2018 International Workshop on Modern Optimization and Applications

June 16-18, 2018

Beijing, China

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Information for Participants

Conference Site

Conference Site:	South Building, Academy of Mathematics and Systems Science (AMSS), Chinese Academy of Sciences (CAS)
Address:	No. 55, Zhong Guan Cun East Road, Hai Dian District, Beijing, CHINA

Registration

Registration will take place on **June 15 from 15:00 to 20:00** and **June 16 from 7:50 to 8:20** at **the first floor of the South Building**. If you want to register at other time, please contact our conference secretary Mr. Liang Chen, chenliang@lsec.cc.ac.cn.

WiFi Connection

The WiFi is available in the conference room. To use it, first search the wireless connection, find "**AMSS**" and click it; then input the workshop code "**P1C2S5C8**" and your personal information.

Contact Information

If you need any help, please contact the conference secretaries:

- Ms. Ji-Ping Wu: +86-10-8254-1738 (in Chinese), +86-10-8254-1993 (Fax), wjp@lsec.cc.ac.cn.
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Local Map


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Workshop Schedule

June 16, 2018 Room 204, South Building of AMSS	
Opening Ceremony, 8:30 - 9:10, Chair: Xin Liu	
8:30 - 8:50	Welcome Address (Jialin Hong, Yu-Hong Dai, Tamás Terlaky)
8:50 - 9:10	Photo Taking
Session 1, 9:10 - 10:00, Chair: Jiming Peng	
9:10 - 10:00	**Sergiy Butenko** (Texas A&M University)
	Continuous approaches to cluster-detection problems in networks
10:00 - 10:20	Coffee Break
Session 2, 10:20 - 12:00, Chair: Oleg P. Burdakov	
10:20 - 11:10	**Zhi-Quan Luo** (The Chinese University of Hong Kong, Shenzhen & University of Minnesota)
	Solving large linear systems with a double stochastic Gauss-Seidel algorithm
11:10 - 12:00	**Nick Sahinidis** (Carnegie Mellon University)
	ALAMO: Machine learning from data and first principles
12:00 - 14:00	Lunch (4th floor of Wuke Restaurant)
Session 3, 14:00 - 15:40, Chair: Zhi-Quan Luo	
14:00 - 14:50	**Tamás Terlaky** (Lehigh University)
	Quadratic convergence to the optimal solution of second-order conic optimization
14:50 - 15:40	**Xiaojun Chen** (The Hong Kong Polytechnic University)
	Spherical designs and non-convex minimization for recovery of sparse signals on the sphere
15:40 - 16:00	Coffee Break
Poster Session, 16:00 - 18:00, Chairs: Xiaojun Chen, Fengmin Xu	
16:00 - 18:00	Poster Session (1st floor of South Building)
18:00	Dinner (4th floor of Wuke Restaurant)

June 17, 2018 Room 204, South Building of AMSS	
Session 4, 8:20 - 10:00, Chair: Defeng Sun	
8:20 - 9:10	**Jiming Peng** (University of Houston)
	Assessing systemic risk in financial networks under incomplete market information
9:10 - 10:00	**Tsung-Hui Chang** (The Chinese University of Hong Kong, Shenzhen)
	Transceiver optimization in full-duplex multi-user networks
10:00 - 10:20	Coffee Break
Session 5, 10:20 - 12:00, Chair: Naihua Xiu	
10:20 - 11:10	**Wotao Yin** (University of California, Los Angeles)
	Douglas-Rachford splitting for pathological problems
11:10 - 12:00	**Hulin Wu** (The University of Texas Health Science Center at Houston)
	Optimization challenges for big data analytics and predictions: Examples from GEO genomics and EHR phenomics data analysis and modeling
12:00 - 14:00	Lunch (4th floor of Wuke Restaurant)
Session 6, 14:00 - 15:40, Chair: Sergiy Butenko	
14:00 - 14:50	**Panos M. Pardalos** (University of Florida)
	On the limits of computation in non-convex optimization
14:50 - 15:40	**Ya-xiang Yuan** (Academy of Mathematics and Systems Science, CAS)
	Stochastic proximal quasi-Newton methods for nonconvex composite optimization
15:40 - 16:00	Coffee Break
Poster Session, 16:00 - 18:00, Chairs: Zhi-Quan Luo, Deren Han	
16:00 - 18:00	Poster Session (1st floor of South Building)
18:00	Banquet (4th floor of Wuke Restaurant)

June 18, 2018 Room 204, South Building of AMSS	
Session 7, 8:20 - 10:00, Chair: Ya-xiang Yuan	
8:20 - 9:10	**Oleg P. Burdakov** (Linkoping University)
	Spectrum-based limited memory algorithms
9:10 - 10:00	**Anthony Man-Cho So** (The Chinese University of Hong Kong)
	On the linear convergence of the ADMM for regularized non-convex low-rank matrix recovery
10:00 - 10:20	Coffee Break
Session 8, 10:20 - 12:00, Chair: Xin Liu	
10:20 - 11:10	**Yanfei Wang** (Institute of Geology and Geophysics, CAS)
	Nano-CT imaging in shale structure analysis
11:10 - 12:00	**Zaiwen Wen** (Peking University)
	A stochastic semismooth Newton method for nonsmooth non-convex optimization
12:00 - 14:00	Lunch (4th floor of Wuke Restaurant)
Session 9, 14:00 - 15:40, Chair: Donglei Du	
14:00 - 14:50	**Yuantao Gu** (Tsinghua University)
	Restricted isometry property of random projection for low-dimensional subspaces
14:50 - 15:40	**Neng Fan** (University of Arizona)
	Multi-level optimization for resilient planning and operations of interdependent infrastructures
15:40 - 16:00	Coffee Break
Session 10, 16:00 - 16:50, Chair: Tiande Guo	
16:00 - 16:50	**Defeng Sun** (The Hong Kong Polytechnic University)
	A block symmetric Gauss-Seidel decomposition theorem and its applications in big data nonsmooth optimization
Closing Ceremony, 16:50 - 17:10, Chair: Yu-Hong Dai	
16:50 - 17:10	Closing Address and "Best Poster Award" Announcement (Ya-xiang Yuan, Xiaojun Chen)
17:10	Dinner (4th floor of Wuke Restaurant)

June 16-17, 16:00-18:00, South Building of AMSS		
Poster Session		
A1	A confined Newton-type method for nonsmooth generalized equations with metrically regular mapping	Mohammed Harunor Rashid
A2	Compressive signal recovery and phase retrieval via convex and nonconvex minimization	Peng Li
A3	A Euclidean distance matrix model for protein molecular construction	Fengzhen Zhai
A4	Alternating projection method for tensor equation	Zhibao Li
A5	Solution uniqueness of convex piecewise affine functions based optimization with applications to constrained L1-minimization	Jinglai Shen
A6	Spherical $t_\epsilon -$design for numerical approximations on the sphere	Yang Zhou
A7	Calibrated zero-norm regularized LS estimator for high-dimensional error-in-variables regression	Shujun Bi
A8	New stepsizes for the gradient method	Cong Sun
A9	Variable splitting based method for image restoration with impulse plus Gaussian noise	Tingting Wu
B1	A successive difference-of-convex approximation method for a class of nonconvex nonsmooth optimization problems	Tianxiang Liu
B2	Convergence analysis of sample average approximation of two-stage stochastic generalized equations	Hailin Sun
B3	Proximal algorithms with extrapolation for structured nonconvex optimization problems	Bo Wen
B4	Convergence of DRSM for optimization problems involving weakly convex functions	Ke Guo
B5	An alternating direction method of multipliers with a worst-case $O(1/n^2)$ convergence rate	Wenyi Tian
B6	A relaxation approximation method for l_p regularized mathematical programs with equilibrium constraints	Lei Guo
B7	Inexact successive quadratic approximation for regularized optimization without global Lipschitz continuous gradients	Wei Peng
B8	ADMM for nonconvex box constrained quadratic programming	Liaoyuan Zeng
B9	Local linear convergence of the alternating direction method of multipliers for nonconvex separable optimization problems	Zehui Jia

Abstracts

Part I

Invited Talks

Continuous approaches to cluster-detection problems in networks

Sergiy Butenko
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We propose continuous formulations for several cluster-detection problems in networks, including the maximum edge weight clique, the maximum s-plex, and the maximum independent union of cliques problems. More specifically, the problems of interested are formulated as quadratic, cubic, or higher-degree polynomial optimization problems subject to linear (typically, unit hypercube) constraints. The proposed formulations are used to develop analytical bounds as well as effective algorithms for some of the problems.

Solving large linear systems with a double stochastic Gauss-Seidel algorithm

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In this talk, we propose a double stochastic Gauss-Seidel (G-S) type algorithm for solving a linear system of equations $Ax = b$. Although it is generally known that the G-S scheme and many of its variants diverge when A is neither diagonal dominant nor symmetric positive definite, we show a positive result: with a random choice of equations and variables, the (over relaxed) G-S algorithm converges globally linearly (in expectation) for any feasible linear systems of equations. The key in the algorithm design is to introduce a nonuniform and double randomization rule for picking the equations and the variables in each update step. Our analysis also generalizes to certain iterative alternating projection algorithms for solving the linear inequality system $Ax \leq b$ with an arbitrary A. Our result demonstrates that properly introducing randomization can ensure global linear convergence of an (otherwise divergent) G-S type algorithm for arbitrary A.

This is a joint work with Mingyi Hong, Meisam Razaviyayn, Navid Reyhanian.

ALAMO: Machine learning from data and first principles

Nick Sahinidis
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We have developed the ALAMO methodology with the aim of producing a tool capable of using data to learn algebraic models that are accurate and as simple as possible. ALAMO relies on integer nonlinear optimization, derivative-free optimization, and global optimization to build and optimize models. We present the methodology behind ALAMO and comparisons with a variety of learning techniques, including the lasso.

Quadratic convergence to the optimal solution of second order conic optimization

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In this paper, we establish the quadratic convergence of Newton's method to the unique maximally complementary optimal solution of second-order conic optimization, when strict complementarity fails. Only very few approaches have been proposed to remedy the failure of strict complementarity, mostly based on nonsmooth analysis of the optimality conditions. Our local convergence result depends on the optimal partition of the problem, which can be identified from a bounded sequence of interior solutions. We provide a theoretical complexity bound for identifying the quadratic convergence region of Newton's method from the trajectory of central solutions.

Spherical designs and non-convex minimization for recovery of sparse signals on the sphere

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This talk considers the use of spherical designs and non-convex minimization for recovery of sparse signals on the unit sphere S^2. The available information consists of low order, potentially noisy, Fourier coefficients for S^2. As Fourier coefficients are integrals of the product of a function and spherical harmonics, a good cubature rule is essential for the recovery. A spherical t-design is a set of points on S^2, which are nodes of an equal weight cubature rule integrating exactly all spherical polynomials of degree $\leq t$. We will show that a spherical t-design provides a sharp error bound for the approximation signals. Moreover, the resulting coefficient matrix has orthonormal rows. In general the L_1 minimization model for recovery of sparse signals on S^2 using spherical harmonics has infinitely many minimizers, which means that most existing sufficient conditions for sparse recovery do not hold. To induce the sparsity, we replace the L_1-norm by the L_q-norm $(0 < q < 1)$ in the basis pursuit denoise model. Recovery properties and optimality conditions are discussed. Moreover, we show that the penalty method with a starting point obtained from the re-weighted L_1 method is promising to solve the L_q basis pursuit denoise model. Numerical performance on nodes using spherical t-designs and t_ϵ-designs (extremal fundamental systems) are compared with tensor product nodes. We also compare the basis pursuit denoise problem with $q = 1$ and $0 < q < 1$.

Assessing systemic risk in financial networks under incomplete market information

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Since the financial crisis in 2007-2008, systemic risk in a financial network has become a major concern in financial engineering and economics.

In this talk, we study the vulnerability of a financial network based on the linear optimization model introduced by Eisenberg and Noe (2001), where the right hand side of the constraints is subject to market shock and only partial information regarding the liability matrix is revealed. We conduct a new sensitivity analysis to characterize the conditions under which a single bank is solvent, default or bankrupted, and estimate the probability that some financial institute in the network will be bankrupted under mild assumptions on the market shock and the network structure. We also show that the asset inequalities among the banks have a negative impact on the efficiency and stability of the network, and that the so-called monopoly network is the most vulnerable.

Transceiver optimization in full-duplex multi-user networks

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Full-duplex can double the capacity of the wireless networks, making it one of the key technologies for the next-generation communication systems. In this talk, we consider a multi-user wireless system with one full duplex (FD) base station (BS) serving a set of half duplex (HD) mobile users. We first review the classical optimal transceiver designs for a HD BS in a single-cell multi-antenna multi-user network, in particular the elegant solutions obtained by the convex optimization theory. Then we introduce the new challenges in transceiver design and resource allocation in the FD multi-user network. In particular, the FD system couples the downlink (DL) and uplink (UL) transmission owing to the in-band self-interference (SI) and the new co-channel interference (CCI) between the uplink users and the downlink users. To cope with the SI and CCI, we formulate a quality-of-service (QoS) constrained linear transceiver design problem. The problem jointly optimizes the DL and UL beamforming vectors of the BS and the transmission powers of UL users so as to provide both the DL and UL users with guaranteed signal-to-interference-plus-noise ratio performance, using a minimum UL and DL transmission sum power. The formulated design problem is not convex and challenging to solve in general. We first show that for a special case with a worst-case SI channel estimation error, the QoS-based linear transceiver design problem is globally solvable by a polynomial time bisection algorithm. For the general case, we propose a suboptimal algorithm based on alternating optimization (AO). The AO algorithm is guaranteed to converge to a Karush-Kuhn-Tucker solution. To improve the computational efficiency of the AO algorithm, we further develop a fixed-point iterative method by extending the classical uplink-downlink duality in HD systems to the FD system. Simulation results are presented to demonstrate the performance of the proposed algorithms and the comparison with HD systems.

Douglas-Rachford splitting for pathological problems

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First-order methods such as ADMM and Douglas-Rachford splitting (DRS) are known for their easy implementations and low per-iteration costs. What is less known is their usefulness for "solving" pathological problems, which are infeasible or feasible yet unbounded. In this talk, we establish that DRS only requires strong duality to work, even if the problem is pathological, in the sense that asymptotically iterates are approximately feasible and/or approximately optimal. Furthermore, we present a method for classifying infeasible, unbounded, andother pathological conic programs. This is joint work with Yanli Liu and Ernest Ryu.

Optimization challenges for big data analytics and predictions: Examples from GEO genomics and EHR phenomics data analysis and modeling

Hulin Wu

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In both standard statistical data analysis and state-of-the-art Big Data analytics, a key step is to optimize an objective function derived from statistical estimation or inference theories based on the assumption of underlying models and data distributions. In this talk, I will present the optimization challenges as we encountered during Big Data analytic practice, in particular in dealing with Big Data from biomedical research projects such as genomics and electronic health record (EHR) data analysis and modeling. One example is to estimate more than a million of unknown parameters in a high-dimensional differential equation model using experimental data and another example is to deal with a large number of predictors in a neural network or machine learning model to predict the disease onset based on EHR data. It is challenging to deal with the nonlinear and high-dimensional optimization problem from Big Data analytics.

On the limits of computation in non-convex optimization

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Large scale problems in engineering, in the design of networks and energy systems, the biomedical fields, and finance are modeled as optimization problems. Humans and nature are constantly optimizing to minimize costs or maximize profits, to maximize the flow in a network, or to minimize the probability of a blackout in a smart grid. Due to new algorithmic developments and the computational power of machines (digital, analog, biochemical, quantum computers etc), optimization algorithms have been used to "solve" problems in a wide spectrum of applications in science and engineering. But what do we mean by "solving" an optimization problem? What are the limits of what machines (and humans) can compute?

Stochastic proximal quasi-Newton methods for nonconvex composite optimization

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In this talk, we propose a generic algorithmic framework for proximal stochastic quasi-Newton (SPQN) methods to solve nonconvex composite optimization problems. Stochastic second-order information is explored to construct proximal subproblem. Under mild conditions we show the non-asympotic convergence of the proposed algorithm to stationary point of original problems and analyze its computational complexity. Besides, we extend the proximal form of Polyak-Łojasiewicz (PL) inequality to constrained settings and obtain the constrained proximal PL (CP-PL) inequality. Under CP-PL inequality linear convergence rate of the proposed algorithm is achieved. Moreover, we propose a modified self-scaling symmetric rank one (MSSR1) incorporated in the framework for SPQN method, which is called stochastic symmetric rank one (StSR1) method. Finally, we report some numerical experiments to reveal the effectiveness of the proposed algorithm.

Spectrum-based limited memory algorithms

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Limited memory quasi-Newton methods are among the most powerful tools used for solving large scale optimization problems. A compact representation of limited memory quasi-Newton updates allows for obtaining, in a cheap way, an implicit spectral decomposition of the Hessian approximation. We present here an overview of spectrum-based limited memory algorithms.

The spectral decomposition allows for efficiently combining limited memory and trust region techniques. We show how this idea can be employed when a cubic regularization is used instead of the trust region approach. To the best of our knowledge, it is the first attempt to combine the limited memory and cubic regularization techniques. Their straightforward combination is prohibitively too expensive.

We also show how to exploit the spectral decomposition for finding the steepest descent path defined as the solution of the ordinary differential equation whose right-hand side equals the minus gradient of the quadratic model originating from the Hessian approximation. We exploit this path for organizing a curvilinear search, as well as for finding an approximate solution of the subproblem based on the trust region or cubic regularization approach.

Fore the sake of computational efficiency, the conventional limited memory algorithms use, at each iteration, a multiple of the identity matrix as an initial Hessian approximation. We show how the efficiency can even be improved by using a special dense initialization.

Our numerical experiments indicate that the spectrum-based algorithms are competing with the widely used line-search-based limited memory algorithms and even often over-perform them.

On the linear convergence of the ADMM for regularized non-convex low-rank matrix recovery

Anthony Man-Cho So

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In this talk, we consider the convergence behavior of the alternating direction method of multipliers (ADMM) for solving regularized non-convex low-rank matrix recovery problems. We show that the ADMM will converge globally to a critical point of the problem without making any assumption on the sequence generated by the method. Furthermore, if the objective function of the problem satisfies the Łojasiewicz inequality with exponent $\frac{1}{2}$ at every (globally) optimal solution, then with suitable initialization, the ADMM will converge linearly to an optimal solution. We then complement this result by showing that three popular formulations of the low-rank matrix recovery problem satisfy the aforementioned Łojasiewicz inequality, which may be of independent interest. Consequently, we are able to exhibit, for the first time, concrete instances of non-convex optimization problems for which the ADMM converges linearly. As a by-product, we establish the global convergence and local linear convergence of the block coordinate descent (BCD) method for solving regularized non-convex matrix factorization problems.

Nano-CT imaging in shale structure analysis

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With the development of nonconventional oil and gas exploration, microscopic analysis of mineral distributions in shale receives much more attention in recent years. Unlike traditional computerized tomography (CT) technique in medical science, the source we used is the synchrotron radiation (SR). This energy is strong enough for emitting monochromatic X rays which will be used for the study of morphology, microstructure, transport properties and fracturing of shale. Note that shale gas usually exists in nano-scale pores, therefore a key issue is how to generate high level reconstructed image data using SR- nano-CT. For nano CT, there usually exists phase effect, e.g., edge enhancement during reconstruction. We use phase retrieval methods to deal with the edge enhancement effect caused by phase shift. The process of phase retrieval can be described by the transport-of-intensity equation (TIE). But this is an ill-posed problem. To tackle the ill-posedness, we propose a regularized block Kaczmarz method. It reveals that the new method performs better than the FBP method and other projection methods in the synthetic and practical data tests.

Acknowledgements

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A stochastic semismooth Newton method for nonsmooth nonconvex optimization

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We present a globalized stochastic semismooth Newton method for solving stochastic optimization problems involving smooth nonconvex and nonsmooth convex terms in the objective function. We assume that only noisy gradient and Hessian information of the smooth part of the objective function is available via calling stochastic first and second order oracles. The proposed method can be seen as a hybrid approach combining stochastic semismooth Newton steps and stochastic proximal gradient steps. Two inexact growth conditions are incorporated to monitor the convergence and the acceptance of the semismooth Newton steps and it is shown that the algorithm converges globally to stationary points in expectation and almost surely. We present numerical results and comparisons on l1-regularized logistic regression and nonconvex binary classification that demonstrate the efficiency of the algorithm.

Restricted isometry property of random projection for low-dimensional subspaces

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Dimensionality reduction is in demand to reduce the complexity of solving large-scale problems with data lying in latent low-dimensional structures in machine learning and computer version. Motivated by such need, in this talk I will introduce the Restricted Isometry Property (RIP) of Gaussian random projections for low-dimensional subspaces in R^N, and prove that the projection Frobenius norm distance between any two subspaces spanned by the projected data in R^n for $n < N$ remain almost the same as the distance between the original subspaces with probability no less than $1 - e^\wedge O(n)$.

Previously the well-known Johnson-Lindenstrauss (JL) Lemma and RIP for sparse vectors have been the foundation of sparse signal processing including Compressed Sensing. As an analogy to JL Lemma and RIP for sparse vectors, this work allows the use of random projections to reduce the ambient dimension with the theoretical guarantee that the distance between subspaces after compression is well preserved.

As a direct result of our theory, when solving the subspace clustering (SC) problem at a large scale, one may conduct SC algorithm on randomly compressed samples to alleviate the high computational burden and still have theoretical performance guarantee. Because the distance between subspaces almost remains unchanged after projection, the clustering error rate of any SC algorithm may keep as small as that conducting in the original space. Considering that our theory is independent of SC algorithms, this may benefit future studies on other subspace related topics.

Multi-level optimization for resilient planning and operations of interdependent infrastructures

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The infrastructure resilience is the ability to reduce the magnitude or duration of disruptive events. In this talk, we will apply the multilevel optimization approach to model the infrastructure planning and operations, and especially to mitigate uncertainties from failures and intermittent renewable energy. The studied interdependent infrastructures consist of power grid, and its interdependent ones, such as water systems, communication systems, production-inventory manufacturing. The proposed approach will enable the coordinated and unified intelligent system-wide decisions for intra- and inter-infrastructure planning and operations.

A block symmetric Gauss-Seidel decomposition theorem and its applications in big data nonsmooth optimization

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The Gauss-Seidel method is a classical iterative method of solving the linear system $Qx = b$. It has long been known to be convergent when Q is symmetric positive definite. In this talk, we shall focus on introducing a symmetric version of the Gauss-Seidel method and its elegant extensions in solving big data nonsmooth optimization problems. For a symmetric positive semidefinite linear system $Qx = b$ with $x = (x_1, , x_s)$ being partitioned into s blocks, we show that each cycle of the block symmetric Gauss-Seidel (block sGS) method exactly solves the associated quadratic programming (QP) problem but added with an extra proximal term. By leveraging on such a connection to optimization, one can extend the classical convergent result, named as the block sGS decomposition theorem, to solve a convex composite QP (CCQP) with an additional nonsmooth term in x_1. Consequently, one is able to use the sGS method to solve a CCQP. In addition, the extended block sGS method has the flexibility of allowing for inexact computation in each step of the block sGS cycle. At the same time, one can also accelerate the inexact block sGS method to achieve an iteration complexity of $O(1/k^2)$ after performing k block sGS cycles. As a fundamental building block, the block sGS decomposition theorem has played a key role in various recently developed algorithms such as the proximal ALM/ADMM for linearly constrained multi-block convex composite conic programming (CCCP) and the accelerated block coordinate descent method for multi-block CCCP.

Part II

Poster Session

A confined Newton-type method for nonsmooth generalized equations with metrically regular mapping

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Notion of metric regularity property and certain types of point-based approximations are used for solving nonsmooth generalized equation $f(x) + \mathcal{F}(x) \ni 0$, where X and Y are Banach spaces, and U is an open subset of X, $f : U \to Y$ is nonsmooth function and $\mathcal{F} : X \rightrightarrows 2^Y$ is a set-valued mapping with closed graph. When f admits point-based and p-point-based approximations on U and $f + \mathcal{F}$ satisfies metric regularity property, we introduce a confined Newton-type method for solving the above nonsmooth generalized equation and establish the semi-local quadratic and super-linear convergence as well as local quadratic and super-linear convergence of sequences generated by the confined Newton-type method.

Compressive signal recovery and phase retrieval via convex and nonconvex minimization

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In this poster, we discuss compressive signals' recovery and phase retrieval via convex and non-convex methods. Firstly, we consider compressive signals' recovery via convex method-ℓ_1 minimization-in the framework of cumulative coherence. Secondly, we consider compressive signals' recovery via non-convex method. We establish two new model: the ℓ_{1-2} minimization with ℓ_1 constraint and Dantzig selector constraint. We give the restrict 1-isometry property characterization and propose LADM-DCA algorithm to solve them. Last, we consider compressive affine phase retrieval. We establish the convex model-Compressive Affine Phase Retrieval via Lifting (CAPRL) and develop inertial proximal ADMM to solve it.

A Euclidean distance matrix model for protein molecular construction

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Protein molecular conformation is an important and challenging problem in biophysics. It is to recover the structure of proteins based on limited information such as noised distances, lower and upper bounds on some distances between atoms. Based on the recent progress in numerical algorithms for Euclidean distance matrix (EDM) based optimization problems, we propose an EDM model for protein molecular conformation. We reformulate the problem as a rank constrained least squares problem with linear equality constraints, box constraints, as well as a cone constraint. We apply the inexact accelerated block coordinate descent (ABCD) algorithm to solve the convex relaxation model. Extensive numerical results demonstrate the efficiency of the proposed model.

Alternating projection method for tensor equation

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This paper considers how to solve a class of tensor equations arising from the unified definition of tensor-vector products. Of special interest is the order-3 tensor equation whose solutions are the intersection of a group of quadrics from a geometric point of view. Inspired by the method of alternating projections for set intersection problems, we develop a hybrid alternating projection algorithm for solving order-3 tensor equations.

Solution uniqueness of convex piecewise affine functions based optimization with applications to constrained L1-minimization

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We study the solution uniqueness of an individual feasible vector of a class of convex optimization problems involving convex piecewise affine functions and subject to general polyhedral constraints. This class of problems incorporates many important polyhedral constrained L1 recovery problems arising from sparse optimization, such as basis pursuit, LASSO, and basis pursuit denoising, as well as polyhedral gauge recovery. By leveraging the max-formulation of convex piecewise affine functions and convex analysis tools, we develop dual variables based necessary and sufficient uniqueness conditions via simpler and yet unifying approaches; these conditions are applied to a wide range of L1 minimization problems under possible polyhedral constraints. An effective linear program based scheme is proposed to verify solution uniqueness conditions. The results obtained in this paper not only recover the known solution uniqueness conditions in the literature by removing restrictive assumptions but also yield new uniqueness conditions for much broader constrained L1-minimization problems.

Spherical t_ϵ−design for numerical approximations on the sphere

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A spherical t-design is a set of points on the sphere that are nodes of a positive equal weight quadrature rule having algebraic accuracy degree t.

A spherical design is only known in a set of interval enclosures on the sphere for $t \leq 100$ but it is unknown how to choose a set of points from the set of interval enclosures to obtain a spherical t-design.

In this work we investigate a new concept of point sets on the sphere named spherical t_ϵ-design ($0 < \epsilon < 1$), which are nodes of a positive weight quadrature rule with algebraic accuracy t.

We show that any point set chosen from the set of interval enclosures in previous work by X. Chen et al. is a spherical t_ϵ-design.

We then study the worst-case errors of quadrature rules using spherical t_ϵ-designs in a Sobolev space, and investigate a model of polynomial approximation with the l_1-regularization using spherical t_ϵ-designs.

Numerical results illustrate good performance of spherical t_ϵ-designs for numerical integration and function approximation on the sphere.

Calibrated zero-norm regularized LS estimator for high-dimensional error-in-variables regression

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This paper is concerned with high-dimensional error-in-variables regression that aims at identifying a small number of important interpretable factors for corrupted data from many applications where measurement errors or missing data can not be ignored. Motivated by CoCoLasso due to Datta and Zou (The Annals of Statistics, 45: 2400-2426, 2016) and the advantage of the zero-norm regularized LS estimator over Lasso for clean data, we propose a calibrated zero-norm regularized LS (CaZnRLS) estimator by constructing a calibrated least squares loss with a positive definite projection of an unbiased surrogate for the covariance matrix of covariates, and use the multi-stage convex relaxation approach to compute the CaZnRLS estimator. Under a restricted eigenvalue condition on the true matrix of covariates, we derive the ℓ_2-error bound of every iterate and establish the decreasing of the error bound sequence, and the sign consistency of the iterates after finite steps. The statistical guarantees are also provided for the CaZnRLS estimator under two types of measurement errors. Numerical comparisons with CoCoLasso and NCL (the nonconvex Lasso proposed by Poh and Wainwright (The Annals of Statistics, 40: 1637-1664, 2012)) demonstrate that CaZnRLS not only has the comparable or even better relative RSME but also has the least number of incorrect predictors identified.

New stepsizes for the gradient method

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For a multiple input single output downlink network, a novel algorithm is proposed to solve the sum rate maximization problem. We fix the precoding beamforming vector, and design the power allocation scheme. The KKT equations of the nonconvex optimization problem is analyzed and approximated, where the highly nonlinear terms are ignored. It is proved that in both low and high Signal to Noise Ratio (SNR) regimes, the approximation is nearly optimal. We propose a water-filling-like algorithm to solve the approximated equations. Theoretical analysis guarantees that the proposed algorithm terminates in finite iterations and has very low computational complexity. Simulation results also indicate the high efficiency of the propose algorithm: compared to the state of the art, the proposed algorithm achieves high sum rate with very little computational cost.

Variable splitting based method for image restoration with impulse plus Gaussian noise

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Image denoising is a fundamental problem in realm of image processing. A large amount of literature is dedicated to restoring an image corrupted by a certain type of noise. However, little literature is concentrated on the scenario of mixed noise removal. In this paper, based on the model of two-phase method for image denoising and the idea of variable splitting, we are capable of decomposing the image denoising problem into subproblems with closed form. Numerical results illustrate the validity and robustness of the proposed algorithms, especially for restoring the images contaminated by impulse plus Gaussian noise.

A successive difference-of-convex approximation method for a class of nonconvex nonsmooth optimization problems

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We consider a class of nonconvex nonsmooth optimization problems whose objective is the sum of a smooth function and a finite number of nonnegative proper closed possibly nonsmooth functions (whose proximal mappings are easy to compute), some of which are further composed with linear maps. This kind of problems arises naturally in various applications when different regularizers are introduced for inducing simultaneous structures in the solutions. Solving these problems, however, can be challenging because of the coupled nonsmooth functions: the corresponding proximal mapping can be hard to compute so that standard first-order methods such as the proximal gradient algorithm cannot be applied efficiently. In this paper, we propose a successive difference-of-convex approximation method for solving this kind of problems. In this algorithm, we approximate the nonsmooth functions by their Moreau envelopes in each iteration. Making use of the simple observation that Moreau envelopes of nonnegative proper closed functions are continuous difference-of-convex functions, we can then approximately minimize the approximation function by first-order methods with suitable majorization techniques. These first-order methods can be implemented effciently thanks to the fact that the proximal mapping of each nonsmooth function is easy to compute. Under suitable assumptions, we prove that the sequence generated by our method is bounded and any accumulation point is a stationary point of the objective. We also discuss how our method can be applied to concrete applications such as nonconvex fused regularized optimization problems and simultaneously structured matrix optimization problems, and illustrate the performance numerically for these two specific applications.

Convergence analysis of sample average approximation of two-stage stochastic generalized equations

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A solution of two-stage stochastic generalized equations is a pair: a first stage solution which is independent of realization of the random data and a second stage solution which is a function of random variables. This paper studies convergence of the sample average approximation of two-stage stochastic nonlinear generalized equations. In particular an exponential rate of the convergence is shown by using the perturbed partial linearization of functions. Moreover, sufficient conditions for the existence, uniqueness, continuity and regularity of solutions of two-stage stochastic generalized equations are presented under an assumption of monotonicity of the involved functions. These theoretical results are given without assuming relatively complete recourse, and are illustrated by two-stage stochastic non-cooperative games of two players.

Proximal algorithms with extrapolation for structured nonconvex optimization problems

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In this talk, we mainly consider proximal algorithms with extrapolation for solving structured nonconvex nonsmooth optimization problems. We first consider the proximal gradient algorithm with extrapolation for minimizing the sum of a Lipschitz differentiable function and a proper closed convex function. Under one error bound condition, we establish the linear convergence rate of both the objective sequence and the iterate sequence generated by the algorithm. Then, we propose a proximal difference-of-convex (DC) algorithm with extrapolation for solving a class of DC problems. We show that any accumulation point of the sequence generated by our algorithm is a stationary point of the DC optimization problem for a general choice of extrapolation parameters. Moreover, using the Kurdyka-Lojasiewicz inequality, we establish global convergence of the sequence generated by our algorithm and analyze its convergence rate. Some numerical experiments are conducted to illustrate our theoretical results.

Convergence of DRSM for optimization problems involving weakly convex functions

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We consider the convergence of the Douglas-Rachford splitting method (DRSM) for minimizing the sum of a strongly convex function and a weakly convex function. This setting has various applications, especially in some sparsity-driven scenarios with the purpose of avoiding biased estimates which usually occur when convex penalties are used. Though the convergence of the DRSM has been well studied for the case where both functions are convex, its results for some nonconvex-function-involved cases, including the "strongly + weakly" convex case, are still in their infancy. In this paper, we prove the convergence of the DRSM for the "strongly + weakly" convex setting under relatively mild assumptions compared with some existing work in the literature. Moreover, we establish the rate of asymptotic regularity and the local linear convergence rate in the asymptotical sense under some regularity conditions.

An alternating direction method of multipliers with a worst-case $O(1/n^2)$ convergence rate

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The alternating direction method of multipliers (ADMM) is being widely used for various convex programming models with separable structures arising in many scientific computing areas. The ADMM's worst-case $O(1/n)$ convergence rate measured by the iteration complexity has been established in the literature when its penalty parameter is a constant, where n is the iteration counter. Research on ADMM's worst-case $O(1/n^2)$ convergence rate, however, is still in its infancy. In this paper, we suggest applying a rule proposed recently by Chambolle and Pock to iteratively updating the penalty parameter and show that the ADMM with this adaptive penalty parameter has a worst-case $O(1/n^2)$ convergence rate in the ergodic sense. Without strong convexity requirement on the objective function, our assumptions on the model are mild and can be satisfied by some representative applications. We test the LASSO model and numerically verify the significant acceleration effectiveness of the faster ADMM with a worst-case $O(1/n^2)$ convergence rate. Moreover, the faster ADMM is more favorable than the ADMM with a constant penalty parameter, as the former is much less sensitive to the initial value of the penalty parameter and can sometimes produce very high-accuracy solutions.

A relaxation approximation method for l_p regularized mathematical programs with equilibrium constraints

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We consider an l_p $(0 < p < 1)$ regularized mathematical program with equilibrium constraints (MPEC). The sparse solution selection from the solution set of convex programs and the second-order road pricing problem in transportation science can be modelled as this kind of problems. Due to the non-Lipschitzness of the l_p regularization function, constraint qualifications for locally Lipschitz MPECs are no longer sufficient for KKT conditions to hold at a local minimizer. We first propose some qualification conditions and show that they are sufficient for KKT conditions to be necessary for optimality. Then we present a relaxed approximation method for solving this kind of problems where all the subproblems are more favorable compared with the original problem in the sense that the objective function is locally Lipschitz even smooth and the constraints typically satisfy certain constraint qualification. In our method, all the subproblems are solved until a weak approximate stationarity condition is satisfied. Due to the possible nonsmoothness of the objective function of the relaxed approximation subproblem, we also develop second-order necessary optimality for relaxed approximation subproblem. We show that any accumulation point of the sequence generated by our method is Clarke stationary if MPEC linear independence condition holds; it is Mordukhovich stationary if, in addition, an approaching subsequence satisfies an approximate weak second-order necessary condition; it is strongly stationary if, in addition, an upper level strict complementarity condition holds.

Inexact successive quadratic approximation for regularized optimization without global Lipschitz continuous gradients

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The successive quadratic approximations (SQA) method (also called proximal quasi Newton method, or variable metric forward-backward splitting method) is numerically efficient for minimizing the sum of a smooth function and a convex function. However, there are very few results on its convergence without global gradient Lipschitz continuity. To close this gap, we consider an inexact SQA with four kinds of line search strategies. We first show its well-definedness and decreasing property. Then, under the quadratic growth condition and a local Lipschitz assumption, we show that the inexact SQA is linearly convergent and the inner iteration number is upper bounded. At last, we carry out several numerical simulations to illustrate the different performance of these line search strategies.

ADMM for nonconvex box constrained quadratic programming

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We use ADMM and proximal ADMM for solving nonconvex box constrained quadratic programming. The convergence results with weak assumptions for the particular problem are given. In order to get solution with better function values, we combine the proximal ADMM with a preprocessing scheme based on coordinate descent. The method is compared with QUADPROG (Matlab solver) and minq8 (Huyer and Neumaier, 2017) on three public test sets and it performs better on most test problems.

Local linear convergence of the alternating direction method of multipliers for nonconvex separable optimization problems

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In this paper, we consider the convergence rate of the alternating direction method of multipliers for solving the nonconvex separable optimization problems. Based on the error bound condition, we prove that the sequence generated by the alternating direction method of multipliers converges locally to a KKT point of the nonconvex optimization problem in a R-linear convergence rate; and the corresponding sequence of the augmented Lagrangian function value converges in a Q-linear convergence rate. We illustrate the analysis by applying the alternating direction method of multipliers to solve the nonconvex quadratic programming problems with simplex constraint, and comparing it with some state of the art algorithms, the proximal gradient algorithm , the proximal gradient algorithm with extrapolation , and the fast iterative shrinkage-thresholding algorithm.

This work is joint with Xue Gao, Xingju Cai and Deren Han.

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The organizing committee wishes you a pleasant stay in Beijing!