Tuesday 6:00 - 9:00 PM
► Registration - The Merrick and Gables Foyer

Wednesday 7:00 - 9:00 AM
► Continental Breakfast and Welcoming Remarks- Merrick I

Wednesday 8:00 AM - 5:00 PM
► Registration - The Merrick and Gables Foyer

Wednesday 9:00 - 10:30 AM
► WA01 - The Gables Salon

Networks and Graphs I

Chair: Anuj Mehrotra Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237, anuj@miami.edu

1- A Branch-and-Price Approach for Graph Multi-Coloring
Anuj Mehrotra, Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237, anuj@miami.edu
Michael A. Trick, Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA 15213-3890, trick@cmu.edu

We present a branch-and-price framework for solving the graph multi-coloring problem. We propose column generation to implicitly optimize the linear programming relaxation of an independent set formulation (where there is one variable for each independent set in the graph) for graph multi-coloring. This approach, while requiring the solution of a difficult subproblem, is a promising method to obtain good solutions for small to moderate size problems quickly. Some implementation details and initial computational experience are presented.

2 - A Genetic Algorithm for Solving the Euclidean Non-Uniform Steiner Tree Problem
Ian Frommer, Department of Mathematics, United States Coast Guard Academy, New London, CT 06320, ifrommer@exmail.uscg.edu
Bruce Golden, R.H. Smith School of Business, University of Maryland, College Park, MD 20742, BGolden@rhsmith.umd.edu

In this paper, we present a genetic algorithm developed to solve a variation of the Euclidean Steiner tree problem. In the problem we consider, the non-uniform Steiner tree problem, the goal is to connect a set of nodes located on an uneven landscape, in a tree in the cheapest possible way. Using a combination of novel operators, our genetic algorithm is able to find optimal or near-optimal solutions in a small fraction of the time taken by an exact algorithm. In tutorial fashion, we describe the problem and some of its applications, our algorithm along with other possible approaches, and present images of several solved problem instances.
3 - Hard Polynomial Systems from Graphs: Degree Growth for the Hilbert Nullstellensatz

Jesús A. De Loera, Jon Lee, Susan Margulies, Shmuel Onn

Systems of polynomial equations over the complex numbers can be used to characterize graph theoretic problems. From the point of view of computer algebra and symbolic computation these are very interesting polynomial systems. For instance, these systems are provably-hard to solve since solving them is as hard as solving NP-complete problems. In this paper we explore different polynomial ideal encodings for the problems of colorability, hamiltonicity, and stable set. Using the famous Hilbert Nullstellensatz, an infeasible polynomial system will give us a proof that a graph does not have a certain property (e.g. 3-colorability, hamiltonicity, etc). As we discuss in this paper, unless NP=co-NP, there must be infinite instance of infeasible graph-polynomial systems for which the minimal degree of a Hilbert Nullstellensatz certificate grows. We investigate the minimal degrees for specific families of graphs.

►WA02 - Merrick II

Simulation I

Chair: Hernan Awad, Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237, awad@miami.edu

1- Sensitivity Analysis in Simulation of Stochastic Activity Networks: A Computational Study

Chris Groër, University of Maryland, and
Ken Ryals, Johns Hopkins University Applied Physics Laboratory, kenneth.ryals@jhuapl.edu

Two important performance measures related to Stochastic Activity Networks (SANs) are the length of the longest path and the probability that this longest path length exceeds a given threshold. We examine the sensitivity of these performance measures to changes in the underlying parameters of the arc length distributions by calculating four different derivative estimators via Monte Carlo simulation. We explore the statistical properties of these estimators and suggest a method of combining these estimators as a tool for variance reduction

2 - Notes on the initial transient problem in steady-state simulation

Hernan Awad, Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237, awad@miami.edu

The time-average estimator is typically biased in the context of steady-state simulation. Two alternative approaches to dealing with this problem are (i) use of low-bias estimators, and (ii) application of initial transient deletion rules. Following the first approach, several low-bias estimators have been developed in the literature. We argue that, in the single replication setting, a second-order asymptotic expansion of the mean square error (MSE) of the estimators is needed to assess whether they improve on the performance of the time-average. When performing such asymptotic expansions for some commonly studied estimators, we find that they can have asymptotically larger or asymptotically lower MSE than the time-average; there is no universal ordering. In contrast, in the presence of parallel processing capability, low-bias estimators arguably out-perform the time-average in terms of completion time. Regarding the second approach, we study an initial transient deletion rule proposed by Glynn and Iglehart. We argue that it has desirable properties both from a theoretical and practical standpoint, discuss its bias reducing properties, and its use both in the single replication setting and in the multiple replications / parallel processing context. (Joint work with Peter W. Glynn.)

3 - Bias-aware Linear Combination of Variance Estimators in Simulation Output Analysis

Wenchih Chiu, Department of Industrial Engineering, National Tsing Hua University, d897802@oz.nthu.edu.tw
Estimating the variance of the sample mean is a prototype problem in steady-state simulation. A commonly used performance criterion for the variance estimators is the mean-squared-error (mse) — the sum of variance and squared bias. In this paper, we attempt to minimize the variance of an estimator subject to a bias constraint — a goal that differs from that of minimizing mse, in which case there would be no explicit bias constraint. We propose a bias-aware mechanism to achieve our goal. Specifically, we use linear combinations of estimators based on different batch sizes to satisfy the bias constraint; and then we minimize variance by choosing appropriate linear combination weights. We illustrate the use of this mechanism by presenting bias-aware linear combinations of several variance estimators, including non-overlapping batch means, overlapping batch means, and standardized time series weighted area estimators. We evaluate our mechanism with Monte Carlo examples.

Wednesday 10:30 - 11:00 AM

► Coffee Break - The Merrick and Gables Foyer

Wednesday 11:00 - 12:30 PM

► WB01 - The Gables Salon

Networks and Graphs II

Chair: Cenk Caliskan, Department of Business Administration, University of Delaware, Newark, DE 19716, caliskanc@lerner.udel.edu

1- A New Class of Algorithms for the Maximum Flow Problem

Cenk Caliskan, Department of Business Administration, University of Delaware, Newark, DE 19716, caliskanc@lerner.udel.edu

We introduce a new class of algorithms for the maximum flow problem that use the concept of pseudoflows. The new algorithms have the same worst-case time as their augmenting path and preflow-push counterparts. A pseudoflow-push algorithm starts with a pseudoflow that is not necessarily as a preflow and converts it to a flow, at which point the maximum flow is established. The results of computational experiments with the new algorithms are also presented.

2 - A Unified Framework for Integer Programming Formulation of Graph Optimization Problems Using Graph Matching Approach

Bahram Alidaee, MIS/POM Department, Hearin Center for Enterprise Science, School of Business Administration, The University of Mississippi, University, MS 38677, balidaee@bus.olemiss.edu

Graph theory has been a powerful tool in solving difficult and complex problems arising in mathematics, engineering, sciences, and social sciences. In particular, graph matching has an enormous application. Many graph problems have been formulated as a mathematical optimization then solved using exact and/or heuristic procedures. On the other hand, graph theory has been a powerful tool in visualizing and understanding of complex mathematical programming problems, especially integer programs. Formulating graph problems as natural integer programs is often a challenging task. Due to such difficulty often researchers use an indirect linear
programming formulation of the problem and use as an upper (or lower) bound to designing algorithms. However, a natural integer programming formulation of the problem has several advantages including, (1) it is equivalent to the graph problem, (2) its relaxation often serves as a good upper (or lower) bound for the graph problem, and (3) they are often used in designing approximation and heuristic algorithms. Several researchers have noted the lack of natural linear integer programming formulation of graph theoretic problems. The aim of the present study is to provide a unified framework, based on graph matching that allows natural integer programming formulations for a many graph optimization problems. The proposed framework is very general that can be used to formulate many graph optimization problems.

3 - Solving a Network Design Problem

I. Rodríguez Martin, DEIOC-Matemáticas, Universidad de La Laguna, 38296 La Laguna, Tenerife, Spain, irguez@ull.es
J. J. Salzar González, DEIOC-Matemáticas, Universidad de La Laguna, 38296 La Laguna, Tenerife, Spain, jjsalaza@ull.es

In this paper we address a problem consisting of determining the routes and the hubs to be used in order to send, at minimum cost, a set of commodities from source terminals to destination terminals in a given capacitated network. The capacities and costs of the arcs and hubs are given, and the arcs connecting the hubs are not assumed to create a complete graph. The problem arises in a telecommunication context. We present a mixed integer linear programming formulation and describe two branch-and-cut algorithms based on decomposition techniques. We evaluate and compare these algorithms on instances with up to 25 commodities and 10 potential hubs. One of the contributions of this paper is to show that a Double Benders' Decomposition approach outperforms the standard Benders' Decomposition, which has been widely used in recent articles on similar problems. For larger instances we propose a heuristic approach based on a linear programming relaxation of the mixed integer model. The heuristic turns out to be very effective and the results of our computational experiments show that near-optimal solutions can be derived rapidly.

►WB02 - Merrick II

Simulation II

Chair: Paulo Goncalves, Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237, paulog@miami.edu

1- Behavioral Causes of Product Returns in the Seed Supply Chain

Paulo Goncalves, Assistant Professor in Management Science, University of Miami School of Business Administration, Coral Gables, FL, 33124, paulog@miami.edu

The hybrid seed industry experiences excessive and costly rates of seed returns from distributors. Dealers must order in advance of grower demand realization, and may return unsold seed to manufacturers at the end of the season. Returns impose substantial costs on the manufacturer, including transportation, conditioning, discards and excess production capacity. Here we investigate the processes that lead to high return rates through a model-based field study. We develop a formal dynamic model of sales resource allocation as it interacts with customer and producer behavior in the seed supply chain. While sales representatives know they should carefully position seed types and quantities to match heterogeneous demand by learning about dealer and grower needs, we show, however, that sales agents abandon time-consuming positioning to meet quotas late in the sales cycle. Such sales "push" leads to excessive returns in the next period, increasing the total sales agents must attain to reach their quota, leading them to push still more seed. Model analysis shows how this positive feedback can tip the system into a self-reinforcing high-return equilibrium. We discuss policies to reduce returns and implementation issues that arise. The implications are of general interest because the seed industry is similar to other high-technology, high-velocity industries characterized by short and unpredictable product lifecycles, rapid turnover of SKUs in the catalog, long product development and production delays, and volatile and unpredictable customer demand.
2 - Computer Simulation for Emergency Care Process Reengineering in Hospitals
Arun Kumar, School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, makumar@ntu.edu.sg
Sung J. Shim, Stillman School of Business, Seton Hall University, 400 South Orange Avenue, South Orange, New Jersey 07079, USA, shimsung@shu.edu

As healthcare costs increase, hospitals look for ways to contain costs and to achieve high efficiency at their facilities without sacrificing healthcare quality. Just as many businesses successfully reduce costs and gain competitive advantage by reengineering their business processes, hospitals reengineer the way certain healthcare processes are carried out to achieve cost containment and efficiency. The emergency department is a critical portion of any hospital, as it takes care of patients who need immediate treatments and contributes a significant portion of patient admissions to the hospital. Computer simulation, which has proved to be successful in improving various healthcare applications, can be also an effective tool in the search for more efficient emergency care processes in hospitals. This paper describes a case study undertaken at Singapore Hospital. Using computer simulation, the study assesses the efficiency of the emergency care process in the Hospital and recommended ways to improve the efficiency of this process. The results will prove helpful to those who are considering reengineering and improving emergency care or other similar processes in hospitals.

3 - Manatee Use Analysis with ARC/View
Edward Baker, Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237
Maria Villanueva, Division of Marine Affairs, University of Miami, Coral Gables, FL 33124

Boating facility development in the state of Florida requires a Boating Facility Siting Plan. The plan requires an assessment of boating activity as well as manatee sighting and mortality data in the related area. This presentation demonstrates how the ARC/INFO geographic information system may be used to simulate the interaction of these two effects. Data are presented from the recent development of a boating facility in southwest Florida.

Wednesday 12:30 - 2:00 PM - Lunch on Your Own

Wednesday 2:00 - 3:30 PM
► WC01 - The Gables Salon

The Traveling Salesman Problem

Chair: Bruce Golden, R.H. Smith School of Business, University of Maryland, College Park, MD 20742

1 - The Generalized Traveling Salesman Problem: A New Genetic Algorithm Approach
John Silberholz, R.H. Smith School of Business, University of Maryland, College Park, MD 20742
Bruce Golden, R.H. Smith School of Business, University of Maryland, College Park, MD 20742

The Generalized Traveling Salesman Problem (GTSP) is a modification of the Traveling Salesman Problem in which nodes are partitioned into clusters and exactly one node from each cluster is visited in a cycle. It has numerous applications, including airplane routing, computer file sequencing, and postal delivery. To produce solutions to this problem, a genetic algorithm (GA) heuristic mimicking natural selection was coded with several new features including isolated initial populations and a new reproduction mechanism. During
modeling runs, the proposed GA outperformed other published heuristics in terms of solution quality while maintaining comparable runtimes.

2 - The Colorful Traveling Salesman Problem
Yupei Xiong, Goldman, Sachs & Co., 85 Broad Street, New York, NY 10004
Bruce Golden, R.H. Smith School of Business, University of Maryland, College Park, MD 20742
Edward Wasil, Kogod School of Business, American University, Washington, DC 20016

Given a connected, undirected graph \( G \) whose edges are labeled (or colored), the colorful traveling salesman problem (CTSP) seeks a Hamiltonian tour of \( G \) with the minimum number of distinct labels (or colors). We prove that the CTSP is NP-complete and we present a heuristic algorithm and a genetic algorithm to solve the problem.

3 - Heuristic Approaches for a TSP Variant: The Automatic Meter Reading Shortest Tour Problem
Jing Dong, Ning Yang, and Ming Chen, Department of Civil & Environmental Engineering, Glenn L. Martin Hall, University of Maryland, College Park, MD 20742

This paper addresses the automatic meter reading shortest tour problem (AMRSTP), a variant of the traveling salesman problem (TSP). The AMRSTP can be formulated as a mixed-integer nonlinear program (MINLP), but solving for the exact solution is impractical. Therefore, two heuristic approaches, a clustering-based algorithm and a convex hull-based algorithm, are proposed to find near-optimal feasible solutions. The algorithms are tested on various datasets, and the numerical results show that both heuristic algorithms perform effectively and efficiently.

► WC02 - Merrick II

Grid Computing for Optimization

Chair: Jeff Linderoth, Industrial and Systems Engineering, Lehigh University, jtl3@lehigh.edu

1 - Solving Intractable MIP's via GAMS and the Grid
Michael Bussieck, GAMS Development Corporation

GAMS is a commercial modeling system for mathematical programming problems. Condor is a resource manager that delivers huge amounts of computing cycles from large collections of distributively owned computing resources. We describe new modeling features of GAMS and recent solver enhancements that allow us to harness the computational resources of Condor for solving difficult mixed-integer programs. We report on the solution of the MIPLIB problems timtab2, roll3000, a1c1s1 and swath. This is joint work with Michael Ferris

2 - A Monte-Carlo Sampling Approach towards Solving Stochastic Convex Programs on a Computational Grid
Ankur Kulkarni and Uday V. Shanbhag, udaybag@uiuc.edu

We present a sequential quadratic programming (SQP) algorithm for the solution of a two-period stochastic convex programs with recourse. The quadratic subproblems are solvable by an extension of the L-shaped method (Van-Slyke and Wets, 1969). In instances when the sample-space is restrictively large, we use fixed sample sizes to compute sampled cuts for the recourse function. Furthermore, we provide estimators and rigorous confidence statements for the optimal value and solution. Finally, we discuss an implementation of this algorithm on a grid-computing framework at the National Center for Supercomputing Applications (NCSA).
3 - Solving Stochastic Linear Programs over the Grid
Jeff Linderoth, Industrial and Systems Engineering, Lehigh University, jtl3@lehigh.edu
Doug Thomas, Smeal College of Business, The Pennsylvania State University,
   thomas@psu.edu

Stochastic linear programs can be solved approximately by drawing a subset of all possible random scenarios and solving the problem based on this subset, an approach known as sample path optimization. The value of the optimal solution to the sampled problem provides an estimate of the true objective function value. This estimator is known to be optimistically biased; the expected optimal objective function value for the sampled problem is lower (for minimization problems) than the optimal objective function value for the true problem. We investigate how two alternative sampling methods, antithetic variates and Latin Hypercube sampling, affect both the bias and variance, and thus the mean squared error (MSE), of this estimator. For a simple example, we analytically express the reductions in bias and variance obtained by these two alternative sampling methods.

For eight test problems from the literature, we computationally investigate the impact of these sampling methods on bias and variance. We find that both sampling methods are effective at reducing mean squared error, with Latin Hypercube sampling outperforming antithetic variates. Whether the bias reduction or variance reduction plays a larger role in MSE reduction is problem and parameter specific.

Wednesday 3:30 - 4:00 PM
► Coffee Break - The Merrick and Gables Foyer

Wednesday 4:00 - 5:30 PM
► WD01 - The Gables Salon

Vehicle Routing Problems

Chair: Jeffrey W. Ohlmann, University of Iowa, Jeffrey-ohlmann@uiowa.edu

1- Solving the Multi-Depot Location-Routing Problem with Lagrangian Relaxation
Zeynep Özürt, Industrial Engineering Department, Koç University
Deniz Aksen, College of Administrative Sciences and Economics, Koç University,
   Rumelifeneri yolu 34450 Sariyer, Istanbul, Türkiye

Multi-depot Location-Routing Problem (MDLRP) is about finding the optimal number and locations of depots while allocating customers to depots and determining vehicle routes to visit all customers. In this study we propose a nested Lagrangian relaxation-based method for the discrete incapacitated MDLRP. An outer Lagrangian relaxation embedded in subgradient optimization decomposes the parent problem into two subproblems. The first subproblem is a facility location-like problem. It is solved to optimality with Cplex 9.0. The second one resembles a capacitated and degree constrained minimum spanning forest problem, which is tackled with an augmented Lagrangian relaxation. The solution of the first subproblem reveals a depot location plan. As soon as a new distinct location plan is found in the course of the subgradient iterations, a tabu search algorithm is triggered to solve the multi-depot vehicle routing problem associated with that plan, and a feasible solution to the parent problem is obtained. Its objective value is checked against the current upper bound on the parent problem’s true optimal objective value. The performance of the proposed method has been observed on a number of test problems, and the results have been tabulated.

2 - Route Design for the Delivery of Electronic Voting Machines: A VRPTW Case Study
Jeffrey W. Ohlmann, University of Iowa, Jeffrey-ohlmann@uiowa.edu
Michael J. Fry, mike.fry@uiowa.edu
Starting in Spring 2006, Ohio election sites replaced punch card voting machines with electronic voting machines. In Hamilton County, Ohio, this change requires the delivery of voting machines to over 500 polling locations over the course of several days. We solve this vehicle routing problem with time windows using heuristic search techniques. To identify cost-saving strategies, we analyze the sensitivity of the objective function to the time window and delivery day constraints. Using the insight from these computational results, the Board of Elections re-negotiates the protocol for determining the delivery day and time window for each polling location.

3 - Applications of Revenue Management to the Freight Industry

Qing Zhu, Tsinghua University, Beijing, China, 100084, zhuqing04@gmail.com

Revenue management has achieved great success in the airline industry and is widely adopted in the retail and hotel industries. With increasing globalization, the freight industry is also a natural field for revenue management. In this paper, the concept, as well as technology, of revenue management is introduced into the transportation system. By analyzing the unique features of freight, we consider that optimization in vehicle routing problem is the backbone not only in reducing the cost, but also in providing service of different classes to heterogeneous customers. Finally, a pricing strategy based on the VRPTW is introduced. Price discrimination is conducted in the operational level of vehicle routing problem, which for the first time indicates a way to combine revenue management with freight industry and optimization technology. This paper will serve as the first step towards applying revenue management into freight industry. Directions for future research are also discussed.

► WD02 - Merrick II

COIN-OR

Chair: Francois Margot, Tepper School of Business, Carnegie Mellon University

1- The Optimization Services Project on COIN-OR

Robert Fourer, Professor, Northwestern University, Dept of Industrial Eng & Mgmt Sciences, 2145 Sheridan Rd, Evanston IL, 60208-3119, United States, 4er@iems.northwestern.edu
Jun Ma, Postdoctoral Fellow, Northwestern University, Dept of Industrial Eng & Mgmt Sciences, 2145 Sheridan Rd, Evanston IL, 60208-3119, United States, maj@northwestern.edu
Kipp Martin, Professor, University of Chicago, 5807 South Woodlawn, Chicago IL 60637, United States, kipp.martin@chicagogsb.edu

Optimization Services (OS) is a unified framework for a new generation of distributed optimization systems, mainly for optimization over the Internet. It incorporates XML-based standards for representation and communication of optimization-related data between OS-compatible software components. We describe the open-source OS project and its implications for both developers and users of optimization software.

2 - COIN-OR: Open Source Software for OR

Francois Margot, Tepper School of Business, Carnegie Mellon University

COIN-OR is a collection of Open-Source Software for Operations research. The available software covers a wide range of optimization techniques, among others Linear Programming, Integer Linear Programming, Nonlinear Programming, Integer Nonlinear Programming, and Semidefinite Programming. This talk presents an overview of the COIN-OR initiative, including recent developments. The available software, building tools, and user feedback mechanism are presented, as well as future development directions. Rules and information for contributions are also covered.
3 - COIN-OR: Open-Source Software for Operations Research--A Status Report
Matthew Saltzman, COIN-OR Foundation and Clemson University
The Computational Infrastructure for Operations Research (COIN-OR) initiative was launched over six years ago to facilitate and encourage the development of open software, standards, and data for computational OR. Since that time there has been considerable growth and development of the project, which is now managed by an independent non-profit educational foundation. This talk will give an update on the initiative, including opportunities to make use of the initiative's projects and ways to become a part of the COIN-OR community.

Wednesday, 5:30 - 7:00 PM
► ICS Business Meeting - The Gables Salon

Wednesday, 7:00 - 9:00 PM
► Conference Reception - The Rotunda
Thursday 7:00 - 9:00 AM
► Continental Breakfast - Merrick I

Thursday 8:00 AM - 5:00 PM
► Registration - The Merrick and Gables Foyer

Thursday 9:00 - 10:30 AM
► TA01 - The Gables Salon

Search Methods

**Chair:** Kevin R. Hutson, Department of Mathematics, Furman University, Greenville, SC 29613 kevin.hutson@furman.edu, and

1 - A Neighborhood Search Technique for the Freeze Tag Problem
   Dan Bucantanschi, Department of Mathematics & Computer Science, Denison University, Granville, Ohio 43023, bucata d@denison.edu
   Blaine Hoffmann, College of Information Sciences and Technology, Penn State University, University Park, PA 16802, bho_man@ist.psu.edu
   Kevin R. Hutson, Department of Mathematics, Furman University, Greenville, SC 29613 kevin.hutson@furman.edu, and
   R. Matthew Kretchmar, Department of Mathematics & Computer Science, Denison University, Granville, Ohio 43023, kretchmar@denison.edu

The Freeze Tag Problem arises naturally in the field of swarm robotics. Given n robots at different locations, the problem is to devise a schedule to activate all robots in the minimum amount of time. Activation of robots, other than the initial robot, only occurs if an active robot physically moves to the location of an inactive robot. Several authors have devised heuristic algorithms to build solutions to the Freeze Tag Problem. Here, we investigate an update procedure based on a hill-climbing, local search algorithm to solve the Freeze-Tag Problem.

2 - An Adaptive Algorithm for the Optimal Sample Size in the Non-Stationary Data-Driven Newsvendor Problem
   Gokhan Metan, Department of Industrial and Systems Engineering, Lehigh University, Bethlehem, PA 18015, gom204@lehigh.edu
   Aurélie Thiele, Department of Industrial and Systems Engineering, Lehigh University, Bethlehem, PA 18015, aurelie.thiele@lehigh.edu

We investigate the impact of the sample size in the non-stationary newsvendor problem when the underlying demand distribution is not known, and performance is measured by the decision-maker's average regret. The approach we propose is entirely data-driven, in the sense that we do not estimate the probability distribution of the demand and instead rely exclusively on historical data. We propose an iterative algorithm to determine the number of past observations that should be included in the decision-making process, provide insights into the optimal sample size and perform extensive computational experiments.
3 - A Hybridization of Direct Search Optimization and Treed Gaussian Process
Genetha Gray and Monica Martinez-Canales, Sandia National Laboratories, Computational Sciences & Math Research, gagray@sandia.gov and mmarti7@sandia.gov
Herbie Lee and Matt Taddy, Department of Applied Mathematics & Statistics, University of California, Santa Cruz, herbie@ams.ucsc.edu and taddy@soe.ucsc.edu
We consider a derivative-free method from the pattern search class of algorithms for the solution of simulation-based optimization problems. Because simulations often require significant computational time and resources, we are striving to reduce the number of runs needed by the optimization method. Moreover, since pattern searches are local methods, we are investigating ways of introducing robustness and some global properties. To accomplish these goals, we are using ideas from the design of computer experiments literature and using random functions to model the deterministic computer output function. We treat the output of the simulations as realizations of a Gaussian Process (GP). Then, the uncertainty about future computer evaluations can be quantified by finding the predictive distribution for new input locations conditional on the points that have already been evaluated. These ideas have been adapted to complex computer simulations in an R code referred to as tgp. This work combines the search properties of a pattern search with the statistical properties of the GP to create a new hybrid algorithm. In this presentation, we will describe the optimization algorithm, the GP algorithm, and the resulting hybrid method. We will present some numerical results and discuss appropriate applications.

4- An Analysis of Finding Near-Optimal Solutions Using Local Search Algorithms
Sheldon H. Jacobson and Director, Simulation and Optimization Laboratory, Department of Computer Science, University of Illinois, Urbana, IL 61801-2906, shj@uiuc.edu
Alex Nikolaev, Department of Computer Science, University of Illinois, Urbana, IL 61801-2906
Shane N. Hall, Department of Operational Sciences, Air Force Institute of Technology
Wright Patterson AFB, OH 45433, shane.hall@afit.edu
This paper presents an approach to analyze and compare local search algorithms for hard discrete optimization problems using the $\beta$-acceptable solution probability. The $\beta$-acceptable solution probability captures how effectively an algorithm has performed to date and how effectively an algorithm can be expected to perform in the future. The $\beta$-acceptable solution probability is used to derive necessary conditions for a local search algorithm to converge in probability to a $\beta$-acceptable solution, as well as necessary and sufficient conditions for a local search algorithm to visit with probability one a $\beta$-acceptable solution. To compare the effectiveness of local search algorithms, two estimators for the expected number of iterations to visit a $\beta$-acceptable solution are obtained. Computational experiments with the Lin-Kernighan-Helsgaun algorithm applied to several traveling salesman problem instances with known optimal solutions are reported to evaluate these estimators in visiting near-optimal solutions.

► TA02 - Merrick II

Constraint Programming

Chair: Tallys H. Yunes, School of Business, University of Miami

1- An Integrated Solver for Optimization Problems
Ionut, Aron, IBM T. J. Watson Research Center
John N. Hooker, Tepper School of Business, Carnegie Mellon University
Tallys H. Yunes, School of Business, University of Miami
One of the central trends in the optimization community over the past several years has been the steady improvement of general-purpose solvers. A logical next step in this evolution is to combine mixed integer linear programming, global optimization, and constraint programming in a single system. Recent research in the area of integrated problem solving suggests that the right combination of different technologies can simplify modeling and speed up computation substantially. In this talk we address this goal by presenting a general purpose solver that achieves low-level integration of solution techniques with a high-level modeling language.
We validate our solver with computational experiments on problems in production planning, product configuration and job scheduling. Our results indicate that an integrated approach reduces modeling effort, while solving two of the three problem classes substantially faster than state-of-the-art commercial software.

2 - Differentiable Invariants
P. Van Hentenryck, Brown University, Box 1910, Providence, RI 02912
Laurent Michel, University of Connecticut, Storrs, CT 06269-2155

Invariants that incrementally maintain the value of expressions under assignments to their variables are a natural abstraction to build high-level local search algorithms. But their functionalities are not sufficient to allow arbitrary expressions as constraints or objective functions as in constraint programming. Differentiable invariants bridge this expressiveness gap. A differentiable invariant maintains the value of an expression and its variable gradients, it supports differentiation to evaluate the effect of local moves. In this talk, the benefits of differentiable invariants will be illustrated on a number of applications that feature complex, possibly reified, expressions and whose models are essentially similar to their CP counterparts. Experimental results demonstrate their practicality as a vehicle to easily develop high-level constraints and objectives for constraint-based local search.

3 - Integer Programming with Binary Decision Diagrams
John Hooker, Carnegie Mellon University, john@hooker.tepper.cmu.edu

We explore binary decision diagrams (BDDs) as a tool for solving linear and nonlinear integer programming problems, and particularly for post-optimality analysis. Optimal solutions can be found by identifying shortest paths in the reduced ordered BDD that represents the constraint set. Since the BDD efficiently encodes the feasible set, in-depth post-optimality analysis can be provided interactively in response to real-time queries. We illustrate the technique on capital budgeting, network reliability, and portfolio design problems. This is joint work with Tarik Hadzic of IT University of Copenhagen.

4 - Optimal Scheduling of Collaborative Agents
Willem-Jan van Hoeve, Cornell University, vanhoeve@cs.cornell.edu

We consider the problem of optimally scheduling the actions for collaborative agents. That is, the actions of one agent can influence the actions of other agents. The underlying problem can be seen as a multi-machine scheduling problem with time windows and hard and soft precedence relations. The objective is a nonlinear function that aggregates the total 'quality' of a schedule. We show how we can model and efficiently solve this problem with constraint programming. Elements of our proposed solution process include domain filtering, search strategies, problem decomposition, and a linear programming relaxation. We present experimental results on realistic problem instances to display the different elements of the solution process. This is joint work with Carla P. Gomes (Cornell University), Michele Lombardi (University of Bologna), and Bart Selman (Cornell University).

Thursday 10:30 - 11:00 AM

► Coffee Break - The Merrick and Gables Foyer
Thursday 11:00 - 12:30 PM
► TB01 - The Colonnade Ballroom

Plenary Session

Dr. Robert Atlas
Director, Atlantic Oceanographic and Atmospheric Laboratory
National Oceanographic and Atmospheric Administration
Miami, Florida

IMPROVING HURRICANE PREDICTION THROUGH INNOVATIVE GLOBAL MODELING

Current global and regional models incorporating both in situ and remotely sensed observations have achieved a high degree of skill in forecasting the movement of hurricanes. Nevertheless, significant improvements in the prediction of hurricane landfall and intensification are still needed. To meet these needs, research on new observing systems, data assimilation techniques, and better models is being performed. These include the Hurricane Weather Research and Forecasting regional model development by NOAA, as well as the development of an advanced “seamless” global weather and climate model, as a collaborative project involving both NOAA and NASA. This latter model, when completed, will be used to improve short and extended range forecasts of hurricanes, as well as to determine the relationship between global climate change and long-term variations in hurricane frequency and intensity, more accurately than is possible today. As a starting point for the seamless global weather and climate model, the horizontal resolution of the previously developed finite volume General Circulation Model has been increased to 1/12° (approximately 9 km) in a series of successive steps. This was made possible by advances in both computing and optimization technologies.

Collaborative work with

Shian-Jiann Lin, NOAA/Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey,
Bo-Wen Shen, University of Maryland, College Park, Maryland, and
Oreste Reale and Kao-San Yeh, University of Maryland, Baltimore County, Maryland

Thursday 12:30 - 2:00 PM
► The Conference Luncheon - Merrick I

Professor Harvey Greenberg with remarks on the History of the INFORMS Computing Society
Thursday 2:00 - 3:30 PM

► TC01 - The Gables Salon

Toward a Better Understanding of MIP's

Chair: John W. Chinneck, Systems and Computer Engineering, Carleton University, Ottawa, Ontario K1S 5B6, Canada

1 - Strong(er) Branching for Mixed Integer Programming
Jeff Linderoth, Lehigh University, email: jtl3@lehigh.edu

Strong branching is a method for selecting a branching entity in mixed integer linear programming. It works by explicitly computing the impact of many different branching choices, and then chooses the best. The talk will begin by describing the concept of strong branching. We next will discuss improvements to the original idea, and we will mention extensions of strong branching to realms outside of mixed integer linear programming. We will conclude by considering a "look-a-head" branching method that asks the question: by taking into account the impact of the current branching decision on the bounds of the child nodes two levels deeper than the current node, can better branching decisions be made?

2 - Infeasible MIP’s Are Not All Bad
Lloyd Clarke, ILOG Inc., 13316 Canterbury Drive, Hagerstown, MD, 21742, lclarke@ilog.com, and Roland Wunderling

Infeasibility is often due to mistakes in modeling. However, if suitable tools are available, infeasible models can also be analyzed in order to better understand the real problem at hand. For example, one could deliberately introduce infeasibility by adding an objective cutoff, in order to analyze what is preventing further improvement in the objective function. One new tool in CPLEX 10.0 for analyzing infeasible models is the Conflict Refiner. The idea of conflicts extends the well known concept of IIS (irreducibly inconsistent sets) for linear programs to general MIP's. We will describe the implementation of the conflict refiner in CPLEX as a hybrid algorithm that incorporates methods from both Mathematical Programming and Constraint Programming. The benefits from this hybrid approach will be discussed through computational results.

3 - Visualization Tools for Branch-and-Bound Algorithms
Brady Hunsaker, University of Pittsburgh, 1036 Benedum Hall, Pittsburgh, PA 15261, hunsaker@engr.pitt.edu
Osman ¨ Ozalty ¨ n, University of Pittsburgh, 1069 Benedum Hall, Pittsburgh, PA 15261, oyo1@pitt.edu
Ted Ralphs, Lehigh University, 200 W. Packer Ave., Bethlehem, PA 18015-1582, tkralphs@lehigh.edu

We present methods and implementations for visually monitoring the progress of branch-and-bound algorithms by making use of data extracted from the branch-and-bound tree. Our goal is to provide users with more useful information about the progress of the algorithm as well as the likelihood of it finding better solutions. We demonstrate the potential usefulness of these tools using three open-source solvers (CBC, SYMPHONY, and GLPK) on instances from the MIPLIB 2003 library.

4 - Progress on Finding and Selecting a Variety of Solutions
David L. Woodruff, Graduate School of Management, UC Davis, Davis CA 95616, DlWoodruff@UCDavis.edu

For many optimization problems, the objective function and constraints are rough approximation to a real-world problem. Solutions to the problem are used as a starting point for further consideration and processing. Consequently, many decision makers would like to see a variety of good solutions to the problem rather than
just a single optimal solution. In this talk, I outline progress on research done with many co-authors on this issue.

**TC02 - Merrick II**

**Decision Technologies I**

**Chair:** Douglas R. Shier, Dept of Mathematical Sciences, Clemson University, Clemson, SC 29634

1 - Bid Optimization in Sponsored Search Auctions

Abhishek Pani and S. Raghavan; Smith School of Business, University of Maryland, College Park, MD 20742-1815

In the last five years, internet search based ads have been the fastest growing segment in the entire advertising domain. Potential advertisers provide their valuations for various keywords and also, specify overall budget for a period of time. The search operator, then, solves a multi-unit allocation problem with the specified bidder values and budgets, and determines two things - the order to place the ads and the amount to charge the respective bidders. The advertisers, on the other hand, regularly solve a bid determination problem for the various keywords, given budget and other constraints. The advertiser’s problem can be viewed as a large-scale multiple choice knapsack problem. We first discuss the properties of the optimal solution to the linear relaxation. We then develop a branch and price approach that is computationally viable for a large scale multiple choice knapsack problem.

2 - An Efficient Enumeration Algorithm for the Two-Sample Randomization Distribution

Marie A. Coffin, Biostatistics Group, Monsanto, Inc., Research Triangle Park, NC 27709

James P. Jarvis and Douglas R. Shier, Department of Mathematical Sciences, Clemson University, Clemson, SC 29634

In many experimental situations, subjects are randomly allocated to treatment and control groups. Measurements are then made on the two groups to ascertain if there is in fact a statistically significant treatment effect. Exact calculation of the associated randomization distribution theoretically involves looking at all possible partitions of the original measurements into two appropriately sized groups. Computing every possible partition is computationally wasteful, so our objective is to systematically enumerate partitions starting from the tail of the randomization distribution. A new enumeration scheme that only examines potentially worthwhile partitions is described, based on an underlying partial order. Numerical results show that the proposed method runs quickly compared to complete enumeration and its effectiveness can be enhanced by use of certain pruning rules.

3 - Optimal Multiperiod Portfolios of Hydrocarbon Exploration and Production Projects under Uncertainty

Wei Chen, wei.chen@phd.bus.utexas.edu

Leon Lasdon, Lasdon@mail.utexas.edu

James Dyer, j.dyer@mail.utexas.edu, IROM Department, McCombs School of Business, University of Texas, Austin, TX, 78712

We model a single project as a multistage decision tree, and consider sets of projects linked by sharing of revenues, and budget and joint production constraints. Chance nodes focus on geologic uncertainties, while decision nodes include acquisition, exploration, and development stages, and include information acquisition and production activities. A homogeneous tank model with uncertain parameters is used for oil production. While a single project may be solved by dynamic programming, mixed integer LP models have promise for project portfolios: see Gustafsson and Salo, “Contingent Portfolio Programming for the Management of Risky Projects”, Operations Research Vol 53 Issue 6, Nov 2005. We describe some realistic (but hypothetical) instances of such problems, and show their sizes and CPLEX behaviors when posed as MILP’s using GAMS. We also describe models in the decision tree modeling system DPL. Strategies for solving larger instances include model simplification and Lagrangian relaxation. Plans for future work are discussed. This research is
4 - Finding Prices for Integer Decisions in Unit Commitment Problems

William R. Stewart, Jr., David L. Peebles Professor, College of William and Mary, Mason School of Business, P.O. Box 8795, Williamsburg, Virginia 23187-8795, William.Stewart@mason.wm.edu

In scheduling the dispatch of electrical generators, there are numerous 0 - 1 decisions that must be made. In order to dispatch the generators efficiently, it is important that these decisions be priced in such a way as to encourage efficiency. All of the generators that are dispatched should realize at least a nonnegative profit over their bid costs, and all generators that are not dispatched should not be able to show a positive profit using the prices established by the market (unit commitment solution). To effectively establish such market clearing prices, generators must be allowed to bid into the auction both the costs incurred for any integer decisions (e.g. startup or minimum output constraints) and their marginal production costs for each megawatt-hour of electricity. To price the integer decisions, they are treated as continuous commodities and dual prices are extracted from a linear program that produces the same optimal solution as the original mixed integer unit commitment optimization problem. The merits of the approach are illustrated by applying it to the scheduling of a combined cycle combustion turbine, a generator with a highly non-convex cost function. We discuss the relative merits of solving this problem using a mixed integer programming approach versus using the more traditional Lagrangian relaxation approach.

Thursday 3:30 - 4:00 PM

► Coffee Break - The Merrick and Gables Foyer

Thursday, 4:00 - 5:30 PM

► TD01 - The Gables Salon

Faster MIP Feasibility

Chair: John W. Chinneck, Systems and Computer Engineering, Carleton University, Ottawa, Ontario K1S 5B6, Canada

1- A Feasibility Pump Heuristic for General Mixed-Integer Problems

Livio Bertacco, Matteo Fischetti, Andrea Lodi, bertacco@math.unipd.it

Finding a feasible solution of a given Mixed-Integer Programming (MIP) model is a very important (NP-complete) problem that can be extremely hard in practice. Very recently, Fischetti, Glover and Lodi proposed a heuristic scheme for finding a feasible solution to general MIPs, called Feasibility Pump (FP). According to the computational analysis reported by these authors, FP is indeed quite effective in finding feasible solutions of hard 0-1 MIPs. However, MIPs with general integer variables seem much more difficult to solve by using the FP approach. In this paper we elaborate on the Fischetti-Glover-Lodi approach and extend it in two main directions, namely (i) handling as effectively as possible MIP problems with both binary and general-integer variables, and (ii) exploiting the FP information to drive a subsequent enumeration phase. Extensive computational results on large sets of test instances from the literature are reported, showing the effectiveness of our improved FP scheme for finding feasible solutions to hard MIPs with general integer variables.
2 - Can Branching and Reasoning Techniques for Satisfiability Be Useful for Mixed Integer Programming?

Chumin Li, Université de Picardie Jules Verne, LaRIA - 33 Rue St. Leu, 80039 Amiens Cédex 01, France, email: chu-min.li@u-picardie.fr

Branching and reasoning are among the most effective techniques to solve a hard combinatorial problem. The goal of branching rules is to make the search tree as small as possible, and the goal of reasoning is to simplify the current problem instance as much as possible. Many branching and reasoning techniques are developed to solve particular problems such as SAT and Mixed Integer Programming (MIP). Because of the combinatorial nature of SAT and MIP, techniques for SAT can inspire those for MIP, and vice versa. In fact, we already find similar techniques for SAT and for MIP, such as branching heuristics based on unit clause propagation for SAT and strong branching for MIP, although they are developed independently in different communities. Effort should be made to develop more new techniques for one problem by adapting techniques for another problem. In this talk, we present an overview of different branching and reasoning techniques for SAT that might be useful for MIP.

3 - Active-Constraint Variable Ordering for Faster Feasibility of Mixed Integer Linear Programs

John W. Chinneck, Systems and Computer Engineering, Carleton University, Ottawa, Ontario K1S 5B6, Canada

The selection of the branching variable can greatly affect the speed of branch and bound when solving a mixed-integer or integer linear program. Traditional approaches to branching variable selection rely on estimating the effect of the candidate variables on the objective function. However, the optimum point at the current LP-relaxation solution is determined by the active constraints. Hence our approach instead tries to choose the candidate variable that has the most impact on the active constraints in the current LP relaxation. We apply this method to the problem of finding the first feasible solution as quickly as possible. Experiments demonstrate a significant improvement compared to a state-of-the art commercial MIP solver.

| TD02 - Merrick II |

Integer Programs and Special Structures

Chair: Anito Joseph, Department of Management Science, University of Miami, Coral Gables, Florida 33124, ajoseph@miami.edu

1 - Cardinality and the Simplex Tableau for the Set Partitioning Problem

Anito Joseph and Edward K. Baker, Department of Management Science, University of Miami, Coral Gables, Florida 33124, ajoseph@miami.edu and ebaker@miami.edu

In this work, we show how cardinality-related information for the set partitioning problem is represented within the simplex tableau and how a fractional solution can be interpreted in terms of unresolved solution cardinality. We include a cardinality row within the linear programming relaxation of the set partitioning problem to demonstrate the associated cardinality-related information present in the tableau. Working with a basic feasible solution, the cardinality row is shown to provide valuable information for branching along the cardinality dimension of the solution space of the problem. It is shown that cardinality information may be derived from the simplex tableau for any subset of structural variables in the problem. An illustrative example and computational results for problems from the literature are presented.

2 - Solving the Maximum Cardinality Bin Packing Problem with a Weight Annealing-Based Algorithm

Kok-Hua Loh, Robert H. Smith School of Business, University of Maryland, College Park,
In the maximum cardinality bin packing problem (MCBPP), we have \( n \) items with different sizes and \( m \) bins with the same capacity. We want to assign a maximum number of items to the fixed number of bins without violating the capacity constraint on each bin. We develop an algorithm for solving the MCBPP that is based on weight annealing. Weight annealing is a metaheuristic that has been recently proposed in the physics literature. We apply our algorithm to two well-known sets of benchmark problems containing more than 3,600 instances and show that it outperforms an enumeration algorithm and a branch-and-price algorithm.

3 - An Exact Algorithm for Multistage Integer Multi-Commodity Flow Problems with Demand Uncertainty

Ioannis Gamvros, ILOG, Inc., 1080 Linda Vista Avenue, Mountain View CA 94043,
S. Raghavan, Smith School of Business, University of Maryland, College Park, MD 20742-1815

Multi-stage stochastic programming problems in which decision variables are integer in all stages are exceptionally hard and are typically approached with approximation algorithms. We propose a reformulation scheme and an associated branch-and-price-and-cut approach that can solve exactly stochastic multistage integer multi-commodity flow problems. We present computational results on a problem motivated from the telecommunications industry.

Thursday, 5:30 - 7:00 PM

► Committee Meetings - TBA
Friday 7:00 - 9:00 AM
► Continental Breakfast - Merrick I

Friday 8:00 - 11:00 AM
► Registration - The Merrick and Gables Foyer

Friday 9:00 - 10:30 AM
► FA01 - The Gables Salon

Computational Complexity

Chair: Edward Baker, Department of Management Science, School of Business Administration, University of Miami, Coral Gables, FL 33124-8237, anuj@miami.edu

1 - P = NP: Linear Programming Formulation of the Traveling Salesman Problem
Moustapha Diaby, OPIM Dept., University of Connecticut, Storrs, CT 06268, moustapha.diaby@business.uconn.edu
In this paper we present a first polynomial-sized linear programming formulation of the Traveling Salesman Problem (TSP). The proposed linear program is a network-flow based model and has $O(n^9)$ variables and $O(n^7)$ constraints, where $n$ is the number of cities. Numerical implementation issues and results are discussed.

2 - Why LP Cannot Solve Large Instances for NP-Complete Problems in Polynomial Time
Radoslaw Hofman
This article discusses ability of Linear Programming models to be used as solvers of NP-complete problems. Integer Linear Programming is known as NP-complete problem, but non-integer Linear Programming problems can be solved in polynomial time, what places them in P class. During past three years there appeared some articles using LP to solve NP-complete problems. This methods use large number of variables ($O(n^9)$) solving correctly almost all instances that can be solved in reasonable time. Can they solve infinitively large instances? This paper gives answer to this question.

► FA02 - Merrick II

Decision Technologies II

Chair: Robin Burk, Department of Electrical Engineering & Computer Science, U.S. Military Academy

1- Knowledge Representation for Military Mobility Decision-Making by Humans and Intelligent Software: The Mobility Common Operational Picture Data Model and Ontology
Robin Burk, Department of Electrical Engineering & Computer Science, U.S. Military Academy;
Niki Goerger, U.S. Army Engineer Research and Development Center;
Buhrman Gates, U.S. Army Engineer Research and Development Center,
The U.S. military is constructing a Global Information Grid that provides key software services to complex networks of computers and software clients in an operational theater. Commanders’ need for accurate and timely information in support of complex decisions requires that application programs, intelligent agents and humans be able to exchange, analyze, interpret and report information to one another. While interoperability of human soldiers has traditionally been accomplished by the creation of tacit and explicit knowledge through training, construction of software applications and intelligent agents for the GIG requires a standardized vocabulary and semantically rich formalization of common sense knowledge for the various domains of operation spanned by military planning and operations. This formalization is appropriately captured in ontologies which both provide representation vocabularies and facilitate information exchange. Our recent project to define a data model and ontology for the Mobility Common Operating Picture and our ongoing work to support dynamically computed Common Maneuver Networks illustrate the knowledge engineering challenges inherent in a domain where humans have traditionally relied on tacit knowledge to evaluate information as it influences key decisions. Distinguishing concepts that are inherently relational in nature from those that represent object attributes is a key success factor.

2 - Combined Discrete-Continuous Simulation Modeling of an Autonomous Underwater Vehicle

Roy Jarnagin and Senay Solak, Department of Industrial Engineering Technology, Southern Polytechnic State University, 1100 South Marietta Parkway, Marietta, GA 30060

In this study, we develop a combined discrete-continuous simulation model for the trajectory control of an autonomous underwater vehicle. The differential equations governing the movements of the autonomous underwater vehicle are integrated numerically and the results are used to simulate the trajectory control of the vehicle. The developed model is to be used in the design of the command and control software and the internal communication interface architecture for the vehicle. The model may also be used to assess the effects of random message delivery variation and sensor inaccuracies.

3- Gradient-based Search in Parameterized Policy Space for Markov Decision Processes

Enrique Campos-Nanez, Department of Engineering Management and Systems Engineering, The George Washington University, 1776 G Street NW, Suite 161, Washington, DC 20052, ecamposn@gwu.edu

We consider the problem of gradient-based search in parameterized policy space for Markov decision processes. Most relevant techniques for gradient estimation rely on the observation of regenerative cycles of the process to obtain unbiased estimates of the gradient. A major problem with such approaches is their scalability, as a result of the so-called ‘curse of dimensionality’. In many applications, the state space and control actions can be naturally distributed. We introduce a technique for such situations where each of the distributed agents can compute an estimate of the partial derivative of the objective with respect to the parameters under its control. We illustrate the algorithm with an application to energy-efficient coverage in sensors networks with rechargeable batteries via solar panels. The resulting algorithm can be implemented with only local information, and therefore is scalable. Numerical evaluation of the scheme shows encouraging results.

Friday 10:30 - 11:00 AM

► Coffee Break - The Merrick and Gables Foyer
Network Systems

Chair: Nasser Fard, Dept. of Mechanical & Industrial Eng., Northeastern University, Boston, MA 02115, USA

1 - Reliability Measures in Distributed Systems

Nasser Fard, Dept. of Mechanical & Industrial Eng., Northeastern University, Boston, MA 02115, USA
Dr. Indra Gunawan, Dept. of Mechanical and Production Eng., Auckland University of Technology, Auckland 1020, New Zealand

A major problem in designing large-scale distributed systems is the construction of an interconnection network to provide inter-processor communications and in some cases, memory access for the processors. The task of interconnecting $N$ processors and $N$ memory modules, where $N$ may be in the range of 26 to 216, is not trivial. The interconnection scheme must provide fast, flexible, and reliable communications at a reasonable cost. Unfortunately, these configurations are highly impractical when $N$ is large because $N - 1$ unidirectional line are required for each processor. The configuration of multistage interconnection network systems (MINs), as one class of interconnection network, depends on the number of stages, types of switches, and interconnection among the network switches and stages. The main issue in the area of MINs is to obtain a reliable network topology so that the communication paths among processors and memories can be achieved properly. Terminal and broadcast reliability of MINs presented in this paper are measures of network reliability.

Terminal Reliability, generally used as a measure of robustness of a MIN, is the probability of existence of at least one fault free path between a designated pair of input (s) and output (t) terminals (two terminals). Terminal reliability can be defined as the probability that at least one path exists from a particular processor to a particular set of memories. In this paper, terminal reliability of MINs will be evaluated and the comparison of terminal reliability between unique path MINs and multi-path MINs will also be analyzed. Another useful measure of the reliability of a MIN is its ability to broadcast data from a given input terminal to all the output terminals of the network. A network is said to have failed when a connection cannot be made from the given input terminal to at least one of the output terminals. Method for broadcast reliability of a specific MIN is also presented.

2 - Exhaustive Design: Evaluating Many Cell Signaling Networks

Leo Lopes, Systems and Industrial Engineering, University of Arizona
Matej Boguszak, Applied Mathematics, University of Arizona
Jay Kognieczka, Molecular and Cellular Biology, University of Arizona
Parker Antin, Cell Biology and Anatomy, University of Arizona

Phenotypes result from complex interactions between many complex molecules. These interactions can be modeled using networks. Analyzing these network models is one of the pillars of a new discipline: Systems Biology. Many aspects of the analysis of these networks are reasonably mature for the case where the network is known. Our research takes the next logical step: searching over the network topology space. To enable this step, new technology that enables approximate evaluation of very large sets of related systems of differential equations is needed. Our approach to this evaluation combines trust region approaches with Markov Chain Monte Carlo techniques to quickly screen network designs for promising explanations to the expression of a given phenotype.
FB02 - Merrick I

Advances in Computational Optimization

Chair: Alkis Vazacopoulos, Dash Optimization Inc, 560 Sylvan Avenue, Englewood Cliffs, NJ 07632, av@dashoptimization.com

1- Complexity Issues in Sparse Unsymmetric LU Factorization.

Arne Stolbjerg Drud, ARKI Consulting & Development A/S, Bagsvaerdvej 246A, DK-2880 Bagsvaerd, Denmark, e-mail: adrud@arki.dk.

Complexity measures for sparse LU factorization of basis matrices, widely used in LP and NLP algorithms, are not well developed. While optimal ordering for sparse LU-factorization is NP complete, simple ordering heuristics can give polynomially bounded algorithms. The aim of the Markowitz heuristic is to limit the numerical work. However, other components of the algorithm may dominate if not properly implemented, and we will give some examples where LU factorizations from commercial LP software perform poorly. We analyze pivot selection, sparsity structure updates, tests for numerical stability, and memory management to see if these other components can be bounded relative to the numerical work and we discuss appropriate methods and data structures.

2- Branch-and-Price with Xpress-Mosel

Hernan Wurgaft, SUNY Maritime College, 6 Pennyfield Avenue, Bronx, New York 10465, hwurgaft@sunymaritime.edu

Alkis Vazacopoulos, Dash Optimization Inc, 560 Sylvan Avenue, Englewood Cliffs, NJ 07632, av@dashoptimization.com

We present the use of Mosel’s functionality for model management and synchronization of concurrent models to implement Branch-and-Price algorithms. These algorithms, which apply column generation at every node of the branch-and-bound tree, have traditionally been hard to implement because they require specialized branching and specialized relaxation techniques. We show how Mosel eases the implementation of Branch-and-Price through its abilities to interact with the Xpress-Optimizer and to manage the sequential and parallel solving of multiple models. We present a number of examples and we also discuss how to extend these ideas for Branch, Cut, and Price algorithms.

3- Solving Hard Mixed Integer Programming Problems

Alkis Vazacopoulos, Dash Optimization Inc, 560 Sylvan Avenue, Englewood Cliffs, NJ 07632, av@dashoptimization.com

Richard Laundy, and

Gabriel Tavares

Xpress-MP features sophisticated, robust algorithms to quickly and accurately solve industry's most demanding Mixed Integer Programming Problems with millions of variables and constraints. Practical evidence of the Xpress performance will be shown on MIPLIB-2003. Using Xpress-2006 five MIP's from MIPLIB-2003 (a1c1s1, atlanta-ip, msc98-ip, rd-plusc-21 and swath) were solved for the first time on a single standard computer. The first known feasible solution of problem stp3d has been found by Xpress. In addition, new local search heuristics built on top of Xpress-2006 found improved solutions for all of the remaining (seven) open problems from MIPLIB 2003. Finally, it is shown how to speed-up Xpress MIP solve times through the use of automatic fine-tuning and the usage of parallel-based algorithms.

Friday 12:30 - 2:00 PM - Lunch on Your Own
Friday 2:00 - 3:30 PM

► FC01 – Gables Salon

Production Operations and Scheduling

Chair: Zhaoqiong Qin, Department of Management, Marketing, Strategy & Operations, Embry-Riddle Aeronautical University, Daytona Beach FL 32114, qina50@erau.edu

1 - A Co-evolutionary Algorithm for the Production Scheduling of Facilities in the Semiconductor Manufacturing System

Hoyeon Chung, Department of Manufacturing and Design Engineering, Jeonju University, Korea, hychung@jj.ac.kr
Dongju Shin, 3Ga 1200 Hyoja-dong Wansan-gu Jeonju-si Jeollabuk-do 560-759 South Korea

The purpose of this study is to suggest a co-evolutionary algorithm for the multiobjective scheduling problem in order to simultaneously optimize the due date and cycle time of the wafer sort and the final test process of the ASIC(Application Specific Integrated Circuits) semiconductor manufacturing system. Recently the ASIC system has become the most common order-type manufacturing system. Typically the multi-objective scheduling problem is NP-hard. Therefore, a heuristic algorithm is needed to find a near-optimal solution. Co-evolutionary algorithms provide an effective method to solve this problem. We will suggest a symbiotic type co-evolutionary algorithm. For this, we will specify the individual representations, the constitution of the population, the objective functions, the trade-off parameters, and the evolutionary strategies. Finally, we will document its performance through the computer experiments.

2 - A Branch and Bound Algorithm to Evaluate the Performance of Open and Closed Stations in Mixed-Model Assembly Lines

Ghorbanali Mohammadi, Dept. of Industrial Engineering, College of Engineering, Shahid Bahonar University of Kerman, gnohammadi@mail.uk.ac.ir

Assembly lines have traditionally been used to products that have the same physical design. Operators execute a predetermined set of tasks at each workstation as products move through an assembly line. In a workstation, one or more operators work on the same product. Objective of this work is Finding the best possible line parameters such as launch interval, sequences of work-pieces, station length and so on to minimize utility and idle time cost in a mixed-model, multi-station assembly line. A branch and bound algorithm will be constructing for the optimum solution of the mixed integer program.

3 - Analysis of a Decentralized Assembly System with Two Parties

Zhaoqiong Qin, Department of Management, Marketing, Strategy & Operations, Embry-Riddle Aeronautical University, Daytona Beach FL 32114, qina50@erau.edu

In the current global competition and cost reduction, a decentralized assembly channel structure has been widely adopted by many manufacturing firms. We study a two-party system where one party needs to pay the wholesale price to order one component from the other party and assembles the final product. Based on each party pursuing its own maximized profit, we develop the model and analyze different mechanisms of deciding the wholesale price of the component. Our objective is to optimize the whole supply chain for improving the customer service level. Results are derived by simulation for us to recommend the optimal mechanism.

► FC02 – Merrick II

Data Driven Decision Making

Chair: Joseph P. Bailey, The Robert H. Smith School of Business, University of Maryland, College Park, MD 20742-1815
1 - Ex-Post Internet Charging: An Effective Bandwidth Model
Joseph P. Bailey, Ioannis Gamvros, and S. Raghavan, The Robert H. Smith School of Business, University of Maryland, College Park, MD 20742-1815

Generally Internet Service Providers (ISPs) have charged their customers flat fees for their Internet connections. This has resulted in frequent congestion for many users. There are many different approaches to address this problem. Effective utilization of scarce resources is important to managers in the telecommunications industry, and thus usage-based pricing has become an important tool to address this problem—since it does not require large capital expenditures. In this paper, we develop an ex-post charging mechanism based on the effective bandwidth concept. This model, effectively characterizes the utilization and burstiness of a user in a single metric. Further, we introduce a novel market for buffer size. In this market users purchase a specific buffer size from their ISP. Our model directs users with bursty traffic to purchase larger buffers, while users with well-behaved traffic are directed to purchase smaller buffers. From a resource usage standpoint, this is also the appropriate decision. We conduct computational experiments to show the viability of this approach, and also discuss real-world implementation issues.

2 - Solving a Mixed-Integer Programming Formulation of a Constrained Discrimination Model
Paul Brooks, Virginia Commonwealth University, Eva Lee, Georgia Institute of Technology

Classification, the development of rules for the allocation of observations to groups, is a fundamental machine learning task. A classic example is an automated system for a bank that decides whether to accept or reject a credit application. A classification rule that maximizes (minimizes) the total probability of correct (incorrect) classification of new observations may have inter-group misclassification rates that are higher than desirable. Constrained discrimination seeks to maximize the probability of correct classification while satisfying pre-specified limits on misclassification rates. The constraints on misclassification rates are met through the introduction of a reserved judgment group for observations not demonstrating properties of membership to any of the groups. We consider a two stage constrained discrimination model. The first stage of the constrained discrimination model involves estimating conditional group density function values for training observations, and the second stage requires the solution of a mixed-integer program (MIP). The problem is NP-Complete for a general number of groups, but polynomially solvable for the two-group case. Solution methods for the MIP are presented, including techniques for generating and exploiting the conflict graph. Improvement in computation times over industry-standard software is demonstrated.

3 - Estimating Residual Bladder Volume in Order to Adjust Collected Potassium Excretion
David Afshartous, School of Business, University of Miami, Coral Gables, FL 33214
Richard Preston, Miller School of Medicine, University of Miami, 1500 NW 12th Avenue, 15th Floor West Tower, Miami, FL 33136

Medical studies often collect data via repeated measurements on patients. For example, in order to study potassium handling, voided potassium concentration is measured each hour after administering a potassium load. However, the existence of residual bladder volume at each collection point presents difficulties when attempting to estimate actual/internal potassium handling via observed measurement. Specifically, the potassium collected during a one hour collection may not represent the actual potassium handled/excreted (introduced into the bladder) during that hour. We present an unbiased method to estimate the residual bladder volumes via a mathematical model of the bladder process. The model leverages constant concentration and constant mass principles in order to solve a system of recursive equations. We verify the model on simulated patients and also investigate the sensitivity of the model to initial value specification.
Interconnection networks provide communication among processors, memory modules, and other devices in parallel computer systems. Among several advantages of multistage interconnection network systems (MINs) are: high reliability through backup and redundancy, high speed in data transmission, maximum performance through interconnection among processors, and low cost. This paper presents a methodology for the reliability evaluation of a specific structure of MINs. The MINs connect input devices to output devices through a number of switching stages in which each switch is a crossbar network. The properties of MINs and several types of MINs are presented first, followed by different measures of reliability assessments for MINs. Terminal Reliability, generally used as a measure of robustness of a MIN, is the probability of existence of at least one fault free path between a designated pair of input (s) and output (t) terminals (two terminals). Terminal reliability can be defined as the probability that at least one path exists from a particular processor to a particular set of memories. In this paper, terminal reliability of MINs will be evaluated and the comparison of terminal reliability between unique path MINs and multi-path MINs will also be analyzed. A numerical example is presented to demonstrate the reliability evaluation procedure for a specific MIN.
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