2026 Workshop on Mathematical Theory and Methods in Intelligent Transportation, Tianyuan Mathematics Research Center Conference

Handbook

Conference Dates: January 11 - 17, 2026

Conference Venue: Tianyuan Mathematics Research Center, Kunming, Yunnan, China

Organizers:

Deren Han (Beihang University)

Caihua Chen (Nanjing University)

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Workshop Content and Scientific Significance:

This workshop aims to promote innovation and expand the boundaries of applied mathematical theory. The challenges of high dimensionality, dynamism, and uncertainty faced by intelligent transportation will drive demand for new mathematical tools, algorithms, and models, which will in turn nourish the development of mathematics, creating a positive feedback loop. The workshop will build a collaborative platform for mathematicians, transportation engineers, computer scientists, and urban planners. It will focus on joint research and case validation in areas such as multi-source heterogeneous data fusion, spatiotemporal prediction, network optimization and control, game theory and mechanism design, stochastic and robust optimization, causal inference and evaluation. Research topics include: 1) Conducting spatiotemporal modeling and

fusion of multi-source heterogeneous data to form interpretable demand prediction and congestion evolution models; 2) Designing stochastic/robust/distributed algorithms for scheduling, signal control, and route optimization, and providing computable convergence and error bounds; 3) Conducting game theory and mechanism design for complex systems to characterize traveler behavior and incentives; 4) Constructing standard datasets, evaluation metrics, and open-source tools to support reproducibility and benchmarking. The scientific significance lies in: using mathematical, verifiable models to connect mechanisms with applications, promoting deep integration among mathematics, computing, and transportation engineering; deepening the quantitative characterization of the underlying principles of complex transportation systems, fostering deep coupling between mathematical theory and engineering practice, and accelerating the transition of research outcomes from the "lab" to the "road"; providing verifiable theoretical support and decision-making basis for future intelligent, green, and safe transportation infrastructure; enhancing system resilience and emergency response capabilities through systematic modeling of uncertainty and risk; cultivating interdisciplinary talent, enhancing innovation capabilities in industry and public governance, ultimately improving urban operational efficiency, reducing carbon emissions, and ensuring public safety, which holds long-term and profound strategic value.

Expected Outcomes:

1. Formation of a Theoretical Framework Consensus: Clarify the application pathways and bottlenecks of key mathematical techniques in core intelligent transportation problems, distill future key research directions, and provide theoretical guidance for the field's development.
2. Promotion of Interdisciplinary Collaboration: Establish a platform for in-depth exchange among mathematics, computer science, transportation engineering, and other disciplines, facilitating the creation of several interdisciplinary collaborative projects and teams.
3. Generation of Decision Support Recommendations: Summarize and form an expert recommendation white paper on intelligent transportation system optimization, policy formulation, and standard development, providing a theoretical basis for scientific decision-making by relevant departments.
4. Discovery and Cultivation of Talent: Stimulate innovative thinking among young scholars and graduate students, cultivating much-needed compound-type reserve talent for the field.

Schedule

January 12, 2026 (Monday)			
09:00-09:30	Opening Ceremony & Group Photo		
Time	Speaker	Presentation Title	Chair
09:30-10:20	Yuhong Dai Academy of Mathematics and Systems Science, CAS	A Surrogate Value Function Formulation for Bilevel Optimization	Xinwei Liu
10:20-10:50	Break		
10:50-11:40	Hai Yang Hong Kong University of Science and Technology	Some Emerging Research Issues in Ride-sourcing Markets	Xinwei Liu
11:40-14:30	Free Time: Lunch		
14:30-15:20	Caihua Chen Nanjing University	Identifying spatiotemporal positions of network-wide traffic incidents with floating car data: A shockwave-informed optimization model	Jin Zhang
15:20-15:50	Break		
15:50-16:40	Yaohua Hu Shenzhen University	Nonconvex Sparse Optimization and Matrix Low-Rank Optimization	Jin Zhang
16:40-17:30	Free Discussion		Chunfeng Cui
17:30-19:30	Free Time: Dinner		

January 13, 2026 (Tuesday)			
Time	Speaker	Presentation Title	Chair
09:00-09:50	Haijun Huang Beihang University	Research Progress on the Continuous Corridor Problem	Wei Xu
09:50-10:20	Break		
10:20-11:10	Zhixing Luo Nanjing University	Approximation for Pure Integer Two-stage Distributionally Robust Service Network Design Problem with Demand Uncertainty	Wei Xu
11:10-12:00	Free Discussion		
12:00-14:30	Free Time: Lunch		Zhengli Wang
14:30-15:20	Hu Shao China University of Mining and Technology	Modeling and Algorithms for Traffic Demand Flow: Observation, Estimation, and Prediction	Hongli Xu
15:20-15:50	Break		
15:50-16:40	Meng Long Chongqing National Applied Mathematics Center	Dynamic Bus Signal Priority under Vehicle-Road Coordination: Deep Reinforcement Learning Methods and Optimization	Hongli Xu
16:40-17:30	Free Time: Lunch		Meng Long
17:30-19:30	Free Time: Dinner		

January 14, 2026 (Wednesday)			
Time	Speaker	Presentation Title	Chair
09:00-09:50	Deren Han Beihang University	Efficiency, Equity, and Mechanism Design in Traffic Management	Xingju Cai
09:50-10:20	Break		
10:20-11:10	Liwei Zhang National Frontiers Science Center for Intelligent Industrial Systems & Optimization, Northeastern University	Halpern Acceleration of the Inexact Proximal Point Method of Rockafellar	Xingju Cai
11:10-12:00	Free Discussion		Yuqia Wu
12:00-14:30	Free Time: Lunch		
14:30-17:30	Free Discussion		
17:30-19:30	Free Time: Dinner		

January 15, 2026 (Thursday)			
Time	Speaker	Presentation Title	Chair
09:00-09:50	Xiaolei Wang Tongji University	Service Network Design of Modular Vehicles on General Road Networks Considering Passengers' Turning Choices	Mengwei Xu
09:50-10:20	Break		
10:20-11: 10	Junfeng Yang Nanjing University	A Single-Loop Algorithm for Decentralized Bilevel Optimization	Mengwei Xu
11:10-12:00	Free Discussion		Shangzhi Zeng
12:00-14:30	Free Time: Lunch		
14:30-15:20	Jianlin Jiang Nanjing University of Aeronautics and Astronautics	Sparse-dense flight copy-based interactive mechanism to airline integrated recovery with cruise speed control	Linglin g Xu
15:20-15:50	Break		
15:50-16:40	Shangzhi Zeng Southern University of Science and Technology	Extended SQP Methods in Nonsmooth Difference Programming Applied to Problems with Variational Inequality Constraints	Linglin g Xu
16:40-17:30	Free Discussion		
17:30-19:30	Free Time: Dinner		

January 16, 2026 (Friday)			
Time	Speaker	Presentation Title	Chair
09:00-09:50	Jiaxin Xie Beihang University	Enhanced randomized Douglas-Rachford method: Improved probabilities and adaptive momentum	Zaiyun Peng
09:50-10:20	Break		
10:20-11: 10	Xiangfeng Wang East China Normal University	Verifiably Improving Optimization Algorithms via LLMs	Zaiyun Peng
11:10-12:00	Free Discussion		
12:00-14:30	Free Time: Lunch		
14:30-17:30	Free Discussion		
17:30-19:30	Free Time: Dinner		

A Surrogate Value Function Formulation for Bilevel Optimization

Yuhong Dai

Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: The value function formulation captures the hierarchical structure of bilevel optimization through the optimal value of the lower level problem, but its implicit and nonsmooth nature poses significant analytical and computational challenges. We propose a surrogate value function formulation that replaces the implicit value function with an explicit surrogate based on lower level stationarity. Unlike Karush-Kuhn-Tucker formulations, our proposed formulation avoids incorporating the entire stationary set of the lower level problem into the upper level feasible region. The surrogate value function formulation is shown to be equivalent to the original bilevel program when the lower level Lagrangian is pseudoconvex. In addition, the relationships between the stationarity conditions of the surrogate value function formulation and those of existing single-level models are characterized. To handle the complementarity constraints, we develop a smoothing barrier augmented Lagrangian method and show that accumulation points of the generated iterates are Clarke stationary. Extensive numerical experiments, including nonconvex and degenerate cases, demonstrate the effectiveness of the surrogate value function formulation. This is a joint work with Mengwei Xu, Xin-Wei Liu and Meiqi Ma.

Speaker Bio: Yuhong Dai is an Academician of the Chinese Academy of Sciences, Deputy Director and a Research Fellow/Ph.D. Supervisor at the Academy of Mathematics and Systems Science, CAS. He currently serves as the Chairman of the Chinese Society of Operations Research, Vice Chairman of the Chinese Mathematical Society, and Vice President of the International Federation of Operational Research Societies (IFORS). Researcher Dai has long been engaged in theoretical and applied research on optimization methods, making systematic and creative contributions in continuous optimization, integer programming, and applied optimization. He has presided over or is presiding over several major funding projects, including the National Science Fund for Distinguished Young Scholars, the NSFC Innovative Research Group Project, and the "14th Five-Year Plan" National Key R&D Program

Project. He was invited to give a 45-minute invited presentation at the 2022 International Congress of Mathematicians and a one-hour invited presentation at the 24th International Symposium on Mathematical Programming in 2022. He received the National Natural Science Award (Second Class, 2006, ranked second), the Feng Kang Prize for Scientific Computing (2015), the Chen Xingshen Mathematics Prize of the Chinese Mathematical Society (2017), the first Xiao Shutie Applied Mathematics Prize of the China Society for Industrial and Applied Mathematics (2018), and the Operations Research Application Award of the Chinese Society of Operations Research (2018). He was elected as a Fellow of the China Society for Industrial and Applied Mathematics in 2021, an inaugural Fellow of the Chinese Society of Operations Research in 2022, a Fellow of the International Federation of Operational Research Societies in 2023, and an Academician of the Chinese Academy of Sciences in 2025.

Some Emerging Research Issues in Ride-sourcing Markets

Hai Yang

The Hong Kong University of Science and Technology

Abstract: Urban mobility has undergone drastic changes in recent years with the introduction of application-based taxi and car service e-hailing systems. These systems provide timely and convenient on-demand ride services to anyone, anywhere and anytime. E-hailing is now prevalent in the traditional taxi industry by effectively mitigating information asymmetry and uncertainty between customers and taxi drivers; E-hailing in the form of ride-sourcing can efficiently match a requesting customer with an affiliated private car driver nearby for on-demand ride services. This talk highlights some emerging research issues and latest developments in ride-sourcing markets, including demand forecasting, surge-pricing, matching and ridesharing, as well as analysis of human mobility and network property with big car trajectory data.

Speaker Bio: Prof. Hai Yang is a highly regarded Chair Professor at The Hong Kong University of Science and Technology, with a global reputation as an active scholar in the transportation field. He has published over 350 papers in leading international

journals, including Transportation Research, Transportation Science, and Operations Research, and has an impressive SCI H-index citation rate of 73. Prof. Yang has received numerous national and international awards, including the 2020 Frank M. Masters Transportation Engineering Award and the 2021 Francis C. Turner Award of the American Society of Civil Engineers. He was also appointed as Chang Jiang Chair Professor of the Ministry of Education of PR China and served as the Editor-in-Chief of Transportation Research (TR) Part B: Methodological from 2013 to 2018. Currently, Prof. Yang serves on the Distinguished Editorial Board of Transportation Research Part B: Methodological, Scientific Council of Transportation Research Part C: Emerging Technologies, and serves as an Advisory Editor of Transportation Science.

Identifying spatiotemporal positions of network-wide traffic incidents with floating car data: A shockwave-informed optimization model

Caihua Chen

Nanjing University

Abstract: Accurate spatiotemporal positions of traffic incidents, namely their occurrence times and links, are crucial for extensive incident-related analyses and traffic management systems. Such information is difficult to obtain directly from incident reports due to ambiguous text descriptions and unreported incidents. To address this issue, some existing studies have utilized various data sources, like social media data, and develop data-driven methods for incident identification. However, the limited data availability and potential low data quality across the road networks, including data missing and errors, may prevent these methods from accurately identifying the spatiotemporal positions of network-wide incidents. In this research, we attempt to address these challenges by developing a shockwave-informed optimization model using floating car data (FCD). The input to our model includes network-wide traffic speeds during the analysis period, which may contain measurement errors and missing data but are generally available across the entire network. Our model then outputs the most likely spatiotemporal positions of

network-wide incidents. Specifically, the identification is achieved by analyzing the origins associated with spatiotemporal progression of incident impact. To address missing and erroneous speed data, we formulate shockwave propagation as constraints to characterize the incident impact on speed evolution across adjacent links and time intervals, which compensates for the limited information in the corrupted data. Moreover, the complex road network structure influencing shockwave propagation is incorporated within the constraints. Under suitable assumptions, we prove that solving the model is equivalent to performing maximum likelihood estimation. Numerical experiments are conducted to validate our model and results show that satisfactory results can be achieved under different missing rates and noise magnitudes, which demonstrates the accuracy and robustness of our proposed model.

Speaker Bio: Caihua Chen is a recipient of the National Science Fund for Outstanding Young Scholars and a principal investigator for a major project under the National Natural Science Foundation of China. He is currently a Professor, Ph.D. Supervisor, and Vice Dean of the School of Engineering Management at Nanjing University. He holds a Ph.D. in Science from Nanjing University and was a joint Ph.D. candidate at the National University of Singapore. His research focuses on data-driven decision-making, theory and algorithms for decision-making under uncertainty, and design and application of optimization algorithms. Representative works have been published in journals such as Management Science, Mathematical Programming, INFORMS Journal on Computing, SIAM series, IEEE series magazines, and top AI conferences like NeurIPS and CVPR. Awards include the Chinese Mathematicians Alliance Best Paper Award (2017, 2018), the Youth Science and Technology Award of the Chinese Society of Operations Research (2018), and the Youth Award of the Jiangsu Society for Industrial and Applied Mathematics (2020). He received the Nanjing University May Fourth Youth Medal (Individual in 2019, Team in 2024), and was selected for the inaugural Nanjing University Zhongying Young Scholars Program (2017), the Nanjing University Young Distinguished Teacher and Course Cultivation Plan (2020), and the Jiangsu Social Science Outstanding Young Talent

Program (2019). He teaches and participates in courses including Introduction to Data Analysis and Decision Making (in-person), Applied Statistics (in-person), Stochastic Optimization Theory and Applications (in-person), Applied Statistics and R Language (MOOC, launched Spring 2021, National First-class Course), Optimization Theory and Methods (MOOC, launched Spring 2022), and Graduate Academic Norms and Integrity (MOOC, launched Fall 2021, Jiangsu Provincial High-quality Teaching Resource). He has guided undergraduate students to win awards such as Finalist in the American Mathematical Contest in Modeling multiple times, and first prize in the National Industrial Engineering and Lean Management Innovation Competition. His graduate students have won gold awards in the China College Students International Innovation Contest.

Nonconvex Sparse Optimization and Matrix Low-Rank Optimization

Yaohua Hu

Shenzhen University

Abstract: Sparse optimization and low-rank optimization are hot research topics in operations research and optimization, with wide applications in information theory, imaging science, machine learning, and other fields. Nonconvex regularization methods have demonstrated powerful sparsity-inducing and noise-robust properties in applications. Bioinformatics, an emerging interdisciplinary field, explains phenomena of life and evolution through interactions between genes. This talk will introduce the bridge between sparse/low-rank optimization and bioinformatics, describing various nonconvex sparse/low-rank optimization models corresponding to different gene regulatory network structures. We will also focus on the mathematical theory of nonconvex sparse/low-rank optimization models, including model consistency and asymptotic theory, equivalent characterization of optimal solutions, linear convergence rate, and global convergence theory for first-order algorithms.

Speaker Bio: Yaohua Hu received his Bachelor's and Master's degrees from Zhejiang University and his Ph.D. from The Hong Kong Polytechnic University. He is currently a Distinguished Professor, Vice Dean, and Ph.D. Supervisor at the School of Mathematical Sciences, Shenzhen University, and an adjunct Ph.D. Supervisor at The

Hong Kong Polytechnic University. His main research areas are continuous optimization theory, methods, and applications. Representative works have been published in journals such as SIAM Journal on Optimization, Mathematical Programming, Inverse Problems, Journal of Machine Learning Research, Genome Biology, and Bioinformatics. He holds several authorized national invention patents and has developed multiple bioinformatics toolkits and databases.

Research Progress on the Continuous Corridor Problem

Haijun Huang

Beihang University

Abstract: This report unfolds around four aspects: (1) Introducing the fundamental importance, basic formulation, and open problems of the corridor problem. (2) Introducing the latest research progress on the continuous corridor problem. (3) Proof: When the unit penalty function for early/late arrival time is continuous, under the non-toll equilibrium state, the spatiotemporal departure distribution of commuters on the corridor is horn-shaped, and the vertex of the horn is the corridor endpoint. (4) Proof and observation: The distribution density of commuter quantities increases first and then decreases along the corridor from the starting point to the endpoint.

Speaker Bio: Haijun Huang is a Changjiang Distinguished Professor at Beihang University and Director of the Key Laboratory of Complex System Analysis and Management Decision, Ministry of Education. He is a member and advisory committee member of the National Natural Science Foundation of China, a member of the ISTTT International Advisory Committee, a member of the WCTRS Steering Committee, Editor-in-Chief of Transport Policy, and an Associate Editor of TR Part E, TS, and other journals. Focusing on themes such as traffic network models, road traffic flow models, congestion pricing, and smart transportation and logistics, he has presided over and completed projects including the National Science Fund for Distinguished Young Scholars, the Innovative Group Science Fund, the National 973 Program, and key national R&D programs. Awards received include the Fudan Management Outstanding Contribution Award, the Chinese Society of Systems

Engineering Theory Contribution Award, and the National Natural Science Award (Second Class).

Approximation for Pure Integer Two-stage Distributionally Robust Service Network Design Problem with Demand Uncertainty

Zhixing Luo

Nanjing University

Abstract: We investigate a distributionally robust service network design problem with integer recourse and addresses the computational challenge stemming from integer recourse. Based on a two-stage consolidation-based formulation, the second-stage worst-case expected cost can be evaluated in closed form by leveraging the concave envelope of the recourse function. The closed-form nature enables reformulation of the original two-stage model into an approximate model that can be solved directly by commercial solvers. Numerical experiments on the Civil Aeronautics Board dataset show that the proposed approximation approach is capable of solving large-scale instances—with up to 3.5 million variables—within acceptable computation time. Out-of-sample simulations demonstrate that our model outperforms both deterministic and stochastic benchmarks, validating the quality of the approximation.

Speaker Bio: Dr. Zhixing Luo received his Bachelor's degree from South China University of Technology in 2010 and his Ph.D. from City University of Hong Kong in 2014. He is currently a Professor and Ph.D. Supervisor at the School of Engineering Management, Nanjing University. His main research areas are operations research optimization algorithm design, smart logistics, and intelligent manufacturing. He has presided over one National Natural Science Foundation Youth Project, one General Project, and one Excellent Young Scientists Project. He has published over ten papers in internationally renowned journals such as Management Science, Manufacturing & Service Operations Management, INFORMS Journal on Computing, Transportation Science, Transportation Research Part-B: Methodological, and Naval Research Logistics. In 2018, he participated in JD Logistics' "Global Operations

Research Optimization Challenge" and won first place in the Urban Logistics Vehicle Intelligent Dispatch track. He was selected for the China Association for Science and Technology Young Talent Support Project in 2019 and received the Huawei Noah's Ark Lab Outstanding University Cooperation Project Award in 2020.

Modeling and Algorithms for Traffic Demand Flow: Observation, Estimation, and Prediction

Hu Shao

China University of Mining and Technology

Abstract: Traffic demand flow estimation (TDFE) is a critical task in urban transportation planning and management, as it provides a scientific foundation for decision-making in infrastructure construction, public transit optimization, and congestion mitigation. To address this problem, this study comprises three systematic and interconnected research components: (1) the establishment of an observability theory based on graph isomorphism to guide cost-effective data acquisition, (2) the development of a deep learning-based model for accurate and interpretable dynamic TDFE, and (3) the construction of a bilevel origin-destination (OD) demand model along with the design of a corresponding efficient solution algorithm. To overcome the economic constraints of limited sensing resources, this research first establishes a graph theory-based analytical framework for traffic network flow observability. It derives the analytical relationship for the minimum number of observable links and subsequently proposes a resource-constrained sensor deployment optimization model. By quantifying the information loss imposed by budget limitations, the model aims to maximize network flow observability at minimal cost, thereby laying a high-quality data foundation for subsequent analysis. For accurate and interpretable estimation of dynamic traffic demand, a Multi-feature Recurrent Learning Network (MRLN) that integrates physical traffic mechanisms is developed. This model structures key system processes such as trip distribution, route choice, and traffic assignment into interpretable computational units. Through a temporal-recursive and feature-fusion architecture, it achieves high-fidelity inversion of dynamic origin-destination (OD)

demand, significantly enhancing both model interpretability and estimation accuracy. Addressing the practical challenge of solving complex models with real-world, multi-source heterogeneous data, a bilevel OD estimation model is constructed. A tailored, efficient heuristic solving algorithm based on the proximal linearized Alternating Direction Method of Multipliers (ADMM) is designed for this model. This algorithm substantially improves computational efficiency and numerical stability in data-sparse and heterogeneous scenarios, ensuring the practical utility of advanced estimation models. The three research components follow a progressive logic: the economical deployment establishes the essential data foundation for precise modeling, which in turn drives the development of robust solving algorithms. This complete technical chain ensures the practical applicability of advanced models, ultimately delivering an implementable framework for TDFE that provides tangible support for decision-making in intelligent transportation systems.

Speaker Bio: Hu Shao is a Professor, Ph.D., and Ph.D. Supervisor at the School of Mathematics, China University of Mining and Technology. He serves as a Standing Committee member of the University Academic Committee, Deputy Director of the Jiangsu Applied Mathematics Center (CUMT), Director of the Mathematics Discipline Construction and Guidance Committee, and Director of the Professor Committee of the School of Mathematics. He is a National Coal Industry Teaching Master, an Outstanding Instructor for the National Undergraduate Mathematical Contest in Modeling, an Outstanding Communist Party Member of Jiangsu Universities, the Leader of the Jiangsu "Qinglan Project" Outstanding Teaching Team, and Vice Chairman of the Jiangsu Society of Operations Research. As principal investigator, he has continuously presided over five National Natural Science Foundation projects (four General Projects and one Youth Project) and three Provincial Teaching Reform Projects (including two key projects). He has published over 70 research papers, authored one monograph as first author, co-authored two textbooks, and received over 100 awards including the Jiangsu Teaching Achievement Award (First Class), the Ministry of Education Natural Science Award (Second Class), and the CUMT Teaching Contribution Award and Teaching Model Award. His

research primarily focuses on problem-driven "applied mathematics," involving optimal control theory applications, traffic network modeling and algorithm design, data-driven network modeling and algorithms, and applications of machine learning.

Dynamic Bus Signal Priority under Vehicle-Road Coordination: Deep Reinforcement Learning Methods and Optimization

Meng Long

Chongqing National Applied Mathematics Center

Abstract: Traffic signal priority is an effective measure to alleviate traffic congestion in metropolises and improve bus efficiency. Addressing the shortcomings of existing bus signal priority methods in terms of model dependency and response lag, this work proposes a deep reinforcement learning-based bus signal priority method in a vehicle-road coordinated environment. It integrates engineering constraints into the learning algorithm to ensure decision rationality and effectively handles multiple conflicting bus priority requests, the trade-off between priority and non-priority vehicles, and multi-intersection coordinated control. Simulation results for single and multiple intersections show that this method can significantly improve bus operation reliability and road traffic efficiency, demonstrating good prospects for engineering application.

Speaker Bio: Meng Long is a Lecturer at the Chongqing National Applied Mathematics Center, Chongqing Normal University, and a core member of the Mathematics and Intelligent Transportation team. He received his Master's degree in Traffic Information Engineering & Control from Dalian University of Technology in 2020 and his Ph.D. in Intelligent Transportation Systems from The Hong Kong Polytechnic University in 2024. He visited the Institute of Industrial Science, the University of Tokyo, Japan, for six months. In 2025, he was selected for the New Chongqing Talent Introduction Plan - Outstanding Youth Special Program. His main research focuses on AI-enabled road traffic control and management, including reinforcement learning-based bus signal priority and freeway weaving area merging control. His work has been published in journals such as Transportation Research Part

C and IEEE Transactions on Intelligent Transportation Systems.

Efficiency, Equity, and Mechanism Design in Traffic Management

Deren Han

Beihang University

Abstract: Traffic management employs means such as the planning, design, construction, operation, and maintenance of road traffic to improve traffic efficiency, reduce congestion, enhance safety, improve the traffic environment, and promote sustainable urban development. Through mathematical models, this report focuses on the design and efficiency analysis of charging strategies for road congestion management, and analyzes equity issues involved in such strategies.

Speaker Bio: Deren Han is a Professor and Ph.D. Supervisor, currently serving as Dean of the School of Mathematical Sciences, Beihang University, and Secretary-General of the Teaching Guidance Committee for Mathematics Majors, Ministry of Education. His research focuses on large-scale optimization problems, variational inequality problems, as well as traffic planning and magnetic resonance imaging. He has received awards including the Ministry of Education Award for Outstanding Scientific Research Achievements (Natural Sciences and Engineering Technology, Second Class), the Jiangsu Science and Technology Progress Award, and the Youth Science and Technology Award of the Chinese Society of Operations Research. He has presided over multiple projects including the National Science Fund for Distinguished Young Scholars and key NSFC projects. He serves as Vice Chairman of the Chinese Society of Operations Research and Chairman of its Algorithm Software and Application Branch. He is an editorial board member of Numerical Mathematics: A Journal of Chinese Universities (English Series), Journal of the Operations Research Society of China, Journal of Global Optimization, and Asia-Pacific Journal of Operational Research.

Halpern Acceleration of the Inexact Proximal Point Method of Rockafellar

Liwei Zhang

National Frontiers Science Center for Intelligent Industrial Systems & Optimization, Northeastern University

Abstract: This work investigates a Halpern acceleration of the inexact proximal point method of Rockafellar for solving maximal monotone inclusion problems in Hilbert spaces. The proposed Halpern inexact proximal point method (HiPPM) is shown to be globally convergent, and a unified framework is developed to analyze its worst case convergence behavior. Under mild conditions on the inexactness tolerances, HiPPM achieves an $O(k^{-2})$ convergence rate in terms of the squared fixed point residual. Moreover, under additional well-studied regularity conditions, the method attains a fast linear convergence rate. Building on this framework, we further extend the Halpern acceleration to the inexact augmented Lagrangian method for constrained convex optimization. In the spirit of Rockafellar's classical results, the resulting accelerated inexact augmented Lagrangian method inherits the convergence rate and iteration complexity guarantees of HiPPM. Numerical experiments are provided to support the theoretical findings.

Speaker Bio: Liwei Zhang is a Professor at the National Frontiers Science Center for Intelligent Industrial Systems & Optimization, Northeastern University, and a Supervisor of the Chinese Society of Operations Research. He has long been engaged in research on the theory and algorithms of "matrix optimization," "stochastic programming," and "equilibrium optimization," achieving systematic research results in stability analysis and proximal point methods. He has published over 130 SCI-indexed papers in professional journals, including more than twenty in top international journals such as Mathematical Programming, Operations Research, SIAM Journal on Optimization, Mathematics of Operations Research, Mathematics of Computation, JMLR, and IEEE Transactions on Automatic Control. He has published 6 monographs and textbooks with Science Press. He is currently presiding over a key project under the National Key R&D Program and has completed/hosted several NSFC General Projects and two key project sub-tasks. He is an editorial board member of *APJOR*, *NACO*, and *Operations Research Transactions*. He received the

Operations Research Research Award from the Chinese Society of Operations Research in 2020.

Service Network Design of Modular Vehicles on General Road Networks Considering Passengers' Turning Choices

Xiaolei Wang

Tongji University

Abstract: The emergence of modular vehicles (MVs) opens the avenue to an entirely new urban transit system, in which a fleet of MVs circulating within the road network constitute a dynamic MV service network, and transit passengers can freely and stop-lessly choose where they go at each intersection by transferring to the appropriate pod. Provided feasible MV circulation patterns on the road network, this paper develops a novel mathematical model to depict passengers' turning choices at user equilibrium in the MV service network. We establish the equivalence of this model to a linear optimization problem, which can be further transformed into a multi-commodity network flow problem on a revised network. Taking passengers' turning choices as the lower-level problem, we then propose a bi-level problem to optimize the modular pod (MP) circulation pattern. We show that this bi-level problem can be transformed into a non-convex single-level problem with bi-convex property, and employ a multi-start alternating minimization (AM) algorithm to solve it by iteratively solving two convex subproblems. The convergence of the AM algorithm is established, and tailored algorithms are developed for solving each subproblem efficiently in large-scale networks. To mitigate the AM algorithm’s susceptibility to poor local optima in non-convex problems, an enhanced multi-start heuristic (MSAM) is proposed. Numerical experiments on small- to large-scale networks validate the effectiveness of the proposed model and demonstrate the computational efficiency of the developed algorithms.

Speaker Bio: Xiaolei Wang is a Tenured Professor (Youth Hundred A-Level) at the School of Economics and Management, Tongji University. She received her Bachelor's degree from the University of Science and Technology of China in 2008

(recipient of the Guo Moruo Scholarship) and her Ph.D. from The Hong Kong University of Science and Technology in 2012 (recipient of the HKUST SENG PhD Research Excellence Award). She has been dedicated to research in urban transportation system optimization, with main research interests: shared mobility service operation optimization and urban traffic management under shared mobility. She has published over 30 papers in major SCI/SSCI transportation journals, with 16 in top journals in operations research and transportation such as INFORMS Journal on Computing, Transportation Research Part B, and Transportation Science, with an average citation count of over 80 per paper. She has presided over key, excellent young scientist, general, and youth projects of the National Natural Science Foundation of China, and the CCF-Didi Gaia Youth Fund Project, and is a key member of the innovative group project "Integrated Transportation System Operation Management." She is the Chair of the Shared and On-Demand Mobility Technical Committee of the World Transport Convention, a member of the Transportation Management Branch of the Management Science and Engineering Society, and an editorial board member of the major transportation journal Transportation Research Part E.

A Single-Loop Algorithm for Decentralized Bilevel Optimization

Junfeng Yang

Nanjing University

Abstract: Bilevel optimization (BO) has gained significant attention in recent years due to its broad applications in machine learning. In this talk, we focus on decentralized BO and proposes a novel single-loop algorithm for solving it with a strongly convex lower-level problem. Our approach is a fully single-loop method that approximates the hypergradient using only two matrix-vector multiplications per iteration. Our algorithm does not require any gradient heterogeneity assumption and achieves the best-known convergence rate for BO algorithms. We also present experimental results on hyperparameter optimization problems using both synthetic and MNIST datasets, which demonstrate the efficiency of our proposed algorithm.

（Joint with Dong Youran, Ma Shiqian, and Yin Chao)

Speaker Bio: Junfeng Yang, Professor, School of Mathematics, Nanjing University. His research interests are computational methods of mathematical optimization and their applications, with a particular focus on the algorithm design and analysis for large-scale structured optimization problems arising from image/signal processing, compressed sensing, sparse/low-rank optimization, statistics/machine learning, etc. He has developed MATLAB packages FTVd, YALL1, and RecPF, which are dedicated to image restoration, compressed sensing decoding, and magnetic resonance imaging. His research works have been published in prestigious journals such as SIAM Journal on Optimization, Mathematics of Operations Research, SIAM Journal on Scientific Computing, SIAM Journal on Imaging Sciences, Mathematics of Computation, and IMA Journal of Numerical Analysis.

Sparse-dense flight copy-based interactive mechanism to airline integrated recovery with cruise speed control

Jianlin Jiang

Nanjing University of Aeronautics and Astronautics

Abstract: Aircraft rerouting and passenger reallocation are critical in airline recovery. The recovery decision of aircraft rerouting greatly affects other recovery phases, and the recovery performance of passenger reallocation influences the direct revenue of airline companies and the social reputation of the airline industry. We consider aircraft rerouting and passenger reallocation from an integration perspective to preserve their interdependence, which is neglected by the regular sequential recovery. In addition, we take the cruise speed control into consideration to improve the recovery performance. As a common way to describe the adjustments of flights in disruptions, the flight copy approach requires a lot of flight copies to obtain high-quality recovery plans, especially when considering cruise speed control. Then, the network scale of the associated problem is quite huge, and thus, solving such an integrated problem is challenging due to the real-time requirement in disruption management. This paper introduces a sparse-dense flight copy approach and proposes an interactive

mechanism that alternately adjusts aircraft routes on the sparse flight copy-based network and reallocates passenger itineraries on the dense flight copy-based network. These two networks become much smaller than those from the regular flight copy approach, and the solution difficulty decreases significantly. To realize such a mechanism, we develop a mathematical model to formulate the integrated recovery problem and propose a customized Benders decomposition (CBD) method to solve the model. The Benders decomposition strategy divides the proposed model into the aircraft rerouting subproblem and passenger reallocation subproblem, benefitting from the sparse-dense flight copy approach. By exploiting the properties and structure of the integrated recovery problem, we propose some acceleration techniques (including an effective feasibility certificate, scale management, and valid inequalities) to further promote the efficiency of the CBD method. Computational experiments on real-world data show that high-quality integrated recovery solutions (with optimality gaps within 5%) can be obtained by the proposed method within reasonable runtime. The effectiveness of acceleration techniques is also verified by the experiments.

Speaker Bio: Jianlin Jiang is a Professor and Ph.D. Supervisor at Nanjing University of Aeronautics and Astronautics. He received his Bachelor's degree in Computational Mathematics from the Department of Mathematics, Nanjing University in 2000, and his Ph.D. in Computational Mathematics from the same department in 2005. His research directions include numerical optimization, air traffic operations research and optimization. He has published over 40 academic papers in domestic and international formal journals. He has presided over one Key Project, three General Projects, two Tianyuan Fund projects, and one Special Fund project of the National Natural Science Foundation of China. He was appointed as a "Chutian Scholar" Distinguished Professor of Hubei Province and was selected for the Jiangsu "333 High-Level Talent Training Project" and the Jiangsu "Qinglan Project."

Extended SQP Methods in Nonsmooth Difference Programming Applied to Problems with Variational Inequality Constraints

Shangzhi Zeng

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Abstract: This work explores a class of constrained difference programming problems, where the objective and constraints are formulated as differences of functions, without requiring their convexity. To investigate such problems, new variants of the extended sequential quadratic method are introduced. These algorithms iteratively solve strongly convex quadratic subproblems constructed via linear approximations of the given data by using their gradients and subgradients. The convergence of the proposed methods is rigorously analyzed by employing, in particular, the Polyak-Lojasiewicz-Kurdyka property that ensures global convergence for various classes of functions in the problem formulation, e.g., semialgebraic ones. The original framework is further extended to address difference programming problems with variational inequality (VI) constraints. By reformulating VI constraints via regularized gap functions, such problems are naturally embedded into constrained difference programming that leads us to direct applications of the proposed algorithms. Numerical experiments for the class of continuous network design problems demonstrate the efficiency of the new methods.

Speaker Bio: Shangzhi Zeng is an Associate Professor at the Shenzhen National Center for Applied Mathematics/Department of Mathematics, Southern University of Science and Technology. He received his Bachelor's degree from Wuhan University in 2015 and his Ph.D. from The University of Hong Kong in 2021. He conducted postdoctoral research at the University of Victoria, Canada, from 2021 to 2024, and joined Southern University of Science and Technology in 2024. His research interests include optimization theory and methods, bilevel optimization, and machine learning optimization algorithms. His research results have been published in journals such as Math Program, SIAM J Numer Anal, J Mach Learn Res, IEEE Trans Pattern Anal Mach Intell, and conferences including ICML, NeurIPS, and ICLR.

Enhanced randomized Douglas-Rachford method: Improved probabilities and adaptive momentum

Jiaxin Xie

Beihang University

Abstract: Randomized iterative methods have gained recent interest in machine learning and signal processing for solving large-scale linear systems. One such example is the randomized Douglas-Rachford (RDR) method, which updates the iterate by reflecting it through two randomly selected hyperplanes and taking a convex combination with the current point. In this talk, we enhance RDR by introducing improved sampling strategies and an adaptive heavy-ball momentum scheme. Specifically, we incorporate without-replacement and volume sampling into RDR, and establish stronger convergence guarantees compared to conventional i.i.d. sampling. Furthermore, we develop an adaptive momentum mechanism that dynamically adjusts step sizes and momentum parameters based on previous iterates, and prove that the resulting method achieves linear convergence in expectation with improved convergence bounds. Numerical experiments demonstrate that the enhanced RDR method consistently outperforms the original version, providing substantial practical benefits across a range of problem settings.

Speaker Bio: Jiaxin Xie is an Associate Professor and Ph.D. Supervisor at the School of Mathematical Sciences, Beihang University. He received his Ph.D. in Computational Mathematics from Hunan University in 2017. His research interests are stochastic optimization algorithms and their acceleration techniques. He has published multiple papers in journals such as SIAM J. Optim., SIAM J. Matrix Anal. Appl., Math. Comp., and Numer. Math. He has presided over sub-projects of the National Key R&D Program and General Projects of the National Natural Science Foundation of China. He currently serves as Secretary-General and Council Member of the Algorithm Software and Application Branch of the Chinese Society of Operations Research, and a Youth Council Member of the Mathematical Programming Branch of the Chinese Society of Operations Research.

Verifiably Improving Optimization Algorithms via LLMs

Xiangfeng Wang

East China Normal University

Abstract: Recent breakthroughs in LLM-driven mathematical discovery and evolutionary architectures—exemplified by frameworks such as FunSearch and AlphaEvolve—have demonstrated significant efficacy across various applications. Building on these advancements, this research extends similar methodologies to the LLM-aided design of optimization methods, with a specific focus on refining specialized techniques within optimization algorithms. We will discuss leveraging the code-generation capabilities of Large Language Models (LLMs) to enhance and accelerate the Alternating Direction Method of Multipliers (ADMM). To ensure the reliability of the newly discovered methods, we integrate formal verification languages such as Lean to provide rigorous provability. By employing formal methods as a constraint, we can establish a framework for trustworthy code generation, ensuring that the LLM-optimized algorithms are both efficient and mathematically verifiable.

Speaker Bio: Xiangfeng Wang is a Professor at East China Normal University and Deputy Director of the Key Laboratory of Mathematics and Engineering Applications, Ministry of Education. He currently serves as Vice Chairman of the Shanghai Society of Operations Research and Executive Director of the Algorithm Software and Application Branch of the Chinese Society of Operations Research. His main research focuses on agents (optimization, reinforcement learning, large language model-driven agents) and their applications. Awards received include the China Society for Industrial and Applied Mathematics Applied Achievement Award, the Chinese Society of Operations Research Youth Science and Technology Award Nomination, the IEEE Signal Processing Society Best Paper Award, and the Huawei Cloud Technology Cooperation Outstanding Partner Award.