The COVID-19 Pandemic

Epidemiological Modeling and Operational Applications

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Topics Covered Today

- ***Standard Modeling Concepts***
- ***Model Projections & Proper Use***
- ***Complements and Alternatives to Standard Modeling Approaches and Intermediate Projection Horizons***

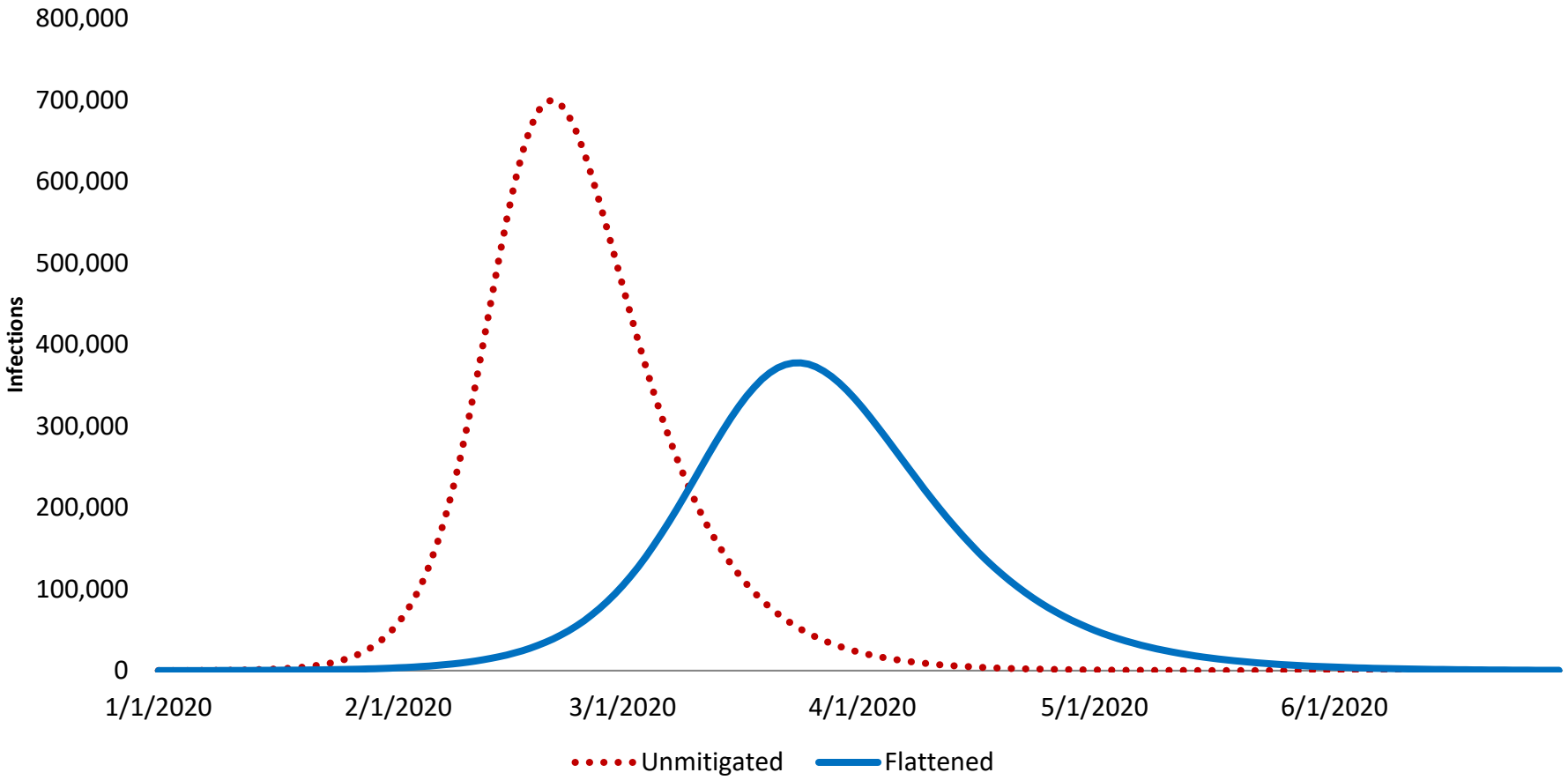
The COVID-19 Pandemic

Timeline: https://www.nbcnews.com/health/health-news/coronavirus-timeline-tracking-critical-moments-covid-19-n1154341

Statistics as of 5/10

- ***4 Million Infections and 280,000 Deaths Globally***
- ***1.3 Million Infections and 80,000 Deaths U.S.***
- ***6,251 infections and 67 Deaths Utah***

Flatten the Curve Example



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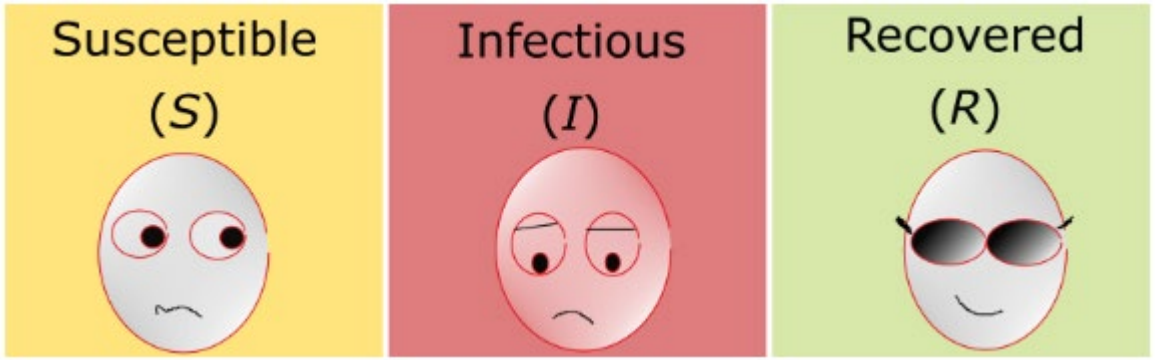
The Standard Epidemiological Model

Susceptible, Infected, Recovered (SIR)



Source: https://triplebyte.com/blog/modeling-infectious-diseases

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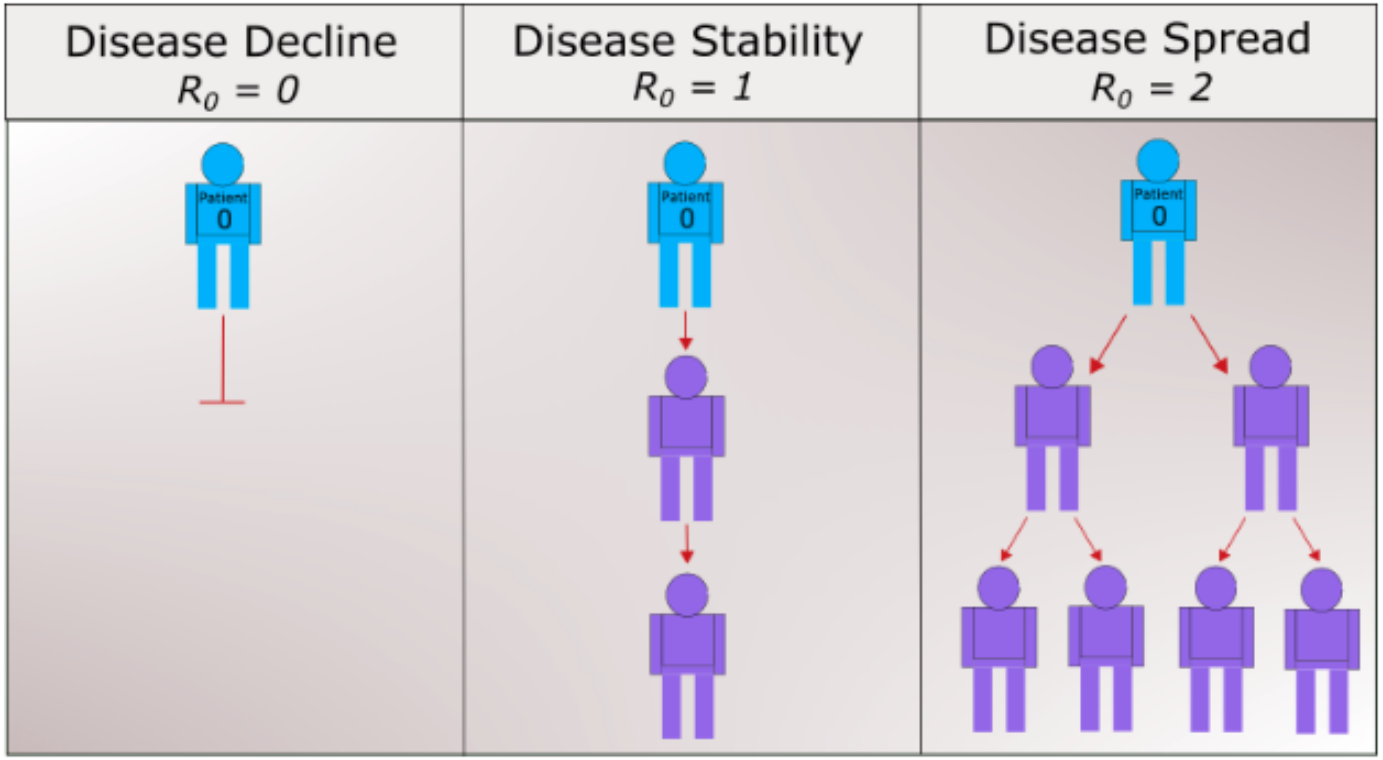
SIR Model Initial Conditions

- ***Susceptible: Uninfected & Unrecovered Population***
- ***Infected: Active Infected Population***
- ***Recovered: Post Infection and Not Contagious Population***

SIR Initial Parameters

- ***R-Naught (R-0): Reproduction Rate***



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SIR Initial Parameters

R-0 Components

- ***Transmission Rate: Force of Infection***
  - ***Contacts: Number of Contacts***
  - ***Infectiousness: Probability of Infection***
- ***Recovery Rate: Duration of Infectiousness***

Ordinary Differential Equations

Change in S: -beta * S * I

Change in I: beta * I * S – gamma * I

Change in R: gamma * I

Where

- ***S = Susceptible***
- ***I = Infected***
- ***R = Recovered***
- ***Beta = Transmission Rate***
- ***Gamma = Recovery Rate***

Putting it all Together

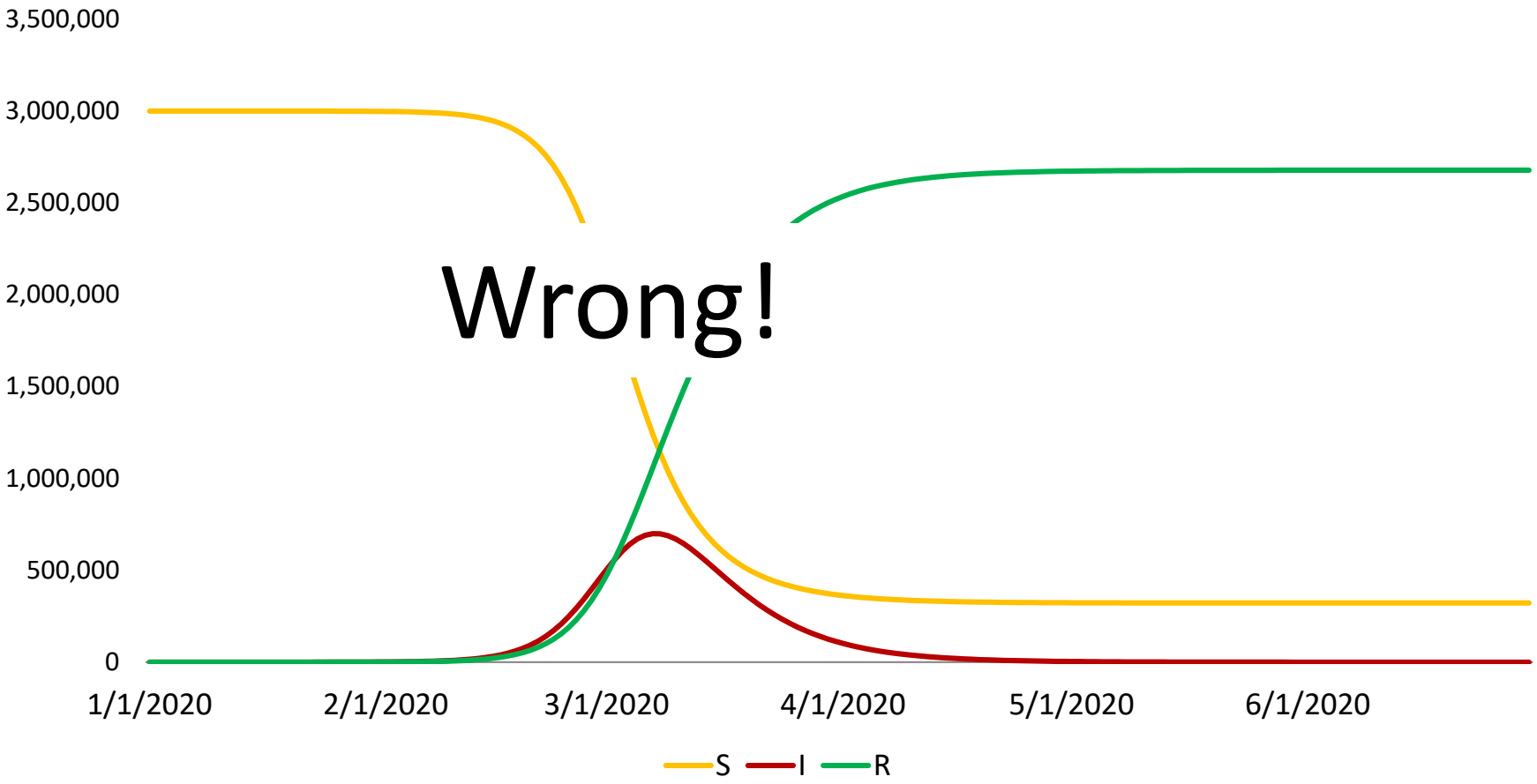
Initial Conditions

- *S = 2,999,999*
- *I = 1*
- *R = 0*

Initial Parameters

- *Transmission Rate = 0.1282-e6*
- *Recovery Rate = 1/6.5*
- *R-0 = 2.5*

Ta-Da!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4/1/2020
5/1/2020
6/1/2020
S
I
R

Wrong!

Projections not Forecasts

Why was the model so far off?

- ***Basic vs. Advanced Models***
  - **Susceptible, Exposed, Recovered, Infected (SEIR)**
  - **Susceptible, Exposed, Infected, Quarantined (SEIQR)**
- ***Much Remains to be Learned***
  - ***What are the true disease characteristics?***
- ***Planning Scenarios vs. Predictions***
  - ***Projecting a 'what-if' not a discrete prediction***

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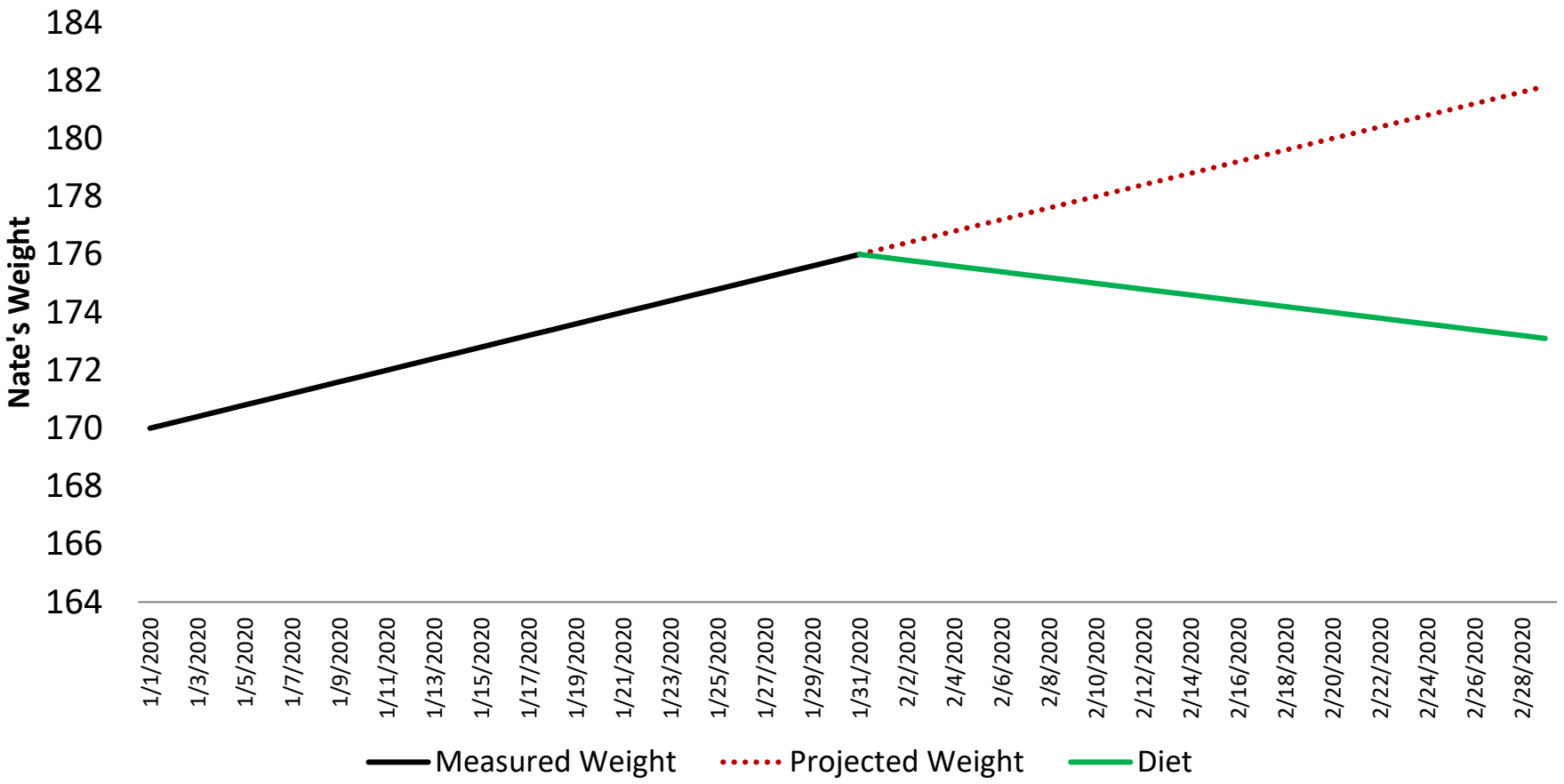
Weight Loss Analogy



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Planning Scenario Hypotheticals

Unmitigated Transmission: R-0 of 2.5

Transmission with Nonpharmaceutical Interventions (NPI)

- ***Scenario 1: Social Distancing ~ R-0 of 1.5****
- ***Scenario 2: Social Distancing + School Closures ~ R-0 of 1.25****
- ***Scenario 3: Social Distancing + School Closures + Widespread Use of Masks: R-0 of 1****

*Hypotheticals Only & Not Actual Estimates for R-0 associated with NPI

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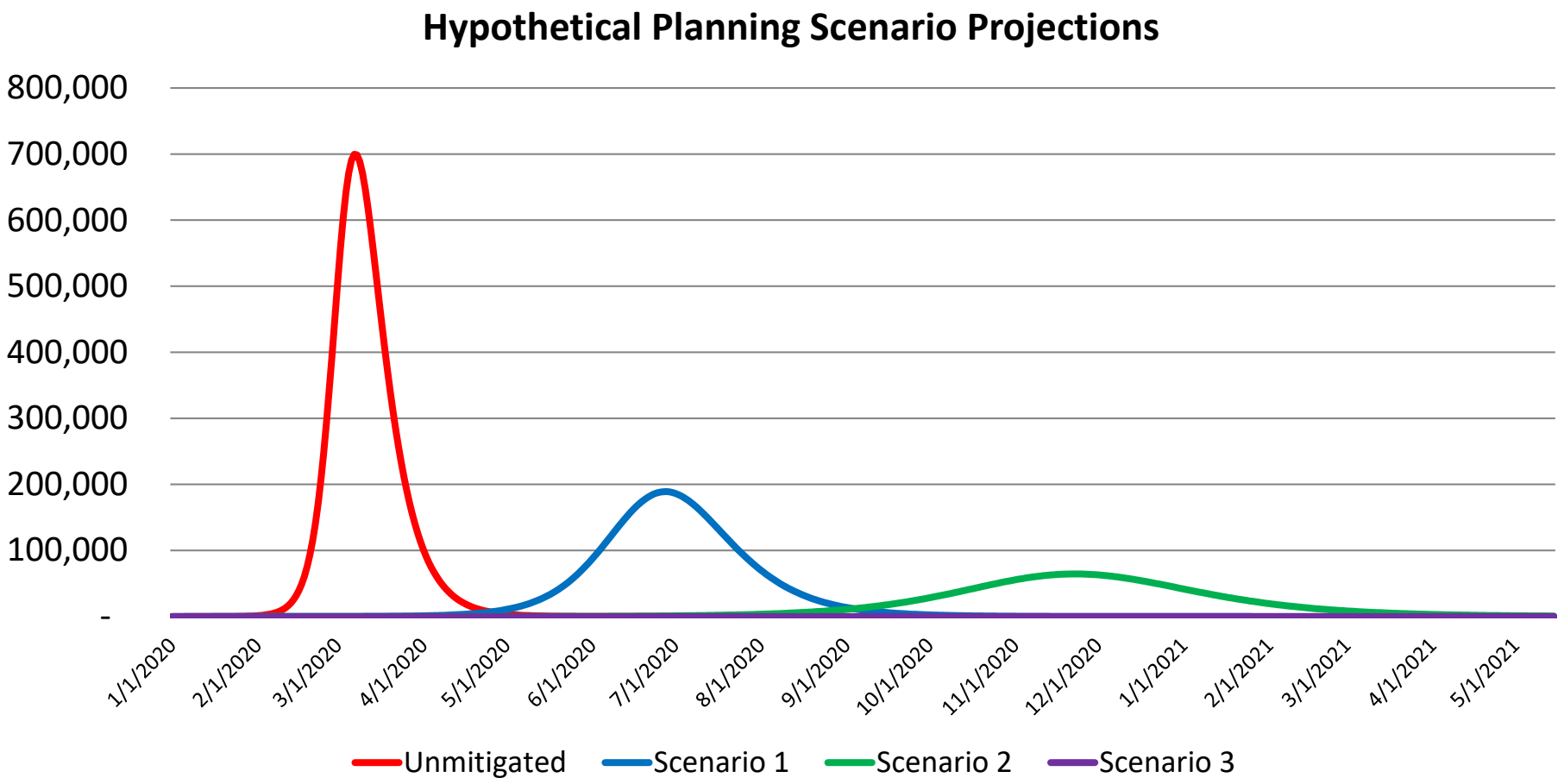
Planning Scenario Hypotheticals



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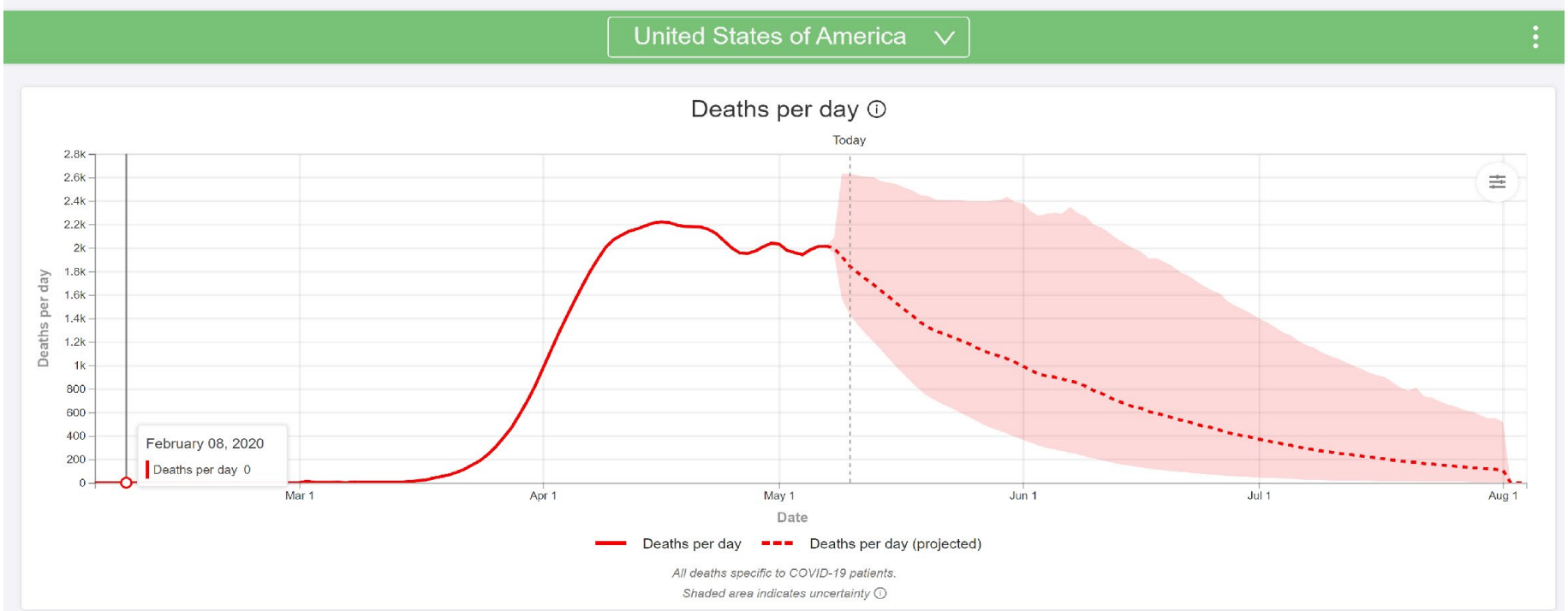
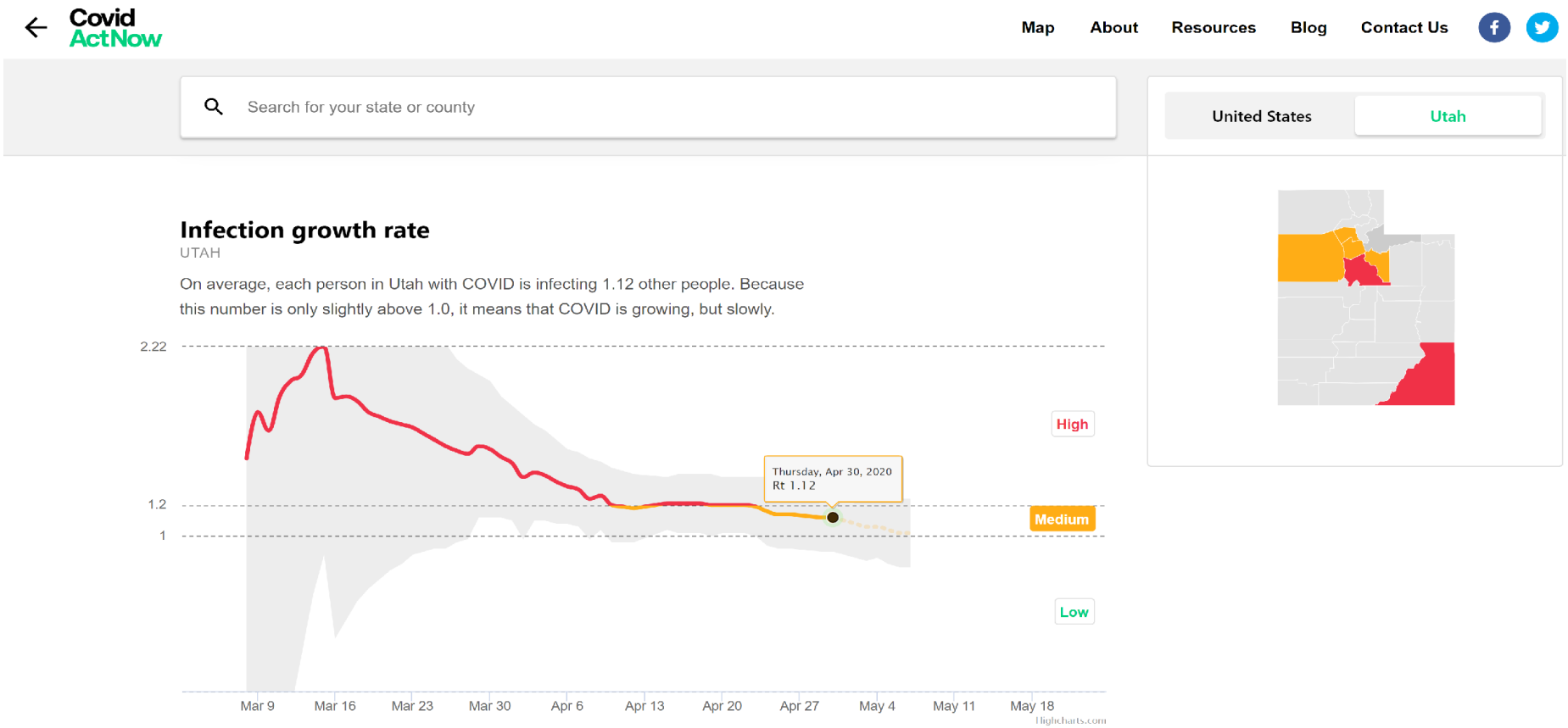
National Models

- The Institute for Health Metrics and Evaluation (IHME)
  https://covid19.healthdata.org/united-states-of-america



National Models

- ***COVID ActNow:*** https://covidactnow.org/us/ut



Operational Data Monitoring

Complements and Alternatives to Projections

- ***Operational Data Collection & Monitoring***
  - ***Real-time Transmission Rate***
  - ***Real-time Hospitalization Occupancy***
  - ***Real-time Testing Statistics***
  - ***Real-time Point of Origin Monitoring***

Where does Utah stand today/last week?

- ***>6,000 experienced cases (Utah 30th in infections per million population)***
- ***~70 Deaths (47th in Deaths per million population)***
- ***~10% of Cases among >64 years old compared to ~+20% Nationally***

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Where does Utah stand today/last week?

- ***~3,200 estimated active cases***
- ***~100 current hospitalizations***
- ***Transmission Rate less than ~1.3***
- ***60% of Cases Traced to Known Contact***
- ***143,000 tests (5th highest per capita)***
- ***Moved from 'Red' to 'Orange' Risk level***

Questions?

Contact

- ***natetalley@utah.gov***
- ***(801) 538-1556***

COVID-19 Resources

- ***CDC:*** https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html
- ***State of Utah:*** https://coronavirus.utah.gov/

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