Mathematical Modelling and simulation using an efficient PINNs algorithm to understand spread of infection in enclosed spaces

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ABSTRACT

Over the past several decades, there have been several advances in understanding the spread of infectious diseases through compartmental models in mathematical epidemiology. Most of these models were developed from foundational S-I-R type compartmental models, where S denoted a susceptible population, I infected, and R denoted the recovered population. *When* studying such problems in enclosed places, one must also take into account the fluid dynamic behavior coupled with existing S-I-R models. In this work, we propose to mathematically model and simulate the coupled dynamics of flow-mediated spreading of disease or infection. To accomplish this, we employ a Physics Informed Neural Networks (PINNs) approach. Leveraging recent advances in PINNs techniques, we propose to put forth an algorithmic framework to develop consistent predictions of infection based on limited dataset as well as unspecified boundary conditions. Our approach will be validated against a benchmark dataset to validate our infection spreading behavior, which is applicable to achieving higher confidence with big size prediction data. This PINNs-based approach will also be considered in an inverse fashion to estimate optimal parameters to predict transmission and recovery rates. Our model presents insights into how we can effectively employ computations to understand the spread in enclosed spaces such as buildings and aircraft cabins.

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[2] The work of this author is supported in part by National Science Foundation grant DMS 2031029.