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Estimating Hidden Epidemic: A Bayesian Spatiotemporal Compartmental Modeling Approach

Efforts to mitigate public health crises have been complicated by unreported cases and the ever-changing trends of those monitored health events across geographic regions and socioeconomic cultures. To resolve both challenges, we propose a Bayesian spatiotemporal susceptible-exposed-infected-recovered-removed (BaySTSEIRD) framework that builds the hidden effects of neighboring communities, local features, and the reporting rates into its transmission mechanism. To alleviate the computational burdens embedded in a fully Bayesian algorithm, we propose an alternating approach that learns the compartmental structure and the spatial effects separately. With a simulation study, we show that this algorithm can accurately retrieve our designed system. Then, we apply BaySTSEIRD to model the coronavirus disease 2019 (COVID-19) dynamics in the metropolitan Atlanta area. We observe that most counties' reporting rates were below 10% of the projected total infected population and that age and educational level are negatively correlated with the exposing rate, suggesting the needs for stronger incentives for COVID-19 testing and quarantine among the younger population. Importantly, BaySTSEIRD facilitates the reconstruction of actual case counts of the monitored subject among neighboring communities, which is critical to designing impactful public health policy interventions.

Special/ Invited session

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