Thematic Talk

1: Title: Quasidifferential Analysis and Its Application in Interval-Valued Multiobjective Optimization

All Authors' Names and Affiliations:

1) Prashant Jaiswal, Department of Mathematics, Institute of Science, Banaras Hindu University;

2) Akriti Dwivedi, Department of Mathematics, Institute of Science, Banaras Hindu University;

3) Vivek Laha, Department of Mathematics, Institute of Science, Banaras Hindu University

Presenter's Name: Prashant Jaiswal

Abstract: The aim of this talk is to investigate approximate solutions in an interval-valued multiobjective optimization problem with inequality constraints involving quasidifferentiable functions, which is denoted by QIVMOP. We establish the Karush-Kuhn-Tucker (KKT)- type necessary optimality conditions to identify a type-2 E−quasi weakly Pareto solution of the QIVMOP under the assumption of a suitable constraint qualification. We also deduce the conditions under which the necessary optimality conditions become sufficient under the assumptions of generalized convexity in terms of quasidifferentials. The effectiveness and applicability of these conditions are demonstrated through several numerical examples.

Keywords: Quasidifferentiability; Interval-valued programming; Multiobjective optimization; Optimality conditions

2: Title: Approximate Stationarity Conditions for Nonsmooth Interval-Valued Multiobjective Optimization with Vanishing Constraints

All Authors' Names and Affiliations:

1) Akriti Dwivedi, Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi 221005, India;

2) Vivek Laha, Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi 221005, India;

3) Miruna-Mihaela Beldiman, Institute of Mathematical Statistics and Applied Mathematics of the Romanian Academy, 13 September Street~No.~13, 050711 Bucharest, Romania;

4) Andrei-Dan Halanay, Department of Mathematics, Bucharest University, 14 Academiei Street, 010014 Bucharest, Romania.

Presenter's Name: Akriti Dwivedi

Abstract: The purpose of this research is to develop approximate weak and strong stationary conditions for interval-valued multiobjective optimization problems with vanishing constraints (IVMOPVC) involving nonsmooth functions. In many real-world situations, the exact values of objectives are uncertain or imprecise; hence, interval-valued formulations are used to model such uncertainty more effectively. The proposed approximate weak and strong stationarity conditions provide a robust framework for deriving meaningful optimality results even when the usual constraint and data qualifications fail. We first introduce approximate variants of these qualifications and establish their relationships. Secondly, we establish some approximate KKT type necessary optimality conditions in terms of approximate weak strongly stationary points and approximate strong strongly stationary points to identify type-2 E-quasi weakly Pareto and type-1 E-quasi Pareto solutions of the IVMOPVC. Lastly, we show that the approximate weak and strong strongly stationary conditions are sufficient for optimality under some approximate convexity assumptions.

Keywords: interval-valued multiobjective optimization; vanishing constraints; approximate constraint qualifications; approximate stationary conditions; approximate efficient solutions

3: Title: Dynamic Filtering-Based False Data Injection Attacks Detection for IEC 61850 Architecture

All Authors’ Names and Affiliations:

1) Haoyu Yang, School of Electrical Engineering, Computing and Mathematical Sciences, Curtin University, Perth, Australia;

2) Yanqing Liu, School of Electrical Engineering, Computing and Mathematical Sciences, Curtin University, Perth, Australia;

3) Yanyan Yin, School of Electrical Engineering, Computing and Mathematical Sciences, Curtin University, Perth, Australia

Presenter’ s Name: Yanyan Yin

Abstract: With the continuous development of digital substations based on the IEC 61850 standard, it significantly improves the real-time communication capabilities for power system protection, control, and measurement. However, the open and high-speed nature of sampled values (SV), GOOSE messages, and MMS-based station control layer communication makes the system vulnerable to False Data Injection Attacks (FDIA). The injection of false data will threaten power system stability and cause huge losses. Malicious attackers can bypass traditional static residual-based detection mechanisms by carefully designing attack vectors, thereby undermining the security and stability of power systems. Therefore, to address this issue, a dynamic filtering based FDIA suppression strategy is proposed for the IEC-61850 architecture. Specifically, it is a multi-source measurement verification mechanism based on unscented Kalman filtering (UKF) and integrates it into the dynamic state estimation layer. The strategy integrates synchronous data streams from IEC-61850 SV and PMU, embeds an anomaly detection module based on innovative sequence, and incorporates it into the filtering process. By calculating the normalized innovation square (NIS) in real time and comparing it with the chi-square distribution threshold, real-time verification of anomalous measurement data can be achieved. When the system detects an anomaly in the innovation data sequence, it triggers an adaptive data weighting mechanism to dynamically reduce the weight of suspicious data while not completely discarding suspicious measurements data, thereby effectively resisting covert fake data injection attacks. This protection strategy fully leverages the dynamic constraints, time consistency characteristics, and data cross-validation mechanisms of the power system, which is significantly different from traditional static residual detection methods. By deploying the filtering layer on a ruggedized communication infrastructure secured under IEC 62351-6 communication security mechanisms and placing it below the protection decision logic, a layered defense system is formed, improving the operational security of the power system while ensuring system performance.

Keywords: Digital substation; IEC 61850 standard; False Data Injection Attacks; unscented Kalman filtering

4: Title: Data-Driven Discovery of a Refined Dynamical Model for Ocean Internal Solitary Waves

All Authors' Names and Affiliations: Saheya Baribtag, Xia Ren

Presenter's Name: B. Saheya

Abstract: Internal solitary waves (ISWs) are a typical form of nonlinear wave phenomena in the ocean, characterized by large amplitudes and high energy, and they play a critical role in both marine engineering safety and ecosystem stability. Accurately characterizing their propagation properties and evolutionary mechanisms is essential for understanding ocean dynamic processes. Although traditional theoretical models have yielded certain achievements, their applicability in complex marine environments is limited due to reliance on numerous idealized assumptions. At present, constrained by the scarcity of in-situ observational data, it remains challenging to directly identify and validate the governing equations under realistic oceanic conditions. In light of the above considerations, this preliminary study proposes a data-driven modeling approach that employs sparse regression techniques to automatically discover the structural form of the governing equations for ISWs, while ensuring physical interpretability. Additionally, the Levenberg-Marquardt (LM) algorithm is introduced to optimize model parameters, thereby enhancing prediction accuracy and stability. The governing equations derived through this method are further solved numerically to enable high-precision simulation of the propagation process of ISWs. This study synthesizes laboratory observations and numerical simulations spanning a wide range of ocean stratification regimes and ISW generation scenarios. By imposing multiple physical constraints, this paper establish a comprehensive ISW dynamics database that enables systematic investigation of wave evolution characteristics and the associated dynamical mechanisms under diverse environmental conditions. The results show that, when multi-source data and physical constraints are jointly incorporated, the proposed method significantly outperforms traditional models in both equation identification accuracy and propagation-process prediction. Compared with traditional models, the proposed method improves the overall amplitude-prediction accuracy in numerical simulations by approximately 0.3 m. For physical experimental data, when the prediction horizon exceeds 10 steps, the proposed method achieves at least a 0.02 m improvement in amplitude-prediction accuracy over theoretical models such as KdV and mKdV. While conventional approaches require selecting an appropriate model

based on the specific physical setting, the proposed method relies solely on data and thus enables dynamical-process prediction without presupposing physical conditions.

Keywords: Internal solitary wave(ISW),data-driven modeling, machine learning, Levenberg-Marquardt (LM), system identification

5: Title: A Relaxation Method for Nonsmooth Nonlinear Optimization with Binary Constraints

All Authors' Names and Affiliations:

1) Lianghai Xiao, Jinan University;

2) Yitian Qian, The Hong Kong Polytechnic University;

3) Shaohua Pan, South China University of Technology

Presenter's Name: Lianghai Xiao

Abstract: We study binary optimization problems of the form $\min_{x\in\{-1,1\}^n} f\,(Ax-b)$ with possibly nonsmooth loss f. Following the lifted rank-one semidefinite programming (SDP) approach \cite{qian2023matrix}, we develop a majorization-minimization algorithm by using the difference-of-convexity (DC) reformuation for the rank-one constraint and the Moreau envelop for the nonsmooth loss. We provide global complexity guarantees for the proposed Difference of Convex Relaxation Algorithm (DCRA) and show that it produces an approximately feasible binary solution with an explicit bound on the optimality gap. Numerical experiments on synthetic and real datasets confirm that our method achieves superior accuracy and scalability compared with existing approaches.

Keywords: Binary orthogonal optimization problems; global exact penalty; relaxation methods; semantic hashing

6: Title: An Inexact ADMM for Nonconvex and Nonsmooth Optimization Problems

All Authors' Names and Affiliations: Jianchao Bai, Miao Zhang, Hongchao Zhang

Presenter's Name: Jianchao Bai

Abstract: In this talk, an Inexact Alternating Direction Method of Multiplies (I-ADMM) with an expansion linesearch step will be presented for solving a family of separable minimization problems subject to linear constraints, where the objective function is the sum of a smooth but possibly nonconvex function and a possibly nonsmooth nonconvex function. A unified proximal gradient method with momentum acceleration is also proposed for solving the smooth but possibly nonconvex subproblem. Numerical experiments on testing nonconvex quadratic programming problems and sparse optimization problems show that the proposed I-ADMM performs faster than some state-of-the-art algorithms in the literature.

Keywords: Nonconvex optimization, inexact ADMM, proximal gradient method, convergence

7: Title: Optimization of Beamspace Blind Signal Separation Method

All Authors' Names and Affiliations:

Ka Fai Cedric Yiu and Qi He, Department of Applied Mathematics, The Hong Kong Polytechnic University, Hunghom, Kowloon, Hong Kong, China

Presenter's Name: Cedric Yiu

Abstract: For speech extraction, multi-sensors are often deployed in order to pick up and enhance multi-source speech signals. This is the typical cocktail party problem. In general, there are two popular techniques, namely blind signal separation (BSS) and beamforming. BSS exploits the statistical properties of the signals while beamforming capitalizes on spatial information. One possible method, which combines the strength of both techniques, to carry out BSS under a pre-designed beamspace. However, in a dynamic environment, a fixed beamspace is not practical and more dynamic approach is required. Here, we discuss different optimization formulations and propose an optimization method which optimizes on both beamforming and BSS techniques. We demonstrate the performance of the method via several examples.

Keywords: Signal processing; beamforming; blind signal separation (BSS)

8: Title: Optimal Microphone Subset Selection for Beamforming

All Authors' Names and Affiliations:

1) Yuhan Zhang, Department of Applied Mathematics, The Hong Kong Polytechnic University, Kowloon, Hong Kong, PR China;

2) Ka-Fai Cedric Yiu, Department of Applied Mathematics, The Hong Kong Polytechnic University, Kowloon, Hong Kong, PR China;

3) Zhibao Li, School of Mathematics and Statistics, Central South University, Changsha, Hunan 410083, PR China.

Presenter's Name: Yuhan Zhang

Abstract: Microphone arrays are widely utilized in speech-related applications, where selecting an optimal subset of microphones is crucial for minimizing computational burden without degrading beamformer performance. This subset selection is inherently a challenging combinatorial problem, conventionally addressed by greedy-based heuristics that cannot guarantee optimality. In this paper, we propose a novel exact formulation for microphone subset selection. By rigorously reformulating the combinatorial conditions into continuous algebraic constraints, we transform the problem into a novel mixed-integer linear programming (MILP) model. The optimal subset is derived from a multi-objective optimization problem that maximizes beamforming performance while minimizing the number of selected microphones. A branch-and-bound algorithm is employed to find the global optimum. Numerical experiments demonstrate that our proposed MILP approach achieves competitive beamforming performance compared to greedy and genetic algorithms (GA), while strictly minimizing the active microphone count, making it highly effective for hardware-constrained applications.

Keywords: Microphone selection; Beamformer design; Mixed integer linear programming; Branch-and-bound

9: Title: Accelerated proximal gradient algorithms for nonsmooth multiobjective optimization

All Authors' Names and Affiliations: Chengzhi Huang, sichuan university;

Presenter's Name: Chengzhi Huang

Abstract: Many practical problems can be modeled as nonsmooth multiobjective optimization problems; however, subgradient methods suffer from slow convergence and the lack of explicit convergence rate guarantees. To address these issues, this paper proposes two improved algorithms. First, based on a backtracking strategy, we develop a backtracking accelerated proximal gradient method, which achieves a convergence rate of $O(1/k^2)$ under relatively mild assumptions. By further incorporating smoothing techniques, the method is extended to the nonsmooth setting, attaining a convergence rate of$O(\ln k/k)$, and outperforming classical subgradient methods in both iteration complexity and computational time. Second, to avoid the additional overhead introduced by backtracking, we propose an adaptive accelerated proximal gradient method by modifying the inertial term, under the assumption that an upper bound on the initial estimate of the Lipschitz constant of the gradient is available. Combining this approach with smoothing techniques extends it to the nonsmooth case. The resulting method enjoys the same convergence rate as the aforementioned algorithm while requiring less computational time. Finally, we analyze the influence of the inertial parameter on convergence behavior, providing theoretical guidance for subsequent algorithm design.

Keywords: Nonsmooth multiobjective optimization; accelerated proximal gradient method; backtracking; adative updating scheme;

10: Title: New Algorithms via Multiobjective Damped Inertial Gradient-like Systems with Asymptotic Vanishing Normalized Gradient

Presenter's Name: Yingdong Yin

Abstract: For unconstrained convex smooth multiobjective optimization, we propose a novel inertial gradient-like system that incorporates the asymptotic vanishing normalized gradient. In the scalar case, this system reduces to a first-order method with strong empirical performance, as introduced by Wang et al. [SIAM J. Sci. Comput., 2021]. We prove the existence of a trajectory solution and, using Lyapunov analysis, establish convergence rates of $O(1/t^2)$ and $O(\ln^2 t/t^2)$ under two distinct parameter choices. Under certain assumptions, we employ new techniques to establish the convergence of solution trajectories to weakly Pareto optimal solutions. Based on this system, we designed a new multiobjective accelerated algorithm. Numerical experiments demonstrate the effectiveness of the proposed algorithm.

Keywords: Multiobjective optimization; Inertial Gradient-like system; Accelerated gradient method; Direction correction; Lyapunov analysis

11: Title: The control parametrization technique for numerically solving fractal-fractional optimal control problems involving Caputo–Fabrizio derivatives

All Authors' Names and Affiliations:

1) Chongyang Liu, Shandong Technology and Business University,

2) Xiaopeng Yi, Sunway University,

3) Zhaohua Gong, Curtin University,

4) Meijia Han, Shandong Technology and Business University

Presenter's Name: Chongyang Liu

Abstract: Fractal–fractional derivatives open new opportunities for modelling complex processes. In this talk, we develop a novel numerical computation approach for solving optimal control problems with Caputo–Fabrizio derivatives. Firstly, we propose a general class of fractal–fractional optimal control problems with Caputo–Fabrizio derivatives and subject to state constraints of equality and inequality. Then, by using control parametrization technique, the fractal–fractional optimal control problem is approximated by a series of finite-dimensional optimization problems. Furthermore, the gradients of the cost and constraint functions in regard to decision variables are derived, which can be obtained by solving auxiliary fractal–fractional systems. A 3rd-order numerical scheme is also presented to solve the involved fractal–fractional systems. On the basis of this result, we develop a gradient-based optimization algorithm to solve the resulting optimization problem. Finally, numerical examples are provided to demonstrate the applicability and effectiveness of the developed algorithm.

Keywords: Fractal-fractional optimal control, Caputo-Fabrizio derivative, Numerical scheme, Numerical optimization

12: Title: Optimal quality supervision control model based on Internet plus agricultural product quality traceability system

All Authors' Names and Affiliations:

1) Ying Zhang, Zhejiang Normal University;

2) Yingtao Xu, Zhejiang Normal University;

3) Jinlin Xu, China Telecom Corporation Limited Jinhua Branch

Presenter's Name: Ying Zhang

Abstract: Quality traceability is a guarantee to reduce agricultural product safety risks, since it allows problems to be traced to all stages of production and distribution. Most of the research in this field is about system design or qualitative nature. This paper focuses on the quantitative approach to broaden the scope of current study. By supposing the enforcement of quality supervision as control variables, and taking selling price and sales volume as states variables, this paper presents a optimal quality supervision control (OQSC) model in the form of a discrete-time optimal control problem. The aim is to optimize an overall profit. Based on the gradient formulae for the cost and canonical constraint functions, the optimal control problem can be solved by any existing constraint optimization technique. A case study arising from Suichang's agricultural product traceability system reveals a better solution of effective optimal quality supervision.

Keywords: Discrete-time optimal control; quality traceability; gradient formulae; case study

13: Title: Riemannian Bilevel Optimization with Gradient Aggregation

All Authors' Names and Affiliations:

1) Zhuo Chen, Department of Mathematics, Shanghai University, Shanghai, China;

2) Xinjian Xu, Qian Weichang College, Shanghai University, Shanghai, China;

3) Shihui Ying, School of Mechanics and Engineering Science, Shanghai University, Shanghai, China;

4) Tieyong Zeng, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong, China

Presenter's Name: Zhuo Chen

Abstract: Bilevel optimization (BLO) provides a powerful framework for hierarchical decision-making and is widely used in machine learning tasks like hyperparameter optimization and meta-learning. Traditional BLO methods mainly operate in Euclidean spaces, yet many real-world problems have structural constraints. We propose a novel Riemannian bilevel optimization (RBLO) algorithm incorporating a bilevel descent aggregation (BDA) scheme to coordinate updates at both levels efficiently. Our approach abstracts constraints as manifold structures and reformulates the constrained BLO into an unconstrained RBLO problem. To overcome convergence limitations of existing methods, we leverage smooth manifold mappings and offer convergence guarantees under geodesic convexity and Lipschitz smoothness assumptions. Finally, we demonstrate our method on multi-view hypergraph spectral clustering with the 3sources dataset, showing superior performance compared to Euclidean and manifold-based baselines.

Keywords: Riemannian Optimization; Bilevel Optimization; Gradient Aggregation; Convergence Analysis; Hypergraph Spectral Clustering;

14: Title: Multi-Objective Online Convex Optimization from Metric Theory to Discrete Representations

All Authors' Names and Affiliations:

1) Jieyuan Guo, Key Laboratory of Knowledge Automation for Industrial Processes of Ministry of Education, School of Automation and Electrical Engineering, University of Science and Technology Beijing, Beijing 100083, China;

2) Lizhen Shao, Key Laboratory of Knowledge Automation for Industrial Processes of Ministry of Education, School of Automation and Electrical Engineering, University of Science and Technology Beijing, Beijing 100083, China;

3) Fangyuan Zhao, KINGSEMI Co., Ltd, Shenyang 110169, China

Presenter's Name: Jieyuan Guo

Abstract: Multi-Objective Online Convex Optimization (MO-OCO) has garnered significant attention for its ability to simultaneously address conflicting objectives and dynamic environmental changes in streaming data-driven decision-making scenarios. However, existing studies remain limited in two key aspects: on one hand, the geometric implications and theoretical properties of the metrics employed require further refinement; on the other hand, the continuous Pareto front generates an infinite number of potential solutions during the online process, imposing substantial computational and cognitive burdens on practical decision-making. To address these challenges, in this talk, we first proposes a multi-objective regret metric based on ε-nondominance, providing a novel perspective for evaluating the convergence performance of online decision sequences for MO-OCO problems. Theoretical analysis demonstrates that this metric is a natural extension of the regret concept in traditional single-objective online convex optimization. Furthermore, to address the practical demand for finite yet high-quality solution sets in decision-making, this paper proposes a Online Discrete Representation (ODR) algorithm. Theoretical proofs first demonstrate that each online decision sequence generated by the ODR algorithm achieves sublinear multi-objective regret. On this basis, this paper analyzes the uniformity of distribution and coverage accuracy of the entire discrete representation solution set in the objective space, revealing the intrinsic connection between the convergence of individual sequences and the representativeness of the overall solution set. Finally, this paper applies the proposed multi-objective regret and the ODR algorithm to several classic convex machine learning tasks. Experimental results demonstrate that compared to existing baseline methods, the ODR algorithm achieves a more uniformly distributed and broader non-dominated solution set while maintaining the fastest convergence rate. In summary, this paper not only theoretically unifies the measurement criteria for single-objective and multi-objective regret but also proposes the ODR algorithm for multi-objective decision-making in online settings, which simultaneously guarantees convergence and representativeness.

Keywords: multi-objective online convex optimization; Pareto front; ε-nondominance; discrete representation; convergence analysis

15: Title: High-order finite-difference methods for hyperbolic nonconservative systems of partial differential equations

Presenter's Name: Baifen Ren

Abstract: This work aims to extend the well-known high-order WENO finite-difference methods for systems of conservation laws to nonconservative hyperbolic systems. The main difficulty of these systems both from the theoretical and the numerical points of view comes from the fact that the definition of weak solution is not unique: according to the theory developed by Dal Maso, LeFloch, and Murat in 1995, it depends on the choice of a family of paths. A new strategy is introduced here that allows non-conservative products to be written as the derivative of a generalized flux function that is defined locally on the basis of the selected family of paths. WENO reconstructions are then applied to this generalized flux. Moreover, if a Roe linearization is available, the generalized lux function can be evaluated through matrix-vector operations instead of path-integrals. Two different known techniques are used to extend the methods to problems with source terms and the well-balanced properties of the resulting schemes are studied. These numerical schemes are applied to a coupled Burgers' system and to the two-layer shallow water equations in one- and two-dimensions to obtain high-order methods that preserve water-at-rest steady states.

Keywords: WENO finite difference scheme, High order accuracy, Well-balanced scheme, Nonconservative equations, Path-conservative method

16: Title: A control parameterization method for solving combined fractional optimal parameter selection and optimal control problems

Presenter's Name: Xiaopeng Yi

Abstract: In this paper, we consider a class of combined fractional optimal parameter selection and optimal control problems involving nonlinear fractional systems with Caputo fractional derivatives and subject to canonical equality and inequality constraints. We first approximate this problem by a set of finite-dimensional optimization problems using the control parameterization method, where both the heights of parameterized controls and system parameters are taken as decision variables. We then show that the gradients of the cost and constraint functions with respect to the decision variables can be expressed as the solutions of a series of auxiliary fractional systems, which can be solved together with the original fractional system forward in time, simultaneously. Furthermore, we present a third-order numerical scheme for solving both the original and auxiliary fractional systems. On this basis, a gradient-based optimization algorithm is developed to solve the resulting optimization problems. Finally, we demonstrate the effectiveness and applicability of the developed algorithm through two non-trivial examples.

Keywords: Fractional parameter selection; Fractional optimal control; Control parameterization; Numerical scheme; Numerical optimization

17: Title: Fractional Optimal Control in Cancer Chemotherapy

Presenter's Name: Meijia Han

Abstract: In this paper, considering the memory effect and non-local characteristic in biological systems, we propose a nonlinear fractional system with free terminal time to describe the tumor dynamics in cancer chemotherapy process. Based on this, we present a fractional optimal control problem subject to safety threshold constraints on cell counts, where the cost function aims to minimize the tumor cell population and the drug usage in an average sense. Then, we apply time-scaling transformation and constraint transcription to convert the problem into a sequence of optimal control problems with fixed terminal time and canonical constraints. Furthermore, an optimization algorithm, which combines a discretization scheme and gradients of the cost and canonical constraint functions, is developed to solve the resulting problems. Finally, numerical results show that the proposed algorithm is highly effective.

Keywords: Fractional optimal control; free terminal time; time-scaling transformation; numerical optimization; cancer chemotherapy.

18: Title: A multi-strategy improved Kepler optimization algorithm for feature selection

All Authors' Names and Affiliations:

1) Dongmei Yu, College of Science, Liaoning Technical University;

2) Qihang Guo, College of Science, Liaoning Technical University

Presenter's Name: Qihang Guo

Abstract: Kepler Optimization Algorithm (KOA) is a metaheuristic inspired by the laws of planetary motion. Although KOA has demonstrated superior performance in several benchmark test sets, it still faces challenges such as susceptibility to local optima and imbalances between exploration and exploitation. To address these issues, we developed an improved version of the algorithm, named the Improved Kepler Optimization Algorithm (IKOA), designed for both global optimization and feature selection problems (FS). IKOA incorporates three key enhancements: Adaptive Sine-Cosine Heliocentric Motion (AHM), Extreme-guided Exponential Exploration (EGEE), and Elite Opposition-based Levy Flight (EOLF). The effectiveness of IKOA was validated using the CEC2022 benchmark function. Additionally, IKOA was applied to ten real-world datasets from the UCI repository. The numerical results demonstrate that IKOA outperforms other methods in the field of feature selection (FS). Overall, this study confirms that IKOA exhibits exceptional robustness, practicality, and effectiveness in feature vector reduction.

Keywords: Kepler optimization algorithm; Adaptive sine-cosine heliocentric motion; Extreme-guided exponential exploration; Elite opposition-based levy flight; Feature selection

19: Title: Near-Optimal Algorithms for Convex Simple Bilevel Optimization under Weak Assumptions

All Authors' Names and Affiliations:

1) Rujun Jiang, School of Data Science, Fudan University;

2) Xu Shi, School of Data Science, Fudan University;

3) Weizheng Song, School of Data Science, Fudan University;

4) Jiulin Wang, School of Mathematical Sciences, Nankai University

Presenter's Name: Jiulin Wang

Abstract: We consider the simple bilevel optimization (SBO) problem, which minimizes a composite convex function over the optimal solution set of another composite convex minimization problem. We first show that this bilevel problem is equivalent to finding the left-most root of a nonlinear equation. Based on this and a novel dual approach for solving the subproblem in each iteration, we efficiently obtain an (ϵ, ϵ)-optimal solution through the bisection and Newton methods. The proposed methods achieve near-optimal operation complexity of $\tilde{O}\left(\sqrt{1/\epsilon}\right)$ under mild assumptions, aligning with the lower complexity bounds of the first-order methods in SBO with both level objectives being smooth convex and unconstrained composite convex optimization when ignoring logarithmic terms.

Keywords: Simple bilevel optimization; Bisection method; Near-optimal complexity

20: Title: The multi-objective portfolio model for oil and gas exploration drilling projects selection and its operator-enhanced non-dominated sorting genetic algorithm based solution

All Authors' Names and Affiliations:

1) Chao Min, Southwest Petroleum University;

2) Junyi Cui, Southwest Petroleum University;

3) Stanislaw Migorski, Jagiellonian University;

4) Yonglan Xie, Southwest Petroleum University;

5) Qingxia Zhang, Southwest Petroleum University;

6) Jun Peng, Southwest Petroleum University.

Presenter's Name: Junyi Cui

Abstract: Drilling investment is a critical component of oil and gas exploration planning. Conventional drilling deployment relies heavily on fragmented expert assessments of geological and economic factors, resulting in limited capability for information integration. Motivated by portfolio theory as a parsimonious yet effective framework for asset allocation, we develop a multi-objective mean-variance portfolio model that explicitly accounts for uncertainty in geological parameters to enable an effective risk–return trade-off and optimal selection. First, probabilistic distributions of key geological parameters are constructed for the candidate exploration projects using expert-elicited priors. Second, drilling project screening is formulated as a portfolio selection problem, and an optimization model is established to characterize the return and risk of short-term plans under multiple constraints. Third, we propose an operator-enhanced non-dominated sorting genetic algorithm tailored to the model. Specifically, (i) a directional crossover operator is designed to embed improving directions in objective space-derived from dominance and objective differences-into recombination, and (ii) a structure-aware mutation operator is designed to prioritize high-utility bit flips via probabilistic sampling with feasibility repair, thus improving the search ability for

superior Pareto solutions. Finally, the proposed framework is validated using the 2023 exploration drilling deployment as a case study. The results indicate that the proposed method provides a reusable solution for drilling portfolio optimization in oil and gas exploration.

Keywords: Multiple objective programming; Optimal drilling; Portfolio; Meta-Heuristic; Non-dominated sorting genetic algorithm

21: Title: A DC-Based Optimization Method for Solving Reverse Convex Programming Problems

All Authors' Names and Affiliations:

1) Adil. M. Bagirov, Centre for Smart Analytics, Federation University Australia, Ballarat, Victoria, Australia;

2) Sona Taheri, Mathematical and Geospatial Sciences, RMIT University, Melbourne, Victoria, Australia;

3) Kaniz Fatema, Mathematical and Geospatial Sciences, RMIT University, Melbourne, Victoria, Australia;

4) Andrew Eberhard, Mathematical and Geospatial Sciences, RMIT University, Melbourne, Victoria, Australia

Presenter's Name: Bagirov Adil

Abstract: In this talk, we consider reverse convex programming problems. A novel solution approach that integrates the difference-of-convex (DC) optimization with the concept of sharp augmented Lagrangians is introduced. Sharp Lagrangians are first employed to formulate the dual problem, and subgradients of the resulting dual function are computed to determine ascent directions. The sharp Lagrangians are represented as

DC functions with respect to the primal variables, and a new scheme based on the ε-subdifferentials of the DC components is developed to approximate these functions. The proposed method comprises two interrelated components: an ε-subdifferential-based procedure for approximating global minimizers in the primal space, and a subgradient method for solving the corresponding dual problem. To further improve the solution accuracy, a local refinement step is applied to the final approximation. The effectiveness of the proposed method is validated through a series of academic benchmark problems and comparative analyses with an existing algorithm.

Keywords: Reverse convex programming; DC programming; Sharp augmented Lagrangians; ε-subdifferential

22: Title: A New Class of Convex Functions and Characterizations

All Authors' Names and Affiliations: Soumitra Dey, Department of Mathematics, Hebrew University of Jerusalem, Jerusalem, Israel

Presenter's Name: Soumitra Dey

Abstract: In this talk, we introduce a new class of convex functions that generalizes several existing well-known classes of convex functions. We establish both first-order and second-order characterizations of this class. Furthermore, we introduce two notions of monotonicity that are closely related to this class of functions. Finally, we present several non-trivial examples to illustrate the concepts and support the theoretical results.

Keywords: Convex functions, quasi-convex functions, monotone mappings, differentiable functions

23: Title: Semi-orthogonal matrix factorization with sparse constraint in topic modeling

All Authors' Names and Affiliations:

1) Gillian Yi Han Woo, Universiti Tunku Abdul Rahman;

2) Hong Seng Sim, Universiti Tunku Abdul Rahman;

3) Yong Kheng Goh, Universiti Tunku Abdul Rahman;

4) Wah June Leong, Universiti Putra Malaysia

Presenter's Name: Yong Kheng Goh

Abstract: This study introduces a novel method for topic modeling by combining semi-orthogonal matrix factorization with sparse constraints to improve interpretability, coherence, and scalability. Traditional techniques such as Latent Dirichlet Allocation (LDA) and Nonnegative Matrix Factorization (NMF) often face challenges in maintaining these qualities, especially with high-dimensional data. To address these issues, we propose the Spectral Proximal Method (SPM), an optimization approach that uses proximal variable metric updates with spectral diagonal scaling. SPM enforces both l1-norm sparsity and semi-orthogonality to generate diverse and interpretable topics. The algorithm uses SPM, with initialization based on NMF to enhance computational efficiency. Experiments conducted on the 20 Newsgroups dataset demonstrate that SPM outperforms the Proximal Steepest Descent (PSD) method in terms of topic coherence, sparsity of the topic-term matrix, and reduced computation time. These results highlight the scalability and effectiveness of SPM in text analysis, clustering, and recommendation systems. This research contributes a practical, interpretable, and scalable solution to existing limitations in traditional topic modeling techniques.

Keywords: Proximal variable metric; matrix factorisation; orthogonal matrix; sparse optimization; topic modelling

24: Title: Fast online ℓ_0 elastic net subspace clustering via a novel dictionary update strategy

All Authors' Names and Affiliations:

1) Wentao Qu, Jiangsu Normal University;

2) Lingchen Kong, Beijing Jiaotong University;

3) Linglong Kong, University of Alberta;

4) Bei Jiang, University of Alberta

Presenter's Name: Wentao Qu

Abstract: Driven by rapidly growing data volumes and increasing demands for real-time analysis, online subspace clustering has emerged as a valuable tool for processing dynamic data streams. However, existing online subspace clustering methods struggle to capture the complex and evolving distribution of such data due to rigid dictionary learning frameworks. In this work, we propose a novel ℓ_0 elastic net subspace clustering model that integrates the ℓ_0 norm and the Frobenius norm to achieve the desirable block diagonal property. To enable dynamic adaptation, we further design a fast online alternating direction method of multipliers featuring an innovative dictionary update strategy based on support points-a compact set capturing the underlying data distribution. By selectively updating dictionary atoms guided by the support points, the proposed method dynamically adapts to shifting data characteristics, thereby enhancing adaptability and computational efficiency. Moreover, we provide rigorous convergence guarantees for the algorithm. Extensive numerical experiments demonstrate superior clustering accuracy and computational efficiency of our method, confirming its suitability for real-time and large-scale data processing tasks.

Keywords: Sparse optimization, subspace clustering, online algorithm, support points

25: Title: A Machine Learning-Based Fast and Robust Operational Reliability Assessment Method for Power Systems

All Authors' Names and Affiliations:

1) Jueyou Li, National Center for Applied Mathematics in Chongqing, Chongqing Normal University, Chongqing, China;

2) Kairui Gu, National Center for Applied Mathematics in Chongqing, Chongqing Normal University, Chongqing, China;

3) Kequan Zhao, National Center for Applied Mathematics in Chongqing, Chongqing Normal University, Chongqing, China;

4) Tao Xie, National Center for Applied Mathematics in Chongqing, Chongqing Normal University, Chongqing, China;

5) Zhengmao Li, School of Electrical Engineering, Aalto University, Espoo, Finland;

6) Zhaoyang Dong, Department of Electrical Engineering, City University of Hong Kong, Hong Kong Special Administrative Region of China

Presenter's Name: Tao Xie

Abstract: The strong stochasticity and volatility of wind power generation pose new challenges to the operational reliability of power systems. Traditional reliability assessment often struggles to balance economic efficiency and robustness under high-penetration wind power integration, yielding either optimistic or overly conservative results. We develop a data-driven distributionally robust optimization (DRO) model for operational risk assessment, which computes state-conditioned reliability indices while hedging probability misspecification and distribution shifts. To meet real-time needs, we propose a CNN-DRO method that predicts the worst-case probability distribution (WPD) and thereby collapses the tri-level "min-max-min" DRO model to a single-level OPF-consistent optimization problem solved per operating state. This preserves physical feasibility and enables minute-level updates. A hybrid CNN Classifier-Regressor design first screens secure states (no load shedding needed) and then predicts the WPD for insecure states, so only the latter invokes the single-level optimization solve. The CNN inference is negligible relative to the solver. Numerical simulations are conducted on the RTS-79 and IEEE 118-bus systems under varying wind power penetration levels, with comparisons against stochastic optimization (SO) and robust optimization (RO) methods. The results validate the superior robustness and economic benefits of the proposed DRO model in operational risk assessment for high-penetration wind power systems. Additionally, experiments demonstrate that the proposed method has much higher computational speed and accuracy when compared with the classical column and constraint generation (CCG) algorithm.

Keywords: Distributionally robust optimization; convolutional neural network; power system with high wind power penetration; risk assessment; uncertainty

26: Title: A Fast Block Coordinate Descent Method for Orthogonal Nonnegative Matrix Factorization

All Authors' Names and Affiliations:

1) Liangshao Hou, School of Science, Sun Yat-sen University, Shenzhen;

2) Delin Chu, Department of Mathematics, National University of Singapore;

3) Li-Zhi Liao, Department of Mathematics, Hong Kong Baptist University

Presenter's Name: Liangshao Hou

Abstract: Orthogonal nonnegative matrix factorization (ONMF) extends traditional matrix factorization by incorporating nonnegativity and orthogonality constraints. It has gained significant attention for applications in dimension reduction and data clustering. This paper proposes a novel algorithm for solving ONMF within the block coordinate descent (BCD) framework. Both subsequence and whole sequence convergence of the algorithm are rigorously established, representing a major advancement in ONMF research. Extensive experiments on real-world datasets demonstrate the method's effectiveness and efficiency. Compared with several state-of-the-art ONMF techniques, the proposed algorithm achieves superior performance in terms of computational efficiency, relative error, and optimality gap.

Keywords: Orthogonal nonnegative matrix factorization; Block coordinate descent method; Kurdyka-Lojasiewicz property

27: Title: Directionally Variational Analysis and Second-Order Optimality Conditions of Optimization with SC

All Authors' Names and Affiliations: Jiawei Chen; Liu Luyu; Dai Yuhong; Kobis Eisabeth

Presenter's Name: Jiawei Chen

Abstract: We focus on directionally variational analysis and the second-order optimality conditions for mathematical programs with switching constraints (MPSC) originated from optimal control theory. Developing the variational analysis associated with switching constraints, we present explicit formulas of radial cone, (directional) tangent cones, (directional) normal cones, outer (inner) second-order tangent set as well as geometrically derivability and parabolically derivability of the cross set. The relations among the (directional) tangent cones and normal cones, and second-order tangent set are established. The decompositions of normal cones, tangent cones and second-order tangent sets associated with Cartesian product of the cross set and a nonempty closed set are also obtained. We derive the characterizations, such as the non-emptiness, uniqueness, convexity and compactness, of the multiplier sets and directional multiplier sets associated with the stationary points and directional stationary points of MPSC. Then the second-order necessary conditions and the second-order growth conditions of MPSC are established by the second-order tangent sets. Besides, the second-order optimality conditions of MPSC are also established by using the Fréchet second-order subdifferentials, where the involved functions are lack of the twice-differentiability.

Keywords: Second-order necessary conditions; Constraint qualifications; Directionally variational analysis

28: Title: A Behavior-Aware Influence Maximization Model with Informed Users: A Hybrid Optimization Approach Based on RIS and DQN

All Authors' Names and Affiliations:

1) Yifan Gu, Wuhan University;

2) Jie Hu, Wuhan University

Presenter's Name: Yifan Gu

Abstract: With the rapid growth of social networks, the scale and speed of information spread have increased significantly, making viral marketing and online advertising key application areas for combinatorial optimization. The Influence Maximization (IM)

problem, a well-known discrete combinatorial optimization challenge in network analysis, aims to select a limited set of seed nodes within a social network to maximize overall information diffusion, which holds great practical importance in optimization tasks. However, traditional IM models mainly depend on network topology and typically focus only on the number of activated nodes. This approach makes it difficult to account for behavioral factors involved in real-world diffusion processes, such as user interests, content quality, and differences in user value, often resulting in suboptimal optimization outcomes. To address this limitation, this paper introduces a behavior-aware influence maximization model from the perspective of optimization modeling. Based on the Independent Cascade (IC) model, we refine the propagation probability by incorporating multiple behavioral factors, including the influence of the propagator, user interests, and the relevance between users and information topics, to enhance the rationality of the optimization model. Additionally, an informed state is introduced, extending the traditional two-state diffusion process (active and inactive) to a three-state model (active, informed, and inactive). In this model, informed users are those who receive information but do not propagate it further, which makes the diffusion process more aligned with real-world scenarios and provides a solid foundation for accurate optimization. Simultaneously, a user-value weighting mechanism is integrated into the optimization objective function, enabling the model to focus on the economic value generated by information diffusion among target user groups and facilitating multi-objective optimization of both diffusion effectiveness and economic value. Regarding algorithm design, we develop a hybrid optimization framework that combines Reverse Influence Sampling (RIS) with a Deep Q-Network (DQN) to efficiently solve the IM optimization problem. RIS is initially used to estimate influence spread and generate an initial seed set through a greedy approach; DQN then further refines the seed selection policy, effectively overcoming the limitations of traditional greedy methods in local optimization. Since the objective function is submodular, the greedy approach provides theoretical approximation guarantees, which are essential for evaluating optimization algorithms. Experimental results show that, compared to models that overlook user heterogeneity and refined

propagation probabilities, the proposed method achieves a higher diffusion value while maintaining efficient dissemination, confirming the effectiveness and superiority of the proposed model and algorithm in solving the IM optimization problem.

Keywords: targeted Influence Maximization; Information Diffusion; Reverse Influence Sampling; Deep Reinforcement Learning; Social Network Analysis

29: Title: Convergence analysis of the transformed gradient projection algorithms on compact matrix manifolds

All Authors' Names and Affiliations:

1) Wentao Ding, The Chinese University of Hong Kong;

2) Jianze Li, Sun Yat-sen University;

3) Shuzhong Zhang, University of Minnesota

Presenter's Name: Wentao Ding

Abstract: Existing algorithms for Riemannian optimization can be classified into retraction-based and projection-based methods. While retraction-based algorithms admit a unified comprehensive convergence theory, projection-based line-search methods with possibly non-tangent search directions remain less understood. To address this gap, we propose a unified framework called the Transformed Gradient Projection (TGP) algorithm, where the search direction is defined as a transformed Riemannian (or Euclidean) gradient augmented with a normal component. This construction generalizes various existing methods, including the classical Euclidean gradient projection algorithm, the shifted power method, and certain retraction-based algorithms, while also producing new variants on Stiefel and Grassmann manifolds. Within this framework, we establish weak convergence, global convergence, and iteration complexity under Armijo, Zhang-Hager type nonmonotone Armijo, and fixed stepsizes. A key ingredient of our analysis is the development of new geometric properties of projections onto compact matrix manifolds, which may be of independent interest. Numerical experiments further demonstrate that different choices of scaling matrices and normal components significantly affect performance, implying the flexibility of the TGP framework enables it to outperform classical methods in several scenarios.

Keywords: optimization on manifold; transformed gradient projection algorithm; Euclidean gradient projection algorithm; convergence analysis

30: Title: Sum of Radii Clustering with Concave Power Costs

All Authors' Names and Affiliations:

1) Xianrun Chen, The University of Hong Kong, Hong Kong, China;

2) Yicheng Xu, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China

Presenter's Name: Yicheng Xu

Abstract: We study a covering problem in Euclidean and general metric spaces: given a set of clients P and a prescribed set of admissible centers S, assign a radius $r_s \geq 0$ to each $s \in S$ so that every client in P is covered by at least one ball $B(s, r_s)$. The objective is to minimize the concave power cost $\sum_s \in S\ r_s^{\alpha}$ for a fixed exponent $0 < \alpha < 1$. This concave regime complements the classical linear sum-of-radii objective $(\alpha = 1)$ and the extensively studied convex power cover objective $(\alpha > 1)$. Our main contribution is a PTAS in Euclidean space: for any fixed dimension and $\varepsilon > 0$, we compute a $(1 + \varepsilon)$-approximate solution in time polynomial in $|P| + |S|$. The analysis turns concavity into structure: a merging inequality induces an uncrossing

principle that limits how large-radius balls can interact locally within a hierarchical geometric decomposition, enabling a dynamic program with constant-size boundary information per cell. In general metrics, we additionally obtain a 3^{α}-approximation via a primal–dual (radius-inflation) framework, consistent with the best-known constant-factor approximations for the linear case [Buchem et al., SODA'24] and with 3^{α} −type guarantees in the convex regime [Bar-Yehuda and Rawitz, CGTA'13].

Keywords: Clustering, Sum of radii, Power Cover, Approximation Algorithm, Concave Function

31: Title: A decentralized mini-batch variance-reduced gradient tracking method with Barzilai-Borwein step sizes

All Authors' Names and Affiliations:

1) Juan Guo, Tianjin University of Technology;

2) Xin-Wei Liu, Hebei University of Technology;

3) Chenchen Wu, Tianjin University of Technology;

4) Chunming Xu, Tianjin University of Technology

Presenter's Name: Juan Guo

Abstract: This paper investigates the problem of minimizing the finite sum of smooth and strongly convex cost functions, where these functions are nested on a decentralized, undirected network of agents. We present a decentralized mini-batch variance-reduced gradient tracking algorithm with Barzilai-Borwein (BB) step sizes, termed DmSVRG-BB. Our method employs the uncoordinated and dynamic step sizes that are automatically computed by using local information. The combination of the mini-batch stochastic variance reduced gradient and the gradient tracking technique facilitates exact convergence of the algorithm. We establish the conditions under which DmSVRG-BB linearly converges to the exact optimal solution in expectation. Owing to the incorporation of the BB step sizes and the mini-batch technique, DmSVRG-BB achieves a faster convergence rate, both theoretically and numerically, compared to the existing decentralized variance-reduced gradient tracking method with the coordinated constant step size (GT-SVRG). Numerical experiments on standard data sets show that DmSVRG-BB is superior to GT-SVRG with best-tuned step sizes, and can outperform several advanced decentralized stochastic gradient algorithms.

Keywords: Decentralized optimization; machine learning; variance reduction; Barzilai-Borwein step sizes; linear convergence

32: Title: Existence and relaxation in nonconvex optimal control problems governed by sweeping processes with composed perturbations

All Authors' Names and Affiliations:
1) Chen Bin: School of Mathematical Sciences, Huaqiao University, Quanzhou, China
2) Sergey A. Timoshin: School of Mathematics and Physics, Xi'an Jiaotong-Liverpool University, Suzhou, Jiangsu, China

Presenter's Name: Sergey A. Timoshin

Abstract: We study optimal control problems governed by sweeping processes with composed perturbations of different structural types. The perturbations may include control-dependent multivalued mappings, upper semicontinuous operators, and additional nonsmooth components. We establish existence of trajectories using fixed-point techniques and derive relaxation results for nonconvex optimal control problems. In particular, we prove existence of optimal relaxed solutions and establish the fundamental relaxation equality. The results provide a unified framework combining existence theory for sweeping processes with relaxation methods in optimal control.

Keywords: sweeping process; optimal control; relaxation; nonconvex control; composed perturbations.