Tuesday, August 30, 14:00, Room H107

Generalized Hessian for $C^{1,1}$ Functions in Infinite Dimensional Spaces

Zsolt Páles, Kossuth Lajos University, Debrecen, Hungary
Vera Zeidan, Michigan State University, USA

The subject is the systematic study of second order notions concerning differentiable functions with Lipschitz derivative. This research is motivated by recent results of Cominetti, Correa and Hiriart-Urruty.

Let X be a normed space and let $D \subset X$ be a nonempty open subset of X. If $f : D \to \mathbf{R}$ is a differentiable function with Lipschitz derivative, then define the second order directional derivative of f at $x_0 \in D$ by

$$f''(x_0; u, v) := \limsup_{x \to x_0, \epsilon \to 0} \frac{[f'(x + \epsilon u) - f'(x)](v)}{\epsilon}$$

for $u, v \in X$. Then $f''(x_0, . , .)$ turns out to be a symmetric bisublinear function. The generalized Hessian $\partial^2 f(x_0)$ of f at x_0 is now defined to be the set of symmetric bilinear functions $B : X \times X \to \mathbf{R}$ satisfying $B(u, v) \leq f''(x_0, u, v)$ for all $u, v \in X$. The main result is the following formula, which describes the correspondence between f'' and $\partial^2 f$:

$$f''(x_0, u, v) = \sup\{B(u, v) : B \in \partial^2 f(x_0)\}.$$

The generalized Hessian inroduced above plays a similar role as Clarke's generalized subgradient.

Tuesday, August 30, 14:00, Room H104

A Quadratic Programming Solver Using an Interior Point Method

Anna Altman, Polish Academy of Sciences Warszawa

We consider a modified higher order primal-dual interior point method for solving separable quadratic programming problems. The quadratic solver is based on the linear programming solver HOPDM. The method is efficient and numerical stable. A set of modified problems from NETLIB collection was solved.

Tuesday, August 30, 14:30, Room H104

A Finite Algorithm for Solving General Quadratic Problems

Immanuel M. Bomze, University of Vienna

A global optimization method for general, i. e. indefinite quadratic problems is proposed, which is shown to be finite and exact. The algorithm uses copositivity arguments to ensure escapes form inefficient local solutions. A similar approach is used to generate an improving feasible point, if the starting point is not the global solution, irrespective of whether or not this is a local solution. Also, definiteness properties of the quadratic objective funciton are irrelevant for this procedure. To increase efficiency of these methods, we employ pseudoconvexity arguments. Pseudoconvexity is related to copositivity in a way which might be helpful to check this property efficiently even beyond the purposes considered here.

Key words: Copositivity, global optimization, indefinite quadratic problems, pseudoconvexity.

Topic: Global (quadratic/nonlinear) optimization

Tuesday, August 30, 14:30, Room H107

Topological Properties of the Approximate Subdifferential

René Henrion, Humboldt-Universität zu Berlin

We study topological properties of the approximate subdifferential (introduced by Mordukhovich) which is known to be non-convex in general. In a separable Hilbert space any weakly compact set is representable as the Kuratowski-Painlevé limit of approximate subdifferentials taken from a sequence of lipschitzian functions which are evaluated at a fixed point. In finite dimensions it even holds that any compact set is homeomorphic with the approximate subdifferential of some lipschitzian function. On the other hand, exact realization of arbitrary compact sets is not possible since, for instance, in the one-dimensional case the approximate subdifferential may comprise at most two connected components. However, due to its specific structure, the so-called *partial* approximate subdifferential introduced by Jourani/Thibault allows for such exact realization (using locally lipschitzian functions).

Tuesday, August 30, 15:00, Room H107

Minimal Ellipsoids and Semi-Infinite Optimization

Friedrich Juhnke, Universität Magdeburg

The ellipsoid of smallest volume containing a given bounded n-dimensional set $\mathbf{K}$ is considered (minimal ellipsoid, Loewner ellipsoid). Using the Minkowski support function, we investigate a corresponding semi-infinite optimization problem for this task and give necessary and sufficient optimality conditions of the John - Kuhn/Tucker type. It will be shown - only using the derived optimality conditions - that the minimal ellipsoid is uniquely determined and that it coincides with the minimal ellipsoid of a certain finite set of "characteristic boundary points" $\{y^1, \ldots, y^r\} \subseteq \mathbf{K}$, where $n+1 \leq r \leq n(n+3)/2$. In special cases the minimal ellipsoid can be explicitely determined using the derived optimality conditions.

Tuesday, August 30, 15:00, Room H104

A Class of Quadratic Transportation Problems

Rumena Kaltinska, Bulgarian Academy of Sciences

The characteristics of the quadratic transportation problems

$$\text{minimize (maximize)} \quad F(x) = P(x)Q(x)$$

subject to

$$\begin{array}{lll} \sum_{j=1}^{n} & x_{ij} = a_i, & i = 1, 2, \cdots, m, \\ \sum_{i=1}^{m} & x_{ij} = b_j, & j = 1, 2, \cdots, n \\ & x_{ij} \geq 0, & i = 1, 2, \cdots, m, \quad j = 1, 2, \cdots, n, \end{array} \tag{1}$$

where $P(x)$ and $Q(x)$ are affine functions of $x \in E^{m \times n}$, are studied and an algorithm for their solving is proposed. The optimal solutions of such problems lie on an edge of the transportation polyhedron (1). That allows any simplex procedure using the typical 'transportation techniques' to be applied. The algorithm reduces the solving of the problem to solving of two one-parametric linear transportation problems, the objective functions of which contain a parameter. The parameter is changing only in the interval $[0, 1]$ during the solving. An interactive system, using this algorithm is presented.

This work is supported by the Bulgarian Ministry of Education and Sciences under the Grants No. I-11/91 and No. MM-50/91.

Tuesday, August 30, 15:30, Room H104

Finiteness of Modified Beale's Algorithm for Solving Nonconvex Quadratic Programs

Frantisek Mraz, University of South Bohemia

In (1) a modified version of Beale's algorithm for calculating a local minimum of nonconvex quadratic problem was proposed. The example of degenerated problem given in (2) illustrates that cycling can occur. It will be shown that degenerated problems can be solved by means of the above algorithm by using a usual perturbation technique to avoid degeneracy. The finiteness of the algorithm will be proved and numerical experiences with an implementation on computer will be mentioned. (1) Mraz, F.: Local Minimizer of a Nonconvex Quadratic Programming problem. Computing 45, 283-289 (1990). (2) Vaeliaho, H.: Cycling Can Occur in Mraz's Algorithm for Nonconvex Quadratic Programming. Computing 51, 183-184 (1993).

Semi-Plenary Lecture

Tuesday, August 30, 16:30, Room H104

Interior Point Methods for Nonlinear Programming and Nonlinear Complementarity

David F. Shanno, Rutgers University

The talk first examines modified-barrier methods for nonlinear programming, and demonstrates computational superiority to classical log-barrier methods. The talk then explores eliminating numerical difficulties by adopting a joint penalty-barrier strategy. Equality constraints are introduced via an augmented Lagrangian. The penalty-barrier method is then utilized to solve nonlinear complementarity problems, and the result compared to continuation methods derived from the classical log-barrier method. Extensive computational experience is given on a variety of algorithms.

Wednesday, August 31, 10:00, Room H104

New LP-Bound for Lipschitz Optimization and Systems of Inequalities

Reiner Horst, Universität Trier
M. Nast, Universität Trier
Nguyen van Thoai, Universität Trier

A new method is presented for the unconstrained and linearly constrained global optimization of a Lipschitz function which calls for one function evaluation and one small LP in each iteration. Numerical aspects and applications are emphasized. In the unconstrained case (which is the most often studied one), a brief introduction is given to the many existing approaches, and it is shown that new method alleviates different disadvantages of previous methods. In the linearly constrained case, the new approach is the first one which can be implemented in a practical sense. Applications stress mixture identification problems (which lead to systems of quadratic inequalities over simplices). In this case, previous approaches are outperformed. The talk concludes with pointing out the limits of pure Lipschitz optimization and directions of further research.

Wednesday, August 31, 10:00, Room H107

A Non-Completeness Result for Quadratic Programming

Klaus Meer, RWTH Aachen

The complexity of linearly constrained (non-convex) Quadratic Programming is analyzed within the framework of real number models, namely the one of Blum, Shub, and Smale and its modification recently introduced by Koiran (ẁeak BSS-model ́). In particular we show that this problem is not NP-complete in the Koiran-setting. Applications to the (full) BSS-model are discussed.

Wednesday, August 31, 10:30, Room H104

Mathematical Model for Optimization of Cutting Conditions in Machining

Jan Madl, Czech Technical University, Prague, Czech Republic
Jitka Dupacova, Carles University, Prague, Czech Republic

Optimization of cutting conditions represents one of the main problems of nowadays technology of machining. Taylorxs tool life equation that relates the tool life and the machining conditions plays an important role in designing optimization schemes for various machining processes. The equation results from statistical regression analysis therefore, in the contrast to common approaches, we suggest to treat the corresponding input of the coefficients in the related geometrical programming problems as statistical estimates of the true coefficients. The initial approach applied to a single tool problem will be generalized to a problem with nonlinear smooth and nonsmooth constraints that correspond to restrictions on torque and power, respectively.

Wednesday, August 31, 10:30, Room H107

A Descent Level Bundle Method for Convex Nondifferentiable Minimization

Ulf Brännlund, Royal Institute of Technology, Stockholm
Krzysztof C. Kiwiel, Systems Research Institute, Warsaw
P.O. Lindberg, Royal Institute of Technology, Stockholm

We give a proximal level method for convex linearly constrained minimization that uses projections onto successive approximations of level sets of the objective. Specifically, the next trial point is the projection of the current iterate onto the level set of a polyhedral objective model derived from the accumulated objective subgradients, and it becomes the next iterate when sufficient descent is obtained. The level is chosen via a lower bound that converges to the optimal value. In contrast to the original level methods of Lemarechal, Nemirovskii and Nesterov, our method is globally convergent without any compactness assumptions and requires bounded storage. It does not employ potentially expensive linesearches as does the level method of Brännlund. Encouraging preliminary numerical results are reported.

Wednesday, August 31, 14:00, Room H107

The Simple Block Iterative Algorithm of an Extended Entropy Model and its Convergence

Zeguang Tan, Tsinghua University at Beijing, China

We have discussed an extended entropy model for the predication of trip amount in transportation planning, and provided a method, called Simple Block Interative Algorithm, shortly SBIA, to solve it. Because the algorithm gives consideration to the characteristic of the model it has better effect in our practice and theoretically. The results presented in this peper are

- Simple Block Iterative Algorithm for solving a class of extended entropy models.
- The proofs of the existence, uniqueness of the solution and convergence of the algorithm, and the estimation of its convergent speed.
- Some numerical examples.

Wednesday, August 31, 14:00, Room H104

Newton Methods for Large-Scale Optimization

Ali Bouaricha, Argonne National Laboratory
Jorge Moré, Argonne National Laboratory

We describe current research on the development of software for the solution of large-scale optimization problems. The talk centers on the development of a trust region Newton method for the solution of bound-constrained optimization problems. Two interesting features of this algorithm are the use of an incomplete Cholesky factorization to obtain a scaling matrix for the trust region subproblem, and the use of projected searches to determine the active set. We describe the algorithm, and discuss the rate of convergence properties for degenerate problems. We show that the algorithm is efficient and remarkably effective on a collection of large-scale optimization problems from applications.

Wednesday, August 31, 14:30, Room H107

Computing the Directional Derivative of Optimal Solutions

Stephan Dempe, Technical University Chemnitz, Germany
Danny Ralph, University of Melbourne, Australia

We consider locally optimal solutions of nonlinear programming problems having a parametric objective function and parameter- depending inequality constraints. If a strong sufficient optimality condition of second-order together with the Mangasarian-Fromowitz constraint qualification are satisfied, this optimal solution is known to be directionally differentiable; its directional derivative can be computed by solving a certain optimization problem depending on the direction and on the Karush-Kuhn-Tucker multipliers of the nonlinear problem provided that a right multiplier vector has been inserted. The choice of that multiplier is a difficult task if it is not uniquely determined. Assuming that a constant rank assumption is satisfied as well, we are able to give a simple rule for determining a suitable multiplier. So we are now in a position where a practical way for computing the directional derivative can be given as follows: First, compute a Karush-Kuhn-Tucker vector as an optimal solution of a linear programming problem closely related to the min-max problem used for calculating the directional derivative of the optimal value function of the nonlinear problem. Then, compute the directional derivative of the optimal solution by solving a quadratic convex programming problem using the selected multiplier. Some applications will be given.

Wednesday, August 31, 14:30, Room H104

Newton-Type Algorithms for the Solution of Inequality Constrained Minimization Problems

Francisco Facchinei, Università di Roma "La Sapienza"
Stefano Lucidi, Università di Roma "La Sapienza"

We describe a new, broad class of Newton-type algorithms for the solution of inequality constrained minimization problems. The algorithms are based on an active-set strategy and, at each iteration, only require the solution of linear systems. Under mild assuptions, and without requiring strict complementarity, we prove q-quadratic convergence of the primal variables towards the solution. We also consider quasi-Newton versions of the algorithms described and give a characterization of superlinear convergence extending the classical result of Boggs, Tolle and Wang for the equality constrained case.

Wednesday, August 31, 15:00, Room H107

On Sensitivity Analysis for Minimization Algorithms

Ursula Felgenhauer, Technical University Cottbus

In the paper there will be given a comparative analysis of sensitivity with respect to gradient approximation errors for three types of minimization algo- rithms:

(1) quasi-Newton descent method for convex unconstrained optimization problems, (2) a trust-region method with gradient projection technique for (general) smooth unconstrained optimization, (3) modified trust-region projection method for problems with simple bounds.

The methods under consideration are connected mainly by the following elements: - use of local quadratic function model given by quasi-Newton approaches, - least descent bounds for the function values at every iteration step.

In all cases there are formulated descent characteristics when inexact gradients are used, and there are given error propagation bounds (üncertainty balls") for the perturbed iteration as well as abstract accuracy restrictions which will guarantee global convergence (ßufficient convergence conditions"). The quantitative error estimates confirm qualitative results formerly found for the algorithms (1),(2). The results complete the known global convergence theory and should help to obtain "realisticnumerical implementations.

Wednesday, August 31, 15:00, Room H104

Newton Based Exact Penalty Techniques for Nonlinear Optimization with Constraints

Edite Fernandes, University of Minho, Portugal

Numerical experiments with exact penalty techniques based on an augmented Lagrangian function for the minimization of nonlinear equality constrained problems are reported. The unconstrained minimum, with respect to x alone, is sought with a Newton based algorithm. At each iteration, a descent direction is computed as a suitable linear combination of steepest descent and Newton directions. Two implementations are considered. One uses the penalty parameter fixed over the iterative procedure, the other takes it proportional to the inverse of the constraint violation. When x is within a perturbation feasible set a unit parameter is found to be suitable.

Wednesday, August 31, 15:30, Room H107

On Stability Concepts in NLP

Harald Günzel, RWTH Aachen
M. Shida, Tokyo Institute of Technology

Kojima's strong stability of stationary solutions can be characterized by means of first and second order terms. We treat the problem whether there is a characterization of the stability concept allowing perturbations of the objective function only, keeping the feasible set unchanged. If the feasible set is a convex polyhedron, then there exists a characterization which is in fact weaker than that one of strong stability. However, in general it appears that data of first and second order do not characterize that kind of stability. As an interpretation we obtain that strong stability seems to be the only concept of stability which admits a characterization and works for large problem classes. This is a joint paper with M. Shida, Tokyo Institute of Technology.

Wednesday, August 31, 15:30, Room H104

A Class of Newton-Type Methods for Equality and Inequality Constrained Optimization

Helmut Kleinmichel, Technische Universität Dresden
Christian Kanzow, Technische Universität Dresden

We consider the nonlinear programming problem with equality and inequality constraints. In order to find a Kuhn-Tucker point, we use an equivalent formulation of the Kuhn-Tucker conditions consisting of nonlinear equations only. Then Newton's method is used to solve this system of nonlinear equations. Thus, we have to solve only one linear system at each iteration. By using a decomposition principle, we are able to reduce the dimension of this linear system. Some quasi-Newton variants and a local convergence theory are given. Finally, we present the results of some numerical experiments.

Wednesday, August 31, 16:30, Room H104

The Modifications of Simplicial Embeddings Method and its Applications.

Elena Apekina, Siberian Energy Institute (Russia, Irkutsk)
Valerian Bulatov, Siberian Energy Institute (Russia, Irkutsk)

Description of the method of simplicial embeddings for solving the convex programming problems is given in [1]. The concept of the method consists in successive localization of the optimum solution with the help of a sequence of simplices that contain it and whose volumes tend to zero. A non-prospec- tive part of the initial simplex is cut off by a secant plane and a “cut-off simplexïs embedded into a simplex with minimum volume. Estimation of the simplex volumes ratio shows that convergence rate of the simplicial embedding method depends only on the number of cut off vertices.

The essence of the method modification lies in the fact that more than one secant plane (m in the general case) is introduced at each step of the itera- tion process. The number of secant planes equals the number of constraints violated in the centre of the current simplex. It is evident that with intro- duction of additional secant planes the probability of cutting off the larger number of simplex vertices is higher than in the base method. This improves the convergence rate. The paper presents the estimates of convergence rate of the modified simplicial embedding method for a number of typical cases and these estimates are much better than those in the base case.

1. E.G. Antsiferov, V.P. Bulatov, An algorithm of simplicial embeddings in convex programming.- Journal of computational mathematics and mathematical physics, 1987, v.3, p.377-384.

Wednesday, August 31, 16:30, Room H107

A Numeric Method for Solving the Problem of Separable Programming

Tigran A. Arakelian, American University of Armenia

A numeric problem for solving the problem of separable programming based on spline-approximation of the aim function and the constraint functions is considered in this paper. The problems of separable programming are constituting a separate class of mathematical programming problems. Particularly the problems of the choice theory with a separable utility function. Separable utility functions are particular kind of utility functions. These utility functions are called separable in the sense that consumption decisions about one good or a group of goods do not affect the utility received from some other good or group of goods. The problem of creation of numeric methods for solving the separable programming tasks is risen and solved in works of Charnes et al., Danzig et al., Miller, and Wolf. This work is continuing the approach of author’s previous works and is devoted to elaboration of numeric methods based on spline approximation for solving the separable programming tasks. Wide application of splines in computational mathematics is caused by their convenience, the splines in power not greater then three have good convergence properties and are enough smooth.

Wednesday, August 31, 17:00, Room H107

Computing Fix Points in Parametric Optimization Problems

Anatoly Antipin, Center for Program Studies Russian Academy of Sciences

The problem of finding the equilibrium points of a extremal mapping

$$v^* \in Argmin\{\Phi(w, v^*) : w \in \Omega\}, v \in \Omega \tag{2}$$

is considered. Here $\Phi(w, v)$ is a function determined at the quadrate $\Omega \times \Omega$, where a set $\Omega \in R^n$. The methods controlled by means of feedback are suggested to compute the fixed points of the extremal mappings. These methods can be described by a set of proximal differential equations of the form

$$\frac{dv}{dt} + v = argmin\{\frac{1}{2} \parallel w - v \parallel^2 + \alpha\Phi(w, v + u) : w \in \Omega\}, v \in \Omega, \tag{3}$$

or a set of gradient differential equations of the form

$$\frac{dv}{dt} + v = \pi_\Omega(v - \alpha \bigtriangledown_w \Phi(v, v + u)), v(t_0) = v^0. \tag{4}$$

If u = 0 then trajectories of systems (2) and (3) does not converges to the equilibrium points of (1). If $u = \frac{dv}{dt}$ or $u = argmin\{\frac{1}{2} \parallel w - v \parallel^2 + \alpha\Phi(w, v) : w \in \Omega\} - v, v \in \Omega$ then trajectories of systems (2) and (3) converges to the equilibrium points of (1) under some conditions.

Wednesday, August 31, 17:00, Room H104

Complexity Estimates of Some Cutting Plane Methods for Convex Minimization Using Analytic Centers

Krzysztof C. Kiwiel, Systems Research Institute Warsaw

We consider cutting plane methods for minimizing a convex (possibly nondifferentiable) function subject to box constraints. At each iteration, subgradient cuts accumulated at previous test points define a polytope that localizes the minimum. The analytic center of this polytope is used as the next test point to evaluate the objective and its subgradient. This new information is exploited to construct a cut that improves the next localization set. We give complexity estimates for several variants of such methods. We also establish convergence of implementable methods in which each test point is an approximate analytic center that can be computed by a finite number of Newton steps.

Wednesday, August 31, 17:30, Room H107

The Reduced Direction Methods for Solving Stochastic Problems in the Dialog Optimization System ODiS

Victor Izhutkin, Mary State Universityät Russia
Mihail Petropavlovskii, Mary State Universityät Russia

In the report we deal with the nonlinear programming problem with inequality constraints. We assume the object function is nondifferentiable and the constraints functions are supposed to be smooth. New iteration is obtained from the current point along "reduced" direction calculated explicitly from the systems of linear equations. We use the stochastic approximation instead of the gradient of object function. The stepsize is chosen using differ row from the condition of accessories to the feasible region. The method is the modification of the feasible point algorithm formulated to smooth problems. We include the method into the optimization dialog system ODiS realized the united scheme of "reduced" direction methods, which also includes groups of feasible direction methods, the methods of linearization and differentiable cost function methods for smooth nonlinear problems and the projected subgradient method for nondifferentiable problems.

Wednesday, August 31, 17:30, Room H104

The GRG Approach for Large Scale Models

Arne Stolbjerg Drud, ARKI Consulting and Development A/S, Denmark

The Generalized Reduced Gradient (GRG) algorithm for general Nonlinear Programming (NLP) has been used succesfully for over 25 years. The ideas of the original GRG algorithm have been modified and have absorbed developments in unconstrained optimization, linear programming, sparse matrix techniques, etc. The talk will review the essential aspects of the GRG approach and will discuss current development trends, especially related to very large models. Examples will be based on the CONOPT implementation.

Wednesday, August 31, 18:00, Room H107

Prox-Regularization Approach for Fully-Parametrized Convex Semi-Infinite Programming Problems

A. Kaplan, Humboldt-Universität Berlin
Rainer Tichatschke, Humboldt-Universität Berlin

In this paper a family of convex problems

$$\mathcal{P}(\gamma): \quad min\{J(u,\gamma) \;:\; g(u,t,\gamma) \leq 0 \quad \forall\, t \in T\}$$

is considered, with $\gamma \in \Gamma$ a parameter and $T \subset \mathbf{R}^m$ a compact set and $\Gamma \subset \mathbf{R}^P$ a connected bounded set. We assume that for some $\gamma_0 \in \Gamma$ a solution of $\mathcal{P}(\gamma_0)$ is known with a sufficient accuracy and for a given $\overline{\gamma} \in \Gamma$ an optimal vector of $\mathcal{P}(\overline{\gamma})$ is sought. The numerical procedure will be constructed such that the parameter γ varies on a path from γ_0 to $\overline{\gamma}$ and, solving problem $\mathcal{P}(\overline{\gamma})$, we shall obtain as a by-product approximate solutions of the problems $\mathcal{P}(\gamma)$ for the chosen intermediate values γ together with two-side bounds for these solutions. For this purpose we combine a special discretization procedure and a regularized variant of a penalty method.

Wednesday, August 31, 18:00, Room H104

Network Methods of Solving Smooth and Nonsmooth Extremal Problems

Rafail Gabasov, Belarus State University, Minsk
Faina M. Kirillova, Belarus State University, Minsk
Yekaterina A.Kostina, Belarus State University, Minsk
Andrew V.Pokatayev, Belarus State University, Minsk

We investigate the general problem of nonlinear programming in network form. The network maximum principle and algorithms of solving the prob- lem both smooth and nonsmooth are justified. The algorithms under con- sideration consist of a general part (forming and solving special LP support problems) and a finishing procedure at which finishing equations are solved using the Newton method. The investigations are based on the results of the authors on the constructive theory of extremal problems (Constructive Methods of Optimization. Minsk, 1984-1993. Gabasov R., Kirillova F.M. and etc.)

Thursday, September 1, 09:00, Room H107

Applications of Derived Sets

Wolfgang Breckner, Universitatea Babes-Bolyai, Romania

no abstract received

Thursday, September 1, 09:00, Room H104

Some Tshebyshev Approximation Problems with Extremal Operations

Karel Zimmermann, Charles University, Praha, Czech Republic

Some operations research problems (e. g. some transferability problems, reliability problems or decision making problems) lead to the following optimization problem

$$\begin{array}{ll} \text{minimize} & \max\limits_{i\in S}|d_i - b_i| \\ \text{subject to} & d \in R, \end{array}$$

where

$$R = \{d|\max_{i\in S}\min(a_{ij}, x_j) = d_i, h_j \le x_j \le H_j, i \in S, j \in N\}$$

S, N are given finite sets, and a_{ij}, h_j, H_j, b_i are given numbers. A parametrical solution method for solving this problem is suggested, possible generalizations are briefly discussed.

Thursday, September 1, 09:30, Room H107

Regularization of the Continuous Projection Gradient Methods of Minimization

Fedor Vasilyev, Moscow State University, Russia

no abstract received

Thursday, September 1, 09:30, Room H104

Approximate Solutions of Location Problems

H. Benker, Martin-Luther-Universität Halle-Wittenberg
A. Hamel, Martin-Luther-Universität Halle-Wittenberg
Christiane Tammer, Martin-Luther-Universität Halle-Wittenberg

Location and approximation problems have been studied by many authors from the theoretical as well as the computational point of view. In the first part of our paper we derive a variational inequality for approximately efficient elements of a location problem from a variational principle. Let us assume that $(X, ||\ .\ ||_X)$ and $(Y, ||\ .\ ||_Y)$ are reflexive Banach spaces. Suppose, that $c : X \longrightarrow R$ and $A_i : X \longrightarrow Y$, are linear continuous mappings; $\alpha_i \geq 0$; $x \in X$, $a^i \in Y$, $[i = 1, ..., p]$; and S a convex closed subset of X. Then we consider the following optimization problem:

$$(P): \qquad f(x) := c(x) + \sum_{i=1}^{p} \alpha_i \, || \, A_i(x) - a^i \, || \longrightarrow \inf_{x \in S} .$$

We assume $inf\{f(x) \mid x \in S\} > -\infty$. Special cases of the problem (P) are approximation and location problems, optimal control problems, perturbed linear optimization problems and surrogate problems for linear optimization problems with an objective function $f(x) := c(x)$ subject to $x \in S$ and $A_i(x) = a^i$, $i = 1, ..., p$; for which the feasible set is empty, but S is nonempty.

We will derive necessary conditions for approximate solutions of (P) by using the directional derivative and the subdifferential calculus. Finally, it will be shown, how these results can be used in order to develop a numerical algorithm.

Thursday, September 1, 14:00, Room H107

A Globally Convergent Penalty-Barrier Algorithm for Nonlinear Programming and its Computational Performance

Marc Breitfeld, Rutgers University

We will develop a penalty-barrier method for equality and/or inequality constrained general nonlinear programming. The method that will be presented is essentially a composite of augmented Lagrangian and modified log-barrier approaches. To overcome problems particularly associated with modified log-barrier methods, simple bounds are handled separately and logarithmic terms are extrapolated quadratically. Computational results suggest that the presented penalty-barrier algorithm is a robust and efficient method for solving general nonlinear optimization problems. Under common conditions, we will establish global convergence of a sequence of iterates to a first-order stationary point for the constrained problem. The iterates are approximate minima of a sequence of unconstrained penalty-barrier functions.

Thursday, September 1, 14:00, Room H104

On Continuous Deformations of Semi-Infinite Optimization Problems

Rainer Hettich, University of Trier
Hubertus Jongen, Aachen University of Technology

We consider differentiable semi-infinite optimization problems depending on a real parameter. For generic one-parametric families we roughly classify the corresponding set of generalized critical points into eight types. Five of these types also occur in problems with a finite number of inequality constraints. The other three types are typical for the semi-infinite case. We discuss Type 6 in detail. This singularity is due to the fact that in the associated lower level problem a Lagrange parameter corresponding to an active inequality constraint vanishes. The set of generalized critical points is not smooth at such a point. In addition it will be shown that the (quadratic) index either remains constant or changes by at most one when passing along a point of Type 6. An explicit example will be provided. The points of Type 1-6 generically occur if the index set of inequality constraints is constant and is described by means of finitely many smooth constraints for which the gradients of active constraints are linearly independent throughout. The other types (Type 7 and 8) are related to the violation of the latter linear independence.

Thursday, September 1, 14:30, Room H107

On the Multiplicative Barrier Function Approach for Nondifferentiable Optimization Problems

Vincentiu Dumitru, The Academy of Economic Studies, Bucharest
Florica Luban, The Academy of Economic Studies, Bucharest

In previous papers, we extended the Iri-Imai multiplicative barrier function approach for solving the linear programming problem: $\min\{f(x)|g_i(x) \geq 0,\ i = 1, \ldots, m\}$ to nonlinear convex problems of class C^2 by optimizing sequentially the function $B(x, \mu) = (\varphi(x) - \mu)^\alpha \cdot (\bigodot g_i(x)^\beta), \alpha > 0, \beta \in R$, where $\bigodot$ stands either for the product $(\sqcap_{i=1}^m)$ or sum $(\sum_{i=1}^m)$ operator, and $\varphi(x) := \pm f(x)$.

In this paper we give results and algorithms for the convergence of the procedure to a local or global optimum in the case of a nondifferentiable optimization problem.

Thursday, September 1, 14:30, Room H104

Subdifferentials with Respect to Dualities

Juan-Enrique Martínez-Legaz, Universitat Autonòma, Barcelona
Ivan Singer, Universitat Autonòma, Barcelona

Let X and W be two sets and $\triangle : \overline{R}^X \to \overline{R}^W$ a duality (i. e., a mapping $\triangle : f \in \overline{R}^X \to f^\triangle \in \overline{R}^W$ such that $\inf_{i \in I} f_i)^\triangle = \sup_{i \in I} f_i^\triangle$ for all index sets I and all $\{f_i\}_{i \in I} \subseteq \overline{R}^X$). We introduce and study the subdifferential $\partial^\triangle f(x_O)$ of a function $f \in \overline{R}^X$ at a point $x_O \in X$, with respect to $\triangle$. We also consider the cases when $\triangle$ is a (Fnechel-Moreau) conjugation (obtaining then e. g. the Balder subdifferentials, the quasi-subdifferentials of Greenberg-Pierskalla and Zabotin-Korablev-Habibullin, etc.), or a $\bigvee$-duality (i. e., a duality satisfying $(f \bigvee d) = f^\triangle \bigvee -d$ for all $f \in \overline{R}^X$ and $d \in \overline{R}$, where each $d \in \overline{R}$ is identified with the constant function taking everywhere the value d), or a $\perp$-duality, in the sense of [J.-E. Martínez-Legaz and I. Singer, $\bigvee$-dualities and $\perp$-dualities, Optimization 22 (1991), 483-511].

Thursday, September 1, 15:00, Room H107

Solution of Specially Structured Linear Complementarity Problems

Andreas Fischer, Technische Universität Dresden

We consider the quadratic programming problem (QP)

$$\frac{1}{2}x^T Qx + q^T x \to \min \quad \text{subject to} \quad Ax \le a$$

with a $n \times n$ positive semidefinite matrix Q and a $m \times n$ matrix A. The method we want to propose is based on a special transformation of the above problem into an equivalent nonlinear system of equations. To solve this system a damped Newton-type method will be suggested. In particular, the talk will deal with the following topics:

- Solvability of all occuring Newton subproblems,
- Global convergence, existence of accumulation points,
- Fast local convergence,
- Decomposition of the subproblems with the aim that a special sparse structure (irregularly sparse or block–banded matrices A, Q) can be exploited efficiently,
- Numerical experience, e.g. for specially sparse structured problems which come from shape preserving spline interpolation.

Thursday, September 1, 15:00, Room H104

A Greedy Algorithm for Solving the Nonlinear Complementarity Problem

Tudor Dumitrescu, The Academy of Economic Studies, Bucharest

Starting from the equivalence between a nonlinear complementarity problem and a certain combinatorial maximization problem, a best-in-greedy algorithm for solving that problem is presented. The algorithm operates on a matroid structure, thus the supplied solution is an optimal one.

Thursday, September 1, 15:30, Room H107

The Hybrid Methods of the Reduced Directions for Solving Nonlinear Extremal Problems on the Frame of the Dialogue Optimization System ODiS

Victor Izhutkin, Mary State University Russia
Mihail Petropavlovskii, Mary State University Russia

In the report we consider the nonlinear programming problem with inequality constraints. All problem functions are supposed to be sufficiently smooth. The united scheme based on the using of the "reduced" direction for moving in the current iteration point is developed for solving this problem. On the frame of the scheme it is constructed and theoreticaly founded the methods of different groups (the feasible direction methods, the cost and barrier function methods) based on the linear and quadratic approximation of the "activecon-straints. On the basis of the scheme of "reduced"direction methods it is constructed the hybrid algorithms combined methods of nondifferentiable cost function and feasible direction methods. The hybrid methods uniting algorithms of different orders. They combine global convergence with relatively low calculation ex-pences far from the optima with high rate of convergence in the neighbour of solution. The hybrid methods are realized into the dialogue optimization system ODiS developed for solving the initial problem and based on the united calculation algorithm of the "reduced"direction methods.

Thursday, September 1, 15:30, Room H104

Pathfollowing Methods in Nonlinear Optimization: Lagrange Multiplier Embedding

Jürgen Guddat, Humboldt-University Berlin
Darina Pateva, Bulgarian Academy of Sciences
Jan-J. Rückmann, Humboldt-University Berlin
Klaus Wendler, Hochschule für Technik, Wirtschaft und Sozialwesen Görlitz/Zittau

This paper deals with Lagrange multiplier methods which are interpreted as pathfollowing methods. We investigate how successful these methods can be for solving "really nonconvex" problems for which the so-called Enlarged Mangasarian Fromovitz Constraint Qualification is not satisfied at all considred points. Singularity theory developed by Jongen/Jonker/Twilt will be used as a successful tool for providing an answer to this question. Certain modifications of the original Lagrange multiplier method extend the possibilities for solving nonlinear optimization problems, but in the worst case we have to find all connected components in the set of all generalized critical points. That is still an open problem.

Friday, September 2, 10:30, Room H104

Error Bounds for Solutions of Parametric Programs

Diethard Klatte, Universität Zürich

In the first part of the talk, we recall and compare various forms of sharp Lipschitz constants for the feasible and optimal set mappings of linear programs under right-hand-side perturbations. Then consequences for the quantitative stability analysis of parametric nonlinear programs are discussed.

Friday, September 2, 10:30, Room H107

Automatic Differentiation in Software Tools for Decision Support

Jerzy Paczyński, Warsaw University of Technology

Problems of modeling and simulation of analytic models for decision support are considered. Modern model-ing and simulation use optimization techniques and multi-objective approaches as tools for the implementa-tion of their advanced methods, which include e.g. inverse modeling, incorporation of indirect constraints on intermediate and outcome variables. Optimization and sensitivity analysis methods need automatic creation of necessary derivatives. On this basis optimization procedures, scalarizing modules and sensitivity models are created. Experience gained during the implementation and usage of three such tools is presented.

Friday, September 2, 11:00, Room H107

Graph coloring and the estimation of the Jacobian matrix

Trond Steihaug,, University of Bergen,
A.K.M. Shahadat Hossain, University of Bergen

It has been observed that number of function evaluations necessary to estimate a sparse *Jacobian matrix* can be reduced by employing the socalled CPR (Curtis, Powell and Reid, 1974) technique. We show that in some cases, by partitioning the rows of the matrix, further reduction in number of function evaluation is possible . In this talk we show the relationship between estimating the Jacobian matrix by row and column partitioning and the graph coloring problem. We also give an easy implementation of *element isolation* principle.

Friday, September 2, 11:00, Room H104

Properties of Globally Convex Functions

Hoang Xuan Phu, Institute of Mathematics, Vietnam

There are some concepts of globally convex functions for investigating global behaviour of non-convex functions, such as δ-convexity of T. C. Hu, V. Klee and D. Larman, roughly convexity of R. Klötzler and H. Hartwig, and γ-convexity of H. X. Phu. In this talk, we present some properties of γ-convex functions and compare them with other concepts.

Friday, September 2, 11:30, Room H104

On Global Optimality Conditions for a Class of Nonconvex and Nonsmooth Problems

Helmut Dietrich, Martin-Luther-Universität Halle-Wittenberg

Inspired through a paper of Strekalovski 1990, we investigate the problems

$$extremum\{f(x) : x \in M\},$$

where f is a proper convex and closed function and M a nonempty, arbitrary subset of a reflexive Banach space, and prove necessary and sufficient optimality conditions for a global minimizer or maximizer of the problems above. In contrast to Strekalovski we make use of a suitable dual problem. In this way we obtain in the case of the problem

$$sup\{f(x) : x \in M\}$$

the same optimality condition as Strekalovski, in the second case but another condition.
The application of this dual method to minimization problems for d.c. func- tions with an arbitrary set of restrictions immediately leads to sharp necessary conditions for global optimality.
An application of the results to problems of mathematical programming is given.

References:
Strekalovski,A.S.: To problems of the global extremum of nonconvex extremal problems, Izv.Vysš. Učebn. Zaved. Mat.8(1990) 74-80, (russian).

Friday, September 2, 11:30, Room H107

Partial Derivatives in Non-smooth Optimization

Peter Recht, Universität Dortmund

In classical calculus the "derivative" and the "gradient" as a vector of special partial derivatives are strongly related to each other. In these cases a representation of the derivative $df|_{x_0}$ for a function f at a point x_0 as a linear function reduces to the computation of n one-dimensional derivatives, i. e. the computation of n real numbers. The classical partial derivatives provide a varity of informations, e. g. concerning optimality conditions for that given x_0. For the nondiffentiable case we will provide a similar instrument, which allows a corresponding characterization by a similar "playing with figures" as in standard cases.

In the talk we answer the following questions:

- Is it possible to construct a similar tool like the "classical" gradient (as a vector of real number) for the nonsmooth case?
- is it possible to compute corresponding "partial derivatives", and is this computation easy? What meaning do such partial derivatives have?
- How look necessary and sufficient conditions for optimality within such an instrument?

Friday, September 2, 12:00, Room H107

Directional Differentiation of Computer Programs

Andreas Griewank, TU Dresden

Apart from arithmetic operations and transcendental functions that are real analytic in the interior of their domains, the absolute value function is quite likely to occur in evaluation procedures written in a programming language like Fortran or C. Sometimes, this occurence does not destroy the differentiability of the functional relationship between the input and output variables that the user has specified as independent and dependent variables, respectively. For example this is the case when absolute values or the closely related min and max functions are used in l-1 or l-2 norms to compute scaling factors, whose presence is important numerically but does not affect the results in exact arithmetic at all.

In other cases, e.g. through the use of l-1 penalties in optimization, the input-output relationship can become genuinely nonsmooth in that there are hypersurfaces in the domain on which the first derivative may have discontinuities. In either situation it is not a priori clear what automatic differentiation, i.e. the computation of derivatives of composite functions from the partials of their constituent components, should do about absolute values and more generally program branches. We will show how directional derivatives can be propagated unambiguously in the so-called forward mode of automatic differentiation and discuss ideas how to compute generalized gradients using the reverse, or adjoint, mode.

Friday, September 2, 12:00, Room H104

The Second Order Cuts Methods in E^{n+1} and their Application in Global Optimization

Peter Semenei, Siberean Energy Institute, Irkutsk

The general scheme for constructing the so called second order cuts in E^n is described in [1] (Bulatov V.P., 1990) applied to the minimization problem of concave function on a polytope.
The author of the report presented about the effective modification of such a scheme at the 25-th annual conference on Mathematical Optimization in September, 1993 in Germany, Vette.
The analogue calculation schemes can be used for constructing deep cuts in E^{n+1} for the global optimization problems of convex functions on polytopes.
The report presents the results of theoretical investigation in this scientific direction and the results of testing the programms constructed.

[1]. Antsiferov E.G., Ashchepkov L.T., Bulatov V.P. Metody Optimizatsii i ikh prilozheniya. T. 1. Matematicheskoe Programmirovanie. (The Methods of Optimization and their applications. V.1. The Mathematical Programming).-Novosibirsk: Nauka, 1990 (in Russian).

Friday, September 2, 15:30, Room H107

Fast and Storage Efficient Sensitivity Analysis for Computational Models Involving Matrix/Vector Computations

Dimitri Shiriaev, Universität Karlsruhe

Any computational model operating with real numbers requires some kind of numerical approximation. To analyze a mathematical model, optimization techniques use *sensitivities*, i.e. partial derivatives of intermediate or final results with respect to input parameters or other intermediate variables.

Automatic differentiation is a non-approximative method allowing fast and exact evaluation of derivatives of any degree. The method does not incur any truncation errors and could yield exact results if the calculations would be carried out with infinite precision. The only errors introduced are those associated with floating-point arithmetic instead of rational arithmetic. The temporal requirement of gradient computation using the the Fast Automatic Differentiation (FAD) is only a small multiple of that of the program, computing the underlying function.

We discuss an extension of the general scheme of FAD from scalar arithmetic to the customary vector/matrix spaces. The set of basic operations is extended to vector operations, including accurate dot product and improving the numerical, space and time performance of the method.

Friday, September 2, 15:30, Room H104

On an Augmented Lagrange Approach for Computing Local Minimizers

Klaus Tammer, Halle

In their book from 1989 Gol'stein and Tretyakov have developed an augmented Lagrange approach to generate local minimizers for nonlinear optimization problems of the form

$$f_0(x) \longrightarrow min! \text{ subject to } f_k(x) \leq 0, \; k = 1, ..., m, \; x \in X. \tag{5}$$

In this approach the original problem (1) will be replaced by a special two-level problem with the parametric lower level

$$P(y) : g_0(x, y) \longrightarrow min! \text{ subject to } x \in X \tag{6}$$

and the upper level

$$h_0(y) \longrightarrow max! \text{ subject to } y \in R^m, \tag{7}$$

where
$g_0(x, y) = \inf\{f_0(x) + y'(f(x) + w) + \alpha(f(x) + w)/w \geq 0\}, \; h_0(y) = \inf\{g_0(x, y)/x \in X\}$
and α is a suitable strongly convex function.
We can show in our paper, that some assumptions, originally used by Gol'stein and Tretyakov, can be omitted or generalized. In this connection we mention the C^2-type of the functions in (1), which can be replaced by the piecewise twice differentiability, as well as the strict complementarity of the local solution of (1), which can be omitted. A second aim of our paper is the representation of some possibilities to control the accuracy in (2) with help of the defect of the corresponding Kuhn-Tucker conditions, to ensure convergence of a gradient-type method for (3).

Friday, September 2, 16:00, Room H104

A Modified Truncated Newton Method Which Uses Negative Curvature Directions For Large Scale Unconstrained Problems

Stefano Lucidi, AFFILIATIONS
Francesco Rochetich, AFFILIATIONS
Massimo Roma, AFFILIATIONS

¡ Università di Roma “La SapienzaÜniversità di Roma “La SapienzaÜniversità di Roma “La Sapienza≫

In this work we consider large scale unconstrained minimization problems assuming that the objective function is twice continuously differentiable. Our aim is to define efficient and globally convergent algorithms which can handle problems where the dimension is large. The distinguishing feature of the methods considered in this work, is to ensure, under suitable assumptions, the superlinear convergence to stationary points where the Hessian matrix is positive semidefinite. This result is obtained by means of nonmonotone stabilization strategy based on a curvilinear linesearch which uses a Newton-type direction along with a negative curvature direction. In order to be able to solve large scale problems, we use a iterative truncated algorithm for computing an approximation of both directions. The error introduced by this truncated scheme does not affect the second order global convergence and the superlinear rate of convergence.

Friday, September 2, 16:00, Room H107

A Class of Algorithms of Unidimensional Optimization

Radu Serban, Academy of Economic Studies - Bucharest

Using a new methods without divergence point for a class of nonlinear equations, a new class of unidimensional optimization algorithms, are presented.

Friday, September 2, 16:30, Room H104

On Iterative Methods for Nonlinear Least Squares Problems

Otu Vaarmann, Estonian Academy of Sciences, Tallinn

The aim of this report is to present a study of computing an approximate solution of the equation $F(x) = 0$ (1), if it exists, otherwise, a solution of (1) in the least squares sense, i.e. of minimizing the functional $\varphi(x) = \frac{1}{2} \parallel F(x) \parallel^2$ (2), where F is a nonlinear differentiable operator from a Hilbert space into another. From solving (1) or (2) one considers a general class of methods which includes as particular cases the Newton, Gauss-Newton, Levenberg-Marquardt method etc. as well as ones with successive approximation of the pseudoinverse operator and those based on the use of iterative methods to obtain cheap solution of limited accuracy for corresponding linear equation(s) at each iteration. Computational aspects as well as questions of preconditioning and numerical stability are discussed.

Friday, September 2, 17:00, Room H104

Augmented Lagrangian Methods for Nonsmooth Optimization and Application to Image Reconstruction

K. Ito, North Carolina State Univ., Raleigh, N.C., USA
Karl Kunisch, Technische Universität Berlin, Germany

Augmented Lagrangian methods for nonsmooth convex optimization problems in infinite dimensional Hilbert spaces are discussed. The solution to the nonsmooth problem is obtained as the limit of solutions to a sequence of C^1–smooth problems. Based on the augmented Lagrangian formulation, we also obtain existence of the Lagrange multiplier and a regularized optimality condition. Application to variational inequalities and image restoration are given. For the discretized problems an active set strategy, converging in *finitely* many steps is proposed. Numerical results are given.