Tuesday, August 30, 14:00, Room H110

The Generalized Problem of Center Location

Michael Rubinstein,

The Generalized Problem of Center Location (GPCL) is formulated as follows. There are a Set of Served Users (SU), a Set of Serving Centers (SC) and a Set of possible Center Position (SP). Some characteristics of these Sets are given: Disposition of SU relative to the Set of SP, Volumes of resources, taken by SU, Volumes of resources, which SC have, Distances between SP, Installation costs of SC and some others. At last, a Function is known, which depends on these characteristics, on assignments of SU to separate SC and on locations of SC in SP and determines the corresponding expenditures. GPCL is in minimizing this Function on above "assignments" and "locations" under Resource and Compatibility Constraints. Resource Constraints provide a sufficient volumes of resources for serving groups of SU, assigned to separate SC, and Compatibility Constraints from Sets of feasible "assignments" and "locations". It is shown, that GPCL is a generalization of classical problems of Optimal Location of Medians and Centers in Graphs. It is also shown, that some other problems can be reduced to GPCL (for instance, the problem of Standardization of industrial products). For solving GPCL a general approximate method is suggested. This iterational method is based on using in each iteration the solution of Assignment Problems of different types. Besides, it includes a nontrivial initial step, which is reduced to solving an option of Taxonomy Problem. Some Particular Cases of GPCL are considered, in which GPCL may be solved (exactly or approximately) by polynomially bounded algorithms.

Tuesday, August 30, 14:30, Room H110

Some L-Class Enumeration Algorithms for Simple Plant Location Problem

Alexander A. Kolokolov, Inst. of Information Technologies and Applied Mathematics, Omsk
Tatyana V. Levanova, Inst. of Information Technologies and Applied Mathematics, Omsk

We suggested the approach to the development and solving of integer programming problems (IPP), which is based on the application of regular partitions of the Euclidean space. With the help of such partitions, we introduced new classes of cuts, obtained bounds of iterations number for fractional cutting plane algorithms (in particular, for first algorithm of Gomory), for some branch and bound algorithms, suggested L - class enumeration and hybrid algorithms for solving and analysis of IPP, obtained some other theoretical and experimental results.

In this paper we develope decomposition L - class enumeration and hybrid algorithms for simple plant location problem. The Benders and Gomory's cuts are used in the algorithms also. We consider exact and approximate versions of the algorithms and experimental study.

Tuesday, August 30, 15:00, Room H110

Matrices with Some Forbidden Configurations

Oto Hudec, Technical University Kosice, Slovakia

no abstract received

Wednesday, August 31, 10:00, Room H110

Solving Set Partitioning Problems Arising in Handicapped People's Transport

Ralf Borndörfer, Technische Universität Berlin
Martin Grötschel, Konrad-Zuse-Zentrum für Informationstechnik Berlin

In dial-a-ride systems, for instance in the Telebus-system for handicapped people's transport in Berlin, the problem of routing and scheduling a fleet of transportation vehicles to fulfill the user requests in a best possible way arises. This problem can be modelled as a Set Partitioning Problem. In a polyhedral approach, facets namely of Set Packing polyhedra can be used in a cutting plane algorithm to solve the problem.

In this talk we discuss a branch and cut algorithm for Set Partitioning problems and computational results for it. For our Telebus application these indicate that substantial improvements in both quality of transport and reduction of costs are possible.

Wednesday, August 31, 10:30, Room H110

A Polyhedral Approach to a Contrained Assignment Problem

Andreas Hefner, Universität Passau

We consider the following problem (called the Master/Slave-Matching Problem): Given an undirected bipartite graph $G = (V, E)$ with bipartition $V = W \cup U$ and a digraph $D = (U, A)$. A Master/Slave-matching in G is a matching in G such that for every arc $(u, v) \in A$ the node v is matched whenever the node u is matched. The problem is, to find a Master/Slave-matching of maximum cardinality. The motivation for the study of this problem arises from the area of manpower scheduling where one tries to assign workers to jobs such that the assigned jobs satisfy certain dependency constraints. Let k be the maximum size of a (weakly) connected component of D. First we show that the problem is $\mathcal{NP}$-hard and remains $\mathcal{NP}$-hard even if $k = 3$. Second we focus on the case $k = 2$: We use polyhedral combinatorics to establish a min-max equation which well-characterizes the cardinality of a maximum Master/Slave-matching. This equation can be viewed as a generalization of König's min-max theorem. Finally, we show (for $k = 2$) how the weighted Master/Slave-Matching Problem (where every edge $e \in E$ has a nonnegative weight) can be transformed to the (non-bipartite) weighted Matching Problem.

Wednesday, August 31, 14:00, Room H106

A New Heuristic Algorithm Solving the Problem of Linear Ordering

Stefan Chanas, Technical University of Wroclaw
Przemysław Kobylański, Technical University of Wroclaw

A new heuristic algorithm solving the problem of linear ordering is presented. It makes use of some properties of the problem and especially of the criterion function symmetry in the problem. This property consists in the fact that the reversal of the order constituting the optimal solution of the problem gives an optimal solution of the problem with the opposite criterion function.

This new algorithm was compared with the other ones solving the same problem in a numerical experiment. The results of this experiment are presented. The conclusion is that this new algorithm is better than all the other ones.

Wednesday, August 31, 14:00, Room H110

Subproblems of the One-Dimensional Cutting Stock Problem Having MIRUP

Johannes Terno, Technische Universität Dresden

A linear integer optimization problem (IP) has the modified integer round-up property (MIRUP) if the optimal value of any instance of IP is not greater than the optimal value of the corresponding LP relaxation problem rounded up plus one.

The aim of this paper is to consider the classical linear integer optimization model (Gilmore/Gomory 1961) of the one-dimensional cutting stock problem and to investigate whether this model has the MIRUP.

The validity of the MIRUP is proven for various subproblems characterized by the number of small pieces, by the sizes of the small pieces, by the natural material bound or by the structure of the optimal solution of the continuous relaxation.

Wednesday, August 31, 14:30, Room H106

k-Cardinality Subgraphs

Matthias Ehrgott, Universität Kaiserslautern

The problem of finding a subgraph S of a given graph $G = (V, E)$ containing exactly k edges which is minimal with respect to edge weights $w(e) \in IR$, $\forall e \in E$ is considered. We will prove that the problem is NP hard. An Integer-Programming formulation will be given and some classes of inequalities are shown to be facet-defining for the corresponding polytope. An algorithm for the separation-problem for the most important class of inequalities is given and implemented in a branch-and-cut approach. Finally the results of this algorithm are compared with a heuristic based on Prim's algorithm.

Wednesday, August 31, 14:30, Room H110

Mixed Optimization Problems in Spacecraft Design

Eugene Semenkin, Siberian Aerospace Academy

We call as mixed optimization problem such one which has variables of some types (continuos, discrete, Boolean, combinatorial) at the same time. Additional feature of discussed problems is of objective function which can be given by computer program, simulated model or as output of real process. The necessity of mixed optimization problems of implicit functions appears by a design of structure and parameters of spacecrafts, especially their control systems, and other high complex systems.

It is attended to discuss some real world problems which give such optimization problem because of hard dependence between structure and parameter values.

Author would like to discuss also approaches to solving of mixed optimization problems which are development of ones discussed before. One approach is oriented to decomposition of problem into some optimization problems with one type variables and need special software which can call optimization procedure as objective function for higher level optimization procedure. Author doesn't know optimization software with such a possibility. The second approach supposes reduction mixed optimization problem to one with unique type variables. It is proposed to work with discrete variables only and to develop special algorithms of implicit function optimization on discrete lattice.

Wednesday, August 31, 15:00, Room H110

An Integer Programming Approach to Optimal Software Metrics Selection

Günther Ruhe, Universität Kaiserslautern

We investigate an integer programming approach for a practical problem occuring within the context of software measurement. The problem is to determine an optimal subset of software metrics according to a given budget constraint.

After presenting an integer programming formulation of the problem we prove its strong $\mathcal{NP}$-completeness. The main difficulty of the solution approach results from the structure of the objective function, which is defined on the family Θ of all subsets N_j of the set N of all possible metrics and which has to fulfill some additional structural properties.

We present an algorithm computing in $O(n \cdot (n \cdot logn + card(\Theta)))$ steps the locally best element $i \in N \setminus S$ for inclusion into the current solution set S. This computation is based on a hypergraph formulation H with the elements of Θ as the vertices and a labeling process defined on H. It is defined in such a way that the different evaluations for the locally optimal choice of inclusion are based on decomposition and need not be computed from scratch. The overall solution algorithm needs $O(n \cdot (n^2 \cdot logn + card(\Theta)))$ steps to determine an approximate solution.

Wednesday, August 31, 15:00, Room H106

Genetic Algorithm for Generalized Graph Partitioning Problem

Piotr Kadluczka, University of Mining and Metallurgy
Konrad Wala, University of Mining and Metallurgy

The paper considers the generalized problem of partitioning the nodes of a weighted graph into m disjoint subsets of bounded size, such that the objective function connected with the weights of the graph edges is maximized. The application of the investigated model for the problem solution of processing large computer programs in distributed computing systems is presented.

Genetic algorithm, adapted for solution of the generalized graph partitioning problem, refers to genetic type algorithms with evaluation function consisting of objective function and weighted infeasibility measure. It exploits six genetic operators where some of them realized, except random choice operations, simple search operations.

There are reported the computer experiment results for a test example.

Wednesday, August 31, 15:30, Room H106

Solving Graph Partitioning Problems under Side Constraints

Carlos Ferreira, Universidade de Sao Paulo, Brazil
Alexander Martin, Konrad-Zuse-Zentrum Berlin
Cid de Souza, CORE, Belgium
Robert Weismantel, Konrad-Zuse-Zentrum Berlin
Laurence Wolsey, CORE, Belgium

In this talk we consider the problem of k-partitioning the nodes of a graph with capacity restrictions on the sum of the node weights in each subset of the partition, and the objective of minimizing the sum of the costs of the edges between the subsets of the partition. Based on a study of valid inequalities for the associated polyhedron, we have implemented various separation procedures that are integrated in a branch and cut algorithm. We have applied this algorithm to three classes of problems: equipartitioning problems arising in finite element methods and partitioning problems associated with the layout of electronic circuits and the design of compilers.

Wednesday, August 31, 15:30, Room H110

Design and Analysis of Some Approximation Algorithms for Large Scale Travelling-Salesman Problem

Edward Gimadi, Institute of Mathematics at Novosibirsk, Russia

The Travelling-Salesman Problem (TSP) is known to be NP-hard. A number of approximation simple algorithms have been proposed for the problem and their perfomance determined. We consider the probabilistic behaviour of some polynomial-time algorithms on a random $n \times n$ – matrix (c_{ij}) of distances between cities. Additionally to the running-time of the presented algorithms we consider the relative error ε_n and the failure probability δ_n for which the following inequality holds:

$$Pr\{F_A > (1+\varepsilon_n)F^*\} \leq \delta_n,$$

where F^* and F_A are values of the objective function for the optimal solution and obtained by algorithm A respectively.

One of the results obtained is a analysis of a patching algorithm modification that uses an optimal assignment as the starting point for the constructing of a TSP-tour. When the elements of distance matrix are independent random variables with the identical distribution there are established following estimates:

$$\varepsilon_n = c^* ln\ n/F^*_{AP}, \qquad \delta_n \leq (e/n)^{0.38},$$

where c^* – the maximal element of distance matrix, F^*_{AP} – optimal value of objective function in related Assignment Problem. Some conditions when the algorithm is asymptotically exact (i.e. above mentioned estimates go to 0 as $n \to \infty$) are presented as well. Moreover, these results hold in a more general case when the columns of a distance matrix are random n-vectors with the symmetric function of joint distribution.

Wednesday, August 31, 16:30, Room H106

Efficient Algorithms and Proof of Polyhedral Characterization for the Fixed Charge Single Source Network Flow Design Problem in Series-Parallel Graphs

Michel Schaffers, Université Catholique de Louvain, Belgium

The Fixed Charge Single Source Network Flow Design problem is the problem of building a network in a directed graph, such that every commodity can be shipped from a common source node to its own sink node by arcs of the network. In the version we consider here, the cost in an arc is constituted of a fixed amount, if the arc is used, plus a variable amount proportional to the volume of commodities flowing through the arc.

We describe an efficient algorithm that solves this problem if the graph is Series-Parallel.

Further, we present some linear formulations of the problem, and prove a polyhedral characterization when the graph is Series-Parallel.

Relations beween the character Series-Parallel of the graphs, the efficiency of algorithm and the proof of the polyhedral characterization are emphasized.

Wednesday, August 31, 16:30, Room H110

Flexibility in Flow Networks

Graciela Nasini, Universidad Nacional Rosario, Argentina

Based on the Flexible Heat Exchanger Network Design Problem in Chemical Engineering, we introduce the concept of Flexibility in Flow Networks: a subnetwork is flexible for a set S of capacity vectors if the max-flow value in the subnetwork and in the original network coincide for each capacity vector in S.

We investigate sufficient conditions for a subnetwork to be flexible when the set S is of the form

$$(c_{ij}) : l_{ij} \leq c_{ij} \leq u_{ij} \qquad \text{for each} \quad i, j$$

where l_{ij} and u_{ij} are given, and the computational complexity of the problem of deciding whether a given subnetwork is flexible for sets S of this form.

The results presented in this paper are

- A sufficient condition of the type "A subnetwork is flexible for the set S (S as above) if it is flexible for all the extreme points of S".
- A necessary condition of the type "There are some networks where it is necessary to be flexible for all the extreme points of S to guarantee flexibility for S"
- A Mixed Integer Linear Model of the problem to decide if a given subnetwork of a Transportation Network (modelling Heat Exchanger Networks) is flexible for S.

Thus we introduce a novel problem, we give some theoretical results and a model for the applications to Heat Exchanger Networks. We present a few open problems related to this subject.

Wednesday, August 31, 17:00, Room H110

A Vehicle Routing and Scheduling Problem with Time Windows

Bronisław Florkiewicz, Technical University of Wroclaw
MichałKulej, Technical University of Wroclaw

The following generalization of m–travelling salesman problem with time windows is considered. The fleet of vehicles are to serve a set of customers. The route is a sequence of customers beginning and ending at the depot. A vehicle can be assigned to serve more than one route.

The problem is to determine the routes and schedules for the vehicles so that each customer is served within a specific time window, while total travel time for the vehicles is minimized.

A heuristic method for solving this problem is presented using feasibility and optimality conditions of time schedules.

Wednesday, August 31, 17:00, Room H106

Solving Asymmetric Travelling Salesman Problems with Side Constraints by Branch&Cut

Norbert Ascheuer, Konrad–Zuse–Zentrum für Informationstechnik Berlin (ZIB)

We consider the following problem that arises, e.g., in Flexible Manufacturing: Given n jobs to be performed on one machine, setup costs between the jobs and precedence relationships between them, in the form that certain jobs have to be executed before another job can start. The question is to find a sequence of the jobs that miminizes the overall setup costs and does not violate the given precedences. This is known as the Sequential Ordering Problem and can be modelled as an Asymmetric Hamiltonian Path Problem with side constraints.
We present different models, several classes of valid inequalities, a polyhedrally based Branch & Cut approach to solve the problem to optimality, and computational results on real–world instances up to 100 jobs.

Wednesday, August 31, 17:30, Room H106

Methods and Strategies for Robust Combinatorial Optimization

Manuel Laguna, University of Colorado at Boulder

Robust Optimization (RO) was recently proposed to provide a practical approach for handling noisy data and uncertainty. Almost all decision problems in practice contain certain degree of uncertainty, e.g., rates of return for different investment opportunities, demands for products and services, the time to complete a job, the amount of resources needed to complete an activity in a large project, etc. The RO approach has only been used in problems where the decision variables are real numbers, and where the models are mostly linear. This paper, proposes to expand the robust optimization methodology to deal with decision problems where some of the relevant variables are discrete (either zero-one or general integer variables). This is an important enhancement of the RO approach given that a large number of business problems can be modeled using discrete optimization formulations (e.g., investment decision, production and staff scheduling, air line crew scheduling, research and development project selection, etc.) The large size of discrete RO formulations makes the use of classical solution techniques impractical. We develop solution methodologies that can effectively deal with discrete RO models.

Wednesday, August 31, 17:30, Room H110

The Tuning of the Threshold Accepting Heuristic for Traveling Salesman Problems - Results of a Simulation Study

Peter Winker, Universität Konstanz

The Travelling Salesman Problem is investigated as one of the most famous problems in discrete optimization. As many other discrete optimization problems it belongs to the class of $\mathcal{NP}$-complete problems. Thus, the use of optimization heuristics seems indicated. A TSP with 442 points and known optimal solution is used to compare three multiple purpose optimization heuristics based on local search. For the best performing one, the Threshold Accepting algorithm, a simulation study demonstrates the crucial influence of the choice of optimization parameters. The influence of the parameter determining the threshold sequence on the results seems to be quite deterministic and rather independent of the number of iterations performed. Therefore, the parameters might be choosen by some automatic based on the local structure of the problem. The length of the best tour obtained using this method is as close as 0.05% to the optimal one.

Wednesday, August 31, 18:00, Room H106

Motion Planning in a Changing Environment

Valentin E. Brimkov, Bulgarian Academy of Sciences
Svetoslav Petrov, University of Sofia

The subject of the paper is a variant of the Motion Planning Problem - central one in Robotics: Given a robot R and its environment, to plan an obstacle avoiding path of R from an initial to some final position. In addition, our model presumes appearing of some changes in the environment during the problem solving.

We concentrate our attention on the case when R is a straight-line segment that moves among polygonal obstacles, and we suppose that during the motion some new obstacles (line segments) could appear, and other could disappear (for example it could be imagined that at some stage an obstacle must be picked up by the robot and moved to another place, which leads to changes in the environment, and eventually in the moving system).

The paper presents algorithms for fast local updating the environment description (and the data structures used) after every change, that permits to save considerable computational resources.

Wednesday, August 31, 18:00, Room H110

Approximation Algorithms for the ATSP

Giovanni Righini, Technische Universiteit Eindhoven
Marco Trubian, Politecnico di Milano

Computational complexity theory allows to classify combinatorial problems and it does not take into account the data of any particular instance. However when a particular instance of an NP-hard optimization problem has to be solved it is possible to achieve more insight about how difficult is to find its optimal solution by exploiting information contained in input data.
We consider the ATSP and we look for the largest set of instances such that a polynomial-time approximation algorithm providing a constant worst-case ratio is applicable. For this purpose we use polynomial-time approximation algorithms originally developed for the Stacker-Crane Problem and we derive sufficient and meaningful conditions for ATSP instances to be solvable within worst-case bounds equal to 3, 15/7 and 9/5.

Thursday, September 1, 09:00, Room H110

Reverse-Fit: A 2-Optimal Algorithm for Packing Rectangles Two Dimensional Packing Problem

Ingo Schiermeyer, Technische Hochschule Aachen

In this paper we describe and analyze a "level-oriented" algorithm, called "Reverse-Fit", for packing rectangles into a unit-width, infinite-height bin so as to minimize the total height of the packing. For L an arbitrary list of rectangles, all assumed to have width no more than 1, let h_{OPT} denote the minimum possible height within in the rectangles in L can be packed, and let $RF(L)$ denote the height actually used be Reverse-Fit. We will show that $RF(L) \leq 2 \cdot h_{OPT}$ for an arbitrary list L of rectangles.

Key words: level-oriented packing algorithm, bin-packing, two-dimensional packing, k-rectangle packing problem, rectangle packing conjecture

Thursday, September 1, 09:00, Room H106

Generalized Path Inequalities for the Asymmetric Traveling Salesman Problem

Egon Balas, Carnegie Mellon University

We introduce a new class of inequalities for the asymmetric traveling salesman (TS) polytope, which generalizes the path or star inequalities. The latter have been shown both theoretically and experimentally in the case of the symmetric TS polytope to provide stronger bounds than comb or clique tree inequalities. Our inequalities are asymmetric and of high rank. We give their Chvátal derivation and show that subject to a mild restriction they are facet defining.

Thursday, September 1, 09:30, Room H106

Some New Results on Supermodular Polyhedra in Machine Scheduling

Maurice Queyranne, The University of British Columbia
Andreas S. Schulz, Technische Universität Berlin

For some machine scheduling problems the feasible schedules are uniquely determined by their associated job completion time vectors. It has recently been observed that for the simple single machine problem the convex hull of all feasible completion time vectors is a linear transformation of a supermodular polyhedron. We extend this result in the case of unit processing times to parallel machines, either uniform or identical with integer job release dates. Complete and minimal linear descriptions for the polyhedra associated with these problems are presented. Since these descriptions are also defining systems of supermodular polyhedra, the generalizations of Smith's rule to these problems are special cases of the general framework of the greedy algorithm for supermodular polyhedra. In addition, we point out an extension of our results to the parallel machine scheduling problem with planned machine maintenance intervals and with machines varying in their speed.

Thursday, September 1, 09:30, Room H110

Parallel Tabu Search for Two-Dimensional Cutting

Jacek Błazewicz, Technical University of Poznań
Rafal Walkowiak, Technical University of Poznań

The problem of cutting figures of various shapes out from the rectangular area is considered. The method proposed is based on the tabu search metaheuristic adapted for the problem. This includes defining the neighborhood, various types of moves and search strategies. The exact algorithm for finding placement of the polygon in the polygon has been used in order to enhance the quality of solutions. The parallel version of the algorithm has been proposed and implemented for the transputer environment. The experimental results are accompanied by a discussion and comments concerning the future research.

Semi-Plenary Lecture
Thursday, September 1, 10:30, Room H110

Global Optimization and Location Theory

Pierre Hansen, Gerad-Ecole des HEC

Global optimization methods have made progress recently. The tools thus made available for d.-c., concave and non convex programming, i.e. continuous branch-and-bound, outer-approximation and vertex enumeration, etc, have significantly enlarged the class of solvable problems in several domains of application. Recent methods and their uses in location theory are reviewed. Applications include multifacility location for profit maximization under various price policies, the Weber problem with attraction and repulsion, the Weber problem on the sphere and the multisource Weber problem.

Thursday, September 1, 14:00, Room H106

Regular Partitions and Cuts in Integer Programming

Alexander A. Kolokolov, Institute of Information Technologies and Applied Mathematics at Omsk

We develop an approach in integer programming, which is based on the application of regular partitions of the Euclidean space. Using such partitions we have obtained some theoretical and experimental results in considered field.

In this work we give a survey of above results and new ones. It includes description of regular space partitions, in particular, of L-partition, investigation of L-structure of integer programming problems (IPP) and of regular cut class, upper and lower bounds of iterations (cuts) number for fractional cutting plane algorithms, L-class enumeration and hybrid algorithms for solving of IPP, application of the approach to some branch and bound algorithms, results of computer experiments.

Thursday, September 1, 14:00, Room H110

Parallel Cutting Stock Algorithms

Csaba Fabian, Academy of Economic Studies, Bucharest

A two-dimensional cutting stock problem and a solving algorithm for Neumann type computer is presented. The algorithm has three steps:

- directed simulation, according of a discret repartition function deduced from required quantities of pieces to be cut,
- technological feasible placing of pieces on the support according to cutting machine using several packing methods,
- simplex iterations according column generation method.

The parallelization are made on all steps of this algorithms and we get three types of parallel algorithms: for two processors, for several processors and for any number of processors. Consideration for balanced using of parallel processors during the cutting stock algorithms are also made.

Thursday, September 1, 14:30, Room H110

Cutting Stock by Iterated Matching

Andreas Fritsch, Universität Osnabrück
Oliver Vornberger, Universität Osnabrück

The combinatorial optimization problem considered in this paper is a special two-dimensional cutting stock problem arising in the wood, metal and glass industry. Given a demand of non-oriented small rectangles and a theoretically infinite set of large stock rectangles of given lengths and widths, our aim is to generate layouts specifying how to cut the demand out of the stock rectangles. Only guillotine cuts are permitted. We are looking for layouts whose waste is minimal. We developed an iterative algorithm for solving this problem heuristically. With help of a maximum weight matching, known from combinatorial optimization, we match in every iteration step suitable rectangles and consider the matched pairs as new, so called meta-rectangles. These meta-rectangles can be treated in the same way as ordinary rectangles. Furthermore, we use shape-functions, known from floorplaning problems, so that the orientations of the demand rectangles are not fixed until the layout has been computed. The algorithm, programmed in C, has been tested with several instances, containing between 50 and 100 rectangles, taken from real demands of a glass factory. The resulting layouts, calculated within a few minutes (on a 486-PC), have an average waste of less than 5 percent.

Thursday, September 1, 14:30, Room H106

Revisiting Subgradient Techniques Applied to 3D Linear Assignment Problem

Alexandre Tusera, Inst. N. de Recherche en Inf. et en Aut., Rocquencourt
Dominique Fortin, Inst. N. de Recherche en Inf. et en Aut., Rocquencourt

A subgradient technique which relies on a local approximation of the AP3 polytope is proposed. On the one hand, it improves over standard subgradient enhanced with a whole class of facets, since it requires far less facets; furthermore, the selected facets are more accurate with respect to the gap between a relaxed solution and a feasible one. On the other hand, it compares favorably to the Bundle-Trust method which is based on a subgradient approximation. Apart from this method, a Monge sequence is devised on a substructure local to relaxed/feasible gap, that affords us to recover from zig-zagging in some pathological cases.

Thursday, September 1, 15:00, Room H110

Modelling of Packing Problems

Guntram Scheithauer, Technische Universität Dresden

In this paper the modeling of packing problems (cutting and allocation problems) is investigated.

Especially, linear mixed-integer models are proposed for two-dimensional packing problems of convex and non-convex polygons. The models are based on the so-called (outer) hodograph and the inner hodograph. Rotations of the polygons are not allowed.

The principles of modeling in the two-dimensional case can be applied also for three- and higher dimensional packing problems.

Thursday, September 1, 15:00, Room H106

The General Integer Quadratic Programming Problem

Nguyen van Thoai, Universität Trier

We consider the problem of minimizing a general quadratic function over a polytope in the n-dimensional space with integrality restrictions on all of the variables. (This class of problems contains, e.g., the quadratic 0–1 program as a special case).

A finite solution method of branch and bound type is proposed in which the branching procedure is the so–called "integral rectangular partition" and the bound estimation is performed by solving either a concave programming problem with a special structure or some linear programs.

Thursday, September 1, 15:30, Room H106

Faces and Graphs of Cut Polyhedra

Antoine Deza, Université de Paris-Sud, Orsay, France
Michel Deza, CNRS-LIENS, Ecole Normale Supérieure, Paris, France.

The cut polytope is the $\binom{n}{2}$-dimensional polytope generated by all the cuts of the complete graph on n nodes. One of the applications of the cut polytope, the polyhedral approach to the maximum cut problem, leads to the study of its facets. We present some results concerning the facets, the vertices, the face-lattice and the shape of the cut polytope and related cut polyhedra.

Thursday, September 1, 15:30, Room H110

A New Parallel Branch-and-Bound Method to Solve the 2-dim Guillotine Cutting Stock Problem

Burkhard Monien, Universität Paderborn
Norbert Holthöfer, Universität Paderborn
Stefan Tschöke, Universität Paderborn

Many combinatorial optimization problems are solved with branch-and-bound methods. In recent years a lot of work was done to parallelize sequential branch-and-bound algorithms, most of them were tailored to special applications and special architectures with their own programming environments.

Based on our own experiences concerning load-balancing and parallel branch-and-bound we build a toolset of library functions, that allow an easy way of porting a sequential branch-and-bound algorithm to a parallel system. The portable parallel branch-and-bound library consists of an application interface, a loadbalancing interface and local queue management.

With this library we developed and implemented a new efficient parallel best-first branch-and-bound algorithm for solving the contrained two-dimensional guillotine cutting stock problem.

The underlying sequential algorithm computes very good upper bounds by a combination of the dynamic programming recursion of Gilmore and Gomory (1966) and a knapsack problem.

We present an efficient parallel algorithm which guarantees the same behaviour as the underlying sequential best-first algorithm, although the degree of nodes in the search tree increases during computation and is in worst case O(number of heapelements). Results of benchmark instances will be presented.

Friday, September 2, 10:30, Room H110

Multicriterial and Restricted Location Problems with Polyhedral Gauges

Stefan Nickel, Universität Kaiserslautern

Given a finite set $Ex = \{Ex_1, Ex_2, \ldots, Ex_M\}$ in the plane, a forbidden region $\mathcal{R}$, we want to find a point $X \notin int(\mathcal{R})$, such that

$$\sum_{i=1}^{M} w_i \gamma_{Ex_i}(X - Ex_i)$$

is minimized.

This is a variant of the well-known Weber Problem, where we measure the distance with polyhedral gauges. The unit ball of a polyhedral gauge may be any convex polyhedron containing the origin. This large class of distance functions allows very general (practical) settings – such as asymmetry – to be modeled. Each Ex_i is allowed to have its own gauge γ_{Ex_i} and the forbidden region $\mathcal{R}$ enables us to include negative information in the model.

Efficient algorithms and structural properties for that non-convex optimization problem based on combinatorial methods are presented.

Also the multicriterial case and the connection to point-objective location problems is discussed.

Friday, September 2, 10:30, Room H106

Special Cones of Rank Functions

Eberhard Girlich, Otto-von-Guericke-Universität Magdeburg
M.Höding, Otto-von-Guericke-Universität Magdeburg
Gabriele Schneidereit, Otto-von-Guericke-Universität Magdeburg
Alexander Zaporozhets, Belarus State University Minsk

Many practical discrete optimization problems have a submodular, increasing objective function or the feasible solution set of these problems can be described by a submodular, increasing function.

The cone $A(n)$ of all rank functions r (submodular, increasing and normalized ($r(\emptyset) = 0$) is finitely generated.

We investigate properties of subcones of rank functions, which are generated by special rank functions. Especially we consider the subcones $Mo(n)$ (generated by modular rank functions), $H(n)$ (by Boolean), $S(n)$ (by symmetric), $M(n)$ (by Matroid rank functions) and $L(n)$ (generated by the rank functions of semimodular lattices). The cone $C(n)$ of all "plant-location-functions" is equal to the subcone $H(n)$.

Friday, September 2, 11:00, Room H110

Complex of Discrete Optimization Algorithms for Spacecraft Optimum Design

Olga Semenkina, Siberian Aerospace Academy
Valery Garipov, Siberian Aerospace Academy
Eugene Diakov, Siberian Aerospace Academy
Sergey Vakhtel, Siberian Aerospace Academy

As it was suggested in (Semenkin, 1992), search discrete optimization methods for implicit functions can be used by solving of problems of optimum design and technology process optimum control in aerospace industry.

Local search algorithms for such problems was developed and some real world problems have been solved. These algorithms realize normal local descent ideology with different neighbourhood systems and different ways of locality seeking. It has been made a comparison of algorithms by results and expenditures for optimization. Algorithms have usual disadvantages for local descent .

It was made attempt to improve global convergence of algorithms by using of randomness in accordance to three main approaches, namely genetic algorithms ideas, tabu search and simulating annealing. Corresponding algorithms was used for solving of test problems and their comparison with normal local descent algorithms has been fulfilled.

Reference (Semenkin, 1992) E.Semenkin Search discrete optimization for CAD of spacecrafts. Optimization-Based Computer-Aided Modeling and Design - 2nd Working Conference of the IFIP-TC 7 Work.Group 7.6., Schloss Dagstuhl, 1992.

Friday, September 2, 11:00, Room H106

Non-simple Polymatroids of Degree 2 and 3

Eberhard Girlich, Otto-von-Guericke-Universität Magdeburg
M. Höding, Otto-von-Guericke-Universität Magdeburg
Gabriele Schneidereit, Otto-von-Guericke-Universität Magdeburg
Alexander Zaporozhets, Belarus State University Minsk

In our talk we consider polymatroids, which are special polytopes that can be described by submodular, increasing and normalized rank functions r. A vertex x of an n-dimensional polymatroid is called non-simple of degree d, if x is on exactly $n + d$ facets. An n-polymatroid is called non-simple of degree d, if there is a vertex which is non-simple of degree d, and if there is no vertex which is non-simple of degree t $(t > d)$.

There are known necessary and sufficient conditions for the non-simplicity of polymatroids, but these conditions give no information about the degree of non-simplicity. Therefore, we will give some conditions for non-simplicity of degree 2 and 3.

Friday, September 2, 11:30, Room H106

The Cone of Semimodular Rank Functions

Eberhard Girlich, Otto-von-Guericke-Universität Magdeburg
Gabriele Schneidereit, Otto-von-Guericke-Universität Magdeburg
Alexander Zaporozhets, Belarus State University Minsk

We introduce one new subcone of the cone of rank functions which are defined on subsets of the set $\{1, 2, \ldots, n\}$. We call it the cone of semimodular rank functions and denote by $L(n)$. The characterization of the extremal functions of this cone is given. We show that the cone $L(n)$ contains all subcones of the cone of rank functions known to this time. We establish the correspondence between the extremal functions of the cone $L(n)$ and the extremal functions of the cone of matroid rank functions $M(n)$. We investigate the non-simplicity of the extremal functions of the cones $M(n)$ and $L(n)$, too.

Friday, September 2, 11:30, Room H110

Greedy Algorithms for On-Line Data Compression

József Békési, JGYTF Szeged
Gábor Galambos, JGYTF Szeged
Ulrich Pferschy, TU Graz
Gerhard J. Woeginger, TU Graz

We consider text-compression where substrings of the original text are substituted by code-strings according to a static dictionary.

As the optimal compression can not be performed in reasonable time, very efficient on-line compression algorithms are used. For a worst-case analysis we study the worst possible compression ratio for any text-string (i.e. the length of the code-string generated by an on-line algorithm vs. the shortest possible code-string) based on a fixed dictionary. This ratio depends on the properties of the underlying dictionary and on parameters of its entries.

For the longest matching and the differential greedy algorithm we improve and complete the previously known results. Further on, we introduce and analyze the fractional greedy algorithm.

We give worst-case bounds on the compression achieved by these algorithms for all usually studied types of dictionaries. Moreover, we show that all these bounds can be attained.

Friday, September 2, 12:00, Room H106

A New Look at the Greedy Algorithm

Walter Wenzel, University Augsburg

Oriented matroids are combinatorial abstractions of finite geometric configurations in vector spaces over some ordered field. In a similar way, A.W.M. Dress and the author introduced the concept of a valuated matroid which may be interpreted as an abstraction of matroids representable over a field with a nonarchimedean valuation. It is shown that valuated matroids may be characterized by the fact that some variant of the Greedy Algorithm works. As an application, one can compute the diameter of a weighted tree in linear time. Furthermore, we extend this algorithm to A. Bouchet's Δ-matroids and show that it works exactly for "valuated Δ-matroids". Examples come from valuation theory via skew symmetric matrices. This follows from an identity concerning Pfaffians quite similar to the well-known Grassmann-Plücker identity for determinants.

Friday, September 2, 15:30, Room H110

Binpacking with Randomly Distributed Items

Walter Goessens, Universität Antwerpen

One-dimensional binpacking is a combinatorial problem consisting in finding the optimal way of packing a number of items into 'bins' of given size. An optimal packing is one that minimizes the number of bins used. The appropriate way of solving these problems are heuristics. In this paper, we will present some results, in case the lengths of the items to pack are randomly distributed.

Friday, September 2, 16:00, Room H110

Probabilistic Analysis of Some Generalized Knapsack Problems

Krzysztof Szkatula, Syst. Res. Inst., Polish Academy of Sciences

Let us consider the $m-$dimensional binary knapsack problem:

$$z_{OPT}(n) = \max \sum_{i=1}^{n} c_i \cdot x_i$$

$$\text{subject to} \quad \sum_{i=1}^{n} a_{ij} \cdot x_i \leq b_j(n)$$

$$\text{where} \quad j = 1, ..., m, \quad x_i = 0 \ \ or \ 1$$

The following random model of the $m-$dimensional binary knapsack problem is considered:

- $n \to \infty$, m bounded, $i = 1, ..., n \ \ j = 1, ..., m$.
- c_i, a_{ij} are realizations of mutually independent, uniformly distributed over $(0, 1]$ random variables.
- $b_j(n)$ deterministic and there exists constant δ, $b_j(n) > \delta$.

Goal of this presentation is to exhibit asymptotical growth of the $z_{OPT}(n)$.

Two cases of the constraints right hand sides are under consideration:

1) If $\frac{b_j^{m+1}(n)}{b_1(n) \cdot b_2(n) \cdot \ldots \cdot b_m(n)} \leq \frac{1}{(m+1)!}$, $j = 1, ..., m$ then $z_{OPT}(n) \sim (m+1) \cdot (\frac{b_1(n) \cdot b_2(n) \cdot \ldots \cdot b_m(n)}{(m+2)!})^{\frac{1}{m+1}}$.

2) If $\frac{(3m-1) \cdot m}{12} \leq \sum_{j=1}^{m} b_j(n) \leq \frac{m \cdot n}{2}$ then $z_{OPT}(n) \sim \frac{1}{3m+1}(\frac{n}{2} + 6 \cdot (\sum_{j=1}^{m} b_j(n) + \frac{6}{n} \cdot \sum_{j=1}^{m} \sum_{k=j+1}^{m} b_j(n) \cdot b_k(n) - \frac{3m-2}{n} \sum_{j=1}^{m} b_j^2(n)))$

Friday, September 2, 16:30, Room H110

Solving Multiple Knapsack Problems by Cutting Planes

Carlos Ferreira, Universidade de São Paulo, Brazil
Alexander Martin, Konrad-Zuse-Zentrum Berlin
Robert Weismantel, Konrad-Zuse-Zentrum Berlin

In this talk we consider the Multiple Knapsack Problem which is defined as follows: Given a set N of items with weights f_i, $i \in N$, a set M of knapsacks with capacities F_k, $k \in M$, and a profit function $c_{ik}, i \in N, k \in M$; find an assignment of a subset of the set of items to the set of knapsacks that yields maximum profit (or minimum cost). This problem arises as a subproblem in several practical applications like layout of eletronic circuits and design of processors for mainframe computers. With every instance of this problem we associate a polyhedron whose vertices are in one to one correspondence to the feasible solutions of the instance. For this polytope we present several new classes of inequalities and work out necessary and sufficient conditions under which the corresponding inequalities define facets. Some of these conditions involve only properties of certain knapsack constraints, and hence, apply to the generalized assignment polytope as well. We use this inequality description to develop a branch and cut algorithm. We will sketch some of the implementation details of this algorithm including separation and primal heuristics and report on our computational experiences with several practical problem instances.