# MODELING THE "NOVEL CORONA VIRUS" USING SIR AND SIR-∂i

At present we don't know many of the details about CoVid19. But using preliminary reports I'm free-styling some numbers for use in the SIR model. Refer to the SIR GoogleSheets I made or the ones you made.

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## SIR Notes vis-a-vis CoVid19

1) A person is infectious for about 10 days, peaking on Day-5 or so. Often by Day-10 the viral level in an Infected person is significantly lower and the person is told to self-isolate. Assuming the patient does this, they are effectively not infectious anymore, since they are no longer in the world of the Susceptible. What this means for SIR is that the recovery rate, ***r*, is about 0.1 = 1/10 = 10%** ... because after 10 days they have accumulated 100% of a recovery: $0.1 \times 10 days = 1 = 100\%$ ...they are effectively moved into the Recovered population (no longer infectious, for all practical purposes).

2) The $R_0$ [R-naught[a]-see note "a" below] appears to be between 2 and 2.5, meaning that a person with the virus will infect 2 to 2.5 susceptible people while infectious. Let's go with 2.5.

Combining 1 and 2: If a person is infectious for 10 days and in those 10 days s/he infects 2.5 people, then we can calculate an infection rate, *i*: 2.5 infections per 10 days. $\boldsymbol{i = \frac{2.5\ infections}{10\ days} = 0.25 = 25\%}$.

So now we have and *r* and and *i*.

$$\boldsymbol{r = 0.1 \quad and \quad i = 0.25}$$

All that remains to decide are the initial population numbers for S, I, and R.

I typically go with these ranges for the 3 initial populations:

$$9 < S_0 < 1{,}000{,}000$$
$$I_0 = 1$$
$$R_0 = 0$$

Feel free to try other numbers.

-For example if you put $R_0 = 100$, they could represent 100 vaccinated individuals.
-You could input an $S_0$ to represent a particular population, like Bard College or the city of Toledo.
-You could use $I_0 = 20$ in order to model an outbreak that started when 20 people got off a cruise ship in Sacramento.

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## SIR-∂i Notes

The SIR-*∂i* Model allows you to input a linear rate at which people implement social distancing. A rate, *∂i* per day, of 0.1/day means that each day the infection rate, *i*, goes down by 0.1. This is a crude attempt to model the implementation of social distancing.

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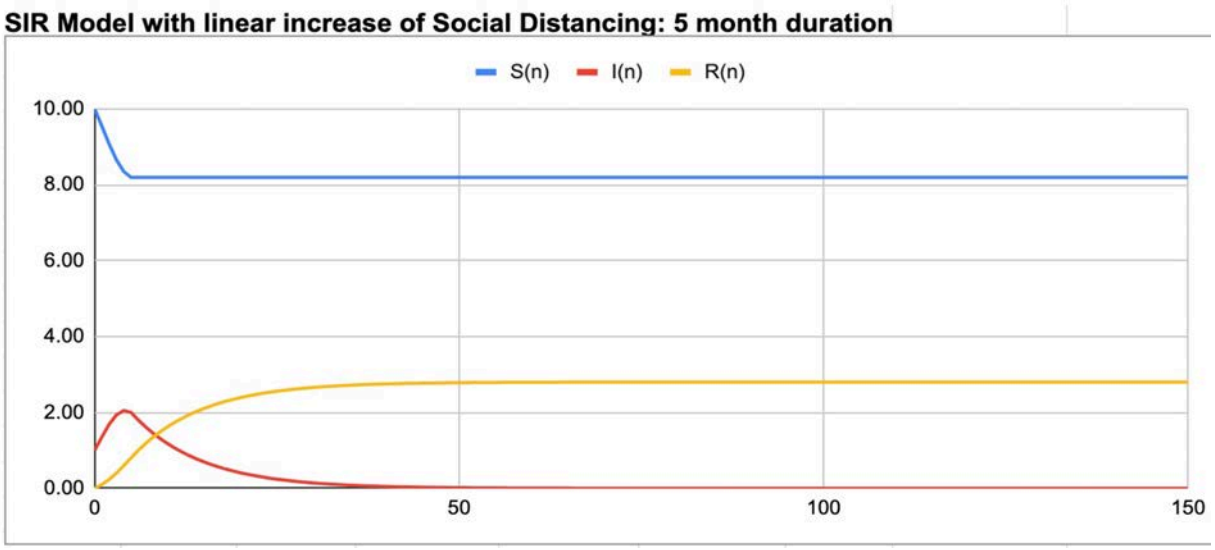
[a] Pronounced, "R-naught," not to be confused with the $R_0$ in the SIR Model, which means initial Recovered population. In SIR terms the R-naught can easily be calculated as *i/r*.

E.g. If the infection rate starts at 0.5 on Day-0 and the $\partial i$ is 0.1, then on Day-1 the infection rate is lowered by 0.1 to 0.4. Day-2 the infection rate lowers again to 0.3, Day-3 to 0.2, Day-4 to 0.1, and finally on Day-5 the infection rate is 0. The outbreak has ended. But the recovery is still active.
Try these numbers in the SIR-$\partial$i GoogleSheet:

| Infection rate | recovery rate | Initial Sus. Pop | Initial Inf. Pop | Initial Rec. Pop | Total Pop. | Input change i/day |
|---|---|---|---|---|---|---|
| **i** | **r** | **$S_0$** | **$I_0$** | **$R_0$** | T | **$\partial$i** |
| 0.5 | 0.1 | 10 | 1 | 0 | 11 | 0.1 |




| B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|
| Infection rate | recovery rate | Initial Sus. Pop | Initial Inf. Pop | Initial Rec. Pop | Total Pop. | Input change i/day | | |
| **i** | **r** | **$S_0$** | **$I_0$** | **$R_0$** | T | **$\partial$i** | | |
| 0.5 | 0.1 | 10 | 1 | 0 | 11 | 0.1 | Effective i | |
| 50.0% | 10.0% | | | | | 10.0000% | i(n)-$\partial$i | |
| # months | Day #, n | S(n) | I(n) | R(n) | T(n) | S/T | i(n) | i(n) % |
| 0.00 | 0 | 10.00 | 1.00 | 0.00 | 11 | 90.9% | 0.5 | 50.0% |
| 0.03 | 1 | 9.55 | 1.35 | 0.10 | 11 | 86.8% | 0.40 | 40.0% |
| 0.07 | 2 | 9.08 | 1.69 | 0.24 | 11 | 82.5% | 0.30 | 30.0% |
| 0.10 | 3 | 8.66 | 1.94 | 0.40 | 11 | 78.7% | 0.20 | 20.0% |
| 0.13 | 4 | 8.35 | 2.05 | 0.60 | 11 | 75.9% | 0.10 | 10.0% |
| 0.17 | 5 | 8.20 | 2.00 | 0.80 | 11 | 74.5% | 0.00 | 0.0% |
| 0.20 | 6 | 8.20 | 1.80 | 1.00 | 11 | 74.5% | 0.00 | 0.0% |
| 0.23 | 7 | 8.20 | 1.62 | 1.18 | 11 | 74.5% | 0.00 | 0.0% |

As you can see in column D, the Susceptible population stabilizes at 8.20 when the Effective infection rate (Column I) hits 0. You clearly see this in the graph... the blue line. It makes sense. The infection rate is 0 on Day-5, thus no new infections.
The recovery rate is still 0.1, so the Infected population continues to smoothly decrease and the Recovered population smoothly increases. See the yellow and red lines in the graph.

Eventually we get a stable population graph by about Day-57 (data not shown). You can see this clearly on the graph too. Out of a Total population of 11 (Column G), by Day-57 the Susceptible population is 8.2 and the Recovered population is 2.8. From then on nothing changes. The outbreak and the recovery from the outbreak has played out. It took about 2 months, 57 days.

Of course 8.2 and 2.8 are weird numbers when discussing whole people, but feel free to round these numbers to 8 and 3 if you are bothered by this detail.

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Observations:

Keep in mind that before the advent of easy long-distance travel, the world practiced social distancing, on a regional basis. Ebola is a good example. Ebola probably comes from bats in West Africa. Before easy access to world travel Ebola, no doubt, broke out in various communities. But it was contained to these communities since people didn't fly off to Paris or LA on a whim. Lots of people would have died, but eventually the Susceptible population ran out. No more victims.

Similarly, HIV appears to have emerged numerous times from roughly the same geographical location, West Africa. In the preFlight world, HIV simply stayed put. It still killed people, but it eventually ran out of victims since it was totally local. With the advent of long-distance travel... look what happened. HIV went everywhere. It found millions of Susceptible populations all over the globe.

These epidemiological observations make the various conspiracy theories about disease sources less potent. The reason we see these global outbreaks (SARS, HIV, CoVid19, and innumerable seasonal Influenza strains) is not because the CIA is cooking them up in a secret laboratory at Fort Detrick, Maryland, it is because we are global. These viruses and ones similar to them have been attacking humanity forever. The difference is globalism. We didn't previously know about them. Who knew a tiny community in the Congo was wiped out by Ebola back in 1685? Now, it's very different. We can get anything from anywhere.

This isn't to say that nefarious interests are not involved, but it is highly highly unlikely that some secret lab is producing these viruses. Nature produces these viruses. We spread them over the globe. The nefarious interests take advantage of the situation that Nature sets up.

E.g. Small Pox used to kill Native Americans. HIV policy as a way to ostracize or eliminate "gays" or "blacks" or "drug addicts." Cholera to thin the population of Haiti. The real conspiracy theory is not the disease itself, but how we deal with the disease. The nefarious people take advantage of situations, they don't necessarily initiate them.

E.g. Trump using CoVid19 to further his immigration policies. That guy who hoarded hand sanitizer. The senator who sold his stock while pretending that the virus was not a big deal.

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The SIR model is basic, but can be customized.

Alterations that I can imagine inserting into the SIR model:

-Accounting for the effects of weather or seasons on both r and i.
-Accounting for vaccination against the virus, and determining "herd immunity."
-Accounting for incremental increase in social distancing. [I did this in SIR-$\partial$i]

Limitations of the SIR model:

-There is no geographic information in this model and I don't see an easy way to put geography into it.
-Infection networks are not possible to determine.
-The Recovered population, R, disappears from the model and has no influence on infection rate, *i*.