AI, DATA, AND DECISIONS 2023

Thursday, October 12

8:30 – 8:55	**Continental Breakfast**
8:55 – 9:00	Welcome Address Pavlo Krokhmal (Organizing Committee Chair, University of Arizona)
	Session: AI and Optimization Chair: Afrooz Jalilzadeh
9:00 – 9:30	The Fusion of Machine Learning and Optimization Pascal Van Hentenryck (Georgia Institute of Technology)
9:30 – 10:00	AI and Optimization in Energy Systems for a Sustainable Future Panos M. Pardalos (University of Florida)
10:00 – 10:30	Scalable Algorithms for Multiclass Probability Estimation in High Dimensional Data Hao Helen Zhang (University of Arizona)
10:30 – 11:00	**Coffee Break**
	Session: Optimization and Computation Chair: Pavlo Krokhmal
11:00 – 11:30	Stochastic Approximation Methods for Solving Stochastic Nash Equilibrium Problems Afrooz Jalilzadeh (University of Arizona)
11:30 – 12:00	Conditional Gradient Methods for Solving Bilevel Optimization Problems Erfan Yazdandoost Hamedani (University of Arizona)
12:00 – 1:30	**Lunch**

Session: Distributionally Robust Optimization
Chair: Jianqiang Cheng

1:30 – 2:00 Distributionally Robust Optimization: The Science of Underpromising and Overdelivering
Daniel Kuhn (École Polytechnique Fédérale de Lausanne)

2:00 – 2:30 Data-driven Conditional Robust Optimization
Erick Delage (HEC Montréal)

2:30 – 3:00 Optimized Dimensionality Reduction for Moment-based Distributionally Robust Optimization
Jianqiang Cheng (University of Arizona)

6:00 – 8:00 **Dinner – Moonstone**

Friday, October 13

8:30 – 9:00 **Continental Breakfast**

Session: Data and Networks
Chair: Neng Fan

9:00 – 9:30 A Hierarchy of Nonconvex Continuous Reformulations for Discrete Optimization
Sergiy Butenko (Texas A&M University)

9:30 – 10:00 Locating Most Central Shortest Paths in Graphs and Networks
Dmytro Matsypura (University of Sydney)

10:00 – 10:30 Detecting Cohesive Clusters in Networks via Distance-Based Clique Relaxations
Vladimir Boginski (University of Central Florida)

10:30 – 11:00 **Coffee Break**

Session: Advances in Optimization and Analytics
Chair: Jian Liu

11:00 – 11:30 Efficient Algorithms for Minimizing Compositions of Convex Functions and Random Functions and Its Applications in Network Revenue Management
Xin Chen (Georgia Institute of Technology)

11:30 – 12:00 Pricing Analytics of Primary and Ancillary Products Using Conversion Rate Data
Chung-Piaw Teo (National University of Singapore)

12:00 – 1:30 **Lunch**

Session: Stochastic Optimization
Chair: Erfan Yazdandoost Hamedani

1:30 – 2:00 Expectile Quadrangles and Applications
Stan Uryasev (Stony Brook University)

2:00 – 2:30 A Data-Driven Integrated Chance Constraints Approach for Optimal Vaccination Strategies for COVID-19
Lewis Ntaimo (Texas A&M University)

2:30 – 3:00 Complexity Guarantees for an Inexact Implicit Scheme for Stochastic Mathematical Programs with Equilibrium Constraints (MPECs)
Uday V. Shanbhag (Pennsylvania State University)

3:00 – 3:30 **Coffee Break**

Session: Advances in Optimization
Chair: Pavlo Krokhmal

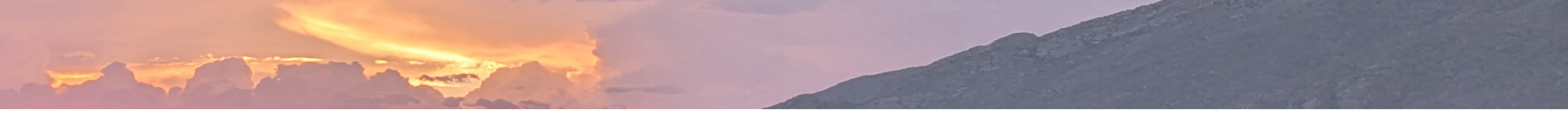
3:30 – 4:00 On the Minimization of Piecewise Functions
Jong-Shi Pang (University of Southern California)

4:00 – 4:30 Huber Loss-based Penalty Approach to Problems with Linear Constraints
Angelia Nedić (Arizona State University)

4:30 – 5:00 On Squared-Variable Formulations
Stephen Wright (University of Wisconsin-Madison)

5:00 – 5:30 Compromise Decisions and Variance Reduced Validation for Stochastic MIP Problems with Application to Very Large Scale Facility Location Models
Suvrajeet Sen (University of Southern California)

6:00 – 8:00 **Dinner – Agustin Kitchen**



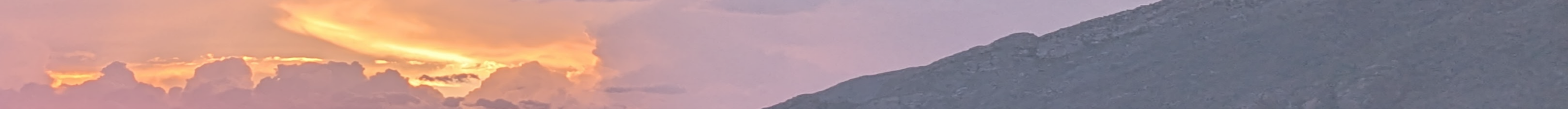
Detecting Cohesive Clusters in Networks via Distance-Based Clique Relaxations

Vladimir Boginski | University of Central Florida

Joint work with A. Veremyev, E.L. Pasiliao, and O.A. Prokopyev

Networks can be found everywhere in the modern world: application areas are abundant and diverse, spanning the domains of big data and physical/virtual complex systems. One of the important classes of optimization problems arising in network analysis is the detection of "tightly knit" (cohesive) clusters in networks. The maximum clique problem is probably the most well-known in this domain; however, extensions of the clique concept aimed at mitigating the overly restrictive nature of clique-based clusters, commonly referred to as clique relaxations, have recently gained popularity. In this presentation, we focus on our recent developments in solving optimization models associated with distance-based clique relaxations: k-clubs, robust k-clubs, as well as so-called "ultra-small world" clusters, which are essentially subgraphs with prescribed distance distributions.

Dr. Vladimir Boginski is a Professor of Industrial Engineering and Management Systems at the University of Central Florida (Orlando, FL). He received his PhD degree in Industrial and Systems Engineering from the University of Florida in 2005. His research interests primarily focus on using mathematical modeling and optimization techniques in network science. He has served as PI/co-PI on projects supported by the Air Force Research Laboratory, National Science Foundation, and other U.S. federal agencies, with total funding of over $16M. He has co-authored over 80 publications, including 49 refereed journal articles.



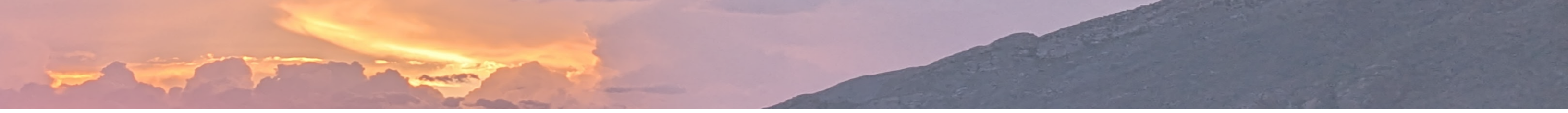
A Hierarchy of Nonconvex Continuous Reformulations for Discrete Optimization

Sergiy Butenko | Texas A&M University

Joint work with Mykyta Makovenko and Miltiades Pardalos

Many discrete optimization problems can be formulated can be formulated as binary integer programs. Some of the most powerful general-purpose approaches for solving binary linear programs are based on hierarchies of successive convex (linear or semidefinite) relaxations that converge to an exact solution of the original formulation in a finite number of steps (given by the number of variables in the original formulation). The well-known examples of such approaches include Sherali-Adams, Lovasz-Schrijver and Lasserre hierarchies. Each next level of these hierarchies requires additional variables and constraints, eventually yielding an exact exponential-size convex reformulation of the original model. The excessive size of the reformulations limits the practical applicability of this methodology to a few initial levels of the hierarchies. We propose a fundamentally different approach to designing hierarchies of continuous formulations for discrete and combinatorial optimization problems. It shifts the focus from convexifying a given formulation to establishing equivalent non-convex reformulations of the original problem. The aim is to move towards an "equi-maximal" reformulation in which every local optimum is global. This property is eventually achieved at the final level of the hierarchy. In terms of computational complexity, the improved quality of local maxima in the proposed approach comes with an increased cost of objective function evaluation, as opposed to the increase in the number of variables and constraints in the existing hierarchies. The approach is demonstrated by extending the Motzkin-Straus formulation for the maximum clique problem to a hierarchy of standard polynomial programming formulations with the above-described properties.

Sergiy Butenko is a Professor and Donna and Jim Furber '64 Faculty Fellow in Industrial and Systems Engineering at Texas A&M University. He also serves as the Editor-in-Chief of Journal of Global Optimization. He received his B.S. and M.S. degrees in Mathematics at Kyiv National Taras Shevchenko University (Ukraine) and M.S. and Ph.D. degrees in Industrial and Systems Engineering at the University of Florida. His research focuses on discrete and global optimization, network analysis and network-based data mining, and graph theory. Applications of interest include biological, social, and financial networks, wireless ad hoc and sensor networks, transportation, and energy systems. His work has been supported by the Air Force office of Scientific Research, the U.S. Department of Energy, the National Science Foundation, and North Atlantic Treaty Organization, and the Office of Naval Research. In particular, he was a recipient of Air Force Office of Scientific Research Young Investigator Program Award in 2008.



Efficient Algorithms for Minimizing Compositions of Convex Functions and Random Functions and Its Applications in Network Revenue Management

Xin Chen | Georgia Institute of Technology

Motivated by network revenue management problems using booking limit control and inventory models with random capacities, we study a class of nonconvex stochastic optimization in which the objective function is a composition of a convex function and a random function. Leveraging a convex reformulation via a variable transformation, we develop stochastic gradient-based algorithms and establish their sample and gradient complexities for achieving an epsilon-global optimal solution. Interestingly, our proposed Mirror Stochastic Gradient (MSG) method operating in the original variables achieves complexities that match the lower bound for solving stochastic convex optimization problems. Extensive numerical experiments on air-cargo network revenue management problems with random two-dimensional capacity, random consumption, and routing flexibility demonstrate the superior performance of our proposed MSG algorithm and booking limit control policies vs. state-of-the-art bid-price-based control policies.

Xin Chen is a James C. Edenfield chair and professor in the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Tech. Prior to this appointment, he was a professor of industrial engineering at the University of Illinois at Urbana-Champaign. His research interest lies in optimization, data analytics, revenue management and supply chain management. He received the Informs revenue management and pricing section prize in 2009. He is the coauthor of the book "The Logic of Logistics: Theory, Algorithms, and Applications for Logistics and Supply Chain Management (Second Edition, 2005, & Third Edition, 2014)", and serving as the department editor of logistics and supply chain management of Naval Research Logistics and an associate editor of several leading journals including Operations Research, Management Science, and Production and Operations Management.

Optimized Dimensionality Reduction for Moment-based Distributionally Robust Optimization

Jianqiang Cheng | University of Arizona

In this talk, we present an optimized dimensionality reduction approach to solve moment-based distributionally robust optimization (DRO). We first show that the ranks of the matrices in the SDP reformulations are small, by which we are then motivated to integrate the dimensionality reduction of random parameters with the subsequent optimization problems. Such integration enables two outer and one inner approximations of the original problem, providing two lower bounds and one upper bound correspondingly. As these approximations are nonconvex low-dimensional SDPs, we develop modified Alternating Direction Method of Multipliers algorithms to solve them efficiently. Numerical results show significant advantages of our approach on the computational time and solution quality over the three best possible benchmark approaches.

Jianqiang Cheng is an Associate Professor in the Department of Systems & Industrial Engineering at the University of Arizona. His research interests are in developing computationally efficient techniques to solve difficult optimization problems under uncertainty. He is the recipient of a Bisgrove Early Career Scholar Award (Arizona Science Foundation) and a 2022 NSF CAREER Award. His research has been supported by National Science Foundation, Arizona Science Foundation, Office of Naval Research, and Department of Transportation.

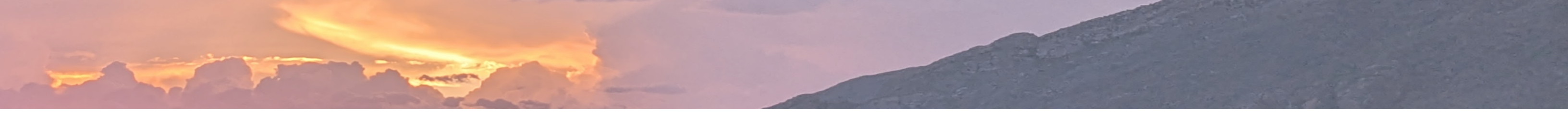
Data-driven Conditional Robust Optimization

Erick Delage | HEC Montréal

Joint work with Abhilash Chenreddy and Nymisha Badi

Conditional Robust Optimization (CRO) is a decision-making framework that blends the flexibility of robust optimization (RO) with the ability to incorporate additional information regarding the structure of uncertainty. This approach solves the RO problem where the uncertainty set structure adapts to account for the most recent information provided by a set of covariates. In this presentation, we will introduce two data-driven approaches to CRO: a sequential predict-then-optimize method and an integrated end-to-end method. We will also show how hypothesis testing can be integrated to the training in order to improve the quality of conditional coverage of the produced uncertainty sets.

Erick Delage is a professor in the Department of Decision Sciences at HEC Montréal, a chairholder of the Canada Research Chair in decision making under uncertainty, and a member of the College of New Scholars, Artists and Scientists of the Royal Society of Canada. His research interests span the areas of robust and stochastic optimization, decision analysis, machine learning, reinforcement learning, and risk management with applications to portfolio optimization, inventory management, energy and transportation problems.

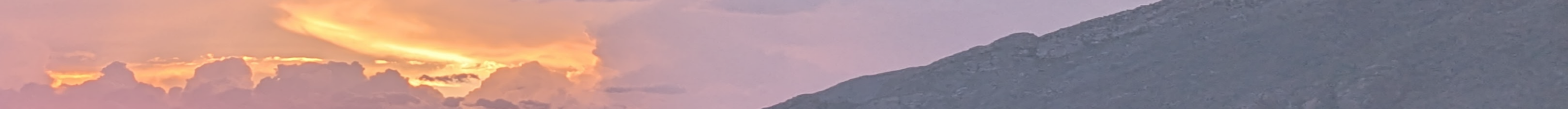


Stochastic Approximation Methods for Solving Stochastic Nash Equilibrium Problems

Afrooz Jalilzadeh | University of Arizona

Nash equilibrium (NE) is one of the most important concepts in game theory, capturing a wide range of phenomena in engineering, economics, and finance. NE is characterized by the observation that in a stable game, no player can lower their cost by changing their action within their designated strategy. Equilibrium in the Nash game can be found by solving a variational inequality (VI) problem. Solving VI and stochastic VI (SVI) problems becomes more challenging when considering that players also interact at the level of feasible sets. This situation arises naturally when players share common resources, leading to a Generalized NE (GNE) problem that can be formulated as a Quasi VI (QVI) or Stochastic QVI (SQVI). In this presentation, we introduce efficient iterative schemes with guaranteed convergence to solve SVI and SQVI problems.

Dr. Jalilzadeh is an assistant professor at The University of Arizona in the Department of Systems and Industrial Engineering. She received her bachelor's degree in Mathematics from the University of Tehran and earned her Ph.D. in Industrial Engineering and Operations Research from Pennsylvania State University. Dr. Jalilzadeh's areas of expertise include designing, analyzing, and implementing stochastic approximation methods for solving stochastic optimization and variational inequality problems. Her research has received support from the National Science Foundation (NSF) and the University of Arizona Research, Innovation & Impact (RII) Funding. She received several awards and fellowships including the 2022 Teacher of the Year award from the College of Engineering, University of Arizona.

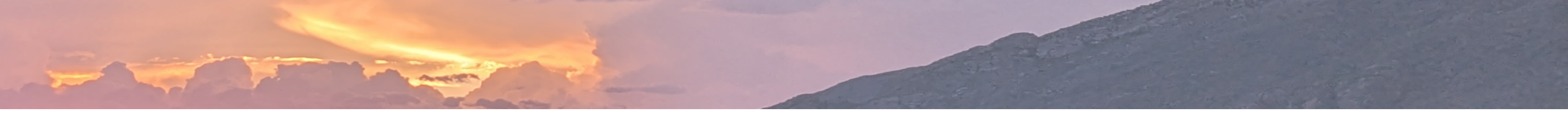


The Fusion of Machine Learning and Optimization

Pascal Van Hentenryck | Georgia Institute of Technology

The fusion of machine learning and optimization has the potential to achieve breakthroughs in decision making that the two technologies cannot accomplish independently. This talk reviews a number of research avenues in this direction, including the concept of optimization proxies and end-to-end learning. Principled combinations of machine learning and optimization are illustrated on case studies in energy systems, mobility, and supply chains. Preliminary results show how this fusion makes it possible to perform real-time risk assessment in energy systems, find near-optimal solutions quickly in supply chains, and implement model-predictive control for large-scale mobility systems.

Pascal Van Hentenryck is the A. Russell Chandler III Chair and Professor in the H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology. He is also the director of the NSF AI Institute for Advances in Optimization. His current research focuses on machine learning, optimization, and privacy with applications in energy, manufacturing, mobility, and supply chains. Van Hentenryck is an INFORMS Fellow and a Fellow of the Association for the Advancement of Artificial Intelligence (AAAI).

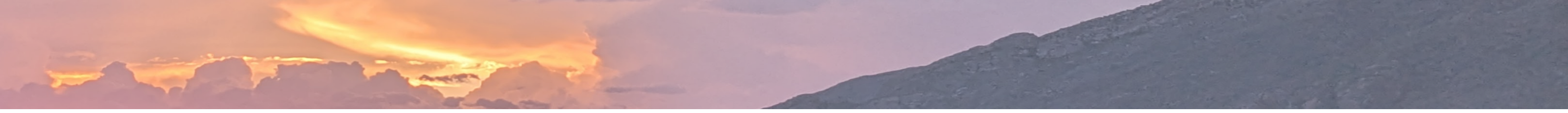


Distributionally Robust Optimization: The Science of Underpromising and Overdelivering

Daniel Kuhn | École Polytechnique Fédérale de Lausanne

Many decision problems in science, engineering and economics are affected by uncertain parameters whose distribution is only indirectly observable through samples. The goal of data-driven decision-making is to learn a decision from finitely many training samples that will perform well on unseen test samples. This learning task is difficult even if all training and test samples are drawn from the same distribution especially if the dimension of the uncertainty is large relative to the training sample size. Wasserstein distributionally robust optimization (DRO) seeks data-driven decisions that perform well under the most adverse distribution within a certain Wasserstein distance from a nominal distribution constructed from the training samples. It has a wide range of conceptual, statistical and computational benefits. Most prominently, the optimal decisions can often be computed efficiently, and they enjoy provable out-of-sample and asymptotic consistency guarantees. This talk will highlight two recent advances in Wasserstein DRO. First, we will develop a principled approach to leveraging samples from heterogeneous data sources for making better decisions. In addition, we will prove the optimality of linear policies in Wasserstein distributionally robust linear-quadratic control problems with imperfect state observations, and we will show that these policies can be computed efficiently using dynamic programming, Kalman filtering and automatic differentiation.

Daniel Kuhn is a Professor of Operations Research in the College of Management of Technology at EPFL, where he holds the Chair of Risk Analytics and Optimization. His research interests revolve around stochastic, robust and distributionally robust optimization, and his principal goal is to develop efficient algorithms as well as statistical guarantees for data-driven optimization problems. This work is primarily application-driven, the main application areas being energy systems, machine learning, business analytics and finance. Before joining EPFL, Daniel Kuhn was a faculty member in the Department of Computing at Imperial College London and a postdoctoral researcher in the Department of Management Science and Engineering at Stanford University. He holds a PhD degree in Economics from the University of St. Gallen and an MSc degree in Theoretical Physics from ETH Zurich. He is an INFORMS fellow and the recipient of several research and teaching prizes including the Friedrich Wilhelm Bessel Research Award by the Alexander von Humboldt Foundation and the Frederick W. Lanchester Prize by INFORMS. He is the editor-in-chief of Mathematical Programming and the area editor for continuous optimization of Operations Research.



Locating Most Central Shortest Paths in Graphs and Networks

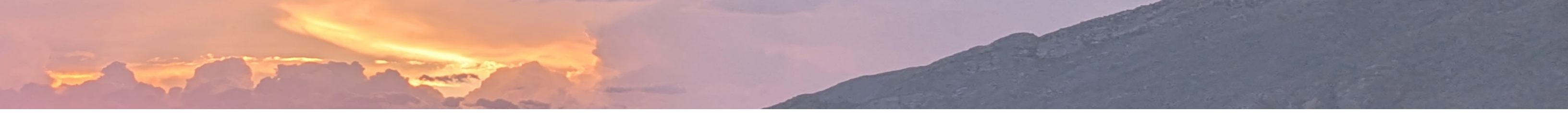
Dmytro Matsypura | University of Sydney

In network analysis, the notion of centrality is used to quantify a node's importance to the network's structure. Several centrality indices that capture complementary aspects of a node's position have been proposed in the literature over the years. One of the most popular among them is degree centrality. Informally, degree centrality of a node is the number of nodes adjacent to it.

Despite its simplicity, degree centrality can be very revealing. It measures the immediate reachability of a node. In other words, a node's importance depends on how many other nodes can be reached directly from it. For example, in a typical social network, where each node corresponds to an actor, and an edge between two nodes indicates social interaction, degree centrality captures the size of the social circle of an actor. In sensor and facility location applications, degree centrality captures the number of instantaneously reachable or covered nodes.

In this talk, we extend the concept of node centrality to centrality of a path in a graph. We focus on degree centrality of the shortest path between two nodes. We show that the number of shortest paths between two nodes can be exponential in the worst case. Nevertheless, we can find the most degree-central shortest path in polynomial time. We develop efficient algorithms to solve the unweighted and weighted versions of the most degree-central shortest path problem. We discuss algorithm implementations and numerical results.

Dmytro Matsypura is an Associate Professor in the Discipline of Business Analytics at the University of Sydney Business School. He received his B.S. and M.S. degrees in Information Systems from Kyiv Polytechnic Institute (Ukraine) and a Ph.D. degree in Management Science from University of Massachusetts Amherst. His current research focuses on applications of convex and combinatorial optimisation in forecasting, graph theory, transportation, and ecology.

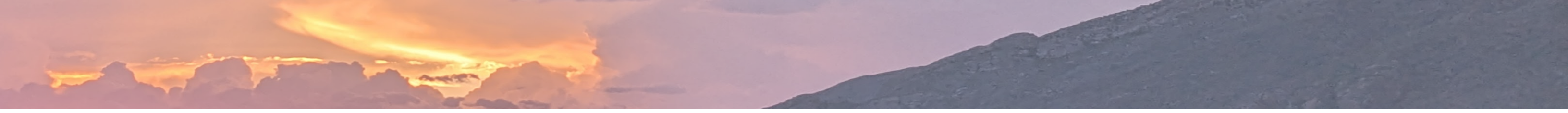


Huber Loss-based Penalty Approach to Problems with Linear Constraints

Angelia Nedić | Arizona State University

The optimization problems with a large number of constraints are emerging in many application domains such as optimal control, reinforcement learning, and statistical learning, and artificial intelligence, in general. The challenges posed by the size of the problems in these applications resulted in prolific research in the domain of optimization theory and algorithms. Many refinements and accelerations of various (mainly) first-order methods have been proposed and studied, majority of which solves a penalized re-formulation of the original problem in order to cope with the large number of constraints. However, while the main focus has been on the penalized variants, not much has been done about re-thinking the whole approach to these problems. This talk will focus on a different viewpoint and discuss the optimization methods that use randomization and penalty approach to deal with a large number of constraints. The performance and efficiency of such algorithms will be addressed, as well as auxiliary theory that supports them.

Angelia Nedić has a Ph.D. from Moscow State University, Moscow, Russia, in Computational Mathematics and Mathematical Physics (1994), and a Ph.D. from Massachusetts Institute of Technology, Cambridge, USA in Electrical and Computer Science Engineering (2002). She has worked as a senior engineer in BAE Systems North America, Advanced Information Technology Division at Burlington, MA. Currently, she is a faculty member of the school of Electrical, Computer and Energy Engineering at Arizona State University at Tempe. Prior to joining Arizona State University, she has been a Willard Scholar faculty member at the University of Illinois at Urbana-Champaign. She is a recipient (jointly with her co-authors) of the Best Paper Award at the Winter Simulation Conference 2013 and the Best Paper Award at the International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt) 2015. Her general research interest is in optimization, large scale complex systems dynamics, variational inequalities and games.

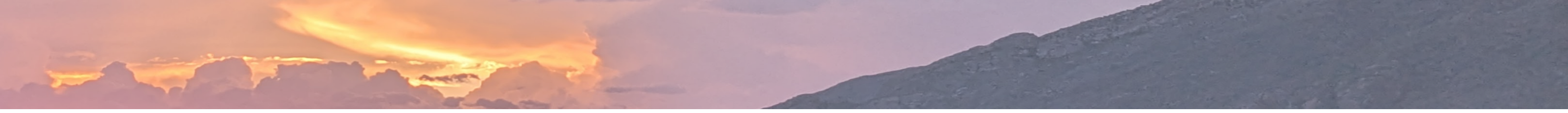


A Data-Driven Integrated Chance Constraints Approach for Optimal Vaccination Strategies for COVID-19

Lewis Ntaimo | Texas A&M University

COVID-19 is caused by Severe Acute Respiratory Syndrome SARS-CoV-2 virus and was declared a pandemic by the World Health Organization in early 2020. Despite concerted efforts by health authorities worldwide to contain the disease, the virus continues to spread and mutate leading to new variants with uncertain transmission characteristics. There is a need for data-driven models for determining optimal vaccination strategies that adapt to new variants and uncertain vaccine efficacy. Motivated by this challenge, we derive integrated chance constraints stochastic programming epidemiology models for finding optimal vaccination policies for multi-community epidemics that incorporate population demographics, age-related heterogeneity in disease susceptibility and infectivity, vaccine efficacy, and the decision-maker's level of risk. An optimal vaccination strategy specifies the proportion of individuals in a given community and household type to vaccinate to bring the reproduction number below one. The new models were tested on real data for seven neighboring counties in the U.S. state of Texas. The results reveal, among other findings, that vaccination strategies for controlling outbreaks should prioritize vaccinating specific households and age groups with relatively high combined susceptibility and infectivity levels.

Lewis Ntaimo is Professor and Department Head, and Sugar and Mike Barnes Department Head Chair of the Wm Michael Barnes'64 Department of Industrial and Systems Engineering at Texas A&M University. He has been with the university since 2004 after obtaining his PhD in Systems and Industrial Engineering from the University of Arizona. He received his MS in Mining and Geological Engineering in 2000, and BS in Mining Engineering in 1998, both from the University of Arizona. Ntaimo's primary research interests include modeling and algorithms for decision-making problems involving uncertainty and risk, systems modeling, process optimization, and computer simulation. Applications of interest include vaccination policies for epidemics, wildfire management, healthcare management, college counseling and psychological service management, and power systems operations and maintenance. His research over the years has been funded by the U.S. federal agencies and industry. Ntaimo is a member of INFORMS and IISE, and he is the Past-President of the INFORMS Minority Issues Forum. He has served on several journal editorial boards including IISE Transactions, INFORMS Journal on Computing, IISE Transactions on Healthcare Systems Engineering, Journal of Global Optimization, and Computational Optimization and Applications.



On the Minimization of Piecewise Functions

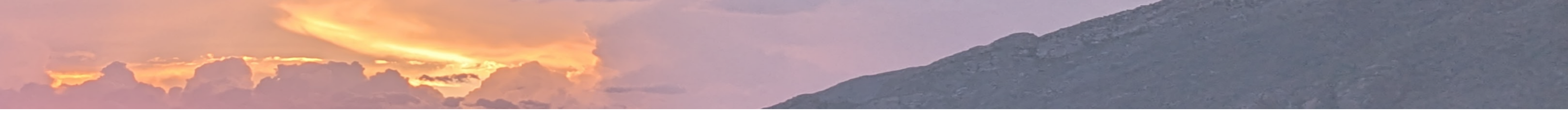
Jong-Shi Pang | University of Southern California

Joint work with Ying Cui and Junyi Liu

Building on our recent research on modern nonconvex nondifferential optimization, we report on our work pertaining to the minimization of possibly discontinuous piecewise functions. Motivation for the study of such highly un-usual optimization problems is drawn from several modeling domains. Concepts of stationarity, i.e., necessary conditions for (local) optimality, are defined via a fixed-point property and methods for computing such stationary solutions are briefly mentioned. This is joint work with Ying Cui at the University of California at Berkeley and Junyi Liu at Tsinghua University. The paper is accepted for publication in a special issue of the Journal on Convex Analysis in honor of Professor Roger Wets' 85th birthday.

Elected a member of the National Academy of Engineering in February 2021 and appointed a Distinguished Professor in April 2023, Jong-Shi Pang joined the University of Southern California as the Epstein Family Chair and Professor of Industrial and Systems Engineering in August 2013. Prior to this position, he was the Caterpillar Professor and Head of the Department of Industrial and Enterprise Systems Engineering at the University of Illinois at Urbana-Champagne for six years between 2007 and 2013. He held the position of the Margaret A. Darrin Distinguished Professor in Applied Mathematics in the Department of Mathematical Sciences and was a Professor of Decision Sciences and Engineering Systems at Rensselaer Polytechnic Institute from 2003 to 2007. He was a Professor in the Department of Mathematical Sciences at the Johns Hopkins University from 1987 to 2003, an Associate Professor and then Professor in the School of Management from 1982 to 1987 at the University of Texas at Dallas, and an Assistant and then an Associate Professor in the Graduate School of Industrial Administration at Carnegie-Mellon University from 1977 to 1982. During 1999 and 2001 (full time) and 2002 (part-time), he was a Program Director in the Division of Mathematical Sciences at the National Science Foundation. Professor Pang has served as the Department Academic Advisor of the Department of Mathematics at the Hong Kong Polytechnic University. He has given many distinguished lectures at universities worldwide and plenary lectures at international conferences.

Inducted a Fellow of the Institute for Operations Research and Management Science (INFORMS) in October 2019, Professor Pang was a recipient of the 2019 John von Neumann Theory Prize awarded by the same Institute for his sustained contribution to multi-agent optimization and equilibrium theory and applications. Previously, he was a winner of the 2003 George B. Dantzig Prize awarded jointly by the Mathematical Programming Society and the Society for Industrial and Applied Mathematics for his work on finite-dimensional variational inequalities; in addition, he was a co-winner of the 1994 Frederick W. Lanchester Prize awarded by INFORMS. Several of his publications have received best paper awards in different engineering fields: signal processing, energy and natural resources, computational management science, and robotics and automation. He is an ISI Highly Cited Researcher in the Mathematics Category between 1980--1999; he has co-authored 3 widely cited monographs, edited several special journal volumes, and published more than 160 scholarly journals in top peer reviewed journals. His fourth monograph was published in December 2021. Dr. Pang is a member in the inaugural 2009 class of Fellows of the Society for Industrial and Applied Mathematics. Professor Pang's general research interest is in the mathematical modeling and analysis of a wide range of complex engineering and economics systems with focus in operations research, single-agent optimization, equilibrium programming, noncooperative game theory, and constrained dynamical systems. Since July 2019, he serves as the Editor-in-Chief of the prestigious SIAM Journal on Optimization. Prior to that, he was the Editor-in-Chief of the journal Mathematical Programming, Series B. He was an Area Editor of Continuous Optimization in the journal Mathematics of Operations Research from 1999 till 2006.



AI and Optimization in Energy Systems for a Sustainable Future

Panos M. Pardalos | University of Florida

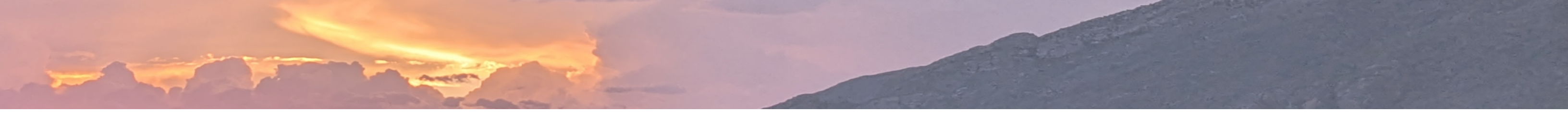
Advances in AI tools are progressing rapidly and demonstrating the potential to transform our lives. The spectacular AI tools rely in part on their sophisticated mathematical underpinnings (e.g. optimization techniques and operations research tools), even though this crucial aspect is often downplayed. In this lecture, we will discuss progress from our perspective in the field of AI and its applications in Energy systems and Sustainability.

Panos Pardalos was born in Greece and graduated from Athens University (Department of Mathematics). He received his PhD (Compute and Information Sciences) from the University of Minnesota. He is a Distinguished Emeritus Professor in the Department of Industrial and Systems Engineering at the University of Florida, and an affiliated faculty of Biomedical Engineering and Computer Science & Information & Engineering departments.

Panos Pardalos is a world-renowned leader in Global Optimization, Mathematical Modeling, Energy Systems, Financial applications, and Data Sciences. He is a Fellow of AAAS, AAIA, AIMBE, EUROPT, and INFORMS and was awarded the 2013 Constantin Caratheodory Prize of the International Society of Global Optimization. In addition, Panos Pardalos has been awarded the 2013 EURO Gold Medal prize bestowed by the Association for European Operational Research Societies. This medal is the preeminent European award given to Operations Research (OR) professionals for "scientific contributions that stand the test of time."

Panos Pardalos has been awarded a prestigious Humboldt Research Award (2018-2019). The Humboldt Research Award is granted in recognition of a researcher's entire achievements to date fundamental discoveries, new theories, insights that have had significant impact on their discipline.

Panos Pardalos is also a Member of several Academies of Sciences, and he holds several honorary PhD degrees and affiliations. He is the Founding Editor of Optimization Letters, Energy Systems, and Co-Founder of the International Journal of Global Optimization, Computational Management Science, and Springer Nature Operations Research Forum. He has published over 600 journal papers, and edited/authored over 200 books. He is one of the most cited authors and has graduated 71 PhD students so far. Details can be found in www.ise.ufl.edu/pardalos.



Compromise Decisions and Variance Reduced Validation for Stochastic MIP Problems with Application to Very Large Scale Facility Location Models

Suvrajeet Sen | University of Southern California

Joint work with Jiajun Xu

Facility Location Problems arise in many applications and have been extensively studied for decades. Most real-world applications of such models not only lead to very large scale problems, but they also encounter effects of intractability due to the very large number of scenarios required for representing real-world problems. In this talk, I will present joint work with my former Ph.D. student who has generalized the concept of Compromise Decisions to the case of Mixed Binary Stochastic Programs. While ordinary SAA approaches may fail to provide computationally viable approaches for very large scale problems, a new notion on Binary Compromise Decisions provides significant variance reduction for very large realistic models which were first posed for the AWS fORged-by-Machines contest several years ago.

Suvrajeet Sen is Professor at the Daniel J. Epstein Department of Industrial and Systems Engineering at the University of Southern California. Prior to joining USC, he was a Professor at Ohio State University (2006-2012), and University of Arizona (1982-2006). He has also served as the Program Director of OR, as well as Service Enterprise Systems at the National Science Foundation. Professor Sen's research is devoted to many categories of optimization models, and he has published over 120 papers, with the vast majority of them dealing with models, algorithms and applications of Stochastic Programming problems. He has served on several editorial boards, including Operations Research as Area Editor for Optimization and as Associate Editor for INFORMS Journal on Computing, INFORMS Journal on Optimization, Journal of Telecommunications Systems, Mathematical Programming B, Operations Research, SIAM J. on Optimization. He also serves as an Advisory Editor for several newer journals. Professor Sen was instrumental in founding the INFORMS Optimization Society in 1995, served as its Chair (2015-16), and led the process culminating in the creation of the new journal, INFORMS Journal on Optimization. He led a team of colleagues who were jointly recognized by the INFORMS Computing Society for their "seminal work" on Stochastic Mixed-Integer Programming in 2015. Professor Sen is a Fellow of INFORMS, and has been recognized at all his alma maters as a distinguished alumnus. Except for his years at NSF, he has received continuous extramural research funding from NSF for a stretch of years lasting over 25 years. His current work is funded by AFOSR, ONR, and DOE.

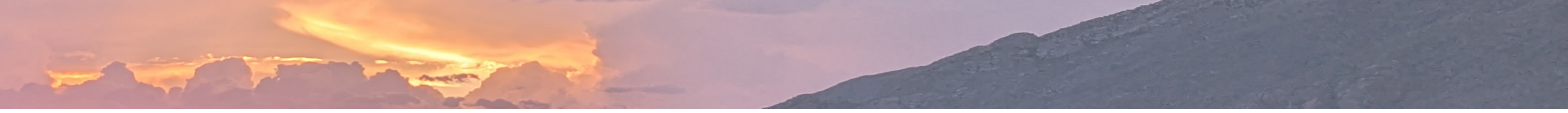
Complexity Guarantees for an Inexact Implicit Scheme for Stochastic Mathematical Programs with Equilibrium Constraints (MPECs)

Uday V. Shanbhag | Pennsylvania State University

Joint work with Shisheng Cui and Farzad Yousefian

The Mathematical Program with Equilibrium Constraints (MPEC) is a nonlinear nonconvex program, afflicted by ill-posedness in that standard constraint qualifications fail to hold at any feasible point. This problem has assumed relevance in settings arising in game-theory, finance, electricity markets, and machine learning, amongst others. Motivated by the absence of finite-time algorithms for computing an ϵ-stationary point and under the assumption that the lower-level problem has some desirable properties, we present an inexact sampling-enabled zeroth-order implicit method for a subclass of stochastic MPECs. Rate and complexity guarantees are provided for this scheme. We observe that in a subclass of settings, this scheme can obtain approximate global minimizers. Time permitting, I will provide a brief overview of related work on stochastic hierarchical games and federated generalizations. Preliminary numerics suggest that the schemes compete well with commercial solvers.

Since November 2016, Uday V. Shanbhag has held the Gary and Sheila Chaired Professorsip in the department of Industrial and Manufacturing Engineering (IME) at the Pennsylvania State University, having been a tenured associate professor since arriving in Fall 2012. Prior to being at Penn. State, from 2006-2012, he was first an assistant professor, and subsequently a tenured associate professor in the department of Industrial and Enterprise Systems engineering (ISE) at the University of Illinois at Urbana-Champaign (UIUC). His research interests lie in the analysis and resolution of optimization, variational, and game-theoretic problems, particularly in nonconvex, stochastic, and networked regimes. His research honors include the triennial A.W. Tucker Prize by the mathematical programming society (MPS) in 2006, the NCSA Faculty Fellowship in 2006, the Computational Optimization and Applications (COAP) best paper award (with advisor Walter Murray) in 2007, and the best theoretical paper award in the Winter Simulation Conference (WSC) in 2013 (with Angelia Nedich and Farzad Yousefian). He currently serves as an Associate Editor (AE) for SIAM Journal of Optimization, Computational Optimization and Applications, and Optimization Letters and is a past AE for IEEE Transactions on Automatic Control. In addition, he has served as Vice-chair (Nonlinear Programming) in the Informs Optimization society OS (2009, 2010), co-chair of the Nicholson paper prize committee (with Kavita Ramanan) (2014), Informs Computing Society Prize (Chair, 2023), as well as a committee member for the Tucker Prize and the INFORMS OS Student Paper prize. He holds a Ph.D. from Stanford University's department of Management Science and Engineering (2006), with a concentration in operations research and was associated with the Systems Optimization Laboratory when at Stanford. He also holds masters and undergraduate degrees from the Massachusetts Institute of Technology (MIT), Cambridge (in Operations Research) and the Indian Institute of Technology (IIT), Bombay, respectively.



Pricing Analytics of Primary and Ancillary Products Using Conversion Rate Data

Chung-Piaw Teo | National University of Singapore

Ancillary products (services) have consistently contributed a significant portion of revenue in various industries such as airlines, hotels, and automobiles. This paper focuses on a firm that sells both primary and ancillary products to customers, with the condition that customers can purchase the ancillary products only if they purchase the primary ones. Our goal is to jointly determine the prices for all the products to optimize profits to the firm. This problem is challenging as it involves customer choice over subsets (primary product + ancillary services) and precedence constraints on purchase decisions. To tackle these challenges, we use a class of additive perturbed utility model (APUM) to explicitly capture the complex customer choice behaviour and extract values from the conversion data captured in A/B test experiments.

We show that the ground-truth choice model can be uniformly approximated by an APUM under suitable reformulation. To facilitate the model calibration, we construct a tractable APUM by introducing slack variables of the choice constraints. In particular, we leverage the separable structure of APUM to design a polynomial number of price experiments to obtain conversion rates data, to calibrate an APUM model with shape constraints. By utilizing piecewise linear approximation arguments, we demonstrate that the resulting data-driven pricing problem can be solved to within ϵ-optimality as a mixed integer program. Through extensive numerical experiments, we provide compelling evidence of the superior performance of our framework compared to other methods. This opens up a new way to solve the ancillary pricing problem (and potentially other multidimensional pricing problems under complex customer choice behavior) in a data-driven manner.

Chung Piaw Teo is Provost's Chair Professor and Executive Director of the Institute of Operations Research and Analytics in the National University of Singapore. Prior to the current appointments, he was Head of Department, Acting Deputy Dean, Vice-Dean of the Research & Ph.D. Program as well as Chair of the Ph.D. Committee in the NUS Business School. He was a fellow in the Singapore-MIT Alliance Program, an Eschbach Scholar in Northwestern University (US), Professor in Sungkyunkwan Graduate School of Business (Korea), and a Distinguished Visiting Professor in YuanZe University (Taiwan). He was elected INFORMS Fellow in 2019. He is currently serving as a department editor for MS (Optimization), and a former area editor for OR (Operations and Supply Chains). His main interest is in service and manufacturing operations, supply chain planning, discrete optimization, and machine learning.

Expectile Quadrangles and Applications

Stan Uryasev | Stony Brook University

Joint work with Anton Malandii and Viktor Kuzmenko

The paper considers the expectile risk measure in the framework of the Fundamental Risk Quadrangle (FRQ) theory. A quadrangle includes four stochastic functions: "error", "regret", "risk", and "deviation" interconnected by "statistic". Expectile risk measure is used in risk management similar to VaR (quantile) and CVaR (superquantile). The paper considers recently proposed quadrangles based on expectile statistic, similar to the well-established quadrangles with VaR and CVaR statistics. This paper rigorously examines these Expectile Quadrangles, focusing on the quadrangle where expectile is both a statistic and risk.

We reduce expectile minimization to convex and linear programming using the FRQ Regret theorem. Also, we estimate expectile with linear regression, employing linear programming in accordance with the FRQ Regression theorem. The theory is supported by several case studies.

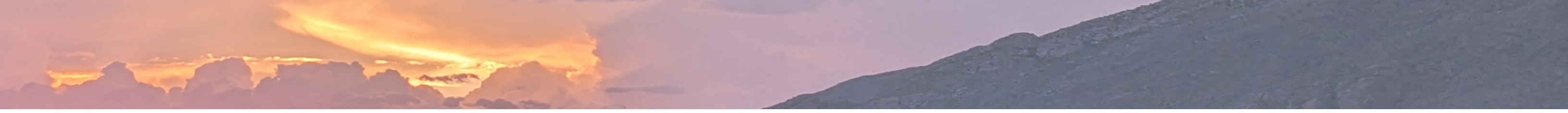
Stan Uryasev is Professor and Frey Family Endowed Chair at the Stony Brook University.

He received his Ph.D. in Applied Mathematics from the Glushkov Institute of Cybernetics, Kiev, Ukraine in 1983. From 1979 to 1987 he held a research position at the Glushkov Institute. From 1988 to 1992 he was a Research Scholar at the International Institute for Applied System Analysis, Luxenburg, Austria. From 1992 to 1998 he held the Scientist position at the Risk and Reliability Group, Brookhaven National Laboratory, Upton, NY. From 1998 to 2019 he was the George and Rolande Willis Endowed Professor at the University of Florida, and the director of the Risk Management and Financial Engineering Lab.

His research is focused on efficient computer modeling and optimization techniques and their applications in finance and DOD projects. He published four books (two monographs and two edited volumes) and more than 130 research papers. He is a co-inventor of the Conditional Value-at-Risk and the Conditional Drawdown-at-Risk optimization methodologies.

His joint paper with Prof. Rockafellar on Optimization of Conditional Value-At-Risk in The Journal of Risk, Vol. 2, No. 3, 2000 is among the 100 most cited papers in Finance. This paper is popular in many engineering areas. Many risk management/optimization packages implemented the approach suggested in this paper (MATLAB implemented a toolbox).

Stan Uryasev is a frequent speaker at academic and professional conferences. He has delivered seminars on the topics of risk management and stochastic optimization. He is on the editorial board of a number of research journals and is Editor Emeritus and Chairman of the Editorial Board of the Journal of Risk.



On Squared-Variable Formulations

Stephen Wright | University of Wisconsin-Madison

Joint work with Lijun Ding

We revisit a formulation technique for inequality constrained optimization problems that has been known for decades: the substitution of squared variables for nonnegative variables. Using this technique, inequality constraints are converted to equality constraints via the introduction of a squared-slack variable. Such formulations have the superficial advantage that inequality constraints can be dispensed with altogether. But there are clear disadvantages, not least being that first-order optimal points for the squared-variable reformulation may not correspond to first-order optimal points for the original problem, because the Lagrange multipliers may have the wrong sign. Extending previous results, this paper shows that points satisfying approximate second-order optimality conditions for the squared-variable reformulation also, under certain conditions, satisfy approximate second-order optimality conditions for the original formulation, and vice versa. Such results allow us to adapt complexity analysis of methods for equality constrained optimization to account for inequality constraints. On the algorithmic side, we examine squared-variable formulations for several interesting problem classes, including bound-constrained quadratic programming and linear programming. We show that algorithms built on these formulations are surprisingly competitive with standard methods. For linear programming, we examine the relationship between the squared-variable approach and primal-dual interior-point methods.

Stephen J. Wright holds the George B. Dantzig Professorship, the Sheldon Lubar Chair, and the Amar and Balinder Sohi Professorship of Computer Sciences at the University of Wisconsin-Madison. His research is in computational optimization and its applications to data science and many other areas of science and engineering. Prior to joining UW-Madison in 2001, Wright held positions at North Carolina State University (1986-1990) and Argonne National Laboratory (1990-2001). He has served as Chair of the Mathematical Optimization Society (2007-2010) and as a Trustee of SIAM for the maximum three terms (2005-2014). He is a Fellow of SIAM. In 2014, he won the W.R.G. Baker Award from IEEE for best paper in an IEEE archival publication during 2009-2011. He was awarded the Khachiyan Prize by the INFORMS Optimization Society in 2020 for lifetime achievements in optimization and received the NeurIPS Test of Time Award in 2020 for a paper presented at that conference in 2011. Prof. Wright is the author/coauthor of widely used text and reference books in optimization including "Primal Dual Interior-Point Methods" and "Numerical Optimization" and, most recently, "Optimization for Data Analysis." He has published widely on optimization theory, algorithms, software, and applications. Prof. Wright served from 2014-2019 as Editor-in-Chief of the SIAM Journal on Optimization and previously served as Editor-in-Chief of Mathematical Programming Series B. He has also served as Associate Editor of Mathematical Programming Series A, SIAM Review, SIAM Journal on Scientific Computing, and several other journals and book series.

The Solution Path of the Distributionally Robust SVMs

Erfan Yazdandoost Hamedani | University of Arizona

Bilevel optimization is an important class of optimization problems where one optimization problem is nested within another. This framework is widely used in machine learning problems, including meta-learning, data hyper-cleaning, and matrix completion with denoising. In this talk, we consider bilevel optimization (Bi-Opt) problem with simple and general formulation and introduce conditional gradient methods with convergence rate guarantee. In particular, for simple Bi-Opt problems our proposed method locally approximates the solution set of the lower-level problem via a cutting plane and then runs a conditional gradient update to decrease the upper-level objective. For general Bi-Opt problems, we proposed a single-loop projection-free method using a nested approximation technique. Furthermore, we present numerical experiments to showcase the superior performance of our method compared with state-of-the-art methods.

Dr. Yazdandoost Hamedani is an Assistant Professor at the University of Arizona, Department of Systems and Industrial Engineering. He received the B.S. degree in mathematics and applications from the University of Tehran, Tehran, Iran, in 2015 and the Ph.D. degree in industrial engineering and operation research with minor in statistics from Pennsylvania State University in August 2020. His research interests include distributed optimization, large-scale saddle point problems, and bilevel optimization in machine learning. His research has received support from the National Science Foundation (NSF).

Scalable Algorithms for Multiclass Probability Estimation in High Dimensional Data

Hao Helen Zhang | University of Arizona

Multiclass probability estimation deals with the likelihood of a data point's class membership based on its covariates and provides measure of uncertainty. Conventional techniques largely rely on model-based approaches, making specific assumptions about the log-odds or data distribution. We introduce a new class of robust and model-free methods by leveraging large-margin classifiers to determine class probabilities. Tailored for high-dimensional data with a large number of classes, the method utilizes a divide-and-conquer strategy, which solves multiple weighted binary classification problems and then subsequently constructs probability estimates by aggregating various decision rules. The estimates are shown to be consistent asymptotically under general conditions. Through simulated and real-world examples, we showcase the performance of our new method and compare it with existing alternatives.

Dr. Hao Helen Zhang is Professor of Mathematics at UArizona and also serves as the Chair of the Graduate Interdisciplinary Program (GIDP) in Statistics and Data Science. Her research areas include statistical machine learning, nonparametric smoothing, and high-dimensional data analysis, with support from NSF, NIH, NSA including the NSF CAREER award. Dr. Zhang recently led the UA-TRIPODS iniative to strengthen the theoretical foundations of data science. She is an ASA Fellow, IMS Fellow, and an IMS Medallion Lecturer.