In persona Simulation of Epidemics

Thomas Trikalinos   Jason Gantenberg

1/17/23

Epidemic simulation

Status quo

- Epidemic simulations are based on computer models

- Choice of model type depends on:
    - Goals / question asked
    - Granularity of available data

Research interests

We are interested in questions that require detailed information on who interacts with whom

What is the probability of an epidemic occurring in a school?

What is the effect of limiting class size on incidence or epidemic potential?

What is the effect of targeting vaccination or masking to specific individuals in a communal space?

Typical data sources

- We usually do not have detailed, real-time information on our target population

- Instead, we rely on:

  - Historical data

  - Retrospective recall

  - Aggregates and summaries

… and use these data to parameterize network generation models

⚠️ A Big Question

How well do these methods imitate what happens in reality?

ⓘ The Major Limitation

Methods used to grow networks or simulate contacts make strong assumptions regarding the generative processes that drive network formation.

We seek to reduce assumptions

- Reduce assumptions about how the patterning of human interactions arises

- Instead, observe humans' interactions (the original non-parametric data-generating mechanism)

> (i) **To What End?**
>
> - More realistically simulate epidemic and intervention scenarios
> - Evaluate how well typical statistical and algorithmic methods reconstruct observed interaction patterns

MAPPING@Brown

Fall 2023

School of Public Health
BROWN UNIVERSITY

Faculty
Staff
Students

Mapping exercise

- Track individuals' location and proximity to others using a **smartphone app**

- Infer contacts and **emulate** biologically plausible pathogen **transmission mechanisms**

- *In persona* simulation

Physics of Transmission

Emulate a plausible transmission mechanism

- Probability of infection proportional to pathogen load incurred

Infectious people

Deposit pathogens in the surrounding space

Susceptible people

Exposed to pathogens at different concentrations as they move

Data to record: location

- This mechanism implies that location (absolute position) data over time are important to collect.

- Location over time determines:

    - How an infectious person deposits pathogens

    - How a susceptible person becomes exposed to those pathogens

- Can simulate both direct and indirect transmission

- May be more difficult to record than pairwise distances

Data to record: pairwise distances

- Possibly easier to measure than location

- Can simulate direct transmission (not necessarily indirect)

Data needs

Record:

- Absolute location of each person over time (preferred)

- Pairwise distances between persons over time

(e.g., as inferred from device Bluetooth received signal strength or other data)

With this *in persona* simulation scheme

- We observe collocation patterns

- We make no statistical/computational assumptions about the network or its generative mechanism(s)

- Can emulate different respiratory pathogens

Challenges

Scientific

- Defining data required to measure network features (in real-time and post hoc)

- Developing contact definitions for multiple disease types

Technical

- Device capacities and limitations

- Battery life

- iPhone/Android implementations

- Transmitting data to MAPPS servers securely