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Team Control Number

41523

Problem Chosen

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2015 Mathematical Contest in Modeling (MCM) Summary Sheet

CasPPonNET: A predictive method to model the dynamics and control of Ebola

The world has been suffering from the Ebola virus disease (EVD) since March 2014. Recent days, a new round of outbreaks happened in West Africa. Imagine that we already have advanced medication for Ebola, but how can we develop a combination of optimal strategies to defeat Ebola in the most efficient and feasible ways?

We adopted a two-step framework to solve the problem. First, we built a predictive model to describe the spread of Ebola. Unlike traditional epidynamics model such as SIHR, we considered the effect of underlying network of the disease transmission based on geographical locations and population flow. We used a cascaded Poisson Process on the network, dubbed **CasPPonNet** to model the disease diffusion and progress. Hyper parameters λ_1 and λ_2 are used to control the ratio of transmission from the same location and other locations, and are learned from data.

Not only the number of new cases can be predicted precisely, but also outbreaks in new areas can be predicted. Secondly, we used the precious information our model yield to design theoretical optimal drug and vaccine delivery strategies.

Results from experiments on simulated data are proposed to demonstrate the performance of our model. Compared with baseline strategies, our strategy is better on both short term and long term goals. Based on our model and real-world data, we concluded Freetown(SL), Conakry(GN), Western rural(SL) and Port Loko(SL) are in urgent need of medicine and Dubreka(GN), Forecariah(GN) and Western rural(SL) are in need of vaccination now. We also determined the critical value for speed of manufacturing drug to bring the disease under control.