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An Agent-Based digital twin for exploring localized non-pharmaceutical interventions to control COVID-19 pandemic

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Abstract

The COVID-19 epidemic has created highly unusual and uncertain socio-economic conditions. Containing the pandemic while also keeping the wheels of economy turning albeit slowly is the challenge. Based on the current understanding of the epidemiological characteristics of COVID-19, a broad set of control measures has emerged along dimensions such as restricting people's movements, high-volume testing, contract tracing, and Covid appropriate behaviour. However, these interventions have their own limitations and varying levels of efficacy depending on factors such as the population density and the socioeconomic characteristics of the area. To help tailor the interventions, we have developed a configurable, fine-grained agent-based simulation model that serves as a virtual representation, i.e., a digital twin of a diverse and heterogeneous area such as a city. This digital twin is being used to predict and control Covid-19 in the Indian city of Pune. We use the digital twin to simulate various what-if scenarios of interest to (1) predict the spread of the virus; (2) understand the effectiveness of candidate interventions; and (3) predict the consequences of introduction of interventions possibly leading to trade-offs between public health, citizen comfort, and economy. The City Digital Twin serves as an in-silico experimentation aid to predict the trajectory of active infections, mortality rate, load on hospital, and quarantine facility centers for the candidate interventions.
Our key contributions are: (1) a novel agent-based model that seamlessly captures people, place, and movement characteristics of the city, COVID-19 virus characteristics, and primitive set of candidate interventions, and (2) a simulation-driven approach to determine the exact intervention that needs to be applied under a given set of circumstances. Given the configurable nature of City Digital Twin, it can be easily repurposed to address the same problem for a different city.

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