Network Science Institute
at Northeastern University

Examining the Long-term Effects of COVID-19 Through Groundbreaking Research

As the world copes with COVID-19, faculty researchers at Northeastern's Network Science Institute are leading efforts to study how the virus is reshaping science, politics, and social issues—and examining how the virus may influence our lives for years to come.

MODELING THE SPREAD OF COVID-19 AND EVALUATING CONTROL STRATEGIES

When the fight against COVID-19 began, stringent social distancing, robust testing, contact tracing, and quarantining helped to control the virus's spread long enough to allow some social and economic activity to restart. Months on, researchers continue to track the virus and are simulating and assessing the impact of mitigation strategies. Leading these efforts is **Alessandro Vespignani,** director of the Network Science Institute and the Sternberg Family Distinguished University Professor.

Vespignani is collecting data from mobile devices and census records to create a sample of the synthetic population of the Boston metropolitan area. This model explores scenarios of how COVID-19 may spread in the future, and examines ways to mitigate more severe outbreaks while reopening the economy and society. The study's results use two different scenarios: LIFT and LET. In the LIFT scenario, the stay-at-home order is lifted after eight weeks and all work and community places, except for restaurants, theaters, schools, and similar locations with mass gatherings, are reopened. In the LET scenario, the same stay-at-home order is lifted after eight weeks and the same places are reopened, in conjunction with significant contact tracing and precautionary quarantining of potentially exposed individuals. Those individuals, along with their households, would be quarantined.

The study shows that when 40 percent or more of the contacts of people with detected COVID-19 symptomatic infections are traced, and those households are quarantined, the reduction in transmission leads to a noticeable flattening of the epidemic curve. And importantly, this approach appears to effectively limit the virus's resurgence. If the LET scenario is implemented with crowd control, working from home, and mask wearing, it could lead to a further decline of virus transmissibility. This scenario also allows for loosening social distancing measures while retaining hospital demands at levels close to availability and capacity. Vespignani's study demonstrates a method for managing and mitigating the spread of COVID-19, while continuing to reopen society without suffering significant economic losses, widespread social disruptions, or a healthcare system collapse.

The Bill and Melinda Gates Foundation has selected Vespignani's MOBS Lab to model the outcomes of two scenarios of vaccine distribution. In the first scenario, 50 high-income countries monopolize limited doses of the COVID-19

vaccine; in the second, doses are distributed based on each country's population. The lab's results show that cooperation between countries is the most effective way to minimize the global death rate: 61 percent of deaths could be avoided if the vaccine is distributed to all countries proportional to population, versus 33 percent of deaths avoided if high income countries receive the vaccine first. "You see immediately that the second scenario is far superior," says Vespignani.

In a new, data-driven model, the MOBS Lab affirms that global collaboration is necessary to paint a comprehensive picture of the COVID-19 outbreak and forecast future epidemics. The lab is drawing from global public sources–everything from census figures to data sets about where people work and who they live with–to identify interpersonal behavior down to the state or province level. By splitting populations into smaller settings, epidemiologists and public health officials will be better able to make informed decisions about which disease interventions would be most effective in specific regions.

COLLABORATING WITH THE GLOBAL COMMUNITY IN THE FIGHT AGAINST COVID-19

Samuel Scarpino, assistant professor and director of the Emerging Epidemics Lab has been collecting data and creating models forecasting the spread of COVID-19. Since the outbreak of the virus, it has been difficult to collect data due to regulations and mandates regarding data-sharing agreements between member countries of the World Health Organization. Because of this, a new international consortium, in which Northeastern plays a major part, was created to build a comprehensive data set.

Researchers and professors worldwide began contributing vast amounts of health data, epidemiologic data, and other records to provide information about COVID-19. Engineers, designers, and product managers have also been offering support with overseeing the technology and infrastructure of the database–and about two million individual records from 150 countries have been entered.

Scarpino and his team are using the information gathered from the international consortium to build and tailor COVID-19 models specifically for the benefit of the city of Boston and the state of Massachusetts. He hopes to provide local and state leaders and lawmakers with accurate information in order to successfully manage the pandemic.

In addition to being a researcher, Scarpino has become an advocate for and communicator of science. He translates data into insights for members of the media, including news anchors, to stress the importance of using scientific data in the battle to combat COVID-19.

"We are providing information, data points, and model forecasts to aid and support decision making," says Scarpino. "It is to paint a picture and provide the resources necessary for policymakers to make the decisions on how they want to move forward to best protect their populations, try to support the economy, and ensure that individuals have the health services that they need."

REPURPOSING DRUGS TO FIND A CURE FOR COVID-19

As the COVID-19 pandemic continues, researchers are working to develop pharmaceutical drugs that slow the virus's reach and may cure those who are infected. But what if promising therapies already exist? Scientists are racing

to identify approved and experimental drugs that may benefit patients, and network medicine is our most powerful platform to identify candidate therapies.

Albert-László Barabási, Robert Gray Dodge Professor of Network Science, Distinguished Professor of Physics, and director of the Center for Complex Network Research, has assembled a multidisciplinary team that uses network medicine to hunt for a COVID-19 treatment. Barabási is exploring repurposing approved drugs with known toxicity and side effects that may have a therapeutic effect on COVID-19 patients.

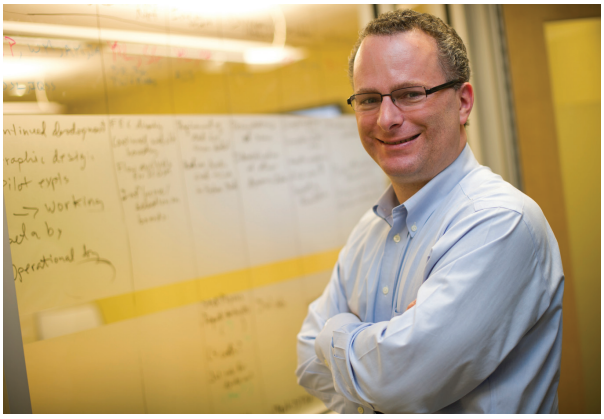
Last year, the Barabási Lab began re-curating its past work on the human interactome, an intracellular and intercellular network of protein interaction. Less than 10 days after starting, the team identified 40 medications that target the cellular areas where COVID-19 works. The virus latches on to a healthy cell's proteins, then disrupts functions within that cell and generates millions more copies of itself. The lab developed a network model of the 332 proteins targeted by COVID-19 and examined how the virus's perturbing activity might affect tissues and organs. Using this model to examine how COVID-19 binds with host proteins, the lab predicted that the virus could attack cells in the brain–which may explain why early symptoms in people with COVID-19 include loss of the senses of smell and taste.

After forecasting the cellular progression of COVID-19, Barabási began looking for drugs and experimental compounds that could fight the virus by targeting proteins in its network vicinity. Through computation, network modeling, and experimental validation, he hopes to better locate candidate therapies, understand the virus's spread, and observe how repurposed drugs can target areas where the virus works.

HOW COVID-19 IS CHANGING PUBLIC OPINIONS OF CURRENT EVENTS

The COVID-19 pandemic has brought to light rapidly changing public opinions of social and political issues. **David Lazer,** University Distinguished Professor of Political Science and Computer and Information Science, is part of a research team collaborating on **The State of the Nation: A 50-State COVID-19 Survey.** This continuing series of surveys studies the opinions of Americans of different races, genders, political affiliations, and locations around issues such as school reopenings, voting by mail, and protests, and how those opinions change over time as the pandemic persists.

In the survey, Lazer found that the environment created by COVID-19 dramatically affected voting preferences in the 2020 U.S. presidential election. Respondents who are concerned about the virus were more likely to support voting by mail than those who are not. People did not want to risk their health or lives by voting in person. There were also differences in views across the country: The West Coast showed strong approval of voting by mail, while the Deep South showed the least support. Although majorities of people in nearly every state supported voting by mail, Lazer and his team continued to survey respondents as the number COVID-19 cases surged in some states to measure how opinions changed as case numbers fluctuated.



Another survey gauged public approval and disapproval of the responses by state governors and President Donald Trump to the pandemic. In summer 2020, governors of states hit hard by the virus in its early stages retained higher ratings than other governors of states affected later. Governor Doug Ducey of Arizona faced the lowest ratings of all 50 governors due to his choosing to reopen the state in May, when many citizens were against it. President Trump's response to the pandemic was rated lower than any governor's, and Lazer predicted that his reelection would be heavily dependent on the nation's battle with the coronavirus.

By gathering this data, Lazer shows the wide variety of opinions held by different groups and explores what sociopolitical issues may continue to change as a result of the COVID-19 crisis in the years to come.

THE NEW NORMAL: ADJUSTING TO WORKING FROM HOME

When businesses and offices shut their doors in March 2020 amid the COVID-19 pandemic, managers sent their employees home to work remotely for what was thought to be a short period of time. But then, the virus spread across the country and stay-at-home orders remained in place. **Christoph Riedl,** associate professor and core faculty member at the Network Science Institute, has been studying how people have been adjusting to the new reality that has resulted from the crisis.

While working from home, employees have been finding ways to balance their professional responsibilities along with their personal lives and childcare. Further, managers have been adapting to support their teams over the long haul to prevent burnout. An experiment conducted by Riedl shows the method of creating shared rhythms–a form of maintaining routine throughout the day–was an effective way to help employees complete their work. Shared rhythms clearly define when to start and stop work, and when to work alone and collectively. Riedl's research demonstrates that "bursty" communication, the rapid back and forth exchange of ideas in a group before parting for solo work was most effective for productivity.

Riedl is also collaborating with researchers at MIT to create Minglr, a new video chat service that can be added to programs like Zoom or Skype. It was developed when research showed that employees missed the ad hoc, spontaneous meetings they used to have with co-workers in the office. Such random interactions help build trust, and can lead to creative breakthroughs and fresh ideas. With Minglr, these exchanges can be part of everyday life again, but virtually. To use Minglr, users sign up on the website, list their interests, and set limits to who they are open to meeting with and talking to. If one user sees another who has similar interests, they can request to chat; if the second user accepts, they start a one-on-one video call. The system was tested at an MIT virtual conference in June, where it was well received and may be used in the future.

While the COVID-19 crisis shows no signs of waning, life will continue to change and people will continue adapting to "the new normal." Through Riedl's work, managers and employees have more ways to address and surmount challenges posed by remote work and can establish new norms within teams.

To learn more about faculty research at the Network Science Institute, contact Assistant Vice President of Advancement James Poulos at 617.373.2015 or j.poulos@northeastern.edu.