COVID-19 Spread (Part II)
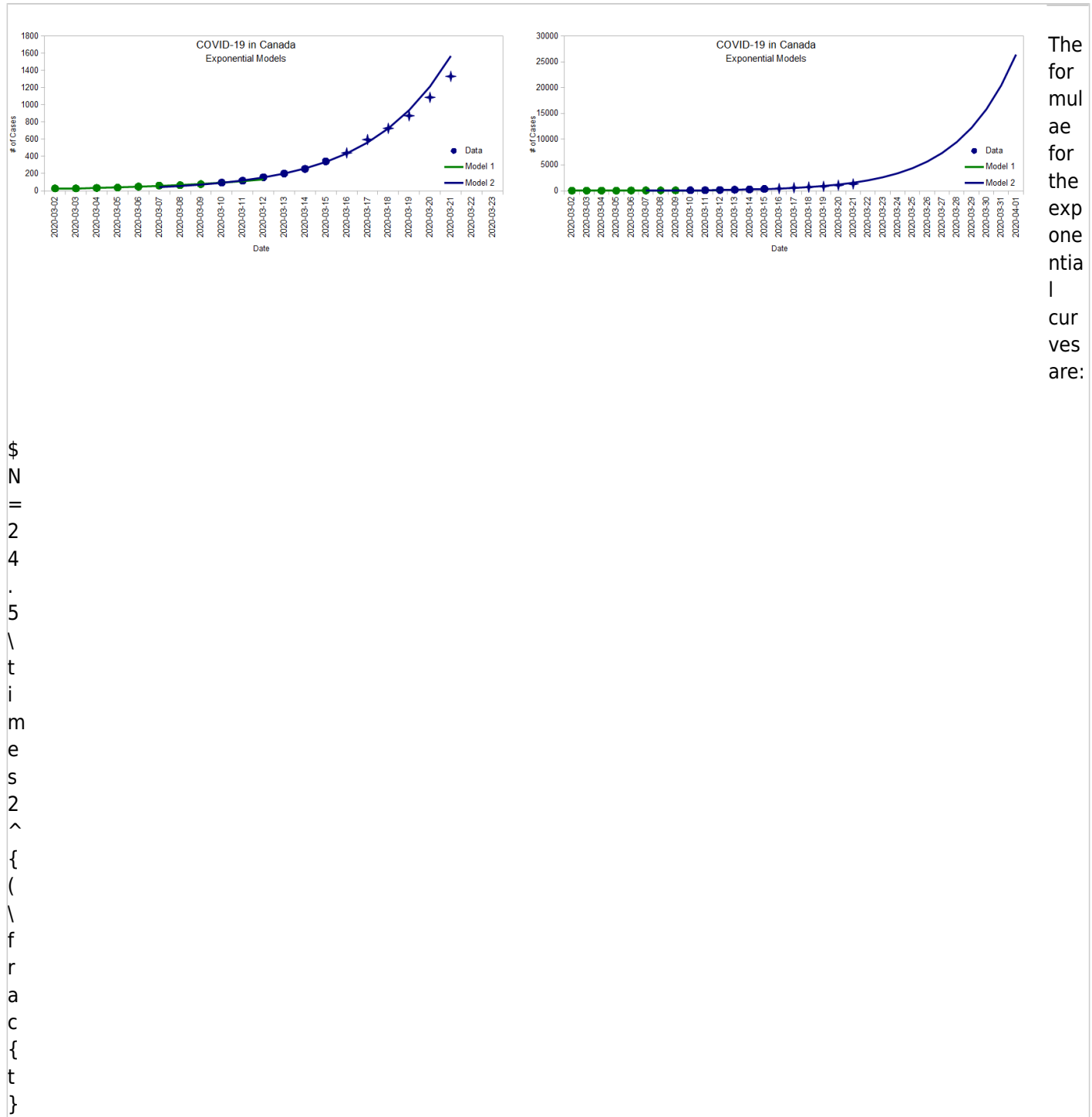
⚠️
- I'm not an epidemiologist, doctor, or any kind of expert on the subject. I just look at the numbers.

In Part I, I built an exponential model using data between March 2 and March 15, then continued to add daily numbers to see how that model tracked:

The formulae for the exponential curves are:

- $$N = 24.5 \times 2^{(\frac{t}{}}$$

{4.1})}$ for the green line (where t is the number of days since

March 2)

- $N = 93.1 \times 2^{\left(\frac{t}{2.7}\right)}$ for the blue l

ine (where t is the number of days since March 1)

Initially, the number of cases doubled every 2.7 days, predicting almost 1600 cases by the end of Saturday, but since Thursday, the rate of infection seems to have slowed down a bit and we got about 240 cases less than predicted. This deviation from the exponential model is what I'm exploring here.

Growth Factor

There's a ratio involving three data points that's useful to track how "fast" the exponential grows. It's easier to explain with an example so suppose we had three days like this:

Day	# of Cases	New Cases	Growth Factor
Day1	100		
Day2	110	10	
Day3	130	20	2

we're still in the exponential phase, growing faster and faster day after day.

- If the growth factor is 1, then the infection is growing at a constant rate. This is the middle of the Logistic Curve (more on that soon).
- If the growth factor is less than 1, then the infection rate is leveling off.

To calculate the growth factor:

- The first step is to calculate the number of new cases from one day to the next.
  - Then, we take the ratio between the number of new cases (20 ÷ 10 = 2)

Here's the number of cases in Canada with the calculated growth factor:

Date	# of Cases	New Cases	Growth Factor
2020-03-01	?		
2020-03-02	27		
2020-03-03	27	0	
2020-03-04	33	6	
2020-03-05	37	4	0.67
2020-03-06	48	11	2.75
2020-03-07	60	12	1.09
2020-03-08	64	4	0.33
2020-03-09	77	14	3.25
2020-03-10	95	18	1.38
2020-03-11	117	22	1.22
2020-03-12	157	40	1.82
2020-03-13	201	44	1.10
2020-03-14	254	53	1.20
2020-03-15	342	88	1.66
2020-03-16	441	99	1.33
2020-03-17	596	155	1.57
2020-03-18	727	131	0.85
2020-03-19	873	146	1.11
2020-03-20	1087	214	1.47
2020-03-21	1331	244	1.14

There's a lot of variation in the growth factor because real life is messy, but if we plot it on a graph, we can see a bit

of a pattern:

Although the growth factor is still above 1, it looks like we might be on track to reach 1 by the end of the month. If that's the case, and if we continue to implement measures to slow the down the spread, then we'll be in a better position to estimate the final outcome by the end of the month. Here's why.

The Logistic Curve

In Part I, I showed very different Logistic Curves and explained that there's really no way of knowing which we'll follow yet. Here they are again:

- Model 3 is the very best case scenario where the total number will be double of what it is today. This assumes that the growth factor reached 1 yesterday (March 21), which it hasn't.
- Model 4 is a very likely scenario where the total number reaches 20,000 and the growth factor reaches 1 on April 1st. This is **not** a worst case scenario. Things could be much worse (look at Italy).
- Model 5 is an optimistic scenario where the total number reaches 12,000 and the growth factor reaches 1 on March 30st.

Model 3	Model 4	Model 5
$$N = \frac{2660}{1 + e^{-0.32(t - 21.1)}}$$	$$N = \frac{20000}{1 + e^{-0.24(t - 32)}}$$	$$N = \frac{12000}{1 + e^{-0.232(t - 30)}}$$

The thing to know about Logistic Curves is that in the middle, the growth factor is 1. That's why we can't really make any prediction until we reach that point. Hopefully that'll be soon. Until then, things are still very much in the air.