Spatio-Temporal Analytics of Network Data

Tao Cheng

Abstract

Traffic congestion, crime and epidemics are all emergent phenomena that detract from citizen well-being in big cities today. They each also impose huge economic and social costs. Prevention, early detection and strategic mitigation are all critical policy interventions, yet each requires understanding of the potentially huge number of factors that may contribute to their emergence, as well as the paths in space and time along which they co-evolve. In the past, identifying the emergence of these phenomena was made difficult by lack of detailed data, and only became possible with the innovation of cheap tagging technologies, GPS, sensor-webs, location-aware devices and field-work flow management tools for assembling massive detailed real-time spatially referenced datasets. These datasets shape enormous spatio-temporal networks (STNs) that evolve in structure and in states, reflecting the emergence and dynamics of real world phenomena in space and time.

The spatio-temporal dependence, nonlinearity and heterogeneity of network data present two fundamental challenges to modelling the complexity of networks: (1) to model dependency in both space and time seamlessly and simultaneously, (2) to fully accommodate the topology and geometry of the networks. This presentation will report the progress made in addressing these challenges through innovative combination of machine learning methods with advanced statistical approaches, drawing upon concepts from network complexity and data mining. It will illustrate the procedures used to integrate spatio-temporal prediction, pattern detection, simulation, and visualization for analysing traffic, crime, and social media in Central London.