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Using Agent-based Simulations with Latent Dirichlet Allocation Topic Modeling on Mobile Location Data to Prescribe COVID-19 Interventions

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Abstract:

Agent-based simulations play a prominent role in guiding critical decision-making to aid in the COVID-19 pandemic. However, many fall short by treating point of interests (POIs) as identical, generic locations in which the virus may spread, relying on the assumption that all POIs receive a relatively equal number of visiting agents per day and that each agent has an equal chance of visiting any given POI. In light of this, we propose a novel COVID-19 simulation using Latent Dirichlet Allocation (LDA) to model agent visits to POIs by treating POIs as “words” and agent home census block groups (CBGs) as “documents”. LDA provides “topics” of CBGs from which a similar proportion of agents visit specific POIs. This preserves the statistical relationship between agent home CBGs and POI visits, allowing us to simulate agent visits to given POIs based on the LDA topic distribution of their home CBG. Using agent and POI data provided by SafeGraph Inc. for Fairfax County, Virginia, our simulation forecasts that mandating a 10-day quarantine after symptom onset would have had the potential to decrease the peak number of incident cases per day by 21.3% and delay the date of the peak by 13% compared to a case of complete non-intervention. Our simulation further shows that mandating mask usage in addition to a 10-day quarantine after symptom onset would have had the potential to decrease the peak number of incident cases per day by 67.5% and delay the date of the peak by 183% compared to complete non-intervention. This study contributes strong evidence to reinforce the notion that government interventions such as mask mandates have the potential to drastically reduce the number of infections and flatten the curve while introducing a novel method of LDA agent-based simulation.

Presentation: