course, did not believed that the population could grow ad infinitum with an exponential growth, but since he estimated that the resources growth follows a linear path, he argued that, at the intersection of the two curves, a consistent part of the population will not have access to the resources. Thus he expected that the exponential growth realizes only in the first part of the growth. Basing on these arguments, a Belgian mathematician Pierre-François Verhulst in 1838, proposed a model [16] in which the key point is the maximum number of people that the resources allows to live, usually called the carrying capacity here indicated as  $K$  ( $P$  and  $r$  have the same meaning of the previous model):

$$\dot{P} = rP \left(1 - \frac{P}{K}\right) \quad (5)$$

that have the following analytic solution

$$P = \frac{KP_0e^{rt}}{K + P_0(e^{rt} - 1)} \quad (6)$$

### 3 DATA ORIGIN

### 4 PANELS

#### 4.1 Home

#### 4.2 Data Inspection

#### 4.3 Data Analysis

### 5 CONCLUSIONS

### 6 PACKAGES USED

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