香港浸會大學理學院
HKBU Faculty of Science

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DEPARTMENT OF COMPUTER SCIENCE

PhD Degree Oral Presentation

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Time:	16 December 2013 (Monday) 1:30 pm – 3:30 pm (35 mins presentation and 15 mins Q & A)
Venue:	SCT716, Cha Chi Ming Science Tower, HSH Campus

"Understanding the Performance of Healthcare Services: A Data-Driven Complex Systems Modeling Approach"

Abstract

Systematically understanding the causes and corresponding dynamics of wait times is of critical importance in improving healthcare performance. This thesis presents a **data-driven complex systems modeling approach** from a self-organizing systems perspective. As the impact factors (as referred to as predictors) of wait times have direct, indirect, and/or moderating effects, referred to as complex effects, a **Structural Equation Modeling (SEM)-based analysis** method is proposed to discover the complex effects from aggregated data. Existing regression-based analysis techniques are only able to reveal pairwise relationships between observed variables, whereas this method allows us to explore the complex effects of observed and/or unobserved (latent) predictors on wait times simultaneously.

This thesis then considers how to estimate the variations in wait times with respect to changes in specific predictors and their revealed complex effects. An **integrated projection** method based on the steps of SEM-based analysis, projection, and a queuing model analysis is developed. Unlike existing studies that either make projections based primarily on pairwise relationships between variables, or queuing model-based discrete event simulations, the proposed method enables us to make a more comprehensive estimate by taking into account the complex effects exerted by multiple predictors, and thus gain insights into the variations in the estimated wait times over time.

This thesis further presents a method for **designing and evaluating service management strategies** to improve wait times, which are significantly determined by service management behaviors. Our proposed strategy for allocating time blocks in operating rooms (ORs) incorporates historical feedback information about ORs and can adapt to the unpredictable changes in patient arrivals and hence shorten wait times.

Finally, this thesis proposes a **behavior-based autonomy-oriented modeling** method for characterizing the emergent tempo-spatial patterns at a systems level by taking into account the underlying individuals' behaviors with respect to various impact factors. This method employs multi-agent Autonomy-Oriented Computing (AOC), a computational modeling and problem-solving paradigm with a special focus on addressing the issues of self-organization and interactivity by modeling heterogeneous individuals (entities), autonomous behaviors, and the mutual interactions. The proposed method therefore eliminates to a large extent the strong assumptions that are used to define the stochastic properties of patient arrivals and services in stochastic modeling methods (e.g., queuing theory), and those of fixed relationships between entities that are held by the method of system dynamics. The method is also more practical than agent-based modeling (ABM) for discovering the underlying mechanisms for emergent patterns, as AOC provides a general principle for explicitly stating what fundamental behaviors of and interactions between entities should be modeled.

To demonstrate the effectiveness of the proposed systematic approach to understanding the dynamics and relevant patterns of wait times in specific healthcare service systems, we conduct a series of studies focusing on the cardiac care services in Ontario, Canada, based on aggregated data that describe the focal system from 2004 to 2007. The results show that our developed **data-driven complex systems modeling approach is** a potentially effective means for investigating various self-organized patterns in complex healthcare systems

***** ALL INTERESTED ARE WELCOME *****