哈工大数学研究院成立 5 周年

暨数学学科博士点设立 35 周年系列学术活动

现代优化理论、方法与应用专题研讨会

会议安排：由于疫情原因，将原 2021 年 7 月 30 日 - 8 月 2 日的线下学术会议变更为线上学术会议，学术报告时间为 2021 年 7 月 31 日 - 8 月 1 日，报告形式采用腾讯线上会议，会议号为 **841 1396 2103** .

与会专家（按姓名首字母排序）：

蔡邢菊　南京师范大学
陈志平　西安交通大学
戴彧虹　中国科学院
范金燕　上海交通大学
郭田德　中国科学院大学
韩德仁　北京航空航天大学
黄南京　四川大学
孔令臣　北京交通大学
彭　拯　湘潭大学
宋　文　哈尔滨师范大学
孙德锋　香港理工大学
文再文　北京大学
徐大川　北京工业大学
张立卫　大连理工大学

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会议日程

7 月 31 日 上午

08:30-08:50	开幕式：领导、嘉宾致辞

主持人：徐大川		
08:50-09:35	戴彧虹	Optimization with Least Constraint Violation
09:35-10:20	孙德锋	Exploring the Second-order Sparsity in Sparse Statistical Optimization Problems
主持人：张立卫		
10:20-11:05	韩德仁	Some Advances in Solving Absolute Equations
11:05-11:50	徐大川	次模优化理论与算法介绍

7 月 31 日 下午

主持人：黄南京		
14:00-14:45	陈志平	Stability of a Class of Risk-Averse Multistage Stochastic Programs and Their Distributionally Robust Counterparts
14:45-15:30	张立卫	Semi-proximal Alternating Coordinate Method for Nonsmooth Convex-Concave Minimax Optimization
主持人：宋 文		
15:30-16:15	文再文	NG+ : A Multi-Step Matrix-Product Natural Gradient Method for Deep Learning
16:15-17:00	孔令臣	Gradient Projection Newton Algorithm for Sparse Collaborative Learning

8 月 1 日 上午

主持人：文再文		
08:30-09:15	郭田德	从数值优化方法到学习优化方法
09:15-10:00	彭　拯	Trace Lasso Regularization for Adaptive Sparse Canonical Correlation Analysis via Manifold Optimization Approach
主持人：韩德仁		
10:00-10:45	范金燕	Convergence of Levenberg-Marquart Method Based on Probabilistic Model
10:45-11:30	蔡邢菊	Improved Variance Reduction Extragradient Method with Line Search for Stochastic Variational Inequalities

报告题目与摘要

7 月 31 日 **08:50-09:35**

Optimization with Least Constraint Violation

戴彧虹
中国科学院

Abstract. Study about theory and algorithms for nonlinear programming usually assumes that the feasible region of the problem is nonempty. However, there are many important practical nonlinear programming problems whose feasible regions are not known to be nonempty or not, and optimizers of the objective function with the least constraint violation prefer to be found. A natural way for dealing with these problems is to extend the nonlinear programming problem as the one optimizing the objective function over the set of points with the least constraint violation. Firstly, the minimization problem with least constraint violation is proved to be an Lipschitz equality constrained optimization problem when the original problem is a convex nonlinear programming problem with possible inconsistent constraints, and it can be reformulated as an MPCC problem; And the minimization problem with least constraint violation is relaxed to an MPCC problem when the original problem is an nonlinear programming problem with possible inconsistent non-convex constraints. Secondly, for nonlinear programming problems with possible inconsistent constraints, it is proved that a local minimizer of the MPCC problem is an M-stationary point and an elegant necessary optimality condition, named as L-stationary condition, is established from the classical optimality theory of Lipschitz continuous optimization. Thirdly, properties of the penalty method for the minimization problem with the least constraint violation are developed and the proximal gradient method for the penalized problem is studied. Finally, the smoothing Fischer-Burmeister function method is constructed for solving the MPCC problem related to minimizing the objective function with the least constraint violation. It is demonstrated that, when the positive smoothing parameter approaches to zero, any point in the outer limit of the KKT-point mapping is an L-stationary point of the equivalent MPCC problem.

7 月 31 日 09:35-10:20

Exploring the Second-order Sparsity in Sparse Statistical Optimization Problems

孙德锋
香港理工大学

Abstract. It is widely believed by many researchers, in particular by those outside the traditional optimization community, that the second-order methods such as Newton's method are no longer applicable for solving large scale optimization problems. This is partially true for optimization models that neither need a good optimal solution nor need to be solved quickly. In this talk, we shall first use large scale statistical optimization problems arising from machine learning to explain why the second-order methods, in particular the proximal point dual Newton methods (PPDNA), if wisely used, can be much faster than the first-order methods. The key point is to make use of the second order sparsity of the optimal solutions in addition to the data sparsity so that, at each iteration, the computational costs of the second order methods can be comparable or even lower than those of the first order methods. Equipped with the PPDNA, we shall then introduce adaptive sieving methodologies to generate solution paths of very large sparse statistical optimization problems of particular importance in applications. Finally, we shall illustrate the high efficiency of our approach with extensive numerical results.

7 月 31 日 10:20-11:05

Some Advances in Solving Absolute Equations

韩德仁
北京航空航天大学

Abstract. Absolute equations play an important role in modeling and solving them is an NP problem. In this talk, we introduce several algorithms and show their advantages.

7 月 31 日 11:05-11:50

次模优化理论与算法介绍

徐大川
北京工业大学

摘要. 离散优化里的次模函数对应于连续优化里的凸函数，许多组合优化问题可以用次模函数来刻画，次模优化成为运筹学和组合优化里的重要概念。本报告首先回顾次模优化的历史，经典模型和扩展模型；然后介绍大数据环境下的次模优化和研究展望；最后概述国内次模优化学术动态。

7 月 31 日 14:00-14:45

Stability of a Class of Risk-Averse Multistage Stochastic Programs and Their Distributionally Robust Counterparts

陈志平
西安交通大学

Abstract. In this talk, we consider the quantitative stability of a class of risk-averse multistage stochastic programs, whose objective functions are defined by multi-period pth order lower partial moments (LPM) with given targets, and their distributionally robust counterparts. We first derive the upper bounds of feasible solutions as preliminaries. Then, by employing calm modifications, the quantitative stability results are obtained under a special measurable perturbation of stochastic process, which extend the present results under risk-neutral cases to risk-averse ones. Moreover, we recast the risk-averse model by probability measures of stochastic process, and obtain new quantitative stability estimations on the basis of proper probability metrics under the general perturbation of stochastic process. Finally, motivated by the availability of only partial information about probability measures, we further consider the distributionally robust counterpart of our recasting model, and establish the discrepancy of optimal values with respect to the perturbation of ambiguity sets.

7 月 31 日 14:45-15:30

Semi-proximal Alternating Coordinate Method for Nonsmooth Convex-Concave Minimax Optimization

张立卫
大连理工大学

Abstract. Minimax optimization problems are an important class of optimization problems arising from modern machine learning and traditional research areas. While there have been many numerical algorithms for solving smooth convex-concave minimax problems, numerical algorithms for nonsmooth convex-concave minimax problems are very rare. A semi-proximal alternating coordinate method (spACM) is proposed, in which a quadratic convex-concave function is adopted for approximating the smooth part of the objective function and semi-proximal terms are added in each subproblem. This construction enables the subproblems at each iteration are solvable and even easily solved when the semiproximal terms are cleverly chosen. We prove the global convergence of the algorithm spACM under mild assumptions, without requiring strong convexity-concavity condition. Under the locally metrical subregularity of the solution mapping, we prove that the algorithm spACM has the linear rate of convergence. Preliminary numerical results are reported to verify the efficiency of the algorithm spACM. (This is a joint work with Professor Yu-hong Dai and Miss Jiani Wang.)

7 月 31 日 15:30-16:15

NG+ : A Multi-Step Matrix-Product Natural Gradient Method for Deep Learning

文再文
北京大学

Abstract. In this talk, we introduce a novel second-order method called NG+. By following the rule "the shape of the gradient equals the shape of the parameter", we define a generalized fisher information matrix (GFIM) using the products of gradients in the matrix form rather than the traditional vectorization. Then, our generalized natural gradient direction is simply the inverse of the GFIM multiplies the gradient in the matrix form. Numerical results on image classification, quantum chemistry, machine translation and recommendation system illustrate that GN+ is competitive with the state-of-the-art methods.

7 月 31 日 16:15-17:00

Gradient Projection Newton Algorithm for Sparse Collaborative Learning

孔令臣
北京交通大学

Abstract. Exploring the relationship among multiple sets of data from one same group enables practitioners to make better decisions in medical science and engineering. In this paper, we propose a sparse collaborative learning (SCL) model, an optimization with double-sparsity constraints, to process the problem with two sets of data and a shared response variable. It is capable of dealing with the classification problems or the regression problems dependent on the discreteness of the response variable as well as exploring the relationship between two datasets simultaneously. To solve SCL, we first present some necessary and sufficient optimality conditions and then design a gradient projection Newton algorithm which has proven to converge to a unique locally optimal solution globally with at least a quadratic convergence rate. Finally, the reported numerical experiments illustrate the efficiency of the proposed method.

8 月 1 日 08:30-09:15

从数值优化方法到学习优化方法

郭田德
中国科学院大学

摘要. 数值计算方法是研究并解决数学问题数值近似解的方法与过程，是解决“计算”问题的桥梁和工具。计算能力是计算工具和计算方法的效率的乘积，提高计算方法的效率与提高计算机硬件的效率同样重要。随着人工智能，特别是深度学习的兴起，学习类方法在许多领域取得了巨大的成功。人工智能解决问题的方法都具有学习功能，本报告首先以最优化计算方法为例，分析数值优化计算方法的一般形式和特点，并与学习类方法进行比较，提出学习优化方法的设计思路。最后，以组合最优化为例，对该类方法的设计原理进行阐述。本报告从新的视角设计优化方法，并由此引出学习优化方法。这是一个全新的研究方向，希望为优化方法的设计和理论开辟一个新的研究范式。

8 月 1 日 09:15-10:00

Trace Lasso Regularization for Adaptive Sparse Canonical Correlation Analysis via Manifold Optimization Approach

彭拯
湘潭大学

Abstract. Canonical correlation analysis (CCA for short) describes the relationship between two sets of variables by finding some linear combinations that maximize the correlation coefficient. However, in high-dimensional settings where the number of variables exceeds sample size, or in the case of that the variables are highly correlated, the traditional CCA is no longer appropriate. In this paper, an adaptive sparse version of CCA (ASCCA for short) is proposed by utilizing the trace Lasso regularization. The proposed ASCCA reduces the instability of the estimator when the covariates are highly correlated, and thus improves its interpretation. The ASCCA is reformulated to an optimization problem on Riemannian manifold, and a manifold inexact augmented Lagrangian method is proposed for the resulting manifold optimization problem. The performance of the ASCCA is compared with the other sparse CCA techniques in different simulation settings, which illustrates that the ASCCA is feasible and efficient.

8 月 1 日 10:00-10:45

Convergence of Levenberg-Marquart Method Based on Probabilistic Model

范金燕
上海交通大学

Abstract. In this talk, we consider the use of probabilistic model within a classical Levenberg-Marquardt framework for deterministic nonlinear equations. We assume that the value of the function itself can be computed without noise, while the model of the Jacobian provides sufficient quality of approximation with probability larger than or equal to 1/2. We prove the global convergence of the proposed method with probability one. Some numerical results are also given.

8 月 1 日 10:45-11:30

Improved Variance Reduction Extragradient Method with Line Search for Stochastic Variational Inequalities

蔡邢菊
南京师范大学

Abstract. The fact that the performance of extragradient method is closely related to the step size motivates us to propose this improved stochastic extragradient method with different step sizes in prediction and correction step. We adopt the line search technique in the prediction step, and for the initial line search step size of each iteration, an adaptive method is adopted. The step size is reduced by the proportion related to the problem to satisfy the line search criterion. Under the assumptions of Lipschitz continuous and pseudo-monotone operator and independent identically distributed sampling, the iterative complexity of O(ε(-1)) and the oracle complexity of O(ε(-2)) are obtained. For estimating the upper bound of the second order moment of martingale difference sequences, we present a more convenient and comprehensible scheme instead of using Burkholder-Davis-Gundy (BDG) inequality. Moreover, in numerical experiment, the proposed algorithm is used to solve fractional programming problems such as energy efficiency in multiantenna communications. Numerical results show that our algorithm has good numerical performance.

数学学院简介

哈尔滨工业大学数学学院前身是创建于 1958 年的计算数学专业，1981 年开始培养基础数学和计算数学专业硕士，1986 年获得基础数学博士学位授予权（是国内最早的两所工科院校之一），1987 年成立数学系，2019 年成立数学学院。2001 年建立了数学学科博士后流动站，2005 年数学学科成为一级学科硕士学位授权点，2010 年数学学科成为一级学科博士授权点，2011 年统计学成为一级学科博士授权点。基础数学是省重点学科（2001 年）和国防科工委重点学科（2002 年）；应用数学是省重点学科（2001 年）。数学学科 2011 年成为省一级重点学科。2013 年基础数学和应用数学成为工信部重点学科。1997 年入选教育部首批七个“工科基础课程（数学）教学基地”之一；2020 年数学类专业入选教育部强基计划和基础学科拔尖学生培养计划 2.0 基地；2020 年获批成立黑龙江应用数学中心。

在教育部第四轮学科评估中，哈尔滨工业大学数学学科位列 A-，统计学位列 B。在 2020 年 10 月《美国新闻和世界报导》（US News）发布的世界大学数学专业排名中，我校数学学科排名全球第 80 位，在内地高校 45 个机构中位于第 14 位。在 2021 年发布的世界大学学科排名（QS World University Rankings）中，我校数学学科排名全球第 126 位，在内地高校 36 个机构中位于第 8 位；统计学排名全球第 101-150 位，在内地高校 17 个机构中并列第 7 位。在最新的 ARWU 排名中，数学学科位列全球第 76-100 位，在内地高校 93 个机构中并列第 5 位。哈尔滨工业大学数学学科自 2013 年 5 月始终保持全球 ESI 前 1%行列。

学院现有专任教师 82 人，博士化率 91.5%；其中，国家杰出青年 1 人，中组部首届青年拔尖人才计划 1 人，教育部新世纪人才 1 人，龙江学者 1 人，中组部“万人青拔”1 人，青年长江学者 1 人，黑龙江省杰出青年基金获得者 1 人，黑龙江省教学名师 4 人，龙江青年学者 1 人，宝钢优秀教师奖 7 人，黑龙江省优秀青年基金获得者 1 人；博士生导师 43 人，硕士生导师 63 人，教授 33 人。

学院现有本科专业三个：数学与应用数学（拔尖学生培养计划 2.0、强基计划（2020）、国家一流本科专业（2020））、信息与计算科学（拔尖学生培养计划 2.0、强基计划（2020）、国家一流本科专业（2019））、统计学（省一流本科专业（2020））。现有在读本科生 307 人，硕士研究生 144 人，博士研究生 195 人。现有：国家级精品资源共享课程 1 门，国家级精品课程 2 门，国家级精品在线开放课程 3 门，省级精品课程 4 门，省级优秀教学团队 1 个，省级优秀教材 2 部，省头雁团队 1 个（数学与人工智能交叉学科创新研究），省级重点实验室（计算与应用数学）1 个，省级领军人才梯队（计算数学）1 个。已培养本科生近 2000 人，硕士生近 1400 人，博士生近 400 人，其中涌现出一大批优秀学子：与境外高水平大学联合培养博士研究生 100 余人；长江学者、国家杰青等高层次人才 10 余人；8 位大学校长、副校长（如：哈工大副校长、电子科技大学副校长等）；国家百篇优博提名奖 3 人；教育部学术新人奖 3 人；20 余位省级学会和国家二级学会理事长及副理事长；校优秀博士学位论文奖 16 人；世界华人数学家大会“新世界数学奖”博士金奖 1 人、本科生银奖 1 人。

数学学科依据国防和社会发展的需求及主流科研方向前沿发展趋势，形成了以传统优势方向为支撑，以新兴与交叉方向为主要生长点的学科格局。主要科研方向有：泛函分析及其应用、代数与数论、常微分方程与动力系统、科学与工程计算、偏微分方程与调和分析、数学物理反问题、运筹控制与优化、概率论与数理统计等。近年来承担国家重点研发计划等国家级课题 50 余项，科研经费千万余元。获黑龙江省科学技术奖一等奖、教育部高校科研优秀成果奖自然科学奖二等奖等多个科研奖项，每年发表高水平学术论文 100 余篇。在全国 SCI 高产机构的排名中，近几年一直在前 20 名，2012 年发表的 SCI 论文数量位居全国数学学科第 3 位。

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数学研究院简介

哈尔滨工业大学数学研究院创建于 2016 年 7 月，首任院长由我校讲席教授许全华担任，研究院直接隶属于学校，是数学学院密不可分的合作伙伴。研究院以基础数学为基石，以从事国际一流的原始创新研究和培养杰出青年数学人才为第一要务，致力于推动数学科学的发展以及数学与物理、工程等领域的交叉研究。

研究院现有科研人员 18 人，其中高层次人才 7 人，分别为：菲尔兹奖得主吴宝珠；国家海外引才计划：许全华；国家海外引才计划、长江学者：吴黎明；国家海外引才计划（青年）：尹智、李科、熊枭、熊欢。

研究院探索实行法国宽松管理模式，不片面追求论文数量或杂志级别，而是着力为科研人员提供利于事业发展的有效平台，积极打造一个愉快、舒适、和谐、向上的工作环境，让每名科研人员都能找到适合自己发展的方式和位置。

数学研究院重点打造现代分析、数论-代数-组合以及概率统计及其应用等优势基础学科方向。五年来，获批各类国家自然科学基金 15 项，博士后基金 7 项，2020 年获批国家自然科学基金重点项目 1 项，填补了我校数学学科在此项目中的空白；学院教师先后在《PNAS》，《Memoirs of the American Mathematical Society》，《Communications in Mathematical Physics》等国内外著名期刊发表高水平论文 50 余篇。研究院组织举办了一系列具有国内外重要影响力的学术会议，先后邀请中国科学院院士田刚、美国加州大学圣塔芭芭拉分校张益唐，以及哈佛大学、美国芝加哥大学、俄罗斯科学院等知名专家学者 300 余人到我校访问交流，并促使我校和法国弗朗什-孔泰大学签订双边合作协议。

我们相信，在学校的大力支持下，数学研究院将进一步加快发展步伐，不断开拓创新，促进学科间的交叉与融合，发展成在国内外具有重要影响的数学研究中心，助力学校“双一流”建设。

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