Report:

Team New York City has concluded that Sanjev is correct (Bonus points for flattery?! xD) and the final outcome is going to be the same for Solution 1 as well as Solution 2.

- # Case-1:

- ## Assumptions
    1. Assuming that the person is detected as soon as he contracts the virus.
    2. A person takes 7 days to get cured in the hospital and our hospitals have an efficiency of 100%
    3. Cases during the first 5 days since the suspected beginning of the pandemic haven't been detected.
    4. The travel rate for the first 5 days i.e. before the restriction on travel has been imposed, is assumed to be 20%

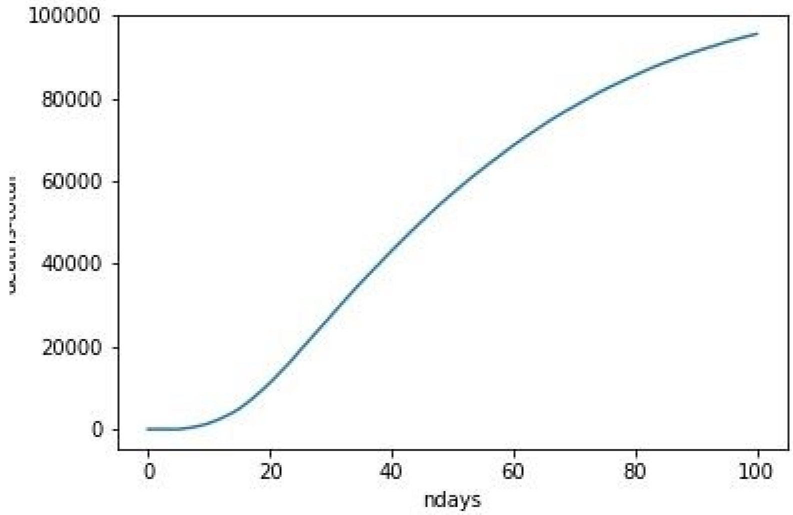
5. The virus has a mortality rate of 5%. Every infected person who hasn't been to the hospital dies with a probability of 5%
6. A cured person can be infected again.
   Bonus: From calculations, we concluded that the probability of any person being in the 10m neighbourhood of an infected person is Population Density / 10,000

● Simulations Worked On:

1.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **10,000.**

- Population = 1,00,000 (1 Lakh)
- Total Number of Beds=12

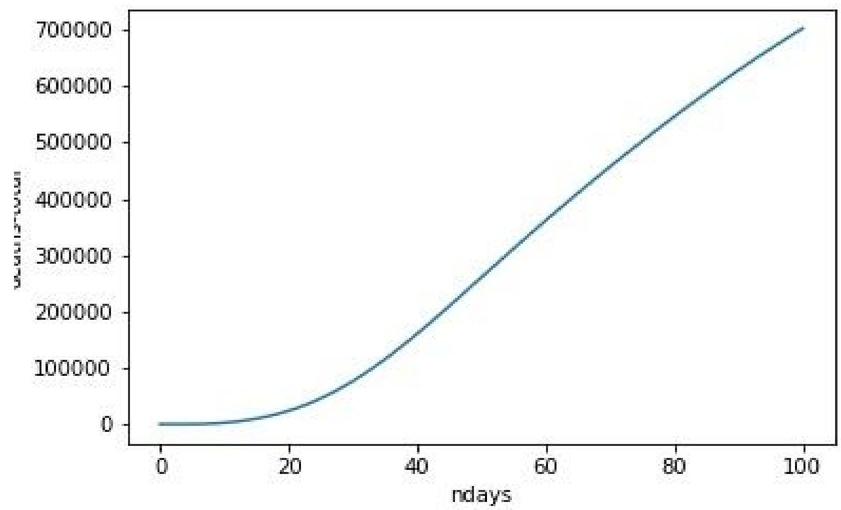
Result: The country ***doesn't survive***, a majority of the total population dies and the outbreak stabilizes only when about 90% of the population is infected or dead, because only a few people haven't been infected and the number of people getting infected per day is almost equal to the number of people being cured everyday by the hospital.



2.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **1,000.**

- Population=10,00,000 (1 Million)
- Total Number of Beds=120

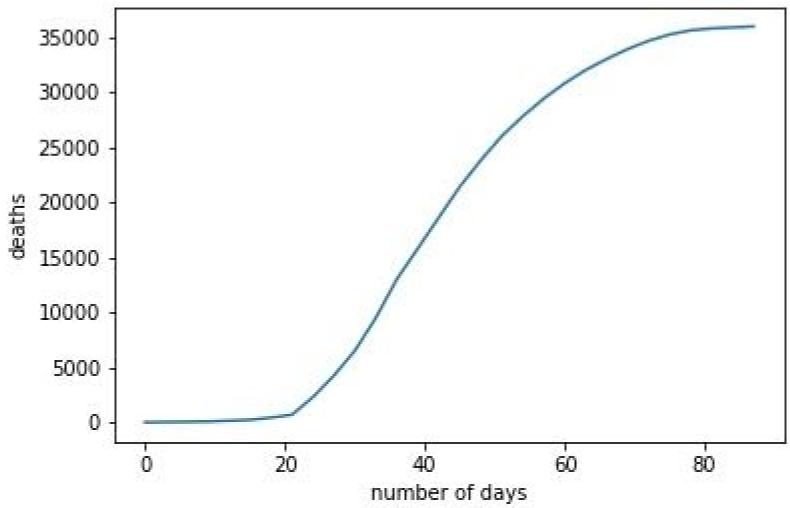
Result:The country *doesn't survive*, a majority of the total population dies and the outbreak stabilizes only when about 90% of the population is infected or dead, because only a few people haven't been infected and the number of people getting infected per day is almost equal to the number of people being cured everyday by the hospital.



3.A linearly scaled down model with population and number of beds linearly scaled down by a factor of **100.**

- Population = 1,00,00,000(10 Million)
- Number of Beds = 1200

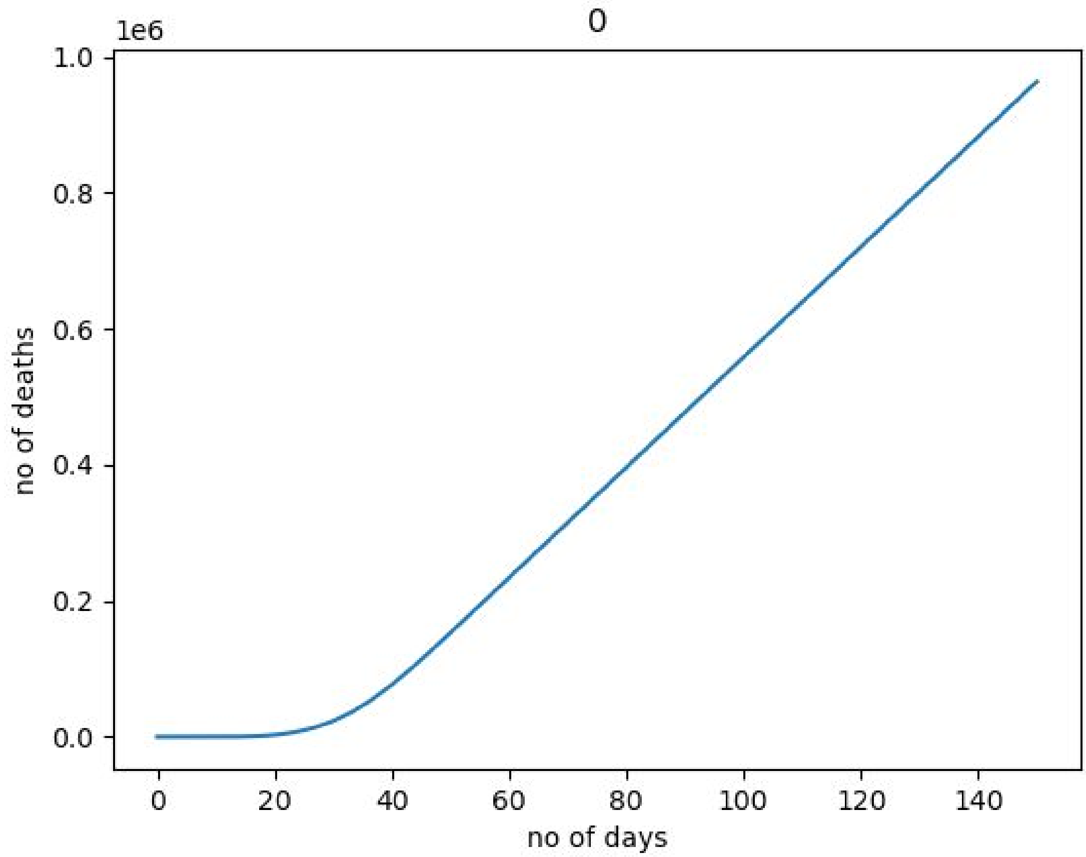
Result: The *country survives.* The number of people dying stagnated after a certain number of days and the number of infected people also started decreasing and almost became negligible.

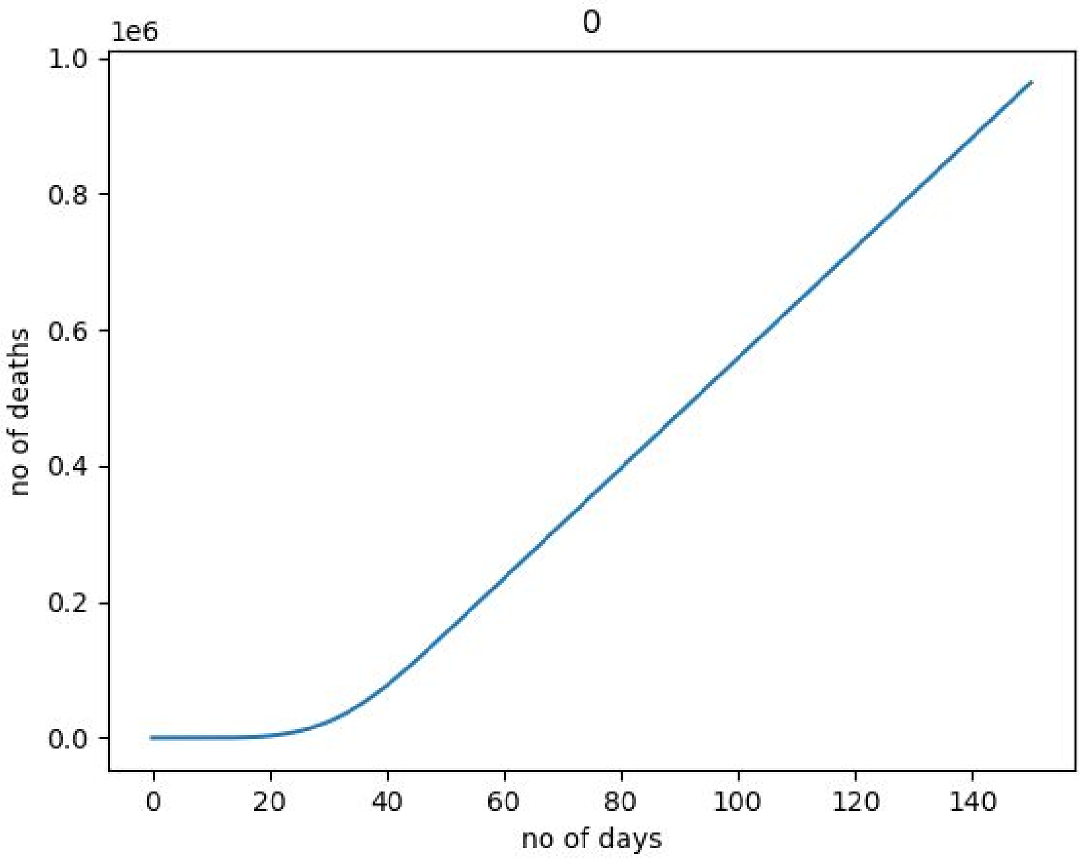


- # Most affected states:

  Here, most affected implies maximum number of people dying.

1. Uttar Pradesh:-




0
1e6
1.0
0.8
0.6
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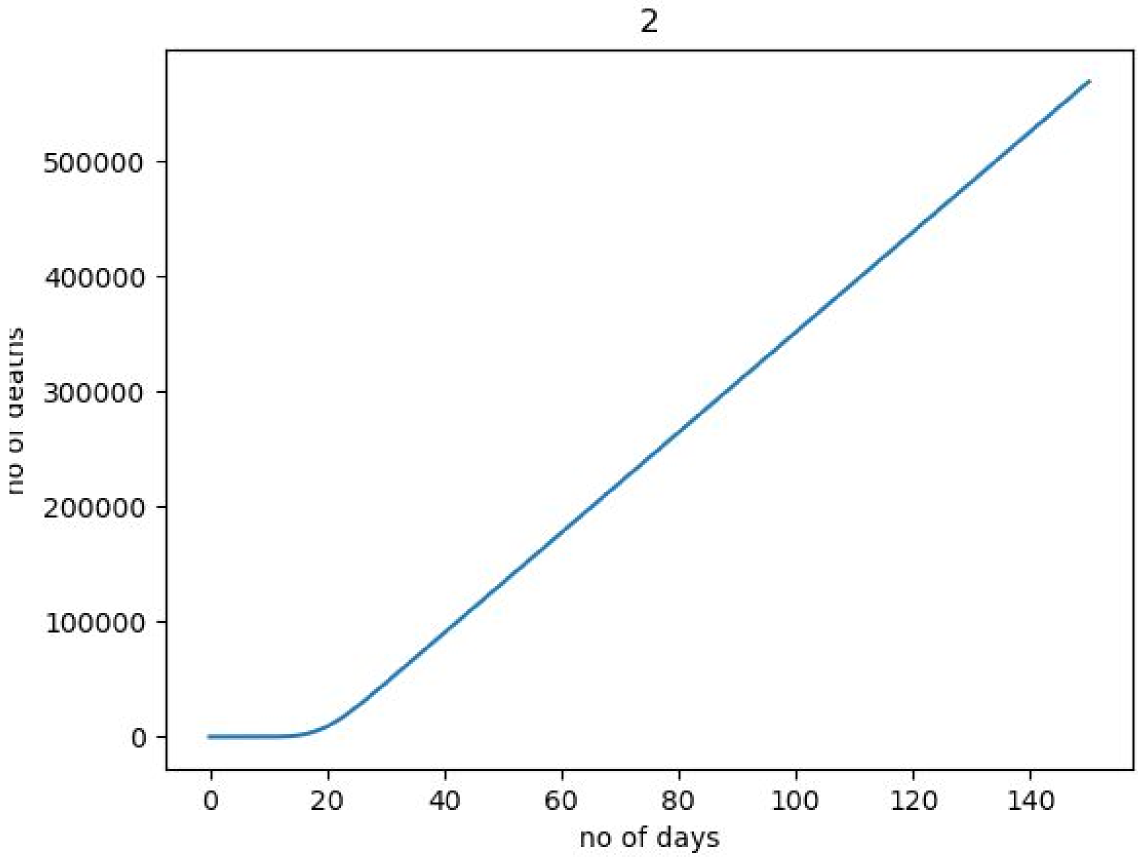
120
140
no of days

2. Bihar:-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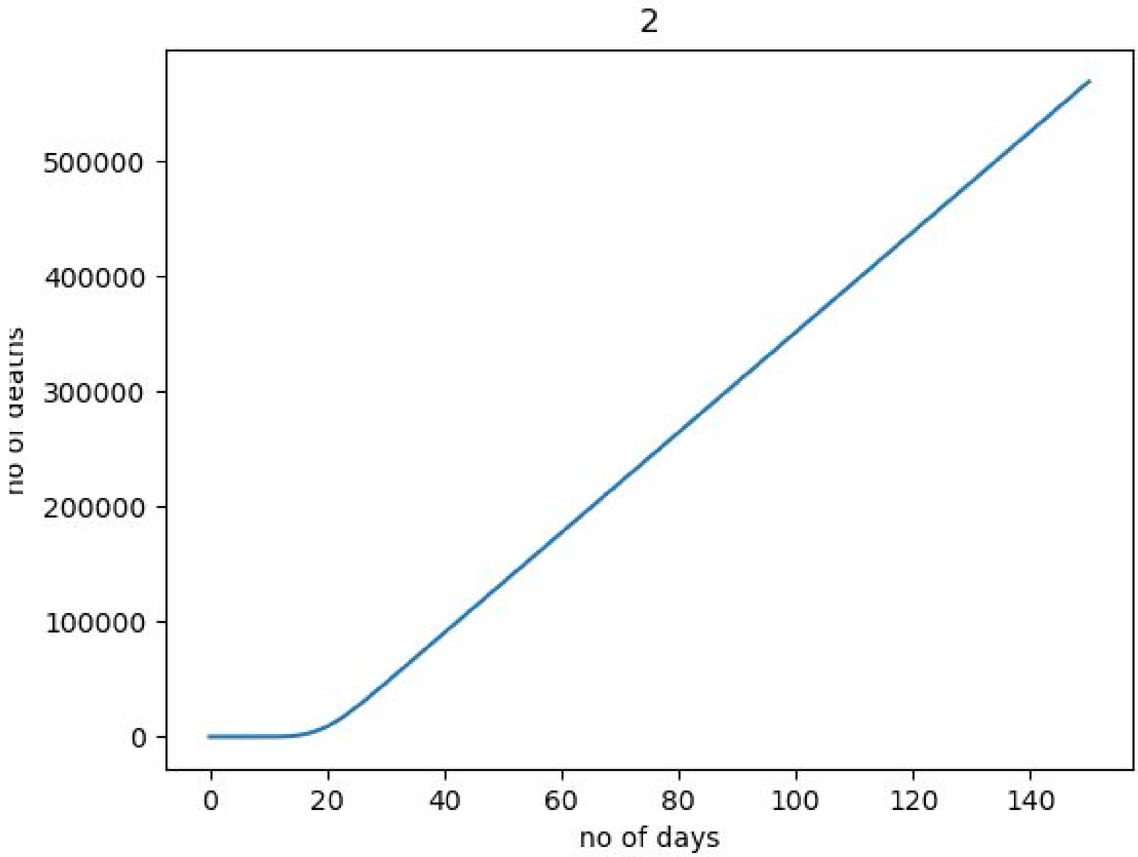
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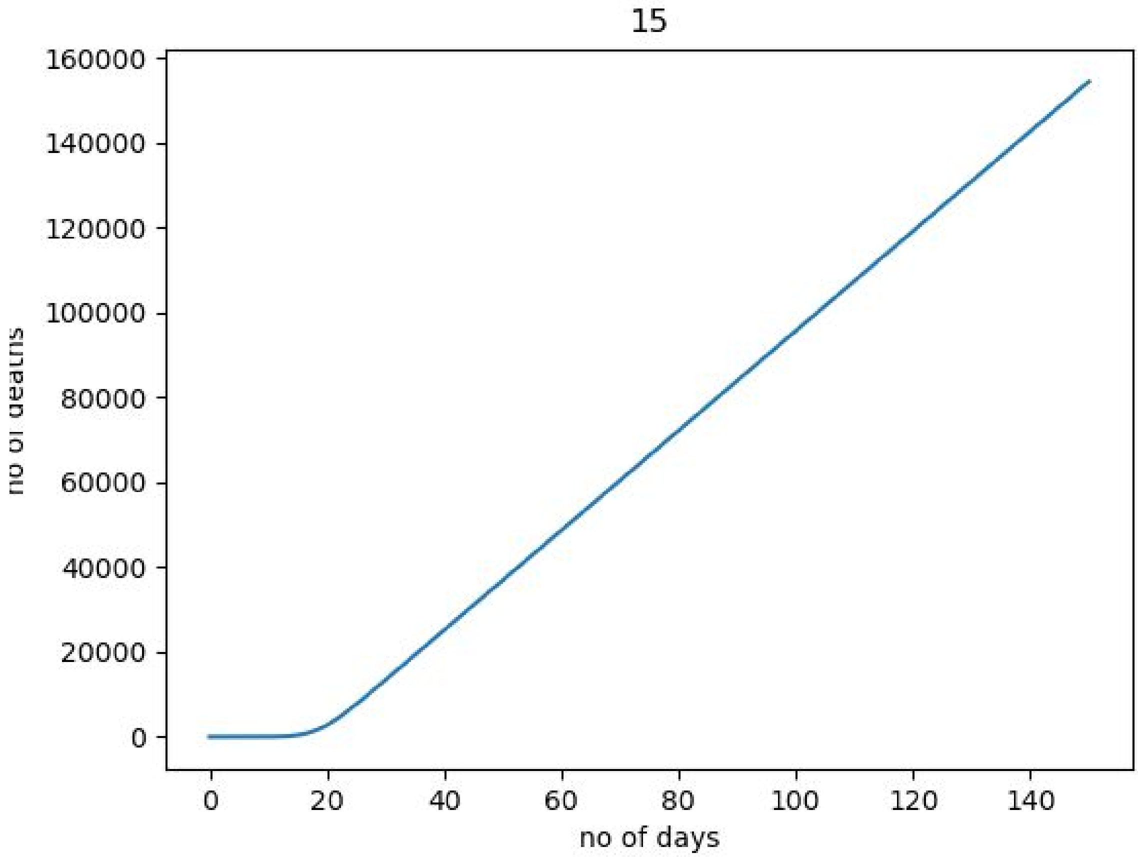
3. Kerala:-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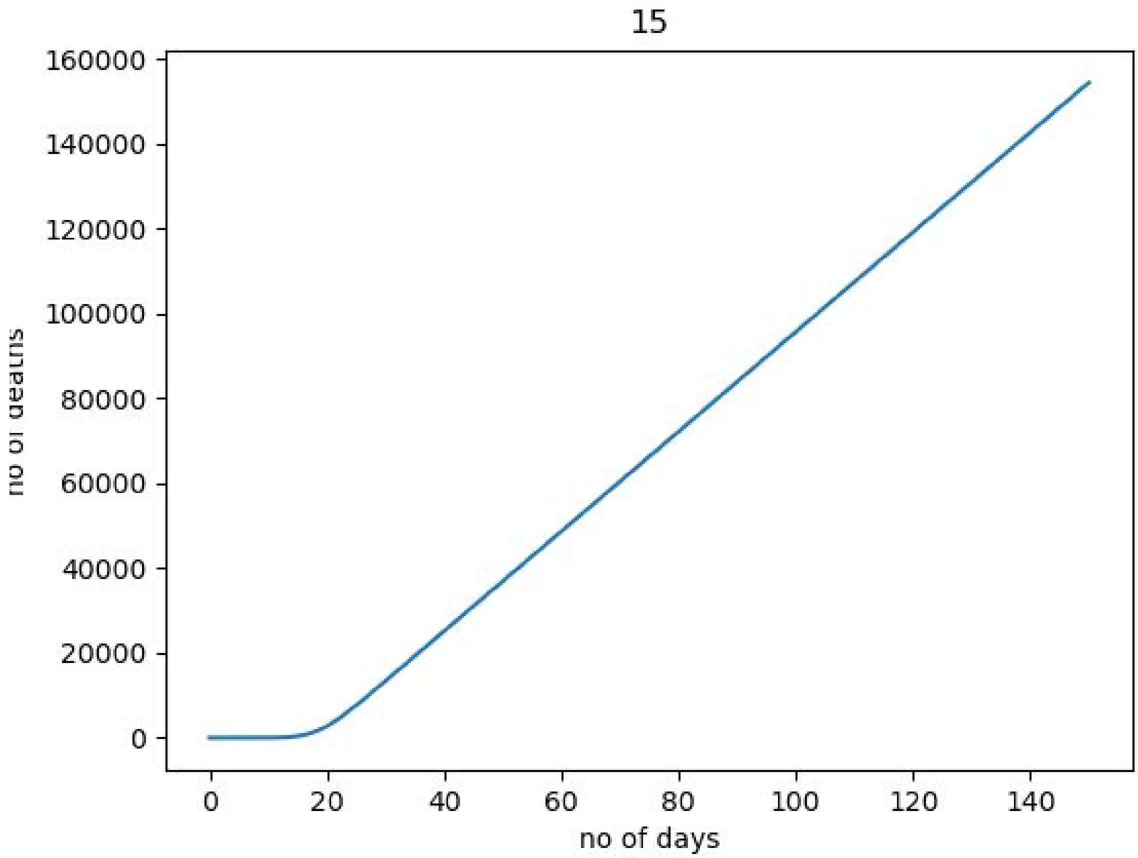
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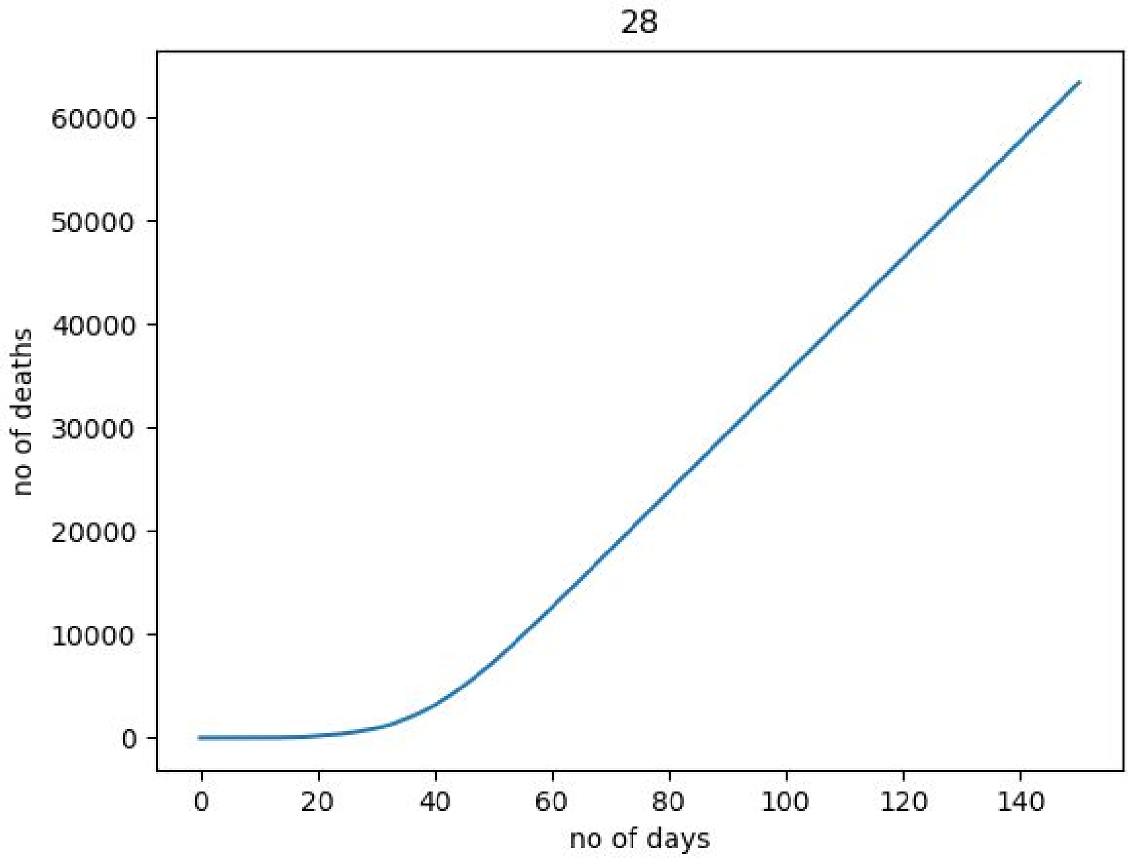
no of days

4. Delhi:-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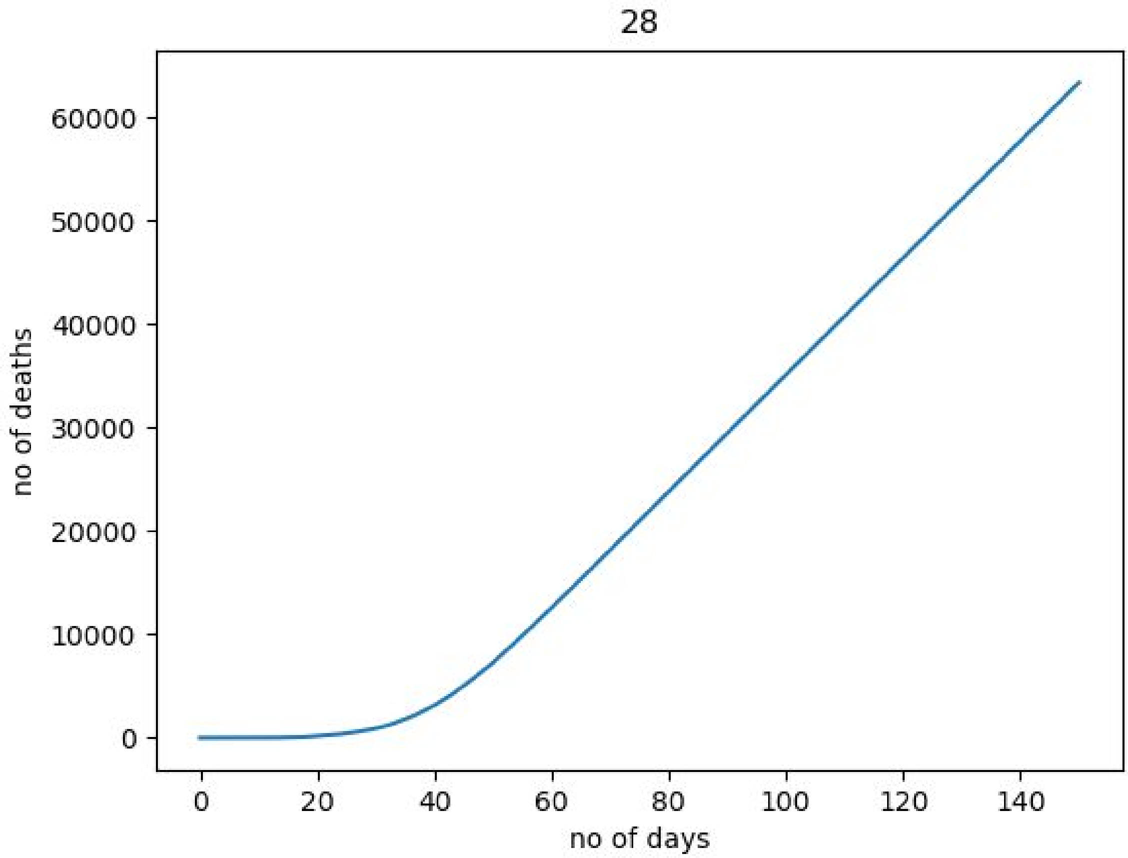
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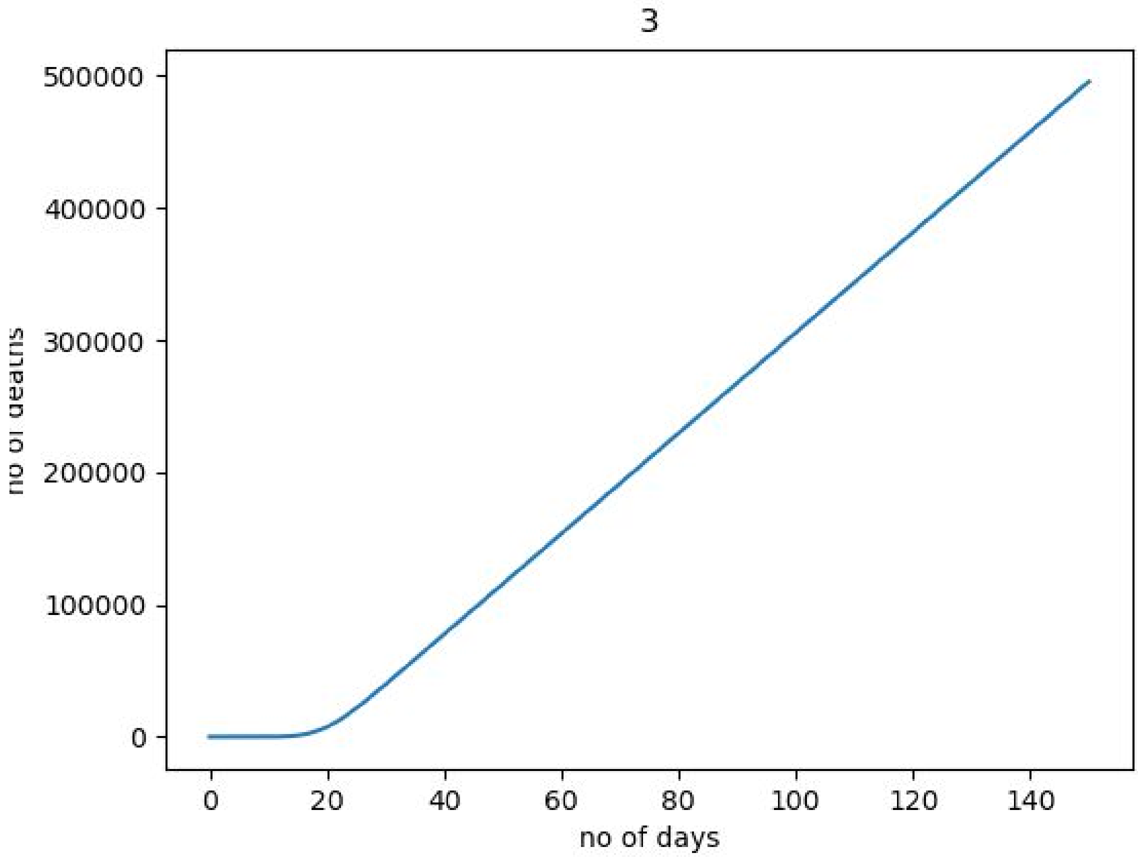
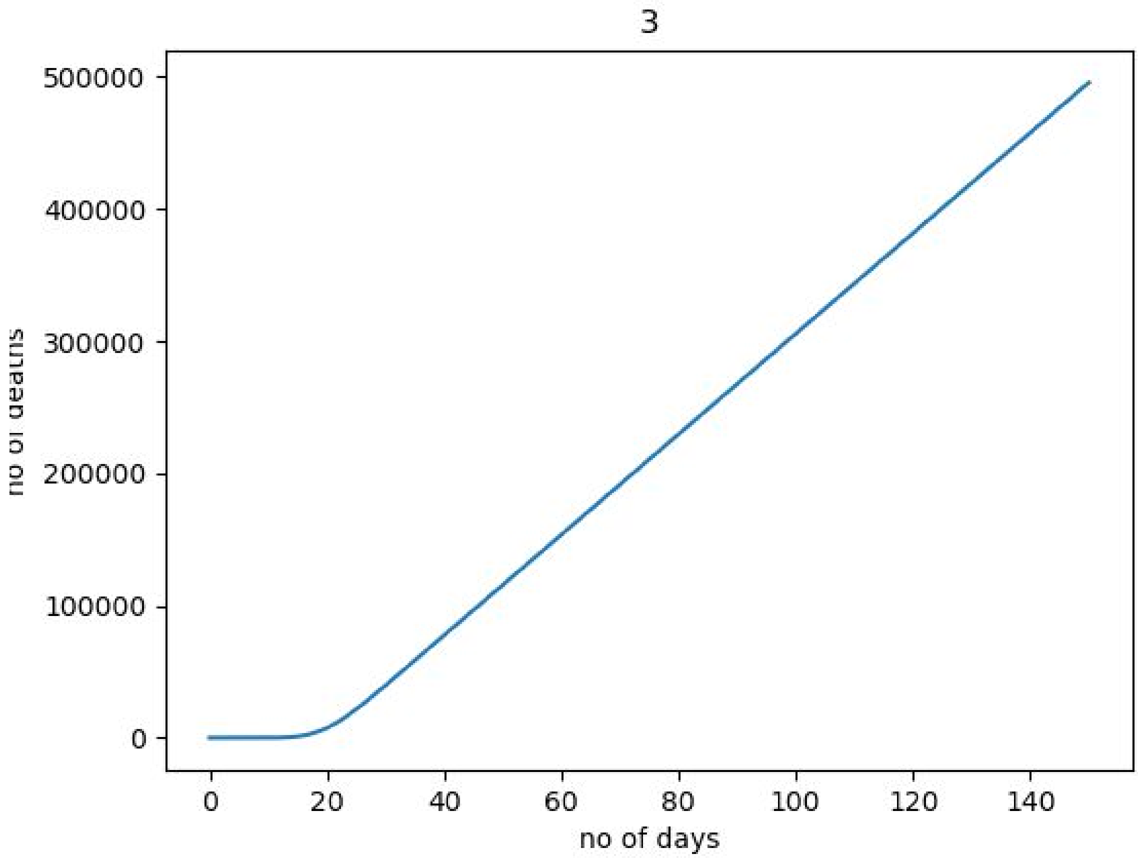
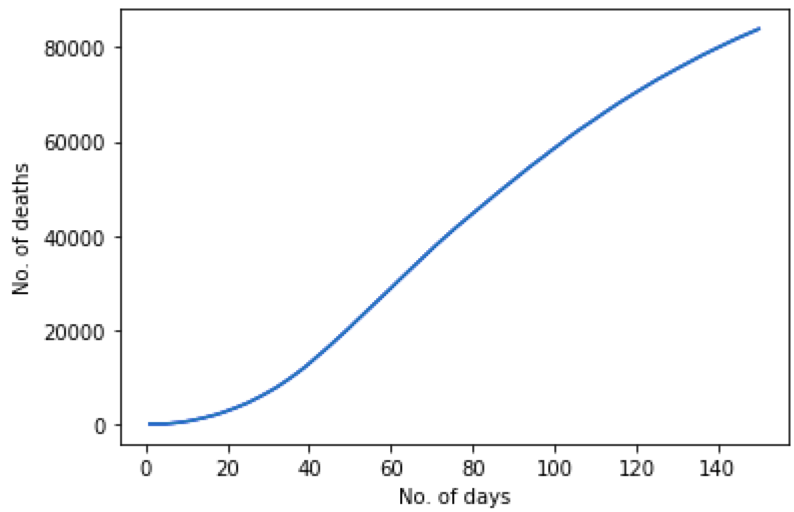
5. West Bengal:-



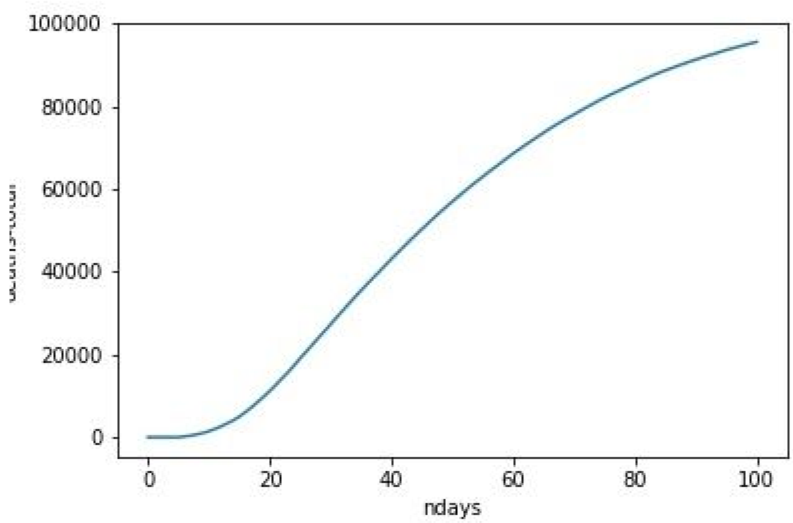


- Conclusions Drawn:
    1. Number of Beds: The safety of people is heavily dependent on the “quantity” of beds,i.e.,the magnitude of people to whom medical attention can be provided.

    2. Inter-State Travel and Intra-State Travel: The outgrowth of the pandemic continues similarly in Solution-1 as well as Solution-2. Hence, we have concluded that there is a negligible difference between the effects of the 2 proposed solutions.



Intra state solution



Interstate Solution

3. The probability of people getting saved increases as we reduce the factor by which we have scaled down the real scenario. Thus, a country as vast

as India with a population of 1 Billion will be saved.

Interstate solution(second) for a linear scale down of 100

- ## Further Analysis:

In reality, assuming the information given in the problem statement, i.e., the total number of beds available is 1,20,000 ; The pandemic won't last more than a fortnight as after the 5 days (upto which people haven't been detected), the number of people being infected is significantly lesser than 1,20,000 (about 2000-3000 only!!). After being informed about the outbreak of the pandemic, all infected people can be admitted to the hospital in a single day, preventing any further spread. Also, after 7 days all these people will get cured, leaving no infected person in the country and hence no possibility of any more cases ; which led us to make an assumption which seemed closer to reality, giving rise to a whole new Case.

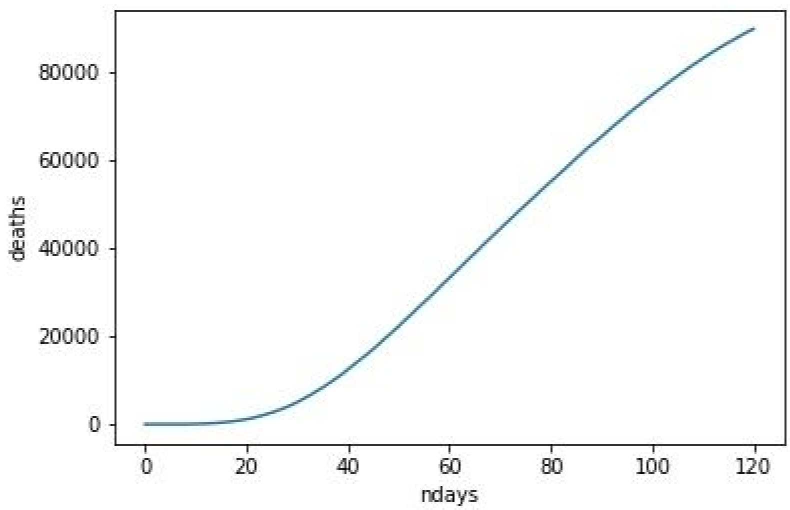
- # Case-2:

- Assumptions:
    1. Assuming that the person is detected 5 days after he contracts the virus.
    2. A person takes 7 days to get cured in the hospital and our hospitals have an efficiency of 100%
    3. Cases during the first 5 days since the suspected beginning of the pandemic haven't been detected.
    4. The travel rate for the first 5 days i.e. before the restriction on travel has been imposed, is assumed to be 20%
    5. The virus has a mortality rate of 5%. Every infected person who hasn't been to the hospital dies with a probability of 5%
    6. A cured person can be infected again.
    7. *<u>Bonus</u>*: From calculations, we concluded that the probability of any person being in the 10m neighbourhood of an infected person is Population Density / 10,000.
- Simulations Worked On:

    1.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **10,000** allowing only Intra-State travel**.**

- Population = 1,00,000 (1 Lakh)
- Total Number of Beds=12

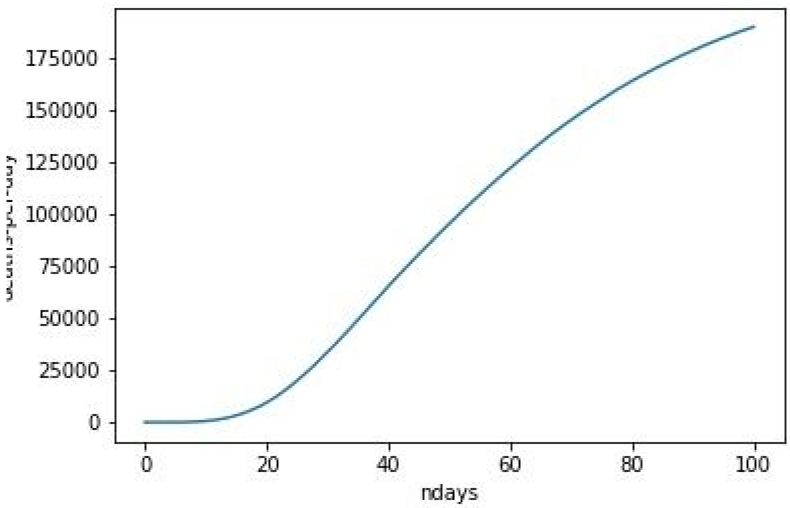
Result:The country *doesn’t survive*, a majority of the total population dies and the outbreak stabilizes only when about 90% of the population is infected or dead, because only a few people haven’t been infected and the number of people getting infected per day is almost equal to the number of people being cured everyday by the hospital.



2.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **5,000** allowing only Intra-State travel.

- Population = 2,00,000 (2 Lakh)
- Total Number of Beds=24

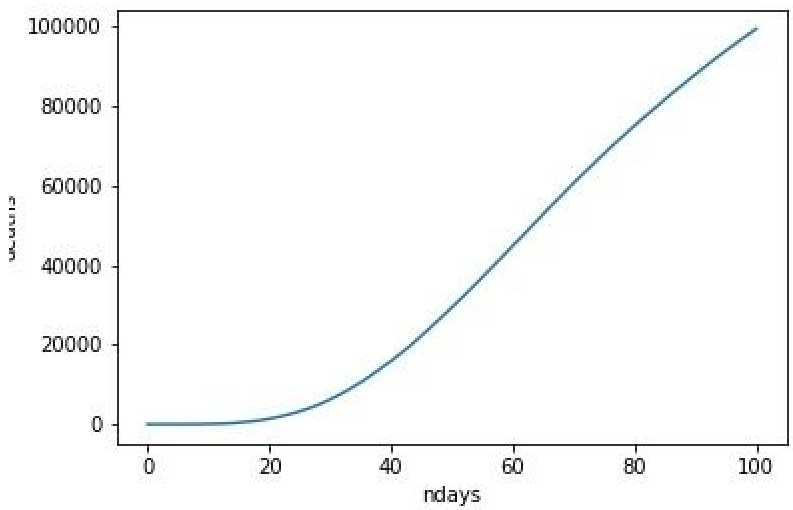
Result:The country *doesn’t survive*, a majority of the total population dies and the outbreak stabilizes only when about 90% of the population is infected or dead, because only a few people haven't been infected and the number of people getting infected per day is almost equal to the number of people being cured everyday by the hospital.



3.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **10,000** allowing Inter-State travel as well as Intra-State travel.

- Population = 1,00,000 (1 Lakh)
- Total Number of Beds=12

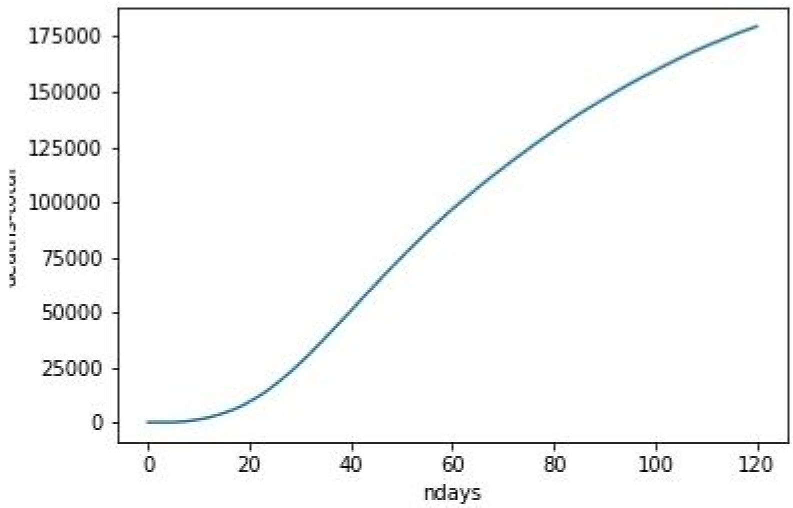
Result: The country *doesn't survive* as there are a significant number of infected people perennially, who continue spreading the virus increasing the number of casualties.



4.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **5,000** allowing Intra-State travel as well as Inter-State travel

- Population = 2,00,000 (2 Lakh)
- Total Number of Beds=24

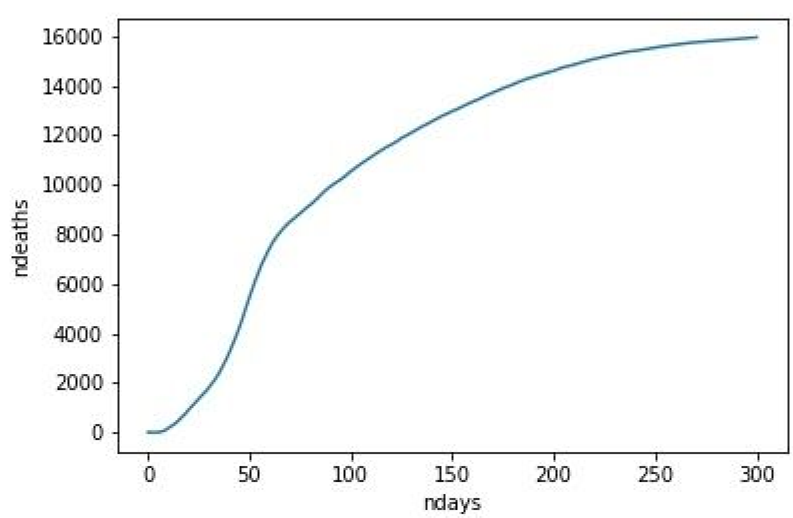
Result:The country *doesn't survive* as there are a significant number of infected people perennially, who continue spreading the virus increasing the number of casualties.



5.A model with the following assumptions:

- Population=1,00,000(1 Lakh)
- Number of Beds=12,000

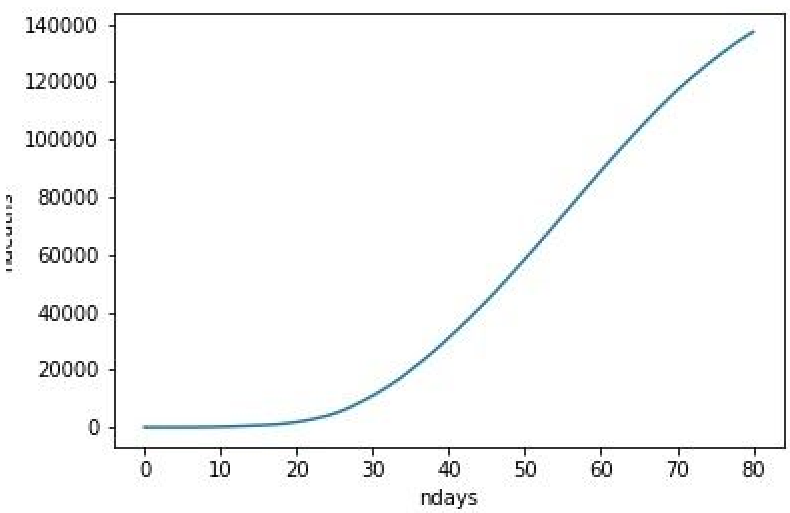
Result: The *country survives*. The number of people dying stagnated after a certain number of days and the number of infected people also started decreasing and almost became negligible.



6.A model with the following assumptions:

- Population=2,00,000(2 Lakh)
- Number of Beds=12,000

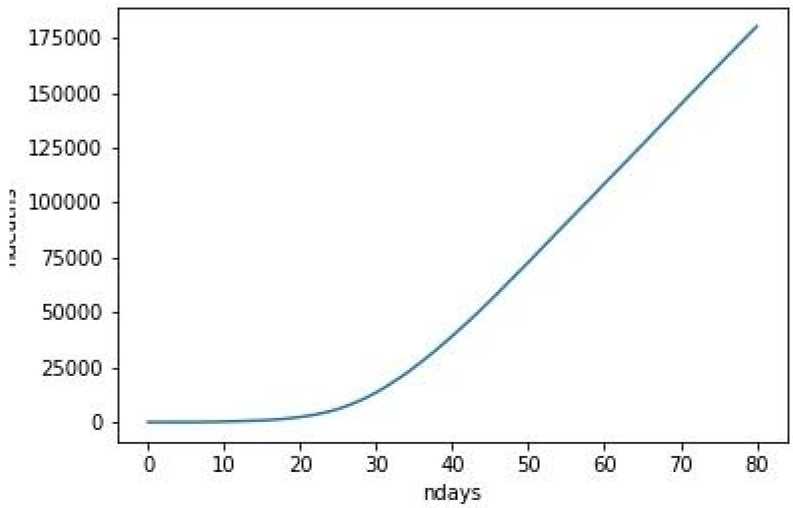
Result: The country *doesn't survive*, a majority of the total population dies (about 60%) and the outbreak cannot be controlled as the number of people getting infected far overpowers the number of people getting cured.



7.A model with the following assumptions:

- Population=4,00,000(4 Lakh)
- Number of Beds=12,000

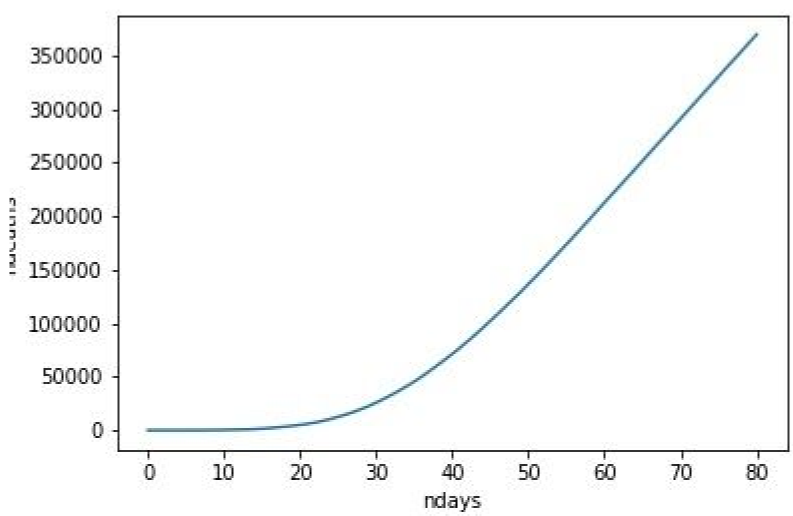
Result:Result: The country *doesn't survive*, a majority of the total population dies (about 60%) and the outbreak cannot be controlled as the number of people getting infected far overpowers the number of people getting cured.



8.A model with the following assumptions:

- Population 8,00,000(4 Lakh)
- Number of Beds=12,000

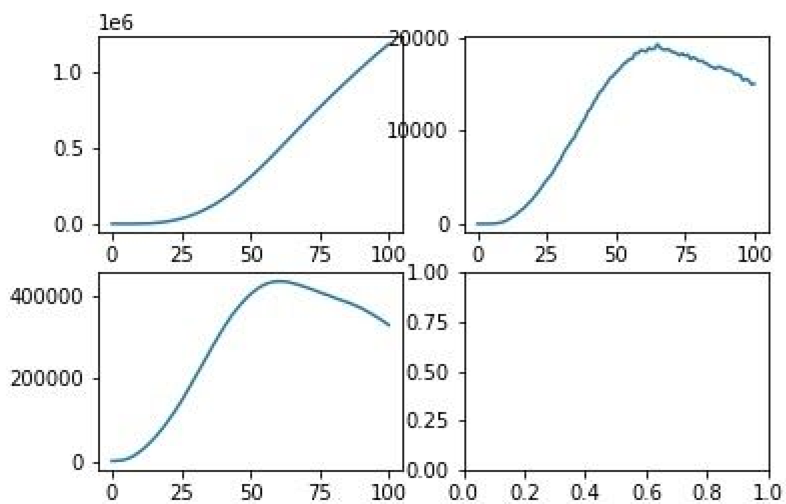
Result:The country ***doesn't survive***, a majority of the total population dies (about 60%) and the outbreak cannot be controlled as the number of people getting infected far overpowers the number of people getting cured.



9.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **625.**

- Population= 16 Lakh
- Number of Beds = 192
- Travel restriction = 0.05 %

Result:The country *doesn't survive*, a majority of the total population dies (about 60%) and the outbreak cannot be controlled as the number of people getting infected far overpowers the number of people getting cured.

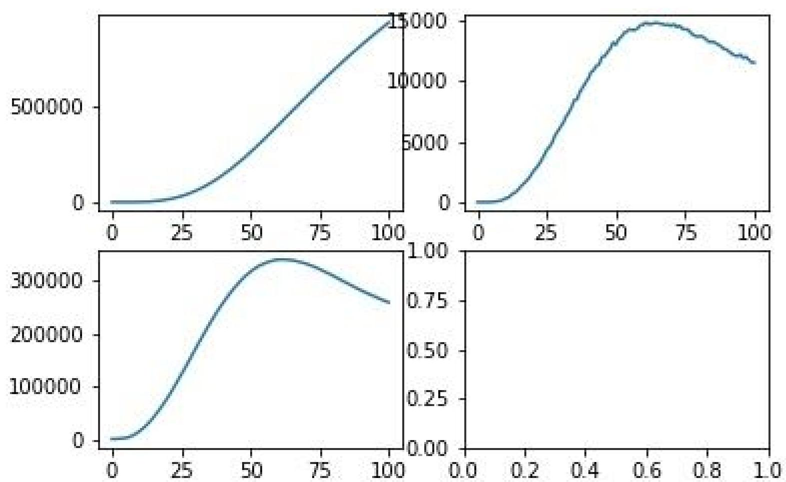


Graph1: Number of deaths wrt days.
Graph2: Number of deaths per day wrt days
Graph3: Number of infections wrt days

10.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **625.**

- Population= 16 Lakh
- Number of Beds = 192
- Travel restriction = 0.01 %

Result:The country ***doesn’t survive***, a majority of the total population dies (about 60%) and the outbreak cannot be controlled as the number of people getting infected far overpowers the number of people getting cured.

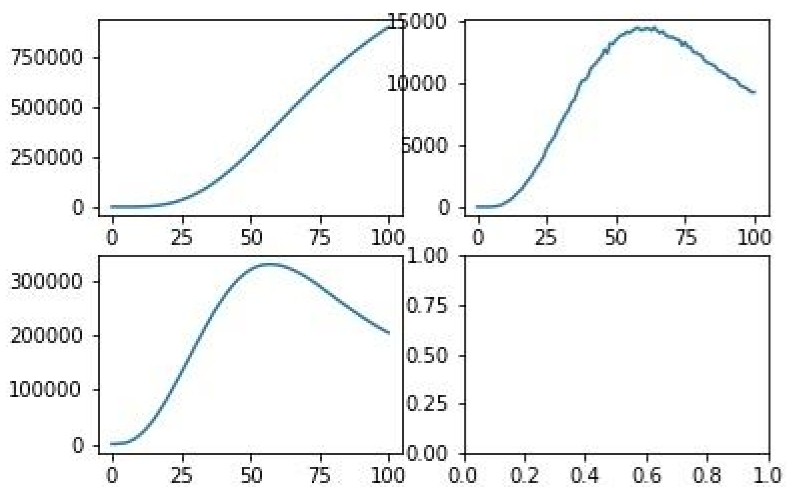


Graph1: Number of deaths wrt days.
Graph2: Number of deaths per day wrt days
Graph3: Number of infections wrt days

10.A linearly scaled down model with population and number of beds in the Hospitals reduced by a factor of **625.**

- Population= 16 Lakh
- Number of Beds = 192
- Travel restriction = 0.00 %

Result:The country ***doesn't survive***, a majority of the total population dies (about 60%) and the outbreak cannot be controlled as the number of people getting infected far overpowers the number of people getting cured.

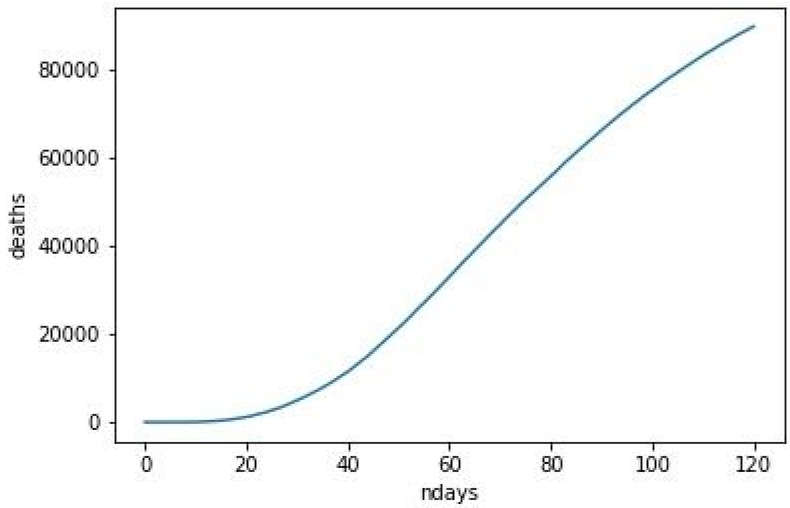


Graph1: Number of deaths wrt days.

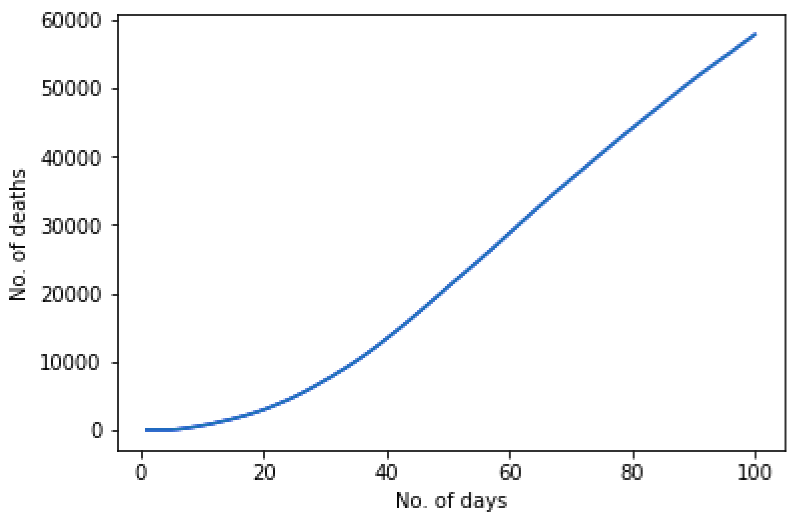
Graph2: Number of deaths per day wrt days

Graph3: Number of infections wrt days

- Comparing the 2 solutions:



Solution 1 Interstate travel for a total population of 1 lakh

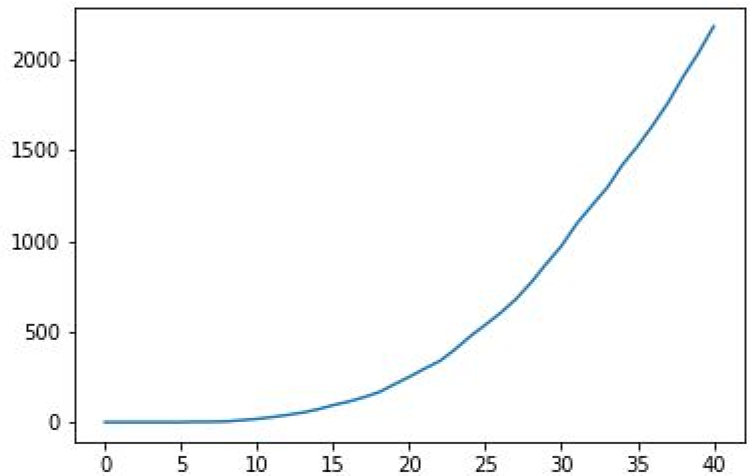


Solution 2 Intrastate travel for total population of 1 lakh

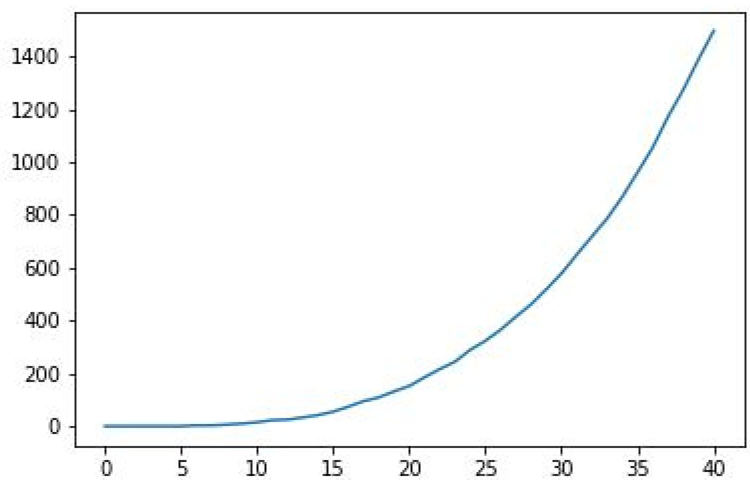
- # Most Affected States:

  The most affected states in terms of number of people died are :

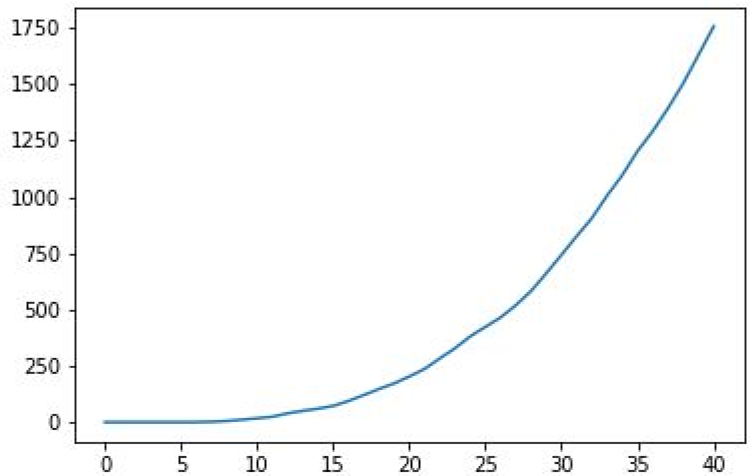
  1. Bihar



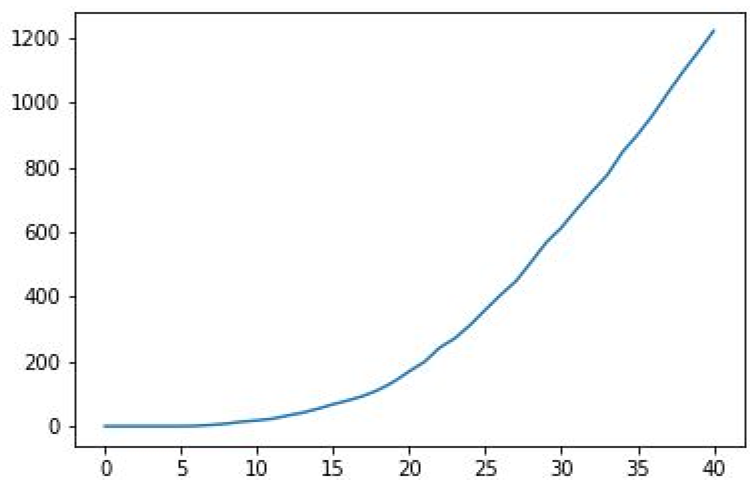
2. Uttar Pradesh



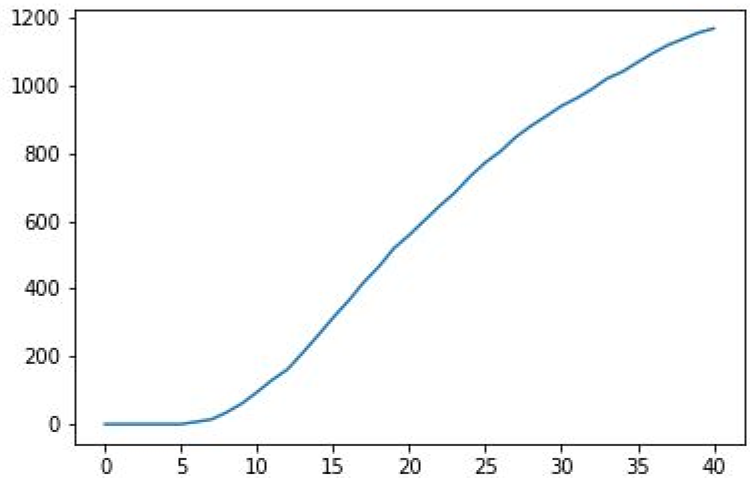
3. West Bengal



4. Kerala



5. Delhi



- Conclusions Drawn:

1. Relation with population: The percentage of the population getting affected increases with the population. So, there is no way a population of 1 billion will survive the pandemic in this situation.
2. Inter-State Travel and Intra-State Travel: The outgrowth of the pandemic continues similarly in Solution-1 as well as Solution-2. Hence, we have concluded that there is a negligible difference between the effects of the 2 proposed solutions.
3. The growth of the pandemic cannot be controlled regardless of the travel restrictions as observed as in the span of time between the person getting infected and being tested positive, he/she spreads the disease to many people leading to a chain reaction and hence no possible solution. This led us to devise a possible

solution, lockdown assuming complete
self-quarantine.

Lockdown: A possible solution

- ## Assumptions

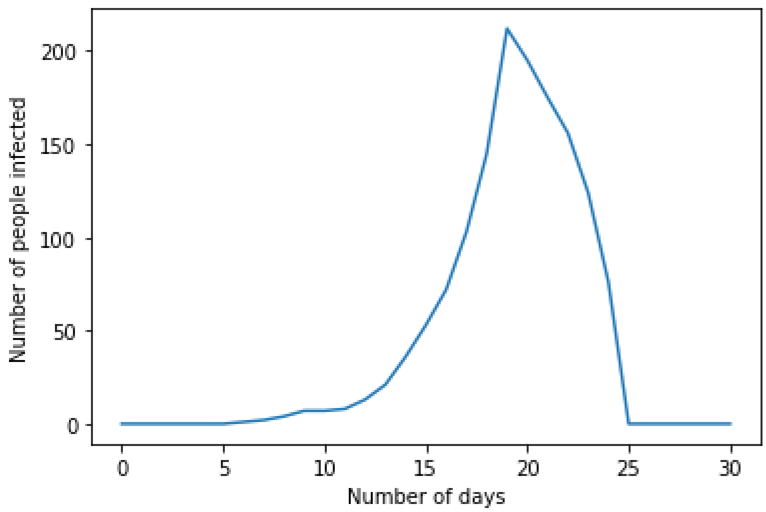
    1. A person infected with virus is detected positive only after 5 days.
    2. A patient needs 7 days to recover completely after being detected and is further safe from virus
    3. Medical facilities are 100% efficient in curing virus.
    4. Transport rate is 20% for the first 5 days and then reduced to 0.05% untill lockdown is imposed.
    5. The Simulations are carried out for scaled down values.
    6. A lockdown is imposed when 10% of medical facilities are occupied and continues till there is complete eradication of the virus

Plots:

1)

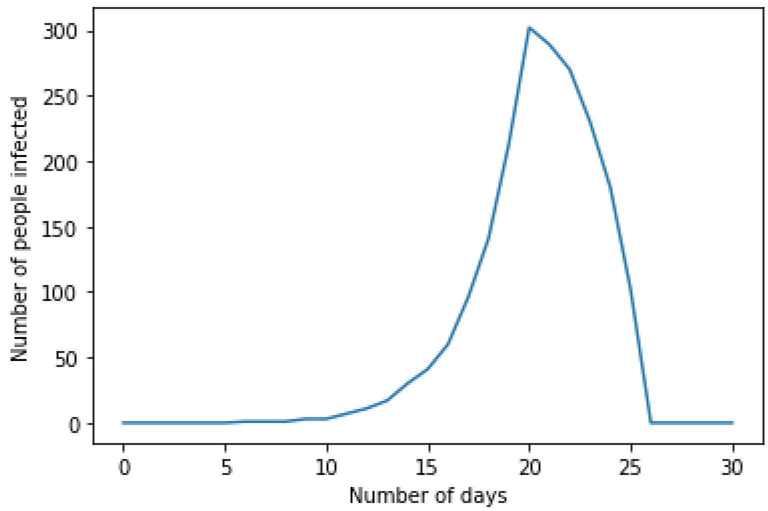
- Population:2.25 million

- Number of people infected on day 1:1
- Medical facilities:220
- Lockdown period:Day 15 to Day 24 (10 Days)
- Casualties:0



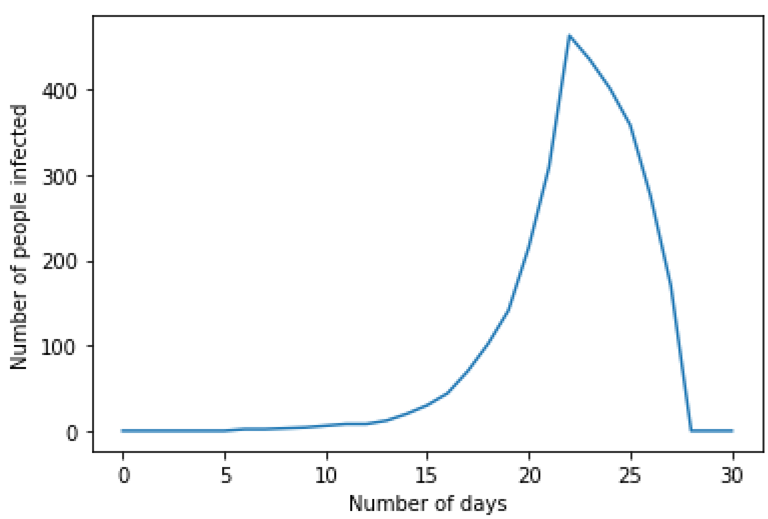
2)

- Population:4 million
- Number of people infected on day 1:1
- Medical facilities:400
- Lockdown period:Day 15 to Day 25 (11Days)
- Casualties:0



3)

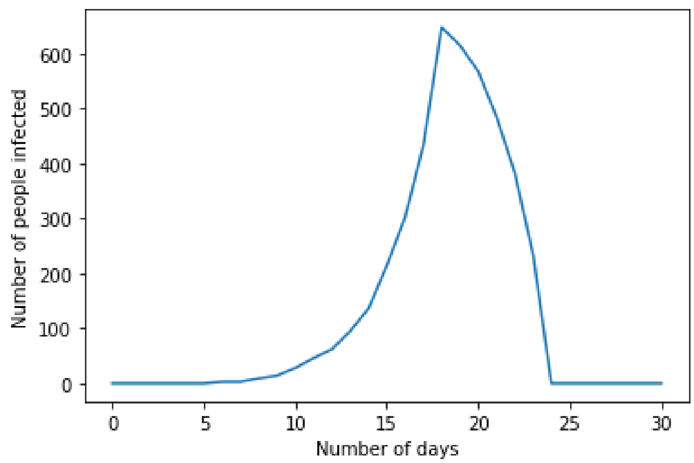
- Population:6.25 million
- Number of people infected on day 1:2
- Medical facilities:600
- Lockdown period: Day 18 to Day 27 (10 Days)
- Casualties:0



4)

- Population:9 million

- Number of people infected on day 1:3
- Medical facilities:880
- Lockdown period: Day 14 to Day 23 (10 Days)
- Casualties:0

- 

Conclusion:

In the above plots we observe that the Lockdown if imposed for 10-11 days can completely eradicate the virus from the country. Because the virus gets detected 5 days after getting infected there is always a set of people who are spreading the virus unknowingly. Here comes the need for complete lockdown where there is no transport and people need to be self quarantined which would lead to no further spread. To be on a safer side, **a lockdown of**

15 days is recommended and should start when 10% of the medical facilities are occupied