THE SECOND COVID-19 WAVE OF 2020 IN ITALY: A BRIEF ANALYSIS

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Abstract:

Introduction/purpose: Based on the results obtained previously, the second wave of Covid-19 infection is analyzed and some predictions on its evolution are given.

Methods: A model of population growth giving a differential equation has been used to describe the pandemic wave.

Results: The second wave of infection is essentially on its peak in the middle of November 2020 and will not decrease very soon.

Conclusions: The second wave is not going to end in the year 2020 and it will take some time before a status of relative normality is restored.

Key words: Coronavirus, COVID-19, differential equation, data fit.

Equation and Fit

The equation we have used in the model of Covid–19 evolution of a number of cases in time (Verhults, 1838) is given by (Fabiano & Radenović, 2020a)

$$\frac{dx(t)}{dt} = \frac{x(t)}{a}\left[1 - \frac{x(t)}{b}\right] , \qquad (1)$$

where the total number of cases $x(t)$ at a given time is given by

$$x(t) = \frac{c}{1 + \exp[(b - t)/a]} \ ,$$ (2)

while the growth of cases is given by its derivative

$$\frac{dx(t)}{dt} = \frac{c}{a} \left\{ \frac{\exp[(b - t)/a]}{(1 + \exp[(b - t)/a])^2} \right\} \ .$$ (3)

The parameter a is related to the growth rapidity, c is the asymptotic total number of cases, and b indicates the peak position of the growth of cases.
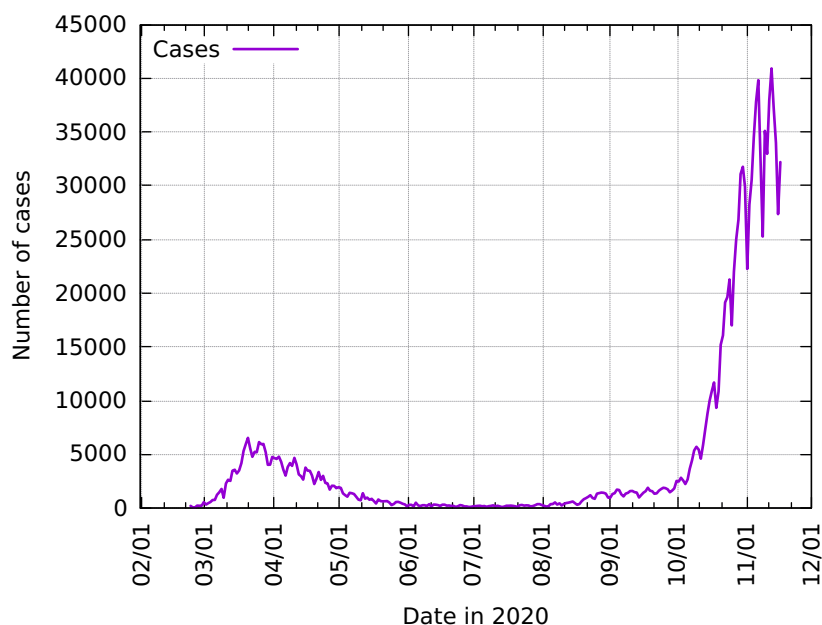

Figure 1 – Number of new cases of coronavirus per day with respect to the date for the year 2020
Рис.1 − Количество новых случаев зараженных коронавирусом за сутки по датам в 2020 году
Слика 1 – Број нових случајева заражених вирусом корона дневно у односу на датуме 2020. године

Figure 1 shows the number of new cases per day of coronavirus in Italy with respect to the date. One can clearly see two peaks corresponding to two different waves of the disease, the first with a maximum of around 6000

cases on the 26th of March, and the second one with around 40000 cases on the 13th of November.

In (Fabiano & Radenović, 2020b) we have compared the current coronavirus pandemic to the influenza pandemic of 1918 and gave some predictions on the possible future waves. Notably, in accordance with the data of 1918, it has been predicted in Table 5 of the above mentioned article that the second wave of the pandemic would have a peak number of new cases per day that has a fivefold increase of the peak of the first wave. According to the above mentioned data the accuracy of this prediction is astonishingly good.

In order to determine the parameters a, b, c of equations 1, 2, 3 for the second wave, we have done a fit to the most recent data available for the coronavirus disease in Italy, available at the GitHub account (Ministero della Salute, 2020).

The minimum value of new cases has been encountered on the 14th of July with 114 new patients on that day. This will be the starting point of the second peak. The results of the fit are shown in Table 1.

Table 1 – Fit for the parameters a, b, c of the second wave
Таблица 1 – Распределение по параметрам a, b, c во второй волне
Табела 1 – Поклапање параметара a, b и c другог таласа

Parameter	Value	Error	Error %
a	9.88343	0.332	3.359
b	119.106	0.558	0.4685
c	1.40299×10^6	4.605×10^4	3.282

The maximum of the peak is obtained from the value of $c/(4a)$, the parameters a and c are linked respectively to the height and width of the bell-shaped function of equation 3, while b traslates in time the position of the peak.

As expected, the values of the parameters are much bigger than the one found in Table 1 of (Fabiano & Radenović, 2020a), because the peak of the second wave is much larger as discussed above, and the rise of the peak is much sharper than the one of the first wave. Observe also that according to the value of c obtained, the total number of cases so far is expected to be not less than 1.4 million, more than 2% of the population.

Figure 2 shows the data of the second wave and the fit to the function 3 with respect to the number of days since the 14th of July. The fit is prolonged
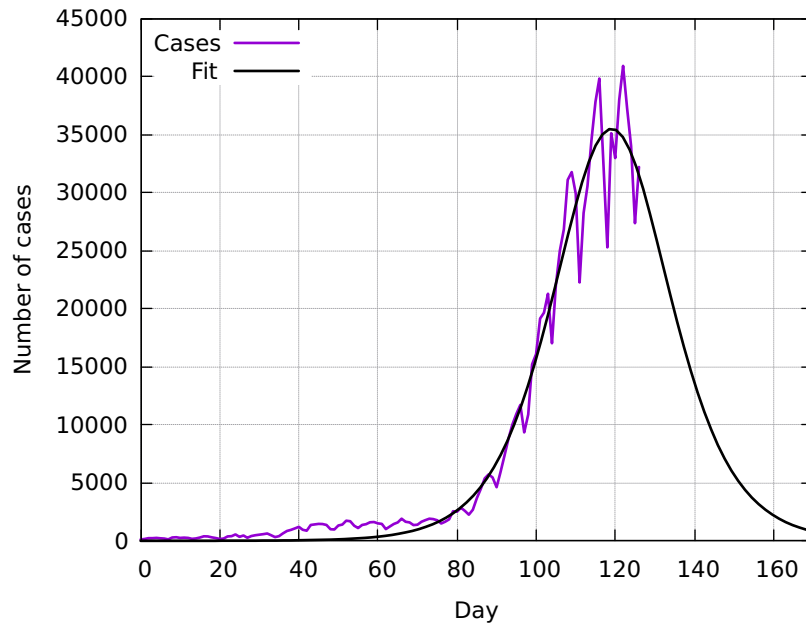
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Figure 2 – Number of new cases of coronavirus per day with respect to the numbers of days starting from the 14th of July 2020 and ending on 31st of December 2020

Рис. 2 – Количество новых случаев зараженных коронавирусом за сутки с 14 июля 2020 г. по 31 декабря 2020 года

Слика 2 – Број нових случајева заражених вирусом корона по дану у односу на број дана почевши од 14. јула 2020. године и закључно са 31. децембром 2020. године

beyond the current date of 17th of November, that is 127 days in order to give some insight of the future situation.

The bell–shaped curve is symmetric around the peak, therefore a quick raise provides also a fast decline of the number of cases, albeit with a caveat that will be discussed later on.

The limit of 5000 new cases per day is crossed again on the 152th day, i.e. around the half of December. On the last day of 2020, i.e. on the 170th day, there will still be more than 800 cases per day, resembling the same situation already encountered in May. Depending on how many new cases per day is considered acceptable, we will not reach again a "normal" status before the half of January 2021.

Yet there is a caveat. Considering again the global situation in Figure 1 and carefully observing the first peak, it is clear that it is not completely symmetric, having a decreasing side lasting longer than the increasing one. This is probably due to the fact that the quarantine rules employed are not static in time, and are progressively relaxed, as the pandemic situation turns better, for various reasons, mainly due to the concern about the worsening of the economic situation. It is also worth mentioning the fact that a part of the population tends not to abide by the quarantine rules after a longer period of time, as it has been observed particularly in the past summer when the pandemic was considered ended by many sources, some of them apparently respectable.

Conclusion

Cosidering all the reasons discussed before it is reasonable to conclude that the obtained fit given for equation 3 and shown in Figure 2 is actually an estimate from below for the return time to a normal situation, and even though we have apparently reached the peak of the second covid infection wave, it is not going to end completely in the year 2020.

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ВТОРАЯ ВОЛНА COVID-19 2020 ГОДА В ИТАЛИИ: КРАТКИЙ АНАЛИЗ

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Резюме:

Введение/цель: Основываясь на полученные ранее результаты, в статье проведен анализ второй волны инфекции Covid-19 и приведены некоторые прогнозы ее развития.

Методы: Для описания волны пандемии использовалась модель роста населения, дающая дифференциальное уравнение.

Результаты: Вторая волна заражения фактически достигла своего пика в середине ноября 2020 года и в ближайшее время не уменьшится.

Выводы: В этом 2020 году вторая волна не закончится, поэтому нам придется подождать, когда наступит безопасное время и мы сможем вернуться к состоянию относительной нормальности.

Ключевые слова: коронавирус, COVID-19, дифференциальное уравнение, соответствие данных.

ДРУГИ ТАЛАС ИНФЕКЦИЈЕ COVID-19 U 2020. ГОДИНИ У ИТАЛИЈИ: КРАТКА АНАЛИЗА

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Сажетак:

*Увод/циљ: На основу претходно добијених резултата, ана-
лизиран је други талас инфекције COVID-19 и дата су нека
предвиђања о његовој еволуцији.*

*Методе: Модел раста становништва који даје диференци-
јалну једначину коришћен је за описивање пандемијског та-
ласа.*

*Резултати: Други талас инфекције налази се на врхунцу
средином новембра 2020. године, и не очекује се да ће до
његовог смањења доћи врло брзо.*

*Закључак: Други талас се неће завршити у 2020. години, па
ће проћи извесно време пре него што се вратимо у статус
релативне нормалности.*

*Кључне речи: коронавирус, COVID-19, диференцијална јед-
начина, уклапање података.*