NEXT GENERATION CB HAZARD PREDICTION AND CONSEQUENCE ASSESSMENT WITH MULTI-ECHELON DECISION SUPPORT APPLICATIONS

Uncertainty Quantification For Epidemiological Decision Support And Quantification Of Mitigation Effectiveness

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For infectious disease outbreaks and epidemics, mitigations such as vaccination, timely treatment of early-stage disease, and effective treatment of late-state disease, determine the size of an epidemic by modifying the level of contagion and the number of susceptible hosts. However, implementation of mitigations in epidemiological models is often highly specific to particular diseases, making it difficult or impossible in many cases to make simulations broadly useful for understanding mitigation effectiveness in the context of decision support. The EpiGrid software enables simulation of epidemics across a broad range of disease dynamics by tying mitigation timeliness to a generalized model of disease progression centered on ideas of timely, late, and too-late intervention. Additionally, capturing geographical heterogeneity and temporal variability in an epidemic model allows for the self-consistent quantification of mitigation across time and space. We use these capabilities to demonstrate the consistent optimization of epidemiological simulations across diseases. We optimize simulated mitigation parameters using quasi-Newton methods with super-linear convergance, and provide both optimal parameterizations, uncertainty estimates for those parameters, and plausible ranges for the time-course of future consequence, including the number-needed-to-treat. With a suite of more than a dozen consistently- and optimally-parameterized EpiGrid epidemic disease simulations, we have the necessary flexibility and accuracy to capture in a simple way the important effects determining epidemic dynamics while allowing interpretable comparisions across diseases and outbreaks.

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