AI and Exascale for Epidemiology - Preparing for the Next Pandemic

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Agent-based models (ABMs) of diseases like COVID-19 have proven valuable in shaping the national response and preparedness. ABM's have three major advantages over other modeling techniques: ABMs can capture emergent phenomena; ABMs provide a fundamental and natural description of a system; and ABMs are quite flexible and adaptable. However, their use for forecasting and control has been limited due to difficulties in calibrating them to the multitude of data streams available during an outbreak and quantifying the uncertainties of the model. Here we propose to tackle these challenges and expand the capabilities of the exascale-ready ABM code ExaEpi by leveraging the adaptive mesh refinement framework, AMReX, to simultaneously model both discrete agents and continuous fields at different spatial resolutions. With this we will be able to create a generalized ABM for epidemiology and model a variety of time-evolving diseases where pathogens can be spread agent-to-agent or via a field defined on a background mesh which could represent pathogens carried by air or water or even an infestation by insects. Coupling these efforts to novel compartmental modeling techniques, we will be able to calibrate these ABMs against a wide-variety of multi-scale data - with a full accounting of the uncertainties in the model. Our end goal is to create new workflows that incorporate both reinforcement learning and surrogate models (trained on large ensembles of ExaEpi runs) to optimally evaluate a variety of intervention scenarios and generate forecasts, with uncertainties, to guide policy decisions.

Friday, April 10, 2026, 10:00 AM

Please pre-register for the Zoom meeting at
https://us06web.zoom.us/meeting/register/ZaeD3sSDQsyqupdXt0VwCw

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