PROJECT TITLE: Understanding Stochastic Spatiotemporal Dynamics of Epidemic Spread to Improve Control Interventions - From COVID-19 to Future Pandemics

Physical Requirement: No physical requirement
Project's Technical Skills Requirement: Proficiency in programming language such as Matlab and/or Python

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Project Description

The COVID-19 pandemic is one of the gravest global public health and socioeconomic challenges of our times. While currently apparently on the wane in the US, the havoc continues in successive waves driven by viral mutations such as the Delta and Omicrons variants and the challenges associated with effective vaccination and herd immunity. Hence the focus has shifted from elimination of COVID-19 to planning for management of future outbreaks. Moreover, epidemiological consensus underscores the inevitability of other future epidemics triggered by novel pathogens. Mitigation of such epidemic spread caused by pathogens is achieved via Non-Pharmaceutical Interventions (NPI) (e.g., social-distancing, use of masks) and Pharmaceutical Interventions (PI) (e.g., vaccines). NPI play a crucial role, particularly during the early stages of an outbreak since developing PI to counter a new pathogen inevitably takes time and hence costs millions of human lives. However, the efficacy of such interventions is critically dependent on the accuracy of scalable, predictive mathematical and computational models of infection spread that can be updated in real-time based on evolving spread data. Overall objective of this project is to create new scientific pathways in epidemic modeling and predictive analysis that will synergistically integrate: first principles mechanistic modelling of infection spread, characterization of the effects of uncertainties driving an epidemic spread using rigorous stochastic analyses, model validation using empirical data, and new knowledge of epidemic dynamics thus created to develop a control-theoretic architecture to analyze PI and NPI countermeasures. This will be done using mathematical framework of partial differential equations for modeling, control-theoretic framework for mitigation of epidemic spread, and validation/verification using COVID-19 data. This is a multi-university National Science Foundation sponsored project that involves cross-disciplinary research comprising engineering and epidemiology.
Skills required: Proficiency in programming language such as Matlab and/or Python

Training provided:
1. Computational/numerical methods
2. Data collection, organization, and processing
3. Cross-discipline collaboration and collaboration with graduate students
4. Research publications in conferences and/or journals