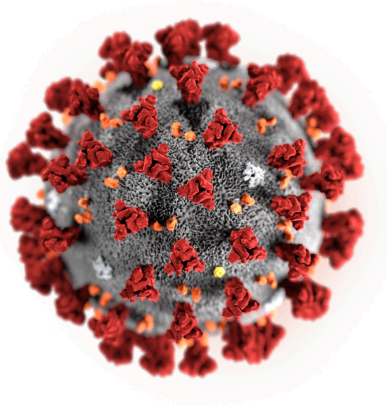

Modeling COVID-19 spread and control: Data needs and challenges

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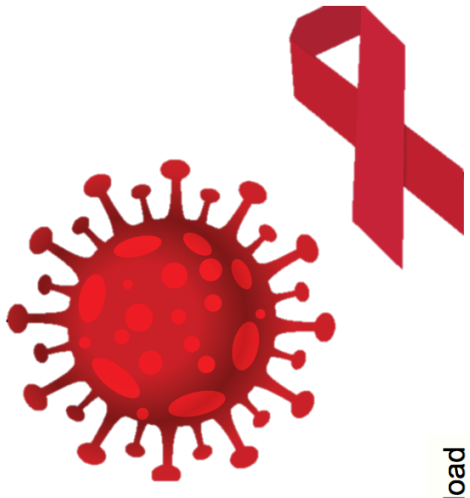
Disclaimers: 1) Like many, I am new to the field of coronavirus research. 2) With the rapid pace of research, things in this talk may be out-of-date or corrected by the time you view it.

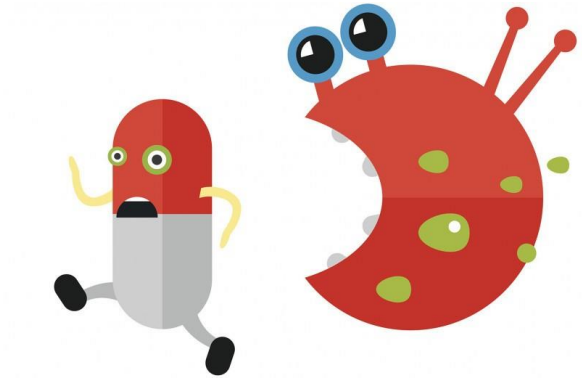
Summary of the epidemic

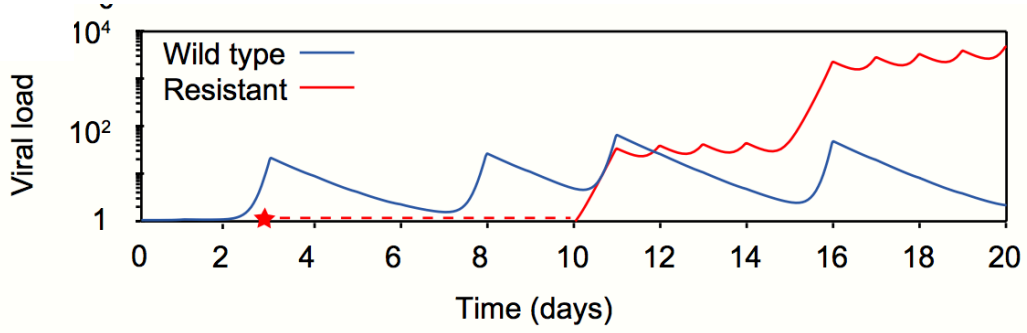
- A newly-recognized virus (**SARS-CoV-2**) which causes a disease (**COVID-19**) characterized by pneumonia and respiratory failure
- Since recognition as a disease syndrome in Dec 2019 and as a novel coronavirus (Jan 2019), has spread to nearly ~~every~~ country in the world
- As of May 14, 2020 12:48 UTC-5, ~4,400,000 recognized cases and ~300,000 deaths
- Like now ranked in Top 5 viral causes of death worldwide

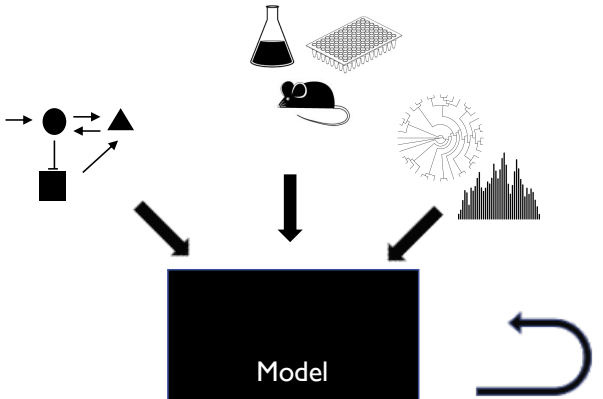
About me

- Infectious disease modeler focusing on HIV/AIDS and drug resistant infections



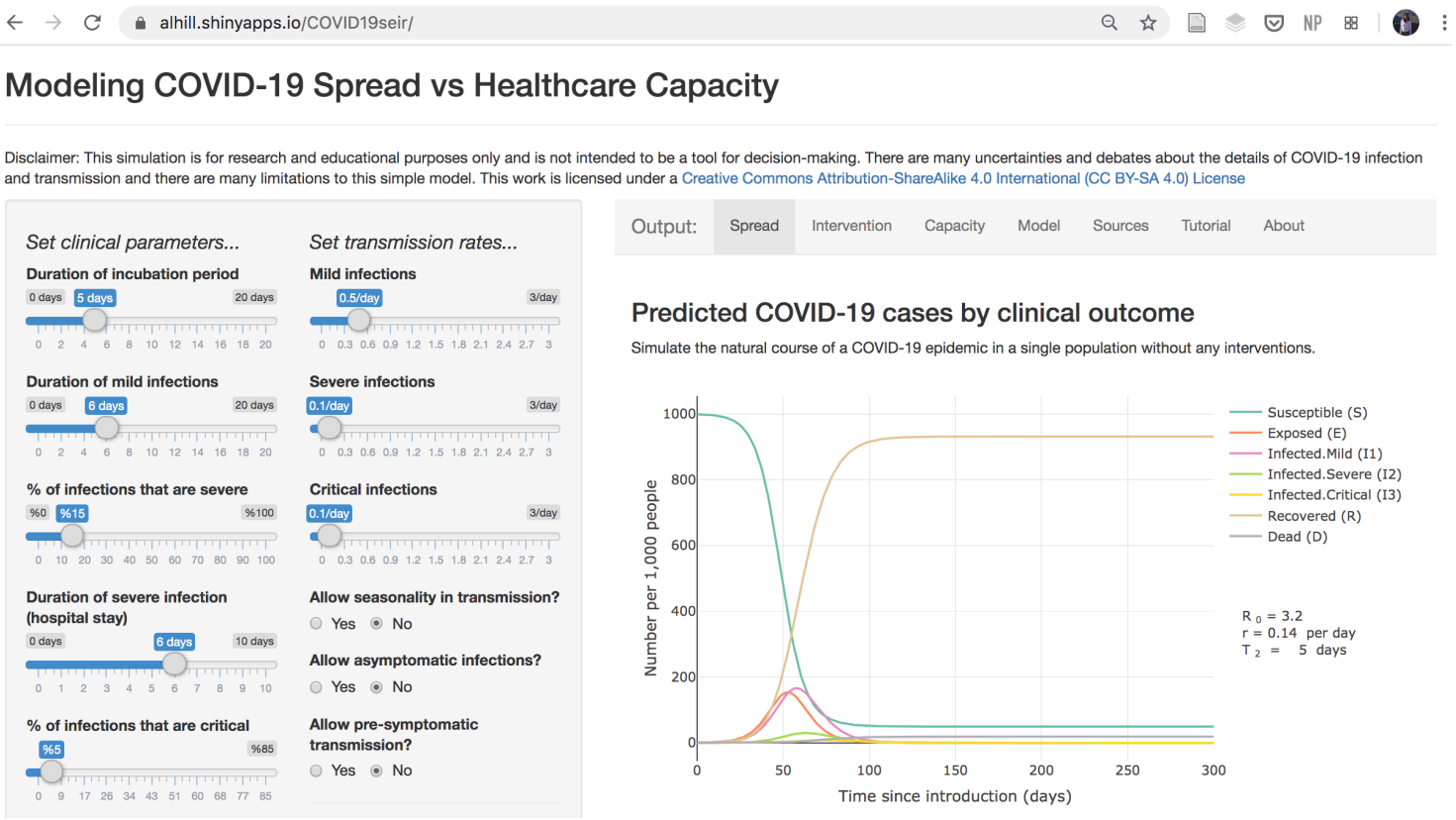






$$P(M|D) = \frac{P(D|M)\,P(M)}{P(D)}$$

Contributions to COVID-19 modeling



- Assisting regional health authorities, NGOs, consultants, educators, and other scientists with COVID-19 modeling projects

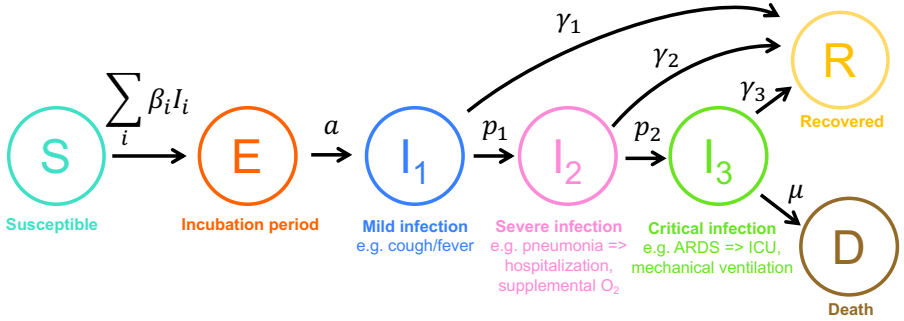
Interactive modeling app available at: https://alhill.shinyapps.io/COVID19seir/

Role of models in COVID-19 epidemic

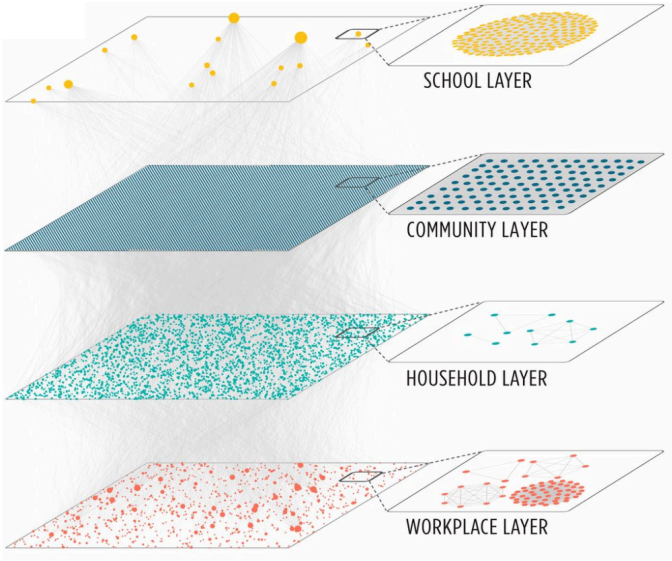
- Making short-term projections (exponential growth)
- Highlighting the risk of healthcare capacity overflow
- Promoting the idea of “flatten the curve”
- Motivating the implementation of strong interventions
- Projecting the course of the epidemic beyond spring 2020
- Estimating the potential impact of seasonality
- Estimating the total burden of infection
- Inferring the efficacy of interventions

Ingredients of COVID-19 models

Clinical course of infection

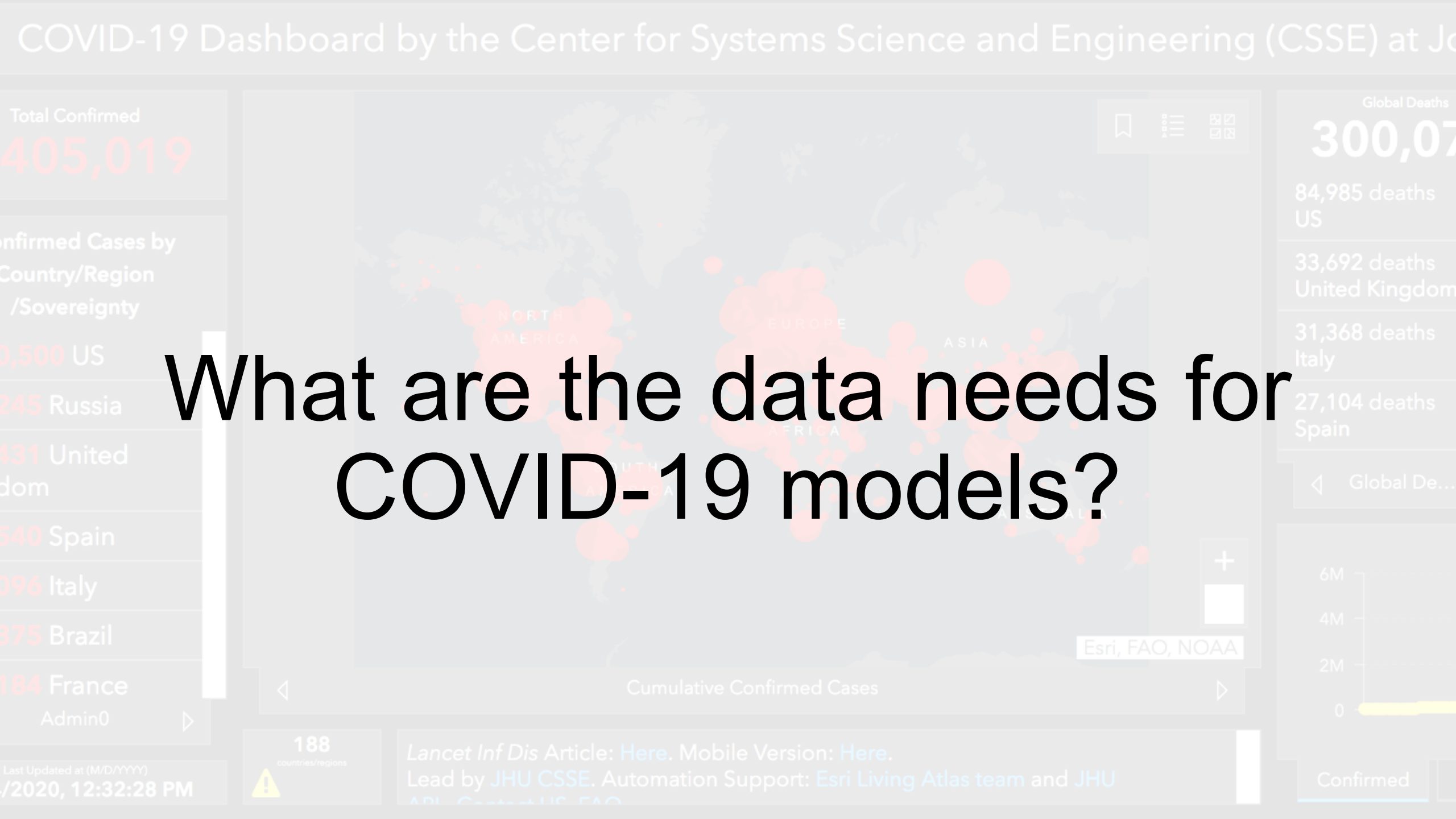


Transmission networks



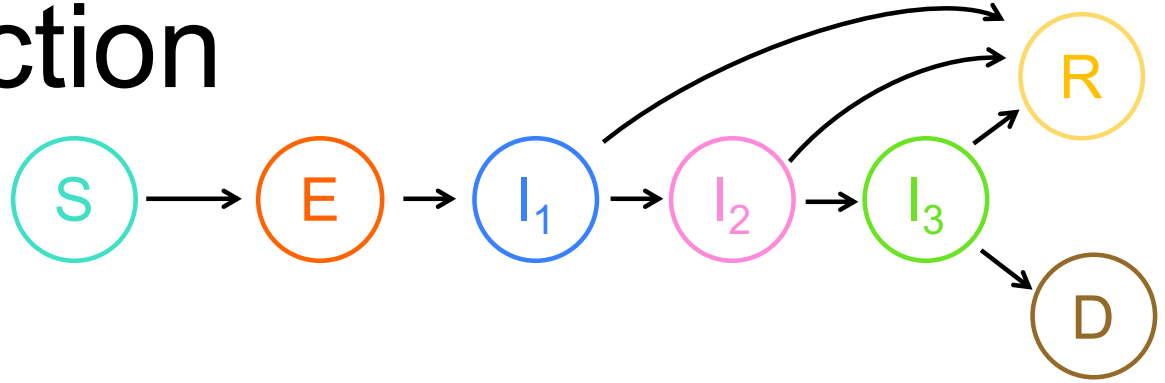
Healthcare resources available

Interventions



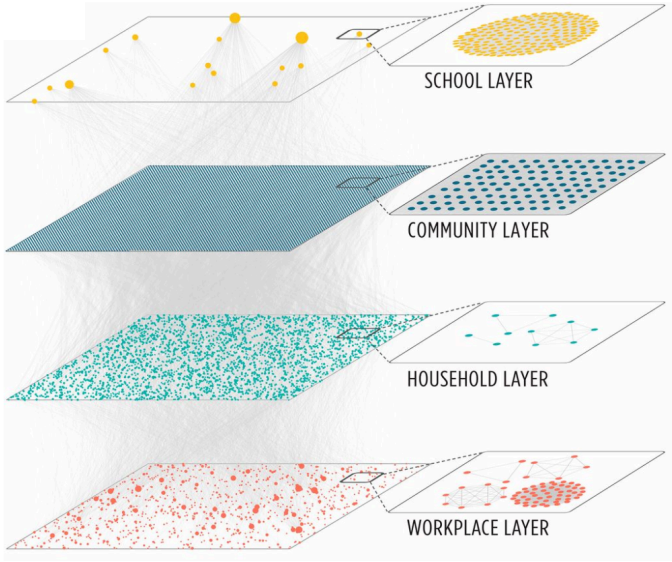
What are the data needs for COVID-19 models?

Clinical course of infection



- Needs:
  - Duration of each stage of infection
  - Probability of progression/death/recovery at each stage
  - % asymptomatic infections
  - Infectiousness of each stage of infection (relationship to viral load, age)
- Gold standard:
  - Detailed cohort study with long-term follow-up
  - Contact tracing studies
  - Universal and centralized reporting
- Challenges
  - Estimating these quantities from population-level cumulative prevalence

Transmission networks



- Potential networks vs realized network
- Questions
  - Who contacts whom, and where, for how long, how often, etc?
  - What type of contact is most risky? (e.g. physical proximity, indoor vs outdoor, duration, surfaces)
  - What setting is most important for transmission? (e.g. home, work, retail)
    - May depend on pre/post intervention, location, age, etc
  - How important is transmission in hospitals?
- Gold standard
  - Contact surveys; proximity tracking; contact tracing; genetic epidemiology
- Challenges: Privacy, resources, reporting infrastructure,

Healthcare requirements vs capacity

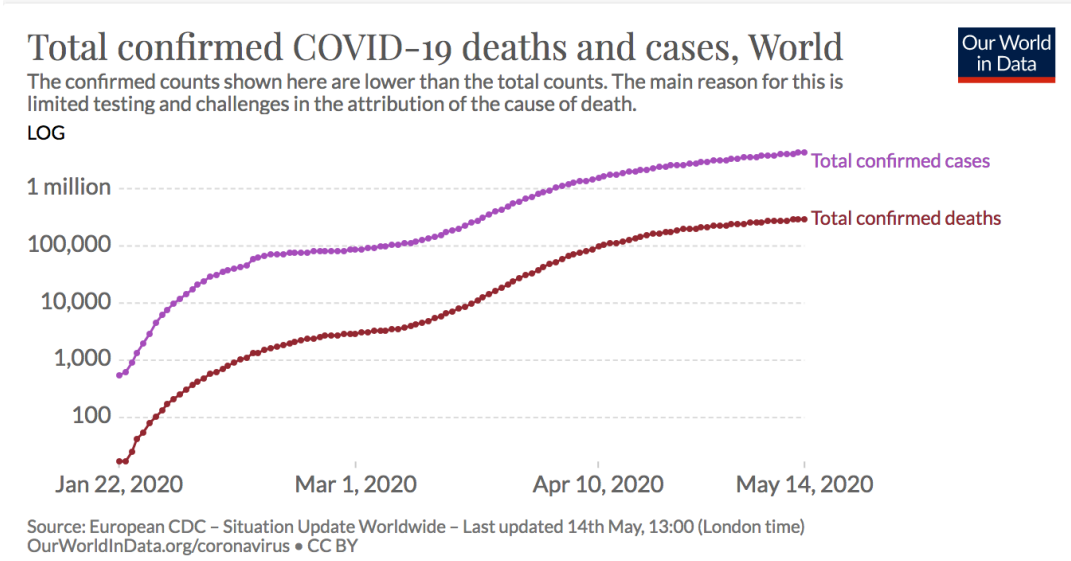
- Needs
  - % cases requiring different levels of care vs age, comorbidity
  - Baseline and surge capacity for PPE, hospital beds, ICU beds, ventilators, masks for the general public, etc
  - Staffing needs
  - Geographic variation in resources (esp. in rural areas, low-income countries)
  - Willingness/ability to access care
  - Impact on non-COVID19 health care delivery
- Gold standard
  - National databases tracking medical resources
  - Real-time reporting of COVID-19 utilization
- Challenges
  - Finding/compiling alternative data sources

Interventions (“non-pharmaceutical”)

- Includes: mask wearing, case isolation, quarantine, school closures, closing of retail/dining, work-from-home policies, stay-at-home orders, complete lockdown
- Questions
  - What is the evidence base for interventions?
  - What was implemented, when and where?
  - How much do they reduce contacts relevant to transmission?
  - What level of adherence is there to interventions?
  - Are they working? Which ones?
- Gold standard: RCTs, surveys, knowledge of transmission networks
- Challenges: Relating alternative data sources to modeled “proportion al reduction in transmission rate”

What about the data we currently have?

- Current data: cases + deaths by region
- Pros
  - easily accessible to anyone from a central source
  - simple metrics that people understand
  - reported from centralized, official sources
- Cons
  - no individual level data
  - delays in time of onset or time of death
  - Imperfect reporting/testing
  - outcome of infection unknown
  - who is in hospital/ICU?
  - detailed geographic or age info



Thanks!

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