“全局最优化理论与应用研讨班”通知

为了提高全局最优化理论与应用的研究水平，介绍全局优化领域的近期研究成果，清华大学方述诚讲席教授组将于 2009 年 5 月 23 - 24 日在清华大学举办 “全局最优化理论与应用研讨班”。本研讨班特别邀请国内外知名学者就全局优化的最新发展与应用等专题进行讲授和讨论。

组织单位

清华大学工业工程系、数学科学系，北京交通大学应用数学系。

倡导和组织人员

方述诚 教授（清华大学，North Carolina State University），李端 教授（香港中文大学），邢文训 教授（清华大学），赵晓波 教授（清华大学），修乃华 教授 （北京交通大学），黄红选 副教授（清华大学）。

资助单位

清华大学教育基金会方述诚讲席教授基金，北京交通大学国家自然科学基金委“两个基地”基金的部分资金支持。

报告地点：清华大学数学科学系

联系人：路程， c-lu06@mails.tsinghua.edu.cn

报到地点：清华大学数学科学系

邀请报告专题

序号	时　间	主　讲	题　　目
专题 1	5 月 23 日 9:30-10:30	黄红选（清华大学）	全局优化的 DC 规划方法
专题 2	5 月 23 日 11:00-12:00	修乃华（北京交通大学）	对称锥互补问题
专题 3	5 月 23 日 13:30-15:00	李端（香港中文大学）	Binary Quadratic Programs: Polynomially Solvable Cases and Geometric Solution Approaches
专题 4	5 月 23 日 15:30-17:00	孙小玲（复旦大学）	Semidefinite Programming Relaxations for 0-1 Quadratic Programs
专题 5	5 月 24 日 9:00-10:30	高扬（Virginia Tech.）	Canonical Duality Theory: Unified Understanding of Global Optimization
专题 6	5 月 24 日 11:00-12:00	邢文训（清华大学）	Canonical Duality and Quadratic Programs

注意事项：

1、 议程安排：5 月 23 日上午 9：00-9：30 为简单开幕式及照相，随后开始专题报告。
2、 本研讨班的工作用语为中文。
3、 研讨班免收会务费。
4、 本研讨班得到清华大学教育基金会方述诚讲席教授组和北京交通大学国家自然科学基金委“两个基地”基金的部分资金支持。
5、 请于 5 月 16 日前将是否参加研讨班的信息返回路程(c-lu06@mails.tsinghua.edu.cn)，以便后勤安排。
6、 会议住宿自行解决。由于清华校内住宿比较紧张，目前我们仅预订到 10 个房间，我们将尽量安排两人一个房间，请北京市外的老师和同学尽早与路程（c-lu06@mails.tsinghua.edu.cn）联系。
7、 2006 年 5 月 22 日 14：00-18：00 在清华大学理科楼数学科学系大厅接待预约安排住宿的研讨班成员。
8、 请尽量采用电子邮件的方式同我们联系。

姓名		性别	
教师/博士生/博士后/硕士生		所在学校	
电话		电子邮箱	
导师姓名		是否安排住宿	

报告人及报告内容简介

黄红选，清华大学工业工程系副教授，博士，1990 年7月获得清华大学应用数学和自动控制学士学位，1997 年12月，获得北京航空航天大学管理科学与工程博士学位。主要从事二次整数规划、全局优化理论与算法、运筹学建模与方法等方面的研究。2000.08－2001.08在美国佛罗里达大学工业与系统工程系和应用优化中心访问P.M. Pardalos，从事有关全局优化方面的研究。目前发表过论文20多篇，担任三个国际杂志的编委。

报告题目：全局优化的DC规划方法

摘要：本报告将围绕DC规划（D.C. Programming）这个主题介绍全局优化中与DC规划有关的基本结论和方法，包括凸性、凸包络、Difference of Convex、DC规划的最优性条件以及DC规划方法的应用模式等方面。

修乃华，北京交通大学应用数学系教授，博士生导师，1997 年获中国科学院应用数学研究所运筹学与控制论博士学位,2000-2002 年为香港城市大学 Research Fellow,2006-2007 年为加拿大滑铁卢大学组合与优化系访问学者。现任中国运筹学会学术委员会主任、数学规划分会副理事长兼秘书长、中国工业与应用数学学会常务理事、《应用数学学报》中英文编委、《运筹学学报》编委、《运筹与管理》丛书编委。多年来一直从事“最优化理论、算法及应用”方面的研究，出版科学前沿进展丛书一部，编写研究生教材一本。发表学术论文 80 余篇，SCI 检索论文 40 余篇，SCI 引用 180 余次，其中一篇被 ISI 列为全世界数学高引用和影响论文。特别是对变分不等式与互补问题的研究取得了重要成果，2006 年获得教育部高校科学技术奖-自然科学奖二等奖，2007 年获得詹天佑铁道科学技术奖-专项基金奖。近五年主持国家自然科学基金 4 项，教育部新世纪优秀人才支持计划、重点基金、博士点基金 3 项。

报告题目：对称锥互补问题

摘要：对称锥互补问题（SCCP）是一类内容新、涵盖面宽、理论丰富、且有广泛应用背景的均衡优化问题。因此，开展对该问题的研究具有重要的科学意义和应用价值。这个报告主要介绍在对称锥互补问题的基础理论和算法方面的最新研究成果，主要内容包括：（1）SCCP 的静态性质、解的存在性与多样性；（2）SCCP 的互补函数和再生公式；（3）SCCP 的内点与光滑化算法。

Duan Li（李端） was born in Shanghai, China. He graduated from Fudan University in 1977 and received the M.E. degree in automatic control from Shanghai Jiaotong University in 1982, and the Ph.D. degree in systems engineering from Case Western Reserve University in 1987. From 1987 to 1994, he was a Faculty Member at the University of Virginia. He joined the Department of Systems Engineering and Engineering Management, the Chinese University of Hong Kong, in December 1994, where he is currently Chair Professor and Department Chairman. Duan Li's research interests include optimization and control. Duan Li was an Associate Editor of *IEEE Transactions on Automatic Control* from 2003 to 2004 and has been a member of the editorial board or a guest editor for many other journals, including *Journal of Global Optimization*, *IIE Transactions on Operations Engineering* and *Control-Theory and Advanced Technology*. He is currently the vice president of Chinese Society of Mathematical Programming.

报告题目：Binary Quadratic Programs: Polynomially Solvable Cases and Geometric Solution Approaches

摘要：It is well known that the general binary quadratic programming program is NP-hard. We summarize in the first part of this talk polynomially solvable subclasses of binary quadratic programming problems studied in the literature and report some new polynomially solvable subclasses revealed in our recent research. Identifying polynomially solvable subclasses of binary quadratic programming problems not only offers theoretical insight into the complex nature of the problem, but also provides platforms to design relaxation schemes for exact solution methods. We explore in the second part of this talk rich geometric properties hidden behind binary quadratic programming. Especially, we derive new lower bounding methods and variable fixation techniques for quadratic 0-1 optimization problems by investigating geometric features of the ellipse contour of a (perturbed) convex quadratic function. These findings further lead to some new optimality conditions for quadratic 0-1 programming. Integrating these novel solution schemes into a proposed solution algorithm of a branch-and-bound type, we obtain promising preliminary computational results.

孙小玲，复旦大学管理学院管理科学系教授, 博士生导师。中国运筹学会常务理事，数学规划分会副理事长。1995 毕业于上海大学“运筹学与控制论”专业，获博士学位。1997 年起多次访问香港中文大学系统工程与工程管理系进行合作研究；1999 年 11 月至 2000 年 11 月和 2002 年 8 月至 12 月在英国爱丁堡大学进行合作研究。主要研究方向为整数规划，全局优化和金融优化。担任国内外多家学术期刊的编委和特邀主编，出版合作专著《Nonlinear Integer Programming》(Springer)。发表论文的国际学术期刊包括： SIAM J. Optim., Math. Oper. Res., Math. Finance 等。

摘要：It is well known that semidefinite programming (SDP) relaxations can be used to generate tight bounds for 0-1 quadratic programs. Probably the most notable result is Goemans and Williamson's approximate ratio of SDP bound for MAX-CUT problem. SDP relaxations for a binary (0-1) quadratic programs can be derived by using either lifting technique or Shor's Lagrange dual method. The two resulting SDP problems are conic dual to each other. We discuss in this talk how to improve the SDP relaxations for 0-1 quadratic programs by the spectral information of the modified matrix and certain distances. Three classes of 0-1 quadratic programs will be considered: unconstrained binary quadratic program, linear equality constrained binary quadratic program and quadratic knapsack program.

We first discuss SDP relaxation for unconstrained binary quadratic program. Based a necessary and sufficient condition for the zero duality gap, we measure the duality gap by the distance, δ, between $\{-1,1\}^n$ and certain affine set C. We show that the SDP bound can be improved by an amount proportional to δ^2 and the minimum positive eigenvalue of the modified matrix. We establish the connection between the computation of δ and the cell enumeration of hyperplane arrangement in discrete geometry.

We then discuss improving SDP bounds for linear equality constrained quadratic binary program and quadratic knapsack problem. Alternative Lagrangian dual schemes for equality constrained problem via the exact penalty and the squared norm constraint reformulations will be discussed. For quadratic knapsack problem, we show that the SDP relaxation of quadratic knapsack problem does not always possess a unique optimal solution. This is in contrast with the unconstrained 0-1 quadratic problem where the SDP relaxation always has a unique optimal solution. Computational issues of the improve bounds will be also discussed.

David Yang Gao (高扬) received his Ph.D. in Engineering Science and Applied Math at

Tsinghua Univ., Beijing in 1986. Since then, he had held research and teaching positions in different institutes including MIT (1986-1987), Yale (1987-1988), Harvard (1989-1991), and the University of Michigan (1991-1992). He has been a faculty member in Math Department at Virginia Tech since 1992. His research interests range over multi-disciplinary fields of applied mathematics and scientific computation, operations research & control, theoretical and applied mechanics. He has published nine books and about 120 research papers including 4 encyclopedia papers. Currently, he is an editor for four book series including (1) Advances in Mechanics and Mathematics, Springer, 2002-present, (2) Optimization and Control of Complex Systems, Taylor & Francis, 2008-present, (3) Computational Methods and Mechanics, Springer, 2008-present. He is also an associated editor for (1) *Journal of Global Optimization*, Springer, 1999-present; (2) *Discrete and Continuous Dynamical Systems*, Series B, 2001-present; (3) *J. Industrial and Management Optimization*, AIMS Press, 2004-present; (4) *Optimization Letters.* Springer, 2005-present; (5) *Electronic Journal of Technology in Mathematics,* 2006-present.

报告题目：Canonical Duality Theory: Unified Understanding to Global Optimization and Complex Systems

摘要：Duality is a beautiful, inspiring, and fundamental concept that underlies all natural phenomena. In mathematical economics, dynamical systems, global optimization, control theory, management and decision science, numerical methods and scientific computation, duality principles and methods are playing more and more important roles. The canonical duality theory is a newly developed, potentially powerful methodology, which can be used to model complex systems with a unified solution to a wide class of discrete and continuous problems in global optimization and nonconvex analysis.

In this lecture, the speaker will present a brief introduction to the canonical duality theory and its role in global optimization and complex systems. By using some simple but very interesting problems in global optimization, the speaker will first present a unified framework and splendid beauty in mathematical science. He will show that many well-known methods and theories, including the variational inequality and complementarity theory, semi-definite and semi-infinite programming methods, second-order conical approaches, etc, can be put in this unified framework. The traditional Lagrangian multiplier method and modern duality theory will be explained in a unified way. A potentially powerful canonical dual transformation method and the associated triality theory will be introduced by using some simple examples in nonconvex optimization. He will show that by using this method, a unified canonical dual solution can be obtained for a wide class of challenging problems in both continuous and discrete systems, and some challenging problems can be solved in an elegant way. Applications will be illustrated by certain well-known global optimization problems, including general polynomial minimization, fractional programming, mixed integer optimization, and general nonconvex minimization with nonconvex constraints. This talk should bring some fundamentally new insights into global optimization and complex systems theory.

邢文训，清华大学数学科学系教授，博士生导师，1982 年在北京大学数学系获理学学士学位， 1997 年在清华大学应用数学系获理学博士学位，自 1997 年以来，在国内外学术刊物发表论文 40 余篇，以第一、二作者出版教材 3 部。其中《现代优化计算方法》已被引用 500 次以上。2008 年获得国家科技进步二等奖，2007 年获得国防科工委国防科

学技术进步奖一等奖，2001 年获中国运筹学会运筹学应用奖（二等）。目前研究兴趣为组合最优化、排序问题、全局优化等。

报告题目：Canonical Duality and Quadratic Programs

摘要：The canonical duality theory is developed recently with a one to one corresponding between a dual and a primal feasible solution. Initially it is shown computationally efficient using the sufficient conditions of the strong duality property for many problems such as the 0−1 quadratic programming, the multi-integer quadratic programming, and the sum-of-quadratic-ratios problem. Moreover, we can find that all these models are or can be transformed to quadratic programs with quadratic constraints. In this talk, we will outline our recent work on the modeling and applications of the canonical duality approaches to quadratic programs. Some well-known problems can be modeled into the quadratic programs, for example, the max-cut, the 0-1 quadratic programming, the sum-of quadratic-ratios programming, the non-convex quadratic programming over linear constraints etc. After a brief introduction of the canonical duality theory, we provide with a canonical duality optimization model by only considering the positive definite region. Analytic properties are given for the canonical duality function. A quadratic programming with a non-convex quadratic constraint is a simple case of quadratic programs. With the application of the canonical duality approaches, it is shown that it is polynomially solvable under duality Slater condition and the global primal minimizer can be easily got. A canonical duality iteration algorithm is provided for the quadratic programming over linear constraints, which converges to a Karush-Kuhn-Tucker point. Some optimality properties are discussed for the canonical duality approach.