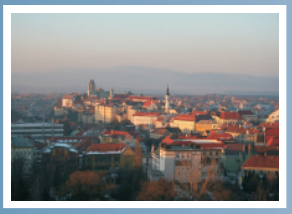

VOCAL2006

PROGRAM and ABSTRACTS

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Contents

VOCAL 2006

The Veszprém Optimization Conference: Advanced Algorithms will be held at the Regional Centre of the Hungarian Academy of Sciences in Veszprém (VEAB), Hungary, December 13-15, 2006. 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.

Invited Speakers

Lorenz T. Biegler

Lorenz T. (Larry) Biegler is currently the Bayer Professor of Chemical Engineering at Carnegie Mellon University, which he joined after receiving his PhD from the University of Wisconsin in 1981. His research interests are in the areas of computer aided process analysis and design and include flowsheet optimization, optimization of systems of differential and algebraic equations, reactor network synthesis and algorithms for constrained, nonlinear process control. Prof. Biegler has been a visiting scholar at Northwestern University, a scientist-in-residence at Argonne National Lab, a Distinguished Faculty Visitor at the University of Alberta, a Gambrinus Fellow at the University of Dortmund and a Fulbright Fellow at the University of Heidelberg. He has authored or co-authored over 200 archival publications, authored or edited seven books and presented numerous papers at national and international conferences.

He is the recipient of numerous awards including the AIChE McAfee Award (Pittsburgh Section), the AIChE Computers in Chemical Engineering Award, the ASEE Curtis McGraw Research Award and the Presidential Young Investigator Award from the National Science Foundation. He is a Fellow of the American Institute of Chemical Engineers and a member of SIAM, ACS and Sigma Xi. In addition, Professor Biegler has been an active consultant on process design and optimization strategies for the chemical and process industry.

Hans Georg Bock

Hans Georg Bock (Germany) is professor of Scientific Computing and head of the Interdisciplinary Center for Scientific Computing at the University of Heidelberg in Germany. He received a PhD in Applied Mathematics from the University of Bonn in 1986 and an honorary PhD from the Institute of Mathematics of Vietnam Academy of Science and Technology in 2000. He was visiting professor at Heidelberg (1987-1988) and full professor at the Universities of Augsburg (1988-1991) and Heidelberg (1991 to present). His recent research interests include direct optimization methods for the real-time computation of constrained closed-loop control, on-line state and parameter estimation, and non-standard optimization and optimal control problems such as stability optimization of gait patterns and control problems in optimum experiment design. Application areas are mostly in mechanical, chemical and process engineering and are changing towards systems biology. He is also interested in the development of computational methods for the preservation of cultural heritage and involves himself in temple conservation projects in the Angkor region in Cambodia. He is the author of over 120 scientific publications, co-editor of two book series and three scientific journals. He is member of the Scientific Advisory Boards of the Research Network "Modeling and Simulation" at the University of Dortmund and the "Center of Multiscale Biomolecular Modeling, Bioinformatics and Applications" at the University of Warsaw. He is chairman of the International PhD Research Programme "Complex Processes: Modeling, Simulation and Optimization" at Heidelberg and Warsaw and chairman of the University Senate's Committee for Development of Computer Science and Computational Science.

J. Frederic Bonnans

Joseph Frédéric Bonnans is a Senior Research Scientist at INRIA, the French National Institute for Computer Science and Automatic Control, and Associate Professor at the Ecole Polytechnique, Palaiseau, France. He is also Corresponding Editor of ESAIM:COCV, and member of the Council at Large of the Mathematical Programming Society.

His research interest are deterministic and stochastic optimal control problems, and their applications in engineering, especially aerospace trajectories and energy storage and production.

Dorit S. Hochbaum

Dorit S. Hochbaum is a full professor at UC Berkeley. She is a professor of Business Administration and of Industrial Engineering and Operations Research (IEOR). Professor Hochbaum holds a Ph.D from the Wharton school of Business at the University of Pennsylvania. Prior to joining UC Berkeley in 1981, Profeesor Hochbaum held a faculty position at Carnegie Mellon university's GSIA. Her research interests are in areas of approximation algorithms, supply chain management, efficient utilization of resources, design and analysis of computer algorithms and discrete and continuous optimization. Her recent applications work is on problems related to customer segmentation, prediction, ranking, group decision making and data mining. Recent theoretical work focuses on efficient techniques for network flow related problems and inverse problems, with applications varying from medical prognosis, error correction, financial risk assessment and prediction.

Professor Hochbaum served as the chair of the Manufacturing and Information Technology group at the Haas School of Business. She is the founder and director of the UC Berkeley Supply Chain Initiative. She is the founder and co-director of the RIOT project.

Professor Hochbaum is the author of over 100 papers that appeared in the Operations Research, Management Science and Theoretical Computer Science literature. She serves as department editor for Management Science department of Optimization and Modelling and on the editorial board of Networks and on the advisory board of Algorithms and Operations Research.

Professor Hochbaum was named in 2004 an honorary doctorate of Sciences of the University of Copenhagen, for her work on approximation algorithms. The title was conferred, at an annual event at

the University, in the presence of the Queen of Denmark. Professor Hochbaum was recently awarded the title of INFORMS fellow.

Etienne de Klerk

Etienne de Klerk obtained his Master of Science degree in Applied Mechanics from the University of Pretoria in South Africa, and a PhD degree from the Department of Statistics, Stochastics, and Operations Research of the Delft University of Technology in The Netherlands. The title of his PhD thesis was /Interior Point Algorithms for Semidefinite Programming/ (December 1997).

Form January 1998 to September 2003, he held assistant professorships at the Delft University of Technology, first in the Department of Statistics, Stochastics, and Operations Research, and later in the Department of Information Systems and Algorithms.

From September 2003 to September 2005 he held an associate professorship at the University of Waterloo, Canada, in the Department of Combinatorics and Optimization. From September 1st 2004 to the present time he has been employed as an associate professor at Tilburg University, The Netherlands, in the Department of Econometrics and Operations Research.

Dr. De Klerk's research interests include mathematical optimization and approximation algorithms for intractable problems, and his publications includes the monograph /Aspects of Semidefinite Programming /(Kluwer Academic Publishers, 2002). He is currently an associate editor of the /SIAM Journal on Optimization/ as well as the /INFORMS Journal Operations Research/.

He is a co-recipient of the Canadian Foundation for Innovation's New Opportunities Fund award, and a recipient of the VIDI award of the Dutch Organization for Scientific Research (NWO).

Yurii E. Nesterov

Yurii Nesterov Born: 1956, Moscow Master degree: 1977, Moscow State University, Faculty of Computational Mathematics and Cybernetics. Doctor degree: 1984, Institute of Control Sciences, Acad. Sci. USSR, Moscow. Professional experience: 1977 - 1992: different research positions at Central Economical and Mathematical Institute, Acad. Sci. USSR, Moscow. 1993 - present: professor at Center for Operations Research and Econometrics (CORE), Catholic University of Louvain (UCL), Louvain-la-Neuve, Belgium.

Author of 4 monographs and more than 70 refereed papers in the leading optimization journals. Winner of the triennial Dantzig Prize 2000 awarded by SIAM and Mathematical Programming Society for a research having a major impact on the field of mathematical programming.

András Prékopa

András Prékopa graduated from the University of Debrecen in 1952 and received Ph.D. from the L. Eötvös University (EU) of Budapest in 1960. His supervisor was Prof. Alfréd Rényi. After graduation he spent four years at the Institute for Applied Mathematics (IAM) of the H.A.S., served as assistant and later associate professor at EU, until 1968. Between 1968 and 1983 he was professor of mathematics at the Technical University of Budapest. In 1983 he returned to EU, founded the Department of O.R. and became its first chairman. Since 1985 he has been professor of O.R. and statistics at Rutgers University. In 1993 he founded the O.R. and Applied Mathematics Doctoral Program at EU and has been its chairman until now. In 1959 he founded, in part time employment, the first O.R. research group in Hungary at IAM. In 1970 it became part of the Computing Center and later on, in an enlarged form, of the Computing and Automation Institute of the H.A.S. His first papers are about the theory of stochastic set functions of which he is one of the founders. His main field is optimization of stochastic systems. He is one of the founders of stochastic programming. He also developed multivariate logconcavity theory that has many applications not only in stochastic programming but also in statistics, economics and various fields of mathematics and the theory of discrete moment problems, used to obtain sharp bounds for probabilities and expectations. He carried out applications of O.R. methodology in economics, power, water resources, production systems and biology. He is the author and editor of more than ten books, published more than 200 papers and 120 research reports and lecture notes. Until now he has supervised 50 defended theses. His most important distinctions are the Széchenyi prize from the Hungarian Government (1996), the EURO

Gold Medal (2003) and the Middle Cross Medal from the president of the Republic of Hungary (2005).

Annick Sartenaer

She got her Ph.D. in 1991, at the University of Namur, Belgium, under the direction of Professor Philippe Toint, and her "Habilitation a Diriger des Recherches" in 1999, at the University Paul Sabatier, Toulouse, France, under the direction of Professor Jean-Baptiste Hiriart-Urruty.

Before becoming Professor in the Mathematic Department of the University of Namur in 2002, she was Research Associate of the "Fond National de la Recherche Scientifique" in Belgium (from 1999 to 2002) and Senior Researcher at CERFACS (European Center for Research and Advanced Training in Scientific Computation) in France (from 1997 to 1999).

During her several years of post doc, she spent time at INRIA Rocquencourt (Paris, France), at Northwestern University (Chicago, USA) and at the University of Trier (Germany), as well as at the University of Waterloo (Canada) during her Ph.D.

She works in the field of nonlinear nonconvex continuous optimization, with a special emphasis on large-scale problems.

Technical Program

December 12, 2006 (Tuesday)

6:00 pm – 8:00 pm **Registration Office Open**

December 13, 2006 (Wednesday)

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

7:00 am – 8:15 am **Registration**

8:15 am – 9:00 am **Opening and Introduction**

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

Operations Research in Hungary: History and State of the Art
András Prékopa

10:00 am – 10:30 am **Coffee break**

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

Handling special constraints in stochastic programming models
Csaba I. Fabian

Pairwise comparison matrices with missing elements
Sándor Bozóki

Recent advances in numerical calculation of multivariate normal probabilities.
Tamás Szántai

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

Improvements on the GLOBAL Optimization Algorithm with Numerical Tests
László Pál, Tibor Csendes, Oscar H. Sendin, Julio R. Banga

Towards solving Copositive Programs
Mirjam Duer, Stefan Bundfuss

Generalized Modified Genetic Algorithm for Functional Constrained Optimization Problems
Jafar Roshanian, Mohammad Yadollahi, Jahangir Jodei

12:00 pm – 1:30 pm **Lunch**

1:30 pm – 3:00 pm **Parallel Session 2A**

Exploiting Structure for Computational Efficiency in Large Scale LP
István Maros

Parallel implementation of an interior point method for large-scale LP
Csaba Mészáros

Cubically convergent methods are no more expensive (almost) than Newton's method
Geir Gundersen, Trond Steihaug

1:30 pm – 3:00 pm **Parallel Session 2B**

Optimization methods modeled by differential equation of second order
Tamás Hajba

Solving Partial Differential Equations with Mixed-Integer Programming Methods
Armin Fügenschuh, Michael Herty, Simone Göttlich

Comparison of computational methods for shape optimization
Zoltán Horváth

3:00 pm – 3:30 pm **Coffee break**

3:30 pm – 4:30 pm **Parallel Session 3A**

Exact duality for homogeneous cone optimization and its complexity implications
Imre Pólik, Tamás Terlaky

Group symmetry in semidefinite programs
Igor Dukanovic, Janez Povh

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

Mean-Risk Models Using Two Risk Measures: A Multi-Objective Approach
Gautam Mitra, Ken Darby-Dowman, Diana Roman

Multiobjective optimiztion for two-dimensional cutting stock problems.
Csaba Fabian

4:30 pm – 4:45 pm **Short break**

4:45 pm – 5:45 pm **Plenary Session 2**

Efficient Methods for Parameter Estimation and Optimum Experimental Design for Dynamic Processes
Hans Georg Bock

6:00 pm – **Organ concert in the St. Michael's Cathedral**

December 14, 2006 (Thursday)

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

8:30 am – 9:30 am **Plenary Session 3**

Optimization models and methodologies for group decision making, rank aggregation, clustering and data mining
Dorit S. Hochbaum

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

Interior-point algorithms for optimal control problems
J. Frederic Bonnans

10:30 am – 11:00 am **Coffee break**

11:00 am – 12:30 am **Parallel Session 4A**

Anstreicher-Terlaky type monotonic simplex algorithms for linear feasibility problems
Zsolt Csizmadia, Filiz Bilen, Tibor Illés

On the empirical behavior of a new network exterior point simplex algorithm for the minimum cost network flow problem.
Konstantinos Paparrizos, Nikolaos Samaras, Angelo Sifaleras

Interior point algorithms for general linear complementarity problems
Marianna Nagy, Tibor Illés, Tamás Terlaky

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

Optimizing multiple aspects of biomass delivery system layout
Ferenc Brachmann

Using S-graph for Throughput Maximization in Multipurpose Batch Plants

Tibor Holczinger, Thokozani Majozi, Mate Hegyhati, Ferenc Friedler

Optimization Problems and Algorithms in Supply-Chain Management
Botond Bertók, Róbert Adonyi, Sándor Bodrogi, Zoltán Kovács

11:00 am – 12:30 am **Parallel Session 4C**

A new reduction technique for PNS problems
Csaba Holló, Balázs Imreh, Csanád Imreh

Solution of Time-Delay Systems by Hybrid Functions
Mohsen Razzaghi

12:30 am – 2:00 pm **Lunch**

2:00 pm – 3:30 pm **Parallel Session 5A**

On the Lovász ϑ-number of 'almost regular' graphs
Renata Sotirov, Etienne De Klerk, Michael Newman, Dimitrii Pasechnik

Polytopes and Arrangements: Diameter and Curvature
Antoine Deza, Tamás Terlaky, Yuriy Zinchenko

Exhaustively Generating Basis Solutions for a System of Stoichiometrically Balanced Elementary Reactions by Resorting to the P-graph-based Method
Botond Bertók, Károly Kalauz, L. T. Fan

2:00 pm – 3:30 pm **Parallel Session 5B**

Monte-Carlo Optimization of Reliability
Zoltán Kovács

Optimization of the Average Waiting Time with Respect to the Express Line's Control Parameter at the Cash Desks of a Superstore
Tamás Koltai, Noémi Kalló

An Overview of Continuous Approximation: Theory and Applications
Abdullah Dasci

2:00 pm – 3:30 pm **Parallel Session 5C**

A new multi-augmenting algorithm for the assignment problem
Eesuk Chung, Jayoung Kang, Sungsoo Park

A novel pinch targeting method and MILP model for

steam system design
Sternberg Coetzee, Thokozani Majozi

Discrete event simulation: A case study
Megdouda Tari-Ourbih

3:30 pm – 4:00 pm **Coffee break**

4:00 pm – 5:00 pm **Plenary Session 5**

A Comparative Study of Kernel Functions for Primal-Dual Interior-Point Algorithms in Semidefinite Optimization
El Ghami Mohamed, Y.q Bai Yanqin, Roos C

5:00 pm – 6:00 pm **Plenary Session 6**

Advanced Nonlinear Programming Algorithms for Process Engineering Models
Lorenz T. Biegler

6:30 pm – **Banquet in Hotel Villa Medici**

December 15, 2006 (Friday)

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

8:30 am – 9:30 am **Plenary Session 7**

Recursive Trust-Region Methods for Multiscale Nonlinear Optimization
Annick Sartenaer, Serge Gratton, Philippe Toint

9:30 am – 10:00 am **Plenary Session 8**

Some new results in derivative free optimization
Andrew Conn

10:00 am – 10:30 am **Coffee break**

10:30 am – 12:00 am **Parallel Session 6A**

Online bin covering with cardinality constraints
Csanád Imreh

Two uniform processors: Competitive ratio of semi online scheduling
Enrico Angelelli, Maria Grazia Speranza, József Szoldatics, Zsolt Tuza

Polynomial Time Algorithms for Stochastic Uncapacitated Lot-Sizing Problems
Andrew Miller, Yongpei Guan

10:30 am – 12:00 am **Parallel Session 6B**

Engine Assignment Problem: General Case
Tibor Illés, Márton Makai, Zsuzsanna Vaik

Model Reduction-based Optimization for Large-Scale and Multi-Scale Systems
Constantinos Theodoropoulos, Eduardo Luna-Ortiz

Elimination of intermediate storage via the exploitation of latent storage capacity
Thomas Pattinson, Thokozani Majozi

10:30 am – 12:00 am **Parallel Session 6C**

Generalized Jacobian in Infinite Dimensional Spaces
Zsolt Páles, Vera Zeidan

The Single Facility Location Problem in Two Regions with Different Norms
Hossein Taghizadeh Kakhki, Mehdi Zafaranieh, Jack Brimberg, George Wesolowsky

New Method to Determine the Globally Optimal Solution of Separation Network Synthesis Problems with NLP Model
Zoltán Kovács, Zsolt Ercsey, Ferenc Friedler, L. T. Fan

12:00 am – 1:30 pm **Lunch**

1:30 pm – 2:30 pm **Plenary Session 9**

Optimization of univariate functions on bounded intervals by interpolation and semidefinite programming
Etienne De Klerk, Gamal Elabwabi, Dick Den Hertog

2:30 pm – 3:30 pm **Plenary Session 10**

Second-order methods with provable global complexity
Yurii E. Nesterov

3:30 pm – **Closing**

Abstracts

Operations Research in Hungary: History and State of the Art

András Prékopa
Rutgers University and L. Eotvos University, Hungary

Operations research in Hungary started in early 1957 under the name: applications of mathematics to economics. The Hungarian revolution of 1956, suppressed by the Russian army, however, resulted in some achievements in the intellectual life. One of them was the acceptance of a few novel sciences, developed in the West, such as operations research. For a few years, however, we had to designate it by another name, more understandable for politicians. It was implemented into the mathematical community, where the leaders were not much interested in creating ideological barriers to scientific endeavor. A few economists and engineers joined the initiators. Teaching and research started at the Loránd Eötvös University and the University of Economics of Budapest as well at the Hungarian Academy of Sciences (HAS). The activities gained momentum in the 1960s and already in 1963 Budapest was the site of a large international conference in which Oscar Morgenstern, Harold Kuhn, Philip Wolfe, Herman Goldstein, Leonid Kantorovich, (the 2005 Nobel laureate) Robert Aumann and many other well-known scientists participated. It was the first large scale meeting at which many operations researchers from East and West met, exchanged ideas in person and made friendship with each other. A nationwide survey, conducted in 1980, by the HAS, showed that teaching and research was already widespread in the country at that time. All universities and almost all colleges had operations research courses or programs, many consulting companies had OR groups, a few research groups had been formed at the Academy and elsewhere, national and international conferences had regularly been organized. The Department of Operations Research at the Computing and Automation Institute of the HAS was the leading unit not only in research and applications but also in teaching. The OR curriculum at the L. Eötvös University was based on the members as instructors of that department. The change of the political system in 1990 resulted in a temporary drawback in OR activities. Foreign companies that had research groups in home countries brought with them know-how and avoided to hire local specialists for problem solution.

Today, however, we are witnessing the beginning of a new flowering period. The lecture will detail the history of OR in Hungary, including its prehistory, marked by the names of Farkas, Haar, Kõnig, Egerváry and von Neumann and will briefly outline the most important results of those OR specialists, who live or at least received their education in Hungary.

Efficient Methods for Parameter Estimation and Optimum Experimental Design for Dynamic Processes

Hans Georg Bock
University of Heidelberg, Germany

The development and quantitative validation of complex nonlinear differential equation models is a difficult task that requires the support by numerical methods for sensitivity analysis, parameter estimation, and the optimal design of experiments. The talk first presents particularly efficient "simultaneous" boundary value problems methods for parameter estimation in nonlinear differential algebraic and partial differential equations, which are based on constrained Gauss-Newton-type methods and a time domain decomposition by multiple shooting. They include a numerical analysis of the well-posedness of the problem and an assessment of of the error of the resulting parameter estimates. Based on these approaches, efficient optimal control methods for the determination of one, or several complementary, optimal experiments are developed, which maximize the information gain subject to constraints such as experimental costs and feasibility, the range of model validity, or further technical constraints.

Special emphasis is placed on issues of robustness, i.e. how to reduce the sensitivity of the problem solutions with respect to uncertainties - such as outliers in the measurements for parameter estimation, and in particular the dependence of optimum experimental designs on the largely unknown values of the model parameters. New numerical methods will be presented, and applications will be discussed that arise in satellite orbit determination, chemical reaction kinetics, enzyme kinetics and biophysics, and transport and degradation processes in soil. They indicate a wide scope of applicability of the methods, and an enormous potential for reducing the experimental effort and improving the statistical quality of the models.

(Based on joint work with I. Bauer, A. Dieses, S. Körkel, E. Kostina, and J. Schlöder.)

Optimization models and methodologies for group decision making, rank aggregation, clustering and data mining

Dorit S. Hochbaum
UC Berkeley, USA

We introduce graph models for problems of group decision making, aggregate ranking and clustering techniques for data mining. One of these graph problems we call the inverse equal paths problem. This problem as well as all problems studied here have convex objective function representing penalties for deviating from specified a-priori comparison/ranking beliefs. The problems are shown to be solvable in polynomial time using network flow techniques such as parametric cut and fractional multicommodity linear programming. Analogous models and algorithms serve to solve the closely related multi-criteria decision making problem.

One application of the aggregate ranking problem is to determine the ranking of sports teams based on the outcomes of games played. Current techniques are based on finding the principal eigenvector. Our alternative model has a number of advantages including the ability to differentiate between games based on some measure of significance. Furthermore, our solution technique of the problem is more efficient.

The area of data mining addresses various forms of rankings or clustering or pattern recognition. We consider data mining with applications to customer segmentation, patient diagnosis and assessment of bankrupcy risk. We provide new models for these data mining problems and show how to solve them with flow techniques.

Interior-point algorithms for optimal control problems

J. Frederic Bonnans
INRIA and Ecole Polytechnique, France

It is now standard to apply interior-point algorithms to optimal control problems. We will review different approaches, and discuss which of them could be appropriate for solving large-scale problems (for example if uncertain events are taken into account). The second part of the talk will be devoted to the question of error estimates.

References

N. Bérend, J.F. Bonnans, M. Haddou, J. Laurent-Varin, Ch. Talbot (2006). An Interior-Point Approach to Trajectory Optimization. J. Guidance, Control and Dynamics, to appear.
[2] J.F. Bonnans, J. Laurent-Varin: Computation of order conditions for symplectic partitioned Runge-Kutta schemes with application to optimal control. Numerische Mathematik 103-1(2006), 1-10.

A Comparative Study of Kernel Functions for Primal-Dual Interior-Point Algorithms in Semidefinite Optimization

El Ghami Mohamed
Bergen University, Norway

Y.q Bai Yanqin
Tilburgh University, The Netherlands

Roos C
Delft University of Thechnology, The Netherlands

Recently, Y. Q. Bai, M. El Ghami, and C. Roos introduced a new class of so-called eligible kernel functions which are defined by some simple conditions. The authors designed primal-dual interior-point methods for Linear Optimization based on eligible kernel functions and simplified the analysis of these methods considerably. In this paper we consider the Semidefinite Optimization problem and we generalize the approach, as presented for linear optimization, to the semidefinite case. The iteration bounds obtained are analogous to the results for Linear Optimization.

Advanced Nonlinear Programming Algorithms for Process Engineering Models

Lorenz T. Biegler
Carnegie Mellon University, USA

This presentation provides a survey of optimization problem classes that deal with engineering models, particularly for chemical processes. These optimization problem formulations consist of differential-algebraic equation models; more recent integration with partial differential equation models is also an active research topic.

To incorporate these models within the optimization problem, we describe a 'hierarchy of model intrusiveness' with levels ranging from 'fully open' to black box models. This hierarchy allows a mapping of recent developments in NLP algorithms to these model levels, and specific instances of this algorithmic mapping will be discussed, particularly with respect to a) the application of gradient based algorithms, b) dealing with second order information and c) globalization strategies.

These concepts are highlighted and further developed through a number of challenging "real-world" examples in the areas of time-critical on-line optimization, dynamic models with periodic boundary conditions and multi-level modeling with detailed models that cannot be directly integrated within the optimization calculation. Current strategies and future directions are explored for these applications.

Recursive Trust-Region Methods for Multiscale Nonlinear Optimization

Annick Sartenaer
FUNDP (University of Namur), Belgium

Serge Gratton
CERFACS, France

Philippe Toint
FUNDP (University of Namur), Belgium

In this talk, a class of trust-region methods is presented for solving unconstrained nonlinear and possibly nonconvex discretized optimization problems, like those arising in systems governed by partial differential equations. The algorithms in this class make use of the discretization level as a mean of speeding up the computation of the step. This use is recursive, leading to true multilevel/multiscale optimization methods reminiscent of multigrid methods in linear algebra and the solution of partial-differential equations. First and second-order convergence properties of this class of algorithms will be outlined and preliminary numerical experience will be described on a small set of multiscale nonlinear optimization problems.

Some new results in derivative free optimization

Andrew Conn
IBM T.J. Watson Research Center, USA

Succesful derivative free methods have to balance the geomtry of sample points with efficiency. We present a general framework for a trust region derivative free algorithm that, for the models, assumes only that they can be made to satisfy Taylor-like error bounds. Under the assumptions that need to be satisfied by the function and the algorithm a suitable second order convergence proof is given. This has broader implications for, for example, second-order trust-region methods, the connection between geometry and a (scaled) basis matrix condition numbers and is of both theoretical and practical interest. In particular, we will relate these results to our work and the wedge-based method that has a direct (exclusionary) approach to the geometry issue, thus providing a modified version of the wedge approach for which convergence can be proved for the first time.

Keyword (as one line) Derivative Free Optimization

Optimization of univariate functions on bounded intervals by interpolation and semidefinite programming

Etienne De Klerk
Tilburg University, The Netherlands

Gamal Elabwabi
Tilburg University, The Netherlands

Dick Den Hertog
Tilburg University, The Netherlands

We consider the problem of minimizing a univariate, real-valued function f on an interval $[a, b]$. When f is a polynomial, we review how this problem may be reformulated as a semidefinite programming (SDP) problem, and review how to extract all global minimizers from the solution of the SDP problem.

For general f, we approximate the global minimum by minimizing the Lagrange or Hermite interpolant of f on the Chebyshev nodes using the SDP approach. We provide numerical results for a set of test functions.

Second-order methods with provable global complexity

Yurii E. Nesterov
CORE/INMA, Belgium

In this talk we discuss a recent progress in the general second-order minimization schemes related to the cubic regularization of the Newton's method. For convex case, we present an accelerated multi-step version of the method. We consider the extensions of the new schemes onto constrained problems. Preliminary computational results are also discussed.

Handling special constraints in stochastic programming models

Csaba I. Fabian
ELTE, Hungary

We propose two-stage generalizations of Integrated Chance Constraints, and decomposition schemes for problems having such constraints.

We also propose decomposition schemes for two-stage problems with constraints on Conditional Value-at-Risk (CVaR). These schemes are based on the Kunzi-Bay - Mayer polyhedral representation of CVAR.

For the solution of these decomposed problems we propose special Level-type methods.

Pairwise comparison matrices with missing elements

Sándor Bozóki

Computer and Automation Research Institute, Hungarian Academ, Hungary

Pairwise comparison matrices are used in Multi Attribute Decision Making (MADM) for determining the weights of the attributes or the evaluation of an alternative with respect to an attribute. When the size of the matrix $(n \times n)$ is high, e.g., $n = 8, 9, 10$, filling in all the $\binom{n}{2}$ elements may be time consuming. The most often studied weighting methods (Eigenvector Method (EM) and distance minimizing methods such as the Least Squares Method (LSM), Logarithmic Least Squares Method ($LLSM$)) can be extended in the case of missing elements. A necessary and sufficient condition is given in the paper regarding the existence and uniqueness of the $LLSM$ solution. The same condition is conjectured to be valid regarding to the existence and uniqueness of the EM solution. The latter leads to an eigenvalue optimization problem.

Recent advances in numerical calculation of multivariate normal probabilities.

Tamás Szántai
Budapest University of Technology and Economics / Institute, Hungary

In the lecture I will summarize results achieved in the area of multivariate normal probability calculations during the last decade. First I will talk about bound calculations based on hypermultitree graph structures. Secondly new sampling techniques like sequential conditioned sampling (SCS) and sequential conditioned importance sampling (SCIS) will be presented. Finally I will summarize results according to calculation of probabilities of singular multivariate normal distributions what is strongly related to the calculation of probability content of a convex polyhedron.

Exploiting Structure for Computational Efficiency in Large Scale LP

István Maros
University of Pannonia, Hungary

State-of-the-art general purpose LP solvers are "intelligent" enough to recognize many chances to solve a given LP problem efficiently (for instance, presolve, adaptive scaling and algorithm control). However, they are usually not able to identify and exploit structure anything more than GUB, and/or imbedded network for the same purpose.

In the case of large to very large LP problems, surprisingly great improvements can be achieved in solution efficiency by relatively simple observations. The nature of them can be, for example, problem formulation, selection of solution algorithm. These tools are in the hand of the modeler rather than included in the solvers. They require some kind of intuition which, on the other hand, can be supported by some paradigms.

In the talk we present some ideas and follow them up in the case of some goal programming models that are large enough and require nearly 'real-time" solution, that is, solution speed is essential.

Parallel implementation of an interior point method for large-scale LP

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The talk concerns the implementation of interior point methods for solving general large-scale optimization problems. In our investigation we focus on the efficiency of computations and show that the capabilities of modern processors can be highly exploited by special data structures and implementation techniques. We describe the implementation design of our parallel interior point solver and demonstrate its performance on modern dual-core platforms.

Cubically convergent methods are no more expensive (almost) than Newton's method

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The use of higher order methods using exact derivatives in unconstrained optimization have not been considered practical from a computational point of view. Folklore says that the complexity grows with the number of variables. However, when the number of variables increases so does the sparsity of the second derivative (the Hessian matrix) and even more the sparsity of the third derivative (the tensor). It is shown that the sparsity structure of the tensor is induced by the sparsity structure of the Hessian matrix. This is utilized to make efficient algorithms for tensors induced by a skyline (or envelope) structure of the Hessian matrix. We show that classical third order methods, i.e Halley's, Chebyshev's and Super Halley's method, can all be regarded as two steps of Newton's method on a (local) cubic model. Third order methods will in most cases use fewer iterations than a second order method to reach the same accuracy. However, the number of arithmetic operations per iteration is higher for third order methods than a second order method. We will show that for a large class of sparse problems the ratio of the number of arithmetic operations of a third order method and Newton's method is constant per iteration. It is shown that

$$\frac{\text{flops(One Step Halley)}}{\text{flops(One Step Newton)}} \leq 5,$$

when the tensor is induced by a skyline (or envelope) structure of the Hessian matrix and we use a direct method to solve the systems of linear equations. The class of matrices that have a skyline structure includes banded and dense matrices.

Exact duality for homogeneous cone optimization and its complexity implications

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Tamás Terlaky
McMaster University, Canada

We present an exact duality theory for homogeneous cone optimization without constraint qualification. Using recent results about homogeneous cones we give an explicit formula for the self-concordancy parameter of the cones in the dual problem, and we also provide a formula for the corresponding self-concordant barrier function. The results have important implications about the classical Ramana dual for semidefinite optimization. Interesting special cases and applications are also highlighted.

Group symmetry in semidefinite programs

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Semidefinite program is group G symmetric, if it is invariant under an action of the group G on its variables. Typical examples arise in the coding theory and also in topology optimization of trusses, quadratic assignment problem, bounding crossing, stability and chromatic number etc. We top recent breakthrough in decreasing computational complexity of such semidefinite programs, and present numerical experience.

Improvements on the GLOBAL Optimization Algorithm with Numerical Tests

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The talk considers the stochastic global optimization algorithm GLOBAL [3], as a non-derivative version of the method of Boender et al. [2]. We introduce a new Matlab based version of the original Fortran and C code together with some algorithmic improvements. The latter include a new, BFGS local search procedure, a new Matlab implementation of the UNIRANDI local search method [5], an extended capability for larger dimensional problems, and further changes to improve the efficiency of the procedure. A special attention has been devoted to increasing the reliability, and keeping the low computational complexity of the original implementation.

The numerical test results will be discussed in detail, e.g. the comparison results with the old versions, with those of a new direct search procedure, C-GRASP [4], as well as on an extensive study regarding the scalability of the new method with respect of the dimension of the optimization problem. The first indicators are encouraging, and the new Matlab version of the algorithm GLOBAL should be available soon at the usual internet place (`www.inf.u-szeged.hu/~csendes/reg/regform.php`) for academic and nonprofit purposes. Some real life applications are also reported from the fields of chemical engineering and control [1, 6, 7].

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Towards solving Copositive Programs

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Optimization over convex cones has become an increasingly popular topic in recent years, the most prominent cones being the positive semidefinite cone and the second order cone. Semidefinite programming provides good and efficiently computable relaxations of several hard combinatorial and quadratic problems. However, it is known that these bounds may be improved by solving optimization problems over the copositive cone. The price of this gain in quality is an jump in complexity, as copositive programs are NP-hard. In this talk, we propose new polyhedral approximations of the cone of copositive matrices which we show to be exact in the limit. This gives rise to necessary as well as sufficient criteria for copositivity, and it can also be used to approximate copositive programs. We present an algorithm resulting from this approach, and conclude by presenting prliminary numerical results.

Generalized Modified Genetic Algorithm for Functional Constrained Optimization Problems

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A typical GA solves unconstrained optimization problems, so that a traditional GA method was presented in which penalty functions have been utilized as the selection criterion of surviving individuals to apply GA for constrained problems. Sensitivity of the convergence properties of this method to the penalty parameter makes the try for a recently new method on title of "Modified Genetic Algorithm", with a special selection criterion to overcome this sensitivity difficulty; but this new method is not general to apply in any optimization problem; thus, in this paper, a method has been proposed to generalize the recent modified GA. Furthermore, in this method, the cost of iteration has been minimized by selecting a suitable termination check. The last section of the article consists of application of this method in some famous optimization problems and a MDO (multidisciplinary design optimization) in aerospace field.

Optimization methods modeled by differential equation of second order

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Modeling the iterative numerical methods of optimization with differential equations has been studied in several papers. However, almost all papers deal only with either the gradient or the Newton method and they are modeled by a system of first order differential aquations.
We investigate the continuous version of the Fletcher-Reeves algorithm described by a system of second order differential equations. Namely: let $f : I\!R^n \to I\!R$ be a continuous function and let us consider the minimization problem

$$f(x) \to \inf_{I\!R^n}. \tag{1}$$

For the solution of this problem lots of methods have been developed. A family of the methods consists of the so called methods of conjugate directions. As a prototype of this family can be considered the method of Fletcher and Reeves, namely, starting from x_0 and $p_0 = -f'(x_0)$ compute the pair of points

$$\begin{aligned} x_{k+1} &= x_k + \alpha_k p_k \\ p_{k+1} &= -f'(x_{k+1}) + \beta_k p_k \qquad k = 1, 2, \dots \end{aligned} \tag{2}$$

where $f'(x)$ denotes the gradient of the function f in the given point, and the parameter α_k usually is chosen as the local minimizer of the function f along to the direction p_k and for β_k there are different choices, for example:

$$\beta_k = \frac{||f'(x_{k+1})||^2}{||f'(x_k)||^2}. \tag{3}$$

We can consider the iteration (2) as a numerical integration step by Euler-method with stepsize $h = 1$ used for the system of differential equations:

$$\begin{aligned} \dot{x} &= \alpha(t)p \\ \dot{p} &= -f'(x + \alpha(t)p) + \beta(t)p \end{aligned} \tag{4}$$

with the initial values

$$x(t_0) = x_0; \;\; p(t_0) = -f'(x_0)$$

We define the connections between the functions of the coefficients under which the minimum point of the function f will be an asymptotically stable limit point of the trajectories of (4).

Solving Partial Differential Equations with Mixed-Integer Programming Methods

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Michael Herty
Universität Kaiserslautern, Germany

Simone Göttlich
Universität Kaiserslautern, Germany

We introduce a continuous optimal control problem governed by ordinary and partial differential equations for a production planning problem. We derive a mixed-integer model by discretization of the dynamics of the partial differential equations and by approximations to the cost functional. Finally, we investigate numerically properties of the derived mixed-integer model and present numerical results for a real-world example.

Comparison of computational methods for shape optimization

Zoltán Horváth

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Computational solution of problems in which the geometry of a fluid flow domain is a subject of the optimization and the objective function is a functional of the computed flow field is still a challenging task. In order to solve this problem we have been developed an automated optimization process with system components geometry construction, grid generation, flow solution, objective function evaluation and optimization.

In this talk we examine and compare several global optimization methods, evolutionary and gradient based ones as well, when – as a component of our automated process – they are applied to shape optimization problems arising from automotive industry.

Mean-Risk Models Using Two Risk Measures: A Multi-Objective Approach

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CARISMA, Brunel University, United Kingdom

Ken Darby-Dowman
School of Information Systems, Computing and Mathematics, Br, United Kingdom

Diana Roman
CARISMA, Brunel University, United Kingdom

We propose a model for portfolio optimization in which distributions are described and compared using three statistics: mean, variance and CVaR at a specified confidence level. The purpose is to improve on mean-variance and mean-CVaR efficient solutions. The problem is multi-objective and transformed into a single objective problem. In the case of scenario models, the problem is a quadratic program. The model is tested on real data drawn from the FTSE 100 index.

Multiobjective optimiztion for two-dimensional cutting stock problems.

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Many objective functions can be defined for cutting stock problems. After showing how to determine the coefficients of each objective function they are grouped in concordance (min, max) or in discordance (max, min) according the direction of optimization. We define a measure for booth and reducing always the multiple objective function problem of two discordance objective functions (for instance waste minimization and productivity maximization) or aggreging in one objective function (for instance in cost minimization.) Some numerical results show us how can be made our procedure practically useful for two-dimensional cutting stock problems.

Anstreicher-Terlaky type monotonic simplex algorithms for linear feasibility problems

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We define a variant of Anstreicher and Terlaky's (1994) monotonic build-up (MBU) simplex algorithm for linear feasibility problems. Under a nondegeneracy assumption weaker than the normal one, the complexity of the algorithm can be given by $m\Delta$, where Δ is a constant determined by the input data of the problem and m is the number of constraints. The constant Δ cannot be bounded in general by a polynomial of the bit length of the input data.

Degeneracy may be handled using flexible index selection rules, or with Bland's rule, or with the following procedure based on a new recursive procedure. The essence of this procedure is as follows. If a degenerate pivot tableau is obtained, we define a smaller problem, restricting the pivot position to a smaller part of the tableau. On this smaller problem, we follow the same principles as before to choose the pivot position. The smaller problem is either solved completely or a new degenerate subproblem is identified. If the subproblem was solved then we return to the starting larger problem, where either we can make a nondegenerate pivot, or detect that the problem is infeasible. It is easy to see that the maximum depth of the recursively embedded subproblems is smaller than $2m$.

Upper bounds for the complexities of linear programming version of MBU and the first phase of the simplex algorithm can be found similarly under the nondegeneracy assumption.

On the empirical behavior of a new network exterior point simplex algorithm for the minimum cost network flow problem.

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Network Optimization is a large part of Mathematical Optimization. The Minimum Cost Network Flow Problem, (MCNFP) consists a wide category of problems; perhaps the most important of the research area of Network Optimization. Recently a new Network Exterior Point Simplex Algorithm (NEPSA) for the MCNFP has been developed. This algorithm belongs to a special "exterior simplex type" category. Contrary to the network primal simplex algorithm (NPSA), the new algorithm computes two flows. One flow is basic but not always feasible and the other is feasible but not basic. This family of algorithms is believed to be more efficient than the classical NPSA in CPU time. This happens due to the essential reduction on the number of iterations, since NEPSA crosses over the area outside of the feasible region. In this paper, for the first time, we discuss the empirical behavior of NEPSA based on computational experiments. The computational study carried out using, sparse and dense, randomly generated problems. It must be mentioned that all the MCNFP instances were created using well known network problem generators, like for example the netgen and the gridgen.

Interior point algorithms for general linear complementarity problems

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Many real life problems that lead to linear complementarity models (LCP), like bimatrix games, does not guarantee nice properties for the matrix of LCP. From practical point of view, it is important to solve such problems of moderate size. However, the linear complementarity problems, without any assumption on the matrix of the problem, are NP-hard. The largest matrix class where the interior point algorithms are polynomial is the class of sufficient matrices. We would like to generalize the interior point methods such that either solve (general) linear complementarity problems or give a certificate that proves the infeasibility of the LCP, or that the matrix of the problem does not belong into the class of sufficient matrices. Such a certificate can be derived using the EP-form of the alternative theorem of the linear complementarity problems. We show that the property $\mathcal{P}_*(\kappa)$ is used only at few well defined steps of the interior point algorithms. When we compute the Newton direction and we found that it is not unique, means the matrix of the problem is not $\mathcal{P}_0$ matrix, therefore it is not $\mathcal{P}_*(\kappa)$ matrix as well. In this case, the actual solution is proper certificate for the EP-theorem. Furthermore, if we can not guarantee such improvement in the complementarity gap as it is prescribed for a step by the worst case analysis of the method, then the Newton direction is a certificate showing that the matrix is not $\mathcal{P}_*(\kappa)$, with the given $\kappa > 0$ parameter. In this case we can show that either the κ value should be increased or there is no appropriate κ at all for the given matrix, namely the matrix is not a $\mathcal{P}_*$ matrix.

On the Lovász ϑ-number of 'almost regular' graphs

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We consider k-regular graphs with loops, and study the Lovász ϑ-number and Schrijver ϑ'–number of the resulting graph when the loop edges are removed. We show that the ϑ-number dominates a recent eigenvalue upper bound on the stability number due to Godsil and Newman [C.D. Godsil and M.W. Newman. Eigenvalue bounds for independent sets. *Journal of Combinatorial Theory B*, to appear]. As an application we compute the ϑ and ϑ' numbers of Erdős–Rényi graphs. This computation exploits the graph symmetry using the methodology introduced in [E. de Klerk, D.V. Pasechnik and A. Schrijver. Reduction of symmetric semidefinite programs using the regular *-representation. *Mathematical Programming B*, to appear]. The computed values are strictly better than the Godsil-Newman eigenvalue bounds.

Polytopes and Arrangements: Diameter and Curvature

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By analogy with the conjecture of Hirsch, we conjecture that the order of the largest total curvature of the central path associated to a polytope is the number of inequalities defining the polytope. By analogy with a result of Dedieu, Malajovich and Shub, we conjecture that the average diameter of a bounded cell of an arrangement is less than the dimension. We substantiate these conjectures in low dimensions, highlight additional links, and prove a continuous analogue of the d-step conjecture.

Exhaustively Generating Basis Solutions for a System of Stoichiometrically Balanced Elementary Reactions by Resorting to the P-graph-based Method

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The adaptation of the P-graph framework originally established by Friedler and Fan for process synthesis has given rise to an efficient method for reaction-pathway identification. This method resorts to graph theoretic algorithms, which drastically reduce the search space by judiciously exploiting the combinatorial properties of the feasible pathways, thereby yielding every combinatorially feasible pathway exactly once. On the other hand, the methods rooted in linear algebra or convex analysis generate independent feasible pathways through a series of basis transformations; however, an effective search strategy is absent in any of these methods, thus apparently rendering them inefficient in exhaustively generating the feasible pathways. The present work explores the relationships between these two major classes of methods for identifying feasible reaction or catalytic pathways. Each independent feasible pathway is generated through a series of linear algebraic basis transformations while the construction of the enumeration tree and the reduction of the search space are performed by procedures derived from the P-graph-based method.

Optimizing multiple aspects of biomass delivery system layout

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The facility layout problem is a central issue of biomass delivery for several reasons. First, the gains in the area of pollution can only be sustained if the delivery of biomass does not create higher levels of pollution itself. Second, biomass investment projects have a very unique characteristic: the presence of state and/or EU funding. This spawns a whole new set of parameters that need to be taken into consideration in any mathematical model of the subject.

The Research team at the University of Pécs developed the F.E.E.S. model-framework for handling Financial, Energetical, Environmental and Social aspects of biomass-related facility layout decisions. The model aims 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).

Using S-graph for Throughput Maximization in Multipurpose Batch Plants

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Mate Hegyhati
University of Pannonia, Hungary

Ferenc Friedler
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In this presentation a graph-theoretic framework for scheduling of multipurpose batch plants is presented. The framework is based on a representation so called S-graph that was introduced in 1998 by Friedler and coworkers mainly for problems of makespan minimization. In these problems, the number of batches of different types of products that have to be produced is known a priori and the task is to determine the minimum makespan that is concomitant with the production of the prescribed batches of products. Recently, this framework has been applied to problems in which the time horizon is fixed and the task is to maximize an economic performance index like throughput or revenue. This presentation gives the performance comparison between this recent contribution and other publications in literature which are based on traditional mathematical programming.

Optimization Problems and Algorithms in Supply-Chain Management

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Róbert Adonyi
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Sándor Bodrogi
MOD ED Co., Hungary

Zoltán Kovács
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The presentation summarizes the research results achieved in the project "On-line optimization of asset traffic satisfying safety regulations". The proposed system covers the complete functional model of asset tracking defined in international civil and military standards and it supports decisions at each level of its hierarchical business-process model. Unique features are considering safety regulations, minimizing risks, and supporting decision in case of unexpected events by optimization methods of critical response time. At the highest level of decisions the aim is determining the cost-optimal network of purchasing, manufacturing, and transporting assets in order to guarantee the availability of a list of assets at desired places in time. Component problems are asset-vehicle assignment, route planning, and three-dimensional packing. An integrated optimization method for the synthesis of the supply-chain network and its component problems is introduced.

Monte-Carlo Optimization of Reliability

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Optimization of reliability aims at distributing resources in a system. The developed simulation modell contains: - distribution of operational times, - distribution of standstill times, - costs: – occasion-dependentend costs (like spare part, maintenance material), – time-dependentend costs (like costs of labour), – opportunity costs(profit loss due to out of operation). Objective function can be the minimum of costs of maximum of income. Maintenance can be built in the model as a system element. Interdependecy among elements can be taken into consideration. Author improved the traditional block-diagram technique also. Examples will show applications for different systems and maintenance strategies using Pascal programs and visual simulation.

Optimization of the Average Waiting Time with Respect to the Express Line's Control Parameter at the Cash Desks of a Superstore

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Noémi Kalló
Budapest University of Technology and Economics, Hungary

Improving the waiting process at cash desks in stores is an important goal of operation management in the era of time based competition. The paper presents a method for evaluating the effect of express lines on the waiting process. An optimization model is developed which minimizes the average waiting time in line with respect to the maximum number of items allowed in express lines, that is, to the value of the limit parameter. The presented research is based on a real case of a do-it-yourself superstore. The optimization model is completed with sensitivity analyses. Sensitivity analyses show how the optimal value of limit parameter changes if major parameters of the model change. The results of these analyses help managers to make decisions about short and medium-term operations of express lines. It is also studied how an acceptable express line policy valid for several periods should be determined. The major conclusion of the paper is that optimal operation of express lines does not decrease the average waiting time significantly, and the effect of non-optimal operation can be very unfavorable. Consequently, the evaluation of the effect of express lines on the service level should be based not only on a thorough analysis of operational issues but should take into consideration the perceptional attributes of the customers as well.

An Overview of Continuous Approximation: Theory and Applications

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Continuous approximation is a solution technique based on transforming the problem through approximate representation of decision variables by a few continuous functions. Continuous approximation can be used in many spatial location problems that arise from location theory, inventory and production planning, and product differentiation. In this talk, we present several applications of continuous approximation as well as initial theoretical progress and a set of numerical results. We further discuss the potential of this method and the future research implications.

A new reduction technique for PNS problems

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In a manufacturing system materials of different properties are consumed through various mechanical, physical and chemical transformations to yield desired products. Devices in which these transformations are carried out are called operating units. Thus, a manufacturing system can be considered as a network of operating units, which is called process network. A design problem is defined from a structural point of view by the raw materials, the desired products, and the available operating units. This triplet determines the structure of the problem as a process graph containing the corresponding interconnections among the operating units. Consequently, the appropriate process networks can be described by some subgraphs of the process graph belonging to the design problem under consideration. Naturally, the cost minimization of a process network is indeed essential. This optimization problem belongs to the class of the NP-hard problems (see [1]) therefore it is important to establish such methods which render possible the reduction of the size of model.

The first reduction technique, called Maximal Structure Generation Algorithm, MSG algorithm for short, was presented in [2] and [3]. Its basic idea is that the unnecessary operating units and materials are eliminated from the problem considered.

Another possibility for reducing of problems is presented in [4]. This procedure is based on the merging of operating units. The mergeable operating units are determined by an equivalence relation on the set of the operating units, and all of the operating units included in an equivalence class are merged into one new operating unit.

In this talk we shortly overview the known reduction techniques for the PNS problems and present a new one which can be considered as the generalization of the reduction rules used for the set covering problem.

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Solution of Time-Delay Systems by Hybrid Functions

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The control of systems with time-delay has been of considerable concern. Delays occur frequently in biological, chemical, electronic and ransportation systems. Time-delay systems are therefore a very important class of systems whose control and optimization have been of interest to many investigators.

Orthogonal functions and Taylor sereies have received considerable attention in dealing with various problems of dynamic systems. Much progress has been made towards the solution of delay systems. The approach is that of converting the delay-differential equation to an algebraic form through the use of operational matrix of integration P. The matrix P can be uniquely determined for Taylor series and the particular orthogonal functions.

In this paper we introduce a new direct computational method to solve delay systems. The method consists of reducing the delay problem to a set of algebraic equations by first expanding the candidate function as a hybrid function with unknown coefficients. These hybrid functions, which consists of block-pulse functions plus Taylor series are first introduced. The operational matrices of integration, delay and product are given. These matrices are then used to evaluate the coefficients of the hybrid function for the solution of delay systems. Illustrative examples are included to demonstrate the validity and applicability of the technique.

A new multi-augmenting algorithm for the assignment problem

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We propose a new multi-augmenting algorithm for the assignment problem. It is motivated by the relation between the existing multi-augmenting algorithm [1] and a folklore method to find initial assignments. The folklore is named as the reduction method in the sense that it finds assignment by reducing the cost matrix. The reduction method consists of two steps, column reduction and row reduction. Nawijn and Dorhout [2] showed that the expected number of assignments by the full reduction approaches eighty-one percent of the maximum cardinality matching, whereas the expected number only by the column reduction is approximately sixty-three percent. The existing multi-augmenting algorithm repeatedly calls an algorithm for the shortest path problem to find augmenting paths, which can be regarded as the generalization of the column reduction. Therefore, we extend the multi-augmenting algorithm by adding a procedure corresponding to the generalized row reduction. The extended algorithm is based on a sequence of two shortest path sub-problems constructing an outward tree and an inward tree respectively. However, the second sub-problem is not expected to cost as much as the first one as the information of the outward tree accelerates the algorithm for the second one.

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A novel pinch targeting method and MILP model for steam system design

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Very common in most chemical plants are process streams that need to be cooled and process streams that need to be heated. To save on energy costs, heat is initially exchanged between hot and cold process streams through process-process heat integration, and then cooling water and steam are used for the remaining process streams. Pinch Analysis (Linnhoff and Hindmarsh, 1983) is commonly used in maximizing process-process heat integration, thereby minimizing external utility requirements. Most industries worldwide have adopted Pinch Analysis as the most powerful tool in achieving a design with optimal usage of external utilities, i.e. cooling water and steam. The GCC (Grand Composite Curve) has further demonstrated the ability of Pinch Analysis to determine optimal steam levels in process design. Cooling towers, steam boilers and the process streams all form part of a heat exchanger network (HEN).

The first step in the pinch design is to target for a desirable flow rate of external utilities. Latent heat is first transferred from the saturated steam to the cold process streams. Thereafter, sensible heat from the resulting saturated liquid is transferred to the remaining cold process streams. By using saturated steam, as well as the saturated liquid from the saturated steam, the overall steam flowrate in the HEN can be reduced, without compromising on the system heat load.

From targeting using saturated steam as well as saturated liquid, two regions are encountered, namely the saturated steam and saturated liquid regions. As stated before, latent heat is transferred in the saturated steam region. This implies that the network layout of the utilities in the saturated steam region will always be parallel. However, since sensible heat is transferred in the saturated liquid region the network layout in the saturated liquid region can be parallel, series or a combination of both series and parallel. Therefore,

by knowing the network layout in the saturated steam region (parallel), time and effort are therefore saved since only the network layout in the saturated liquid region needs to be determined.

To determine the network layout in the saturated liquid region, a mathematical model has been developed using a superstructure of the heat exchanger network in the saturated liquid region. The model exhibits a mixed integer linear programming (MILP) structure and focuses only on network design, using the target set using graphical analysis.

The presentation will focus on the basis of the mathematical model and results that have been obtained with literature problems.

Discrete event simulation: A case study

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This paper compares the performance measures, in terms of precision of the simulation estimates for three sampling methods: random sampling, descriptive sampling and refined descriptive sampling. The comparison was made for the flexible Jobshop type related to a production system of CEVITAL by the three phase discrete event simulation method. We design and realise a software package using a Delphi language to evaluate performance measures of this production problem.

Online bin covering with cardinality constraints

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In the bin covering problem a list of positive numbers which are not greater than 1 is given and the aim is to pack the elements into the maximal number of bins so that the sum of the numbers in any given bin is at least 1. This problem is often called the dual version of bin packing (in the bin packing problem the goal is pack the elements into the minimum number of bins so that the sum of the numbers in any given bin is at most 1).

In this talk we study a further version of the bin covering problem when cardinality constraints are also given. It is supposed that each bin must contain at least k elements. This is the dual version of the cardinality constrained bin packing problem (where the bins are not allowed to contain more the k element) which is a known and well studied version of the bin packing problem. A further closely related problem is the vector covering. In the vector covering problem d dimensional vectors are given and the aim is to pack these vectors into the maximal number of bins so that the sum of the numbers in any given bin and in each coordinates is at least 1. We can consider the cardinality constrained bin covering problem as a particular case of the two dimensional vector covering problem.

We consider the problem both in the online and in the offline setting. In the online version the elements arrive one by one and the decision maker has to pack each element without any information on the further elements. We investigate the behaviour of some vector covering algorithms in this special case of the problem, and we develope further algorithms for the solution of the problem. The algorithms are analysed by the worst case analysis (competitive analysis in the case of the online problem, and approximation ratio in the case of the offline approximation algorithms).

Two uniform processors: Competitive ratio of semi on-line scheduling

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In this paper we consider the problem of scheduling tasks on two processors, P_1 with speed 1 and P_s with speed $s \geq 1$. A task that needs time p on P_1 can be processed in time p/s on P_s. The objective is the minimization of the makespan.

We study the semi on-line version of this problem, where the total sum of the tasks is known in advance. Tasks arrive one at a time and have to be assigned to one of the two processors before the next one arrives, without any information about the items arriving later, and without the option of changing the assignment afterwards.

The competitive ratio of algorithms is analyzed, with respect to the off-line optimum on the input sequences of items. Lower bounds and algorithms are presented, depending on the value of the speed s of the fast processor. The estimates obtained for the best possible competitive ratio are tight in the following ranges: $s \geq \sqrt{3}$, $\frac{1+\sqrt{17}}{4} \leq s \leq \frac{1+\sqrt{3}}{2}$, and $s = 1$. For intermediate values of s, a further method has been developed in order to derive improved bounds, based on a geometric representation.

Polynomial Time Algorithms for Stochastic Uncapacitated Lot-Sizing Problems

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In 1958, Wagner and Whitin published a seminal paper on the deterministic uncapacitated lot-sizing problem, a fundamental that is embedded in many practical production planning problems. In this paper we consider a basic version of this in which demand (and other problem parameters) are stochastic: the stochastic uncapacitated lot-sizing problem. The SULS is the most basic lot-sizing with production, setup, and inventory costs that can be stated as a stochastic programming problem.

We define the *production path property* of an optimal solution for our and use this property to develop a backward dynamic programming recursion. This approach allows us to show that the value function is piecewise linear and right continuous. We then use these results to show that the dynamic programming approach yields an $\emptyset(n^3)$ algorithm for the problem. In addition, we show that the value function for the problem without setup costs is continuous, piecewise linear, and convex, and therefore an even more efficient $\emptyset(n^2)$ dynamic programming algorithm can be developed for this special case.

Engine Assignment Problem: General Case

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At VOCAL 2004 we have presented some combinatorial models for the weak engine assingment problem (WEAP) which was given by MÁV ZRT. The minimum circulation model can be extended for the generalized engine assignment problem, when we have several types of trains and engines. We get an (integer) multi-commodity flow problem. This model and some relaxations of it will be presented.

Model Reduction-based Optimization for Large-Scale and Multi-Scale Systems

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Optimisation of large-scale and multi-scale physical and chemical systems is often hampered by substantial computational requirements and the lack of explicit information on the underlying modeling equations. This is the case when commercial packages are used for process simulation and design, hence the system Jacobians and Hessians cannot be efficiently computed. Also, when detailed simulations at the molecular scale (e.g. Monte Carlo, Molecular Dynamics, Lattice Gas etc) are used, the state equations are not explicitly available. It is therefore computationally inefficient or even impossible to perform gradient-based optimization and parameter estimation using such codes, since a large number of numerical perturbations are needed. A reduced model-based optimization framework is presented to be used with input/output dynamic simulators. We have recently proposed a two-step projection approach to perform steady state optimization using directly large-scale black-box and/or microscopic simulators [1]. We also extended this methodology to perform stable efficient dynamic optimization/optimal control [2]. Both approaches will be discussed with the aid of illustrative examples for both large-scale macroscopic systems, including dynamic models of non-ideally mixed multi-phase reactors, recently developed in the group, and models based on massively parallel CFD simulators, along with MC-based microscopic models.

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Elimination of intermediate storage via the exploitation of latent storage capacity

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The production of low-volume high-value-added chemical products such as pharmaceuticals and fine chemicals is generally conducted in a batch plant. Due to the discrete nature of these processes scheduling of the unit operations is crucial. Much work has been done to improve scheduling methodologies, however this work has mainly focused on the development of effective frameworks and improved mathematical models. The area of intermediate storage has been largely neglected.

From the Gantt chart of a typical batch plant it can be seen that some units may be idle and empty for the duration of the time horizon of interest. This unit availability affords the opportunity to use these processing units as intermediate storage, instead of, or in conjunction with, dedicated intermediate storage. Using processing units in this way can reduce plant size thus reducing the capital cost of the plant, while also increasing the capital utilisation of the equipment.

A mathematical model based on the State Sequence Network and using the continuous time representation has been developed. The model is applied to a number of examples with very good results.

Generalized Jacobian in Infinite Dimensional Spaces

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The question of defining a derivative-like object for nonsmooth functions was initiated in the late fifties by Rockafellar in [4], and in the references therein, where the concept of subgradients for (extended) real-valued convex functions was introduced. Since then, derivative-like objects for nonsmooth, in particular, for locally Lipschitz functions $f : D \subseteq X \to Y$, where X and Y are normed spaces and D is an open set, have been the focus of intensive research.

When X and Y are finite dimensional normed spaces, Clarke introduced in [1] the notion of the *generalized Jacobian* of f at $p \in D$ as

$$\partial^c f(p) := \operatorname{co}\big\{A \in L(X,Y) \mid \exists\,(x_i)_{i\in\mathbb{N}} \text{ in } D : \lim_{i\to\infty} x_i = p,\ f'(x_i) \text{ exists and } \lim_{i\to\infty} f'(x_i) = A\big\}.$$

The nonemptiness of this set is a consequence of Rademacher's theorem on the almost everywhere differentiability of locally Lipschitz functions acting between finite dimensional spaces.

One could expect that the derivatives defined by way of operators have some additional good properties. Such good properties should definitely be translated as having "tight" calculus rules and computational utility in the applications. Motivated by this problem, in our recent paper [2], we have provided an extension of Clarke's generalized Jacobian to locally Lipschitz functions from any normed space into a finite dimensional space. Our generalized Jacobian, denoted by $\partial f(p)$, is a set of linear operators from X to Y. When X is finite dimensional it coincides with the Clarke's generalized Jacobian. On the other hand, when the domain is infinite dimensional and the image space is the real line, $\partial f(p)$ coincides with Clarke's generalized gradient.

In [2] the nonemptiness, the w^*-compactness, the convexity, and the upper semicontinuity property of this generalized Jacobian were

obtained. A chain rule for the composition of a smooth map between finite dimensional spaces with a locally Lipschitz functions and, as consequences, the sum and the product rules were proved. A computational rule for the generalized Jacobian of piecewise smooth functions was also developed. In our subsequent work [3], we obtained a complete characterization of the set-valued map $\partial f(\cdot)$ and we proved that generalized Jacobian is a strict Hadamard prederivative. Chain rules for the composition of two nonsmooth functions were also established in this paper.

In the talk we review all these results and discuss possible generalizations for functions with infinite dimensional range.

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The Single Facility Location Problem in Two Regions with Different Norms

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Abstract: Suppose the plane is divided by a straight line into two regions with different norms. We want to find the location of a single new facility such that the sum of the distances from the existing facilities to this point is minimized. This is in fact a non-convex optimization problem. The main difficulty is caused by finding the distances between points on different sides of the boundary line. In this paper we present a closed form solution for finding these distances. We also show that the optimal solution lies in the rectangular hull of the existing points. Based on these findings then, an efficient Big Square Small Square (BSSS) procedure is proposed.

Key words: continuous location, single facility, branch and bound, global optimization

New Method to Determine the Globally Optimal Solution of Separation Network Synthesis Problems with NLP Model

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The field of separation network synthesis (SNS) as a research area has been developed since the 1970s and it is of mathematical interest as well as industrial significance, since the need of optimal separation processes is obvious. The formulation of SNS problems differ in their exact formalisms, nevertheless, they are raised as NLP models, where both the cost function and the constraints are nonlinear functions and only special problems can be formulated as LP models (for an example see Kovács et al., 2000). Extensive research work can be found in the literature which deals with the solution of NLP models (for a review see Floudas, 2000) from which a large number of methods use linearization techniquies. The common in the linearization methods is the relaxation of the variables, equalities and inequalities one by one. These techniques use great effort in the solution then. In our presentation we give a new linearization method where arbitrary SNS problems can be solved with relative ease. The novelty of the method is based on the feasible range of the SNS problem which is approximated by a convex polieder. In other words, the NLP model of the SNS problem is relaxed by an LP model of which feasible solution range contains the feasible solution range of the original NLP model. The solution of the relaxed LP problem serves as the starting point of the NLP model, with which a simple local search determines the demanded globally optimal solution of the original NLP problem. The method is illustrated with an example.

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Index