V&V for COVID-19 Decisions

Nick Hengartner
Los Alamos National Laboratory
Coronavirus Pandemic

- New virus for which little is known
- Learn as we go
- Need to make high consequence decisions
- Need timely information
- Questionable data quality
V&V and UQ Needs to be Geared Towards Answering Questions

COVID Questions

• What are the historical and current spatial-temporal trends of disease spread?
• What is the estimated newly infected population in a time period?
• How effective are the implemented interventions and mitigations strategies?
• When and where will the infection curves peak?
• What is the duration (time extent) of the overall curve?
• Can we estimate the CFR (case fatality rate) for each of the age stratification?
• What is the estimate of hospital beds needed, ICU units, ventilators etc?
• How much testing capacity is needed and where is it needed?
Past and current Data, and Models

- Past data from similar outbreaks
- Morphological (statistical) models describe the data
- Mechanistic models incorporate knowledge
Modeling strategies enabling epidemiological situational awareness

**Morphological (statistical) models**

1. Use data from past outbreaks to describe baseline
2. Simple summary statistics, like \( r(t) \), to inform public health
3. Useful once the outbreak is in full swing
4. Useful to develop automatic data cleaning algorithms
5. Data mining to discover patterns of disease spread from multiple historical outbreaks

**Mechanistic models**

1. Describe mechanism of how disease spreads
2. Possible to develop high resolution models, long term forecast
3. Useful for what if games to inform on impact of policies and support planning
4. Uncertainty quantification
What to do when data quality is an issue?

Additional and alternative data sources
• Sequencing of pathogen
• Mobility data
• Real-time contact tracing
• Social media
• Mechanistic model output
• Geographical diversity
• Arrival time data

High Contagiousness and Rapid Spread of Severe Acute Respiratory Syndrome Coronavirus 2.

Sanche S, Lin YT, Xu C, Romero-Severson E, Hengartner N, Ke R
Emerging Infectious Diseases, 06 Apr 2020, 26(7)
DOI: 10.3201/eid2607.200282 PMID: 32255761
Preparing for the next one: Modeling integrated into situational awareness systems

Operational Objectives

Observation of disease

Identified Biological Reservoirs

Validated Case Studies

Sequence Analysis and other Data streams

Epidemiological Modeling

Operational Experience

Surveillance Strategies

Estimate Prevalence of Susceptibles

Estimate Contact Matrix

Validated Case Studies