Ruotong Sun

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EDUCATION

TSINGHUA UNIVERSITY Beijing, China 09/2021–present

- Overall GPA: 3.84/4.0
- Research Interest: **Optimization on Graph, Distributed Optimization, Federated Learning**
- Programming & Software: Python, R, C++, Latex
- English Proficiency: TOEFL 101, GRE 325

Main Course and Score

Linear Algebra	92	Convex Optimization	96
Complex Analysis	92	Foundations of Nonlinear Programming	98
Probability Theory	98	Operations Research for Deterministic Models	98
Statistical Inference	97	Operations Research (Decision Making)	87
Multivariate Statistical Analysis	98	Decision Analytics	98
Linear Regression Analysis	98	Big Data and Artificial Intelligence	100
Applied Statistics and Data Analytics	92	Machine Learning	98
Introduction to Bayesian Statistics	98	Data Structures and Algorithms	87
Game Theory	92	Intermediate Microeconomics	90

RESEARCH

Optimal Battery Placement 07/2024-present

Independent Research, Supervised by Prof. Ermin Wei, IEMS, Northwestern

- Developed a mathematical model to determine the optimal placement of a battery in a power grid with general topology to minimize costs over a finite time horizon.
- Applied KKT conditions to analyze the optimal cost and battery charge profile.
- Derived analytical results across a large parameter region for general network topology.
- Provided an analytical expression for cost under a tree topology, revealing its dependence not only on the weighted degree but also on factors such as subgraph connectivity and the centrality of the node where the battery is placed.
- Proposed a low-complexity algorithm for weakly cyclic network topology, significantly outperforming conventional solvers in terms of computational speed.
- Employed spectral graph theory to investigate the problem in a general network with general parameter settings, examining how degree and algebraic connectivity influence the optimal placement decisions.
- Validated the results via simulations on IEEE case (topology).

Dynamic Repositioning in Free-Floating Bike-Sharing Systems 09/2023-01/2024

Group Research, Supervised by Prof. Chen Wang & Prof. Lei Zhao, Dept. of Industrial Engineering, Tsinghua

- Utilized Prof. Powell's unified framework for sequential decision-making to model a Markov Decision Process (MDP) under real-world uncertainty.
- Estimated the bike arrival rate at each gathering point using an inhomogeneous Poisson process.
- Solved the MDP using Approximate Dynamic Programming (ADP) by designing effective policies through Policy Function Approximation (PFA) and Cost Function Approximation (CFA). Specifically, an "Affine Policy" was employed for inventory decision-making, a "Random PFA Policy" based on the Boltzmann distribution was used for routing decisions, and the CFA policy for en route decisions carefully balanced the trade-off between the cost of unmet demand at subsequent nodes and the loading amounts during transit.
- Adopted the Optimal Computing Budget Allocation (OCBA) method to find the optimal parameter settings for the policy.
- Mitigated the spatial-temporal imbalance, achieving an improved demand-satisfaction ratio from 69.50% to 90.21%.

Coupon Personalization in E-commerce Platforms with Multi-Dimensional Data 04/2023-03/2024

Independent Research, Supervised by Prof. Chen Wang, Dept. of Industrial Engineering, Tsinghua

- Proposed a deep learning framework to predict user behavior with both accuracy and interpretability and implemented an iterative algorithm for coupon personalization to maximize revenue, guided by customer behavior predictions.
- Leveraged a heterogeneous GNN on the user-product bipartite graph to enhance feature representation.

- Utilized a transition matrix to model customer transition probabilities across products. Additionally, employed a Hidden Markov Model (HMM) to capture a customer's action sequence with respect to a specific product. The hidden states in the HMM represent customers' psychological processes, enhancing the model's interpretability.
- Analyzed the probability of actions in HMM, revealing the revenue increases were directly proportional to the probability of marking as a favorite and leaving while inversely proportional to the probability of purchasing and adding items to the cart. This analysis demonstrated the model's interpretability. The final revenue is increased by $3 per person.
- **Has been accepted by the IEEE Conference on Automation Science and Engineering (CASE).**
- **Delivered presentation via an online session on 29, Aug 2024**

INTERNSHIP AND PROJECTS

An Optimal Strategy for Substituting the Track Currently in Use 08/2023-09/2023

Member of Logistics Operations AI Algorithm Department at JD Company

- Replacing third-party trucks with company-operated trucks aims to reduce operational costs.
- Extracted constraints from real scenarios and modeled the problem with a large-scale mixed integer program (MIP).
- Solved the problem using methods both with and without Column Generation, utilizing Gurobi in Python.
- The method for generating a substitution policy has now been patented.

Optimize Condenser's Parameters 02/2024-04/2024

Course Project

- Modeled the traditional engineering problem as a black-box optimal design, where results were generated by solving fluid dynamics differential equations in engineering software, a time-consuming process for each iteration.
- Utilized the Bayesian Optimization (BO) method with Expected Improvement (EI) as the acquisition function.
- Attained results that were just as good as those achieved by PSO but with fewer iterations, reducing a lot of time.

Predict Students' Dropout Behavior 04/2023-06/2023

Course Project of Applied Statistics and Data Analytics

- Implemented the classification of students by Random Forest, AdaBoost, KNN, and soft-margin kernel SVM
- Analyzed which features induce students' dropout behavior by Factor Analysis (FA)

Algorithms Implementation 12/2023-01/2024

Course Project of Statistical Computing and Software

- Applied the Simulated Annealing (SA) algorithm to realize manually in Python to solve TWVRP benchmarks.
- Implemented log-barrier method and primal-dual method to solve convex optimization problems with constraints.
- Implemented ADMM, proximal gradient method, and sub-gradient method in Python.

INTERESTS AND HOBBIES

I'm really into sports, especially soccer and tennis, and I'm a huge fan of FC Barcelona. I played on my department's soccer team during my first two years at university. Also, this past summer at Northwestern, I got to play beach volleyball with my lab mates almost every week on Clark Street Beach. Also, I enjoy watching anime and playing board games in my spare time.