

Network Infection Processes and Discrete Optimization

Miklós Krész

InnoRenew CoE, Andrej Marušič Institute, University of Primorska, Slovenia
Faculty of Mathematics, Natural Sciences and Information Technologies, University of
Primorska, Slovenia

Abstract

Network infection processes have been studied for decades across a wide range of disciplines, including epidemiology, sociology, economics, communication networks, statistical physics, and risk management. A major milestone in this area was the introduction of the Influence Maximization problem by Kempe, Kleinberg, and Tardos in 2003, which formulated the spread of influence in social networks as a discrete optimization problem. Their work initiated a large and active research field, leading to numerous extensions and generalizations.

In this lecture, we provide an overview of the theory and applications of network infection processes from a unified perspective, with particular emphasis on the algorithmic challenges arising in discrete optimization. We will discuss both classical optimization problems defined within precise stochastic models and more realistic settings in which only partial observations of the underlying processes are available. Such weakly specified problems are common in practical applications and pose significant methodological challenges. To address these challenges, recent approaches that integrate techniques from discrete optimization, graph theory, and machine learning will be also presented.