# COVID-19 Sim

**A CSCI 154 PROJECT**

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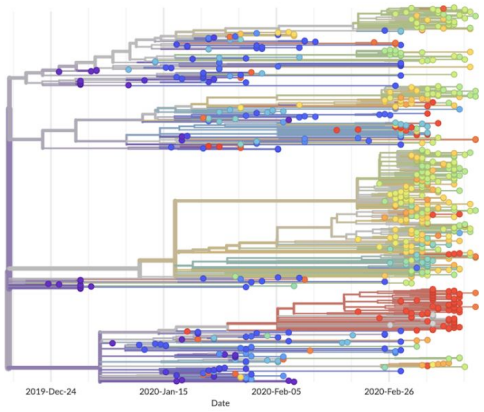
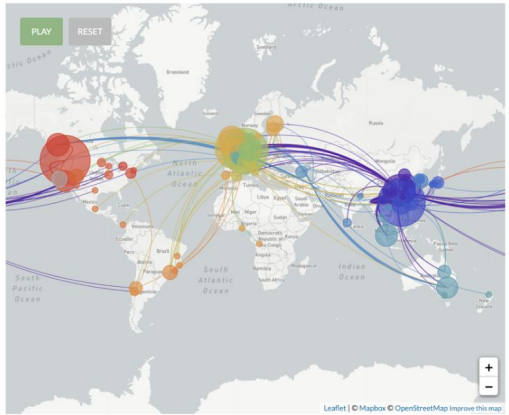
# COVID-19 Article Chosen...

**-Coronavirus: The Hammer and the Dance *by Medium, (Tomas Pueyo)***

- Article discusses about taking strong actions for a short period of time will benefit in the long run.

Chart 6: Mutations in the Coronavirus




Source: Nextstrain, based on open source information gathered through GISAID

# Key Features...

- Not taking any strong measures now (That will only cost society reasonably) will start a domino effect will lead to tens of millions of infections and with a higher death toll including people who not even infected but requiring intensive care cause healthcare will collapse.
- A ‘5 step’ methodology strategy: current, options, time, good strategy, economic & social
- Detailed linear, non-linear, bracket, simulated travel routes and composite bar graphs depicting cases over a span of ‘< month’ in between taking into account different simulations and or hypothesis for different actions.
- Gives possible answers towards concerns regarding social impact
- A comparison of how countries are taking action
- A discussion on Hypothesis cases of “if we do nothing and changing the mortality rate”
- Mitigation and Suppression
- Discusses about the concept of “The Hammer” and “The Dance”
- Discusses a common variable of ‘R’ and how we could manipulate this number to our benefit.

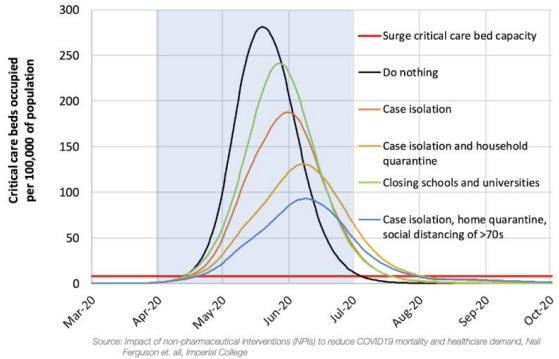
# Mitigation and Suppression

**Mitigation:**

-Corona Virus to large to handle so we will let things run its course for the time being while flattening to a mangangle curve for the healthcare system.

-Relaying on virus not mutating

Chart 5: Peaks in Need for ICU Beds in the UK for Different Social Distancing Measures



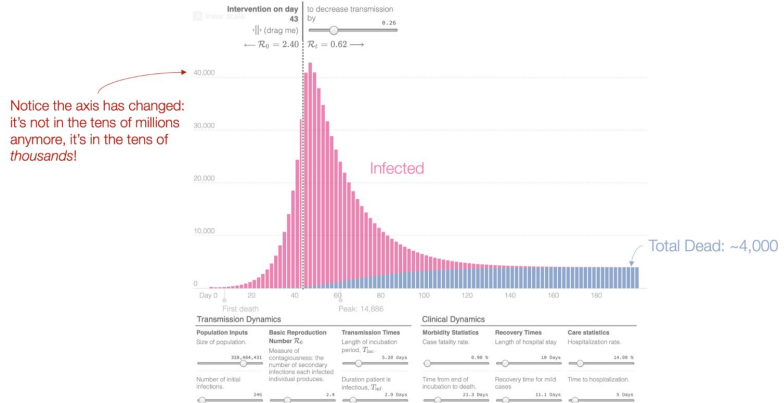

*Source: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand, Neil Ferguson et. all, Imperial College*

**Suppression:**

-Apply heavy measures to quickly get the virus under control so that we can slowly release back freedoms to public

-Relies on people actually following orders and officials taking advantage to build up resources

Chart 7: Coronavirus Cases and Deaths under Suppression Strategy



# How Countries took different Actions...

**Measures taken in France and Spain:**

-Thursday: Admitting fault

-Friday: State of Emergency

-Saturday: Social Distance with lockdown

-Monday: land borders shut

**Measures taken in US and UK:**

-Wednesday: travel ban

-Friday: National Emergency, No S.D.

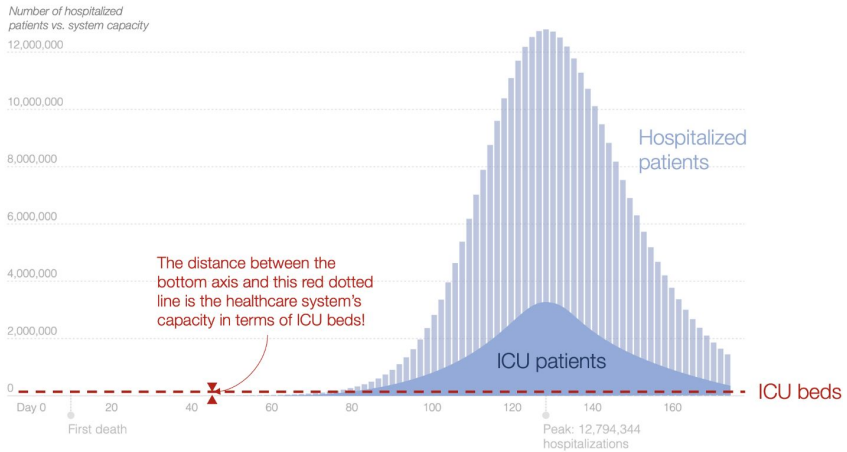
-Monday: an encouragement of S.D not enforced

...Let's remember these for later

# How Impacts Healthcare...

- Claims of US only having 50k ICU beds available
- There are 4 million admissions to the ICU in the US every year, and 500k(~13%) die
- Unbridled coronavirus means healthcare system collapse which leads to mass death
- Not enough resources to go around
- Potentially overloading a system that cannot take this much traffic
- Will force us to change priorities on how we see the Healthcare system.

Chart 4: Hospitalized Coronavirus Patients vs. System Capacity



# The Hammer and The Dance...

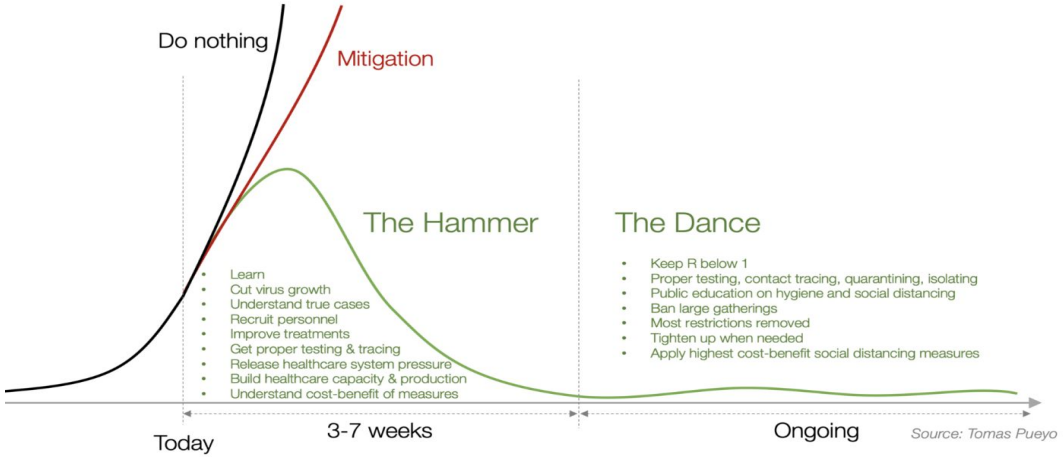
The Hammer: Act aggressively and quickly now to bring down curve quickly to something more manageable

- Implement strong Social Distancing

The Dance: After just weeks of strong practices implemented, the virus should be better under controlled

- Now comes long term effort in keeping virus contained until vaccine is made.

Chart 13: Suppression vs. Mitigation vs. Do Nothing — early on



# Impacts Society...

-Creates a sense of anxiety (Corona Virus could become a recurring fact of life such as the flu but many times deadlier).

-Creates Stricter measures/ practices we should follow

-People could be at risk of losing jobs and financial security 26mil jobs lost

-Will change the way we live for now, but will probably never be able to go back to the way things were after this

-Even after the first spike is reduced, there will probably be more to come later

-Some freedoms may be altered to ensure that practices are being followed

# Impacts Economy...

- France, for small businesses rent, taxes, and utilities are currently suspended.
- Force us in deciding the cost-benefits of the actions we will be taking hard for young
- Possibly stronger domestic supply chains, due to other countries closing borders.
- An inequality gap will widen due to certain business grabbing more income than others during this crisis.
- Essential workers and businesses will discuss about wages

# Solution...

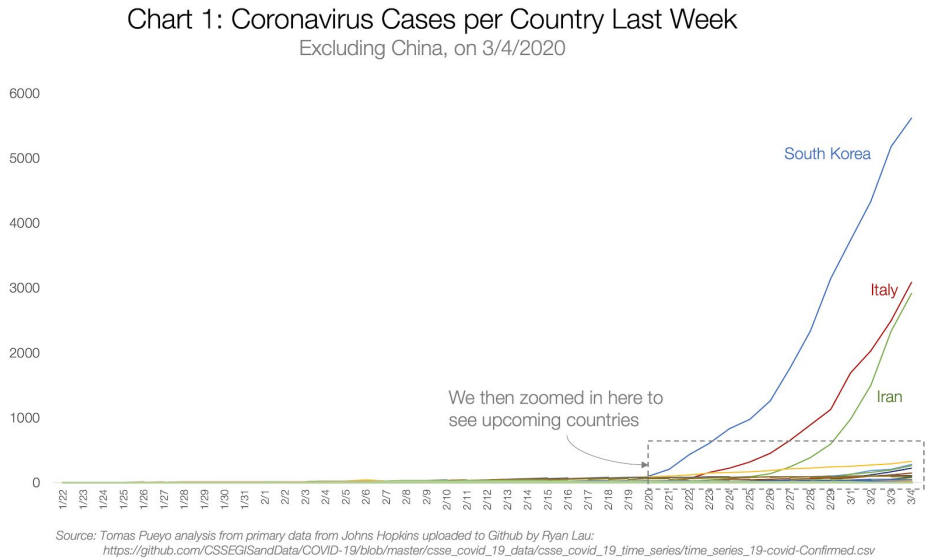
- **Understand the Value of Time:**
  - Could lower number of cases
  - Immediate Relief in healthcare system
  - Reduction of fatality rate
  - Reduction in collateral damage
  - Allow healthcare workers to get better
- **Understand the True problem: Testing and Tracing:**
  - With a few weeks we could gather testing resources
  - Test everyone and gather more information on the subject
- **Build Up Capacity:**
  - More time to build up on equipment we will need
  - More time to focus on making more equipment
- **Understand the Cost Benefit:**
  - Its difficult to understand the cost benefit without much time
  - So we will have more time if we have those few weeks to look over the options.

# Modeling Techniques...

Graphs Used for Modeling:

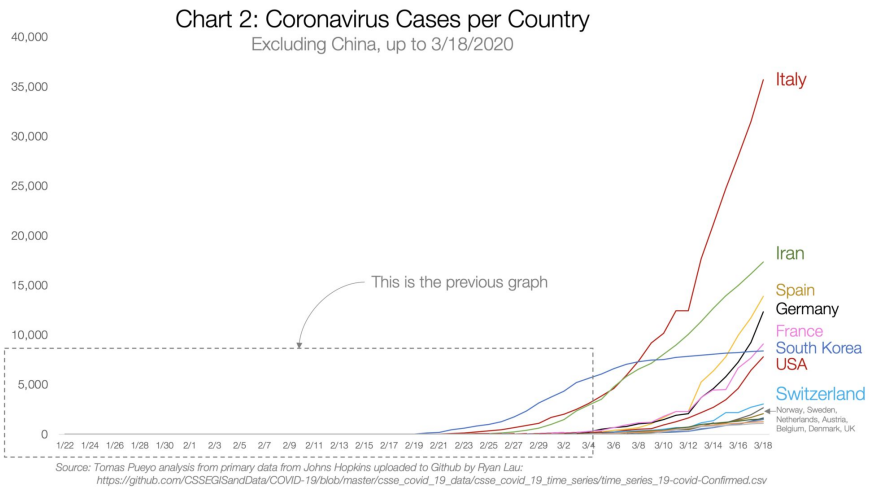
- Detailed linear
- Non-linear
- Bracket
- Simulated travel routes
- Composite bar graphs
- Depicting cases over span of a month

# Graph 1 blackbox Logical Model 3/4/20



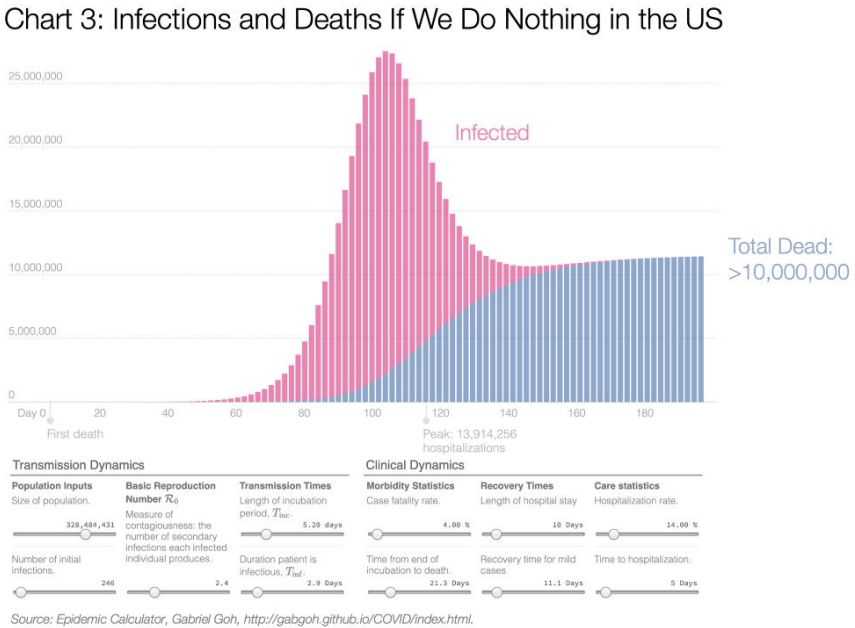

- South korea, italy, iran, leading the case race
- Spain, Germany, France and the US nowhere to be seen

# Graph two Logical blackbox 3/18/20




- Spain, Germany, and U.S. now have more cases than Italy
- 16 more countries have more than Hubei > 1,000
- Notice trend in wealthy countries being infected

# Graph 3 Infections and Deaths if we do nothing Grey Logistical Graph

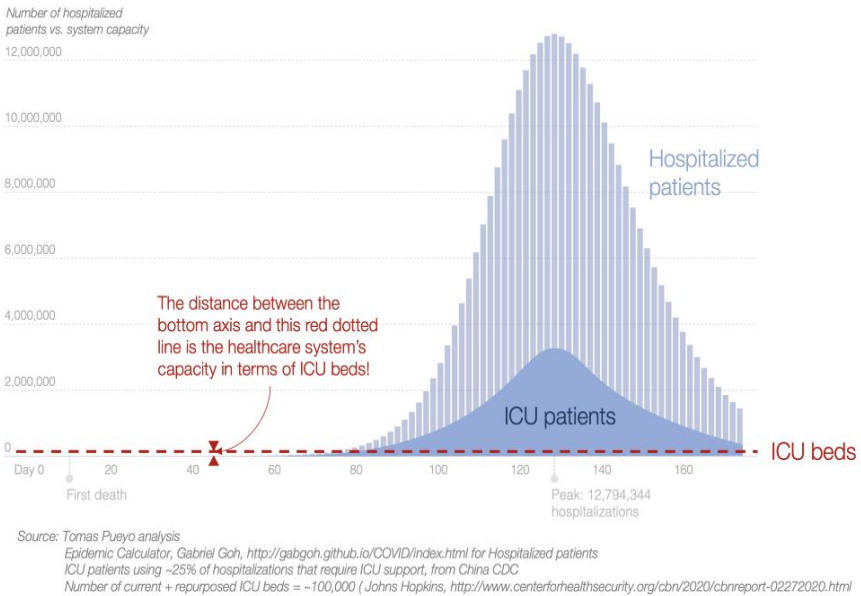



*Source: Epidemic Calculator, Gabriel Goh, http://gabgoh.github.io/COVID/index.html.*

- If we do nothing: Everybody gets infected, the healthcare system gets overwhelmed, the mortality explodes

# Graph 4 Coronavirus Patients vs System Capacity Logistical black

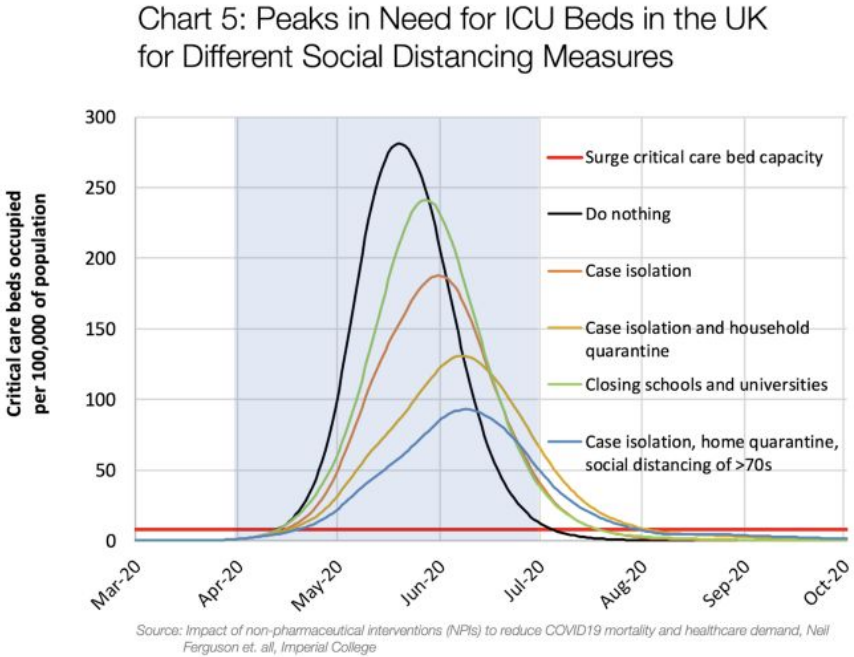
Chart 4: Hospitalized Coronavirus Patients vs. System Capacity




Source: Tomas Pueyo analysis
Epidemic Calculator, Gabriel Goh, http://gabgoh.github.io/COVID/index.html for Hospitalized patients
ICU patients using ~25% of hospitalizations that require ICU support, from China CDC
Number of current + repurposed ICU beds = ~100,000 ( Johns Hopkins, http://www.centerforhealthsecurity.org/cbn/2020/cbnreport-02272020.html

- Helps us understand why we need to act now
- If hospitals reach max capacity graph 3 will be triggered
- Helps control doubters

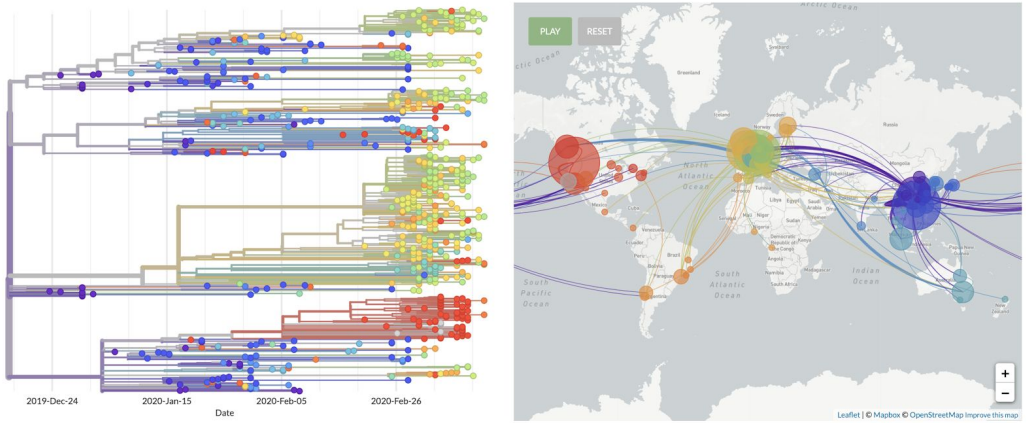
# Chart 5 Peaks in Need for ICU beds in UK Logistical Whitebox Model




- Shows what happens if we practice different social distancing tactics

# Chart 6 Mutations in Coronavirus Logistical Blackbox

Chart 6: Mutations in the Coronavirus

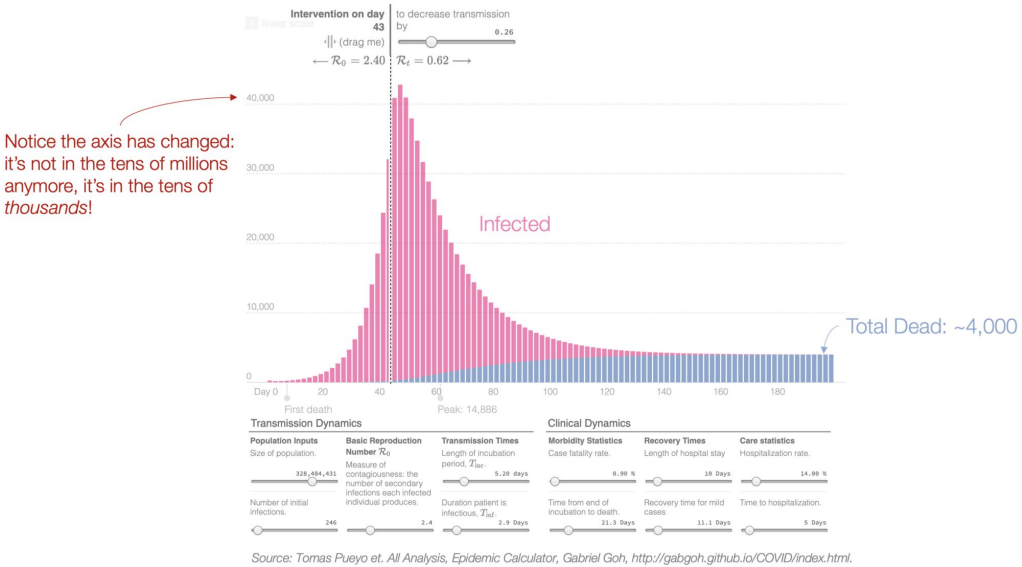



*Source: Nextstrain, based on open source information gathered through GISAID*

- Explains how the virus is able to mutate itself
- RNA viruses mutate 100 times more than DNA viruses like the flu making it more deadly

# Chart 7 Cases and deaths Under Suppression Strategy Logistical B-Box

Chart 7: Coronavirus Cases and Deaths under Suppression Strategy

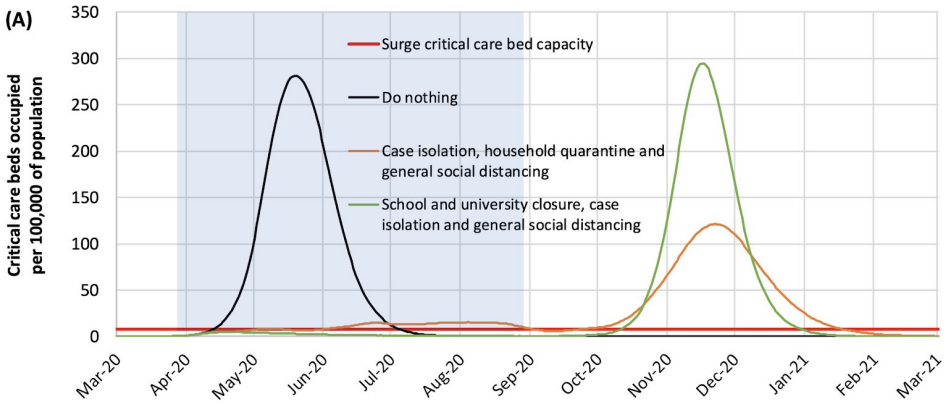



*Source: Tomas Pueyo et. All Analysis, Epidemic Calculator, Gabriel Goh, http://gabgoh.github.io/COVID/index.html.*

- Shows us that death tolls are cut from thousands to millions with suppression

# Chart 8 Suppression Strategy according to the imperial college

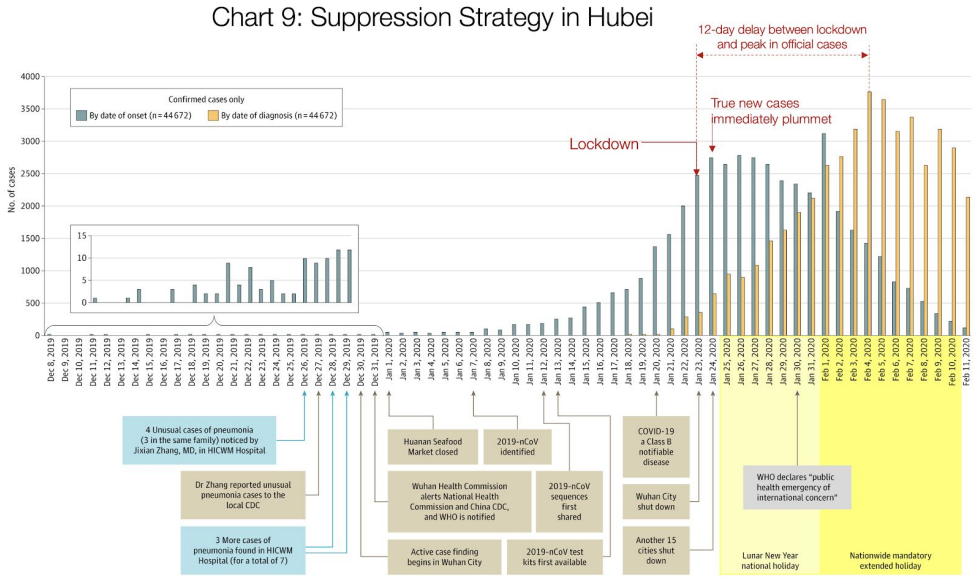
Chart 8: Suppression Strategy According to the Imperial College




*Source: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand, Neil Ferguson et. all, Imperial College*

- Either a lot of people die soon and we don't hurt the economy today, or we hurt the economy today, just to postpone the deaths

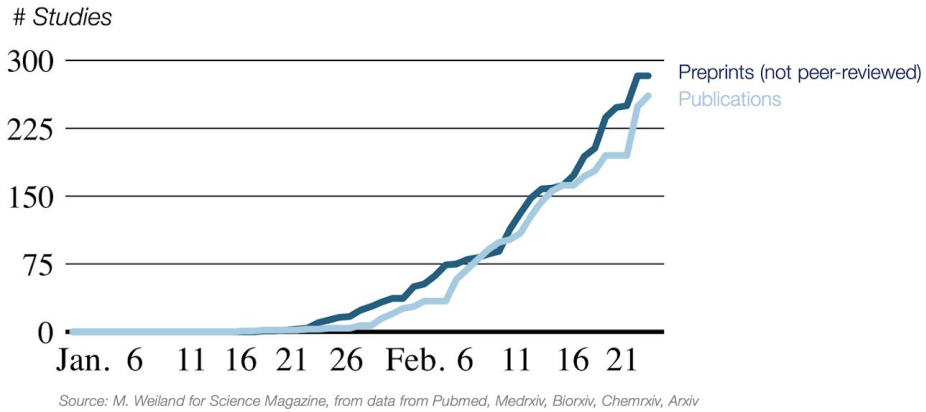
# Chart 9: Suppression Strategy in Hubei




- Fewer total cases of Coronavirus
- Immediate relief for the healthcare system and the humans who run it
- Reduction in fatality rate

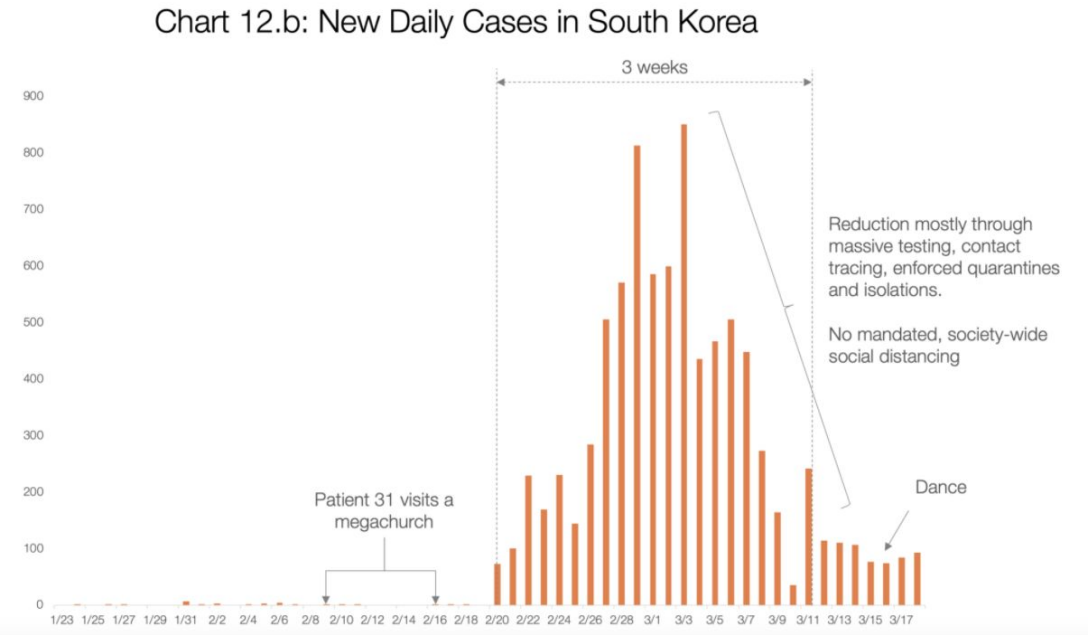
# Chart 10: Speed of Coronavirus Research Logistical White Box

Chart 10: Speed of Coronavirus Research



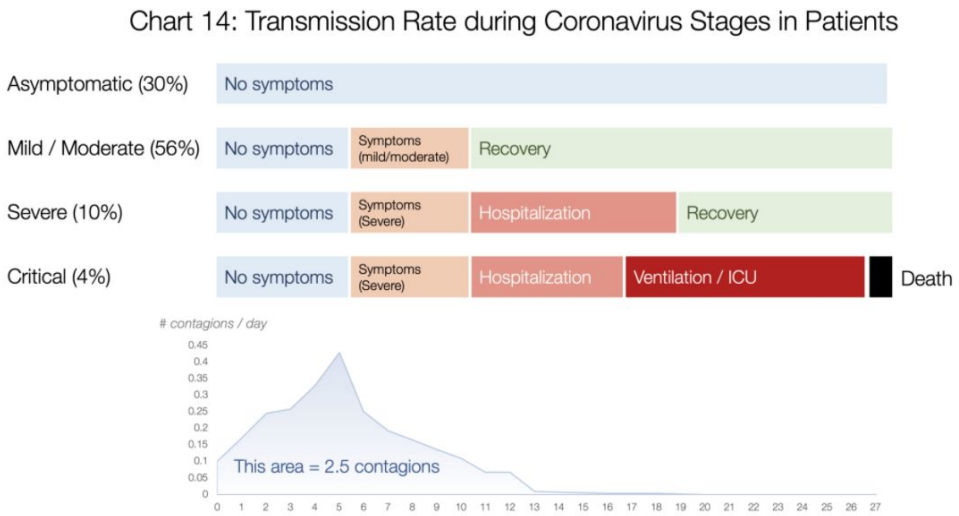

- The world is finally united against a common enemy. Researchers around the globe are mobilizing to understand this virus better.

# Graph 12b. New Cases in South Korea Blackbox




- South Korea went from one of the worst epidemic to largely under control without asking people to stay home.
- Achieved with very aggressive testing, contact tracing, and enforced quarantines and isolations

# Graph 14. Transmission Rate Logistical Whitebox




- This is an approximation of how different types of patients respond to the virus, as well as their contagiousness.
- Nobody knows the true shape of this curve, but we've gathered data from different papers to approximate how it looks like.

# Our Code So Far...

```python
class CoronaAgent(Agent):
    ##Agent with the initial sickeness###
    def __init__(self, unique_id, model):  # initalize agent with unique ID
        super().__init__(unique_id, model)
        self.sick = 1

    def move(self):
        possible_steps = self.model.grid.get_neighborhood(
            self.pos,
            # allows us to get the neighboring cell of the grid object.
            moore=True,
            include_center=False)
        new_position = self.random.choice(possible_steps)
        self.model.grid.move_agent(self, new_position)

    def give_virus(self):
        cellmates = self.model.grid.get_cell_list_contents([self.pos])## allows us to get all the information per c
        if len(cellmates) > 1:
            other = self.random.choice(cellmates)
            other.sick += 1
            self.sick -= 1

    def step(self):
        self.move()
        if self.sick > 0:
            self.give_virus()
```

```python
class SickModel(Model):
    """A model with some number of agents."""
    # This model will store the agents and the number of them

    # initializing itself with Number of agents'N' and width and height of the grid'width''height'
    def __init__(self, N, width, height):
        self.num_agents = N  # number of agents
        # multigrid allowing more than one agent to occupy a single space
        self.grid = MultiGrid(width, height, True)
        # Adds order of random to the agents for placment
        self.schedule = RandomActivation(self)
        self.running = True  # allow us to start the process

        # This will create the agents for the model to use
        for i in range(self.num_agents):
            a = SickAgent(i, self)  # initializing self
            self.schedule.add(a)  # schedule will be acting as our timer
            # this will put the agent on a random spot on the grid
            x = self.random.randrange(self.grid.width)
            y = self.random.randrange(self.grid.height)
            self.grid.place_agent(a, (x, y))
            ##########################################

        self.datacollector = DataCollector(
            model_reporters={"Gini": compute_gini},
            agent_reporters={"Sick": "sick"}
        )
```

# Measures Taken in our Demo

-Multiple People are allowed to be in the same room(i.e. Grid Cell)

-Random chance of someone giving the virus to another person(agent)

-This is to simulate if someone who comes into contact does not take the proper precautions after the matter.

-If a person who has the virus continues to come into  contact and with other who have the virus they can be assumed to be dead and or virus mutated.