Pandemic Outbreak Planner

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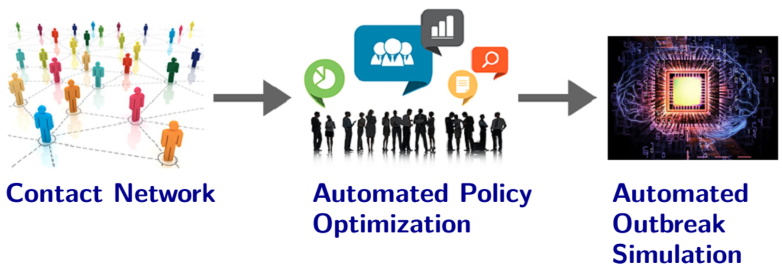
Challenge

General awareness of pandemic risks has been boosted by events over the past two decades, including:



- 1997: first report of Avian Influenza
- 2003: recognition of Severe Acute Respiratory Syndrome (SARS)
- 2009: pandemic of Influenza A (H1N1)
- 2012: first report of Middle East respiratory syndrome coronavirus (MERS-CoV)
- 2014: start of recent outbreak of Ebola haemorrhagic fever in West Africa, a disease first reported in 1976

In addition to minor outbreaks of cholera, Dengue haemorrhagic fever, Marburg virus fever, meningococcal disease, poliomyelitis, Rift Valley fever and yellow fever, among others, the World Health Organisation has also reported several outbreaks of unidentified diseases. Whether any of these unidentified diseases or other emerging diseases or disease variants will become global events is not predictable. The recent emergence of Ebola, H1N1, MERS-CoV and SARS has nevertheless highlighted needs to have regional and international policies and tools in place to mitigate potential impacts from pandemic events.

What can be tested in morPOP?

People
- Demographics
- Schools
- Workplaces
- Public transit
- Medical facility use
- Information spread
- Social distancing
- Compliance rates
- Absenteeism

Policies
- Vaccine/prophylaxis availability, prioritization, effectiveness
- Quarantines
- School closures
- Flu centres
- Gov't, societal costs

Diseases
- Attack rate
- Transmission rate
- Death rate
- Duration of infectiousness
- Age-specific, demographic-specific effects

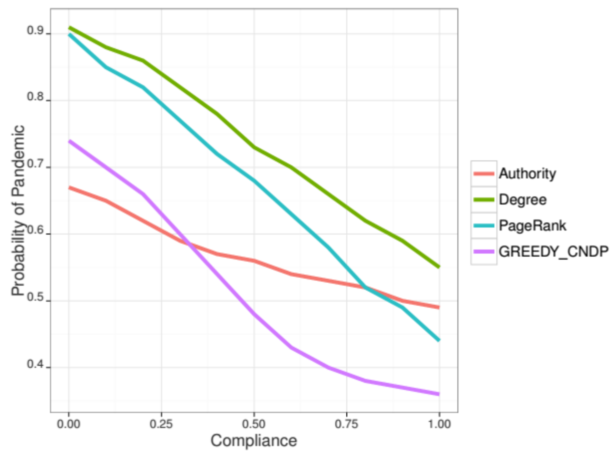
Methodology

morPOP is a computer-based model developed to simulate disease spread through a population, use graph theory to optimize public health policies for the purpose of mitigating outbreak impact, and answer what-if scenarios concerning pandemic spread. It surpasses existing models in accuracy and speed, and a graphical user interface is being added to facilitate implementation. Having C++ as its base code, morPOP is platform independent. Examples of questions that could be answered with the model include:

- Which age groups should be prioritized for vaccination?

- Does it matter if 60% of the population is vaccinated in 12 weeks v. 15 weeks?
- What if the vaccine is 95% effective instead of 98%?
- Under what conditions should a school or subway line be closed?
- Which policy is likely better, and by how much?
- Are flu centres worth the cost and resources in this city?

Results and Impact



Outputs from morPOP include population infection curves and optimised vaccination decision trees. The graph-theory approach (GREEDY CNDP) to vaccination prioritization was shown to be more robust than other measures in reducing the probability of pandemic with compliance to model policy outputs. The model could be effectively run on a desktop computer with 6.5 GB RAM, and runtime could be reduced by over 50% using a supercomputer. Work is continuing to fine-tune policy optimization, comparison of data and strategies across cities with considerations given to their infrastructure, sensitivity analysis, and integration with Excel.

Partner Profile

Interested parties have include Infonaut (health technology company in Toronto), OAHPP (Ontario Agency for Health Protection and Promotion), and SOSCIP (Southern Ontario Smart Computing Innovation Platform, research consortium). We are grateful to SOSCIP for providing access to an IBM Blue Gene supercomputer infrastructure for testing morPOP. We are currently seeking corporate partners to customize inputs and outputs for the model to enhance its application, and to fund relevant graduate student projects.

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