Computational Epidemiology

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ABSTRACT

As recent pandemics such as SARS and the Swine Flu outbreak have shown, diseases spread very fast in today's interconnected world, making public health an important research area. Some of the basic questions are: How can an outbreak be contained before it becomes an epidemic, and what disease surveillance strategies should be implemented? These problems have been studied traditionally using differential equation methods, which are amenable to analysis and closed form solutions. However, these models are based on complete mixing assumptions, which do not hold for realistic populations, thereby limiting their utility.

In this tutorial, we focus on an approach based on diffusion processes on complex networks. This captures more realistic populations, but leads to novel mathematical and computational challenges. The structure of the underlying networks has a significant impact on the dynamical properties, motivating the need for improved network models, and efficient algorithms for computing network and dynamical properties that scale to large networks. We provide an overview of the state of the art in computational epidemiology, which is a multi-disciplinary research area, that overlaps different areas in computer science, including data mining, machine learning, high performance computing and theoretical computer science, as well as mathematics, economics and statistics. Specifically, we will discuss mathematical and computational models, problems of inference, forecasting and state assessment, and epidemic containment.

Target audience and prerequisites

The tutorial is suitable for both novice and expert researchers working in the areas of social and information networks, link prediction and public health. Problems of big data, including large scale optimization and novel statistical techniques are inherent aspects of this area. Public health is an area of great societal importance, with novel problems arising out of the use of network models. Recent advances in network modeling and agent based simulation tools, combined with the use of new datasets, such as social media data, have led to new challenges and opportunities. The tutorial will introduce this emerging area, and will identify some of the key research topics. It will be at a level that is accessible to most KDD attendees who work in these areas.

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