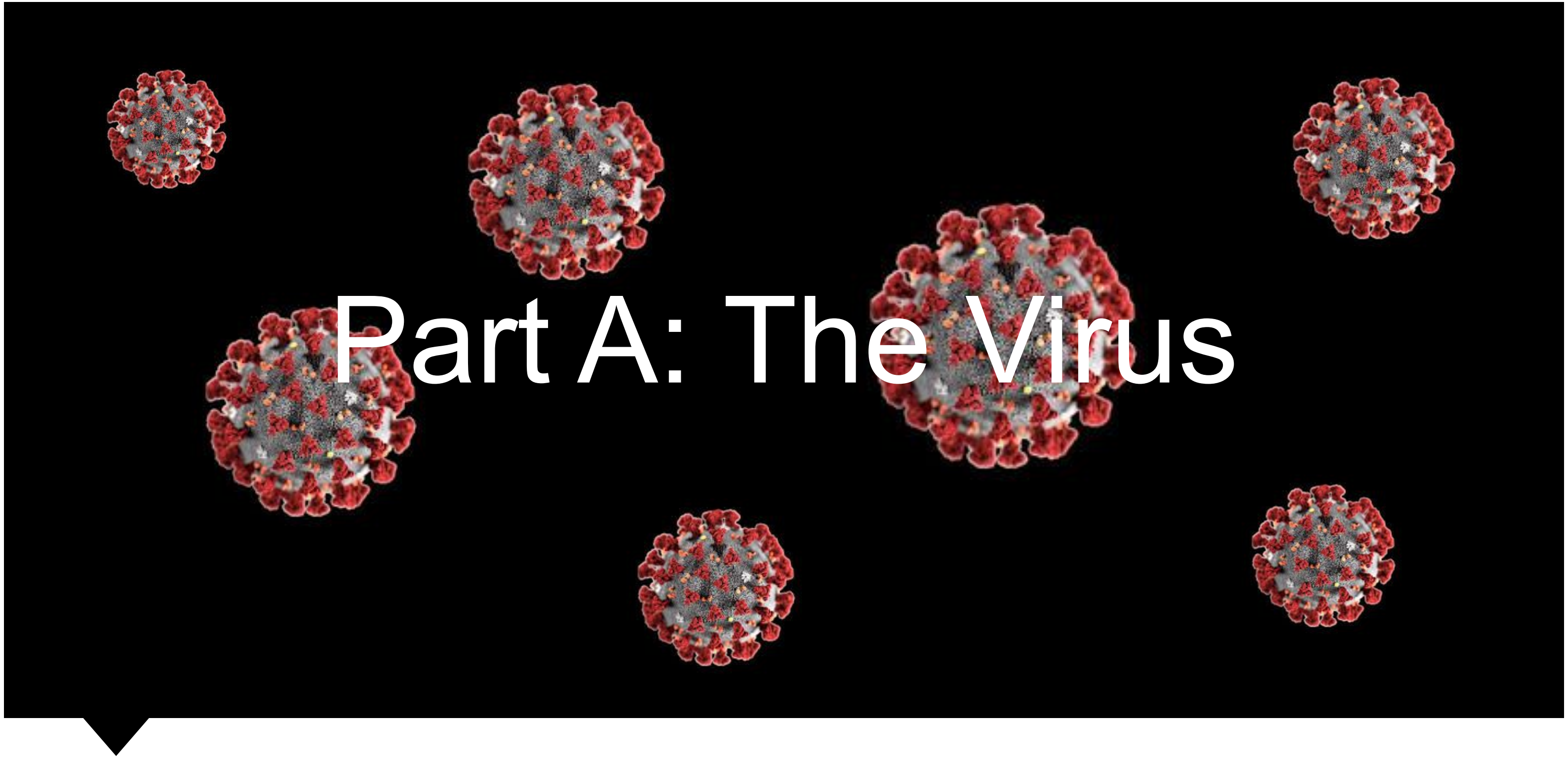
Social Distancing

Is it really helping?

Mathematical Concepts.

- Algebra
- Arithmetic
- Scientific Notation
- Graph Construction
- Exponential and Linear Growth
- Pattern Recognition
- Logic
- Rounding
- Percentages
- Mathematical and Theoretical Biology

Part A: The Virus



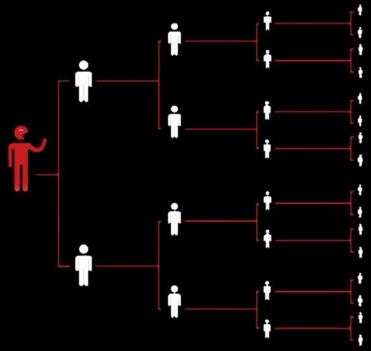
Part A1. Definitions

As we should all know, COVID-19 is a coronavirus (a virus that spreads from animals to people) that originated in Wuhan, China in 2019. Hence the name. It is widely believed that the virus originated in the wet markets of Wuhan where it was transmitted from bats to humans from the illegal consumption of bats in Wuhan, but these facts are still being challenged today.

In this investigation we focus mainly on the terms ‘social distancing’ and the different variables to a hypothetical that can alter or completely change the effect social distancing has on society. We will also use the term ‘overwhelm (get the best of)’ to signify the breaking point of our hypothetical. We define social distancing as when laws are put in place and/or one wishes to prevent too much human interaction. Social distancing is usually seen in the form of crowd restrictions limiting the amount of people who can be at any given place at any given time. And overwhelm refers to the inability of an organisation or person to handle something. In this case it is he inability of a country (Australia) to handle the transmission of COVID-19.

With that out of the way let the investigations begin.

Part A2. The Spread of COVID-19



Like many other type of viruses COVID-19 spreads mainly through the air and its spread follows the pattern of exponential growth, also similar to other viruses they eventually start to flatten. This is when the virus reaches its peak and the amount of people recovered/dead is equal to the amount of people infected. Likely causes for this flattening could be due to the introduction of lockdown and *social distancing*.

But in this hypothetical we will discuss the effects when we do not abide these rules, so theoretically COVID-19 will not reach a flattening point and continue to exponentially increase in size until Australia is *overwhelmed* with cases.

Part A3. Our Aim

During this pandemic we have been told that to beat this virus we must all maintain social distancing. It’s something nobody really wants to put up with but we have to do it for our health. But that begs the question, is social distancing really that important?

In this MTQ we will be breaking apart the situation everyone is in right now into a hypothetical where there is no social distancing. Our aim is to create an accurate representation of what would happen if there was no social distancing, in turn, slowly zoning in to a conclusion as to whether or not social distancing is worth it, or if we should be investing our efforts into another solution that is more effective. We are going to achieve this by slowly adding variable by variable increasing the complexity of our hypothetical and in turn make it more accurate. The hypothetical will start as basic as possible with just a virus free to spread. Then we will continue to discuss the effects recovery, death chance, immunity, reinfections, mutation and research have on the hypothetical. By uncovering each variable we can deduce and understand what makes social distancing so effective or ineffective. In adding the variables we will as accurately as we can, discover what the world would be like without any social distancing.

Our Hypothesis

We believe that without social distancing to keep the virus's spread in check, every person in Australia will be infected by COVID-19. And the amount of deaths would be a little more than 2%.

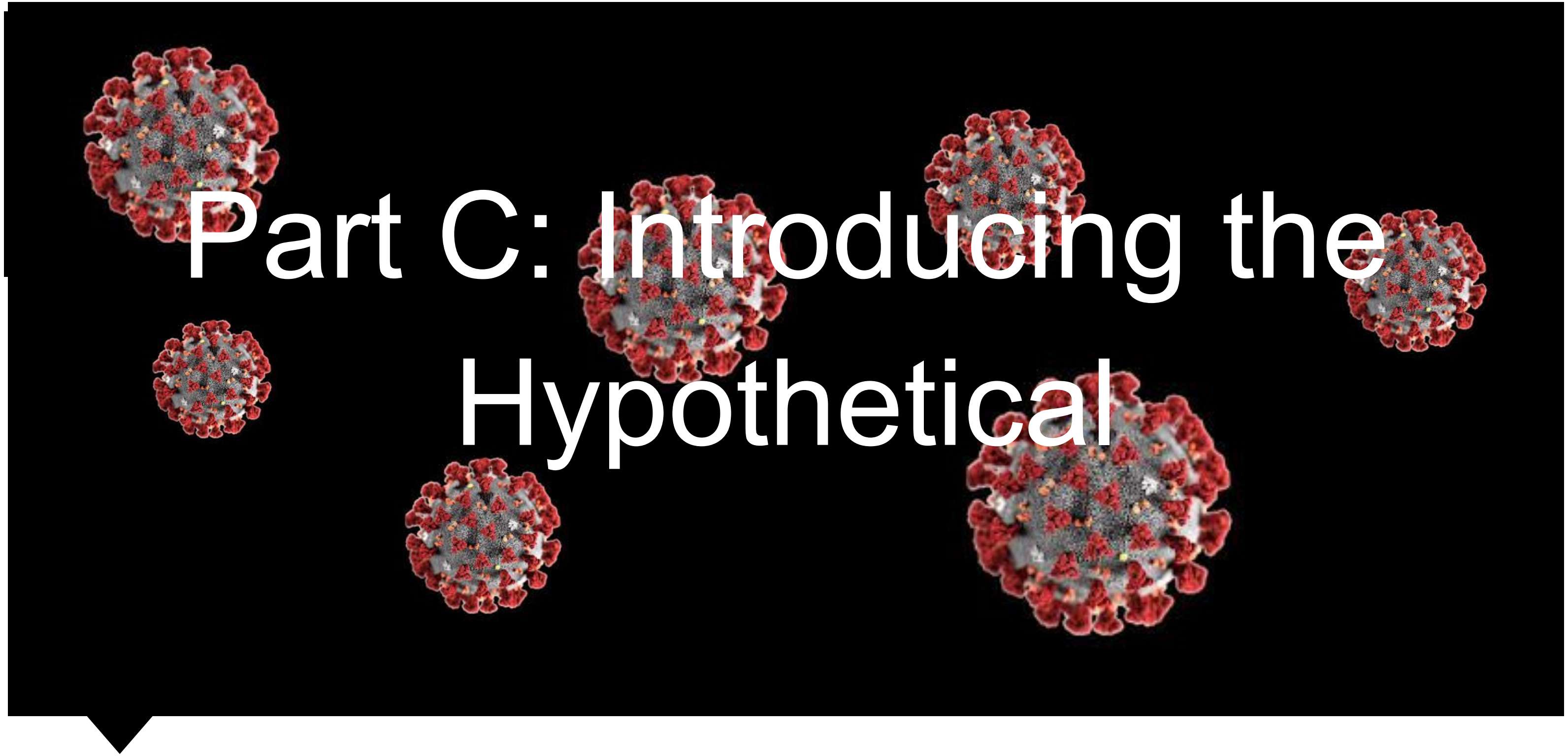
Part B: Social Distancing

Part B1. What is Significant about Social Distancing?

Social distancing is the practice of keeping a required distance from other people. In times such as pandemics it seems like a completely new concept even though humankind does this all the time through what is commonly referred to as a personal bubble/personal space. Despite the fact that not everyone supports social distancing and some think that it is completely useless, there is no doubt that by making social distancing mandatory in times like these has helped stop the spread of physical transmissions.

So what should we be expecting throughout the hypothetical? It is quite clear so far that social distancing has been successful in keeping the infection levels low, so we should be expecting an exponential increase that doesn't start to flatten due to the inability to control transmissions with everyone out and about as usual. Given that even now we don't have a cure for COVID-19 no social distancing would almost have the same effect as taking no action at all.

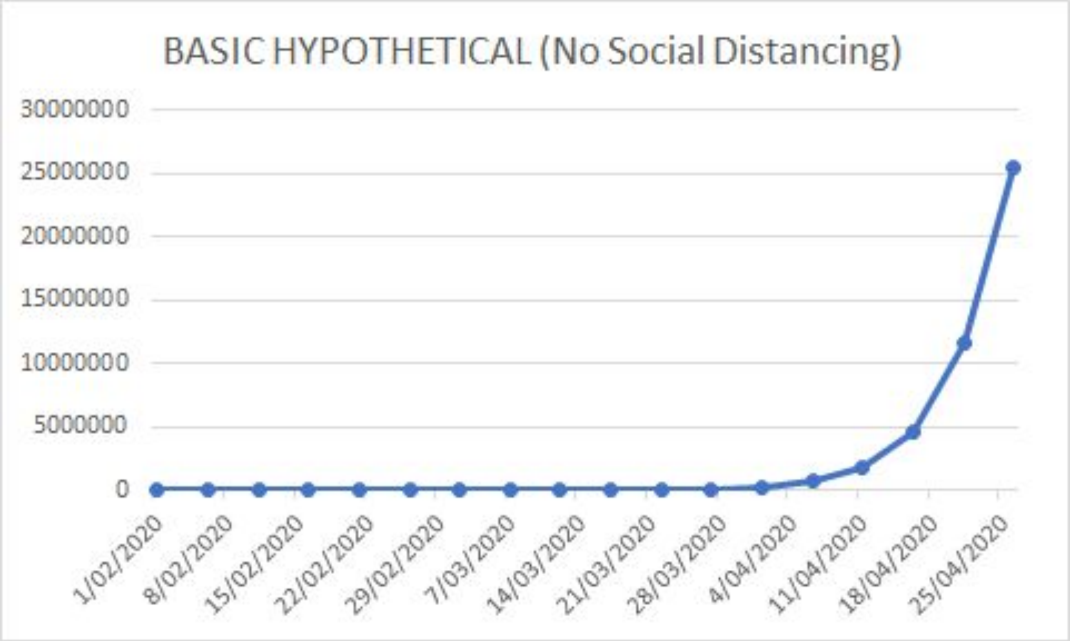
Part C: Introducing the Hypothetical



Part C1. Description/ Rules

The basic hypothetical itself will be quite straight forward. Once someone gets infected they stay infected and only spreads the virus, and everyone has an equal chance of getting infected. On top of that we will presume that no cure/vaccine will be researched into so this is just the results purely to find whether social distancing is benefits the world.

Part C2. Fig 1. The basic Hypothetical graph



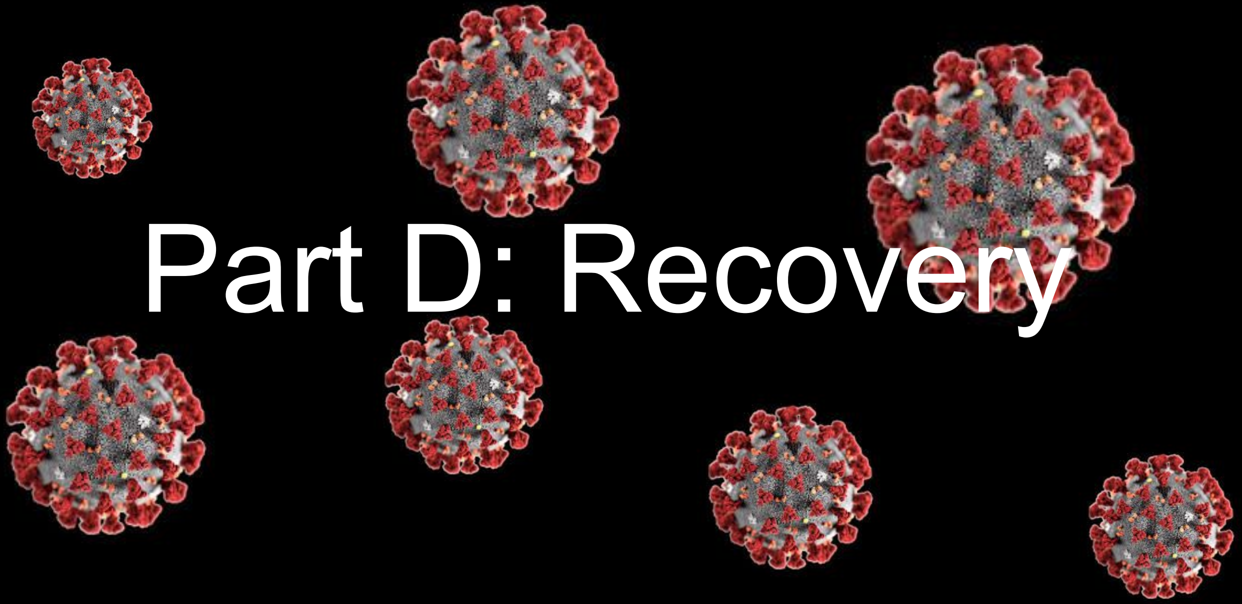
The Maths Behind the Creation of our Hypothetical

The basic hypothetical is very simple and therefore very easy to execute. We assumed that each person (without social distancing) will spread the virus to either 2 or 3 people so we took the average of 2.5. We put in an exponential growth of 2.5. However, 2.5 is a decimal meaning that it wouldn’t work well because we would have fractions of a person, we managed to counter this problem by simply rounding to the nearest whole number. We begin the hypothetical by looking at the real life infecion rate. The people who were already infected will spread COVID-19 to 2-3 (we took the average of 2.5) other people and they will also spread the virus to the same number of people until there are no healthy people in Australia. When put on a logarithmic scale we see a perfectly straight line because the exponential growth and therefore the gradient/slope was consistent the whole way through.

Part C3. The Hypothetical

Assuming social distancing was never put into place we can see that the growth doesn’t start to flatten or stop. This is due to the fact that there is nothing to stop the growth of the infected due to the lack of variables. Though this is not a very accurate representation of the real world, this hypothetical clearly depicts the importance of social distancing. But it is a far stretch just to look at this and say that social distancing is crucial. We just haven’t looked at enough variables yet. So we must move on to our next discussion point.

Part D: Recovery



Part D1. What is Recovery and How Could it Affect the Hypothetical?

The dictionary definition of recovery is; “The act or process of becoming healthy after an illness or injury”. Recovery from COVID-19 likely means that that person will not catch it again as their immune system has gotten experience in fighting the virus. With COVID-19 having a very broad recovery time we had to make an average that balances between the amount of time it takes when someone is in the critical stage and when they are showing minor symptoms. We chose 20 days as we knew that the majority would only be minor and made it easier and simpler to graph out.

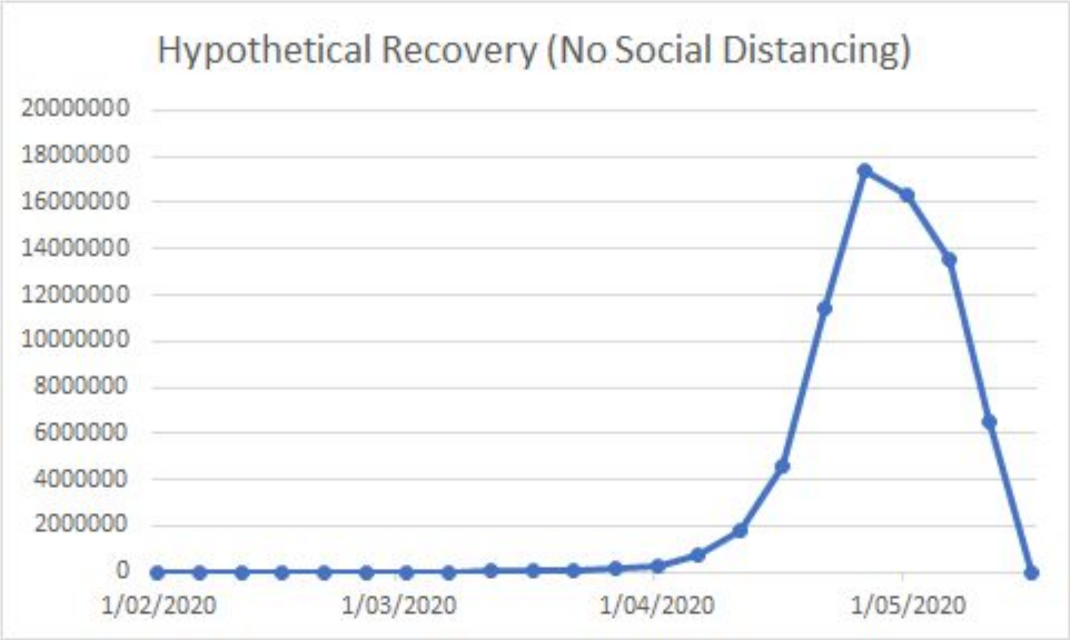
Following that, the introduction of recovery into the hypothetical could in turn change the curve of the exponential growth. The exponential growth would be flatter due to the fact that each recovered person minuses one from the total infected. Not to mention that the more people who have recovered, the less people the virus could potentially spread to and therefore the less it could exponentially spread. Continuing the thought of recovery we will also discuss death. Presuming that it will take around 20 days on average to die from COVID-19, we can assume that for everyday after 20 weeks is through in our hypothetical we can deduct the same amount of people infected exactly 20 daybefore that time. With all that said and done that concludes the math behind recovery and death.

Part E: Applying Recovery and Reinfections

Part E1. Description/ Rules

With the introduction recovery, we need to introduce some rules to our hypothetical to reduce the amount of unknown/undefined variables. For example, because there is no real rate of reinfection after the person has recovered we cannot predict the amount of people who will get COVID-19 again after already recovering from it. To mitigate this problem we are assuming that there cannot be any reinfections. This does reduce the accuracy but ensures that what we ARE putting in, isn’t just a guess. In addition, we are assuming that everyone has an equal chance of being infected to increase simplicity, but later we will introduce immunity as another variable. To keep the infections constant we are making it so the hypothetical multiplies then only does it recover. Finally, we need set it straight that there is no research happening for the cure/ vaccine to see whether or not humankind will survive without any form of a cure and to keep the rate of recovery constant.

Part E2. Fig 2


Hypothetical Recovery (No Social Distancing)
20000000
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
1/02/2020
1/03/2020
1/04/2020
1/05/2020

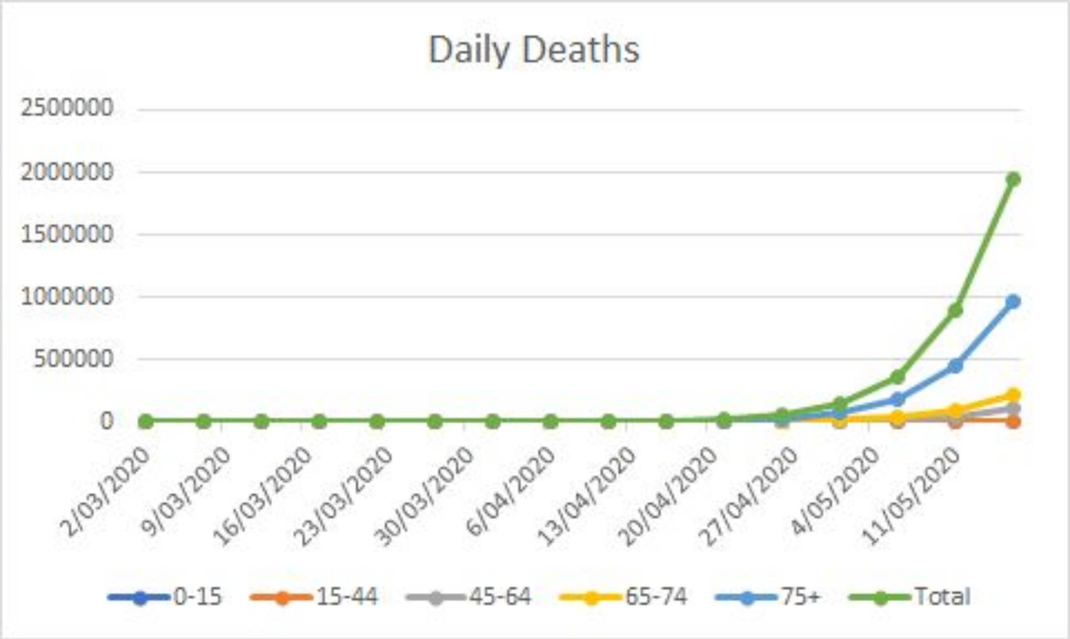
Maths Behind Recovery/Death

We assumed that the time it takes any given person to recover from COVID-19 was around 2 weeks or 14 days and that they will die after 20 days. The percentage of cases with outcomes will go based on a rounded version of the real life equivalent of 98% of the closed cases being recoveries and 2% of them being deaths. This meant that when a person gets COVID-19 they will go through 20 days and will either recover or go on to die and Australia as a whole will lose 510,000 lives. Knowing that we began the hypothetical like usual with the real life infection rate to kick it off. We then implemented recovery and as it appears over 7.5 million people recovered/died before the pandemic hit its apex where there aren't any more people to infect. In the month and a bit that would follow the rest of the Australian population would either recover or die in the ratio 98:2 (recoveries:deaths) until there were no active cases of COVID-19 left meaning that all of Australia has recovered or died. We had used 2% because we weren't properly informed but from here on out we are using the death chance of 4%.

Part E3. GRAPH

So by looking at the graph the differences to the basic hypothetical aren't that great to the naked eye. However, by analysing the data from the graph's template in the excel document, it is obvious that there is a difference. Comparing that to 25,500,000 only makes a marginal difference. We obviously have the decline of cases where people are either recovering or dying faster than new people are being infected all the way until the amount of cases reach 0. The slope down hill is due to there being 25.5 million people being infected, so the last bit was just everyone in the hypothetical either recovering or dying. There were no reinfections because we ruled that out to make the hypothetical more simple. But we need to go deeper. Is the loss of 510,000 lives really that much? And how many of those people will be so old that the flu could have done the same?

Part E4 Fig. 3


Daily Deaths
2500000
2000000
1500000
1000000
500000
0
2/03/2020
9/03/2020
16/03/2020
23/03/2020
30/03/2020
6/04/2020
13/04/2020
20/04/2020
27/04/2020
4/05/2020
11/05/2020
0-15
15-44
45-64
65-74
75+
Total

Part E5. Math behind Fig 3

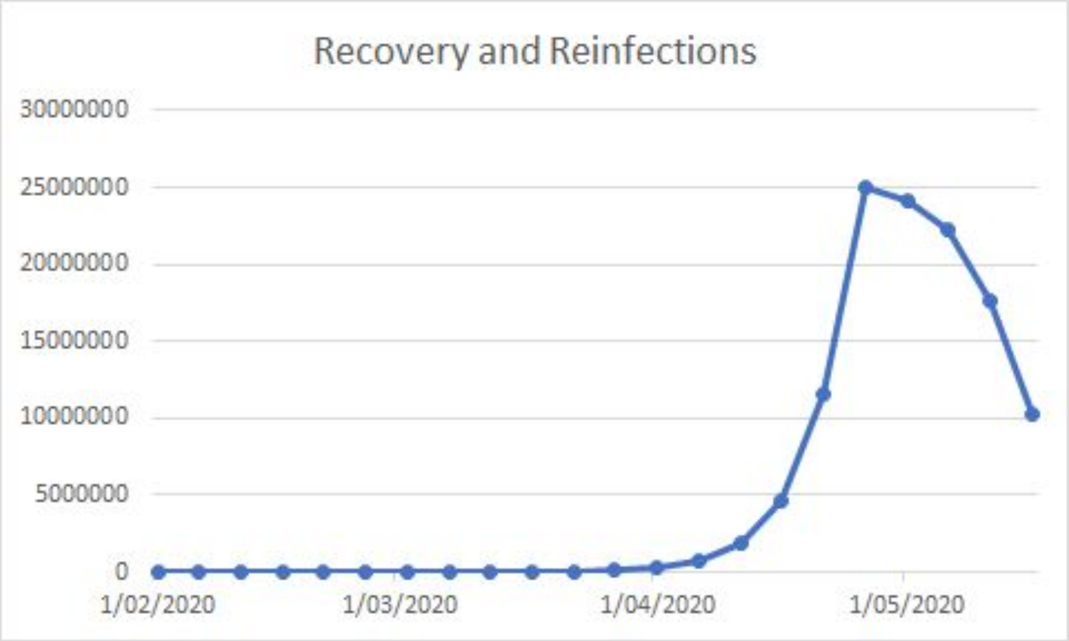
We took the percentage of deaths for each age group (referred to as x) and the percentage of those age groups from Australia (referred to as y). Then we (x*4%)/y and multiplied that by 100 to get the percentage.

Formula:

((x*4%)/y)*100

Part E7. Fig 4

Total Deaths: 1786636



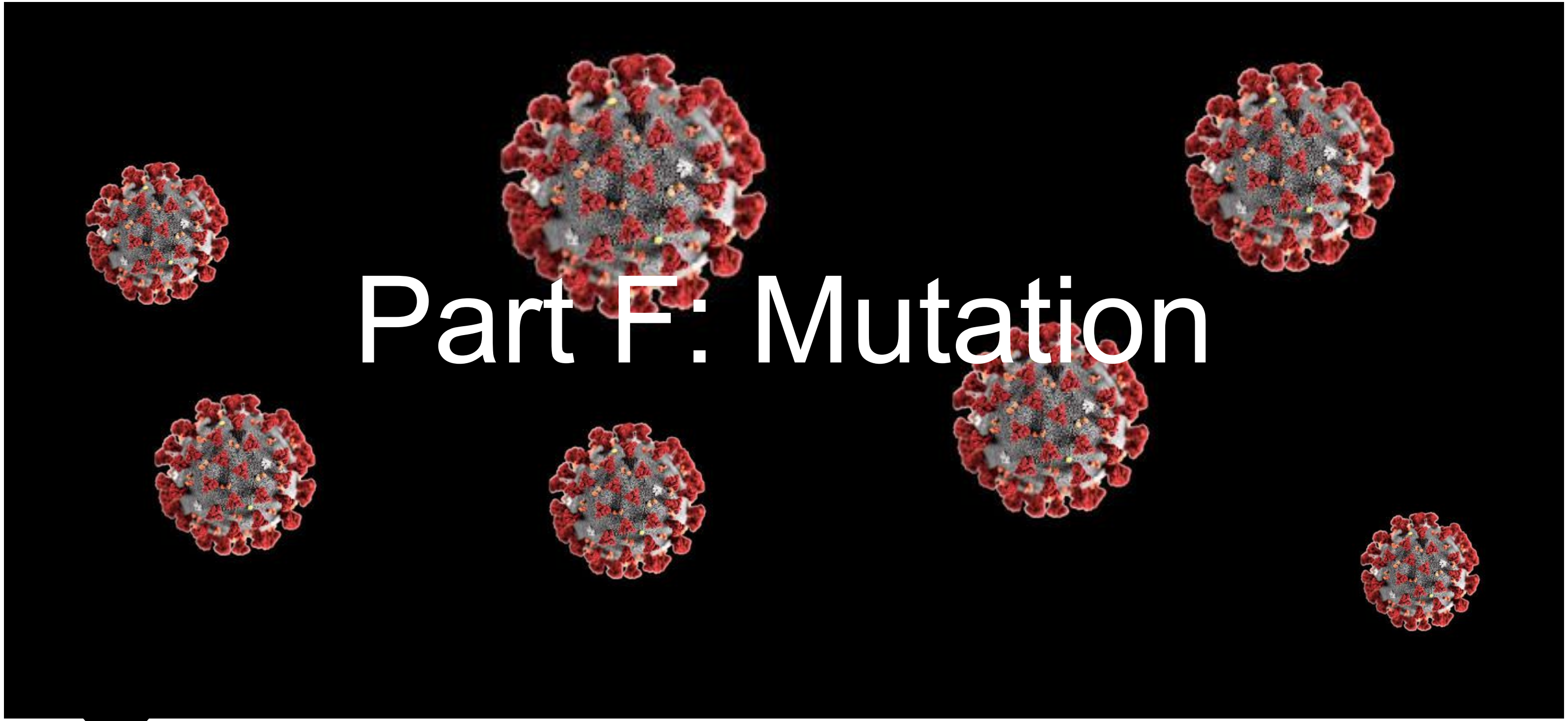
Part E8. Maths Behind Fig 4

This one is a little hard to explain but the excel graphs shows the numbers. They are attached below.

Part E9. Results for Fig 4

It is quite clear that all of the graphs share the same or quite a similar curve. This holds true for this graph as well and it almost looks identical to. But the difference is that instead of a drop that seems to become sharper and sharper the more time goes by, we see a drop that is much more gradual. This is because of the people who are becoming reinfected by COVID-19. Eventually though, the number of active cases will still drop to zero, but there will still be many more lives lost.

Part F: Mutation



Part F1. What is the Research of COVID-19 and how Will it Affect the Hypothetical ?

When we talk about research of COVID-19, we mean the looking into of how the virus works and how we can combat it. Research will eventually lead to treatments, cures and vaccines given enough time. This development will vary depending on how complex and new the virus is.

Research will help us understand more about how the virus spreads and what we can do to stop its spread. The end products of this research can be used to help stop the spread of the virus entirely and can help us completely halt the effects of the virus. This will make the exponential growth even less steep than what it was previously. This is because the more we know about the virus the better equipped we are able to counter it. And the cures and vaccines can directly prevent and reduce the amount of cases going up.

Part F2. What is Mutation and how Could it Affect the Hypothetical?

Mutation is defined as the changing of the structure of a gene, resulting in a variant form that may be transmitted to subsequent generations, caused by the alteration of single base units in DNA, or the deletion, insertion, or rearrangement of larger sections of genes or chromosomes. When a virus mutates it may be a symptom mutation where its effects on the immune system and the human body in general change, or a transmission mutation where how it spreads changes.

Mutation being added into the Hypothetical can potentially increase the exponential growth, severity and lethality of COVID-19. This is because the virus will slowly mutate to both combat and thrive in any environment and spread via any form and/or to harm and kill its host faster. However mutations are rare and we haven’t seen any mutations on COVID-19’s part yet so what we are putting in are simply going to be estimates and approximations based on viruses similar in type.

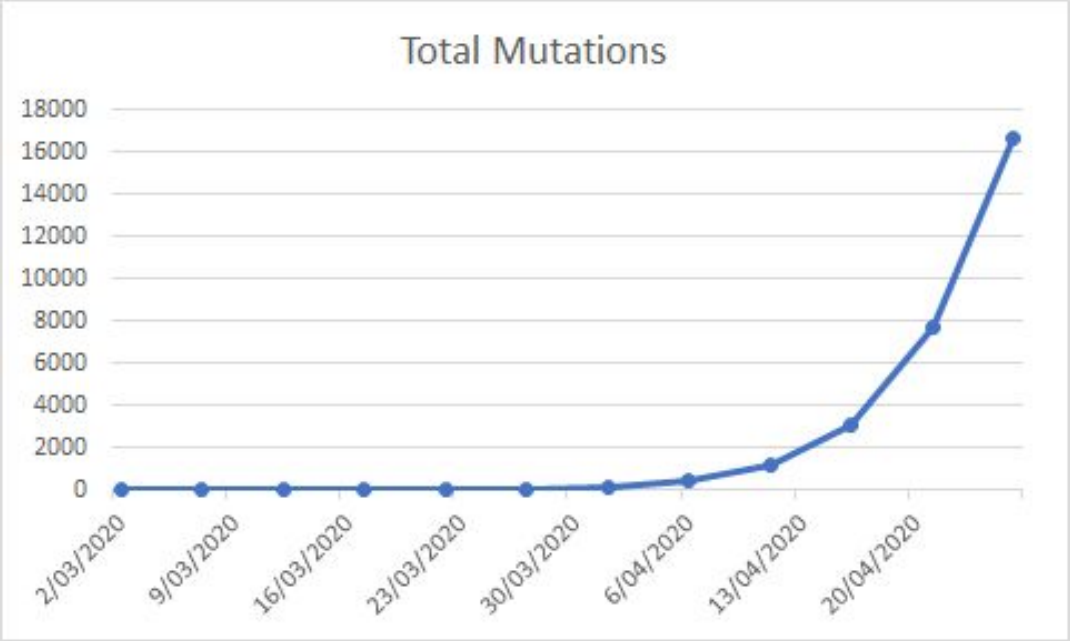
Part G: The Final Variable

Part G1: Description/ Rules

Much like every other time, when we introduce our final variables (Mutation and research) into our hypothetical we have to introduce some rules which make sure that we are getting a much accuracy and as little unknown variables as we can. We are assuming that the virus has a random chance of mutating going from our sources which is about 10^{-6} to 10^{-4} s/n/c (substitutions per nucleotide per cell infection) for RNA viruses like COVID-19. This is simply because mutations are quite common but when they do happen it isn't usually too much of a change so we are assuming that there can be only 2 types of mutations and they happen 50% of the time each. These types of mutations have been pointed out in part I1. COVID-19 for example has mutated once already to differ its symptoms and split into two strains. This mutation wasn't so severe and happened in March.

With research we have to assume that the global effort is on producing a cure and a vaccine and that there are no financial issues showing up meaning that we can take the real life results for previous diseases and

Part G2. Fig 5



Total Mutations
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2/03/2020
9/03/2020
16/03/2020
23/03/2020
30/03/2020
6/04/2020
13/04/2020
20/04/2020

Maths Behind Mutation

To figure out how often COVID-19 might mutate we need to figure out some things: First of all the amount of nucleotides in a human cell is about 6.4 billion, 10^-4 is 0.0001 and 10^-6 is 0.000001.

s/n/c = 0.0001 / 6.4 billion / 1. Is the most the virus will mutate. This is the same as 1.5625e-14 or 0.000000000000015625 (1.5635x10^-14) or 0.0000000000015625% (1.5635x10^-12%) chance of mutating for every cell it infects. Going by our rules we can assume that COVID-19 spread across the cells in a linear way. We understand that it is exponential but for simplicity's sake we are saying that it is linear. We take 17x10^10 (the amount of cells in the average lungs) and divide it by 20. Which gives the rate of cells infected per day, 85x10^8. This means that for each COVID-19 case there is a ((1.5625x10^-12)(17x10^10))% or 0.265625% chance for a mutation for every person killed. This means that statistically once every 500 COVID-19 deaths there will be a mutation, but having a mutation inside a dead person isn't going to spread so we must deduce how many cells will be infected inside a person that could be recovering. Assuming that the virus can infect a person for 5 days until their immune system starts to destroy the virus we can safely say that there is a ((1.5625x10^-12)((85x10^8)x5))% or 0.06640625% chance of mutation for every person infected. This essentially means that after approximately 1506 people get infected the virus mutates once. This mutation may be a positive or a negative one and may be either a minor or significant change and that will be explained in the next part. Knowing this, ((1.5625x10^-12)((85x10^8)x15))% 0.1989375% (rounded to 0.2%) is the chance of a mutation from each dying person who can still spread the virus (5 days before they die)

Mutation graph results.

As you can see, there are just over 16,000 mutations in our hypothetical. This is because considering that each case causes an increase of 0.06640625% and one death causes an increase of 0.1989375% chance of a mutation so to have one mutation guaranteed we need a 100% chance of mutation so we multiply the amounts of deaths by its percentage and the amount of cases by its percentage. With the number left over we divide it by 100 and round to the nearest whole number for the amount of mutations. If you look at the exponential growth of the mutations it looks oddly familiar to the growth on our infections this is due to the fact that the amount of mutations is completely reliant on the infections.

Part H: The Finale

Will COVID 19 get the best of us?

Part H3. The Result

Short answer:

No. According to our information COVID-19 doesn’t seem to get the better of us in the end.

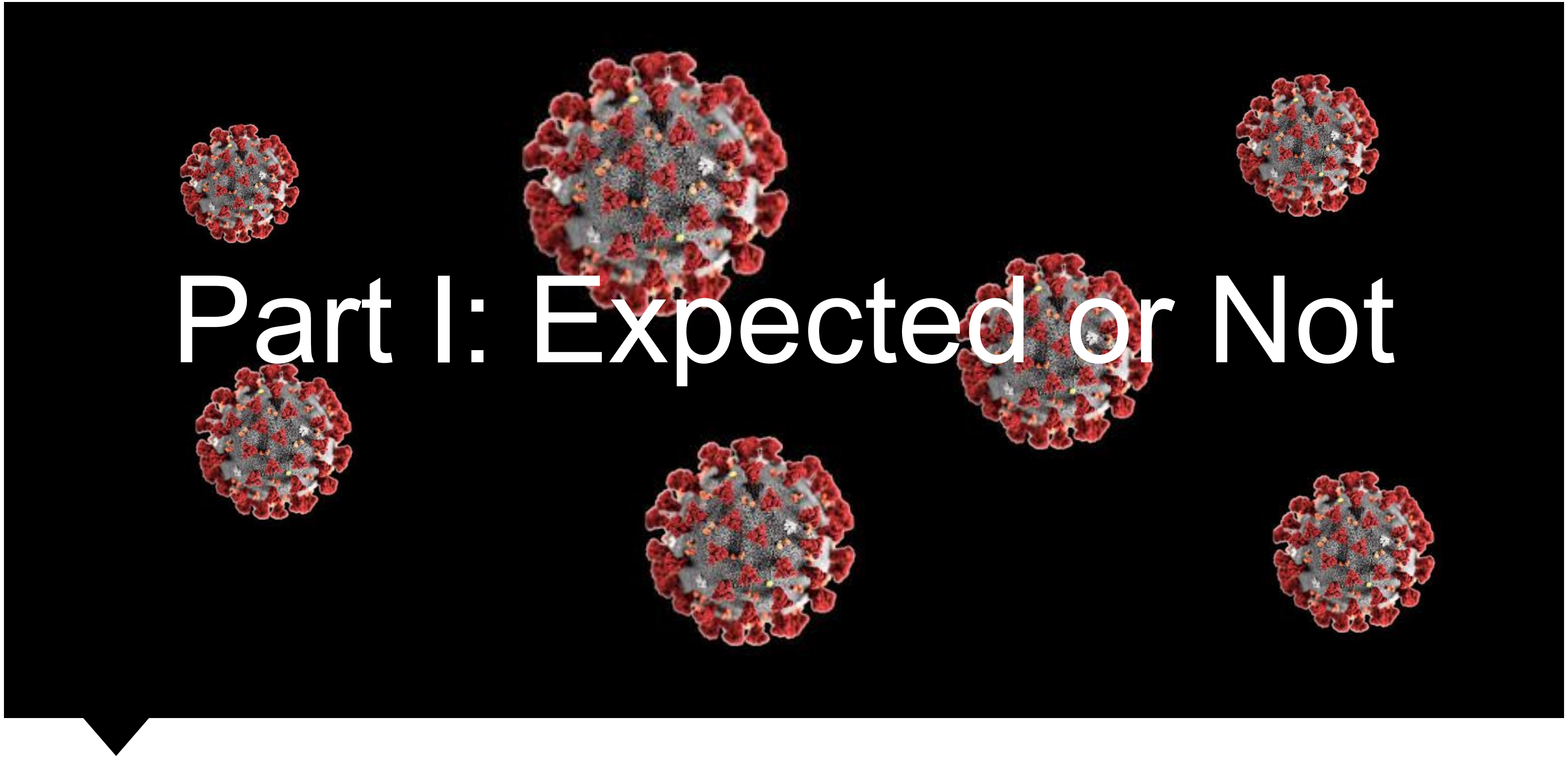
Long Answer:

It doesn’t seem so YET, but adding more variables might change the outcome. And already many more lives than necessary were lost. In the very end the hypothesis we made at the beginning was correct. The whole population of Australia was infected with the virus in quick succession and about 2% of people died. Which is a lot considering that we have a population of 25,000,000.

Part H4: Why is this the case?

In the next slide we will cover other pandemics and epidemics to our hypothetical, but our long answer depends on the percentage of mutations that actually increasing infection rates and death chances. We were originally planning to add things like immunity to the virus but due to time limit drawing nearer and nearer we were cut short.

Part I: Expected or Not



Part I1. Comparison

Researchers and scientists have turned to history to better understand COVID-19 and fair enough. Many of the outbreaks we have seen throughout the existence of humanity transmitted via respiratory droplets and how it causes respiratory system failure. Lessons from 1918 to mitigate have justifiably guided the way for rules such as social distancing and school closures. Despite the valuable lessons extracted from the 1920s it isn’t at template for COVID-19.

Looking at something more deadly we can analyse the BLACK PLAGUE and yet comparing that ratio of population to deaths is not that significant.

Black Plague: Around 40% of the population died

COVID Hypothetical: Around 7% of the population dies

MERS: Very small%

Part I2. The Conclusion

After we have drawn the conclusion that Humanity will win the battle against COVID-19 without social distancing, we have to look into whether or not social distancing has indeed benefited humanity. It is quite clear that even though humanity will win we will still lose many more lives than is necessary and with over 1.7M deaths this will definitely leave a dent in Australia's history, both physically and politically. As a decision like letting millions die even though there was a clear way to prevent this from happening can be and is considered extremely inhumane.

So to all those people out there wondering if social distancing really helps; please just endure this period of relatively excruciating boredom and suffering so that we don't have to deal with even more sadness and suffering in the future. Do it not because you were forced to, or because you had no choice. Do it for all the people out there. Do it for those who may lose their lives, do it for us all.

Excel Spreadsheet:

https://docs.google.com/spreadsheets/d/1ezsMpbRDUaS6Xjb3EYFwUYKOroY3QNtVZ-dMXmlkTXY/edit?usp=sharing

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https://profile.id.com.au/australia/five-year-age-groupshttps://profile.id.com.au/australia/five-year-age-groups
A lot of our knowledge came from the news, peers and parents.