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Deep-learning Enhanced Healthcare Modeling and Optimization

Project Description. This research project proposes the development of a methodological framework leveraging deep learning algorithms to revolutionize data-driven workload prediction and resource allocation in large-scale healthcare systems. In the age of big data analytics, one must consider the continuum from predictive to prescriptive analytics to help managers to improve their day-to-day operations in large-scale healthcare systems. These systems must be run under significant uncertainties and in rapidly changing environments. Prescriptive operations management solutions for these systems requires learning high-fidelity models, that are adaptive to the changing environment, and seamless integration with data-driven prescriptive methods to optimize system operations. In this research project, we will work closely with the largest hospital system in the state of Indiana. These developments are expected to enable profound improvements in short-term and long-term operations for healthcare delivery in this system. Our research agenda, in support of this broader goal, includes (i) development of novel frameworks, including fundamental theory and methods, for learning stochastic models of time-varying healthcare systems from large-scale datasets; (ii) development of a robust resource allocation framework, including fundamental theory and methods, that accounts for model uncertainty and stochastic variation; (iii) integration and deployment of our algorithms into all 18 hospitals belonging to the collaborating healthcare system. This project offers a 'full spectrum' opportunity covering research on both theory and methods, as well as interactions and collaborations with engineers in the field.

Responsibilities. The student is expected to contribute significantly to the theoretical aspects of this project, including large sample statistical inference analyses, stochastic network model analyses and stochastic/dynamic decision-making analyses. Mentoring graduate students and working with undergraduates. Appetite for implementing methods into algorithms is a must.

Qualifications. Majoring in Operations Research, Industrial Engineering, Applied Mathematics, Electrical Engineering or a related discipline. **A strong theoretical background** in stochastic modeling is required. Research experience in statistics/machine learning/deep learning would be a great advantage. A willingness to learn the fundamental theory and methods of statistics/machine learning/deep learning is necessary. Programming skills, fluency in English and excellent communication and presentation skills are essential.

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