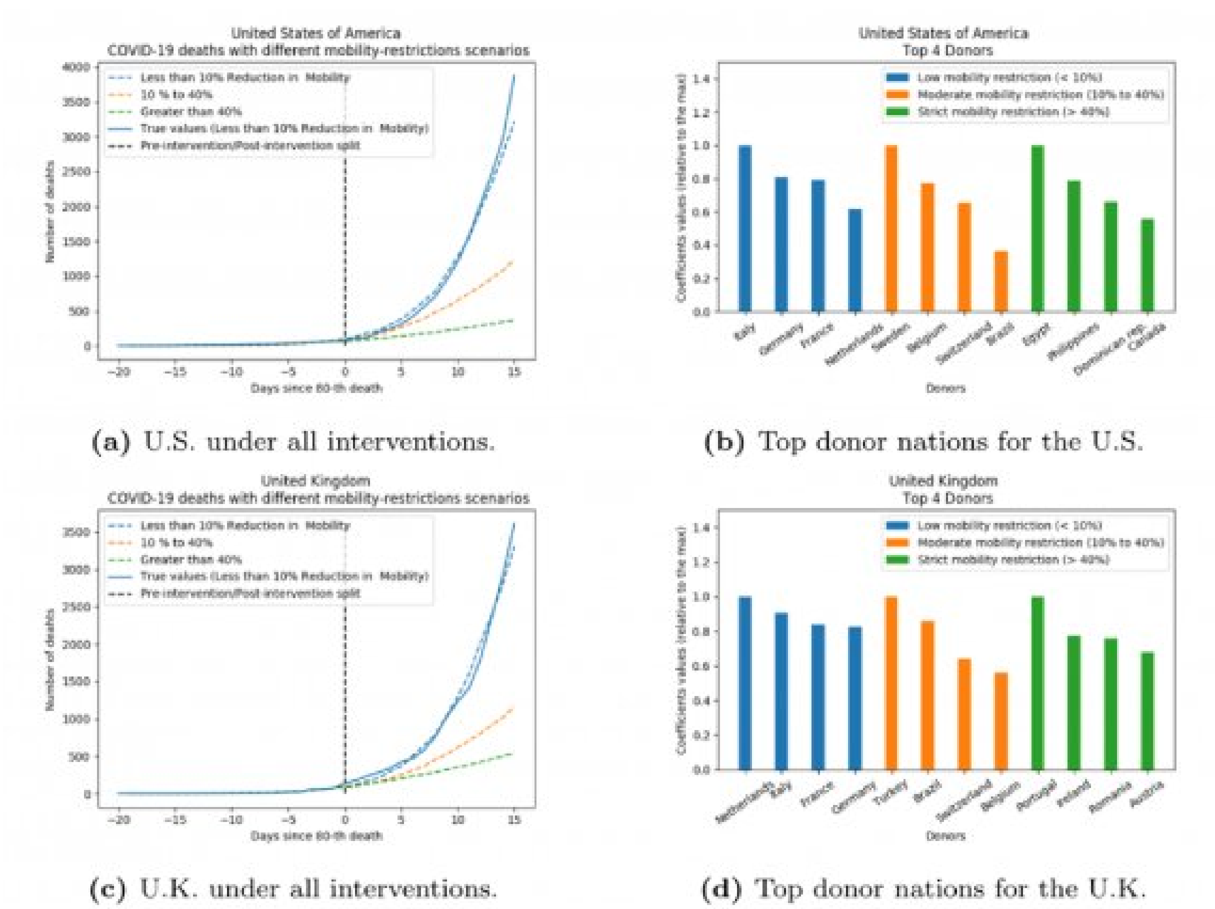
Collaboration informs coronavirus policy by analyzing data associated with the pandemic

May 18 2020, by Scott Murray



(a) U.S. under all interventions. (b) Top donor nations for the U.S.

(c) U.K. under all interventions. (d) Top donor nations for the U.K.

Isolat researchers have designed and applied a method to model policy impact that they call "Synthetic Interventions." Based on the statistical method synthetic control, Synthetic Interventions is a data-driven way to perform what-if scenario planning, leveraging information from interventions that have been enacted around the world and fitting it to another setting. Credit: Massachusetts Institute of Technology collaboration informs coronavirus policy by analyzing data associated with the pandemic

The COVID-19 pandemic continues to challenge how societies and institutions function at macro and micro scales. In the United States, the novel coronavirus has affected everything from the economy to elections—and has raised difficult questions about MIT's capacity to reopen in the fall.

To help policymakers at MIT and beyond make informed decisions, the Institute for Data, Systems, and Society (IDSS) has formed a volunteer research group, Isolat, that provides analysis of pandemic-related data.

"This pandemic has energized the broader IDSS community to bring crucial skills to bear," says IDSS Director Munther Dahleh, a professor of electrical engineering and computer science (EECS). "Probability and statistics are tools for measuring uncertainty, and we have expertise within IDSS in using scientific information to impact policymaking."

The IDSS COVID-19 collaboration (Isolat) consists of MIT faculty, students, and researchers from different departments, as well as partners from around the world. Isolat members are statisticians, epidemiologists, data modelers, and policy researchers.

"There is strong IDSS representation in Isolat, from the Technology and Policy Program (TPP) and Statistics and Data Science Center (SDSC) to the Laboratory for Information and Decision Systems (LIDS)," says Dahleh. "This effort is driven by our community's sense of social responsibility, both within IDSS and across MIT. And it's given us a way to connect and build community in a time when we are far apart."

Real time, noisy data

While there are a lot of data available related to COVID-19, there are also many questions about how complete or useful that data really are. The Isolat group is careful to identify the limits of what existing COVID-19 data can do. "Data is always useful, even if it's noisy," argues Dahleh.

All the same, without widespread, randomized testing, it's difficult for anyone to know the full extent of coronavirus spread. "We need to ask better questions that the data can answer," adds Anette "Peko" Hosoi, an IDSS affiliate who is both a professor of mechanical engineering and associate dean of engineering.

The Isolat group formed teams around three primary needs, each determined in consultation with stakeholders at MIT and the broader community. The Prediction team uses data on time-dependent variables to forecast infection growth rates and when the incidence of new cases should peak. The Intervention team strives to understand and quantify the outcomes of various policies and model "what-if" scenarios in order to make effective recommendations. The Data Infrastructure team gathers, organizes, and shares relevant data—early on they built a "data lake" to consolidate important datasets that are kept updated with Python scripts.

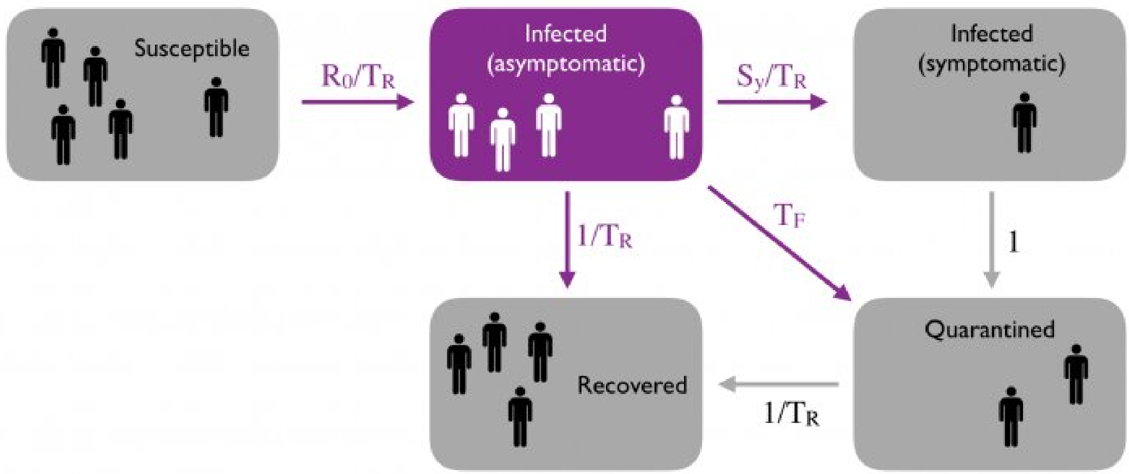
Isolat meets every weekday via teleconference to discuss and vet projects and findings, which are published twice a week to the Isolat webpage. This kind of cross-disciplinary collaboration is typical of IDSS research, but the real-time dissemination of findings is a departure from academic methodology.

"This is a different way of tackling the problem," says Hosoi. "Everybody throws their contribution into the ring. We need answers today."

All the same, the group is mindful that the need for urgency does not eliminate the need for accuracy. "Quantification of the uncertainty in our results is key to providing actionable outcomes," adds Hosoi. "We look forward to engaging the larger scientific community to make these findings more precise."

IDSS has also mobilized policy expertise to support Isolat researchers as they work to make their findings useful to MIT leaders and local governments. "We can help researchers think more critically about the ways in which their research is relevant to decision-making, when and with whom to engage, and what questions to ask" says Noelle Selin, a professor with IDSS and the Department of Earth, Atmospheric, and Planetary Sciences who is director of TPP.

Under their Research to Policy Engagement Initiative, TPP has begun hosting discussions with IDSS and LIDS faculty who are engaged with local communities to help them refine the kinds of questions they can answer for policymakers.



Researchers with the IDSS COVID-19 Collaboration (Isolat) are designing a control model for testing and isolating members of communities like MIT's to reduce COVID-19 infection. Credit: Massachusetts Institute of Technology

Policy evaluation and what-if scenarios

The available data on COVID-19 infection rates and deaths can indicate how fast those rates are changing, and it can indicate which interventions are more or less effective. This means Isolat researchers can not only measure the effectiveness of current policy, but forecast the potential impact of new policies or policy changes.

To that end, Isolat researchers have designed and applied a method to predict policy impact that they call "Synthetic Interventions." Leading this project is Devavrat Shah, an EECS professor and member of LIDS who directs the SDSC within IDSS.

"Having a clear understanding of the trade-offs between interventions is crucial in charting a path forward on how to open up various sectors of society," says Shah. "A key challenge is that policymakers do not have the luxury of actually enacting a variety of interventions and seeing which has the optimal outcome."

Based on a statistical method called synthetic control, the Synthetic Interventions method is a data-driven way to perform what-if scenario planning. The method leverages information from interventions that have already been enacted across the world, and fits this information to a policymaker's setting of interest.

For example, to estimate the effect of mobility-restricting interventions on the United States, Shah and his team used daily death data from countries with more extreme mobility restrictions to create a "synthetic low-mobility U.S." and project the "counterfactual trajectory"—what could have happened—if the U.S. had applied similar interventions.

"The good news," says Shah, "is that so far our models suggest that moderate, precise restrictions in mobility, in particular at retail and transit locations, could play a key role in flattening the curve."

Are curves flattening?

Another use of COVID-19 data is to model the growth and spread of the disease and predict when curves will flatten—when cases of the coronavirus will slow their exponential growth.

At first, Prediction team researchers looked at disease spread in U.S. states. But the availability of case count data at the county-level in the United States allowed Isolat researchers to model growth more granularly by fitting an exponential of a quadratic function to the cumulative number of cases reported in each county.

"This analysis gives us a sense of how the epidemic spread varies within a state," says Hamsa Balakrishnan, an IDSS affiliate who is both a professor and associate department head of aeronautics and astronautics. "A state or the nation as a whole may not be homogeneous in how the epidemic spreads."

Northern and southern California, for example, present two different pictures of spread when looked at county-by-county, suggesting that state officials should not necessarily apply one-size-fits-all policy solutions across the state. Similar differences can be seen in Massachusetts as well; Suffolk, Middlesex, and Norfolk counties all show a longer time to plateau than other counties in the state.

Adds Balakrishnan: "Considering the influence of factors such as population density, demographics, neighboring counties, geography, and mobility can provide insights into the spread of COVID-19."

Impacting policy

With daily meetings, two new posts per week, evolving groups and subteams, and new members joining each week, Isolat is a dynamic and uniquely MIT approach to the coronavirus crisis. But the group remains oriented around its purpose: to inform policymakers with data-driven recommendations.

As Isolat researchers apply different approaches to seek answers to questions at larger scales, the group is also exploring questions related to reopening the MIT campus, and sharing information with others at MIT including the Team 2020 planning group and the We Solve For Fall project. The Isolat group has applied control theory to the problem, looking at the campus as a dynamic network.

"Ultimately, the ingredients of control will be testing, distancing, and quarantining," says Dahleh. "Testing is huge. If we don't have a cure or a vaccine, testing and quarantining is the only way we can control the spread of infection."

Isolat researchers are informing MIT leaders, as well as building connections with local and state governments, advising groups abroad, and coordinating with engineers who are designing apps and solutions to pandemic challenges. They will continue to share their findings on the Isolat webpage.

More information: idss.mit.edu/research/idss-cov … ollaboration-isolat/

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