M I P   2 0 0 9

Workshop on Mixed Integer Programming

University of California, Berkeley

June 8–11, 2009

Welcome to MIP 2009!

Dear colleagues,

It is a great pleasure for the organizing committee to welcome you to MIP 2009 at UC Berkeley! MIP workshops run from the energy and direct contributions of mixed integer optimizers all over the world. While mixed integer programming has a long history, MIP workshops are relatively new. The workshop series is designed to bring together the integer programming research community in an annual meeting and pays particular attention to highlight the works of junior researchers.

This year we are gathering for our sixth meeting. MIP 2009 is a continuation of a founding workshop held at Columbia University in New York in 2003, and the workshop series MIP 2005, MIP 2006, MIP 2007 and MIP 2008 held at the IMA in Minneapolis, at the University of Miami, the Centre de Recherches Mathématiques at the University of Montreal, and at Columbia University. For more information on the MIP Workshop Series, please check our Google web site:

`http://sites.google.com/site/gimmemip/`

We have put together a diverse program representing the many trends and challenges of our field. The workshop program includes 25 invited talks and 19 poster presentations selected among a large number of submissions.

We hope together we will continue the strong growth of mixed integer programming for many years to come and look forward to seeing you again in MIP 2010!

MIP 2009 Organizing Committee

Alper Atamtürk, Industrial Engineering & Operations Research, UC Berkeley
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We are grateful to our sponsors:

We are able to keep the registration for MIP 2009 free of charge and provide partial travel support to students and post-docs due to generous contributions of our sponsors. The organizing committee gratefully acknowledges the financial support of MIP 2009 sponsors listed below. We also thank the ISE department of **Ohio State University** and IEOR department of **UC Berkeley** for their contributions.

ILOG, an IBM Company, continues to set the gold standard in the optimization field. We offer the most advanced optimization development package, the IBM ILOG OPL-CPLEX Development System, for solving the most challenging optimization problems in business or research. More than 1,000 universities and 1,000 commercial customers make smarter decisions every day with ILOG technology. Experience what it's like to work with some of the smartest people in optimization, who create the smartest optimization products available, and are now backed by the resources of two of the smartest companies in the world - IBM and ILOG. We'll give you the tools you need to make YOU smarter, so you can experience smarter optimization for smarter decisions within your organization.

The General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical programming and optimization. It consists of a language compiler and a stable of integrated high-performance solvers. GAMS is tailored for complex, large scale modeling applications and allows you to build large maintainable models that can be adapted quickly to new situations.

The INFORMS Optimization Society seeks to promote the development and application of optimization methods and software tools for the solution of problems in Operations Research and Management Science, and to encourage the exchange of information among practitioners and scholars in the optimization area. The Society awards the Farkas prize for mid-career researchers, the prize for young researchers, and a student paper prize. In addition to sponsoring sessions at the INFORMS annual meeting, the Society organizes its own specialized conference in optimization every two years. The Society currently has over 800 members.

Microsoft is proud to present the Microsoft Solver Foundation the first 360 degree platform and framework for adaptive business insight and planning. A brand new system built entirely within the .Net/CLR system, it provides a rich set of tools, services, and engines to aid companies in their continuous quest for operational efficiency, profit maximization, and risk management. Solver Foundation is designed to help businesses make these (near) optimal, strategic decisions. We refer to this as adaptive business insight and planning.

The MOSEK Optimization Software is designed to solve large-scale mathematical optimization problems. MOSEK provides specialized solvers for linear programming, mixed integer programming and many types of nonlinear convex optimization problems. For continuous problems MOSEK implements both simplex and interior-point based algorithms. For mixed integer problems MOSEK implements a branch and bound and cut algorithm. MOSEK is capable of exploiting multiple processors.

The Gurobi optimization engines represent the next generation in high-performance optimization software. They have been designed from the ground up to fully exploit the latest mathematical and engineering improvements in the underlying methodologies, as well as developments in modern desktop computing hardware and programming environments. Version 1.0 of the Gurobi suite of products will be released through several modeling language vendors in January, 2009, and as a stand along product in April, 2009. Subsequent releases will incorporate quadratic programming, second-order cone programming, and their mixed-integer counterparts.

No matter where discovery takes place, IBM Researchers push the boundaries of science, technology and business to make the world work better. Our global network of scientists work on a range of applied and exploratory research projects to help clients, governments and universities apply scientific breakthroughs to solve real-world business and societal challenges.

For almost three decades, LINDO Systems has been a leader in providing fast, easy to use optimization tools. LINDO offers three products based on industrial strength solvers for linear, quadratic, nonlinear, integer and global optimization. LINGO provides a powerful modeling language and convenient data options to make building optimization models fast and easy. What'sBest! allows Excel users to easily build large optimization models directly in spreadsheets. LINDO API allows application developers to plug the power of the LINDO solvers right into customized applications.

Note: Sponsors are listed in the order of their contributions, ties broken alphabetically.

Schedule

Monday, June 8

9:00-9:45		Registration
9:45-10:00		Welcome Session
10:00-10:30	Agostinho Agra	Mixing Polyhedra with Non-Divisible Coefficients
10:30-11:00	Kiavash Kianfar	n-step Mingling Inequalities and Their Facet-Defining Properties for Mixed Integer Knapsack Sets
		BREAK
11:30-12:15	Shmuel Onn	n-Fold Integer Programming and Multicommodity Flows
12:15-12:45	Raymond Hemmecke	Optimality Certificates, n-fold IPs and Nash Equilibria
		LUNCH BREAK
2:30- 3:15	Paolo Toth	Formulations and Algorithms for the Train Platforming Problem
3:15- 3:45	Ming Zhao	Branch-and-Cut for the Unit Commitment Problem
3:45- 4:15	Richard Karp	Implicit Hitting Set Problems
4:45- 7:00		POSTER SESSION AND RECEPTION (Alumni House)

Tuesday, June 9

9:45-10:30	Friedrich Eisenbrand	Integer Programming and Real-Time Scheduling
10:30-11:00	Hande Yaman	The Robust Network Loading Problem Under Polyhedral Demand Uncertainty
		BREAK
11:30-12:00	Vishnu Narayanan	The Submodular Knapsack Polytope
12:00-12:45	Andrea Lodi	Quadratic {-1,0,1} Optimization
		LUNCH BREAK
2:30- 3:15	Gerard Cornuéjols	Cutting Planes and Maximal Lattice-Free Convex Sets
3:15- 4:00	Ricardo Fukasawa	Master Equality Polyhedron with Multiple Rows
4:00- 4:45	Santanu Dey	Split Rank of Triangle and Quadrilateral Inequalities
7:00-		WORKSHOP DINNER (Downtown Restaurant)

Wednesday, June 10		
9:45-10:30	Renata Sotirov	Algebraic Symmetry in Semidefinite Programs
10:30-11:00	Angelika Wiegele	An SDP Relaxation for Sparse Max-Cut Problems
	Break	
11:30-12:15	Bernd Sturmfels	Convex Algebraic Geometry
12:15-12:45	Pablo Parillo	Interpolation-Based SOS Convex Relaxations
	Lunch Break	
2:30-3:00	George Nemhauser	Lifted Inequalities for 0-1 Mixed Integer Programs: A Computational Study
3:00-3:30	Thorsten Koch	LP/MIP/MINLP Challenges
3:30-4:00	Sanjay Mehrotra	A Method for Rounding a Continuous Solution
	Break	
4:15- 5:00	Roundtable Discussion (Etcheverry 3110)	

Thursday, June 11		
9:45-10:30	Dan Bienstock	Solving Convex Objective, Nonconvex Constraint Problems
10:30-11:15	Anureet Saxena	Convex Relaxations of Non-Convex Mixed Integer Quadratically Constrained Programs
	Break	
11:30-12:15	Jeff Linderoth	Flexible Isomorphism Pruning
12:15-12:45	Pietro Belotti	Disjunctions in Nonlinear MIP: Branching Techniques and Disjunctive Cuts
12:45- 1:00		Concluding Session

Speaker Abstracts

Agostinho Agra (Universidade de Aveiro, Portugal)

Mixing Polyhedra with Non-Divisible Coefficients

One approach to derive strong valid inequalities for general mixed-integer problems is to (i) consider/identify simple substructures (sets) arising in these general problems; (ii) derive facet-defining inequalities for the convex hull of the simple sets; (iii) use these facet-defining inequalities to derive strong valid inequalities for the general sets.

Here, we consider a mixed integer set, X, involving only two integer coefficients which is a subset arising in several mixed-integer problems such as lot-sizing problems. In order to describe the convex hull of X ($\text{conv}(X)$), we decompose X into a small number of subsets whose convex hull description is trivial. The convex hull of X is equal to the closure of the convex hull of the union of those polyhedra which have a higher-dimensional representation as a linear program. From the projection of this higher-dimensional formulation we obtain an implicit linear description of the $\text{conv}(X)$. Then by studying the projection cone we characterize all the facet-defining inequalities of $\text{conv}(X)$ in the space of the original variables.

We discuss the relation of X with other mixed-integer sets focusing on (i) the relevance of studying $\text{conv}(X)$ and (ii) the relation between the inequalities derived from $\text{conv}(X)$ with well-known inequalities of related sets such as the so-called mixed MIR inequalities.

(Joint work with Miguel Constantino)

Pietro Belotti (Lehigh University, USA)

Disjunctions in Nonlinear MIP: Branching Techniques and Disjunctive Cuts

Exact solvers for Mixed-Integer Nonlinear Programming (MINLP) problems have to cope with two types of nonconvexity: the integrality of variables and continuous nonconvex functions. Both types of nonconvexity can be dealt with by means of disjunctions, that divide the feasible set in two or more subsets.

In order to solve MINLP problems to optimality, Branch & Bound algorithms typically apply disjunctions at the branching step, however the use of disjunctive cuts, i.e., valid inequalities based on disjunctions of the feasible set, proved to be effective in the Mixed-Integer Linear case and, recently, also in Mixed-Integer Quadratic Programming.

We discuss a straightforward extension of disjunctive cuts to a general MINLP solver and present some computational results to assess the use disjunctions in both the branching and the cutting plane steps.

Daniel Bienstock (Columbia University, USA)

Solving Convex Objective, Nonconvex Constraint Problems

We describe continuing work on solving problems where the objective is convex while the feasible region is not, even though the actual variables used to model the problem are continuing. A classical example which is of importance is that of minimizing a convex quadratic, subject to linear inequalities and an upper bound on the number of nonzero variables – a cardinality constraint on the support.

We describe approaches that rely on methodologies from constrained eigenvalue optimization problems. These approaches yield bounds frequently far stronger than those obtained through polyhedral mixed-integer programming methods, and scale very well problem size. If time allows, we will also describe branching approaches based on these technique

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Gérard Cornuéjols (Carnegie Mellon University, USA)

Cutting Planes and Maximal Lattice-Free Convex Sets

In this talk we consider a semi-infinite relaxation of mixed integer linear programs. We show that minimal valid inequalities for this relaxation correspond to maximal lattice-free convex sets, and that they arise from nonnegative piecewise-linear positively homogeneous convex functions. The proof relies on an extension to linear subspaces of a theorem of Lovász stating that a maximal lattice-free convex set in $\mathbb{R}^n$ is either an irrational hyperplane or a cylinder over a polytope. This work is joint with Valentin Borozan for the first result and with Amitabh Basu, Michele Conforti and Giacomo Zambelli for the generalization of Lovasz's theorem.

Santanu S. Dey (Université catholique de Louvain, USA)

Split Rank of Triangle and Quadrilateral Inequalities

A simple relaxation of two rows of a simplex tableau is a mixed integer set consisting of two equations with two free integer variables and non-negative continuous variables. Recently Andersen et al. (2007) and Cornuejols and Margot (2008) showed that the facet-defining inequalities of this set are either split cuts or intersection cuts obtained from maximal lattice-free triangles and quadrilaterals. These new families of inequalities can be used to generate valid cutting planes from any two rows of a simplex tableau.

Through a result by Cook et al. (1990) (and more recently in a generalization by Li and Richard (2008)) it is known that one particular class of facet-defining triangle inequality does not have a finite split rank, i.e., it cannot be obtained by repeated application of split cuts. In this talk, we show that all other facet-defining triangle and quadrilateral inequalities have a finite split-rank. The proof is constructive, i.e., for a given facet-defining triangle or quadrilateral inequality we present an explicit sequence of split inequalities that can be used to generate it.

(Joint work with Quentin Louveaux)

Friederich Eisenbrand (Ecole Polytechnique Fédérale de Lausanne, Switzerland)

Integer Programming and Real-Time Scheduling

Real time scheduling is concerned with tasks which periodically release jobs, each of which has to be finished before a certain deadline. Such scheduling problems play an increasing role, since microprocessors are replacing mechanical devices to control and trigger safety-critical applications, for example in fly-by-wire and drive-by-wire. I will show in this talk how classical problems in real-time scheduling, like response-time-computation are related to classical problems in integer programming, in particular to Diophantine approximation. As a result, we will see that response-time computation of tasks is NP-complete. I will also present an approximation algorithm for the task-distribution problem, which has the objective to partition a task-system on a smallest number of processors in a feasible way. I close with open problems from the interplay of Real-Time scheduling and the theory of integer programming.

Ricardo Fukasawa (University of Waterloo and IBM Research, Canada/USA)

Master Equality Polyhedron with Multiple Rows

The Master Equality Polyhedron (MEP) is a canonical set that generalizes the Master Cyclic Group Polyhedron (MCGP) of Gomory and that can be used as a source of cutting planes for general mixed-integer programs. In a result analogous to Gomory's for the MCGP, we recently characterized all nontrivial facet-defining inequalities for MEP as extreme points of a "polar-type" polyhedron.

In this work, we study the MEP when it is defined by $m > 1$ rows. Unlike in Gomory's Master Polyhedron (the generalization of MCGP for $m > 1$ rows), we show that an analogous characterization of all facet-defining inequalities may not be as simple as in the single-row case. However, we show that separation can still be done efficiently in the cases $m = 2$ and $m = 3$.

Finally, in contrast to the Master Polyhedron case, where pairwise subadditivity of cut coefficients imply validity of the cut, we show that in the MEP case, subadditivity conditions with a number of terms subexponential in m is not sufficient to guarantee validity.

(Joint work with Sanjeeb Dash and Oktay Günlük)

Raymond Hemmecke (Otto-von-Guericke University, Germany)

Optimality Certificates, N-fold IPs and Nash Equilibria

In this talk I will present recent advances in the theory of optimality certificates (also known as test sets) for integer programs. I will describe a polynomial oracle-time algorithm to minimize a separable convex function over the lattice points in a polyhedron. Applying this algorithm to structured problems, such as N-fold integer programs, even yields a polynomial time algorithm for their solution. Based on this, I will present a polynomial time algorithm for finding a generalized Nash equilibrium for a family of integer programming games.

(This talk complements the talk by Shmuel Onn.)

Richard Karp (University of California, Berkeley, USA)

Implicit Hitting Set Problems

The weighted hitting set problem is stated as follows: given a finite set U, a positive weight for each element of U, and a family S of subsets of U, find a set of minimum total weight having a nomempty intersection with each set in S. This problem is equivalent to the weighted set cover problem. We consider an implicit version of the hitting set problem, in which the family of sets S is not given explicitly but is accessible via an oracle which, given a proposed hitting set set Q, either verifies that Q is a hitting set or returns a minimum-cardinality set from S that does not intersect Q. A large number of explicit NP-hard problems can be viewed as implicit hitting set problems. We give a general method for solving implicit hitting set problems and describe our computational experience with one such problem arising in genomics, involving the optimal alignment of multiple genomes.

(Joint work with Erick Moreno-Centeno)

Kiavash Kianfar (Texas A&M University, USA)

n-step Mingling Inequalities and Their Facet-Defining Properties for Mixed Integer Knapsack Sets

The n-step MIR inequalities (Kianfar and Fathi, 2008) are valid inequalities for the general mixed integer knapsack set, which are derived based on mixed integer rounding. An n-step MIR inequality can be generated by applying the corresponding n-step MIR function on the coefficients and right-hand side of the original inequality. The mingling inequalities (Atamtürk and Gunluk, 2007) are also derived based on mixed integer rounding and incorporate bounds on integer variables. The mingling and 2-step mingling inequalities have been shown to be facet-defining in many cases. In this talk, we show that the ideas behind n-step MIR and mingling can be used together to generate what we call n-step mingling inequalities for general mixed integer knapsack sets. Furthermore, we show that the n-step mingling inequalities are facet-defining for these sets if certain conditions on coefficients are satisfied (the facet-defining conditions for mingling and 2-step mingling inequalities are special cases of these conditions). This makes n-step mingling a novel method for generating facets for the general mixed integer knapsack set, and presents new facets for this set.

(Joint work with Alper Atamtürk)

Thorsten Koch (ZIB and TU Berlin, Germany)

LP/MIP/MINLP Challenges

It is reported (e.g., by CPLEX developers) that linear programs can today be solved about 5 million times faster than 20 years ago. Are there still any difficult LPs left? What about integer programs? Here the reported speedup is even larger. But how do we measure progress? What are our benchmarks? Considering real world applications, can we really solve most of what is needed in industry? This talk will provide some answers and report, in particular, about new challenges arising in practice.

(Joint work with Martin Grötschel)

Jeff Linderoth (University of Wisconsin, Madison, USA)

Flexible Isomorphism Pruning

Isomorphism Pruning is an effective technique for solving integer programs with many isomorphic solutions. Previous implementations of isomorphism pruning have had the limitation that the algorithm must use a restricted choice of branching variables during the branch-and-bound search. In this talk, we show how remove this limitation—modifying isomorphism pruning to allow for complete flexibility in the choice of branching variable. Computational results showing the benefit of this flexibility will be given.

(Joint work with Jim Ostrowski and Franęis Margot)

Andrea Lodi (University of Bologna, Italy)

Quadratic $\{-1, 0, 1\}$ Optimization

We present a fast branch-and-bound algorithm for the minimization of a convex quadratic objective function over integer variables subject to convex constraints. In a given node of the enumeration tree, corresponding to the fixing of some variables, a simple lower bound is given by the continuous minimum of the restricted objective function. We improve this bound by considering certain lattice-free ellipsoids that are centered in the continuous minimum and determined by a reduced lattice basis. Inside these ellipsoids, we compute the maximal scaling factor of the ellipsoid that is given by the quadratic objective function. This yields an improved lower bound for each considered ellipsoid. The main reason for the high performance of our algorithm in practice is that all expensive calculations can be done in a preprocessing phase, while the running time for a single node in the enumeration tree is at most quadratic in the problem dimension. Experiments show that our approach is fast on both unconstrained problems and problems with box constraints. However, it can handle arbitrary convex constraints by defining the pruning in an appropriate way.

(Joint work with Christoph Buchheim and Alberto Caprara)

Sanjay Mehrotra (Northwestern University, USA)

A Method for Rounding a Continuous Solution

We will present a method for generating integer solutions from a continuous solution in integer programming. The method uses a simple ellipsoid to measure the distance of rounded solution to the continuous one, and progressively generates solutions whose feasibility is checked. It ensures that a feasible integer solution does not escape, should it be available within a specified distance. We will present computational performance of this method depending on the progress.

Vishnu Narayanan (IIT Bombay, India)

The Submodular Knapsack Polytope

The submodular knapsack set is the discrete lower level set of a submodular function. The modular case reduces to the classical linear 0-1 knapsack set. One motivation for studying the submodular knapsack polytope is to address 0-1 programming problems with uncertain coefficients. Under various assumptions, a probabilistic constraint on 0-1 variables can be modeled as a submodular knapsack set. In this talk we describe cover inequalities for the submodular knapsack set and investigate their lifting problem. Each lifting problem is itself an optimization problem over a submodular knapsack set. We give sequence-independent upper and lower bounds on the valid lifting coefficients and show that whereas the upper bound can be computed in polynomial time, the lower bound problem is NP-hard. Furthermore, we present polynomial algorithms based on parametric linear programming and computational results for the conic quadratic 0-1 knapsack case.

(Joint work with Alper Atamtürk)

George L. Nemhauser (Georgia Tech, USA)

Lifted Inequalities for 0-1 Mixed Integer Programs: A Computational Study

We describe four families of strong inequalities for 0-1 mixed integer programming (MIP) problems. We first show how these inequalities can be applied to the simplex tableaux of the LP relaxations of 0-1 MIPs. We then show how these inequalities can be applied to the formulation of 0-1 MIPs and propose di?erent separation algorithms. Finally we present the results of a computational study comparing the performance of these cuts.

(Joint work with Amar Narisetty and Jean-Philippe Richard)

Shmuel Onn (Technion, Israel)

n-Fold Integer Programming and Multicommodity Flows

I will describe our recently developed theory of n-fold integer programming, which enables polynomial time solution of fundamental linear and nonlinear integer programming problems in variable dimension.

I will demonstrate the power of this theory by deriving a polynomial time algorithm for multicommodity flow problems where the cost of flow over a channel is a more realistic, nonlinear, function of the flow, accounting for channel congestion under heavy traffic or communication load.

Pablo Parrilo (MIT, USA)

Interpolation-Based SOS Convex Relaxations

We present a simple and efficient sum-of-squares based method for the formulation of convex relaxations for optimization problems. These relaxations are of importance in the context of branch-and-bound for nonconvex optimization. As opposed to term-based relaxations (e.g., McCormick's), the proposed method is based on barycentric Lagrange interpolation, requiring only pointwise evaluations of the function. The interpolation-based technique yields semidefinite programs that are numerically stable, well-conditioned, and with low-rank and sparsity properties, that can be exploited by current SDP solvers. The results are particularly attractive in the case of cubic splines, in which case the corresponding convex optimization problem reduces to a quadratically constrained quadratic program.

Anureet Saxena (Axioma Inc., USA)

Convex Relaxations of Non-Convex Mixed Integer Quadratically Constrained Programs

A common way to produce a convex relaxation of a Mixed Integer Quadratically Constrained Program (MIQCP) is to lift the problem into a higher dimensional space by introducing variables Y_{ij} to represent each of the products $x_i x_j$ of variables appearing in a quadratic form. One advantage of such extended relaxations is that they can be efficiently strengthened by using the (convex) SDP constraint $Y - xx^T \succeq 0$ and disjunctive programming. On the other hand, their main drawback is their huge size, even for problems of moderate size. In this talk, we discuss methods to build low-dimensional relaxations of MIQCP that capture the strength of the extended formulations. To do so, we use projection techniques pioneered in the context of the lift-and-project methodology. We show how the extended formulation can be algorithmically projected to the original space by solving linear programs. Furthermore, we extend the technique to project the SDP relaxation by solving SDPs. In the case of an MIQCP with a single quadratic constraint, we propose a subgradient-based heuristic to efficiently solve these SDPs. We also propose a new "eigen reformulation" for MIQCP, and a cut generation technique to strengthen this reformulation using polarity. We present extensive computational results to illustrate the efficiency of the proposed techniques. Our computational results have two highlights. First, on the GLOBALLib instances, we are able to generate relaxations that are almost as strong as those proposed in our companion paper even though our computing times are about 100 times smaller, on average. Second, on the box QP instances, the strengthened relaxations generated by our code are almost as strong as the well-studied SDP+RLT relaxations and can be solved in less than 2 sec even for larger instances with 100 variables; the SDP+RLT relaxations of the same set of instances can take up to a couple of hours to solve using a state-of-the-art SDP solver.

(Joint work with Pierre Bonami and Jon Lee)

Renata Sotirov (Tilburg University, Netherlands)

Algebraic Symmetry in Semidefinite Programs

Semidefinite programming (SDP) is a generalization of linear programming where the nonnegativity constraints are replaced by positive semidefiniteness on the matrix variables. SDP has recently become a very powerful tool for providing tight relaxations for hard combinatorial optimization problems. Derived SDP relaxations are often large scale and therefore hard to solve with the currently available algorithms. In order to avoid computational difficulties, there are several techniques for reducing complexity of semidenite programs.

In this talk, we show how to exploit algebraic symmetry of the data matrices, when present, in order to greatly reduce the size of the SDP relaxations. To illustrate this approach, we consider several combinatorial optimization problems, including traveling salesman problem, quadratic assignment problem and quadratic three-dimensional assignment problem. We also report strong bounds for the mentioned problems.

Bernd Sturmfels (University of California, Berkeley, USA)

Convex Algebraic Geometry

Convex algebraic geometry is an emerging field at the interface of convex optimization and algebraic geometry. A primary focus lies on the geometric underpinnings of semidefinite programming. This lecture offers a self-contained introduction, starting with elementary questions concerning multifocal ellipses in the plane, but also touching upon singularities and projections of spectrahedra.

Paolo Toth (University of Bologna, Italy)

Formulations and Algorithms for the Train Platforming Problem

The objective of train platforming, which is the routing problem that generally follows any timetabling phase, is to find an assignment of trains to platforms in a railway station. The practical relevance of the problem inspired the definition of a few different versions, which are relatively easy to solve for small contexts, corresponding to stations with very few platforms and alternative paths to route the trains, but become extremely difficult when applied to complex railway station topologies such as those associated with the main European stations, leading to instances with hundreds of trains and tens of platforms. Moreover, most versions are not concerned with the station topology and ignore the routing phase, whereas the main European stations frequently have complex topologies and the routing issue can be quite a complicated task.

In this paper we study a general formulation of the train platforming problem, which contains as special cases all the versions previously considered in the literature, as well as a case study from Rete Ferroviaria Italiana, the Italian Infrastructure Manager. In particular, motivated by our case study, we consider a general quadratic objective function, and propose a new way to linearize it by using a small number of new variables along with a set of constraints that can be separated efficiently by solving an appropriate linear program. The resulting integer linear programming formulation has a continuous relaxation that leads to strong bounds on the optimal value. An effective heuristic algorithm driven by this relaxation is proposed. For the instances in our case study, the proposed approach produces solutions that often turn out to be (nearly-)optimal and that are much better than those produced by the simple heuristic method currently in use.

(Joint work with A. Caprara and L. Galli)

Angelika Wiegele (Alpen-Andria-Universität Klagenfurt, Austria)

An SDP Relaxation for Sparse Max-Cut Problems

We investigate semidefinite relaxations of the Max-Cut problem, which are formulated in terms of the edges of the graph, thereby exploiting the (potential) sparsity of the problem. We show how this is related to higher order liftings of Anjos and Wolkowicz and Lasserre. Contrary to the basic semidefinite relaxation, which is based on the nodes of the graph, the present formulation leads to a model which is significantly more difficult to solve.

To solve the resulting SDP we developed an algorithm where we factorize the matrix in the dual SDP and apply an augmented Lagrangian algorithm to the resulting minimization problem. We present computational results that indicate that this model is manageable for sparse graphs on a few hundred nodes and yields very tight bounds.

(Joint work with Veronica Piccialli and Franz Rendl)

Hande Yaman (Bilkent University, Turkey)

The Robust Network Loading Problem Under Polyhedral Demand Uncertainty

We consider the network loading problem under polyhedral demand uncertainty. Given an underlying network, a set of commodities, a demand polyhedron, and installation costs for equipment, we would like to select routes for commodities and install equipment on the edges of the network, at minimum cost, under the constraint that the network should be feasible for any demand vector from the demand polyhedron. We provide a mixed integer programming formulation for this problem. This formulation involves flow and capacity variables as in the case of the deterministic problem, as well as some dual variables which arise from the transformation used to incorporate robustness into the problem.

These dual variables break the ties between flow and capacity variables in such a way that when we project out the flow variables, the projection inequalities are simple cut inequalities. Then we focus on a specific demand polyhedron description, called the hose model. Here the polyhedron is defined by nonnegativity of individual demands and upper bounds on the total demands adjacent at terminal nodes. We investigate the polyhedral properties of the associated convex hull and propose a branch and cut algorithm. We also present some preliminary results on a more restricted uncertainty description obtained by adding box constraints to the hose model.

(Joint work with A. Altin and M.C. Pinar)

Ming Zhao (SAS, USA)

Branch-and-Cut for the Unit Commitment Problem

The unit commitment problem is to determine a schedule of power generating units, including nuclear, conventional thermal, and hydro. It is a nonlinear stochastic optimization problem, as the demands are not known with certainty. The resulting optimization problem is typically very large, and contains di?cult constraints that take into account technological and economic restrictions. We use piecewise linear functions to approximate nonlinear terms and give a branchandcut algorithm by studying the inequality description of the resulting knapsack polyhedra.

(Joint work with Jayant Kalagnanam)

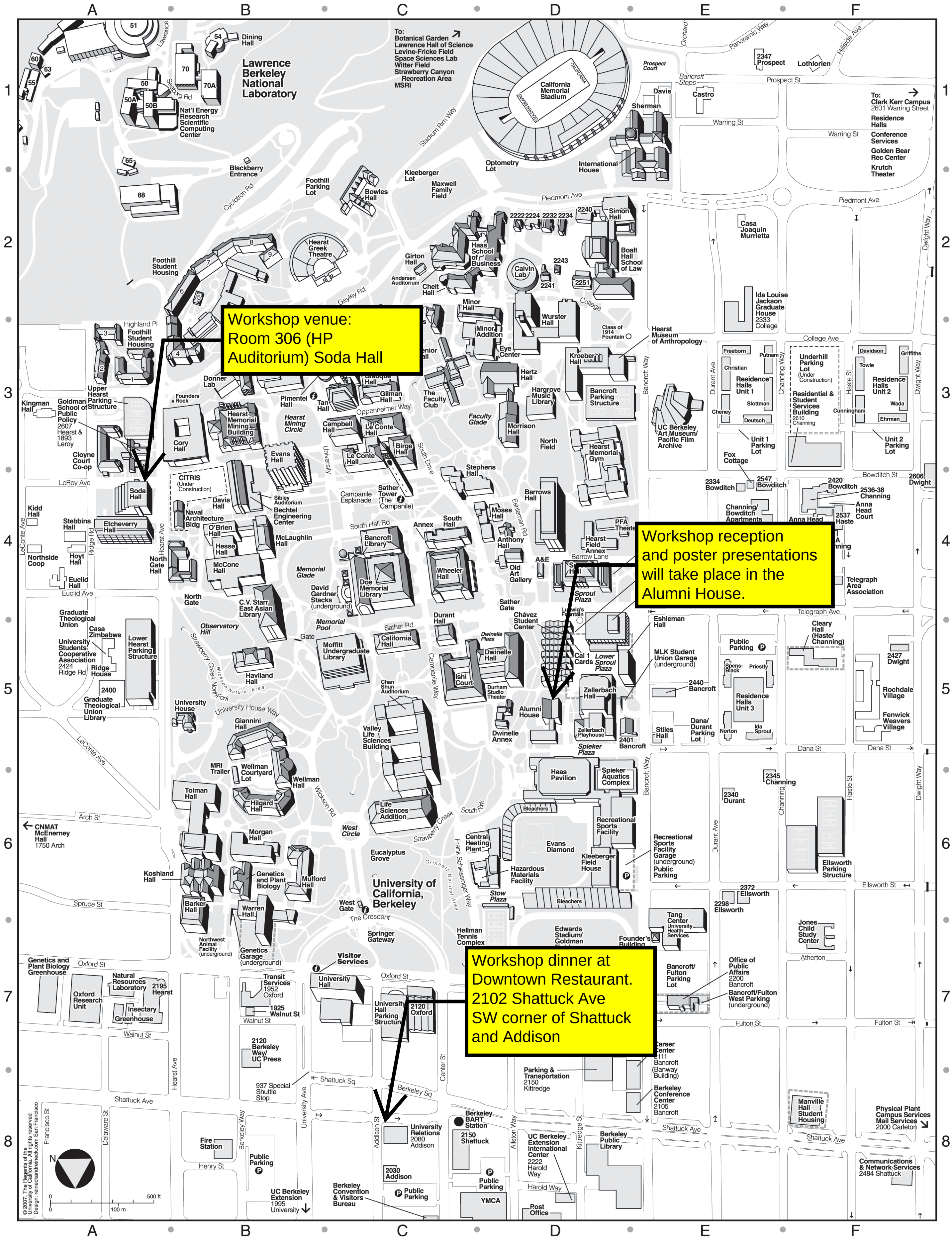
Posters

- Berenguer, Gemma (UC Berkeley) *Conic Programming for a Capacited Location-Inventory Model with Unreliable Supply and Transportation.*
- Berthold, Timo (ZIB, Berlin) *Integrated Modeling and Solution Software for CIPs.*
- Buyuktahtakin, Esra (U. Florida) *Utilizing Objective Function for the Multi-Item Capacitated Lot-Sizing Polyhedron.*
- Derpich, Ivan (U. de Santiago de Chile) *A Heuristic based in Interior Ellipses for Integer Programming.*
- Gleixner, Ambros (ZIB, Berlin) *Constraint Integer Programming for Generic MINLP.*
- Glover, Charles (U. Maryland) *Computationally Tractable Stochastic Integer Programming Models for Air Traffic Management.*
- Hijazi, Hassan (U. de la Mediterannee, France) *Mixed Integer Non-Linear Programs with "On/Off" Constraints: Convex Analysis and Applications.*
- Haws, David (UC Davis) *Computation in Multicriteria Matroid Optimization.*
- Kim, Edward (UC Davis) *The Number of Simplex algorithm pivots on multiway transportation and network flow problems.*
- Khurana, Archana (Guru Gobind Singh Indraprastha Univ., India) *Improving Mixed Integer Linear Programming Formulations.*
- Liu, Ying (U. of Pennsylvania) *Algorithms for the Cross-Dock Door Assignment Problem.*
- Malkin, Peter (UC Davis) *Large-Scale Linear Algebra Relaxations of Combinatorial Problems.*
- Namazifar, Mahdi (U. of Wisconsin-Madison) *Improved Relaxations for Mixed Integer Non-linear Programming Problems with Multilinear terms.*
- Nancini, Giacomo (École Polytechnique) *Improved strategies for branching on general disjunctions.*
- Nourazari, Sara (U. of Oklahoma) *A Convexity Result for functions withInteger Variables.*
- Salazar González, Juan José (U. de Laguna) *Difficult tiny MIPs arising from an application in Commutative Algebra.*
- Ralphs, Ted (Lehigh) *In Search of Optimal Disjunctions in Mixed Integer Linear Programming.*
- Tan, Chee Wei (Caltech) *Single Path Routing.*
- Toriello, Alejandro (Georgia Tech) *Decomposing Multi-Period Inventory Routing Problems with Approximate Value Functions.*

Some useful local information

All workshop talks will take place in Room 306 (HP Auditorium) in Soda Hall, which is located on the north side of the UC Berkeley campus. The map on the next page shows the locations of the workshop venue (Soda Hall), the reception/poster session (Alumni Hall), and the banquet dinner (at the Downtown restaurant).

MIP 2009 attendees will have wireless access to the Internet through a campus AirBears Guest account active for seven days (username and password will be available at registration).


Workshop venue: Room 306 (HP Auditorium) Soda Hall
Workshop reception and poster presentations will take place in the Alumni House.
Workshop dinner at Downtown Restaurant. 2102 Shattuck Ave SW corner of Shattuck and Addison
Lawrence Berkeley National Laboratory
California Memorial Stadium
University of California, Berkeley
Soda Hall
Alumni House
Cory Hall
Etcheverry Hall
Hearst Memorial Mining Building
Evans Hall
Sather Tower (The Campanile)
Doe Memorial Library
Moffitt Undergraduate Library
Valley Life Sciences Building
Haas Pavilion
Haas School of Business
Sproul Plaza
Zellerbach Hall
Hearst Memorial Gym
UC Berkeley Art Museum/ Pacific Film Archive
Berkeley BART Station
University Hall
Visitor Services
Tang Center
Recreational Sports Facility
Hearst Ave
Bancroft Way
Durant Ave
Oxford St
Shattuck Ave
Addison St
Telegraph Ave
Piedmont Ave
College Ave
Euclid Ave
LeRoy Ave
Dwight Way
Haste St
Channing Way
Center St
Allston Way
Kittredge St
Berkeley Sq
Shattuck Sq
Walnut St
University Ave
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