Incorporating Adaptive Human Behavior into Epidemiological Models using Equation Learning

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Mathematical models have been shown to be valuable tools for forecasting and evaluating public health interventions during epidemics such as COVID-19. Covasim is an open-source agent-based model (ABM) that was recently developed to simulate the transmission of COVID-19. Covasim has been validated with real-world data and utilized for simulating the potential effect of public health interventions. Covasim's base model does not implement adaptive behaviors; however, we can utilize its resources to generate data for scenarios where human behavior can adapt based on the current state of the model, subsequently affecting the epidemic. Human behaviors, such as compliance to masking guidelines, have been shown to depend on the state of the epidemic and can have strong effects on the disease spread. We extended the Covasim model to incorporate adaptive masking behavior to investigate its effect on Covasim's predicted forecast. Using an existing compartmental model, we processed the data generated from this extended ABM through Biologically-Informed Neural Networks (BINNs) and sparse regression techniques to estimate parameters and obtain an ordinary differential equation (ODE) approximation of this model. The extended ABM and equation learning computational pipeline we developed is open-source to provide a quantitative framework for incorporating adaptive behaviors into forecasting future epidemics and other similar computational models.