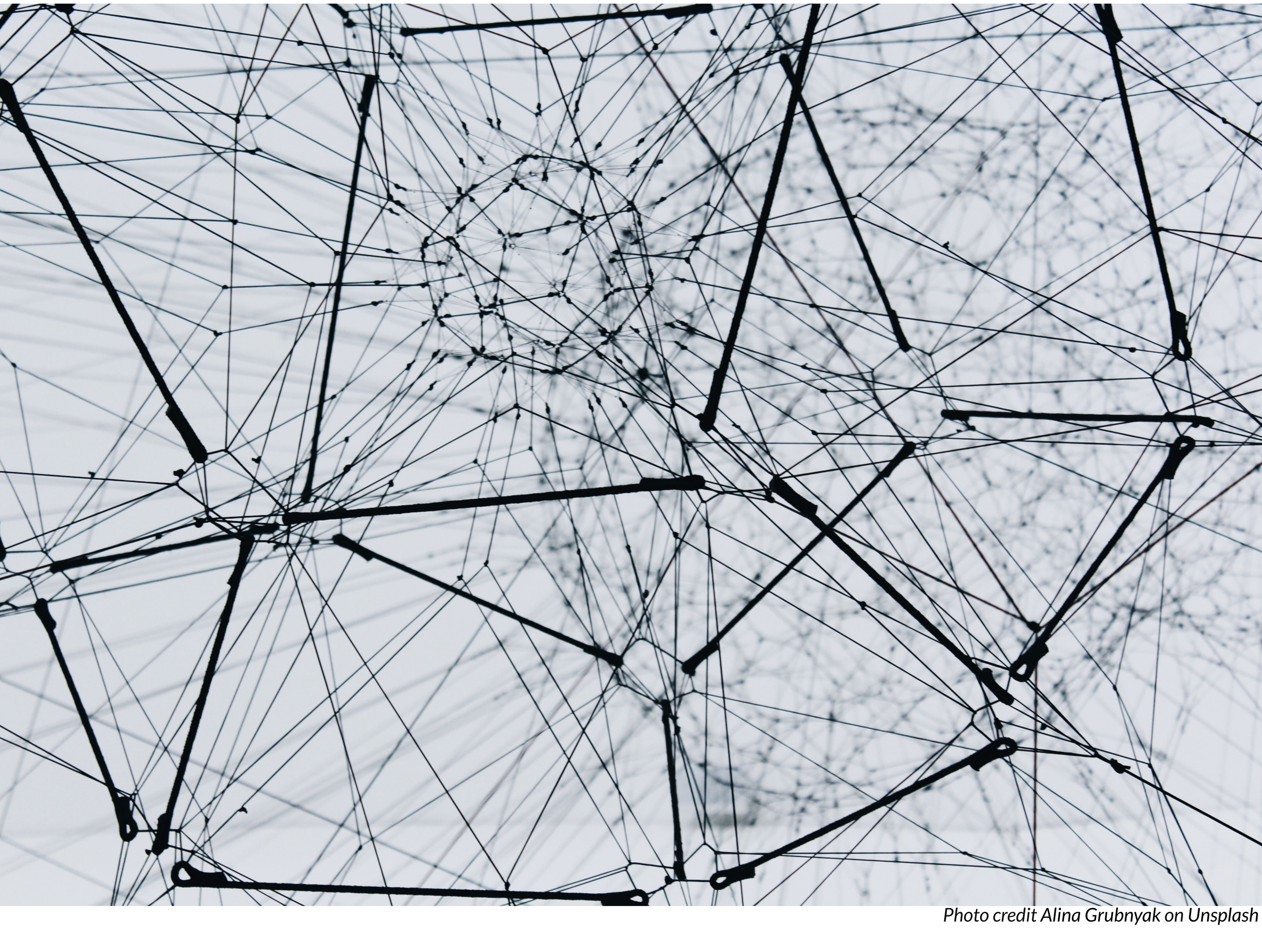
July 2020

CompEpi Quarterly

Newsletter of the Global Pervasive Computational Epidemiology project



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Welcome!

Welcome to our inaugural GPCE newsletter. For more than a decade, the NSF Expeditions in Computing program has supported scientists who extend the frontiers of consequential and complex research problems, providing solutions that improve the lives of millions of people around the world.

Our NSF Expeditions project started in the midst of the global COVID-19 pandemic, the likes of which the world has not seen since 1918. The social, economic, and health impacts of the pandemic continue to grow. These are hard times for all, from healthcare workers to public safety officers, from students to teachers, and from factory owners to workers. The NSF Expeditions program offers a unique opportunity and responsibility to develop a transdisciplinary community to address the complex problems that we face as we plan and respond to the COVID-19 pandemic and future pandemics --- an opportunity to serve the community and develop cutting-edge technologies to support the ongoing COVID-19 response and to do this in a responsible manner, ensuring that our methods and work lead to solutions that are fair, equitable, and understandable. Our collaborative work is more important than ever in the midst of COVID-19.

In an effort to communicate the work we do amongst our team and the broader public health community, we have decided to publish a quarterly newsletter. The newsletter takes a small step in achieving our vision, which is to develop cutting edge computational technologies and evidence-based policy recommendations that will lead to a reduction in the global burden of infectious diseases. In each issue of this newsletter, you'll find the link to our YouTube channel where you can watch our Seminar Series and learn about our Spotlight Students and Researchers. You'll learn about upcoming events and see the publications we have produced. And you'll read thoughts and ideas from our team members.

On behalf of the entire team, I want to thank you all for your participation and look forward to future issues of the newsletter.
Stay safe.

Madhav

Seminar Series - 9 July 20

Click here to watch on YouTube

Projecting hospital utilization and assessing implications of silent transmission during the COVID-19 outbreak in the United States

In the early phase community COVID-19 transmission in the United States, there was a growing public health concern regarding the adequacy of resources to treat infected cases. We developed and parameterized a dynamical transmission model for COVID-19 with the United States population demography to project the timing of the outbreak peak and hospital capacity required at the peak. In the absence of self-isolation, we estimated that the treatment of critically ill individuals would require 3 times more ICU beds and more than 40,000 additional ventilator units at the outbreak peak than the existing capacity for an R0 of 2.5. Self-isolation by 20% of cases 24 h after symptom onset was estimated to delay and flatten the outbreak trajectory, reducing the number of ICU beds needed at the peak by half, although still exceeding existing capacity. Our results highlighted the need of immediate social distancing mitigation approaches to delay and flatten the peak as well as emergency expansion of hospital facilities. After a period of unprecedented social distancing measures implemented worldwide, the socio-economic repercussions have fuelled calls to lift these measures. In the absence of population-wide restrictions, isolation of infected individuals would be the key to curtailing transmission. However, the effectiveness of symptom-based isolation in preventing a resurgence depends on the extent of pre-symptomatic and asymptomatic transmission. We evaluated the contribution of presymptomatic and asymptomatic transmission based on a recent individual-level data regarding infectiousness prior to symptom onset and asymptomatic proportion among all infections. Our results indicate that the majority of incidence and may be attributable to silent transmission from a combination of pre-symptomatic stage and the asymptomatic infections. Therefore, symptom-based isolation must be supplemented by rapid contact tracing and testing that identifies asymptomatic and presymptomatic cases in order to safely lift current restrictions and minimize the risk of resurgence.

Dr. Alison Galvani

Dr. Abhishek Pandey

Professor Alison Galvani received her B.A. in Biological Sciences in 1998 and a D. Phil. in Theoretical Epidemiology in 2002 from University of Oxford. Following a fellowship at UC Berkeley she was recruited to Yale in 2004, rising through the ranks and became one of the institution's youngest-ever tenured faculty members in 2009, at the age of 33. She was a 2012 recipient of the Blavatnik Award for Young Scientists from the New York Academy of Sciences. Other honors include a Guggenheim Fellowship, American Society for Naturalists Young Investigator Prize and the Bellman Prize. She has published over 200 papers, many in high-impact venues including Science, Nature, PNAS and The Lancet. Her work has impacted myriad diseases, including several neglected diseases, and spanned global locations including the US, UK, Brazil, and Africa.

Dr. Abhishek Pandey has a master's in Applied Mathematics from the Indian Institute of Technology (IIT) Roorkee and he received his Ph.D. from Clemson University with a focus on infectious disease modeling. As a mathematical epidemiologist, he is interested in integrating applied mathematics, epidemiology and health economics to inform public health interventions for infectious disease control in developing countries. Abhishek has worked on a variety of infectious diseases including dengue, Ebola and sleeping sickness and published in prestigious journals including Science, Lancet HIV, and PNAS.

Seminar Series - 25 June 20

Click here to watch on YouTube

Climate, Oceans, and Human Health: Cholera as a Paradigm for Predicting Infectious Diseases

Climate and the oceans historically have been closely intertwined with human health. Today significant advances in information technology have brought new discoveries - from the outer reaches of space, where remote sensing monitors on satellites circle the earth, to the ultramicroscopic through application of next generation sequencing and bioinformatics. *Vibrio cholerae* provides a useful example of the fundamental link between human health and the oceans. This bacterium is the causative agent of cholera and is associated with major pandemics, yet it is a marine bacterium with a versatile genetics and is distributed globally in estuaries throughout the world, notably the Bay of Bengal, but also in coastal regions and aquatic systems of the world. Vibrio species, both nonpathogenic and those pathogenic for humans, marine animals, or marine vegetation, play a fundamental role in nutrient cycling. They have also been shown to respond to warming of surface waters of the North Atlantic, with increase in their numbers correlated with increased incident of vibrio disease in humans. The models we have developed for understanding and predicting outbreaks of cholera are based on work done in the Chesapeake Bay and the Bay of Bengal and these models are now used by UNICEF and aid agencies to predict cholera in Yemen and other countries of the African continent. With onset of COVID-19, these models are currently being modified to predict SARS CoV-2 and incidence of COVID-19, the current pandemic of coronavirus. In summary, molecular microbial ecology coupled with computational science can provide a critical indicator and prediction of human health and wellness.

Dr. Rita Colwell

UNIVERSITY OF MARYLAND

Dr. Rita Colwell's interests are focused on global infectious diseases, water, and health and Dr. Colwell developed an international network to address emerging infectious diseases and water issues, including safe drinking water for both the developed and developing world, in collaboration with Safe Water Network, headquartered in New York City. Dr. Colwell served as the 11th Director of the National Science Foundation, 1998-2004. In her capacity as NSF Director, she served as Co-chair of the Committee on Science of the National Science and Technology Council. One of her major interests includes K-12 science and mathematics education, graduate science and engineering education, and increased participation of women and minorities in science and engineering. Dr. Colwell served as President of the University of Maryland Biotechnology Institute and Professor of Microbiology and Biotechnology at the University Maryland. She was also a member of the National Science Board from 1984 to 1990.

Dr. Colwell has been awarded 63 honorary degrees from institutions of higher education, including her Alma Mater, Purdue University and is the recipient of the 2005 Order of the Rising Sun, Gold and Silver Star, bestowed by the Emperor of Japan, the 2006 National Medal of Science awarded by the President of the United States, the 2010 Stockholm Water Prize awarded by the King of Sweden, the 2017 Vannevar Bush Award from the National Science Foundation, the 2017 International Prize for Biology from the Japan Society for the Promotion of Science, the 2017 Chevalier de la Légion d'Honneur ("Knight of the Legion of Honor") bestowed by the Ambassador of France, and the 2018 Lee Kuan Yew Water Prize of Singapore. Dr. Colwell is an honorary member of the microbiological societies of the UK, Australia, France, India, Israel, Bangladesh, and the U.S. and has held several honorary professorships, including the University of Queensland, Australia. A geological site in Antarctica, Colwell Massif, has been named in recognition of her work in the Polar Regions.

Dr. Colwell has held many advisory positions in the U.S. Government, nonprofit science policy organizations, and private foundations, as well as in the international scientific research community. She is a nationally-respected scientist and educator, and has authored or co-authored 19 books and more than 800 scientific publications. She produced the award-winning film, *Invisible Seas*, and has served on editorial boards of numerous scientific journals. She serves as Chair of the Research Board for the Gulf of Mexico Research Initiative (2010-2020).

Dr. Colwell has previously served as Chairman of the Board of Governors of the American Academy of Microbiology and also as President of the American Association for the Advancement of Science, the Washington Academy of Sciences, the American Society for Microbiology, the Sigma Xi National Science Honorary Society, the International Union of Microbiological Societies, and the American Institute of Biological Sciences (AIBS). Dr. Colwell is a member of the U.S. National Academy of Sciences, the Royal Swedish Academy of Sciences, Stockholm, the Royal Society of Canada, the Royal Irish Academy, the Bangladesh Academy of Science, the Indian Academy of Science, the American Academy of Arts and Sciences, and the American Philosophical Society.

Born in Beverly, Massachusetts, Dr. Colwell holds a B.S. in Bacteriology and an M.S. in Genetics, from Purdue University, and a Ph.D. in Oceanography from the University of Washington.

Seminar Series - 11 June 20

Click here to watch on YouTube

Optimal, near-optimal, and robust epidemic control

Dylan H. Morris, Fernando W. Rossine, Joshua B. Plotkin, Simon A. Levin

The COVID-19 pandemic has highlighted the need for control measures that reduce the epidemic peak ("flattening the curve"). Here we derive the optimal time-limited intervention for reducing peak epidemic prevalence in the standard Susceptible-Infectious-Recovered (SIR) model. We show that alternative, more practical interventions can perform nearly as well as the provably optimal strategy. However, none of these strategies are robust to implementation errors: mistiming the start of the intervention by even a single week can be enormously costly, for realistic epidemic parameters. Sustained control measures, though less efficient than optimal and near-optimal time-limited interventions, can be used in combination with time-limited strategies to mitigate the catastrophic risks of mistiming.

Dylan H. Morris's principal research interests are in eco-evolutionary dynamics. He is currently focused on the evolution of RNA viruses, and how they are shaped by ecological processes within and between hosts. He also works on spatial self-organization in ecological communities. Additional research interests include Bayesian statistical approach to ecology and evolution research and the directedness – or historical contingency – of adaptive evolution. He greatly enjoys supervising undergraduate projects and is always eager to hear from students interested in doing research.

Simon A. Levin is the James S. McDonnell Distinguished University Professor in Ecology and Evolutionary Biology at Princeton University and the Director of the Center for BioComplexity in the Princeton Environmental Institute. His research examines the structure and functioning of ecosystems, the dynamics of disease, and the coupling of ecological and socioeconomic systems. Levin is a Fellow of the American Academy of Arts and Sciences and the American Association for the Advancement of Science, a Member of the National Academy of Sciences and the American Philosophical Society, and a Foreign Member of the Istituto Veneto di Scienze, Lettere ed Arti, and the Istituto Lombardo (Milan). He has over 500 publications and is the editor of the *Encyclopedia of Biodiversity* and the *Princeton Guide to Ecology*. Levin's awards include: the Heineken Prize for Environmental Sciences, Kyoto Prize in Basic Sciences, Margalef Prize for Ecology, the Ecological Society of America's MacArthur and Eminent Ecologist Awards, the Luca Pacioli Prize (Ca'Foscari University of Venice), the Tyler Prize for Environmental Achievement, and the National Medal of Science.

PRINCETON UNIVERSITY

Join our Seminar Series the 2nd & 4th Thursday of every month!

7/23 B. Aditya Prakash, Georgia Tech
8/13 Naren Ramakrishnan, Virginia Tech
8/27 Kathy Alexander, Virginia Tech
9/10 Anil Vullikanti, UVA

Would you like to present at a future Seminar?
Email Golda and Erin with your availability, title, and abstract.

Publications & Presentations

Our team has been busy supporting the challenges of real-time epidemic science, particularly pertaining to the COVID-19 Pandemic.

Publications

Cocooning is essential to relaxing social distancing. *medRxiv*. Wang X, Du Z, Huang G, Pasco R, Fox S, Galvani A, Pignone M, Johnston SC, Meyers L (2020)
Impact of Social Distancing Measures on COVID-19 Healthcare Demand in Central Texas. *medRxiv*. Wang X, Pasco R, Du Z, Petty M, Fox S, Galvani A, Pignone M, Johnston SC, Meyers L (2020)
The imperative for universal healthcare to curtail the COVID-19 outbreak in the USA. *EClinicalMedicine*. Galvani A, Parpia A, Pandey A, Zimmer C, Kahn J, Fitzpatrick M (2020)
COVID-19 on the African Continent. *The Lancet Infectious Diseases*. Wells C, Stearns J, Lutumba P, Galvani A (2020)
Proactive social distancing mitigates COVID-19 outbreaks within a month across 58 mainland China cities. *medRxiv*. Du Z, Xu X, Wang L, Fox S, Cowling B, Galvani A, Meyers L (2020)
Temporal estimates of case-fatality rate for COVID-19 outbreaks in Canada and the United States. *CMAJ*. Abdollahi E, Champredon D, Langley J, Galvani A, Moghadas S (2020)
Projecting the demand for ventilators at the peak of the COVID-19 outbreak in the USA. *The Lancet Infectious Diseases*. Wells C, Fitzpatrick M, Sah P, Shoukat A, Pandey A, El-Sayed A, Singer B, Moghadas S, Galvani A (2020)
Projecting demand for critical care beds during COVID-19 outbreaks in Canada. *CMAJ, 192(19):E489-496*. Shoukat A, Wells C, Langley J, Singer B, Galvani A, Moghadas S (2020)
Implementation of Syringe Services Programs to Prevent Human Immunodeficiency Virus Transmission in Rural Counties in the United States: A Modeling Study. *Clinical Infectious Diseases, 70(6):1096-1102*. Goedel W, King M, Lurie M, Galea S, Townsend J, Galvani A, Friedman S, Marshall B (2020)
Projecting hospital utilization during the COVID-19 outbreaks in the United States. *PNAS, 117(16):9122-9126*. Moghadas S, Shoukat A, Fitzpatrick M, Wells C, Sah P, Pandey A, Sachs J, Wang Z, Meyers L, Singer B, Galvani A (2020)
Impact of international travel and border control measures on the global spread of the novel 2019 coronavirus outbreak. *PNAS, 117(13):7504-7509*. Wells C, Sah P, Moghadas S, Pandey A, Shoukat A, Wang Y, Wang Z, Meyers L, Singer B, Galvani A (2020)
Pooling RT-PCR or NGS samples has the potential to cost-effectively generate estimates of COVID-19 prevalence in resource-limited environments. *medRxiv*. Narayanan K, Frost I, Heidarzadeh A, Tseng K, Banerjee S, John J, Laxminarayan R (2020)
Who is at the highest risk for COVID-19 in India? An analysis of health, healthcare access, and socioeconomic indicators at the district level. *medRxiv*. Nandi A, Balasubramanian, Laxminarayan R (2020)
Risks to Children under-five in India from COVID-19. *medRxiv*. Frost I, Tseng K, Hauck S, Kappor G, Sriram A, Nandi A, Laxminarayan R (2020)
Childhood vaccinations and adult schooling attainment: Long-term evidence from India's Universal Immunization Programme. *Social Science & Medicine, 250:112885*. Nandi A, Kumar S, Shet A, Bloom DE, Laxminarayan R (2020)

Publications

COVID-19: Mathematical Modeling & the Transmission Dynamics of SARS-CoV-2 in Cali, Colombia: Implications to a 2020 Outbreak & public health preparedness. *Letters in Biomathematics, May.* Mubayi A, Akman O, Banerjee M, Paredes M, Rojas J (2020)
COVID-19: Regression Approaches of Survival Data in the Presence of Competing Risks: an Application to COVID-19. *Letters in Biomathematics, May*. Ghosh S, Samanta GP, Mubayi A (2020)
Designing Effective and Practical Interventions to Contain Epidemics. *Proceedings of the 19th International Conference on Autonomous Agents and Multiagent Systems, 1187-1195*. Sambaturu P, Adhikari B, Prakash BA, Venkatramanan S, Vullikanti A (2020)
Networked epidemiology for COVID-19. *SIAM News. Forthcoming.* Chen J, Eubank S, Levin S, Mortveit H, Venkataramanan S, Vullikanti A, Marathe M (2020)
Explaining the "bomb-like" dynamics of COVID-19 with modeling and implications for policy. *CDC MinD-Healthcare Program. To be submitted.* Lin G, Strauss AT, Pinz M, Martinez DA, Tseng KT, Schueller E, Gatalo O, Yang Y, Levin S, Klein EY (2020)
Computational challenges and opportunities for forecasting epidemic dynamics using network models. *Submitted.* Marathe M, Vullikanti A, Rosenkrantz D, Ravi SS, Stearns R, Levin S (2020)
Optimal, near-optimal, and robust epidemic control. *Environmental and Resource Economics. Submitted.* Morris D, Rossine F, Plotkin J, Levin S (2020)
Methods for Rapid Mobility Estimation to Support Outbreak Response. *Health Security, 18:1.* Telionis PA, Corbett P, Venkatramanan S, Lewis B (2020)
Evolution of an asymptomatic first stage of infection in a heterogeneous population. *PNAS. Submitted.* Saad-Roy C, Grenfell B, Levin S, Van den Driessche P, Wingreen N (2020)
Dynamics in a simple evolutionary-epidemiological model for the evolution of an initial asymptomatic infection stage. *PNAS. 117(21):11541-50.* Saad-Roy C, Wingreen N, Levin S, Grenfell B (2020)
Staggered Release Policies for COVID-19 Control: Costs and Benefits of Sequentially Relaxing Restrictions by Age. *arXiv*. Zhao H, Feng Z, Castillo-Chavez C, Levin S (2020)
Commentary on Ferguson, et al, "Impact of Non-pharmaceutical Interventions (NPIs) to Reduce COVID-19 Mortality and Healthcare Demand. *Bulletin of Mathematical Biology 82*. Eubank S, Eckstrand I, Lewis B, Venkatramanan S, Marathe M, Barrett C (2020)
Covid-19 risks and response in South Asia. *BMJ 2020;368:m1190.* Bhutta Z, Basnyat B, Saha S, Laxminarayan R (2020)
On Accelerated Testing for COVID-19 Using Group Testing. *arXiv.* Narayanan K, Heidarzadeh A, Laxminarayan R (2020)
Childhood vaccines and antibiotic use in low-and middle-income countries. *Nature, 581:94-99.* Lewnard J, Lo N, Arinaminpathy N, Frost I, Laxminarayan R (2020)
Is Gradual and Controlled Approach to Herd Protection a Valid Strategy to Curb the COVID-19 Pandemic? *Indian Pediatrics.* Laxminarayan R, John TJ *(2020)*
Evaluating the impact of international airline suspensions on the early global spread of COVID-19. *medRxiv.* Adiga A, et al (2020)

Presentations

Uncertainty & Precision in Math Modeling to Mitigate the Threat of COVID-19. *Mathematical Models on Epidemiology in Connection with COVID-19, Dept of Mathematics, Vellore Institute of Technology, TN, India.* Mubayi A (June 2020)

Underreporting, Preparedness, and Silent Typhoid Marys: A Cautionary Tale of Modeling COVID Dynamics. *COVID-19 Modeling Webinar Series, Indian Institute of Public Health, Gandhinagar, Public Health Foundation of India*. Mubayi A (June 2020)

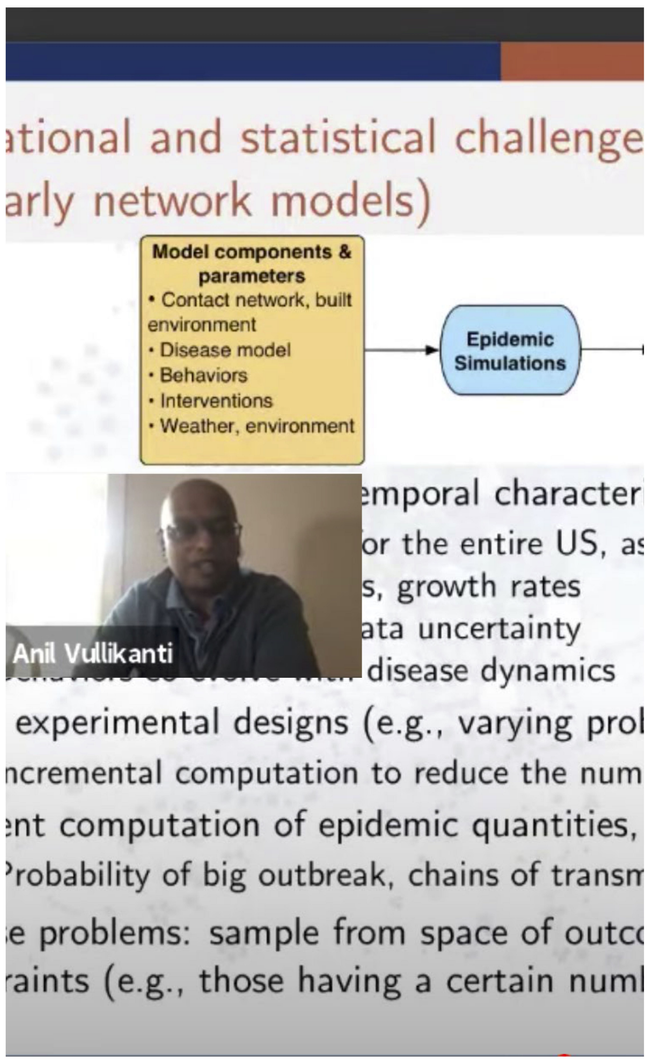
Recommendations for Improving Science During Crisis. *AAAS Annual Meeting.* Colwell R (Feb 2020)

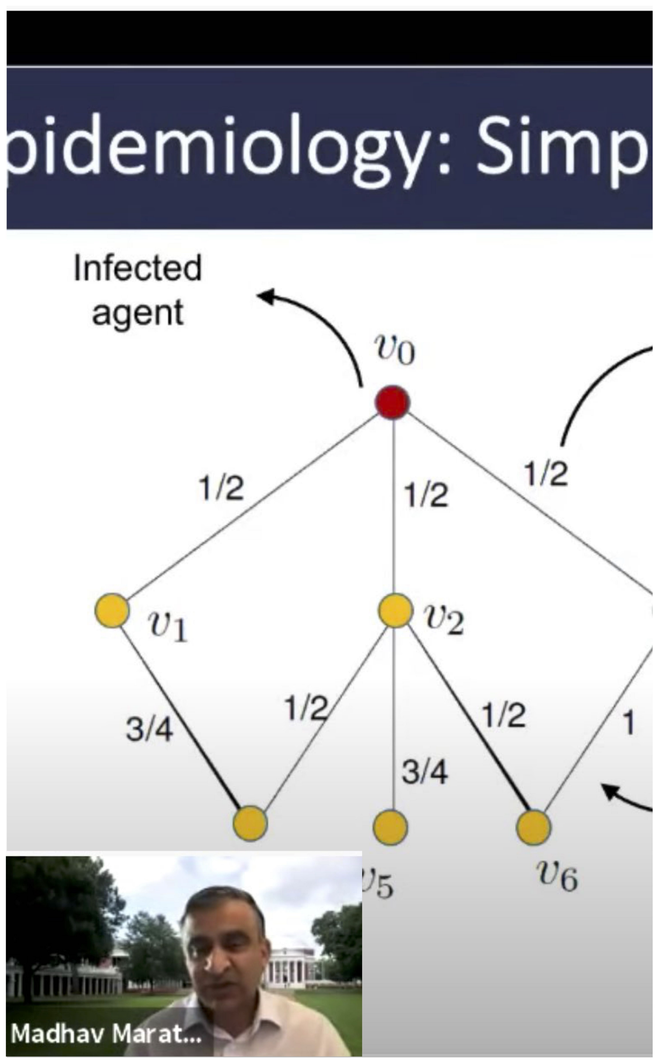
Tackling the COVID-19 Crisis. *UVA Research virtual panel.* Marathe M (May 2020)

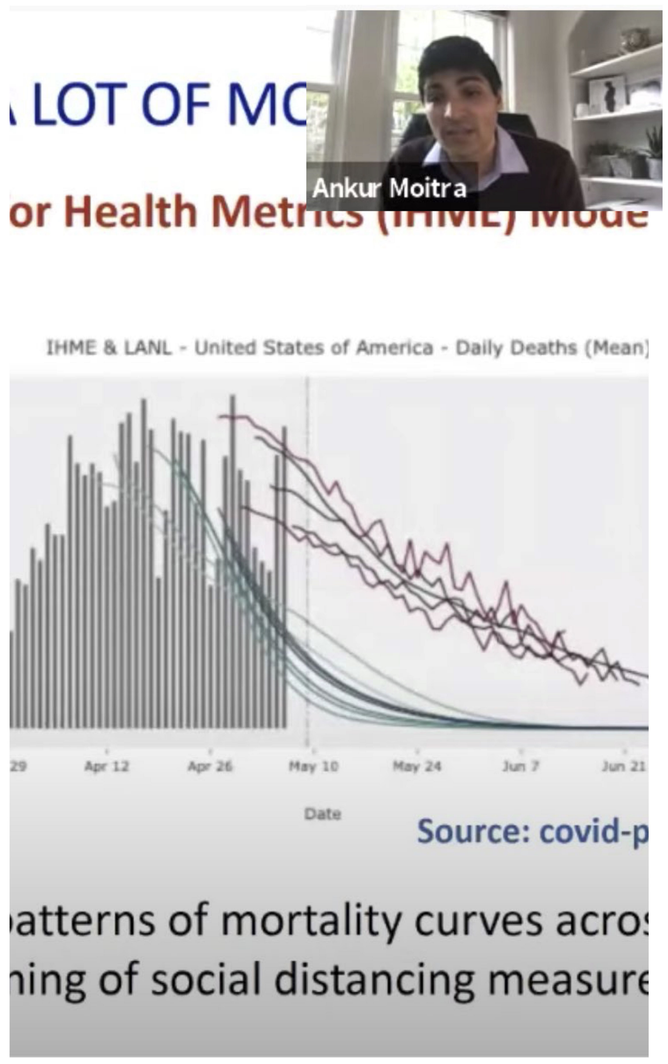
Responding to the COVID-19 Pandemic: Role of Computing and Data Science. *IIT Madras Leadership Lecture Series*. Marathe M (May 2020)

Computational Science for Real-time COVID-19 Response. *ACM India Industry Webinar*. Marathe M (Apr 2020)

Computational and Statistical Tools to Control a Pandemic. *Theoretically Speaking Series, Simons Institute for the Theory of Computing*. Team members on the virtual panel: Moitra A, Marathe M, Vullikanti A (May 2020)







In the news

NSF Announces New Expeditions in Computing Awards
HPCwire 25 March 2020

Biocomplexity Institute wins $10M Grant to Thwart Future Pandemics
UVA Today 25 March 2020

Consortium led by University of Virginia Biocomplexity Institute funded by $10 million, five-year US National Science Foundation grant
Express Healthcare 27 April 2020

How prepared are we for the next pandemic?
ET Healthworld 29 April 2020

UVA to Lead Study of How Big Data Can Battle Future Pandemics
WVTF 1 June 2020

Crowdsourcing site seeks to predict efficacy of social distancing
The Stanford Daily 23 April 2020

Photo credit *UVA Today*

Researcher Spotlight: Dave Higdon, VT

We asked David Higdon from VT what he sees as his contribution to this program. To see his full interview, visit our YouTube channel.

The Expeditions program is really exciting. Even though I'll be kind of a small piece of that, what's great is that it involves subject matter scientists from things like biology, genetics, epidemics, computer science, networks, machine learning - so all of these things kind of come together. And now there's also these new modalities of sensing and getting data, so not only are there kind of these traditional sources of data that we got - ILI records, where people are, how they move - things like that from surveys. But now there's social media, there's things like fitbits or things that see how much people move around, electronic health records are getting more and more prevalent. And so there's all sorts of new types of data and people that really know about these things to put together in this thing.

Along with another exciting thing is this social side, the modeling of human behaviors, how are people going to react to different sorts of stimuli responses in epidemics. All of these modeling features and different pieces of data are really exciting to me.

And so where do I fit in? In the end I'll usually work with the modelers and the data people to say, "Well, how do we put these things together? How do we end up making forecasts?" And eventually we're going to want to do this in real-time, so eventually there's going to be this question of "How do we make forecasts fast?" Usually we'll start by saying how do we make forecasts slowly to begin with in the sort of ways that we like and then how do we make those fast - but kind of think about both of those.

So I see me fitting in as working at putting these things together and then what we end up getting out from these models, how do we say how accurate that's going to be and then how can we use this uncertainty which is kind of this - it's one of the currencies of saying what do we do next and making decisions. So if we want to collect more data or make the model more accurate, or change the system somehow to make people safer. Currency is uncertainty, and what we do moves, channels these changes in things in the computer, in the synthetic world, and then how confident are we in the response that we seem to get? And how likely is that going to bring about a good outcome?

That's the world where I fit in - it's on sort of that decision process and the modeling and putting uncertainty on top of these things, and saying is the model good enough for this sort of purpose.

What's great is that it involves subject matter scientists from things like biology, genetics, epidemics, computer science, networks, machine learning - so all of these things kind of come together.

Student Spotlight: Henry Carscadden, UVA

We asked Henry Carscadden, an undergrad at UVA, about his research. To see his full interview, visit our YouTube channel.

So what I'm working on with Dr. Ravi and also Dr. Marathe is focused on the S-I-R model of epidemics - Susceptible, Infected, Recovered. It really is focused on trying to help build a more flexible model of epidemic spread. Traditional models rely on differential equations assume that there's homogeneous mixing within a population or other graphical models like the SIR model that we're working on put other assumptions on it. We want to be able to predict some of the same things in a way that is computationally tractable but with less assumptions placed on the model.

We don't have any significant results yet because we're still working on manipulating the software side of things. But we're looking to eventually help epidemiologists better understand the spread of disease.

Want to know how Henry would describe his research to a 3rd grader? Watch the full video here.

- **Susceptible (S)**: An individual has never had the disease and is susceptible to being infected
- **Infected (I)**: An individual who currently has the disease and can infect other individuals
- **Recovered (R)**: An individual does not have the disease, cannot infect others, and cannot be infected

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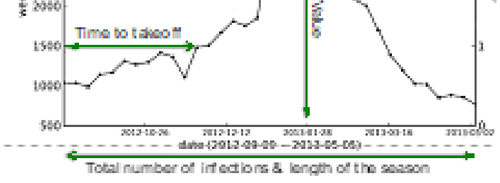

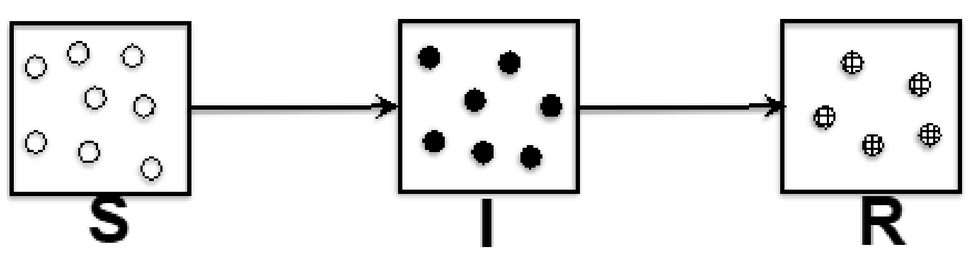

From the admin team

We are excited to be a part of this team and community. Please let us know about your publications and presentations, if you'd like to present at our Seminar Series, or if you want to share the progress your group has made. Building a community on this scale requires an intentional effort and commitment, and we are here to support you in any way we can.

Golda Barrow {ggh5e@virginia.edu} & Erin Raymond {er9ff@virginia.edu}

Social media

We are always looking for content, so please let us know if there is a link, comment, or video we can share on social media.

@comp-epi

Computational Epidemiology

Collaboration opportunities

Check your email for invitations to join our Slack channel and Google groups!

NEXT QUARTERLY MEETING IS LAST WEEK OF SEPTEMBER 2020

NSF acknowledgement

Remember to acknowledge NSF in your publications. Check with your grant manager for the appropriate number.

- In any publication (including web pages) of any material based on or developed under this project: “This material is based upon work supported by the National Science Foundation under Grant No. [CCF-xxxxxxx].”
- All publications except scientific articles or papers appearing in scientific, technical or professional journals: “Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.”
- NSF support must be orally acknowledged during all news media interviews, including popular media such as radio, television and news magazines.