Teng Huang | Ph.D. Candidate

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Short Bio

I am a Ph.D. candidate in the Department of Operations and Information Management at the University of Connecticut School of Business. I am in my fifth year in our Ph.D. program. My research focuses on integrating predictive modeling and discrete optimization into large-scale automated decision-making mechanisms to solve real-world problems. We have implemented such decision-making frameworks on a retail network expansion problem and on a team formation problem. We have also developed a generalized optimization solver for use by practitioners and other researchers in their problem domains. I have work experiences in data analytics and software development along with advanced training in economics/econometrics and discrete optimization during my Ph.D. studies. My overall research focus is on identifying likely causal relationships in business problems and applying predictive modeling and discrete optimization techniques to successfully address those problems. In addition, I worked on adiabatic quantum optimization when I interned at *Mitsubishi Electric Research Laboratories* in spring 2019.

Selective Coursework

Economics

Microeconomics
Mathematical Economics
Applied Econometrics I
Applied Econometrics II
Microeconomic Theory II
Econometrics I
Microeconomic Theory I
Macroeconomic Theory I
Industrial Organization
The Organization of Industry

Statistics

Applied Statistics I
Applied Statistics II

Research Seminars

Special Topics in Information Management
Seminar in Management Information Systems
Seminar in Operations Management
Research Methods for Operations and Information Management
Introduction to Quantitative Applications in Marketing

Research

My dissertation is titled *Discrete Optimization with Objective Functions Learned Through Predictive Modeling*. I am working under the supervision of Dr. David Bergman (Chair), Dr. James Marsden, Dr. John Mathieu, Dr. Manuel Nunez, and Dr. Arvind U. Raghunathan. We first solve two real-world problems with the proposed decision-making framework, which seamlessly integrates predictive modeling and discrete optimization (Essay 1 and Essay 2). We then propose an optimization solver that is able to provide actionable optimal solutions for subsequent practitioners and researchers (Essay 3). Please see their brief descriptions below.

In addition, I have a co-authored paper submitted to *INFORMS Journal on Computing* on adiabatic quantum computing. It is the project I worked on when I interned at *Mitsubishi Electric Research Laboratories* in spring 2019. The brief description of this paper is at the end of this letter.

Essay 1. Predictive and Prescriptive Analytics for Location Selection of Add-on Retail Products

- Teng Huang, David Bergman, and Ram D. Gopal. (2019). Predictive and Prescriptive Analytics for Location Selection of Add-on Retail Products. **Production and Operations Management**, 28(7), 1858-1877.

Abstract: In this paper, we study an analytical approach to selecting expansion locations for retailers selling add-on products whose demand is derived from the demand for a separate base product. Demand for the add-on product is realized only as a supplement to the demand for the base product. In our context, either of the two products could be subject to spatial autocorrelation where demand at a given location is impacted by demand at other locations. Using data from an industrial partner selling add-on products, we build predictive models for understanding the derived demand of the add-on product and establish an optimization framework for automating expansion decisions to maximize expected sales. Interestingly, spatial autocorrelation and the complexity of the predictive model impact the complexity and the structure of the prescriptive optimization model. Our results indicate that the formulated models are highly effective in predicting add-on-product sales, and that using the optimization framework built on the predictive model can result in substantial increases in expected sales over baseline policies.

Essay 2. Data-Driven Optimization for Team Formation

David Bergman, Teng Huang, and John Mathieu. Submitted to ***INFORMS Journal on Optimization***

Abstract: Allocating individuals to teams is a widely studied problem in management, both in the organizational-behavior and the operations-research literature. The former focuses on understanding team performance with little focus on forming teams, whereas the latter typically assumes team formation is based on pairwise utility that individuals receive for being matched with one another. This paper seeks to remedy the lack of cohesion in the literature by studying an end-to-end integrated decision-making framework for composing teams. Using data from a sample of teams competing in a longitudinal business simulation, we apply linear regression and neural network techniques to derive predictive models of team performance based on members' characteristics. We then study how to partition a collection of individuals into teams with best-expected performance based on the predictive models we train. We design various computational approaches that are specifically tailored to the predictive models

we developed in this paper. The optimization algorithms fall into the broader context of optimization with objective functions learned through predictive modeling, which can be applied in myriad of contexts. We exhibit the efficiency of the proposed algorithms and the capacity to employ the framework to compose higher functioning teams than those naturally occurring in practice.

Essay 3. JANOS : An Integrated Predictive and Prescriptive Modeling Framework

David Bergman, Teng Huang, Philip Brooks, Andrea Lodi, and Arvind U. Raghunathan. To be submitted to ***INFORMS Journal on Computing***

Abstract: Business research practice is witnessing a surge in the integration of predictive modeling and prescriptive analysis. We describe a modeling framework JANOS that seamlessly integrates the two streams of analytics, for the first time allowing researchers and practitioners to embed machine learning models in an optimization framework. JANOS allows for specifying a prescriptive model using standard optimization modeling elements such as constraints and variables. The key novelty lies in providing modeling constructs that allow for the specification of commonly used predictive models and their features as constraints and variables in the optimization model. The framework considers two sets of decision variables; *regular* and *predicted*. The relationship between the regular and the predicted variables are specified by the user as pre-trained predictive models. JANOS currently supports linear regression, logistic regression, and neural network with rectified linear activation functions, but we plan to expand on this set in the future. In this paper, we demonstrate the flexibility of the framework through an example on scholarship allocation in a student enrollment problem and provide a numeric performance evaluation.

Template-based Minor Embedding in Chimera Graphs for Adiabatic Quantum Optimization

Thiago Serra, Teng Huang, Arvind U. Raghunathan, and David Bergman. Submitted to ***INFORMS Journal on Computing***

Abstract: Quantum Annealing (QA) can be used to quickly obtain near-optimal solutions for Quadratic Unconstrained Binary Optimization (QUBO) problems. In QA hardware, each decision variable of a QUBO should be mapped to one or more adjacent qubits in such a way that pairs of variables defining a quadratic term in the objective function are mapped to some pair of adjacent qubits. However, qubits have limited connectivity in existing QA hardware. This has spurred work on preprocessing algorithms for embedding the graph representing problem variables with quadratic terms in the hardware graph representing qubits adjacencies, such as the Chimera graph in hardware produced by D-Wave Systems. In this paper, we use integer linear programming to search for an embedding of the problem graph into certain classes of minors of the Chimera graph, which we call *template embeddings*. One of these classes corresponds to complete bipartite graphs, for which we show the limitation of the existing approach based on minimum Odd Cycle Transversals (OCTs). Some of the formulations presented are exact, and thus can be used to certify the absence of a minor embedding. On an extensive test set consisting of random graphs from five different classes of varying size and sparsity, we can embed 38% more graphs than a state-of-the-art OCT-based approach.