

Italian Covid-19 epidemic @ 17 March 2020: logistic and Gompertz

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Update **17 March 2020**; time evolution looks slowly saturating on all variables, with the usual uncertainties on saturation predictions. I compare logistic, Gompertz and their derivatives in the hope of better locating "the peak".

I study the time evolution estimates of the Covid-19 italian epidemic using nation-wide data up to March 17 (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>.

The onset of non-exponential behavior is clear for all quantities (the simple exponential has been statistically rejected since a few days). The issue for any attempt at an extrapolation is now the choice of the model. Here I compare again the logistic and Gompertz functions in Fig.1 for the death count. Both functions track closely the data, and are both statistically acceptable (though the logistic is much better at this stage), so we cannot yet discard either hypothesis.

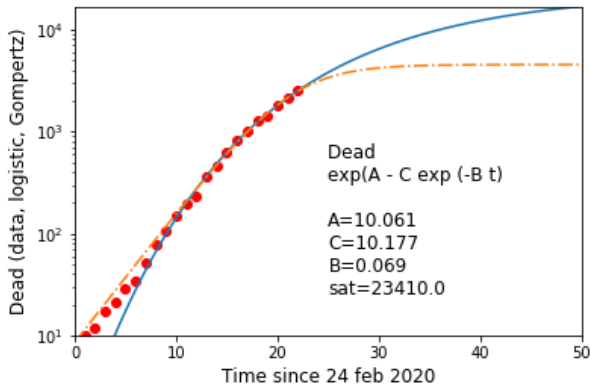


FIG. 1. Gompertz and logistic fit to the death count up to March 17, 2020. The fit parameters are reported.

TABLE I. Statistics (17/03/2020) for logistic and Gompertz.

	S-p	paired-S-p	χ^2/dof	χ^2-p	R^2
Deaths					
L	0.988	0.496	16.66/23	0.782	0.999
G	0.99	0.509	36.141/23	0.029	0.999

More interestingly, the first derivative of the data has now been leveling off for three straight days: 368, 349, 345 dead/day on 15, 16, 17 March (backwards formula) and 359 and 347 dead/day on 15 and 16 March (forward formula; cannot compute for March 17). This is depicted in Fig.2. According to the logistic, we are currently at the

peak rate, meaning halfway up the step of the cumulative death count. This would therefore be around 4500-5000 (Table II). Not so for Gompertz, where we would be only 1/5 or so of the way. One caveat is that the logistic peak is symmetric, so it misses tail effects which will likely be significant and increase the death count further. It goes without saying, of course, that all of this is not yet proof or guarantee of anything.

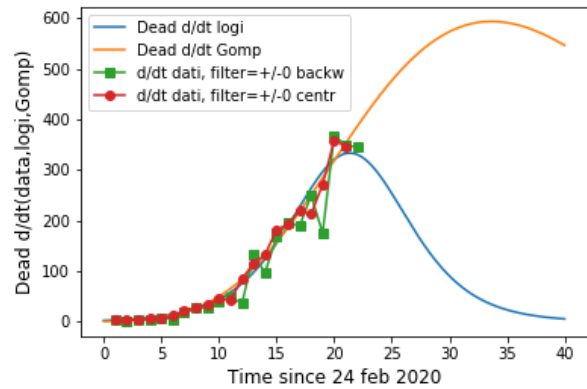


FIG. 2. Derivatives of logistic and Gompertz fits; backward (squares) and centered (circles) derivative of the data.

Table II reports the current saturations and inflections for the last three days. Saturations stay basically in the same ballpark as yesterday for death count (for total infected, the Gompertz saturation is still insane at 650k, but down from 1.3 million yesterday and 3.5 million the day before). Inflection times are stable for both functions (very unreliable for Gompertz totals infected).

TABLE II. Extrapolations with logistic and Gompertz for deaths and total infected (data 17 March 2020). The three values per entry are for the last three days including today.

	Deaths			Total		
Saturation						
L	3283/4118/4543	73250/67811/64710				
G	19870/26375/23409	3.8 M/1.4 M/0.65 M				
Inflection date						
L	15/3, 16/3, 16/3	18/3, 18/3, 17/3				
G	27/3, 30/3, 29/3	05/5, 21/4, —				