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Contents

Part I

Invited Lectures

Smoothing Implicit Programming Methods for Stochastic Mathematical Programs with Equilibrium Constraints

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In this paper, we consider the stochastic mathematical program with equilibrium constraints (SMPEC), which can be thought as a generalization of the mathematical program with equilibrium constraints. Many decision problems can be formulated as SMPECs in practice. We discuss both lower-level wait-and-see and here-and-now decision problems. For the lower-level wait-and-see model, we propose a smoothing implicit programming method and establish a comprehensive convergence theory. For the here-and-now decision problem, we apply a penalty technique and suggest a similar method. We show that the two methods possess similar convergence properties.

Nomonotone Line Search Algorithms for Constrained Minimax Problems

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The Algorithms we considered to the constrained minimax problems employ SQP method by combining a nonmonotone line search and a second-order correction technique, which quarantee a full steplength while close to solutions, such that Marotos effect is avoided and two step superlinear convergence achieves.

Study on Some Approximate Proximal Point Algorithms for Monotone Variational Inequalities

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Let Ω be a nonempty closed convex subset of R^n and F be a continuous mapping from R^n into itself. The variational inequality problem is to determine a vector $u^* \in \Omega$ such that

$$\text{VI}(\Omega, F) \qquad (u-u^*)^T F(u^*) \geq 0, \qquad \forall u \in \Omega.$$

The sub-problem in k-th iteration of the proximal point algorithm for $\text{VI}(\Omega, F)$ is to find

$$\text{(PPA)} \qquad u^{k+1} \in \Omega, \qquad (u'-u^{k+1})^T F_k(u^{k+1}) \geq 0, \qquad \forall u' \in \Omega,$$

where $F_k(u) = (u-u^k) + \beta_k F(u)$. An equivalent recursion form of the exact PPA is

$$\text{(PPAE)} \qquad u^{k+1} = P_\Omega[u^{k+1} - F_k(u^{k+1})].$$

Since solving the sub-problem in each iteration exactly is costly or sometimes impossible, various approximate versions of PPA are developed for practical applications. Let $v^k \in \Omega$ be the approximate solutions of (PPAE) in the sense that

$$v^k \approx P_\Omega[v^k - F_k(v^k)] := \tilde{v}^k.$$

According to equation (PPAE), it is natural to view

$$\zeta^k := v^k - \tilde{v}^k \qquad \text{and} \qquad \xi^k := \beta_k[F(\tilde{v}^k) - F(v^k)]$$

as the measures of the inexactness of PPA in k-th iteration. In this paper, with the notation $\Delta(v^k) = 2(\zeta^k)^T F_k(v^k) - \|\zeta^k\|^2$, we study the following APPAs and their related inexactness restrictions.

The different APPAs and their related inexactness restrictions

	The new iterate u^{k+1} is given by	The related inexactness restrictions	
1.	$u^{k+1} := v^k$	$\Delta(v^k) \le \nu_k^2,$	$\sum_{k=1}^{\infty} \nu_k \le +\infty$
2.	$u^{k+1} := v^k$	$\Delta(v^k) \le \nu_k^2 \|u^k - v^k\|^2,$	$\sum_{k=1}^{\infty} \nu_k^2 \le +\infty$
3.	$u^{k+1} := P_\Omega[u^k - \alpha(u^k - v^k + \zeta^k)]$	$\Delta(v^k) \le \nu \|u^k - v^k\|^2,$	$\nu < 1$
4.	$u^{k+1} := P_\Omega[u^k - \alpha\beta_k F(v^k)]$	$\Delta(v^k) \le \nu \|u^k - v^k\|^2,$	$\nu < 1$
5.	$u^{k+1} := \tilde{v}^k$	$\|\xi^k\| \le \nu_k,$	$\sum_{k=1}^{\infty} \nu_k \le +\infty$
6.	$u^{k+1} := \tilde{v}^k$	$\|\xi^k\| \le \nu_k \|u^k - \tilde{v}^k\|,$	$\sum_{k=1}^{\infty} \nu_k^2 \le +\infty$
7.	$u^{k+1} := P_\Omega[u^k - \alpha(u^k - \tilde{v}^k + \xi^k)]$	$\|\xi^k\| \le \nu \|u^k - \tilde{v}^k\|,$	$\nu < 1$
8.	$u^{k+1} := P_\Omega[u^k - \alpha\beta_k F(\tilde{v}^k)]$	$\|\xi^k\| \le \nu \|u^k - \tilde{v}^k\|,$	$\nu < 1$

It will be shown that $v^k \leftrightarrow \tilde{v}^k$ and $\zeta^k \leftrightarrow \xi^k$ play parallel roles in different classes of APPAs. The study clarifies the properties and the relationships of various APPAs, hence provides a helpful guidance for choosing suitable APPAs with different application purposes.

Penalty Functions Vs Lagrangian Regularizations

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In this paper we present a Lagrangian regularization approach, which builds a bridge between two ways of unconstrained transformations, penalty functions and Lagrange functions, for constrained nonlinear programming. With appropriate choice of the regularizing functions, we derive a family of smooth functions, including all existing penalty functions and augmented Lagrange functions such as the exponential and quadratic penalty functions, logarithmic, inverse and modified barrier functions, and augmented Lagrangian functions. Our approach does not only provide a unified framework for constructing penalty functions, but also renders a new insight into penalty function methods. It is interesting to note that under some conditions, the conjugate of our regularizing functions correspond to the recession functions, used by Auslender to construct penalty functions.

Trust Region Problems of Conic Model

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The problem of minimizing a conic function subject to an ellipsoidal constraint is discussed in this paper. The feasible set of this problem is divided into three different cases. Necessary and sufficient optimality conditions are proposed and proved for different cases where there is a zero-gap optimality condition for the basic case. These conditions provide a sound basis for the further development of efficient methods with conic model and trust region techniques.

On the Stability of Least Frobenius Norm Updating of Quadratic Models

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Quadratic models of the objective function are used in many algorithms for unconstrained optimization. They may be derived from interpolation conditions when derivatives are not available. Let n be the number of variables. Excellent efficiency can be achieved when n is large by letting the number of interpolation conditions, m say, be much less than the number of parameters of the model, the value $m=2n+1$ being typical. We take up the freedom in each new model by minimizing the Frobenius norm of the change to the second derivative matrix of the model. This calculation can be expressed as the solution of an $m+n+1$ by $m+n+1$ system of linear equations. Let W be the matrix of the system and let H be its inverse. The author is developing an algorithm that works with H explicitly. When the t-th interpolation point is moved, then the changes to W are confined to its t-th row and column, so H can be updated in of order $(m+n+1)^2$ operations, by applying a formula that has the following stability property in exact arithmetic. Let H be altered from $H_{\rm old}$ to $H_{\rm new}$. Then, given any $H_{\rm old}$ that is symmetric and nonsingular, the t-th row and column of $H_{\rm new}^{-1}$ are the same as the new t-th row and column of W, while the other elements of $H_{\rm new}^{-1}$ satisfy $(H_{\rm new}^{-1})_{ij} = (H_{\rm old}^{-1})_{ij}$, $i,j \neq t$. Further, by taking advantage of the remark that the rank of the leading $m \times m$ submatrix of W^{-1} is at most $m-n-1$, all errors can be excluded in practice from the trailing $(n+1)\times(n+1)$ submatrix of every H^{-1}. Thus any damage in H from computer rounding errors tends to be corrected automatically as the iterations proceed. These techniques will be described, and their success will be illustrated by numerical results.

Supersymmetric Tensors and Their Applications in Multivariate Polynomial Optimization and Systems [1]

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In this talk, we investigate supersymmetric tensors and supersymmetric tensor vectors, and discuss their applications in multivariate polynomial optimization and multivariate polynomial systems. We show that a multivariate polynomial has a global minimum if its leading coefficient supersymmetric tensor is positive definite, and it is unbounded below if its coefficient supersymmetric tensor is not positive semidefinite. In the first case we show that it is majored below by a one dimensional polynomial and the norms of its global minima are not greater than the largest nonnegative zero of the one dimensional polynomial. We also give second-order sufficient condition and second-order necessary condition for a multivariate polynomial to have a global minimum. We define nonsingularity for a supersymmetric tensor vector and show that the zero set of a multivariate polynomial system is bounded if its leading coefficient totally symmetric tensor vector is nonsingular. This extends the classical definition for nonsingular linear systems. We also discuss multivariate power series based upon norms of supersymmetric tensors.

Key Words. Tensor, norm, supersymmetric tensor, supersymmetric tensor vector, multivariate polynomial, multivariate power series.

Co-Author of the Paper: Yiju Wang

[1]This work is supported by the Hong Kong Research Grant Council.

Low-Cost Methods for Nonlinear Large-Scale Matrix Equations

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Nonlinear matrix equations arise in different applications. Standard approaches to solve them include combine some variations of Newton's method, Schur factorizations, and reduction to generalized eigenproblems. In general, these procedures are not suitable for large-scale problems. Inspired by some recently developed low-cost optimization techniques, we will present and analyze new ideas that only require a few matrix times a matrix operation per iteration, and hence are suitable for the large-scale case. To guarantee convergence, we will also discuss very lenient globalization strategies associated with nonlinear matrix equations.

Preconditioning in Optimal Control Problems

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In this talk we consider an indefinite preconditioner for linear KKT systems that arise in optimization problems governed by differential equations. The preconditioner exhibits, like the KKT system, a specific block structure and is composed of preconditioners for submatrices in the general case. The eigenvalue distribution of the preconditioned system is analyzed. The convergence of the iterative methods for that system is well described by a low–dimensional subsystem. Numerical results for an example problem from ground water modeling illustrate the analysis.

Necessary Conditions and Suffcient Conditions for Non-Decomposable Two-Stage Min-Max Optimizations

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In this paper, a kind of new nonlinear programming is put forward, which is called non-decomposable two-stage min-max optimization. The continuity and differentiability of the maximum funtion $f(x)$ are studied in detail. Necessary conditions and sufficient conditions for new nonlinear programming are given.

Recent Progress in Unconstrained Nonlinear Optimization [2]

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In this paper, we present some recent progress in minimization methods for solving unconstrained optimization problems. By using the sufficient descent property, we propose our new conjugate gradient methods. Based on a new scant equation, we state two new quasi-Newton methods. In the context of a trust region framework, we focus on techniques which ensure that the considered model is always a strictly convex quadratic model. We finally conclude the paper with a discussion of perspectives for these methods.

Key Words. unconstrained optimization, quasi-Newton method, conjugate gradient method, Wolfe-Powell conditions, Armijo condition, global convergence

AMS subject classifications. 90C26, 65H10, 65K05

[2]This work is supported by Chinese NSF grants 10161002 and Guangxi NSF grants 0135004.

Lagrangian Duality and Related Methods for Generalized Nash Equilibriums

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The generalized Nash equilibrium problems (GNEPs) are mathematical models of modern noncooperative multi-person games which have extensive applications in economics, transportation, politics, military affair, etc. Although some theoretical results are given for GNEPs, very few numerical methods are proposed for these problems. In this talk, we will focus on the Lagrangian duality and related multiplier methods for solving GNEPs.

Key Words. Generalized Nash equilibrium, Lagrangian duality, Multiplier method

Pole Assignment in Descriptor Periodic Systems

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In this talk a pole assignment problem is considered for descriptor linear discrete-time periodic systems, which is using periodic proportional-derivative feedback to modify a given system such that the closed loop system has a specified self-conjugate set of eigenvalues. It is shown that complete reachability of an open loop periodic system is equivalent to the possibility of assigning an arbitrary set of the eigenvalues to the system by choosing suitable periodic proportional-derivative feedback. A computational approach is also proposed to solve the problem, which uses reliable numerical techniques based on orthogonal transformations. Numerical examples illustrate the effectiveness of the proposed approach.

Value Functions and Error Bounds for a Trust Region Model

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We study some properties of two trust region subproblems for solving constrained minimization problems. We first consider optimal value functions defined by the predicted reduction of the trust region subproblems and the ratios between each value function and the trust region radius. We expose the close relationship between these ratios and the projected gradient of the objective function. We then show under different conditions that these ratios and the value functions provide global or local error bounds for the distances from the projected gradient to the origin, and from the iterative point to the solution set of the minimization problem. Using these error bounds, we give conditions for global convergence of the iterative sequence generated from trust region methods. Especially, we give a new equivalent condition for finite convergence.

The Simple Smooth Exact Multiplier Penalty Function

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One of the fundamental methods for solving constrained nonlinear programming is to convert it into unconstrained problem. Penalty function is classified as this category. Exact penalty function method manage to obtain the solution of the original problem by solving a single unconstrained programming problem. When the traditional definition of penalty function is used, the simple exact penalty function is nonsmooth, thus unfavorable to deal with. In this paper, a new multiplier penalty function is proposed, and the exact properties of this multiplier function is investigated.

The Bi-CR Method for Solving Large Nonsymmetric Linear Systems

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For solving large nonsymmetric linear systems, a number of Krylov subspace methods are proposed. The Bi-CG method is one of the most popular algorithms and it is considered as natural generalization of the CG method which is proposed for symmetric positive definite systems. However, it is well known that the Bi-CG method may lead to an irregular convergence behavior and may cause breakdown. In this invited talk, a new iterative method, named Bi-CR, will be proposed. Numerical experiments show that the Bi-CR method gives much smoother convergence behavior and often converges faster than the Bi-CG method.

Principal Manifolds and Nonlinear Dimension Reduction via Tangent Space Alignment

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Nonlinear manifold learning from unorganized data points is a very challenging unsupervised learning and data visualization problem with a great variety of applications. In this paper we present a new algorithm called Local Tangent Space Alignment (LTSA) for manifold learning and nonlinear dimension reduction. Based on a set of unorganized data points sampled with noise from the manifold, we represent the local geometry of the manifold using tangent spaces learned by fitting an affine subspace in a neighborhood of each data point. Those tangent spaces are aligned to give the internal global coordinates of the data points with respect to the underlying manifold by way of a partial eigendecomposition of the neighborhood connection matrix. We present a careful error analysis of our algorithm and show that the reconstruction errors are of second-order accuracy. We illustrate our algorithm using curves and surfaces both in 2D/3D and higher dimensional Euclidean spaces, and 64-by-64 pixel face images with various pose and lighting conditions. Numerical experiments show that our LTSA is more stable than LLE in many settings. We also address several theoretical and algorithmic issues for further research and improvements.

Part II

Contributed Talks

Necessary and Sufficient Conditions for Convergence of GCR and GMRES Methods on Singular Systems

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We consider to solve a system of linear equations $A\boldsymbol{x} = \boldsymbol{b}$ or a least squares problem $\min ||\boldsymbol{b} - A\boldsymbol{x}||_2$ by Krylov subspace method, where A is an n by n square, real and singular matrix. Then it is known that Krylov subspace method based on minimum residual approach like the Generalized Conjugate Residual (GCR) and Generalized Minimal RESidual (GMRES) methods is effective for solving the linear system and the least squares problem. The convergence of the GCR and GMRES methods on nonsingular systems is well-known, and also that on singular systems is shown in [1,2]. But then we show the necessary and sufficient conditions for convergence of GCR and GMRES methods by a different approach from the proof written in [1,2].

We take an orthnormal basis $\boldsymbol{q}_1, \ldots, \boldsymbol{q}_m$ for Range(A), and an orthnormal basis $\boldsymbol{q}_{m+1}, \ldots, \boldsymbol{q}_n$ for Range(A)$^\perp$, so that $\boldsymbol{q}_1, \ldots, \boldsymbol{q}_n$ form a full othonormal basis for $\boldsymbol{R}^n$. In this basis, the matrix A is represented in the form $\begin{bmatrix} A_{11} & A_{12} \\ 0 & 0 \end{bmatrix}$, where A_{11} and A_{12} are m by m and m by $(n-m)$ matrices, respectively. Then the necessary and sufficient condition that the GCR method converges to the (least squares) solution without the breakdown for any $\boldsymbol{b}$ is that $A_{12} = 0$ and the symmetric part of A_{11} is definite. Also the necessary and sufficient condition that the GMRES method converges to the (least squares) solution without the breakdown for any $\boldsymbol{b}$ is that $A_{12} = 0$. The expression of our proposition is different from that of [1,2]. Therefore we give a variant means to determine whether the GCR and GMRES methods can be applied to singular systems.

Bibliography

[1] Brown, P., and Walker, H. F., GMRES on neary singular systems, SIAM J. Matrix Anal. Appl.**18** (1997) , pp.37-51.

[2]Zhang, S.-L., Oyanagi, Y. and Sugihara, M., Necessary and sufficient conditions for the convergence of Orthomin(k) on inconsistent linear systems, Numer. Math. **87**(2000), pp.391-405.

An LM Algorithm Using Gradient and Reminder to Determine the Lagrangian Multipliers [3]

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In this paper we present a method that uses residue of expansion to determine the Lagrangian multiplier in trust region method and analyze some properties of the method. We design specifically algorithms that belongs to this method. Numerical results show that the new algorithms can decrease the number of solving linear equation system greatly especially for larger problems, while it does not increase the number of iteration and computing function value.

Keywords: trust region, Levenberg–Marquardt method, residue of expansion.

[3]This work is partially supported by Chinese NNSF grants 19731010 and the knowledge innovation program of Chinese Academy of Sciences.

Eigenvalue Decomposition and Global Optimality Criteria

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In this paper, the technique of eigenvalue decomposition is used to decompose an indefinite matrix H as the difference of a positive semidefinite matrix and a positive definite matrix. Using this positive definite matrix, one can check whether a local minimizer of a quadratic programming which take H as objective matrix is global.

On Some Feasibility Issues in MPEC [4]

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This paper is introduced some feasibility conditions in mathematical programs with equilibrium constraints (MPECs) where additional jiont constraints are present that must be satisfied by the state and design variables of the problems. We prove that two sufficient conditions guarantee the feasibility of these MPECs. We also give some examples to show that the two feasibility conditions are different from the feasibility condition in [2].

Keywords. mathematical programs with equilibrium constraints, feasibility, complementarity problem, quadratic programm.

Multiple Search Direction Conjugate Gradient Method

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In this paper, we proposed a new CG-type method based on domain decomposition method, which is called multiple search direction conjugate gradient (MSD-CG) method. In each iteration, it uses a search direction in each subdomain. Instead of making all search directions conjugate to each other, as in block CG method, we require that they are nonzero in corresponding subdomains only. GIPF-CG method, an approximate version of MSD-CG method, only requires communication between neighboring subdomains and eliminate global inner product entirely. This method is therefore well suit for massively parallel computation. We give some propositions and a preconditioned version of MSD-CG method.

We give the convergence and consistency of MSD-CG method and estimate the convergence rate of this method. Numerical experiments on two distributed parallel computers, Dawning 3000 and P-II Cluster, show the efficiency of our method and that it compares favorably with some domain decomposition methods.

Keywords: Linear systems, conjugate gradient-type method, massively parallel computing, inner product, global communication.

A Class of Node Based Bottleneck Improvement Problems

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In this paper, we consider a class of node based bottleneck improvement problems with respect to the system $(V, E, \mathcal{F})$, where V is a vertex set , E is an edge set , $\mathcal{F} \subseteq 2^E$ is a nonempty family of feasible subsets of E. In the node based upgrading model, a node v can be upgraded at an expense of $c(v)$, and such an upgrade reduces the delay of each edge incident to v. For a given budget B, the objective is to upgrade a subset of nodes $S \subseteq V$ such that the bottleneck weight of the family $\mathcal{F}$ is minimized under the constraint that the overall upgrade cost $c(S)$ does not exceed B. The problem includes some NP-hard cases, and we obtain a constraint approximation algorithm. For the special case in which all the node costs are equal to 1, we present a heuristic algorithm, which outputs a Pareto optimum solution. We also consider some variations of this problem, and related complexity results and algorithms are presented.

Key words: Node based upgrading model, Bottleneck improvement problem, NP-hard, Pareto optimality.

On a Matrix Splitting Method for Affine Second-Order Cone Complementarity Problems

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The affine Second-Order Cone Complementarity Problem (SOCCP) is a wide class of problems that contains the Linear Complementarity Problem (LCP) as a special case. The purpose of this paper is to propose an iterative method for the symmetric affine SOCCP, based on the idea of matrix splitting.

In matrix splitting methods, we consider to split the matrix M involved in the original problem as the sum of two matrices B and C, where B has a certain simple structure. Then, by solving subproblems involving the matrix B successively, we generate a sequence converging to a solution of the original problem. Such approaches have originally been developed for the solution of the system of linear equations, and have subsequently been extended to the linear complementarity problem (LCP) and the affine variational inequality problem.

In this paper, we first give conditions under which the matrix splitting method converges to a solution of the affine SOCCP. We then present, as a particular realization of the matrix splitting method, the block successive overrelaxation (SOR) method for the affine SOCCP involving a positive definite matrix and establish its convergence. Finally, we report some numerical results with the proposed algorithm.

A Short Step Primal-Dual Interior Point Algorithm for Quadratic Semidefinite Prgramming Based on the AHO Direction

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Yongxiang Ling

A primal-dual interior point method for quadratic semidefinite programming (QSDP)is proposed in this paper. At each iteration of the algorithm the AHO direction is computed by applying the Newton method to the complementarity condition of QSDP. We use conjugate residual method to solve the Schur complement equation in computing the AHO search direction. We also prove the existence and uniqueness of the AHO direction for QSDP. The detailed steps of the proposed short step path following algorithm are given and the polynomial convergence property of the algorithm is also given. Numerical experiments on random problems with different dimensions show the efficiency of the proposed algorithm.

Probabilistic Analysis of Infeasible Interior Point Algorithms for Linear Programming

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We provide a probabilistic analysis of infeasible interior-point algorithms for solving random linear programming (LP) problems. We show that the expected number of iterations of the algorithm is bounded above by $O(n^{1.5})$. The random LP problem is Borgwardt's probabilistic model with the stable distributions.

An SQP Feasible Descent Algorithm for Nonlinear Inequality Constrained Optimization without Strict Complementarity [5]

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This paper discusses a kind of nonlinear optimization problems with nonlinear inequality constraints, and presents a new SQP feasible descent algorithm for solving the problems. At each iteration, the new algorithm yields a feasibly descent direction and a height-order correction direction by solving a solvable quadratic program (QP) and updates the solution of the QP by two explicit formulas. The algorithm is proved to be globally convergent and superlinearly convergent under mild conditions without the strict complementarity. Furthermore, the quadratic convergence rate of the algorithm is obtained when the twice derivatives of the objective function and constrained functions are adopted. Finally, some preliminary numerical tests are reported.

Keywords: Nonlinear inequality, constrained optimization, SQP, feasible descent algorithm, superlinear convergence.

Mathematics Subject Classification (2000): 90C30, 49M30

[5]Project supported by the National Natural Science Foundation (No. 10261001) and Guangxi Science Foundation (No. 0236001, 0249003) of China

A Multisplitting Iteration Scheme for Solving Implicit Complenmentarity problems

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In this paper we consider multisplitting and additive/multiplicative Schwarz iteration method for solving the finite dimensional implicit complementarity problems. We establish monotone convergence of the scheme and estimate weighted max-norm bounds for iteration errors with using the concept of M-splitting.

Local Optimality Conditions for A Special CDT Subproblem

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The Celis-Dennis-Tapia problem is a subproblem of trust region algorithms for constrained optimization. The CDT subproblem is studied in this paper. we give second order optimality conditions, when the Hessian matrix of Larangian at the solution has one negative eigenvalue.

Key Words: CDT subproblem, local solution, optimality condition

A Superlinearly Convergent SSLE Algorithm for Optimization Problems with Linear Complementarity Constraints

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This paper studies a special kind of optimization problems with linear complementarity constraints. At first, by a generalized complementarity function and perturbative technique, the discussed problem is transformed into a family of general nonlinear optimization problems containing parameter. Secondly, by a special penalty function as merit function, we establish a sequential systems of linear equations algorithm. Three systems of equations solved at each iteration have the same coefficients. Under some suitable conditions, the algorithm is proved to possess not only global convergence, but also strong convergence and superlinear convergence. At the end of the paper, some preliminary numerical experiments are given.

Keywords: complementarity constraints, sequential system of linear equations, algorithm, globly convergence, superlinear convergence.

Global Convergence Properties of the Conjugate Descent Method with Armijo-type Line Searches

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This paper investigates global convergence properties of the conjugate descent (CD) method. It is an important property that the strong Wolfe line search with $\sigma < 1$ can ensure descent direction at any iteration for the CD method. In this paper, we will propose two Armijo-type line searches. The CD method can also ensure all saerch directions downhill with the two Armijio-type line searches as well as with the strong Wolfe line search or generalized Wolfe line search. Under the two Armijo-type line searches, the CD method is proved to convergence globally.

Regularization Method for Stochastic Mathematical Programs with Complementarity Constraints[6]

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In this paper, we consider a class of stochastic mathematical programs with equilibrium constraints (SMPECs) that has been discussed by Lin and Fukushima (2003). Based on a reformulation given therein, we propose a regularization method for solving the problems. We show that, under a weak condition, an accumulation point of the generated sequence is a feasible point of the original problem. We also show that such an accumulation point is S-stationary to the problem under additional assumptions.

Key words: stochastic mathematical program with equilibrium constraints, S-stationarity, Mangasarian-Fromovitz constraint qualification.

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Convergence Properties of Nonmonotone Spectral Projected Gradient Methods

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In a recent paper, a nonmonotone spectral projected gradient(SPG) method was introduced by Birgin, Martínez and Raydan for the minimization of differentiable functions on closed convex sets and extensive presented results represented that this method was very efficient. In this paper, we give a more comprehensive theoretical analysis of the SPG method. In doing so, we remove various boundedness conditions that are assumed in existing results,such as boundedness from below of f, boundedness of x_k or existence of accumulation point of $\{x_k\}$. If $\nabla f(\cdot)$ is uniformly continuous, we establish the convergence theory of this method and prove that the SPG method forces the sequence of projected gradients to zero. Moreover, we show under appropriate conditions that the SPG method has some encouraging convergence properties, such as the global convergenc of the sequence of itetates generated by this method and the finite termination etc. Therefore,these results show that the SPG method is attractive in theory.

Multi-objective Genetic Algorithm Based on the Optimal Evolution Direction

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In the nature, there is an phenomenon that biology always evolves to the optimal direction is to achieve the maximal total profits. In this paper, combing this phenomenon with the advantaged superiority that Genetic Algorithm solves multi-objective optimization problems, a new genetic algorithm is presented, which is simple and robust. At last, experiments are given.

Keywords: Genetic Algorithm, Multi-objective optimization, Pareto.

A New Class of Memory Gradient Methods with Inexact Line Searches[7]

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A new class of memory gradient methods with inexact line search for unconstrained minimization problems is proposed. The methods use more previous iterative information than other methods to generate search direction and use inexact line searches to select step-size. We prove that the search direction at each iteration satisfies angle property automatically and that the new methods have global convergence under weak mild conditions. The convergence rate of these methods is also investigated in the case of uniformly convex objective functions. Some numerical experiments show that the new algorithm converges more stably than other line search methods and is effective in solving large scale unconstrained minimization problems.

Key words: Unconstrained optimization, descent method, inexact line search, convergence.

AMS subject classifications: 90C30, 65K05, 49M37

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Left Conjugate Gradient Method for Non-hermitian Complex Linear System

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This paper studies the Left-Conjugate Gradient (LCG) method, which is a promising approach to deal with non-hermitian linear systems. Here some properties of LCG are studied and its block form is presented. Results on the existence of Left Conjugate Directions (LCD) are generalized from real linear system to complex version. Numerical results on non-hermitian and indefinite linear systems are reported, and it is found that the LCG method works slightly better than the traditional methods GMRES, BICGSTAB and QMR.

Key words. Left-Conjugate Gradient, non-hermitian linear system, GMRES, BICGSTAB, QMR.

Global Optimization Algorithm Based on Bernstein Polynomial Approximation

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In this paper, a global optimization algorithm based on Bernstein polynomial approximation is proposed for one-dimensional optimization problem with box constraints. This method combines the optimization theory with approximation theory. Through some rules we divide the considered box region into some subboxes, then in the box or the sub-boxes, we construct the corresponding Bernstein polynomial approximation functions of the objective function. The proposed Berstein polynomial approximation algorithm is convergent to the global minimum through the successive refinement of the solutions of a series of Bernstein polynomial optimation method in the box or the sub-boxes which are solved by a present particular optimization method. Finally, the numberical experiment is given to illustrate the feasibility of the present algorithm.

Keywords: Berstein Polynomial Approximation, Global Optimization.

A Subspace Trust Region Method for Large Scale Unconstrained Optimization

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A trust region algorithm for unconstrained optimization is constructed using subspace techniques. The new method can be viewed as an improvement on the limited memory quasi-Newton method with trust regions. Due to the special structures of the subspace trust region subproblems, the method can be applied to very large scale problems. Convergence properties of the method are analyzed. Numerical results using the CUTE examples are reported and it shows that the new algorithm is efficient.

Keywords: subspace method, trust region techniques, limited memory storage, large scale optimization.

A Trust Region Lanczos Method for Image Restoration

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A key problem in remote sensing and astronomical imaging is the image restoration problem. One common method which recover an ideal intensity image from the corrupted image due to indirect measurements is the least squares error (LSE) method. But this method is unstable in practical applications. Reducing the instability by the Tikhonov regularization is the other popular method, i.e., minimize an objective function which enforces a roughness penalty that coherent to the data. However this method is not easy to perform because we have to adjust the so-called regularization parameter and make a truncation at appropriate step. Considering these disadvantages, this paper develops a trust region Lanczos method for such kind of problem. This method is more stable, robust than the LSE method and is easier to perform than the discrete Tikhonov regularization method. Numerical performance on remotely sensed images reveals that this method is promising.

Keywords: Trust region algorithm, image restoration, Lanczos method.

2000 MR Subject Mathematic Classification 47N10, 65J20, 94A08

Multilevel Facility Location Game

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We present a cross-monotonic competitiveness cost-sharing method for the multilevel facility location game which recovers a 1/6 fraction of the total cost.

A Hybrid Semidefinite Programming Method For The Max-cut Programming

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This work combines Limited Discrepancy Search(LDS) strategy [1] with a randomized algorithm of Goemans and Williamson [2] to get a hybrid approach for solving the max-cut problem. The approach consists of two steps: A better upper bound is achieved by using a strengthened semidefinite relaxation and subproblem generation and subproblem solution. We mainly focus on the second part. The most promising subproblems are generated by exploring a search tree using LDS, then the subproblems are being solved. Computational results show the effectiveness of the proposed approach.

A Modified Method for Mathematical Programs with Equilibrium Constraints

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The mathematical programs with equilibrium constraints(MPEC) is an optimization problem with variational inequality constrains. It is very useful in many fields. But it is difficult to solve because of its nature structure. In [1,Math.program, 85(1999), 107-134], the authors give a smoothing method that MPEC problem can be solved by standard available software for NLP, but it is need to adjust the perturbation parameter at each iteration. In order to avoid this operation,we give a modified method in this paper,and the numerical examples also show its validity.

Key words. Mathematical programs, equilibrium constraints, modified algorithm.

Calculating Inverse of Irreducible Nonsingular Tridiagonal Matrices from Determinants

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In this paper, explicit formulas for calculating the elements of the inverse of irreducible nonsingular tridiagonal matrices are presented based on the sub-determinants of the matrices. Since the sub-determinants of the irreducible nonsingular tridiagonal matrices can be calculated in recurrence manner, the work in this paper presents an efficient way to calculate the inverse of irre-ducible nonsingular tridiagonal matrices.

The Bounded Smooth Reformulation and A Trust Region Algorithm for Semi-definite Complementarity Problems [8]

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In this paper, we present a new merit function semi-definite complementarity problem (SDCP) by extending the bounded smooth reformulation for variational inequality problems. We prove that the merit function has a bounded level set and any stationary point of it is a global minimizer without the assumption of monotonicity. Moreover, we present a trust region algorithm for solving the minimization problem with semidefinite constraints. The trust region subproblem is solved by the truncated conjugate gradient method and the global convergence is established even without requiring the existence of an accumulation point of the generated sequence.

Keywords: Semidefinite complementarity problem, bounded smooth reformulation, Trust region method, Truncated conjugated gradient method, Global convergence.

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A New Inexact Proximal Alternating Direction Method for Monotone Variational Inequalities

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We present a new inexact proximal alternating direction method for a kind of special monotone variational inequalities. The sub variational inequalities of the original problem are solved inexactly under new criteria which are significantly relaxed than those presented by Eckstein and Bertsekas [Math. Prog. 55, 293-318, 1992] and He, Liao, Han and Yang [Math. Prog. 92, 103-118, 2002]. In addition, the new criteria make use of the relative error of each iteration, rather than the absolute error, to control the accuracy of the inexact solutions of the sub variational inequalities.

Keywords: Monotone variational inequalities, alternating direction method, proximal point method, inexact criterion.

A New Algorithm to Solve the QP Problem

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Firstly we study the necessary optimality conditions of mathematical programming with equality constraints by the Implicit Function Theorem in Rn, and by applying the results to the quadratic programming with linear equality constraints we get a new algorithm to solve the quadratic programming. The basic method of this Algorithm is to transform the programming to a system with n equalities, and we can at least get a K-T point of the programming by solving it. As we all know, we have to solve a system with (n+m) equalities if we adopt the classical Lagrange multiplier method or the Lagrange-Newton method. But with this Algorithm, we only need to solve a system with n equalities or much less. And compared to some popular algorithms, we dont need to compute the inverse of matrixes. Lots of numerical tests show that the Algorithm is universal, feasible and also effective in solving the Quadratic Programming. In addition, this algorithm offers a helpful way to study algorithms for the general Nonlinear Problem.

A Computationally Efficient Feasible Method for Nonlinear Programming

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In this paper, a new feasible sequential quadratic programmming algorithm is proposed to solve the nonlinear programming, where a feasible descent direction is obtained by solving only one QP subproblem. In order to avoid the Maratos effect, a high-order revised direction is computed by solving a linear system with involving some active constraints. The theorectical analysis shows that global and superlinear convergence can be induced.

Invited Lecture

Implementing Self-Regular Proximity Based IPMs for Linear and Second Order Cone Optimization

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In this paper we discuss our experiences with a MATLAB based implementation of Self-Regular Interior Point Methods (SR-IPMs) for linear and second-order conic optimization. The implementation is based on a class of SR-search directions and the homogeneous self-dual embedding model. To enhance practical performance Mehrotra's predictor-corrector strategy combined with dynamic choice of the barrier degree of the SR function is implemented. 02 Our McIPM package utilizes sparse matrix techniques, pivot shifting an boosting, multi-thread programming, data synchronization, messages passing, and shared memory. McIPM has been tested on the full NETLIB0202LO and the DIMACS SOCO test suite. We evaluate the effect of different self-regular proximities, dynamic and static choice of the barrier degree.

Extensive testing proves that the McIPM software package is competitive with state of the art software packages and the SR-IPM approach offers avenues for improvements when solving difficult problems.

Co-Authors: Xiaohang Zhu , J. Peng, and Bixiang Wang