

Italian Covid-19 epidemic @ 19 March 2020: logistic, Gompertz, and regional clusters

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Update **18 March 2020**. I compare logistic, Gompertz and their derivatives to monitor the possible appearance of "the peak". Also, I look at the current time constants of infection in the various regions, and a few regional clusters.

I study the time evolution estimates of the Covid-19 Italian epidemic using nation-wide data up to March 18 (Protezione Civile, <https://bit.ly/2UbpPzt>). The previous reports are at <https://bit.ly/2W6vs4u> as well as in posts at <https://bit.ly/2QaFQEy>.

Today I will be comparing logistic and Gompertz derivatives, as well as start analyzing regional and regional-cluster data. The provisos stated yesterday, of course, still apply. It is expected that extrapolations will improve as data amass and become more reliable, and that, for example, the rates of change of the cumulant quantities can be better understood.

For the logistic-Gompertz comparison, I compare the data and their derivative with the functions and respective derivatives. Since the logistic function (much less so the Gompertz) adapts to the new data revising its predictions upwards, I compare the logistic fits and their derivatives for the last 4 days. I use the national death count just for definiteness. The conclusion I draw (Fig.1) is that the data and their derivatives are happily chugging along the Gompertz curve and its derivative, confirming yesterday's impression that the rates appear to branch off onto the Gompertz peak rather than bending down on the logistic peak. The earlier logistics are being left behind. As mentioned yesterday, taking the data at face value, this would imply a death rate due to increase over the next days, and peak at 700/day at the end of March. Again, it is difficult to make even semi-quantitative estimates with any degree of certainty, but for the moment the analysis does not bode well for the near future.

Slightly more optimistically, the Gompertz rates are slowly becoming similar for all proxies, see Fig. 2, suggesting some kind of "universal" behavior emerging. Importantly the rate of healing is flattening, which means that the healed are going to rise exponentially soon.

Table I reports the current saturations and inflections for the last four days, again for the national death count. Saturations stay basically in the same ballpark as yesterday, with logistic revised upward, as do inflection times.

The other information I would like to report concerns regions. I have started examining the data with exponential fits, as in most regions the process is at an early stage, and in those in the north we can estimate an instantaneous rate using recent data points. I use fits over typically the last 10 days, giving the recent partially saturating trend for the regions which were hit first, and the initial trend for the others. For most southern regions, the rates of increase expressed as time constants are typ-

ically over 4 days and more, larger than those observed

TABLE I. Extrapolations with logistic and Gompertz for cumulative death count (19 March 2020). The values are for the last five days including today.

Deaths (nationwide)	
Saturation	
L	3283/4118/4543/5500/6130
G	19870/26375/23409/31000/30326
Inflection date	
L	15/3, 16/3, 16/3, 16/3, 15/3
G	27/3, 30/3, 29/3, 30/3, 01/4

initially in the north (3 days or so, or less). In Lombardia, the rate over the last 10 days is a rather large 7.5 days. The data are listed in a rough table. In Fig.3 I report data for the Lazio region. The time constants are all well over 4 days, precisely 4.84 days for deaths, and 4.52 for total infected. Also in Fig.3, I have summed up the data for a cluster of southern regions, plus Lazio. The behavior is analogous, with time constants 4.84 days for totals and 4.0 for deaths (still very noisy).

Time constants for total infected (days)

P.A. Bolzano	3.16
V. d'Aosta	3.48
Calabria	3.57
P.A. Trento	3.58
Abruzzo	3.96
Umbria	4.09
Sardegna	4.3
Puglia	4.33
Liguria	4.37
Lazio	4.52
Piemonte	4.7
Toscana	4.98
Friuli VG	5.44
Sicilia	5.5
Basilicata	5.77
Marche	5.78
Campania	5.82
Veneto	6.32
Emilia Rom.	7.38
Lombardia	7.5
Molise	10.65

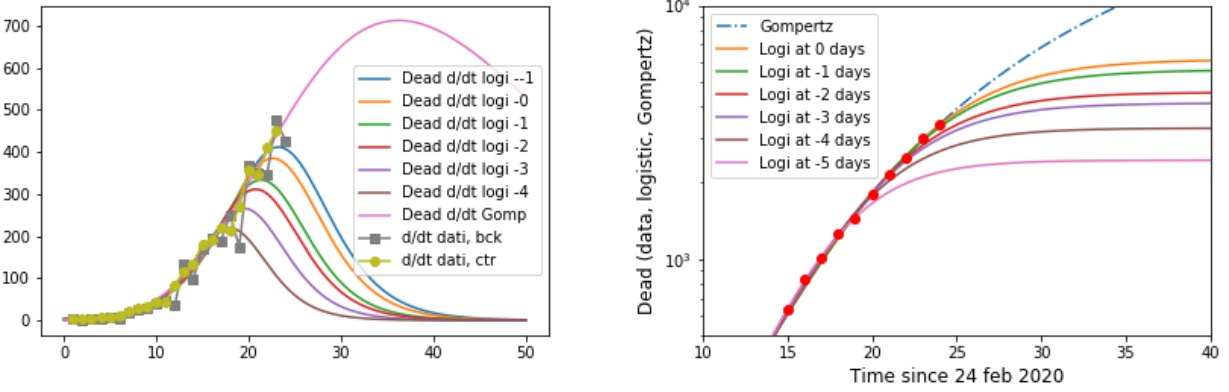


FIG. 1. Left: derivatives of Gompertz and logistic fits, and backward (squares) and centered (circles) derivative of the data for various proxies as indicated in the legends; right: data vs Gompertz and logistic. For both graphs, the logistic functions have been fitted to the data ending in each of the last six days, including today.

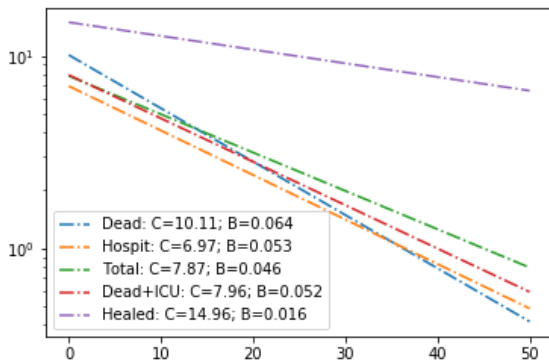


FIG. 2. Gompertz rates

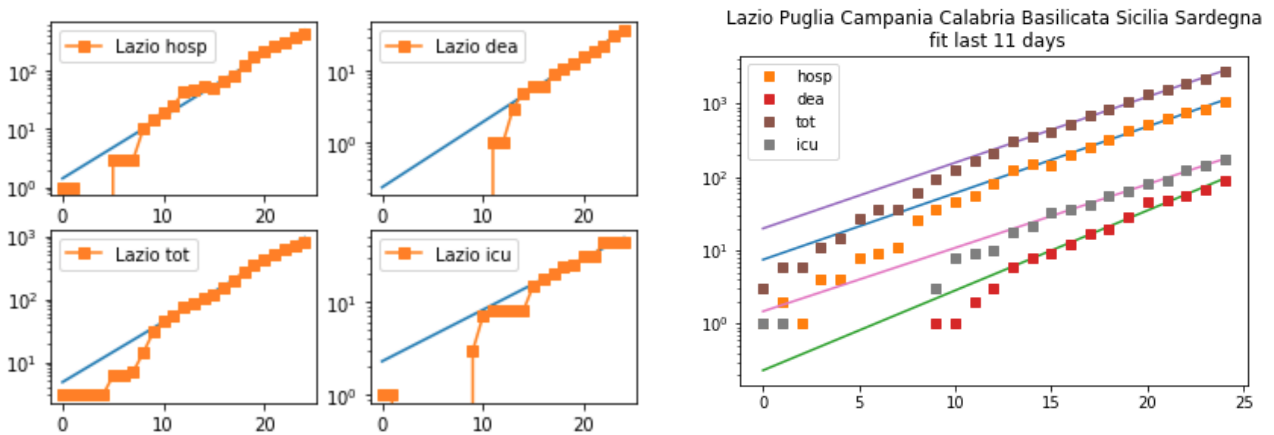


FIG. 3. Data and exponential fits for hospitalized, deaths, totals, ICU for Lazio (left) and for a southern cluster of regions.