Discrete Dynamics and Epidemiological Multi-Physics Models for Transportation Applications

Abstract

Air transportation is central to the global mobility of goods and people. Elimination or reduction of air travel during epidemic emergencies, such as during the 2014 Ebola outbreak in West Africa, carry considerable economic and human costs. Mathematical modeling can help in devising strategies to reduce the impact of the problem and transportation disruptions. We have used social force pedestrian movement models in combination with stochastic epidemic models to study the spread of Ebola aboard Airplanes, however, extending such models to a larger scale has certain problems. Human movement is often guided by discretionary behaviors with respect to route and destination choices, intrinsic variability in pedestrian speed and inter-pedestrian interactions, which results in a high level of uncertainty and requires assumptions regarding input. We propose an innovative approach to deal with this problem using a novel empirical data sources.

We will develop a multiphysics framework with the following components:

I. Novel data backed pedestrian dynamics model of transportation hubs. We will parameterize agent based models with mobile phone location based services (LBS) data and create detailed pedestrian movement and interaction maps for New York, JFK and Orlando MCO international airports.
II. Stochastic compartmental epidemic model, incorporating the above pedestrian interaction data and contact network analysis. We will model the spread of SARS and H1N1 influenza in the above airports using this model.
III. Analysis of aviation and transportation policies that can address emergency transportation disruptions due to epidemics.

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