

VOCAL₂₀₀₈

PROGRAM and ABSTRACTS

Sponsors



Faculty of Information Technology, University of Pannonia,
Veszprém, Hungary



Regional Centre of the Hungarian Academy of Sciences,
Veszprém, Hungary



Integrated Security Research & Development Centre,
Veszprém, Hungary

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Faculty of Information Technology, University of Pannonia
Regional Centre of the Hungarian Academy of Sciences, Veszprém

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József Temesi

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VOCAL 2008

The Veszprém Optimization Conference: Advanced Algorithms will be held at the Regional Centre of the Hungarian Academy of Sciences in Veszprém (VEAB), Hungary, December 15-17, 2008. The conference will be hosted by University of Pannonia.

Conference scope

The VOCAL conference focuses on recent advances on optimization algorithms: continuous and discrete; complexity and convergence properties, high performance optimization software and novel applications are reviewed as well. We aim to bring together researchers from both the theoretical and applied communities in the framework of a medium-scale event.

Plenary Invited Speakers

Rainer E. Burkard

Institute of Optimization and Discrete Mathematics (Mathematics B), Technical University Graz



Admissible transformations and combinatorial optimization

Let S denote a feasible solution of a combinatorial optimization problem and let $c(S)$ be the corresponding objective function value. A transformation T of the costs c to new costs $\bar{c}$ is called *admissible*, if there is a constant $z(T)$ such that for all feasible solutions the equation $c(S) = z(T) + \bar{c}(S)$ holds. It will be shown how linear assignment problems can be solved by admissible transformations. Moreover, it will be outlined, how admissible transformations can be used to get strong lower bounds for various problems like quadratic assignment problems and multi-index assignment problems.

Christodoulos A. Floudas

Department of Chemical Engineering, Princeton University



Deterministic Global Optimization: Advances in Theory and Applications

In this presentation, an overview of the research progress in global optimization will be provided. The focus will be on important contributions during the last five years, and will provide a perspective for future research opportunities. The overview will cover the areas of (a) twice continuously differentiable constrained nonlinear optimization, and (b) mixed-integer nonlinear optimization models. Subsequently, we will present our recent fundamental advances in (i) convex envelope results for multi-linear functions, (ii) a piecewise quadratic convex under-estimator for twice continuously differentiable functions, (iii) the generalized alpha-BB framework, (iv) a new augmented Lagrangian approach for global optimization, and (v) our recently improved convex underestimation techniques for univariate and multivariate functions. Computational studies on important applications will illustrate the potential of these advances.

Katya Scheinberg

Research Staff Member, Mathematical Sciences Department, IBM
Thomas J. Watson Research Center



Model Based Derivative Free Optimization

Derivative free optimization (DFO) is the field of nonlinear optimization which targets functions whose derivatives exist but are not available and cannot be approximated efficiently. It is often also the case that such functions are expensive to evaluate and/or are noisy. In the past decade there has been a significant increase in research in the area of DFO, much of it in the development of model based methods. There are several practical algorithms that have been proposed, most of them lacking global convergence theory. Those methods that do have convergence theory have to resort to impractical extra steps and conditions. But most of the proposed methods have the "right ingredients" for both convergence theory and practical performance. We will discuss these ingredients and try to fit them in a unifying framework for which we can provide convergence theory.

Fabio Schoen

Department of Systems and Informatics, Faculty of Engineering,
University of Florence



Large Scale Global Optimization: from molecular clusters to space trajectories.

In this talk we will present a few problems which can be formulated as global optimization ones characterized by the presence of a huge number of local optima. We will then show how, starting from a very elementary algorithmic scheme suitably adapted in order to take into account problem characteristics, we could "solve" (obviously without any guarantee of having found the global optimum) some very large and notoriously difficult problems, like the optimization of the potential energy of clusters of atoms interacting via Lennard-Jones or Morse potential, the optimal positioning of non overlapping disks in a smallest container, the design of space trajectories with minimal fuel consumption. Although quite different in nature, these problems could be solved with reasonable success by properly mixing a few basic ingredients: choice of good starting points, use of standard nonlinear (local) optimization codes, suitable local exploration obtained by means of perturbations of current solutions; significant improvements could be obtained in some instances by running multiple instances of the same algorithm in a concurrent fashion, trying to maintain a sufficient dissimilarity among the solutions obtained.

This talk is based on research carried out with many co-authors:
B. Addis, A. Cassioli, D. Di Lorenzo, J.P.K. Doye, B. Leary, M.
Locatelli, M. Sciandrone

Philippe Toint

Department of Mathematics, The University of Namur (FUNDP)

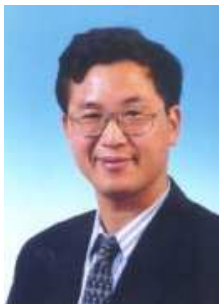


Regularization as an alternative to linesearch and trustregions for nonlinear optimization

The talk will review a new class of regularization techniques resulting from the convergence of various ideas by Griewank, Weiser, Deuffhard and Erdmann and Nesterov, and recently analyzed by Cartis, Gould and the author. Three algorithms will be discussed. The first is for unconstrained optimization and uses a cubic regularization term, the second is for optimization with convex constraints and uses the same regularization in a different context, and the third is for least-squares computations and solution of systems of nonlinear equations, and uses a prox regularization of the unsquared Euclidean norm. Theoretical properties of these algorithms will be reviewed, as well as algorithmic tools for the solution of the relevant subproblems. Some numerical evidence will also be presented, indicating a strong potential for this approach.

Ya-xiang Yuan

State Key Laboratory of Scientific and Engineering Computing, Institute of Computational Mathematics and Scientific/Engineering Computing, Academy of Mathematics and System Sciences , Chinese Academy of Sciences



A Parallel Decomposition Training Algorithm for Multi-class Kernel-based Vector Machines

In this talk, we discuss the kernel based machine learning problems. We consider the multi-class problems, which are extensions to the standard supporting vector machine, the two-class problem. One of the major difficulties for kernel based machine learning is that the kernel matrices are dense and very large scale. We present a decomposition algorithm and its parallel implementation. Numerical results are also reported.

Technical Program

December 15, 2008 (Monday)

7:00 am – 6:00 pm **Registration Office Open**

8:30 am – 9:00 am **Opening ceremony**

- Welcome note
- Johann Sebastian Bach (1685-1750) : Goldberg Variations BWV 988, pianist Péter Rozsnyói

9:00 am – 10:00 am **Plenary Session 1**

Admissible transformations and combinatorial optimization

Rainer E. Burkard

10:00 am – 10:30 am **Coffee break**

10:30 am – 12:00 pm **Parallel Session 1A**

Sparse principal component analysis via maximization of convex functions

Michel Journée, Yurii Nesterov, Peter Richtárik, Rodolphe Sepulchre

Interactive approach for multidimensional non-convex non-linear programming problems based on improved surrogate constraint method

Yuji Nakagawa, Yuriko Isada, Nobuko Igaki

Solving quadratically constrained convex optimization problems with an interior point method

Csaba Mészáros

10:30 am – 12:00 pm **Parallel Session 1B**

A mixed multidimensional bin packing problem

Tamás Bartók, Csanád Imreh

The role of faithful polynomial evaluation in speeding up the computer assisted proof of chaotic property of the Henon map

István Bársony, Balázs Bánhelyi, Tibor Csendes

Differential evolution optimization algorithm in large Unreliable Networks

Balázs Bánhelyi, Márk Jelsai

12:00 pm – 1:30 pm **Lunch**

1:30 pm – 2:30 pm **Plenary Session 2**

Deterministic Global Optimization: Advances in Theory and Applications

Christodoulos A. Floudas

2:30 pm – 4:30 pm **Parallel Session 2A**

A harmony search metaheuristic for the multi-mode resource-constrained project scheduling problem

Anikó Csébfalvi, György Csébfalvi, Etelka Szendrői

Analysis of an Algorithm for the Coupled Task Problem with UET Jobs

József Békési, Gábor Galambos, Marcus Oswald, Gerhard Reinelt

Practical feasibility of mathematical models in scheduling

Máté Hegyháti, Thokozani Majosi, Tibor Holczinger, Ferenc Friedler

2:30 pm – 4:00 pm **Parallel Session 2B**

Generating Test Charts for Adaptive Quality Assurance of Manufacturing Low Volume High Value Products

Ádám Nagy, Norbert Kovács, Tünde Tarczali, Zoltán Süle

Unifying Collaborative Filtering Approaches

Gábor Takács, István Pilászy, Bottyán Németh, Domonkos Tikk

The interpretation of fuzzy linear programming results of production planning problems

Tamás Koltai, Viola Tatay

4:00 pm – 4:30 pm **Coffee break**4:30 pm – 6:00 pm **Parallel Session 3A**

Product type approximations for the probability of the intersection of events

Tamás Szántai, Edith Kovács

DC-approximations to stochastic optimization problems

Georg Pflug

Bounds on the Probability of the Union of Events by the Use of the Binomial MDMF

Gergely Mádi-Nagy

4:30 pm – 6:00 pm **Parallel Session 3B**

Development of MINLP model for optimization of large industrial water system

Hella Tokos, Zorka Novak Pintaric

Modified Outer Approximation algorithm to optimize distillation structure

Tivadar Farkas, Barbara Czuczai, Endre Rév, Zoltán Lelkes

Performing constrained optimisation with large-scale black-box steady-state simulators: A reduced algorithm

Constantinos Theodoropoulos, Ioannis Bonis

December 16, 2008 (Tuesday)7:00 am – 6:00 pm **Registration Office Open**8:30 am – 9:30 am **Plenary Session 3**

Model Based Derivative Free Optimization

Katya Scheinberg

9:30 am – 10:30 am **Plenary Session 4**

Large Scale Global Optimization: from molecular clusters to space trajectories

Fabio Schoen

10:30 am – 11:00 am **Coffee break**11:00 am – 12:30 pm **Parallel Session 4A**

Accelerated Projection Methods for Linear Conic Minimization Problems

Florian Jarre

YAS: an open-source C++ platform for rapid IPM development with SMP

Yuriy Zinchenko

Feasibility and Constraint Analysis of Sets of Linear Matrix Inequalities

Richard Caron

11:00 am – 12:30 pm **Parallel Session 4B**

Reaction-Pathway Identification: Models and Algorithms

Botond Bertók, Károly Kalauz, Ferenc Friedler, L. T.

Fan

On the Ray-based procedure for determining initial bound
in branch and bound method

Erik Bajalinov, Anett Rácz

Formulating and Solving Vehicle Routing Problems by
the P-graph Framework

*István Heckl, Róbert Adonyi, Botond Bertók, Ferenc Friedler,
L. T. Fan*

Combinatorial Approach to the Optimal Design of Secu-
rity Systems

Zoltán Süle, Botond Bertók, Ferenc Friedler

12:30 pm – 2:00 pm **Lunch**

2:00 pm – 4:00 pm **Parallel Session 5A**

Extending algebraic modelling language for chance con-
straints and integrated chance constraints

*Viktar Zviarovich, Gautam Mitra, Francis Ellison, Chris-
tian Valente*

An enhanced model for portfolio choice with SSD crite-
ria: a constructive approach

*Csaba Fábián, Gautam Mitra, Diana Roman, Vikta r
Zviarovich*

A decision optimization modeling framework for multi-
stage stochastic electricity portfolio risk management

Ronald Hochreiter, David Wozabal

Computational methods for processing two stage stochas-
tic programming problems

Eldon Ellison, Csaba Fábián, Gautam Mitra, Viktar Zviarovich

2:00 pm – 4:00 pm **Parallel Session 5B**

Reduction of symmetric semidefinite programs using the
regular *-representation and canonical block diagonal-
ization

Cristian Dobre

A quasi-Newton method using directions of negative cur-
vature with symmetric rank one updates

Figen Öztoprak, Ş. İlker Birbil

The worst-case ineffectiveness of geometric cuts cumula-

tion in projection methods – an extension to the finite-dimensional case

Pawel Bialon

Numerical Optimization in Solid State Laser Pump Cavity Design

Masoumeh Ghaffari-Hadigheh, Alireza Ghaffari-Hadigheh

3:30 pm – 4:00 pm **Coffee break**

4:30 pm – 6:00 pm **Parallel Session 6A**

Adding Flexibility to the Vehicle Routing Problem with Backhauls

Gábor Nagy, Niaz Wassan, Said Salhi

Computer aided tool for optimizing public transport networks

Pál Pusztai

An Adaptative Memory Procedure using Tabu Search to the Team Orienteering Problem

Francisco Henrique de Freitas Viana

4:30 pm – 6:00 pm **Parallel Session 6B**

Computational Study of the Dual Simplex Method

István Maros

Tolerance analysis in linear programming

Milan Hladík

SOHS decomposition of non-commutative polynomial: find it by NCsostools

Janez Povh, Igor Klep

December 17, 2008 (Wednesday)

7:00 am – 6:00 pm **Registration Office Open**

8:30 am – 9:30 am **Plenary Session 5**

Regularization as an alternative to linesearch and trustregions for nonlinear optimization

Philippe Toint

9:30 am – 10:30 am **Plenary Session 6**

A Parallel Decomposition Training Algorithm for Multi-class Kernel-based Vector Machines

Ya-xiang Yuan

10:30 am – 11:00 am **Coffee break**

11:00 am – 12:30 pm **Parallel Session 7A**

Global Optimization with Expensive Model Functions:
A Comparative Computational Study

Zoltán Horváth, János Pintér

An interval global optimization algorithm for INTLAB

László Pál, Tibor Csendes

Promising GAHC and HC12 algorithms in global optimization tasks

Radomil Matousek, Eva Zampachova

11:00 am – 12:30 pm **Parallel Session 7B**

Improved bounds for scheduling two uniform machines with known sum of the jobs

György Dósa, M. Grazia Speranza, Zsolt Tuza

Minimize overtime in a parallel machine environment

Márton Drótos, Tamás Kis

Scheduling multiprocessor UET tasks of two sizes

Tamás Kis

12:30 pm – 2:00 pm **Lunch**

2:00 pm – 3:30 pm **Parallel Session 8A**

Nonrepetitive Graph Coloring

János Barát, David R. Wood

The Frobenius-König theorem, its generalizations, and precoloring extension

Mihály Hujter

Optimization problems on hypergraph classes

Dmitrii Lozovanu, Zsolt Tuza, Vitaly Voloshin

Sub-Division Number and Optimization

Alireza Ghaffari-Hadigheh

2:00 pm – 4:00 pm **Parallel Session 8B**

A new Hybrid Genetic and Simulated Annealing Algorithm to solve Traveling Salesman Problem

Younis Elhaddad, Omar Sallabi

A harmony search metaheuristic for the resource-constrained project scheduling problem with discounted cash flows

Blanka Láng, György Csébfalvi

Optimizing Information Retrieval Process with Evolutionary Algorithms

Piotr Lipinski

Parameter learning algorithm for online data acknowledgement problem.

Csanád Imreh, Tamás Németh

4:00 pm – 4:30 pm **Coffee break**

4:30 pm – 6:00 pm **Parallel Session 9A**

Optimizing biomass delivery system layout in the NUTS 4 region of Sellye, Hungary

Ferenc Brachmann

Optimisation and Simulation Techniques in the Field of Manufacturing Processes

Zoltán Horváth, Károly Kardos, János Jósvai

Conceptual Design of Business Processes by Process-Network Synthesis

Róbert Adonyi, Károly Kalauz, Botond Bertók, L. T. Fan, Ferenc Friedler

4:30 pm – 6:00 pm **Parallel Session 9B**

Maximum l^p -separation arrangements

Péter Gábor Szabó

Investigation of simplicial branch and bound algorithms for multidimensional Lipschitz optimization

Remigijus Paulavicius, Julius Žilinskas

On simplicial partition

Julius Žilinskas

5:30 pm – **Closing**

Abstracts

Sparse principal component analysis via maximization of convex functions

Michel Journée

University of Liège, Belgium

Yurii Nesterov

CORE, Catholic University of Louvain, Belgium

Peter Richtárik

CORE, Catholic University of Louvain, Belgium

Rodolphe Sepulchre

University of Liège, Belgium

In this paper we propose a new general approach to sparse principal component analysis (sparse PCA). The first step consists in constructing several formulations of the sparse PCA problem, all in the form of an optimization program involving maximization of a convex function on a compact set. We then propose and analyze a simple gradient method suited for this purpose. It appears that our algorithm has best convergence properties in the case when either the objective function or the feasible set are strongly convex, which is the case with our formulations. Good practical performance of our approach is demonstrated numerically on a set of random and gene expression test problems.

Interactive approach for multidimensional non-convex nonlinear programming problems based on improved surrogate constraint method

Yuji Nakagawa

Kansai University, Japan

Yuriko Isada

Kwansei University, Japan

Nobuko Igaki

Kwansei University, Japan

In this paper we deal with multidimensional non-convex nonlinear programming problem. An improved surrogate constraints (ISC) method (by Nakagawa) can be applied to this type of problems with discrete values. The ISC method enumerates all solutions within a target region, which includes the exact optimal solution, in order to close the surrogate duality gap. The ISC method has been used to solve to optimality problems with 3 constraints, 1000 variables, and 20 items for each variable and problems with 8 constraints, 500 variables, and 50 items. We propose Hyper-cube method which is an algorithm to solve multidimensional non-convex nonlinear programming problem using ISC method interactively. With this method we demonstrate to solve two types of non-convex portfolio optimization problems, i.e. the Markowitz mean-variance model with transaction costs and the index fund model. In the field of financial engineering, these problems are said to be very difficult to solve exactly unless the objective function is linear. However we obtained an optimal portfolio by using proposed method. Additionally, we succeeded to solve index-plus-alpha fund optimization problem. We considered virtual index which outperform index by a small amount, α . The plus-alpha-fund optimization is a type of index fund model that find the optimal portfolio which is linked to the virtual index.

Solving quadratically constrained convex optimization problems with an interior point method

Csaba Mészáros
MTA SZTAKI, Hungary

During the last two decades interior point methods proved their competitiveness in large-scale numerical optimization. The success of interior point methods in the linear programming practice resulted in an increased interest for the application of the IPM methodology in the nonlinear optimization. In the talk we describe the design of our interior point implementation to solve large-scale quadratically constrained convex optimization problems. We outline the details of the implemented algorithm which is based on the primal-dual interior point method. Our further discussion includes topics related to various parts of the implementation, including scaling, starting point strategies and the numerical kernels. A special attention is given for sparsity and numerical stability issues. Computational results will be presented on a demonstrative set of quadratically constrained convex optimization problems.

A harmony search metaheuristic for the multi-mode resource-constrained project scheduling problem

Anikó Csébfalvi

University of Pécs, Hungary

György Csébfalvi

University of Pécs, Hungary

Etelka Szendrői

University of Pécs, Hungary

This paper presents a harmony search metaheuristic for the multi-mode resource-constrained project scheduling problem (MMRCPSP). Theoretically the optimal schedule searching process is formulated as a mixed integer linear programming (MILP) problem, which can be solved for small-scale projects in reasonable time. The applied metaheuristic is based on the "time oriented" version of the "Sounds of Silence" harmony search metaheuristic developed by Csébfalvi (2007) for the single mode resource-constrained project scheduling problem (RCPPSP). In order to illustrate the essence and viability of the proposed harmony search metaheuristic, we present computational results for the J30MM set from the well-known and popular PSPLIB.

Analysis of an Algorithm for the Coupled Task Problem with UET Jobs

József Békési

University of Szeged, Faculty of Education, Department of Informatics Applications, Hungary

Gábor Galambos

University of Szeged, Faculty of Education, Department of Informatics Applications, Hungary

Marcus Oswald

University of Heidelberg, Institute of Informatics, Germany

Gerhard Reinelt

University of Heidelberg, Institute of Informatics, Germany

The coupled task problem (CTP) is defined as follows: we are given n jobs each of them consisting of two subtasks. The two subtasks have to be executed in a given sequence and there is an exact delay time (gap) to be observed between their execution. We specify job i , $i = 1, \dots, n$, by a triple (a_i, l_i, b_i) of positive integers where the values represent the processing time of the first task, the delay time between the tasks and the processing time of the second task, respectively. During the delay time the machine is idle and other jobs can be processed in this time interval. The aim is to schedule the n jobs on a single machine in such a way that no two tasks overlap and the latest completion time of a job (makespan) is as small as possible. Preemptions are not allowed. In this general version the problem is strongly NP-hard. In this talk we present a lower bound for the problem variant with unit execution times and improve an analysis of Ageev and Baburin.

Practical feasibility of mathematical models in scheduling

Máté Hegyháti

University of Pannonia, Faculty of Information Technology, Department
of Computer Science, Hungary

Thokozani Majoji

University of Pannonia, Faculty of Information Technology, Department
of Computer Science, Hungary

Tibor Holczinger

University of Pannonia, Faculty of Information Technology, Department
of Computer Science, Hungary

Ferenc Friedler

University of Pannonia, Faculty of Information Technology, Department
of Computer Science, Hungary

This paper focuses on eliminating a modeling inaccuracy that appears in the published literature for scheduling problems involving makespan minimization under Common Intermediate Storage (CIS) operational philosophy. As a result, in previous works, a solution has been repeatedly reported by various authors as optimal, although it is impossible to be implemented in practice. This infeasibility - called “cross-transfer”, pertains to two or more processing units exchanging material at a particular point in time without using intermediate storage, which is impossible to effectuate, since a unit must be discharged completely before receiving any new material for processing. Consequently, a schedule with cross-transfer cannot be a feasible - and thus optimal - solution to the original problem.

Additionally, a solution with cross-transfer is preferable for MIP formulation techniques, thus it can appear in both makespan minimization and throughput maximization problems with Zero-Wait (ZW) and Non-Intermediate Storage (NIS) policies. It is, however, not a coincidence that all the solutions that entail this characteristic are obtained using mathematical programming techniques. Mathematical Programming formulations cannot exclude this infeasibility, passing incorrect models to the solvers, leading to unimplementable results.

In contrast, the S-graph framework, used in the current work, bears an intrinsic feature to isolate this infeasibility during optimization, thereby removing it from the search of possible solution candidates. The appearance of a cycle in an S-graph invariably ensures that the corresponding schedule is practically infeasible and has to be eliminated from the search. As a result, the solutions obtained using S-graph based optimization represent optimal schedules with guaranteed structural and temporal feasibility.

Product type approximations for the probability of the intersection of events

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In earlier papers we generalized the Chow-Liu's dependence tree approximation of multivariate discrete probability distributions to higher order dependence tree, called k -th order t -cherry junction tree approximations. In this lecture we will show two different ways for the use of these more general graph structures for the approximation of probabilities of intersection of events. Numerical results will also be presented.

DC-approximations to stochastic optimization problems

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The Basel II accord requires that a certain quantile of the profit/loss distribution should not fall under some limit. Expressing this in terms of a constraint leads to a nonconvex optimization problem.

We show that that the constraint function is even not DC (difference of convex) in general. However, it is DC for sample data points. Thus a DC-type algorithm may work. We have implemented a full global DC method and the approximative DCA method and may compare them.

In the second part of the talk, we show that stochastic programs under model ambiguity lead to nonconvex, but DC problems. Again, DC-type algorithms have been implemented. The results show how model ambiguity influences the optimal solutions.

This is joint work with David Wozabal.

Bounds on the Probability of the Union of Events by the Use of the Binomial MDMP

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The probability of the union of an event system can be bounded by the aid of the univariate and multivariate binomial discrete moment problems (binomial DMP). The bounds are based on the (sub)sums of probabilities of the individual events, of the products of the pairs of the events, of the products of the triples of the events, etc. In the univariate case the aggregate information of the sums of all probabilities are used. However, in the multivariate case the increase of the dimension enables to take more disaggregated information, i.e. subsums of the mentioned probabilities into account. Hence, the multivariate binomial DMP (binomial MDMP) yields better bounds.

The binomial MDMP usually cannot be solved by regular solvers, due to its Vandermonde-type coefficient matrix. Fortunately, a large number of dual feasible bases of the MDMP can be given directly, which yields very close bounds on the objective function, i.e., on the probability of the union of events. Numerical examples show that the binomial MDMP can give better bounds than graph-theory-based probability bounds, e.g. Hunter-bound, Cherry-tree bound, using the same (or less) information of probabilities of the products of events.

A mixed multidimensional bin packing problem

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Bin packing is one of the most widely studied combinatorial optimization problem. In the bin packing problem one has items with size at most 1 and the goal is to pack them into the minimum number of unit bins. The problem has several multidimensional generalization.

It is likely that the two most important multidimensional versions are box packing and vector packing. In box packing the goal is to pack without overlapping d -dimensional boxes into the minimal number of d -dimensional hypercubes. In vector packing the items are d -dimensional vectors, and packing a set of items into one bin is allowed if the sum of the values are at most 1 for each component. In this work we consider a common generalization of these models. We pack three dimensional boxes into unit cubes but the items has a further parameter called weight, and the total weight must be at most one in the cubes.

The motivation of our research is the following. One of the main motivation for box packing models is vehicle loading. On the other hand in real application it is usually not enough if one can pack the boxes into the vehicle one has to keep a weight limit as well. Our mathematical model consider this situation.

We present and analyse heuristic algorithms for the solution of the problem. The online version is also considered.

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The role of faithful polynomial evaluation in speeding up the computer assisted proof of chaotic property of the Henon map

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We demonstrate a faster technique for the computer aided proof of the existence of chaos in the Henon map [1]. We use the compensated Horner algorithm [2]-[3] for the evaluation of the related polynomials, and we apply this method in our optimization framework. The above technique is used only in the search phase, while interval arithmetic is applied for the verification step. The advantages are described in detail on more complex or difficult to solve problem variants.

[1] Tibor Csendes, Barnabás M. Garay, and Balázs Bánhelyi: A verified optimization technique to locate chaotic regions of Hénon systems. *J. of Global Optimization* 35(2006) 145-160.

[2] Stef Graillat, Philippe Langlois, and Nicolas Louvet: Improving the compensated Horner scheme with a fused multiply and add. *SAC 2006*: 1323-1327

[3] Philippe Langlois and Nicolas Louvet: How to Ensure a Faithful Polynomial Evaluation with the Compensated Horner Algorithm. *IEEE Symposium on Computer Arithmetic 2007*: 141-149

Differential evolution optimization algorithm in large Unreliable Networks

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We discuss a new generation of fully-distributed differential evolution global optimization algorithm in the area of peer-to-peer (P2P) computing.

In the first part we show the differential evolution technique. We review more strategies for new generation and show the main difference between them. Then we adopt this technique to grid systems and compare with other optimization technique [1]. The known best result and solution are shared based on gossip method [2].

In the second part we show a mechanism which tries to find the best differential evolution strategy for the current optimization problem. This mechanism calculates a statistic about the efficiency of the strategy and chooses the more effective strategy on more computers in grid system. We show that with numerical results, this strategy does not choose the worse strategy of two possibilities. Furthermore we show some examples that this method is more efficient than the better strategy alone.

[1] Bánhelyi, B., M. Biazini, A. Montresor, and M. Jelasity: Peer-to-peer Optimization in Large Unreliable Networks with Branch-and-Bound and Particle Swarms, manuscript

[2] Jelasity, M., S. Voulgaris, R. Guerraoui, A.M. Kermarrec, M. van Steen: Gossip-based peer sampling. ACM Transactions on Computer Systems 25(3) (August 2007) 8

Generating Test Charts for Adaptive Quality Assurance of Manufacturing Low Volume High Value Products

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The main activity of the IBM DSS Kft. at Vác is the manufacturing of the most advanced TotalStorage DS8000 storage subsystems. The two types represent IBM's multi-billion-dollar investment into storage innovations, research and development, over the past years. In a low volume-high mix production environment every product can be unique. The manufacturing process cannot be automatized due to process complexity or to make it won't be economically efficient the assembly process can be made with human workforce. Due to this the process variance can be high. From quality assurance (visual inspection) point of view 100% of the product and all components of the product requires visual inspection to ensure high quality level. It takes lot of engineering time to continuously monitor manufacturing data and analyze failures which results in frequently updated visual inspection checklists. The visual inspection time spent on boxes is also high. This practice is not fast enough to react immediately on popping up quality issues. For solving the problem, the machine learning algorithms and the data mining methods of the artificial intelligence systems is taken as a basis. Decision trees and data mining are used for examining the given and the simulated data set. The applied rules come from the following systems: from the (1) Decision tree, from the (2) Intelligent Miner, from the (3) engineers' settings and from different (4) intuitive rules. The automatic rule generation is a cost and time

effective tool and opens process optimization possibilities reducing visual inspection time with ensuring same level of high quality with providing product and operator customized visual inspection checklists. A software-system was also developed based on JAVA platform and the different rule generation tools are integrated in this software. The software was tested with different property data sets; the results show that the applied methodology and the created software tool - after a few setting steps - is a good tool to draw up the optimal checklist.

Unifying Collaborative Filtering Approaches

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Matrix factorization (MF) based approaches have been proven to be efficient for rating based recommendation systems. In this talk we propose a hybrid approach that alloys an improved MF and the so called NSVD1 approach, resulting in a very accurate factor model. After that we propose a unification of factor models and neighbor based approaches, which further improves performance. The approaches are evaluated on the Netflix Prize dataset and they provide very low RMSE and favorable running time. Our best solution presented here with Quiz RMSE 0.8851 outperforms all published single methods in the literature.

The interpretation of fuzzy linear programming results of production planning problems

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Linear programming is one of the most frequently used operational research tool in production planning. Cost minimization and profit maximization problems with manufacturing resource constraints are frequently formulated in practice. One of the difficulties is, however, the application of correct data. The objective functions cost coefficients are frequently estimates, or are the results of ambiguously used techniques. The revenues may also change constantly as a consequence of changing market conditions. In the constraints, capacities are difficult to determine and are frequently the results of informal agreements. As a consequence of the ambiguous nature of data, crisp models have limited value for management decision making. There are three possibilities to handle data ambiguity:

1.) Sensitivity analysis of LP provides information about the effect of the change of data on the optimal solution. This approach, however, assume some given values for the parameters.

2.) A stochastic treatment of the ambiguous data uses estimates of the parameters. The proper statistical analysis necessary for the estimation of the major parameters is not easy if at all possible in a real production planning environment.

3.) A fuzzy approach of the ambiguous parameters provides a flexible approach, and helps to avoid statistical analysis. The difficulty is, however, the determination of the membership functions.

The paper explores the possibilities of applying fuzzy linear programming for production planning. A small sample problem is used to illustrate the fuzzy approach of the objective function and the constraints. The fuzzy solution space and the fuzzy results are interpreted and the possibility of applying sensitivity analysis is explored.

Development of MINLP model for optimization of large industrial water system

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This work concerns the application of a large MINLP model for the optimization of a water system, initiated by the industrial needs of a Brewery. Several mathematical models were developed in order to reduce the use of freshwater, by considering the specific requirements of each particular production section. These models are based on the design method developed by Kim and Smith (2004). In order to investigate the interactions between different production sectors, the developed models are combined in one large model. Two sections of brewery are considered in this study: the packaging and production area. The wastewater streams from the continuous processes in the packaging area have low concentrations of contaminants, and can be re-used in batch processes with lower purity requirements. The original formulation is first modified to enable efficient integration of continuous and batch water-using processes. The continuous wastewater streams are treated as limited freshwater sources and the unused wastewater is discharged. In the next step, the model is further extended by the option of installing intermediate storage tanks for the collection of unused continuous wastewater streams. Opportunities for regeneration re-use are analyzed in the production area, because of high contaminant concentrations at this site. The model is extended with the option of installing a local wastewater treatment unit operating in batch or continuous modes. The scheduling of batch wastewater treatment units is performed simultaneously. The option of storage tank installation before and after treatment is included in the model. The logic disjunctions with big-M representations are used for modeling these options.

Modified Outer Approximation algorithm to optimize distillation structure

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Rigorous models of either conventional or extractive distillation systems involve a large scale equation system with a set of linear equations and a set of non-convex equations with strong non-linearity. For determining the optimal structure, a large set of integer variables are also to be considered.

After constructing an R-graph based superstructure of such systems, a GDP representation of the superstructure is first constructed, then it is transformed to MINLP representation to which, in turn, additional trivial improvements are added.

For optimizing complex multicomponent separation systems consisting of several distillation columns, the well known Outer Approximation (OA) algorithm is modified in two essential points. First, not all the non-linear equations are linearized according to the OA principles but some essential equations only, and those non-linear equations that are not linearized do not take place in the MILP subproblems. Second, the NLP subproblems are re-initialized according to the simple Constant Molar Overflow approximation well known in chemical engineering. Without this latter modification, the NLP step notoriously cannot find feasible solutions, even if they exist. Now we can find optimal structure, stage numbers, operation variables, and even the number and kinds of the entrainer feeds. Thus, if there are alternative entrainers and separation structures, the new model and algorithm can be used to optimize the whole system.

Performing constrained optimisation with large-scale black-box steady-state simulators: A reduced algorithm

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The optimisation of complex engineering systems is usually based on the use of sophisticated commercial simulators (which do not always include optimisation capabilities) employing advanced numerical methods. Building a superstructure for optimisation using black box simulators is generally a very challenging task. In recent years we have developed a framework for large scale dynamic and steady state optimisation using black-box dynamic simulators [1,2]. This has been recently extended for steady-state simulators [3]. It is based on reduced Hessian methods and includes a 2-step projection scheme: firstly onto the dominant subspace of the system and secondly onto the subspace of the independent variables. Here we further expand this work to consider inequality constraints by defining the KS function [4] for the inequality constraints and incorporating it to the objective function. This formulation has the advantages of involving no extra cost for the calculation of the dominant subspace and of including no slack variables. The convergence behaviour of the algorithm is discussed and its efficiency is demonstrated with illustrative examples (including tens of thousands of state variables) using state-of-the-art massively parallel CFD software developed at SANDIA National Laboratories USA (codename: MPSalsa).

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Accelerated Projection Methods for Linear Conic Minimization Problems

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We discuss new iterative approaches for solving linear programs over convex cones. Assuming that Slaters condition is satisfied, the conic problem is transformed to the minimization of a convex differentiable “augmented primal-dual (apd) function”. The evaluation of this function and its derivative is cheap if the projection of a given point onto the cone can be computed cheaply, and if the projection of a given point onto the affine subspace defining the primal problem can be computed cheaply. For the special case of a semidefinite program, two types of regularization of the apd-function are analyzed. Large scale numerical examples minimizing the apd-function with a limited memory BFGS method illustrate the potential of the approach.

YAS: an open-source C++ platform for rapid IPM development with SMP.

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We present an object-oriented open-source platform for rapid porting, prototyping and development of interior-point method (IPM) algorithms in C++, targeted for SMP architecture. YAS is designed to allow easy extensions of IPM beyond the symmetric cone programming, e.g., p -norm cones, and the underlying direct linear algebra solvers. Currently within the platform, basic long-step, predictor-corrector, and Nesterov's asymmetric primal-dual methods are implemented. YAS provides SeDuMi-like interface for MATLAB and Octave, with the capability of building standalone applications.

Feasibility and Constraint Analysis of Sets of Linear Matrix Inequalities

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We present a constraint analysis methodology for Linear Matrix Inequality (LMI) constraints. If the constraint set is found to be feasible we search for a minimal representation; otherwise, we search for an irreducible infeasible system. The work is based on the solution of a set covering problem where each row corresponds to a sample point and is determined by constraint satisfaction at the sampled point. Thus, an implementation requires a method to collect points in the ambient space and a constraint oracle. Much of this talk will be devoted to the development of a hit and run sampling methodology. Test results show that our approach not only provides information required for constraint analysis, but will also, if the feasible region has a non-void interior, with probability one, find a feasible point.

Extending algebraic modelling language for chance constraints and integrated chance constraints.

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Algebraic modeling languages have become widely accepted by practitioners in the field of operational research. There are a few examples of extending AMLs for stochastic programming. One of such examples is Stochastic AMPL, or SAMPL, which extends the AMPL modeling language by providing constructs to express scenario-based recourse problems. In this talk we will present the rationale of extending an algebraic modeling language to express stochastic programming problems with chance constraints and integrated chance constraints (ICC). We describe the design and implementation of these extensions in the context of the software system for SP modeling called SPInE (Stochastic Programming Integrated Environment) which uses SAMPL as a modeling language. Apart from making models easier to understand using direct representation of chance constraints and ICCs in the modeling system facilitates usage of specialized algorithms for solving such problems. Computational experience of solving single-stage stochastic programming problems with integrated chance constraints using cutting-plane based solution methods will be provided.

An enhanced model for portfolio choice with SSD criteria: a constructive approach

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Second-order Stochastic Dominance (SSD) is widely recognised as an important criterion for portfolio selection. The multi-objective model of Roman, Darby-Dowman, and Mitra (2006) successfully applies this criterion. The resulting problems were found to be computationally demanding, though. In the first part of this talk we propose a cutting-plane based method for the solution of problems resulting of this multi-objective model. We present algorithmic description, implementation details, and a computational study that demonstrates efficiency of the approach. In the second part, we formulate an enhanced version of the multi-objective model proposed by Roman, Darby-Dowman, and Mitra. The enhancement lies in a special scaling of the different objectives. The enhanced model can be formulated as risk minimisation with the use of a convex risk measure. We characterise this risk measure and the resulting optimisation problem. We outline a solution method and present a computational study demonstrating that the resulting portfolios have superior return distributions.

A decision optimization modeling framework for multi-stage stochastic electricity portfolio risk management

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We present a multi-stage decision model for a large energy consumer, that has to decide about its mid-term electricity portfolio composition. The given stochastic demand may be fulfilled by buying energy on the spot or futures market, by signing a supply contract, or by producing electricity in a small plant. We formulate the problem in a dynamic risk management-based stochastic optimization framework, whose flexibility allows for extensive parameter studies and comparative analysis of different types of supply contracts. A variety of application examples is presented to outline the possibilities of using the basic multi-stage stochastic programming model to address a range of issues related to the design of optimal policies. In particular, the impact of contract parameters on the structure of a swing option-style supply contract will be presented, as well as a real option evaluation of a power plant as a tool to avoid price spikes on the electricity spot market.

Computational methods for processing two stage stochastic programming problems

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Two stage recourse models are the most frequently studied instances of the stochastic programming problem. In this paper we consider alternative solution methods: Deterministic Equivalent, Benders decomposition, some variants of Benders decomposition such as Level Decomposition and stochastic decomposition for processing this class of problem. We provide some insight into the data structure and algorithms; we also report on the computational performance and the scale up properties of these methods for a collection of test problems.

Adding Flexibility to the Vehicle Routing Problem with Backhauls

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The Vehicle Routing Problem with Backhauls is an extension to the vehicle routing problem, where some customers are receiving goods from a depot (called linehaul customers) and some customers are sending goods to the depot (called backhaul customers). Most research on this topic is sharply divided by a crucial assumption. Many researchers assume that backhauls can only be served only after all linehauls have been delivered. This is motivated by the fact that if a mixture of loads exist on a vehicle it may be difficult to access the load needed. Others prefer the flexibility of allowing linehauls and backhauls to be served in any order. This division in models is mirrored in differing solution methods. We propose a generalised model in which a mixture of linehauls and backhauls is permitted subject to there being left a certain amount of free space to facilitate manoeuvring of loads. Clearly this contains both of the above assumptions as special cases. We solve this model using reactive tabu search and draw conclusions regarding the trade-off between the amount of free space needed and solution quality.

Computer aided tool for optimizing public transport networks

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Public transport network planning is an extremely complex problem in which there are several criteria to be taken into consideration and to be evaluated in a complex way, therefore no "push-button-algorithm" is available for the planning work.

In practical planning interactive models are advised to be used which produce variants to be compared and evaluated by the planner.

This presentation introduces self-developed software for supporting public transport network planners in creating and evaluating network variants.

The input data cover the spatial structure of the planning area, the travel demand in O-D matrix form, the vehicle fleet available, cost and service level parameters.

Running the software evaluation lists and parameters are immediately generated and the impact of changes can be followed visually on the screen.

An Adaptative Memory Procedure using Tabu Search to the Team Orienteering Problem

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The Team Orienteering Problem (TOP) is a variant of the Vehicle Routing Problem. There is a set of customers and a profit is collected for the visit of each customer. A fleet of customers is available to visit them. Then, a set of routes are constructed such that the total collected reward received from visiting a subset of the customers is maximized. The length of each route is restricted by a limit specified a priori. This problem is the generalization to the case of multiple tours of the Orienteering Problem, know also as Selective Traveling Salesman Problem. We propose an adaptative memory procedure. At the beginning of the procedure a set of tours are generated in adaptative memory by a greedy randomized algorithm satisfying the give time limit Then, a feasible solution is generated doing a merge between tours randomly selected of the adaptative memory, such that the tours with greater reward have greater probability to be selected. After, a taboo search is executed to improve this feasible solution .This algorithm is repeated until the time pre-specified is expired. Computational experiments are made on standard instances proposed by Chao. The results are as good as the already approaches know in the literature.

Reaction-Pathway Identification: Models and Algorithms

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From modeling point of view reaction pathway identification is generating all of the elementary solutions of an inhomogeneous linear equation systems can be carried out by a variety of methods. Elementary solution is a minimal set of nonzero variables for which the equation system can be satisfied. The methods can be roughly grouped into two classes. Those in the first class are based on graph theory, and those in the second class on linear algebra. The present paper reviews the mathematical models as well as algorithms of both classes.

Reaction-pathway determination plays a key role in the study of chemical kinetics. It is essential for understanding the effects of external conditions on the rates of catalytic or metabolic (biochemical) reactions. Such understanding can serve as a basis for designing novel industrial chemical or biochemical processes. The determination of a reaction pathway or mechanism can be executed in two distinct phases. The first phase called Reaction Pathway Identification entails the identification of all feasible candidate pathways or mechanisms. The second phase involves discrimination among these feasible candidate pathways of mechanisms to determine the ultimate feasible pathway or mechanism.

On the Ray-based procedure for determining initial bound in branch and bound method

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In our talk we present an algorithm for determining initial bound for the Branch and Bound (B&B) method. The idea of the algorithm is based on the use of the "ray" introduced in the "ray-method" developed for solving integer programming problems [2], [3]. Instead of solving a common integer programming problem we use the main idea of the ray-method to find an integer feasible solution of integer linear programming (ILP) problem along the ray as close to optimal solution of relaxation problem, as possible. Objective value obtained in this way may be used as an initial bound for B&B method. The algorithm has been implemented in the frame of educational package WinGULF [1] for linear and linear-fractional programming and has been tested on various ILP problems. Computational experiments with the algorithm proposed show that such preprocessing procedure in many cases results an integer feasible solution very close to the solution of relaxation problem. Initial bound for branch and bound method determined in this way often can significantly decrease the size of the tree to be searched and in this manner can improve performance of the B&B method.

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Formulating and Solving Vehicle Routing Problems by the P-graph Framework

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The vehicle routing problem (VRP) is highly complex, thus, it needs computational decision support. The present work introduces an algorithmic method for synthesizing the optimal routes of vehicles for a particular type of VRP. The scope of the examined vehicle routing problem is the daily delivery of newspapers. The network has one source, some transshipment points, and hundreds of destinations. For delivering numerous trucks with different parameters (e.g., capacity, cost, CO₂ emission, speed) are to be considered.

The proposed set of combinatorial algorithms automatically generates the superstructure, the mathematical model, and optimal and near optimal distribution networks. Each practical aspects, e.g., cost, CO₂ emission, deadlines are represented in the mathematical model, and taken into account during the solution.

The proposed solution technique is based on the P-graph framework which is a graph theoretical approach for solving process network synthesis (PNS) problems. The P graphs are bipartite graphs, each comprising nodes for a set of materials, a set of operating units, and arcs linking them. The materials can be the raw materials, intermediates, and products. The operating units are defined in terms of input and output materials as well as their ratios. The aim of a

PNS problem is to produce the desired products using the available raw materials and operating units. Though the VRP and the PNS problems are quite different, it is shown how to formulate a vehicle routing problem by the P-graph framework.

Parameter learning algorithm for online data acknowledgement problem.

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In the communication of a computer network the information is sent by packets. If the communication channel is not completely safe then the arrival of the packets are acknowledged. In the data acknowledgment problem we try to determine the time of sending acknowledgments. One acknowledgment can acknowledge many packets but waiting for long time can cause the resending of the packets and that results the congestion of the network. On the other hand sending immediately an acknowledgement about the arrival of each packet would cause again the congestion of the network.

In the mathematical model the packets have arrival time, and at any time the algorithm has to make a decision about the acknowledgment of the arrived packets without any information about the further packets. A 2-competitive algorithm called Alarming is known for the solution of the problem.

Alarming is an element of a family of algorithms and its parameter is defined to minimize the competitive ratio. In this talk we present an extended version of the algorithm which learns the optimal parameter value during its execution. We also consider the lookahead version of the problem.

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Combinatorial Approach to the Optimal Design of Security Systems

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The wide-range and various means of threats require joint activity of different protecting mechanisms in security systems, preferably in an integrated manner. In the present paper a combinatorial approach based on the P-graph framework is proposed for modeling as well as optimizing the topologies of the security systems.

The P-graph methodology was originally introduced for process-network synthesis, where operating units produce output materials while consuming input materials and finally results in a set of desired products. In security systems information takes the role of materials, and the operations performed by software and hardware components evolve processed information from measured data, finally resulting in actuator signals.

The conventional P-graph algorithms namely MSG, SSG, and ABB are adapted to find the optimal structure of the security system to be designed, furthermore, a computer program was written which generates the optimal and alternative structures of a security systems. The multiobjective optimization involves determining either the cost optimal security system with predefined minimum levels of confidences for the output signals, or the topology of the security system where the confidence levels are maximized while the overall cost of the system is limited.

Keywords: Integrated Security System, P-graph methodology, Branch&Bound algorithm

Reduction of symmetric semidefinite programs using the regular $*$ -representation and canonical block diagonalization

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We consider semidefinite programming problems for which the data matrices lie in a C^* matrix algebra. We describe a general technique to reduce the size of such problems. The technique is based on a low order matrix $*$ -representation of the matrix $*$ -algebra that contains the data matrices. Further reduction, using canonical block diagonalization of the low order matrix $*$ -representation is presented. This sequence of reduction is useful when the dimension of the problem is too big to be directly handled by canonical block diagonalization. We exemplify by applying it to extend a method of de Klerk et al. that gives a semidefinite programming lower bound to the crossing number of complete bipartite graphs. In this case a permutation group is acting on the initial data matrix of the problem. The permutation matrices generate a matrix algebra. We can restrict optimization to the commutant (centralizer ring) of this algebra that has a low order matrix $*$ -representation (regular $*$ -representation) which can be further block diagonalized.

A quasi-Newton method using directions of negative curvature with symmetric rank one updates

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We propose a quasi-Newton method that uses the negative curvature information for solving unconstrained optimization problems. In this method, the symmetric rank one (SR1) rule is used for updating the Hessian approximation. The SR1 update rule is known to have good numerical performance, however it does not guarantee positive definiteness of the updated matrix. When negative curvature is detected, we use a descent direction that involves the negative curvature information, particularly, in line search. In a number of work in the literature, negative curvature directions have been efficiently used in line search for handling local nonconvexity, when the Hessian of the objective function is exactly computed. In this study, we work with an approximate Hessian matrix produced by the SR1 formula. We conduct numerical experiments and compare our results with those reported in the literature. Our computational study shows the potential of the proposed approach and supports our convergence results.

The worst-case ineffectiveness of geometric cuts cumulation in projection methods – an extension to the finite-dimensional case.

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We show that in sequential projection methods (for feasibility problems or nondifferentiable optimization), even a full cumulation of geometric cuts may, in the worst case, (almost) not accelerate the method.

Such a fact is well-known in the infinite-dimensional case (or at least when the number of iterates is lower than their dimensionality). The counterexamples in the l_2 space usually base on a sequence of iterates like $x^0 = (1, 0, 0, \dots)$, $x^1 = (1, 1, 0, 0, \dots)$, $x^2 = (1, 1, 1, 0, 0, \dots)$, $\dots$. Each iterate in this sequence satisfies each previously constructed geometric cut, and the sequence has zigzagging (i.e., $\|x^k - x^0\| / \sum_{i=1}^k \|x^i - x^{i-1}\|$) of $\sqrt{k}$. Due to this amount of zigzagging, making a step from x^1 to x^k is equally effective in approaching the solution as making k steps from x^i to x^{i+1} and gathering their effects with the Fejér contraction property. Thus, cumulating cuts in obtaining x^k was vain (ineffective).

We extend this counterexample to the finite, n -dimensional case with $k > n$ – constructing a suitable counterexample is nontrivial then (in particular, it is not possible just to take first n coordinates of that example). Our construction has a fractal nature. The obtained sequence of iterates has zigzagging close to the square root of the number of iterates and also each iterate satisfies all earlier cuts. We show the pessimistic consequences to the convergence speed.

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Numerical Optimization in Solid State Laser Pump Cavity Design

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Designing laser pump cavity is one of the challenging issues in physics. Homogenously pumping of lasing media (rod) has main effects in compensation of strains and stresses. One might make use of several elements such as fixed mirrors with different curvatures to overcome this problem. It seems that placing complex system of parabolic mirrors is a suitable tool. Places of these mirrors together with their cavity can vary and henceforth change the efficiency of the system. To Find better design of the mirrors (focal lengths and their distance from center of rod as unknowns) one can use optimization methods. Heuristics such as genetic algorithm has been used for this propose. These method might lead to a better design but not optimal. Here, we formulate the problem as a nonlinear constrained optimization model for a system with four front parabolic mirrors together with a rear mirror with a fixed focal length. The focal lengthes of the front mirrors and there places are unknown. Moreover the distance of light guide from the center of rod and its place are unknown too. In this way, there are ten unknowns. The objective function of the problem is minimizing the distance of the reflected light from the center of the rear mirror, while, keeping it close to the center of the rod. Solving this problem with numerical methods such as line search leads to a local minima.

Keywords: Laser Design, Solid State Laser, Nonlinear Optimization, Numerical Optimization.

Computational Study of the Dual Simplex Method

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The excellent performance of the dual simplex method is a relatively new recognition in the optimization community. However, little effort has been made to explain it. In this talk we go into this direction and present interesting findings of the internal operation of advanced dual phase-1 and a phase-2 algorithms that can help understand the performance edge of the dual method.

Tolerance analysis in linear programming

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We consider a linear programming problem and suppose that we have an optimal solution. In practice it is often important to know how different optimality criteria (optimal solution, optimal basis, optimal partition, etc.) changes when we perturb the input data. Our aim is to compute tolerances (intervals) for the objective function and right-hand side coefficients such that these coefficients can independently and simultaneously vary inside their tolerances while preserving the optimality criterion. We put the tolerance analysis in a unified framework that is convenient for algorithmic processing. We survey the known results (pioneered by R. E. Wendell) and propose an improvement that is optimal in some sense (the resulting tolerances are maximal and they take into account proportionality). We apply our approach to several sensitivity invariances: optimal basis, support set and optimal partition invariance. Thus the approach is convenient not only for simplex method solvers, but also for the interior points methods. We also discuss time complexity, particularly for the degenerate case.

SOHS decomposition of non-commutative polynomial: find it by NCsostools

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The set (free algebra) of *non-commutative* (NC) polynomials in variables $\bar{x} = (x_1, x_2, \dots, x_n)$ is denoted by $\mathbb{R}\langle\bar{x}\rangle$ and consists of linear combinations of all finite words with letters $x_1, \dots, x_n$. We endow $\mathbb{R}\langle\bar{x}\rangle$ with the involution $*$ which reverses the order of the letters in any word, i.e. it holds $(p+q)^* = p^* + q^*$ and $(pq)^* = q^*p^*$. We assume $x_i^* = x_i$.

Thus $\mathbb{R}\langle\bar{x}\rangle$ is the $*$ -algebra freely generated by n symmetric elements. A polynomial of the form g^*g is called a *hermitian square*. The set of all sums of hermitian squares will be denoted by Σ^2 . Note: $\Sigma^2 \subsetneq \mathbb{R}\langle\bar{x}\rangle$.

The decision problem whether given NC polynomial is a sum of Hermitian squares (SOHS) can be solved efficiently by semidefinite programming. Helton proved in 2002 that a given non-commutative polynomial $f(X, Y)$ has SOHS decomposition if and only if f yields a positive semidefinite matrix, after we replace X and Y by any pair of symmetric matrices of the same size. This can be used to tackle the BMV conjecture from 1975, to compute lower bounds for NC polynomials, to analyze the convexity of NC polynomials etc.

We present an algorithm based on semidefinite programming to obtain SOHS decomposition, to compute SOHS lower bounds and to detect whether given NC polynomial is convex. We also announce a Matlab package NCsostools, where we implemented these algorithms.

Global Optimization with Expensive Model Functions: A Comparative Computational Study

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In industrial practice, one frequently has to solve global optimization (GO) problems with expensive (time consuming) model function evaluations. To give an example, the evaluation of an objective function, based on the numerical solution of a partial differential equation, or on a computational simulation procedure, it could take several hours. Therefore we may not have the opportunity of conducting a thorough GO procedure. To illustrate this point, we may not be able to afford more than a few hundred objective function evaluations, as opposed to perhaps millions of evaluations, when optimizing (say) 10 key variables in an automotive design problem.

Since this situation is markedly different from the underlying ideas that drive the construction of a typical "exhaustive" global optimization procedure (and code), we need a well established benchmark of existing codes on a suitable set of practically motivated, resource-limited tests. Here we propose a set of suitable test problems, collected from academic studies and from industrial practice. Next, we test different optimization methods (both research and commercial codes, including genetic, evolutionary, swarm, global and local optimization methods) tailored to our situation. Illustrative computational results are reported and used in our comparative study.

An interval global optimization algorithm for INTLAB

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This talk considers an algorithm for the bound constrained global optimization problem implemented in Matlab. It is based on the methods investigated in the past ([1] and [3]), which were first developed from the global optimization algorithm of the Numerical Toolbox [2]. The algorithm uses interval arithmetic operations and automatic differentiation offered by the INTLAB [5] package.

Our algorithm is based on the branch-and-bound procedure using the most common accelerating devices: the cutoff test, the concavity test, the monotonicity test, and the interval Newton step. We use also multisection and advanced subdivision direction selection combining with the sophisticated pf^* subinterval selection criteria.

We have completed a numerical test, and compared the efficiency and the results of the INTLAB implementation to that of a C-XSC procedure.

Summarizing our numerical results [4], we can conclude that the new implementation is as efficient as the old one, with the exception of the CPU time. In spite of the lower speed, the new method is easy to use, and suitable for finding verified solutions of bound constrained global optimization problems.

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Promising GAHC and HC12 algorithms in global optimization tasks

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There are different types of optimization problems for which we can usually use several solution methods. High nonlinearity and multimodality of the objective function are typical for many real engineering problems. For that reasons optimization process by means of classical optimization methods is made difficult or impossible. Various Monte Carlo approaches or heuristic procedures can be used in these cases. They solve for example choice of the initial solution (first iteration) that is very often critical for successful solution. But not only mathematicians solve optimization problems. Optimization problems are solved by nature herself from her origin.

This paper deals with new stochastic heuristic searching algorithm that is inspired by fundamental biological principles of survival. It presents very promising version of commonly known genetic algorithm denoted as GAHC and algorithm denoted as HC12. Global optimization properties of these algorithms are illustrated with several engineering problems. These problems are also solved by sophisticated solvers in GAMS to increase objectivity and to compare different methods. Presented optimization algorithms are implemented in our own optimization toolbox GATE in Matlab.

Nonrepetitive Graph Coloring

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A vertex coloring of a graph is *nonrepetitive on paths* if there is no path $v_1, v_2, \dots, v_{2t}$ such that v_i and v_{t+i} receive the same color for all $i = 1, 2, \dots, t$. A. Thue showed in 1906 that any path has such a coloring using three colors only. N. Alon et al. generalised the nonrepetitive concept to graphs in 2002. Their work has created great interest among graph theorists and resulted several dozens of articles. We will survey some of these ideas and open problems. Among other things, we proved that every graph has a subdivision that admits a 4-coloring that is nonrepetitive on paths. We also study colorings that are nonrepetitive on walks, and provide a conjecture that would imply that every graph with maximum degree Δ has an $f(\Delta)$ -coloring that is nonrepetitive on walks. The corresponding theorem for path-nonrepetitive coloring was proved by Alon et al. One of the main open problems of the area seeks such an upper bound for the class of planar graphs. If time permits we will mention the algorithmic difficulties of nonrepetitive colorings.

The Frobenius-Kőnig theorem, its generalizations, and precoloring extension

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Almost a century ago the Frobenius-Kőnig theorem started a constructive theory of matchings, maximum flows, schedulings, and graph colorings. The main objective of the talk is to show some results of the two-decade-old precoloring extension theory. The focus is put on applying algorithmic network flow methods. Some implicit enumeration techniques will also be studied. A few practical applications and very recent theoretical results are also to be shown. In addition, well-characterizations and new classes of perfect graphs will be studied as well as some open questions.

Optimization problems on hypergraph classes

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In the last fifteen years, new models of hypergraph coloring have been introduced, including mixed, color-bounded, and stably bounded hypergraphs and some further classes. In the first one, which gave a strong motivation also for the others, the "D-edges" have to contain two vertices with distinct colors (as usual in classical hypergraph coloring), while the "C-edges" have to contain two vertices with a common color. These two types of constraints lead to unexpected phenomena. The new structure classes are especially important in applications, e.g. in modeling resource allocation problems.

The new models raise new kinds of optimization problems, too. Some questions admit a formulation in terms of linear or integer programming. An interesting related invariant is the maximum number of colors that can occur in a coloring, called the upper chromatic number. Comparing it with another maximization parameter, the C-stability number, we arrive at the concept of C-perfectness. This direction may be viewed as a partial analogue of the theory of perfect graphs. Algorithmically, the class of C-perfect hypergraphs is provably more complex than the class of perfect graphs, but still there can be designed polynomial-time algorithms for several kinds of problems on some important subclasses.

Sub-Division Number and Optimization

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For a given graph $G = (V; E)$, a set $S \subseteq V$ of vertices is called a dominating set if every vertex $v \in V$ is either an element of S or is adjacent to an element of S . The domination number $\gamma(G)$ of a graph G equals the minimum cardinality of a dominating set in G characterized the trees achieving this upper bound. A subdivision of an edge $(i; j)$ is obtained by removing edge $(i; j)$, adding a new vertex $\overline{ij}$, and adding edges $(i; \overline{ij})$ and $(\overline{ij}; j)$. In this way, the number of vertices increase as well as the number of edges. This increment in the size and order of a graph may change its domination number. In sub-division domination problem in a graph, one aims to find the minimum number of edges to be divided such that domination number increases at least by one. Here, we present a binary integer programming problem that enables us to identify this value. The Linear relaxation of this problem leads to reasonable bounds to this number.

Key words and phrases. Sub-Division, Relaxation, Domination Number, Integer Programming.

Optimizing biomass delivery system layout in the NUTS 4 region of Sellye, Hungary

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The issue of plant location is a critical one for all biomass delivery systems. This is even more so for biogas fermentors. Low energy content in liquid and straw manure makes the transport of these raw materials the least economical of all biomass types.

A real-life scenario is examined in detail: the NUTS 4 region of Sellye is located at the Croatian border. 8 pig farms are located within the region. With different capacity, locational characteristics and infrastructural background, a complete system design for biogas energy production needs to be based on an optimized layout with all of the cost and income parameters precisely taken into account. For this purpose a MILP model was built to place the seven core-functions of a biomass delivery systems in an optimal layout based on the complex goal structure with a set level of input (biomass) and output (energy consumption). Computational results are discussed with the optimal layout analyzed in detail.

Optimisation and Simulation Techniques in the Field of Manufacturing Processes

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The computer aided planning and manufacturing has an increasing role in order to handle manufacturing processes. Nowadays a product's life cycle involves, in addition to computer aided design and manufacturing, process and material flow simulation in production control, too. This paper aims to describe the structure of the production model and the simulation process. The simulation model must be able to provide a framework for optimisation of the production sequence of the different parts in the production process, which results in a large search space. The authors give a possible way to solve this heavy problem by using genetic algorithms. It will be presented how to set the right parameters for the optimisation algorithm. Moreover, we investigate what other methods can be able to bring such earnings.

Improved bounds for scheduling two uniform machines with known sum of the jobs

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We consider semi on-line scheduling on two uniform processors. The speed of the slow processor is normalized to 1 while the speed of the fast processor is supposed to be $s \geq 1$. Jobs of size $J_1, J_2, \dots$ arrive one at a time, and each J_i ($i \geq 1$) has to be assigned to one of the processors before J_{i+1} arrives. The assignment cannot be changed later. The only information known in advance is the total size $\sum_{i \geq 1} J_i$ of the jobs. The processing time of the i th job is J_i on the slow processor and J_i/s on the fast one. The objective is to minimize the makespan.

We introduce some new classes of algorithms, which improve the previously known estimates on the best possible competitive ratio of semi on-line algorithms compared to the off-line optimum. For several ranges of the speed s , our bounds are tight.

Minimize overtime in a parallel machine environment

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We address a resource levelling problem in a parallel machine environment. Given a set of m parallel machines, one renewable resource, and a set of n tasks each dedicated to exactly one of the parallel machines. Each task has a processing time, an earliest start time, a deadline, and a resource requirement. The resource has a finite capacity, but it can be used above this capacity which is the overtime usage of the resource. A schedule with minimum cumulative overtime resource usage is sought.

There are a number of algorithms for the resource levelling problems in project scheduling (see e.g. [2, 3]), but those only work for small instances. However in machine scheduling, resources are generally considered as constraints ([1]).

We propose an exact Branch-and-Bound algorithm to solve this problem. In order to calculate the lower bound in each node of the search tree we have applied Lagrangian relaxation for the preemptive relaxation of the problem, while the upper bound is determined heuristically. This relaxation allows the decomposition of the problem to smaller independent problems which can be solved parallelly. We have tested the parallel implementation of the algorithm on generated test instances and the results show that within reasonable time the optimality gap can be reduced to less than 4% in average.

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Scheduling multiprocessor UET tasks of two sizes

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In this talk we present algorithmic and combinatorial results on task scheduling problems on m identical parallel processors, where each task has unit execution time, and needs either a single processor, or q processors concurrently, and it has a release date and a due date. Under the assumption that the release dates and due dates of the q -processor tasks are agreeable, we describe a polynomial time algorithm for minimising the number of tardy tasks. In addition, we apply this result for minimising the maximum lateness, and the maximum tardiness. While we are not aware of any results for the former problem, the latter generalizes those of Baptiste and Schieber [1] who described a polynomial time algorithm for minimizing the maximum tardiness of UET tasks when each task requires either a single processor, or all the m processors concurrently. We also discuss the combinatorial background of the polynomial time solvability of all these problems under the 'agreeable' assumption. The main tool in deriving our results are from matching theory.

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A new Hybrid Genetic and Simulated Annealing Algorithm to solve Traveling Salesman Problem

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This paper proposes a new hybrid Genetic Algorithm(GA) and Simulated Annealing(SA) to solve the TSP. A new technique is applied to control the number of trails for each algorithm according to its performance, in order to reduce time consumption. Also multi local search crossover operations and multi mutation operations are used for GA, to have better chance of success. New operation is applied to all tours in the population; this operation is to rearrange the two cities that have the longest distance. The proposed algorithm starts with random population, where this population will be the input of the GA, until no further reduction is possible and then the memorized population which proved the best result will be transferred to the SA. The SA processes will be used to improve the results by using local search technique and if no good results are achieved, then the best memorized population will be moved to the GA and so on. until termination condition met. The algorithm was tested using benchmark data sets for symmetric TSP from TSPLIB, the results indicate that the algorithm provided good results within reasonable time.

A harmony search metaheuristic for the resource-constrained project scheduling problem with discounted cash flows

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This paper presents a harmony search metaheuristic for the resource-constrained project scheduling problem with discounted cash flows. In the proposed approach, a resource-constrained project is characterized by its "best" schedule, where best means a resource constrained schedule for which the net present value (NPV) measure is maximal. Theoretically the optimal schedule searching process is formulated as a mixed integer linear programming (MILP) problem, which can be solved for small-scale projects in reasonable time. The applied metaheuristic is based on the "conflict repairing" version of the "Sounds of Silence" harmony search metaheuristic developed by Csébfalvi (2007) for the resource-constrained project scheduling problem (RCPSp). Although the secondary performance measure - the Net Present Value - is an irregular performance measure, according to the conflict repairing nature of the algorithm, the evaluation of the NPV will be usually a simple task. In order to illustrate the essence and viability of the proposed harmony search metaheuristic, we present computational results for a J30 subset from the well-known and popular PSPLIB. To generate the exact solutions a "state of the art" MILP solver (CPLEX) was used.

Optimizing Information Retrieval Process with Evolutionary Algorithms

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Information retrieval focuses on searching through large databases of unstructural information and finding documents relevant to user queries. Queries are usually imprecise and often do not reflect real user intentions, so in order to return to users appropriate information, some approaches try to detect hidden intentions by analyzing user feedbacks and then to tune information retrieval parameters.

In the model under the scrutiny, the information database stores descriptions of documents, such as blog entries, news headline or on-line articles. Each description consists of some meta parameters, such as authors, languages, publication times and categorizations or evaluations by special external systems, as well as some content parameters, such as significances of some selected terms to the document. Each description component has an importance factor, characteristic to each query independently, that the information retrieval algorithm uses to adapt the result documents to the particular user intentions.

Adapting information retrieval to hidden intentions leads to an optimization problem of discovering importance factors that maximize an objective function measuring matching the result documents with the user intentions, given by evaluations in user feedbacks. Bottlenecks of the optimization problem includes the very large search space, irregularity of the objective function and varying with time the information database as well as the user evaluations.

In order to solve the optimization problem, we propose a few evolutionary algorithms: Simple ones are based on classic Evolution Strategies, which try to find the optimum of the objective function on the search space by maintaining a population of candidate solutions representing data points in the search space and moving it towards more and more promising regions using some evolutionary operators. Advanced ones are based on Estimation of Distribution Algorithms, which try to estimate the probability distribution describing optimal solutions, where the population of candidate solutions is a data sample with a probability distribution approximating

the probability distribution which describes optimal solutions. Using Estimation of Distribution Algorithms with multi-dimensional probability distributions, modeled for instance by Bayesian Networks, enables also to detect dependencies between particular importance factors.

Maximum l^p -separation arrangements

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There are a lot of generalizations of the densest packing of equal circles in a square problem [3]. One of the possible ways is to study the equivalent maximum point-separation arrangements in different l^p -norms. We consider the following problem:

$$\max_{x_i \in [0,1]^2, 1 \leq i \leq n} \min_{1 \leq i < j \leq n} \|\underline{x}_i - \underline{x}_j\|_p,$$

i.e. the maximal separations of n points in a unit square in l^p -norm. The problem is solved for $p = \infty$ for each n in a d -dimensional unit cube, and there are many results and conjectures for $p = 1$ too [1,2].

In our work we investigated the maximum l^p -separation arrangements for different $1 < p < \infty$ based on theoretical way for small n , and using computer optimization tools for the higher values.

Our results show that how is changing the structure of the point arrangements for a given number of points in different l^p -norms.

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Investigation of simplicial branch and bound algorithms for multidimensional Lipschitz optimization

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Most methods for solving multivariate unconstrained Lipschitz optimization problems of dimension greater than two use rectangular or simplicial branch and bound techniques. In this work simplicial branch and bound algorithms with Lipschitz bounds are reviewed and investigated experimentally.

Bounds are very important for the performance of algorithms. Computationally cheap but rather crude lower bounds are often used. One of the possible improvements is combination of bounds based on different (first, Euclidean and infinity) norms. Improved Lipschitz bounds may be used. For example, in the case of the first norm the graph of bounding function is intersection of n -dimensional pyramids and its maximum point is found solving a system of linear equations. The improved bounds may be included in the combination as well.

Influence of the selection strategies (best first, depth first, breadth first) to the performance of simplicial branch and bound is investigated as well.

Optimization of multidimensional Lipschitz optimization problems requires considerable computing time and memory resources. Therefore parallel (MPI and OpenMP) versions of simplicial branch and bound algorithms for Lipschitz optimization have been developed and investigated.

On simplicial partition

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Advantages of simplicial partition in global optimization are shown. Simplicial partition is preferable in covering algorithms for global optimization when the values of an objective function at the vertices of a sub-region are used to evaluate it. This is demonstrated for branch and bound algorithms based on Lipschitz bounds.

Simplicial partition of the feasible region is essential for the construction of the multidimensional statistical model of multimodal functions constructed generalizing computationally favorable properties of the popular one-dimensional model - Wiener process.

Simplicial partition may be used to cover feasible region defined by linear inequality constraints satisfying them by the initial covering. This can also be exploited to reduce the search space of optimization problems with symmetric objective functions. This is demonstrated on engineering problem of optimal pile placement in grillage-type foundations.

Simplicial partition is used in other fields of computational science as well. One of interesting applications is algorithmic copositivity detection by simplicial partition. Known aspects of branch and bound algorithms may be used to improve properties of the algorithm for copositivity detection.

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