



COVID-19 Project

Zelong Chen

Project Objectives



- Problem Statement
- SEIR + D Model
- Assumptions
- Stay-At-Home Order
- Contact Tracing / Testing
- Results



Problem Statement

- Aimed to study the disease progression of COVID-19 in the state of California
- Study the effectiveness of the interventions put in place by the California State officials to lower the spread of COVID-19
 - Stay-At-Home Order (3/19/20)
 - Coronavirus Testing Sites (4/7/20)
- Using System Dynamics and the SEIR infectious diseases model to run simulations under different operating assumptions



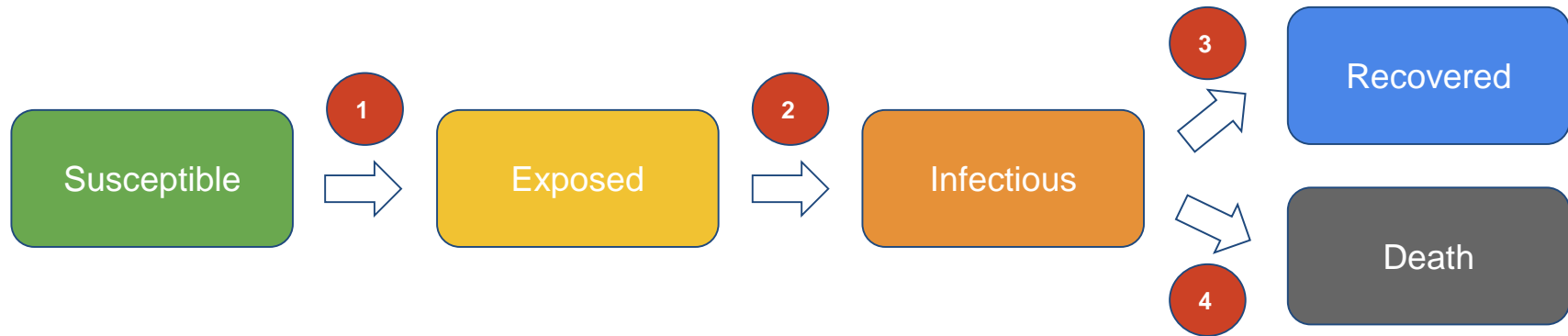
Most states are falling short in testing availability recommended by health experts and federal officials

[Nation/World](#) / 19 hours ago



California stay-at-home order faces revolts at beaches and in rural communities

SEIR + D Model



1 $\text{Exposed Rate} = \text{Contact Rate} * \text{Infectivity} * \frac{\text{Infectious}}{\text{Total Population}} * \text{Susceptible}$

2 $\text{Infectious Rate} = \frac{1}{\text{Average Incubation Time}} * \text{Exposed}$

3 $\text{Recovered Rate} = (1 - \text{Mortality Rate}) * \frac{1}{\text{Average Illness Duration}} * \text{Infectious}$

4 $\text{Death Rate} = \text{Mortality Rate} * \frac{1}{\text{Average Illness Duration}} * \text{Infectious}$



Assumptions

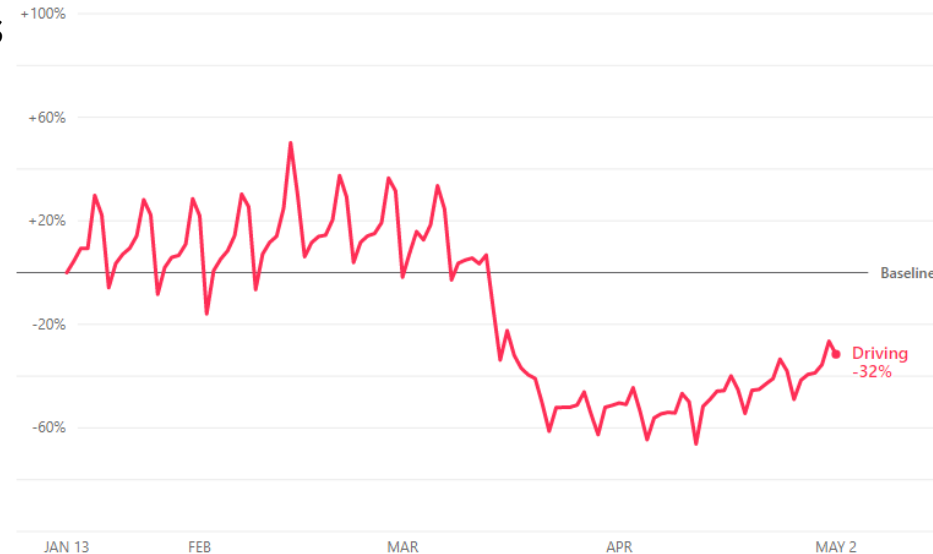
- **Contact Rate: 13.4 contacts per day**
 - <https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.0050074#s1>
- **Infectivity: 5.249%**
 - Based on data from Hubei Province, <http://jtd.amegroups.com/article/view/36385/html>
- **Average Incubation Period: 11.5 days**
 - 97.5% of patients develop symptoms within 11.5 days (CDC)
- **Average Illness Duration: 10 days**
 - 7 days since symptoms first appear + 3 days since recovery (CDC)
- **Mortality Rate: 3.4%**
 - (3/3/2020), WHO Media Briefing
- **Initial Infectious Population: 699**
 - (3/18/20), Number of Confirmed Cases Day before Stay-At-Home Order
- **California Population: 39,512,223**
 - (7/1/2019), US Census Bureau

Stay-At-Home Order

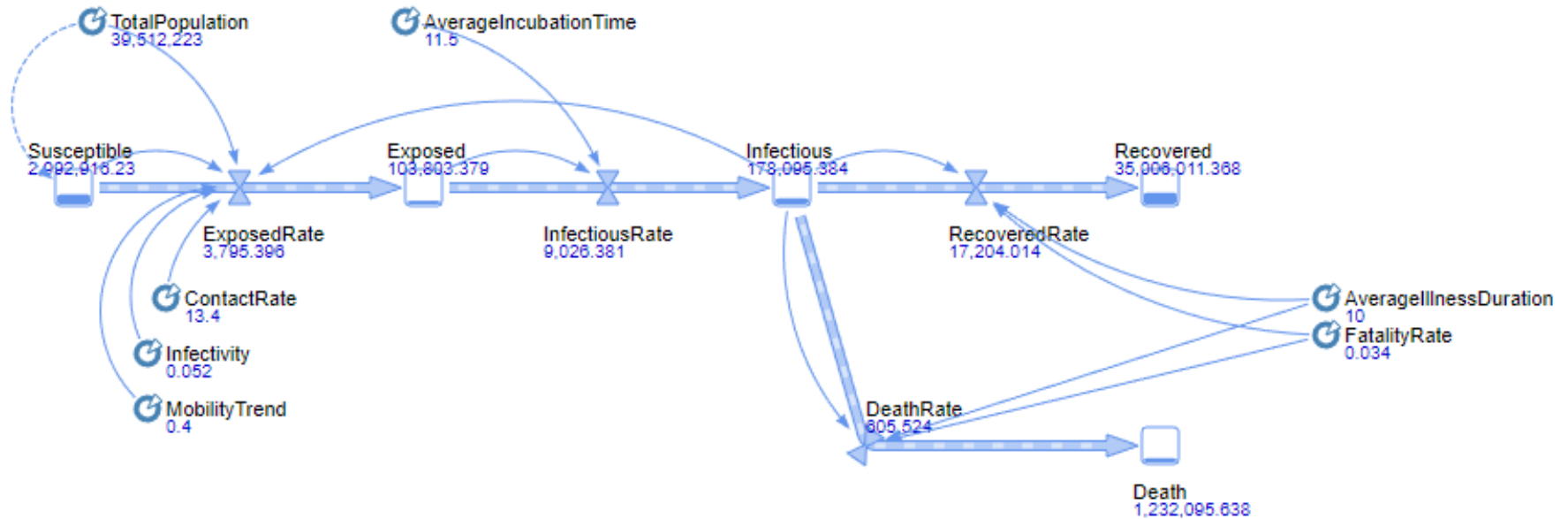


- Stay-At-Home Order aim to reduce the number of contacts among Californians to “flatten the curve”
- Mobility Trends according to Apple Maps Mobility data
 - 70% (Average) of Baseline
 - 40% (Best Effort)
 - 25%
 - 10% (Strict Lockdown i.e. China)

Apple Maps Mobility Trends Report



Stay-At-Home Order



$$\text{Exposed Rate} = \text{Mobility Trend} * 13.4 \text{ contacts per day} * 0.05249 * \frac{\text{Infectious}}{39,512,223} * \text{Susceptible}$$

$$\text{Infectious Rate} = \frac{1}{11.5 \text{ days}} * \text{Exposed}$$

$$\text{Recovered Rate} = (1 - 0.034) * \frac{1}{10 \text{ days}} * \text{Infectious}$$

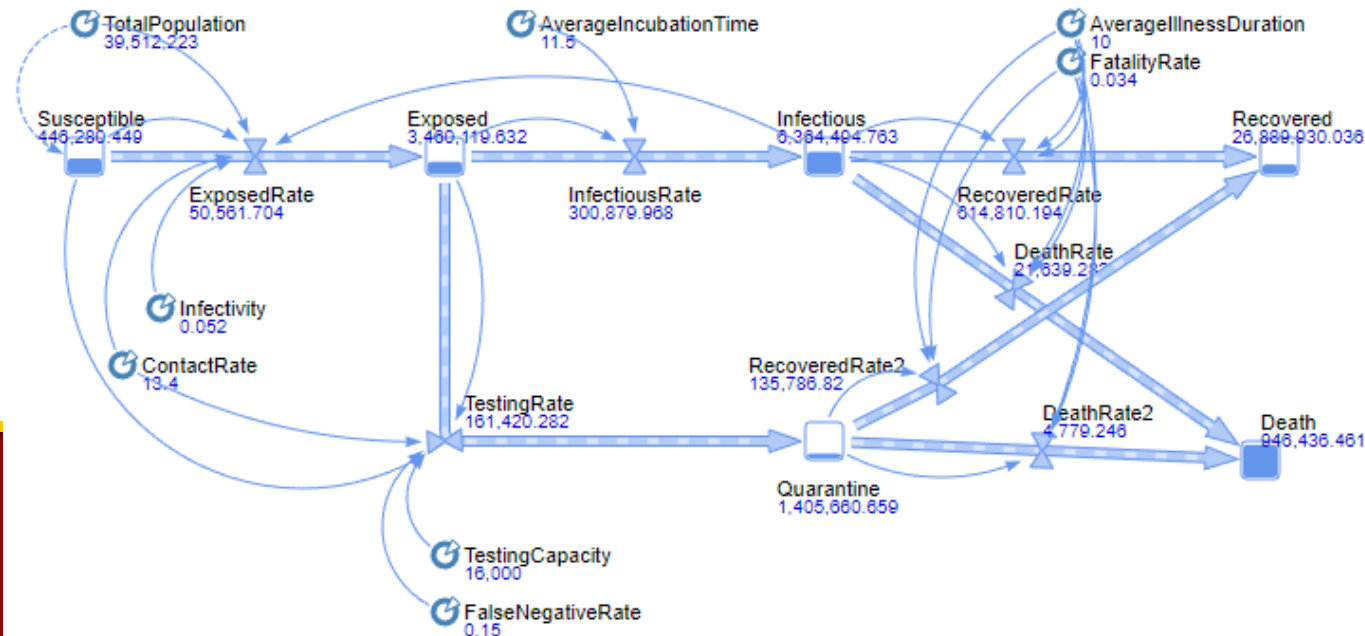
$$\text{Death Rate} = 0.034 * \frac{1}{10 \text{ days}} * \text{Infectious}$$

Contact Tracing / Testing



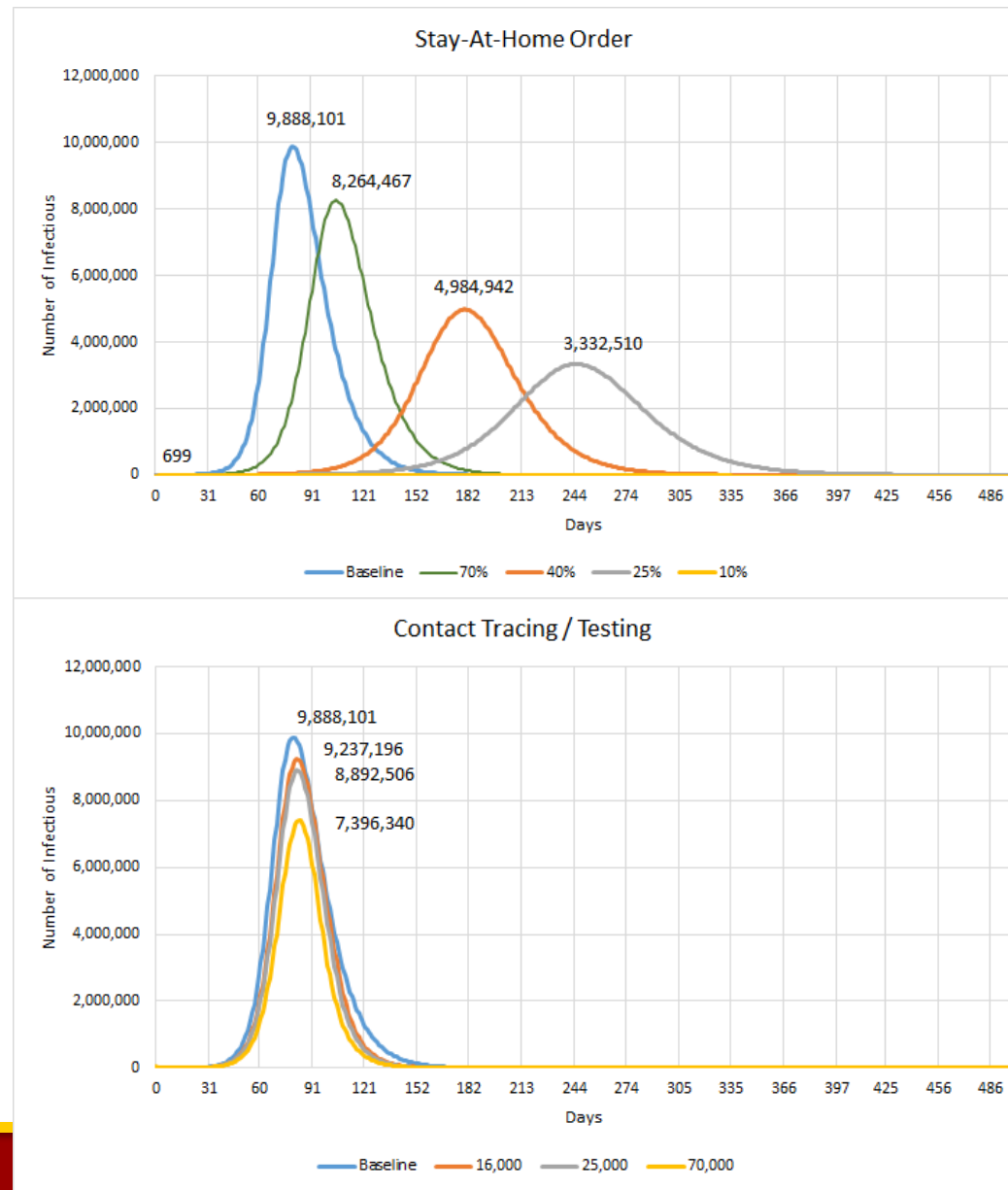
- Testing and Contact Tracing is used to identify potential carriers before they become infectious
- CA Testing Capacity as of 4/24/2020
 - 16,000/day, 25,000/day by May
 - Increase to 60,000-80,000 to consider reopening the state
- False Negative Test Rate: 15%
 - <https://www.cnn.com/2020/04/21/health/abbott-laboratories-coronavirus-rapid-test/index.html>

$$\text{Testing Rate} = \frac{\text{Testing Capacity}}{\text{Susceptible} + \text{Exposed}} * \text{Exposed} * \text{Contact Rate} * (1 - \text{False Negative Rate})$$



Results

- Stay-At-Home Order
 - Mobility Trend at 70%:
 - Infectious: **-16.42%**
 - Peak Delayed: **25 Days**
 - Mobility Trend at 40%:
 - Infectious: **-49.59%**
 - Peak Delayed: **98 Days**
- Contact Tracing / Testing
 - 16,000 Test Capacity:
 - Infectious: **-6.58%**
 - 25,000 Test Capacity:
 - Infectious: **-10.07%**
 - 70,000 Test Capacity:
 - Infectious: **-25.2%**



All-in-One

- Mobility at 70% + 16,000 Test Capacity **(Current)**
 - Infectious: **-23.16%**
 - Death: **-1.59%**
- Mobility at 40% + 16,000 Test Capacity
 - Infectious: **-55.67%**
 - Death: **-10.73%**
- Mobility at 40% + 70,000 Test Capacity **(Best)**
 - Infectious: **-70.97%**
 - Death: **-21.20%**

