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FOREWORD

On behalf of the Organizing and Scientific Committees, it is our pleasure to welcome you to the XXXV Annual Conference of the Italian Operations Research Society.

This edition of the conference, which takes place in Lecce from September 7 to 10, 2004, has registered a particularly large number of participants: 208 contributions, organized in 6 plenary sessions, one semi-plenary, 37 invited parallel sessions and 13 contributed parallel sessions. The topics span the complete universe of operations research, from methodological issues to applications. A parallel session, *Transportation III*, has been organized by SIDT (Società Italiana Docenti Trasporti) in the hope of improving cooperation and knowledge sharing with the Operations Research community. A plenary session has been supported by ORMA (Ottimizzazione di Reti: Metodologie e Applicazioni).

We are indebted to a number of individuals, companies and institutions for their support. First of all, we would like to express our gratitude to Francesco Archetti, Francisco Barahona, Oleg Burdakov, Laureano Escudero, Gilbert Laporte, Pierre L'Ecuyer, Martin Savelsbergh and Annegret Wagler who have accepted to contribute to the success of the conference by giving plenary or semi-plenary talks. Thanks are due to Alessandro Agnetis, Claudio Arbib, Patrizia Beraldi, Luca Bertazzi, Domenico Conforti, Mauro Dell'Amico, Paolo Dell'Olmo, Gianni Di Pillo, Matteo Fischetti, Antonio Fuduli, Francesca Guerriero, Andrea Lodi, Federico Malucelli, Renata Mansini, Silvano Martello, Carlo Meloni, Paolo Nobili, Andrea Pacifici, Fioravante Patrone, Guido Perboli, Giovanni Righini, Fabrizio Rossi, Maria Grazia Scutellà, Antonio Sforza, Maria Grazia Speranza, Paolo Toth, Carlo Vercellis and Daniele Vigo who have organized invited sessions. We would also like to acknowledge the financial support of our sponsors: Università della Calabria (Centro di Eccellenza sul Calcolo ad Alte Prestazioni, Dipartimento di Elettronica Informatica e Sistemistica, Dipartimento di Economia e Statistica, Dipartimento di Matematica), Università di Lecce (Dipartimento di Ingegneria dell'Innovazione, Dipartimento di Matematica), Callipo, CM Sistemi, HP, ILOG, SAP, SGI, TSTAT and Wiley.

Special thanks are due to Roberto Musmanno, whose restless effort and unparalleled commitment have been key to organizing this event, and to Lucio Grandinetti for his encouragement. Moreover, we would like to thank, Valeria Leggieri, Antonella Quaranta, Massimo Ramundo, Sandro Zacchino and Emanuela Guerriero for their valuable professional assistance.

Finally, we would like to take the opportunity to remember Stefano Pallottino whose participation to past AIRO Conferences was fundamental to make our annual meeting more and more stimulating. To him AIRO 2004 Conference is dedicated.

Lecce, September 2004

Gianpaolo Ghiani
Scientific Committee Chair

Chefi Triki
Organizing Committee Chair

PLENARY AND SEMI-PLENARY SESSIONS

PARALLEL SESSIONS

PLENARY SESSIONS

Chairperson: A. Sassano

Separation of partition inequalities and their role in network design
F. Barahona
IBM Watson Center, USA

Partition inequalities are used in network design problems to impose different types of connectivity constraints. We describe several classes of these inequalities, we give separation algorithms and discuss their applications to different Network Design problems.

Chairperson: L. Grandinetti

On solving mixed 0-1 stochastic programs
L. Escudero
Universidad Miguel Hernández, Spain

We present a framework for solving mixed 0-1 multi-stage problems under uncertainty in the objective function coefficients and the right-hand-side. A scenario analysis scheme with full recourse is used. The constraints are modelled by a splitting variable representation via scenarios. So, a mixed 0-1 model for each scenario is considered plus the non-anticipativity constraints that equate the so-called common continuous and 0-1 variables from the same group of scenarios in each stage. A Branch-and-Fix Coordination approach is presented for coordinating the selection of the branching Twin Node Families (TNF) and the branching common variables in the scenario subproblems to be jointly optimized. We consider Lagrangean Substitution and Decomposition schemes for bounding purposes at the so-called candidate and integer TNFs. Some computational experience is reported for different types of problems.

Chairperson: M. G. Speranza

Operations systems and life sciences: integration perspectives
F. Archetti
University of Milan

Chairperson: S. Martello

Logistics challenges and optimization opportunities
M. Savelsbergh
Georgia Institute of Technology, USA

Traditionally companies have focused on improving their own internal business processes when faced with pressures to operate more efficiently and more cost effectively. However, a system-wide focus, e.g., a collaborative focus, opens up cost saving opportunities that are impossible to achieve with an internal company focus. With the possibility of sharing and analyzing data through the connectivity provided by the internet, there has recently been a shift of attention towards controlling and reducing system wide costs and sharing these cost

savings to increase profitability for all parties involved. With the availability of timely and accurate information, new collaborative opportunities which create mutual benefit by taking advantage of operational synergies between buyers, sellers, or buyers and sellers are now arising. Collaborative logistics is viewed by many logistics professionals as the most promising opportunity for reducing logistics costs and therefore increasing profitability and economic prosperity. Probably one of the most successful applications of collaboration in logistics to date is vendor managed inventory (although it is not typically presented as an example of logistics collaboration). In environments where vendor managed inventory partnerships are in effect, the vendor is allowed to choose the timing and size of deliveries. In exchange for this freedom, the vendor agrees to ensure that its customers do not run out of product. In a more traditional relationship, where customers call in their orders, large inefficiencies can occur due to the timing of customers' orders, i.e., high inventory and high distribution costs. By initiating vendor managed inventory partnerships demand variability is decreased, reducing inventory holding and distribution costs. Another, more recent, successful application of collaboration in logistics is found in the trucking industry. To execute shipments from different shippers a carrier often has to reposition its assets, i.e., trucks. Shippers have no insight in how the interaction between their various shipments affects a carrier's asset repositioning costs. However, shippers are implicitly charged for these repositioning costs. No single participant in the logistics system controls asset repositioning costs, so only through collaborative logistics initiatives can these costs be controlled and reduced. Asset repositioning is expensive. A recent report estimates that 18% of all trucks movements every day are empty. In a $921 billion U.S. logistics market, the collective loss is staggering: more than $165 billion. In this presentation, we introduce a variety of challenging optimization problems that arise as a result of these collaborative logistics initiatives and discuss the potential solution approaches.

Chairperson: P. Toth

Metaheuristics for the vehicle routing problem: fifteen years of research

G. Laporte
Canada Research Chair in Distribution Management, Canada

Over the past fifteen years several powerful metaheuristics have been developed for the Vehicle Roputing Problem (VRP). The best methods are based on tabu search, variable neighbourhood search, genetic search, and ant algorithms. Much progress has been accomplished since the publication of the first tabu search heuristic for the VRP in 1989. Several methods have been proposed, but not all have been equally successful. In this talk I will provide an overview of some of the best algorithmic ideas proposed over the past fifteen years, and I will also mention some ideas that did not work so well.

Chairperson: R. Musmanno

Isotonic regression: algorithms and applications

O. Burdakov
Linköping University, Sweeden

The isotonic regression problem (IR) has important applications in statistics, operations research and image processing. It can be formulated as a quadratic programming problem of finding the n-dimensional vector x that minimizes the Euclidean distance from a given vector to a cone. The cone is defined by linear constraints which establishes relations

between some pairs of components of x in the form "component number i is less-or-equal to component number j". The relation between the components can be presented by an acyclic directed graph. The applied IR problems are often characterized by a very large value of n. Therefore, the complexity of IR algorithms is required to rise with n not too rapidly. The IR problem is known to be of polynomial complexity. In our presentation, we discuss applications of the IR problems and give an overview of optimization algorithms developed for solving these problems.

KEYNOTE (SEMI-PLENARY) SESSIONS

Chairperson: S. Salerno

Uniform random number generation: overview and recent developments

P. L'Ecuyer
Université de Montréal, Canada

In this talk, we first outline a set of design principles for uniform random number generators (RNGs) used for stochastic simulation. We recall the main requirements for a good generator (good multidimensional uniformity, high speed, etc.) and theoretical figures of merit for certain classes of linear-type generators. We also discuss theoretical versus statistical testing of RNGs. Bad RNGs are still well alive. As an illustration, we briefly examine those in Excel, Visual Basic, and the Java standard library, and exhibit two very simple simulation models for which these RNGs give totally wrong results. We then summarize some recent ideas for constructing fast and reliable generators. They include: (a) combined multiple recursive generators with coe_cients that are a sum or a diffrence of a few powers of 2; (b) combined generators whose components are based on linear recurrences modulo 2 (such as Tausworthe, twisted GFSR, etc.); (c) polynomial linear congruential generators with tempering; (d) mixted linear/nonlinear combined generators. Practical random number packages with multiple streams and substreams are presented at the end of the talk. Several papers on uniform RNGs are available on this speakers's web page.

Chairperson: A. Agnetis

On the stable set polytopes of claw-free graphs

A. Wagler
Zuse-Institute Berlin

The problem of finding a decent linear description of the stable set polytopes of claw-free graphs is a long-time open question posed by Groetschel, Lovasz, and Schrijver in 1988. This talk surveys related results and conjectures, linking Edmond's historical characterization of the matching polytope, the complete description of the rank-polytope of claw-free graphs by Galluccio and Sassano in 1997, Ben Rebea's Conjecture on the stable set polytopes of quasi-line graphs, and recent achievements on the structure of claw-free graphs by Chudnovsky and Seymour.

INTERNET I (NETWORK OF EXCELLENCE EURONGI SESSION)

Chairperson: A. Pacifici

Telecommunication network design problems related to the notion of max-min fairness

M. Pióro
Warsaw University of Technology, Poland and Lund University, Sweden

In telecommunication network design the notion of Max-Min Fairness (MMF) has so far been studied mainly in the context of allocation of bandwidth to elastic traffic demands (i.e., to demands with best effort traffic). The most commonly known example of a design problem involving MMF is allocating bandwidth to demands for a given single-path routing pattern (cf. [1]). It turns out, however, that MMF (and, for that matter, other fairness principles) is a notion that helps to precisely pose many other valid design problems for telecommunication network design. In the presentation we will give several examples of different network design problems involving MMF, including bandwidth allocation for generalized (multi-path) routing, a capacity protection problem, and a restoration design problem. Then we will generalize all these problems using an appropriate convex programming formulation and present an efficient iterative resolution algorithm based on dual variables. We will illustrate the considerations with some numerical examples. Finally, we will present some extensions of the generalized problem. The presentation will be based on the work presented in [2] and [3].

References

[1] Bertsekas, D., Gallager, R.: Data Networks, Prentice Hall, 1992.
[2] Pióro, M., Medhi, D.: Routing, Flow and Capacity Design in Communication and Computer Networks, Morgan Kaufmann Publishers (Elsevier), 2004.
[3] Ogryczak, W., Pióro, M., Tomaszewski, A.: Telecommunications Network Design and Max-Min Optimization Problem, submitted to EJOR.

Optimization techniques for the dimensioning and reconfiguration of MPLS networks

S. Beker
Ecole Nationale Supérieure des Télécommunications (Telecom Paris)

The calculation of virtual topologies mapped onto physical topologies is one of the main functionalities of the traffic engineering. For a given physical network topology with fixed capacities and a traffic matrix to route, the problem is the one of finding a virtual topology optimally routing the given traffic matrix over the physical topology. Considering the traffic dynamics, when the demand matrix evolves over long timescales we will need to recalculate such optimal layout. Our first contribution consists in the definition of cost functions which better represent the actual costs of operations and maintenance from an operator's standpoint. The second contribution consists in taking into account the costs of *reconfiguring* the layout to adapt it to the new optimal layout. Considering actual operation and maintenance costs, it would be interesting to reduce the layout complexity, measured as a function of the number of virtual paths required by the layout, as opossed to calssical cost functions usually minimizing delay. We have formulated different optimization problems minimizing layout complexity under QoS constraints. This realistic model results in highly

complex problems (NP-complete). We have developped heuristic methods to approximatelly solve it for large network topologies. We have shown the interest of reducing the layout complexity compared to results obtained when optimizing the layout with classical cost functions. The layout reconfiguration induces first a cost of operation, and second a cost associated to the service disruption times and spare resources needed to reconfigure the layout. We have formulated a family of problems taking into account the reconfiguration costs when calculating the new layout. One of the above mentioned heuristics has been adapted to approximately solve the reconfiguration problem.

Polyhedral traffic matrices for the design of the next generation internet

M. Naldi
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The design of telecommunications networks is largely based on the use of traffic matrices, whose entries represent the traffic exchanged between the various origin-destination (OD) couples in the network. A current research focus in Internet traffic analysis is on the estimation of such traffic matrices on the basis of measurements on the network links. A large availability of traffic matrices can therefore be envisaged in the near future (even with a 5 minute resolution), leading to the problem of accounting for them all in the design process. Though each entry in a traffic matrix represents a design constraint (so that a traffic matrix is a point in the constraint space), recent developments in design techniques allow for the use of various forms of constraints, represented under a polyhedral shape in the constraint space. These advancements can be exploited by modifying the traditional formulation of traffic matrices and avoiding the all-maxima approach resulting from satisfying each constraint individually. In the polyhedral formulation of traffic matrices constraints are given on the sum of traffic levels pertaining to different OD couples, rather than to single OD couples. Savings are expected on the overall network costs resulting from a polyhedral design because of the less-than-perfect correlation (or in some cases even negative correlation) existing between the behaviours of different OD couples. In this paper the relationship is explored between the relaxation allowed on the traffic constraints and several key factors: a) the number of available traffic matrices; b) the traffic patterns over the set of matrices, gathered at different times; c) the correlation between the traffic levels pertaining to different OD couples.

Keywords: Telecommunications, Traffic matrix, Polyhedral design methods

References:
[1] A. Medina, N. Taft, K. Salamatian, S. Bhattacharyya, C. Diot: "Traffic Matrix Estimation: Existing Techniques and New Directions", ACM SIGCOMM, Pittsburgh, August 2002
[2] A. Medina, C. Fraleigh, N. Taft, S. Bhattacharyya, C. Diot: "A Taxonomy of IP Traffic Matrices", SPIE ITCOM: Scalability and Traffic Control in IP Networks II, Boston, August 2002
[3] M. Naldi: "A polyhedral formulation for IP traffic matrices based on sum constraints", EuroNGI Workshop on Traffic Engineering, Protection and Restoration for NGI, May 27-28, 2004, Lund
[4] G. Oriolo: "Dominance Between Traffic Matrices", Invited talk, Max-Planck-Institut für Informatik, 31 July 2003

Design and analysis of a traffic engineering system for multi-layer networks with a dynamic handling of optical resources

P. Iovanna
Ericsson Lab

This paper introduces an integrated Traffic Engineering (TE) system for new generation multi-layer networks based on the GMPLS paradigm, which is able to dynamically manage the network resources of both the MPLS and the optical layer, according to traffic demand changes. A performance analysis is also reported, highlighting that the proposed system, in its simplicity, is able to effectively react to traffic changes while consuming a reasonable amount of network resources and fulfilling real time requirements. The proposed solution consists of a system, based on a hybrid routing approach, making use of both off-line and on-line methods, and a bandwidth management strategy, based on an "elastic" use of the bandwidth, allows the handling of different priorities among data flows, possible preemptions, and re-routing. The innovative steps lays in a dynamic controller that is able not only of accommodating on demand traffic requests and changes but even to handle lightpaths dynamically in a multi-layer fashion. The performance analysis also reveals in which range of operations traffic engineering is effective.

LARGE SCALE NONLINEAR OPTIMIZATION I (FIRB PROJECT)

Chairperson: G. Di Pillo

A solving environment for large-scale optimization problems

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We present a preliminary version of a solving environment for large-scale optimization problem. This work is part of the research activities in the context of the M.I.U.R. FIRB Project ``Large Scale Nonlinear Optimization", n. RBNE01WBBB. One of the main objectives of such activities is to integrate and to make available all optimization software provided by people working in the above project. Some of the main tools of the solving environment under development are the software interfaces for using the most common optimization problem modelling languages, some collections of test problems for both unconstrained and constrained optimization, some graphical interfaces to allow a friendly usage of the software, and some graphical tools for performance evaluation and comparison. The solving environment also provides some well-established software, that can be used for software comparison.

Keywords: large-scale optimization, problem solving environment, graphical interfaces.
References:
[1] M. D'Apuzzo, M.L. De Cesare, M. Marino, M.R. Maddalena - A Solving Environment for Large-Scale Nonlinear Optimization Problems - Tech. Report TR-ICAR-NA-05, Istituto di Calcolo e Reti ad Alte Prestazioni (ICAR – Sezione di Napoli) – CNR, aprile 2004.

Potential reduction solvers for large-scale quadratic programs

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We present interior-point algorithms and software for convex quadratic programs. We focus on potential reduction algorithms and on large and sparse problems. Our main interest is on the use of preconditioned iterative techniques to solve the linear system arising at each iteration of the considered algorithms. Furthermore, we analyze suitable termination rules to adapt the accuracy requirements in solving the linear systems on the quality of the current iterate. Starting from software developed for quadratic programming problems with box constraints [1,2,3], we are currently focusing on general quadratic programming problems. We are investigating strategies able to tackle the numerical and computational difficulties due to the presence of the constraint matrix into the linear systems. We show results of numerical experiments, varying the linear system solution approaches and the adaptive termination strategies. This work is part of the research activities aimed at developing an optimization solving environment, in the context of the M.I.U.R. FIRB Project ``Large Scale Nonlinear Optimization", n. RBNE01WBBB.

Keywords: potential reduction methods, iterative solvers, adaptive termination rules.
References:
[1] M. D'Apuzzo, M. Marino, P.M. Pardalos, G. Toraldo - A Parallel Implementation of a Potential Reduction Algorithm for Box-Constrained Quadratic Programming - in Lecture Notes in Computer Science 1900, A. Bode et al. (Eds.), Springer-Verlag, pp. 839-848 (2000)
[2] S. Cafieri, M. D'Apuzzo, M. Marino, A. Mucherino, G. Toraldo - An Interior Point Solver for Sparse Quadratic Programs with Bound Constraints - CPS Tech. Report TR-06-02, Center for Research on Parallel Computing and Supercomputers, CPS-CNR, 2002 (submitted for publication).
[3] M. D'Apuzzo, M. Marino - Parallel Computational Issues of an Interior Point Method for Solving Large Bound-Constrained Quadratic Programming Problems – Parallel Computing, Vol. 29/4 (2003), pp. 467-483.

A convergent decomposition algorithm for training Support Vector Machines

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IASI, Consiglio Nazionale delle Ricerche

In this work we consider the convex quadratic programming problem arising in Support Vector Machine (SVM), which is a technique designed to solve a variety of learning and pattern recognition problems [3]. Since the Hessian matrix is dense and real applications lead to large scale problems, several decomposition methods have been studied, that split the original problem into a sequence of smaller subproblems. SVM light algorithm [1] is a commonly used decomposition method for SVM, and its convergence has been proved only recently under a suitable block-wise convexity assumption on the objective function [2]. At each iteration, SVM light algorithm requires, for the selection of the subproblem variables, the application of a specific ordering procedure (of a vector of dimension equal to the number of variables) connected to the violation of the Karush-Kuhn-Tucker conditions. In this paper we define a new globally convergent decomposition algorithm that differs from the previous methods in the rule for the choice of the subproblem variables and in the presence of a proximal point modification in the objective function of the subproblems. In particular, the new rule for selecting the subproblems appears to be suited to tackle large scale problems. Indeed, the selection of the subproblem variables does not require to apply any specific ordering procedure, that means that no additional computational effort is required to identify the subproblem to be solved. The introduction of the proximal point term allows us to ensure the global convergence of the algorithm even for the general case of nonconvex objective function. The results of a computational experience performed on large dimensional test problems will be presented.

References:
[1]T. Joachims, Making large scale {SVM} learning practical, in Advances in Kernel Methods - Support Vector Learning, C. B. B Scholkopf and A. Smola, eds., MA: MIT Press, Cambridge, 1998.
[2] C. J. Lin, On the convergence of the decomposition method for Support Vector Machines, IEEE Transactions on Neural Networks, 12, pp. 1288--1298, 2001.
[3] V. Vapnik, The Nature of Statistical Learning Theory, Springer-Verlag, New York, 1995.

Evolutionary strategies in the optimization molecular cluster

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In order to efficiently obtain minimum energy conformation for molecular cluster special purpose global optimization algorithms have to be designed. The problem of finding a minimum energy conformation of Morse clusters is an extremely hard global optimization problem, even much harder than the well known similar problem of finding minimum energy Lennard-Jones clusters. The difficulty of the problem lies in the exponential number of local optima and in the great diversity of shapes that local optima possess, even when the differences in energetic value are small. In order to successfully attack this hard problem a composite algorithm has been designed which contains both "intensification" steps (aiming, through the use of local search, at approximating good local optima), and "diversification" steps, whose aim is that of exploring the feasible region. The results so far obtained in Morse clusters with r=14 and up to 80 atoms are currently the best found in literature. This success opens the possibility of exploring even more challenging problems in molecular conformation.

Keywords: Morse clusters, large scale global optimization, molecular conformation

TELECOMUNICATIONS I (PRIN PROJECT)

Chairperson: F. Malucelli

Queueing networks with positive customers, signals and impatient service

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G-networks models have been introduced by Gelenbe and they have been motivated by the analogy with neural networks. Among a wide range of applications they have been applied to evaluate the performance of unreliable flow systems and to describe virus behaviour in a computer network. A G-network is characterized by positive and negative customers, signals and triggers. Positive customers are ordinary customers which join a queue in order to receive service and which can be destroyed by a negative customer arriving to the queue. Negative customers joining a non-empty queue have the effect to destroy a positive customer. The role of a trigger is to displace a positive customer from a queue to another. A signal combines these two kinds of customers and can act either as a negative customer or a trigger. We deal with a queuing network with positive customers and signals. Positive customers and signals arrive from the outside at each node according to two independent Poisson processes. Service times of positive customers at each node are exponentially

distributed. After receiving service, a positive customer goes from a node to another node with fixed probabilities either as a positive customer or as a signal or quits the network. The activation time of a signal is exponentially distributed. Activated signals with fixed probabilities either move a customer from the node they arrive to another node or kill a positive customer. We introduce in the described model a "patient" time. Each customer can be served in a node at most a random time ("patient" time) exponentially distributed. When the patient time is finished the customer goes to another node or leaves the network with fixed probabilities. Stationary state distribution is derived in product form in the case of positive customers processed by a single server and in the case of a symmetrical network in which service rate of a positive customer at each node depends on the number of positive customers in this node.

Keywords: G-networks, positive customers, impatient service, product form solution.
References:
[1] Bocharov P.P. 2002, "Queueing networks with signals and random signal activation". In Automation and Remote Control, Vol. 63, N. 9, Pp 1448-1450.
[2] Gelenbe E. 1991, "Product Form Queueing Networks with positive and negative customers". In Journal of Applied Probability, Vol. 28, Pp 656-663.

Joint optimization of transmit power and detection order in UMTS systems

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In order to distinguish the signals of the different mobile terminals (MTs), the Universal Mobile Telecommunication Standard (UMTS) [1] adopts the code division multiple access (CDMA) technique, where each terminal is identified by a specific code. Due to the distortions introduced by radio propagation, the MTs partially interfere with each other: a promising technique to reduce the multiuser access interference is the successive interference cancellation (SIC). With this method, the signals of MTs are detected sequentially from the received signal with a pre-determined order. A first problem in the design of the SIC system is the choice of the detection order. Usually, users are ordered with decreasing received power [2], although a better performance can be obtained by considering also the level of mutual interference among users. A second issue is the choice of the power level at which each user transmits data. In fact, by appropriately scaling the power, SIC improves while at the same time the minimization of the transmit power yield a longer duration of the batteries of the MT.We propose an exact algorithm for energy saving in CDMA systems based on integer linear programming for the joint optimization of transmit power and detection order in SIC receivers, while ensuring the same signal to noise plus interference power ratio at the detection point for each user.

References:
[1] 3GPP, Technical Specification Group Radio Access Networks; Radio Transmission and Reception, 3G TS 25.102 version 3.6.0., 1999.
[2] P. Patel and J. Holzman, "Analysis of a simple successive interference cancellation scheme in a DS/CDMA system," IEEE J. Select. Areas Commun., vol. 12, pp. 727-807, June 1994.

A model and algorithm for provisioning Virtual Private Networks under demand uncertainty

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A Virtual Private Network (VPN) is created connecting a set of private networks through the access nodes of a large interconnection network. When provisioning a VPN one wishes to reserve bandwidth on the interconnection network to support communication among the set of access nodes. In [1] the following network design formulation is investigated. Given a graph representing the interconnection network and a set of access nodes with a bound on the cumulative amount of traffic each one of them can send or receive, one must select a path for each pair of nodes and a bandwidth allocation for each edge of the network, so that any traffic matrix consistent with the given upper bounds can be routed. Optimal and approximate algorithms are presented for several variants of this problem. To support decisions when establishing multiple VPNs on a backbone network, we propose an incremental model in which we assume that the set of all VPNs, each one represented by its set of access nodes and bandwidth constraints, is subdivided into two types: VPNs that are already provided with the service and those applying for it. Since the uncertainty on the traffic demand between nodes of the two types of VPNs differs substantially, we adopt the Hose model (like in [1]) for the new ones and a less conservative uncertainty model [2] (which exploits the available traffic statistics) for the first type of VPNs. The case in which access nodes must be added to some existing VPNs is also considered. We present an algorithm for tackling this new model and report some computational results.

Keywords: network design, demand uncertainty, robust optimization
References:
[1] A. Gupta, J. Kleinberg, A. Kumar, R. Rastogi, B. Yener, Provisioning a Virtual Private Network: A network design problem for multicommodity flow, Proceedings of the 33rd annual ACM Symposium on Theory of Computing (STOC), pp. 389-398, 2001.
[2] D. Bertsimas, M. Sim, Robust discrete optimization and network flows, Math. Programming, Ser. B 98, pp. 49-71, 2003.

On the new class of covering problems arising in planning wireless LANs

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Wireless Local Area Networks (WLANs) are expected to become pervasive in working environments as well as public areas since they are progressively replacing traditional wired local networks indoor and allowing flexible access outdoor. Although the small systems currently installed are planned using rules of thumb, their rapid spread and size increase calls for quantitative methods to determine cost efficient solutions with service quality guarantees. A WLAN consists of a set of access points (antennas), serving a corresponding subsets of users (area). Given a set of potential access point locations and the corresponding subset of users, WLAN planning amounts, among others, to selecting a subset of locations in which to install access points so as to maximize network capacity. Given the peculiar access scheme, which allows a user to access the network only if no other user is simultaneously connected to the same access point or is interfering with it, this location problem can be seen as an extension of the classical set covering. Since solutions with many access points serving small (possibly non-overlapping) subsets of users must be favored, the overlaps between the subsets of users covered by different access points must be accounted for. Different mathematical programming problems, based on hyperbolic and quadratic formulations, are investigated and some computational results are reported.

Keywords: wireless telecommunication, set covering, quadratic programming.

POLYHEDRAL METHODS IN COMBINATORIAL OPTIMIZATION

Chairperson: F. Rossi

Polyhedral study for a UMTS channel assignment problem

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We investigate the polyhedral aspects of a channel assignment problem in a UMTS system. Given two mobile terminals in the system, differents applications can be provided to users by a unique physical channel. We want to decide how to assign the capacity of the channel to users so that some specific implementation requirements are satisfied. We study the polyhedron defined as the convex hull of feasible assignments. When there is only one user in the system, we prove that the description of this polytope is complete, i.e. every vertex is integer.

Exploring the relationship between max-cut and stable set relaxations

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The max-cut and stable set problems are two fundamental NP-hard problems in combinatorial optimization. It has been known for a long time that any instance of the stable set problem can be easily transformed into a max-cut instance. Moreover, Laurent, Poljak, Rendl and others have shown that any convex set containing the cut polytope yields, via a suitable projection, a convex set containing the stable set polytope. We review this work, and then extend it in the following ways. We show that the rounded version of certain `positive semidefinite' inequalities for the cut polytope imply, via the same projection, a surprisingly large variety of strong valid inequalities for the stable set polytope. These include the clique, odd hole, odd antihole, web and antiweb inequalities, and various inequalities obtained from these via sequential lifting. We also examine a less general class of inequalities for the cut polytope, which we call odd clique inequalities, and show that they are, in general, much less useful for generating valid inequalities for the stable set polytope. As well as being of theoretical interest, these results have algorithmic implications. In particular, we obtain as a by-product a polynomial-time separation algorithm for a class of inequalities which includes all web inequalities.

On the stable set polytopes of classes of claw-free graphs

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Providing a decent linear description of the stable set polytopes of claw-free graphs is a long-standing problem, raised by Groetschel, Lovasz, and Schrijver in 1988. However, even the problem of finding all facets of the stable set polytopes for important subclasses of claw-free graphs, as circulant and quasi-line graphs, is still open. A famous conjecture due to Ben Rebea claims that the stable set polytopes of the latter two graph classes admit one type of non-trivial facets only, so-called clique family inequalities. We address the question how to apply a decomposition result on claw-free graphs, recently obtained by Chudnovsky and Seymour, in order to solve Ben Rebea's Conjecture.

On normal graphs and the normal graph conjecture

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Normal graphs are defined in terms of cross-intersecting set families and constitute a closure of perfect graphs by means of two information-theoretical concepts, co-normal products (Körner 1973) and graph entropy (Cziszar et al. 1990). Perfect graphs have been recently characterized as graphs without odd holes and odd antiholes (Strong Perfect Graph Theorem, Chudnovsky et al. 2002). Körner and de Simone observed that the odd holes and odd antiholes with at most 7 nodes are minimal not normal and conjectured, in analogy to the Strong Perfect Graph Theorem, that every graph without those three subgraphs is normal (Normal Graph Conjecture, Körner and de Simone 1999). We discuss several aspects of normal graphs w.r.t. this conjecture.

Keywords: perfect graphs, normal graphs, graph-entropy.

PACKING (SORSA PROJECT)

Chairperson: S. Martello

Cutting plane approaches for the two-dimensional orthogonal knapsack problem

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The Two-Dimensional Orthogonal Knapsack Problem (2KP) appears in many industries (e.g. wood and steel industries) and consists of cutting a rectangular master surface into a number of rectangular pieces, each with a given size and value. The pieces must be cut with their edges always orthogonal or parallel to the edges of the master surface (*orthogonal cuts*). The objective is to maximise the total value of the pieces cut. We propose some new upper bounds obtained from different mathematical formulations of the 2KP using cutting plane approaches. The proposed approaches have been computationally tested on different test problem sets and the results obtained are compared with results in the literature.

Packing rectangles into a square

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In the Square Packing Problem (SPP), one is required to pack a given set of rectangular items into a unique square bin, in such a way that: (i) all items are packed, with their edges parallel to the edges of the bin; (ii) items do not overlap; and (iii) the side of the square is minimized. Several variants of the problem may be considered, depending on the possibility of rotating the items and on additional requests concerning the way of packing the items (guillotine cuts, two-staged packing, and so on). We introduce some lower bounds for SPP, discussing their performances both for the basic version of the problem (in which items cannot be rotated and no additional requirements are imposed) and for the version of SPP in which items can be rotated by 90 degrees. Finally, preliminary computational results on
some instances from the literature are presented.

An exact approach for the capacitated vehicle routing problem with two-dimensional loading constraints

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The classical Capacitated Vehicle Routing Problem [2] calls for the determination of the optimal set of routes to be performed by a fleet of vehicles, each with a maximum transport capacity, in order to satisfy the demands of a given set of customers. The demands are usually expressed by a positive integer, representing the weight or volume to be delivered. This can lead to a too strong approximation for many practical routing applications, where real demands are composed by items of a given size, and the loading of these items into the vehicles can be difficult. We consider the practical case in which the demand of each customer is defined by a set of rectangular items, each with a given weight and base dimensions. Thus, loading these items into a vehicle requires both checking that the maximum weight capacity is respected, and that the two-dimensional loading is feasible. The problem is composed by a routing part, which was solved through a branch and cut technique, and by a loading part, solved through a dedicated branch and bound derived from the one proposed in [1]. Separation procedures and lower bounds were developed for the new problem, as well as greedy heuristics and local search. The algorithm was coded in C and tested on instances derived from those available in the literature, being able to solve to optimality instances with up to 35 customers and 110 items.

References:
[1] S. Martello and D. Vigo. Exact Solution of the Two-Dimensional Finite Bin Packing Problem. Management Science 44, 388 - 399 (1998).
[2] The Vehicle Routing Problem. P. Toth and D. Vigo editors. SIAM Monographs on Discrete Mathematics and Applications (2002).

A practical heuristic search strategy for two dimensional cutting stock problems

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The paper presents a heuristic search method for two-dimensional cutting stock problem. Aiming at stock efficiency and based on presented packing algorithms for rectangles,

circles and convex- polygons, this method first nests some small items into the holes of the big ones so as to form a sequence of GROUPs which have a better local stock efficiency, then packs these groups to get a preliminary global result, and in the end fills the gaps among the groups in the previous result to get the last optimal result. The method uses a recycling computation of trial-evaluation-trial mode instead of the classical recursive computation and has better computation efficiency. The paper also gives out in detail a method to combine non-convex figures into a convex one and a scanning-line method to search the gaps among adjacent figures; these methods can well solve the local optimal problem in packing and nesting process, and improve the stock efficiency.

Keywords: Geometry Optimization; Cutting Problem; Packing Problem; Heuristic Search.

INTERNET II

Chairperson: A. Agnetis

A queueing system based model for self-similar Internet traffic

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The characteristics of traffic in modern telecommunication networks has led to the investigation of systems with more general than Poisson arrival processes, namely Markov MAP and its generalization Batch Markov Arrival Processes (BMAP). In fact Markovian arrival flows are able to capture the autocorrelation of the traffic in Internet. In the present work we analyze a single server system with the buffer of finite or infinite capacity, Markov arrival process, customers of several types with different priority indices and foreground-background processor sharing discipline (FBPS). The choice of this discipline is due to the fact that service disciplines of processor sharing allow a better usage of such networks resources due to the fact that they provide equal possibility/opportunity to the users. The mathematical relationships among the steady-state joint distributions of the number of customers of all types in these systems are obtained. The Laplace-Stieltjes transform of the steady-state distribution of the sojourn time for a customer of each type for the system with common buffer of infinity capacity is derived too.

Keywords: Queueing systems, Markov flow, foreground-background, processor sharing.
References:
[1] Pechinkin, A.V. 1998. "Steady-state probabilities of states in the MAP/G/1/n queue with the foreground-background processor-sharing discipline", Vestnik rossiiskogo universiteta druzhbi narodov. Ser.\ Applied mathematics and Informatics, No.1, 104-109.
[2] Pechinkin, A.V. 1999. "An BMAP/G/1/∞ queue with the foreground-background processor-sharing discipline", Automatika i telemehanika, No.194, 108-114.
[3] P.P. Bocharov, C. D'Apice, A.V. Pechinkin and S. Salerno, Queuing Theory, Modern Probability and Statistics, VSP, The Netherlands 2004.

Stochastic optimization in profiling web users

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Understanding the behavior of Web users on the basis of interaction data is among the most relevant and demanding tasks of data mining. In order to derive Web users' profile, transaction data must be fed into a model that can be used to predict the behavior of each individual. In this paper we propose a Hidden Markov Models (HMM) framework for modeling the clickstreams of web users, considered as a basis for the design of recommender systems. HMMs are a fairly general modeling tool and can be applied to a wide variety of learning problems. The downside of this generality, shared with other probabilistic graphical models, is the computational complexity of the learning problem which prevents the application of exact algorithms. In this paper it is shown that heuristics based on stochastic gradient can improve the accuracy of the learning phase of the HMMs with respect to the classical Baum-Welch procedure, bringing at the same time its computational cost within the time frame of on-line analysis. A preliminary set of empirical results, obtained from the Web logs of an Italian web site, is eventually discussed along with possible extensions of the model. In particular we will extend our analysis to a mixture of HMMs. Indeed, it has been recently suggested that the use of generative models composed by many small HMMs whose outputs are combined, can improve the effectiveness of HMMs in modeling sequential and partially missing data.

Adaptive information filtering on the web

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The awesome growth of the World Wide Web makes it increasingly necessary to develop new tools for the research and filtering of documents on the web, capable of selecting documents that are effectively useful to system users. In this paper we address the problem of adaptive filtering of documents on the Web, presenting two adaptive information filtering systems: the WIF system, which is able to filter relevant text and HTML documents from the Web and the InfoWeb system (Gentili, Micarelli and Sciarrone, 2003), developed for adaptive retrieval and the filtering of documents belonging to digital libraries available on the Web. The WIFS system features a User Modeling module, based on stereotypes, for the construction of the specific profile corresponding to each user and utilizes a relevance feedback mechanism to update the user models. It works in a parasite way based on the AltaVista engine: when AltaVista returns some documents from a particular query input by the user, the WIFS systems performs a ranking of the retrieved documents on the basis of the user model which input the query. Finally, by a relevance feedback mechanism, based on a score from –10 to +10 given by the user to one or more documents, the user can improve his/her model. The infoWeb system represents the user information needs in a user model, created through a representation, which extends the traditional Vector Space Model and takes the form of a semantic network based on co-occurrences between index terms. This system uses a clustering technique, the k-Means algorithm to build the stereotype library: all documents of the digital library are grouped into k cluster whose centroid becomes a stereotype. Consequently, each user starts using the system by selecting his/her best document. Both systems were evaluated through experimental evaluation with very encouraging results.

References:

[1] Gentili, G., Micarelli, A. and Sciarrone, F.. 2003. InfoWeb: An Adaptive Information Filtering System for the Cultural Heritage Domain. Applied Artificial Intelligence, **17,** 715-744.
[2] Micarelli, A. and Sciarrone, F.. 2004. Anatomy and Empirical Evaluation of an Information Filtering System on the Web. Uer Modeling and User-Adapted Interaction. In printing.

A branch-and-cut algorithm for a vendor-managed inventory-routing problem

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The integration of production, distribution and inventory management is one of the challenges of today's competitive environment. In the last decade the importance of these relations has been widely recognised and the expression "supply chain management", which emphasises the view of the company as part of the supply chain, has become of common use. The availability of new information technologies and the increasing use of Internet have created the conditions for the coordination inside the supply chain and have also led in the last years to the development of new forms of relationships in the supply chain. One of these is the so called Vendor-Managed Inventory (VMI), in which the suppliers monitor the inventory of each retailer and decide the replenishment policy of each retailer. We consider a distribution problem in which a VMI policy is applied. One product has to be shipped from a supplier to several retailers on a given time horizon. Each retailer defines a maximum level of the inventory of the product. Every time the supplier decides to visit a retailer, the quantity delivered is such that the maximum level of the inventory is reached at the retailer (deterministic order-up-to level policy). Shipments from the supplier to the retailers are performed by a vehicle of given capacity. The problem is to determine for each discrete time instant the quantity of the product to ship to each retailer and the route of the vehicle. For this problem, we introduce a mixed integer linear programming model and describe additional inequalities used to strengthen the linear relaxation of the model. We implement a branch-and-cut algorithm to optimally solve the problem. Computational results are shown on a set of randomly generated problem instances.

Keywords: VMI, Inventory, Routing, Branch-and-cut.

LARGE SCALE NONLINEAR OPTIMIZATION II (FIRB PROJECT)

Chairperson: G. Di Pillo

A nonmonotone derivative free method for nonlinear equations

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In this paper we propose a derivative free method for solving a large-scale system of nonlinear equations F(x)=0, which is based on a recent extension of the Barzilai and Borwein gradient method to nonlinear equations [1]. In connection with this technique, we propose a new nonmonotone algorithm, which combines watchdog rules and derivative free line searches along F and does not require finite difference approximations of the Jacobian matrix. In the general case where the Jacobian matrix is indefinite, we introduce a stabilization scheme employing line searches along the coordinate directions, and we prove global convergence under the assumption that the Jacobian is nonsingular. Numerical

results on a set of standard test problems show that the proposed method is competitive with recent implementations of Newton-type methods.

Keywords: Barzilai-Borwein gradient method, nonmonotone techniques, derivative free methods
References:
[1] W. La Cruz and M. Raydan, Nonmonotone spectral methods for large-scale nonlinear systems, Optimization Methods and Software, vol. 18, 2003, pp. 583-599.

An online algorithm for convex min-max problems.

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Online algorithms are usually adopted for minimization problems where the entire objective can be expressed as the sum of many functions (the "data blocks") of several variables. Such kind of problems typically arise in neural network training where an error function, obtained by summing up as many error functions as the number of training samples, is to be minimized. The main aim of the online approach is to devise algorithms which do not require, at each step, full calculation of the objective function, and, instead, stay content with calculation of just one data block at a time. We extend the idea to the minimization of functions of the max type, i.e. to the case when the sum of the data blocks is replaced by their pointwise maximum. This problem is, of course, of the nonsmooth type and we show that, for the convex case, it is possible to design an "incremental" algorithm, which at each step only requires calculation of a single data block. Our algorithm exploits several ideas coming from nonsmooth optimization methods. Convergence of the algorithm is proved and some numerical results are reported.

A derivative-free algorithm for linearly constrained finite minimax problems

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In this paper we propose a new derivative-free algorithm for linearly constrained finite minimax problems. As it is well-known, standard derivative-free algorithms manage to locate points which only satisfy weak necessary optimality conditions for such a class of nonsmooth problems. In this work we define a new derivative-free algorithm globally converging toward standard stationary points for the finite minimax problem. To this end, we convert the original problem into a smooth one by using a smoothing technique based on the exponential penalty function of Kort and Bertsekas. This technique depends on a smoothing parameter which controls the approximation to the finite minimax problem. The proposed method is based on a sampling of the smooth function along a suitable search direction and on a particular updating rule for the smoothing parameter depending on the sampling stepsize. We show also that the proposed approach can be used for defining derivative-free algorithms for general constrained minimization problems. Finally, we report numerical results on a set of standard test problems.

Keywords: Finite minimax problems, smoothing technique, derivative free method.

Induction motors design by a mixed-variable approach

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Three-phase induction motors are widely used in industrial applications, and have a significant impact on electricity consumption. The design of "high efficiency" induction motors requires the use of specific optimization techniques to define more and more efficient designs. To this aim it is necessary to define an analytical model of the motor. Such a model can be obtained by reducing the physical description of the motor to equivalent parameters such as resistances and inductances. The problem of optimally designing a three-phase induction motors has the following features. To evaluate the objective function on a given point, it is necessary to perform a numerical simulation of the motor operating status. For this reason, an explicit representation of the objective function is not available. Moreover, some of the independent variables can assume only a finite number of values. In particular, one discrete variable affects the structure of the objective function and cannot assume any intermediate value since for such values the corresponding optimization problem is undefined. We consider a continuous approach for solving the problem and we compare it with a mixed-variable programming algorithm. The numerical results show the effectiveness of the mixed variable programming approach.

Keywords: Optimal design, Mixed Variable Programming, Nonlinear Optimization.

TELECOMUNICATION II (SORTEL PROJECT)

Chairperson: M. Dell'Amico

Neural approximation of open loop-feedback rate control in satellite networks

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Several optimization problems in telecommunication networks have a stochastic programming nature. Discrete decision variables must be modified along time as parameters of the control policies, in order to optimize the expected system performance (e.g., blocking probability, packet loss probability, packets mean delay or delay jitter) with respect to all the feasible sample paths [1]. Such "Stochastic Discrete Resource Allocation Problems" (SDRAPs) are usually solved by means of centralized approaches in which the control systems are based on closed-form expressions for the performance measure. Unfortunately, closed-forms for important performance measures (e.g., mean delay and delay jitter of the packets) are not always available (for example in the presence of self-similar traffic). Perturbation Analysis (PA) techniques (see, e.g., [2, 3] and references therein) can be applied, based on the observation of the actual sample path, leading to so-called "on-line surrogate optimization methodologies", ([4]). The main drawback of PA-based optimization approaches consists in the presence of sub-optimal transient periods. We shall explicitly take into account the time variable, thus formulating a "Dynamic Stochastic Discrete Resource Allocation Problem" (D-SDRAP). We modify the functional optimization approach proposed in [5], by allowing the system dynamics and an analytical expression for the cost to be not required explicitly. The optimal control functions are assigned the form of nonlinear approximators (e.g., neural networks), thus guaranteeing adaptive on-line resource allocation strategies with a small computational effort. We shall

investigate a D-SDRAP currently quite popular in the telecommunication community: the resource allocation in satellite networks, where variations of fading conditions are added to those of traffic load. Such problem is even more difficult than the typical ones of terrestrial broadband environments, simply because channel degradation effects must be taken into account, together with the traffic changes.

Keywords: Stochastic Discrete Resource Allocation Problems, Satellite networks, Neural Approximators.

References:

[1] T. Ibaraki, N. Katoh, Resource Allocation Problems: Algorithmic Approaches, Cambridge, MA, MIT Press, 1988.

[2] C. G. Cassandras, Discrete Event Systems: Modeling and Performance Analysis, Aksen Associates, Irwin, Boston, MA, 1993.

[3] Y. Wardi, Melamed, B., C.G. Cassandras , C.G.Panayiotou, "Online IPA Gradient Estimators in Stochastic Continuous Fluid Models," J. of Optimization Theory and Applic., vol. 115, no. 2, pp. 369-405, 2002.

[4] K. Gokbayrak, C.G. Cassandras, "Online Surrogate Problem Methodology for Stochastic Discrete Resource Allocation Problems," J. of Optimization Theory and Applic., vol. 108, no. 2, pp. 349-376, 2001.

[5] R. Zoppoli, M. Sanguineti, T. Parisini, "Approximating Networks and Extended Ritz Method for the Solution of Functional Optimization Problems," J. of Optimization Theory and Applic., Vol. 112, No. 2, pp. 403-439, 2002.

Performance of queueing systems with Batch Markovian arrival processes

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The Asynchronous Transfer Mode (ATM) is widely used in the B-ISDN implementation. Traffic measurements in the physical ATM-networks carrying data packets of a broad spectrum applications show that the traffic process is characterized by variability and burstiness. The network traffic is highly correlated which implies that simplifying assumptions for the traffic process such as Poisson process or even phase-type renewal process are not appropriate to capture bursts and long-range dependent behavior in a full measure. Nevertheless, the analytical tractability of the Markovian traffic models stimulated the researchers' efforts to investigate other Markovian models of real network traffic. A suitable solution to this problem was found by Lucantony where the Batch Arrival Markov Process (BMAP) was used to model the correlated arrival traffic. The BMAP/G/1 queueing system analyzed by this author can be used for performance evaluation of the behavior of an ATM-network node. Nevertheless, the simplifying assumptions of buffer infiniteness in many cases do not provide accurate results.We analyze the BMAP/SM/1/r queueing system with a buffer of finite capacity. Two analytical techniques are used to derive the measures of efficiency of the BMAP/SM/1/r system. The first approach is related to the direct solution of the differential equations for the steady-state distribution of the underlying line Markov process. The second one involves a recurrence relation between the steady-state distributions of the underlying Markov chains for the BMAP/SM/1/r system with buffer capacities equal to r,r-1,…,1. Using these approaches, we construct the recurrent matrix computing algorithms for the steady-state probabilities of the queueing system under consideration. On the basis of these algorithms we can calculate the probability of losses, the queue length distribution, and some other important measures of system efficiency. This work has been realized in the framework of the project SORTEL, (SORSA).

Keywords: BMAP, Self-Similar, Queueing System.
References:
[1] Lucantony, D.M., New results on the single-server queue with a batch Markovian arrival process. Communications in Statistics-Stochastic Models. 1991, Vol. 7, pp. 1--46.
[2] P.P. Bocharov, C. D'Apice, A.V. Pechinkin and S. Salerno, Queuing Theory, Modern Probability and Statistics, VSP, The Netherlands 2004.

Fluidodinamica applicata al traffico su reti: un prototipo di simulatore.

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Viene presentato un prototipo di simulatore fluidodinamico di reti, per ora sviluppato per reti di traffico stradale urbano. L'approssimazione delle equazioni del trasporto lungo gli archi del grafo viene effettuata attraverso schemi di approssimazione numerica, mentre il calcolo dei flussi alle intersezioni stradali viene trattato introducendo condizioni aggiuntive di distribuzione. Assieme a cenni sul modello, vengono presentati lo schema di funzionamento del simulatore e l'interazione con i Sistemi Informativi Territoriali per la rappresentazione dell'output. Vengono infine presentati i risultati di alcune simulazioni su casi elementari e porzioni di rete urbana. Infine verrano presentate alcune idee relatice all'estensione del modello a reti di dati.

Decentralized optimal dynamic routing in telecommunication networks by parametrization of the decision strategies

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Packet-switching telecommunication networks can be modeled as graphs in which a set of nodes (with storing capabilities) are connected through a set of links (where traffic delays may be incurred) that cannot be loaded with traffic above their finite capacities. Traffic flows can be described by continuous variables even if the data packets exchanged among the nodes are discrete in nature, since the number of packets is so large as to allow macroscopic modeling. As the traffic flows entering the networks are assumed to vary over time, the nodes or, to be more specific, the decision makers (DMs) acting at the nodes may be requested to change the amount of traffic flow to be sent to their neighboring nodes. Thus a decentralized dynamic routing problem arises. The DMs are realistically assumed i) to generate their routing decisions on the basis of local information and possibly of some data received from other nodes, typically, the neighboring ones, and ii) to cooperate on the accomplishment of a common goal, that is, the minimization of the total traffic cost. Therefore, they can be regarded as the cooperating members of informationally distributed organizations, also called "team organizations". The control of traffic flows is assumed to be exerted over a finite-time horizon. It follows that the routing problem assumes major importance in congestion situations, when the traffic that has accumulated at the nodes must be cleared through the traffic network as soon as possible. However, the finite-horizon routing problem can be extended rather easily to the infinite-horizon case and solved approximately after being restated in receding-horizon form. We consider a dynamic routing problem that do not satisfy the assumptions making a team optimal control problem analytically solvable (namely, the LQG hypotheses and the nestedness of the team information structure). However, even if the problem were stated in a centralized context, that is, if a single decision maker were entrusted with the control of the entire traffic network, the large number of state variables would hinder one from applying dynamic programming, which is ruled out by the curse of dimensionality. We describe a

methodology of approximate optimization that is based on the use of routing strategies expressed as linear combinations of simple computational units dependent on certain parameters to be optimized [1,2,3]. We have successfully applied such a methodology, into which we have recently gained theoretical insights [4,5], also for the approximate solution of other optimization problems in large-scale traffic networks (such as freeway systems and optimal management of water resources in reservoirs networks). Numerical results enhance the effectiveness of the proposed approach.

Keywords: packet-switching networks, dynamic routing, neural networks, extended Ritz method
References:
[1] M. Baglietto, T. Parisini, and R. Zoppoli, Distributed-information neural control: The case of dynamic routing in traffic networks. IEEE Trans. on Neural Networks, vol. 12, pp. 485-502, 2001.
[2] R. Zoppoli, M. Sanguineti, and T. Parisini, Approximating networks and Extended Ritz Method for the solution of functional optimization problems, Journal of Optimization Theory and Applications, vol. 112, pp. 403-440, 2002.
[3] M. Baglietto, M., Sanguineti, M., and R. Zoppoli, Facing the curse of dimensionality by the extended Ritz method in stochastic functional optimization: dynamic routing in traffic networks, in High Performance Algorithms and Software for Nonlinear Optimization. G. Di Pillo and A. Murli, Editors. Kluwer Academic Publishers, pp. 22-55, 2003.
[4] P. C. Kainen, V. Kůrková, and M. Sanguineti, Minimization of error functionals over variable-basis functions, SIAM J. on Optimization, vol. 14, pp. 732-742, 2003.
[5] V. Kůrková and M. Sanguineti, Error estimates for approximate optimization by the extended Ritz method, SIAM J. on Optimization, to appear.

VEHICLE ROUTING I (SORSA PROJECT)

Chairperson: M. Fischetti

A new ILP-based refinement heuristic for Vehicle Routing Problems

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In this talk we address the Distance-Constrained Capacitated Vehicle Routing Problem (DCVRP), where k minimum-cost routes through a central depot have to be constructed so as to cover all customers while satisfying, for each route, both a capacity and a total-distance-travelled limit. Our starting point is the following refinement procedure proposed in 1981 by Sarvanov and Doroshko for the pure Travelling Salesman Problem (TSP):Given a starting tour, (a) all the nodes in even position are removed, thus leaving an equal number of ``empty holes'' in the tour; (b) the removed nodes are optimally re-assigned to the empty holes through the efficient solution of a min-sum assignment (weighted bipartite matching) problem. We extend the Sarvanov-Doroshko method to DCVRP, and generalize it. Our generalization involves a procedure to generate a large number of new sequences through the extracted nodes, as well as a more sophisticated ILP model for the reallocation of some of these sequences. Computational results on a large set of capacitated VRP instances (both with and without distance constraints) from the literature are reported, with an analysis of the performance of the new method and of its features.

Keywords: Vehicle Routing Problem, Heuristics, Computational analysis.

References:
[1] V.I. Sarvanov and N.N. Doroshko, The approximate solution of the travelling salesman problem by a local algorithm with scanning neighborhoods of factorial cardinality in cubic time, (in Russian), Software: Algorithms and Programs 31, Mathematical Institute of the Belorussian Academy of Sciences, Minsk, 1981, 11--13.

The split delivery VRP: properties and algorithms

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We study the Split Delivery Vehicle Routing Problem (SDVRP) where each customer can be visited more than once and the demands of the customers can be any integer number possibly greater than the capacity Q of the vehicles. A customer may be visited more than once also in the case where the demand is lower than Q. Each time a customer is visited by a vehicle, at least one unit of the customer demand must be served. The objective is to minimize the cost of the total distance traveled by the vehicles to serve all the customers. We show that, when the vehicles have a capacity equal to two, the problem is solvable in polynomial time, while when all vehicles have a capacity greater than two the problem is NP-hard, even under restricted conditions on the costs. We also show that, in some special cases, the SDVRP is reducible in polynomial time to a problem of possibly smaller size where each customer demand is strictly lower than the vehicle capacity. For the non reducible instances, we evaluate the worst case error generated by the practical shipping policy which consists in making full load direct trips to every customer until its demand is lower than Q and in solving the reduced SDVRP. Finally, a tabu search algorithm for the vehicle routing problem with split deliveries will be presented. At each iteration, a neighbour solution is obtained by removing a customer from a set of routes where it is currently visited, and by inserting it either into a new route, or into an existing route which has enough residual capacity. The algorithm also considers the possibility of inserting a customer into a route without removing it from another route. The insertion of a customer into a route is done by means of the cheapest insertion method. Computational experiments are reported for a set of benchmark problems, and the results are compared with those obtained by the algorithm proposed by Dror and Trudeau.

Keywords: Split delivery vehicle routing problem, complexity, reducibility, tabu search.

References:
[1] C. Archetti, R. Mansini, M.G. Speranza, The split delivery vehicle routing problem with small capacity, Transportation Science, to appear.
[2] C. Archetti, A. Hertz, M.G. Speranza, A Tabu Search Algorithm for the Split Delivery Vehicle Routing Problem, Transportation Science, to appear.
[3] C. Archetti, M.G. Speranza, Reduction of the Q-split delivery vehicle routing problem with large demands, European Journal of Operational Research, to appear.
[4] M. Dror, G. Laporte, P. Trudeau, Vehicle routing with split deliveries, Discrete Applied Mathematics, 50: 239-254, 1994.
[5] M. Dror, P. Trudeau, Savings by split delivery routing, Transportation Science, 23: 141-145, 1989.
[6] M. Dror, P. Trudeau, Split delivery routing, Naval Research Logistics 37: 383-402, 1990.

An open source library to easily model and solve MIP problems: a real example

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We all recognize the benefits that ILOG Concert Technology provided to the researchers and developers community by offering the possibility to reference variables, constraints and objective function as objects and to define models row-wise like mathematical expressions. These features drastically reduced the time to code a model into an object oriented programming language (C++ or java in the last version), allowing the researchers to concentrate on writing good models and trace how to solve them. In this talk we want to introduce GLPKXX, an open source project to create an object oriented API (Application Programming Interface) to GLPK. Gnu Linear Programming Toolkit (GLPK) is an ongoing project to implement a stable and robust library to solve linear and mixed integer problems; it is released under the GPL licence. GLPK is developed in C and provides a typical C language API to model a problem; it also provides a modeling language that is a subset of AMPL. GLPKXX provides an object oriented interface to GLPK, offering features similar to what Concert Technology offers for CPLEX. The library is entirely developed in standard C++ using containers from the Standard Template Library (STL) in order to guarantee portability across different platforms. We will show how to use GLPKXX to easily implement MIP models in C++ programs and how to modify the model between different runs of execution. A real example will be introduced showing the implementation of a Generalized Traveling Salesman Problem and its solution.

Keywords: Object oriented modeling, open source software, API, GPL.
References:
GLPK official web site: http://www.gnu.org/software/glpk/glpk.html

An iterated local search algorithm for the vehicle routing problem with convex time penalty functions

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We propose an iterated local search algorithm for the vehicle routing problem with time window constraints. We treat the time window constraint for each customer as a penalty function, and assume that it is convex and piecewise linear. As for the capacity constraints, we consider multiple resources, and consider both linehaul and backhaul customers. Dynamic programming (DP) is used to determine the optimal start times to serve the customers so that the total time penalty is minimized. This DP algorithm is then incorporated in the iterated local search algorithm to evaluate solutions in various neighborhoods efficiently. The amortized time complexity of evaluating a solution in the neighbourhoods is a logarithmic order of the input size (i.e., the total number of linear pieces that define the penalty functions). Computational comparisons on benchmark instances with up to 1,000 customers show that the method is quite effective, especially for large instances.

Keywords: vehicle routing with time windows, metaheuristics, dynamic programming.

ELECTRIC POWER MARKETS

Chairperson: C. Triki

Portfolio Optimization for Electricity Traders in the Italian Market

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Electricity traders are new operators that have been introduced by the deregulation process of the Italian market. They mainly use bilateral contracts as a tool to buy energy from the producers and sell it to the consumers with the objective of maximizing their profit. They are also allowed to participate in the wholesale electricity market either as purchaser or as a seller but are subject to a set of technical and operation constraints. In this presentation we will focus on the definition of an optimization model that supports the trader in his decision on which bilateral contract to accept/reject and on how to operate in the different electricity auctions. We also propose a solution method that is based on novel variant of the Simulated Annulling (SA) algorithm and we carry out some experiments in order to compare the performance of our algorithm with respect to the standard SA version.

Natural gas value chain optimization using stochastic integer programming

A. Tomasgard, M. Fodstad, F. Rømo, M.P. Nowak
NTNU - Norway

We will present a supply chain management model for natural gas. The model describes the integrated planning problem of a natural gas producer including production, transportation, storage and trading decisions. The decision horizon is approximately three years. The capacities of the production fields and the transportation pipeline system limits the gas volumes delivered in the downstream markets. Demand is represented by contracts and spot markets. Contract volumes as well as spot prices are uncertain. The model is implemented as a mixed integer multistage stochastic model. Scenario trees are generated by moment matching. Results from pilot tests on Statoil's operations on the Norwegian continental shelf will be presented.

On using stochastic programming for structuring bilateral energy contract portfolios in competitive markets

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A multi-stage full recourse model for structuring energy contract portfolios in competitive markets is presented for price taker operators. The main uncertain parameters are spot price, water exogenous inflow to the hydro system and fuel and gas cost and availability. The uncertainty is represented by a set of scenarios. The problem is formulated as a mixed 0--1 Deterministic Equivalent Model. Only 0--1 variables have nonzero coefficients in the first-stage constraint system. A problem solving approach based on a splitting variable mathematical representation of the scenario clusters is considered. The Twin Node Family (TNF) concept is used in a Branch-and-Fix Coordination scheme for obtaining 0-1 solutions to satisfy the related nonanticipativity constraints. A Lagrangian scheme is used

for bounding candidate TNFs, as well as for obtaining feasible solutions to the original problem from integer TNFs.

A dynamic programming approach for single-unit commitment problems with ramping constraints

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The single-Unit Commitment problem (1UC) requires to optimally operate one generating thermal unit within a certain discretized time horizon. The cost (or revenue) for generating power varies with each time instant. The generating unit is subject to some technical restrictions, most notably minimum up- and down-time constraints, as well as upper and lower bounds over the produced power when the unit is operational. In some cases also ramping constraints are imposed. They limit the maximum increase or descrese of the generated power from one time instant to the next, and reflect the thermal and mechanical inertia that has to be overtaken in order for the unit to increase or decrease its output. (1UC) is particularly relevant because it appears as a subproblem to be repeatedly solved within Lagrangian schemes for (multi-)Unit Commitment (UC) problems, and these are among the most efficient solution techniques for this class of difficult, large-scale mixed-integer nonlinear problems [BLRS01,BFLN03, Beta03, ZhGa88]. We present a dynamic programming algorithm for solving the single-Unit Commitment (1UC) problem with ramping constraints and arbitrary convex cost function. The algorithm is based on a new approach for efficiently solving the single-unit Economic Dispatch (ED) problem with ramping constraints and arbitrary convex cost functions, improving on previously known ones that were limited to piecewise-linear functions [FGZ02]. For simple convex functions, such as the quadratic ones typically used in applications, the solution cost of all the involved (ED) problems, comprised that of finding an optimal primal and dual solution, is $O(n^3)$. Coupled with a ``smart'' visit of the state-space graph in the dynamic programming algorithm, this enables one to solve (1UC) in $O(n^3)$ overall.

Keywords: Dynamic Programming, Unit Commitment problem, Ramping Constraints.
References:
[BLRS01] Bacaud, L., Lemaréchal, C., Renaud, A., and Sagastizábal, C., "Bundle Methods in Stochastic Optimal Power Management: A Disaggregated Approach Using Preconditioners" , Computational Optimization and Applications, vol. 20, pp. 227-244, 2001.
[BFLN03] Borghetti, A., Frangioni, A., Lacalandra, F., and Nucci, C.A., "Lagrangian Heuristics Based on Disaggregated Bundle Methods for Hydrothermal Unit Commitment", IEEE Transactions on Power Systems, vol. 18, pp. 313-323, 2003.
[Beta03] Borghetti, A., Frangioni, A., Lacalandra, F., Nucci, C.A., and Pelacchi, P., "Using of a cost-based Unit Commitment algorithm to assist bidding strategy decisions", Proceedings IEEE 2003 Powerteck Bologna Conference, (Borghetti, A., Nucci, C.A., and Paolone, M., eds.), Paper n. 547, 2003.
[FGZ02] Fan, W., Guan, X., and Zhai, Q., "A new method for unit commitment with ramping constraints", Electric Power Systems Research, vol. 62, pp.215-224, 2002
[ZhGa88] Zhuang, F. and Galiana, F.D., "Towards a more rigorous and practical unit commitment by Lagrangian relaxation",IEEE Transactions on Power Systems, vol. 3, pp. 763-773, 1988.

GAME THEORY

Chairperson: F. Patrone

The dynamic control of the unfaithfulness on a cooperative

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Particularly in recent years, in some countries, the farmars growing the same product (oil, wine, hazelnuts, almonds, chestnuts…) generally form cooperatives in order to coordinate their commercial activities, in particular, the definition of a common price. The problem that the cooperatives face is that generally the prices outside the cooperative are bigger than those offered by the cooperative; this fact creates an incentive for some members of the cooperative to deviate from their commitments to their cooperative by selling a part of their product outside the cooperative. In this paper we address this problem as a dynamic model of a game. Our study consists of two phases, in the first we formulate the game, the discussion of which lead us to the conclusion that, in order to reach a stable solution where all the members of the cooperative will sell their production in the cooperative, is that the cooperative has to restructure the game. In the second phase we propose the restructured game with a system of penalty that can lead to an attractor solution, i.e. an issue where no member of a cooperative will have an incentive to deviate from the cooperative's price policy.

Keywords*:* penalty, attractor, equilibrium.
References:
[1] Bischi G.I., Lamantia F., Sbragia L. (2003): "Competition and cooperation in natural resources exploitation: An evlutionary game approach", XV IMGTA, Urbino.
[2] Larbani M., Lebbah H. (1999): "A Concept of Equilibrium for a Game under Uncertainty", EJOR, Vol. 117, N°1, pp.145-156.
[3] Garay J., Scarelli A., Varga Z., Cressmann R. (2003): "The Dynamic Stability of Coalitionist Behaviour for two-Strategy Bimatrix Games", XV IMGTA, Urbino
[4] Nash J.F. (1951): "Non-cooperative games", Ann. Math. , 54, N 5 pp. 286-295.

TUIC games

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Transferable Utility games with Information Costs are an extension of the standard TU-games model. TUIC games can be quickly described, focusing on cost allocation problems, as a model which tries to keep track of the fact that getting information about the costs is itself costly. Another relevant characteristic of TUIC games is that the model is kept as simple as possible, thus allowing for an easy connection with classical TU games. However, even if the structure is reasonably simple, it provides a language rich enough to discuss about the tradeoff between information costs and equity: for example, there is the possibility of defining "justified claims" for coalitions of players, and even to compare different instances of TU games from a fairness point of view. Examples of TUIC games are provided, and in particular the special case of "cost components" is analyzed.

Application of the Shapley value to microarray data analysis

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It is analyzed the possibility of applying game-theoretical tools, like the Shapley value, to the analysis of microarray data. Microarray data are provided by a relatively new technique which provides a huge amount of genetic information. This information has to be screened to retrieve useful hints, in particular about the relevance of genes for specific diseases, or to find how to assess the presence of a disease. Via a "truncation" technique, we build a simple game whose aim is to stress the relevance ("sufficiency") of groups of genes for the specific disease we are interested in. The Shapley value of this game should point to the most relevant genes, so that it could be useful both as a predicting tool and as a hint for pointing at the genes that mostly deserve increased investigation. Our results are compared with other approaches, which use mainly statistical tools.

Keywords:Game Theory, cooperative TU game, Microarray data analysis
References:
[1] Amaratunga, D., Cabrera, J. (2004) Exploration and Analysis of DNA Microarray and Protein Array Data Wiley Series in Probability and Statistics
[2] Golub, T., Slonim, D., Tamayo, P., Huard, C., Gaasenbeek, M., Mesirov, J., Coller, H., Loh, M., Downing, J., Caligiuri, M., Bloom.eld, C., and Lander, E. (1999). Molecular classification of cancer: class discovery and class prediction by gene expression monitoring. Science, 286:531–537.
[3] Owen G. (1995) Game Theory - Academic Press - Third edition, pp.447.
[4] Shapley, L. S. (1953) A Value for n-Person Games, in "Contributions to the Theory of Games", n. II, (H.W. Kuhn e A.W. Tucker), Annals of Math. Studies, 28, Princeton University Press, Princeton (NJ), 307-317.
[5] Shubik, M. (1982): Game Theory in the Social Sciences: Concepts and Solutions, The MIT Press, Cambridge (MA).

Game theory and wireless communication networks

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We consider a small area where some wireless devices operate. The devices constitute the nodes of a wireless communication network. We consider the nodes grouped in subnetworks (piconets). The nodes may play three different roles: master, bridge or slave. Master nodes, one and only one per piconet, have the main role as they act as hubs collecting all the communications between the nodes of their own piconet and sending them to the masters of other piconets through bridge nodes. Finally slave nodes may communicate directly only with the nodes in their own piconet (but through the master they may reach also the other piconets). Clearly the more communication flow through a node the more energy is required. As each node has a given amount of energy and a given number of messages to exchange with other nodes, it is important to decide the role of each node in order to increase the number of messages that can be effectively exchanged, taking into account that each node prefers to exchange its own messages. In order to define the role of each node, game theory may give a relevant support, especially to understand the interactions among nodes and how the decision taken by each of them may influence the whole network. The situation was tackled first as a non cooperative game, supposing that no information about the role of the agents is known to the others. In order to take into account the role of the other agents two approaches were developed: one as a cooperative

game without transferable utility where each agent perfectly knows the role of each other agent, and another as a bayesian game, where each agent assigns a probability distribution to the role of each other agent. Some preliminary results are given, referring to simple spatial configurations of the agents.

On Berge Equilibrium

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Using the notion of equilibrium of a coalition P relatively to a coalition K of Berge, Zhukovskiy has introduced Berge equilibrium as an alternative solution to Nash equilibrium in non cooperative games in normal form. The essential advantage of this equilibriunm is that it doesn't necessitate negociation of any player with the remaining players, which is not the case when a game has more than one Nash equilibrium. The problem of existence of Berge equilibrium is more difficul (compared to the Nash's), the results obtained so far in this field of research are not enough general. This paper is a contribution to the problem of existence and determination of Berge equilibrium. Indeed, using the g-maximum equality, we establish the existence of a Berge equilibrium of a non cooperative game in normal form and provide two procedures for its determination.

Keywords: Non Cooperative Games, Berge Equilibrium, g-maximum Equality.
References:
[1] Berge C. « Théorie générale des jeux à n personnes », Gauthier Villard, Paris, 1957
[2] Zhukovskii V.I. and Tchikry A.A. « Qudratic Differential Games » , Naukova Dumka, Kiev, 1994 .

LARGE SCALE NONLINEAR OPTIMIZATION III (FIRB PROJECT)

Chairperson: G. Di Pillo

Issues on preconditioned truncated Newton methods

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In this work we deal with truncated Newton methods for the solution of large scale unconstrained optimization problems. Although these methods have been widely studied and extensively tested, two key aspects to improve the behaviour of a truncated Newton method in tackling large scale problems are still considered open questions: how to handle the case with indefinite Hessian and how to formulate a general effective preconditioning strategy. In this work we propose the use of Conjugate Gradient schemes as a tool for facing up to both the questions. As showed in some recent papers [1,2,3] the latter schemes can be successfully applied for computing an efficient Newton-type direction whenever the Hessian is indefinite. Moreover, both the necessity of preconditioning strategies and the great improvement which can be obtained by using diagonal preconditioners has been recently showed in [4]. In this framework, we propose the use of planar CG methods for both computing the Newton direction and defining a “dynamic” preconditioner. We show that the conjugate directions generated by the planar CG method can be used to build

suitable preconditioners for the solution of Newton equation. Preliminary numerical results confirms the reliability of the proposed approach.

Keywords: large scale unconstrained optimization, conjugate gradient methods, truncated Newton methods.

References:

[1] G. Fasano, (2004) A CG-type Method for the Solution of Newton's equation within Optimization Frameworks. To appear on Optimization Methods and Software.
[2] G. Fasano, (2004) A Planar-Conjugate Gradient algorithm for Large Scale Unconstrained Optimization, Part I: Theory. To appear on Journal of Optimization Theory and Applications.
[3] G. Fasano, (2004) A Planar-Conjugate Gradient algorithm for Large Scale Unconstrained Optimization, Part II: Application. To appear on Journal of Optimization Theory and Applications.
[4] M. Roma, (2004) Dynamic scaling based preconditioning for truncated Newton methods in large scale unconstrained optimization. Submitted to Optimization Methods and Software.

Newton method for KKT systems under weak assumptions

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In this talk we deal with the problem of definying a local method for the solution of a KKT system which has a fast convergence rate under assumptions that are weaker than the classical ones. The standard set of assumptions for proving the convergence rate of a Newton method include linear independence of the active constraints, strict complementarity and second-order sufficient conditions. Over the past few years these assumptions have been substantially weakened. We discuss a further step in this direction and define a few new methods whose convergence properties appear to improve on existing results. The tools we use to achieve this are a new reformulation of the KKT system which is reminescent of differentiable exact penalty functions and a technique to identify active constraints at the solution.

Keywords: KKT systems, convergence rate, identification of active contraints.

Modelli ed algoritmi per problemi di equilibrio variazionale

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Department of Mathematics - University of Pisa

Si vogliono illustrare problemi, modelli, metodologie ed algoritmi per problemi di equilibrio su reti. In particolare si illustrano alcuni modelli variazionali sia per problemi di flusso di costo minimo su reti sia per problemi di equilibrio di flusso sui cammini che conducono a formulazioni tramite disequazioni variazionali (DV) in spazi di dimensione finita. La caratteristica che rende tali problemi di soluzione piu' difficile e' rappresentata dal fatto che l'operatore costo non e' simmetrico. Per tali modelli si propongono allora alcune metodologie risolutive: funzioni "gap" regolarizzate per DV, problema ausiliario per DV, metodi lagrangiani tramite potenziali sulla rete. Viene infine presentata un'analisi preliminare dei risultati computazionali su alcune reti classiche e su altre reti proposte in letteratura.

Keywords:Disequazioni Variazionali, equilibrio su reti, principio di Wardrop.

References:
[1] Dafermos S., Traffic equilibria and variational inequalities, Mathematical Programming, vol. 26, pp. 40-47, 1980.
[2] Fukushima M., Equivalent differentiable optimization problems and descent methods for asymmetric variational inequality problems, Mathematical Programming, Vol. 53, pp.99-110, 1992.
[3] Larsson T. and Patriksson M., On Side Constrained Models for Traffic Equilibria, in Variational Inequalities and Network Equilibrium Problems, F. Giannessi and A. Maugeri (eds.), Plenum Publishing, New York, pp. 169-179, 1995.
[4] Mastroeni G. and Pappalardo M., A variational model for equilibrium problems in a traffic network, RAIRO Operations Research, Vol. 38, pp.3-12, 2004
[5] Pappalardo M. and Passacantando M., Equilibrium concepts in transportation networks: generalized Wardrop conditions and variational formulations, in Equilibrium problems: nonsmooth optimization and variational inequality models, P.Daniele, A.Maugeri and F.Giannessi (ed.s), Kluwer, Dordrecht, 2003.

A path-based extragradient algorithm for network equilibrium problems

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It is well known that the classical asymmetric network equilibrium problem can be formulated as a variational inequality problem in the space of path flow variables. In order to deal with medium-large scale networks, without enumerating all the paths connecting the origin/destination (O/D) pairs, we use a column generation approach based on a variant of Khobotov's extragradient method with new stepsize rules. The algorithm is the following: we start with the free-flow travel times as link costs and, for each O/D pair, we assign the total demand to the shortest path connecting the O/D pair. Then we compute, for each O/D pair, a shortest path with respect to link costs for the current flow, this path will be added to those previously obtained, if it was not included yet. Finally, the path flow is updated by an iteration of the extragradient method and the whole process continues iteratively. This method converges under pseudomonotonicity condition of the path cost operator. Furthermore, we propose a heuristic variant of the above method, in which all O/D pairs are taken up in sequence and the cost of each arc is reevaluated. These two algorithms have been tested on small networks as well as on realistic medium-large sized networks. The computational experience suggests that, especially for medium-large scale networks, the heuristic version performs better than the exact one.

Keywords: network equilibrium problem, variational inequality, extragradient algorithm.
References:
[1] Dafermos S., Traffic equilibrium and variational inequalities, Transportation Science, vol. 14 (1980), pp.42--54.
[2] Khobotov E.N., Modification of the extra-gradient method for solving variational inequalities and certain
optimization problems, U.S.S.R. Computational Mathematics and Matematical Physics, vol. 27 (1987), pp. 120--127.
[3] Korpelevich G.M., The extragradient method for finding saddle points and other problems, Matekon, vol. 13, (1977), pp. 35--49.
[4] Marcotte P., Application of Khobotov's algorithm to variational inequalities and network equilibrium problems,
INFOR, vol. 29 (1991), pp. 258--270.
[5] Smith M. J., The existence, uniqueness and stability of traffic equilibria, Transportation Research Part B,vol. 13 (1979), pp. 295--304.

TELECOMUNICATION III (SORTEL PROJECT)

Chairperson: M. Dell'Amico

Metric inequalies and the network loading problem

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Given a simple graph G(V,E) a set of traffic demand between the nodes of G, the Network Loading Problem consists of installing minimum cost integer capacities on the edges of G guaranteeing that traffic demands can be routed simultaneously. In this paper we study the Capacity Formulation of the Network Loading Problem, i.e. the formulation defined only by the variables expressing the amount of capacity to be installed on the edges of G. The Capacity Formulation is described by a family of valid inequalities, the Metric Inequalities, whose properties are analyzed in order to improve standard separation algorithms. We introduce the family of the Tight Metric Inequalities and prove that they provide the complete description of the convex hull of the integer feasible solutions. Computational experience with a cutting plane algorithm based on the Capacity Formulation shows that the improvement in separation algorithms yields remarkable results with difficult instances.

Keywords: Network Loading Problem, metric inequalities.
References:
[1] P. Avella, S. Mattia, A. Sassano. "Metric Inequalities and the Network Loading Problem". Proceedings of IPCO X (2004).
[2] S. Mattia. PhD dissertation (2004).
[3] F. Barahona. "Network design Using Cut Inequalities, SIAM J. Optimization, 6, (1996).
[4] D. Bienstock, S. Chopra, O. Gunluk, Y. Tsai. "Minimum Cost Capacity Installation for Multicommodity Network Flows". Mathematical Programming 81, (1998).
[5] T. L. Magnanti, P. Mirchandani, R. Vachani. "The Convex Hull of two Core Capacitated Network Design Problems".Mathematical Programming. 60, 233-250 (1993).

Heuristic and exact algorithms for the design of urban optical networks

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In this paper we have considered the problem of designing urban optical networks. In particular, given a set of telephone exchange, we must design a collection of cycles (rings) each one including a telephone exchange (central depot), some customers and other possible points called (transition points) that could be used to save routing costs. The ring topology is chosen in many fiber optic communication networks since it allows to prevent the lost of connection due to a single edge or even a single node failure. The total cost of the optical network depends on several elements: the fibers, the devices needed for communication and restoration, etc. We have called this problem Multi-Depot Capacitated m-Ring-Star Problem (MDCmRSP) and we have formulated it as an optimization problem in Graph Theory. We present heuristic algorithms for the MDCmRSP and exact algorithms for the simgle-ring version of the MDCmRSP. Computational results on randomly generated instances and real-life datasets are also presented.

Keywords: Covering Tour, Branch-and-Cut, Network Design, Heuristics.

Network design with non-linear node cost function: valid inequalities and a branch-and-cut approach

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Given a network topology, represented as a graph, and a set of traffic demands from source to destination nodes, a network design problem consists in minimizing the total cost of the installed resources so as to route the traffic demands. Nodes are often a significant part of the network cost. Node technologies may have high costs with non-linear dependence on the number of entering connections. Hence, designers must cope with a problem with node costs as part of the objective function, a problem which has not drawn much attention in the literature so far. We adopt a multi-facility MCNF model and study a branch-and-cut scheme. Two variants of the cut-set inequalities, used in many multicommodity problems (see e.g. (Atamtürk 2002), (Bienstock et al. (1998)), are studied as cutting planes. Their separation procedures are based on two methods for calculating the set of minimum cuts on both non-oriented and oriented graphs presented in (Hao et al. 1992) and (Gusfield 1990). We then introduce the new Vertex Cut and Vertex Band inequalities, suited to this peculiar problem and inspired by a previous work (Stoer et al. 1994); their separation also uses the Hao-Orlin method and one (Shen et al. 1997) for obtaining all minimal vertex cuts. The branch-and cut method is compared with a well-known MIP solver over several real-world networks whose dimension range from 10 to 40 nodes. It is worth emphasising that, due to the difficulty of the problem, for certain instances we do not obtain the optimum solution but rather a lower bound. When given the same time limit of one hour, our method proves to be more efficient in reaching the optimum or in computing a lower bound, especially with help from the vertex-band inequalities.

Keywords: Multicommodity flow, Valid inequalities, Non-linear node cost.
References:
[1] A. Atamtürk (2002), On capacitated network design cut-set polyhedra, Mathematical Programming Ser. B 92, pp. 425-437.
[2] D. Bienstock, S. Chopra, O Günlük, C. Tsai (1998), Minimum cost capacity installation for multicommodity network flows, Mathematical Programming 81, pp. 177-199.
[3] D. Gusfield (1990), Very simple methods for all pairs network flow analysis, SIAM Journal on Computing 19, pp. 143-155.
[4] J. Hao, J.B. Orlin (1992), A Faster Algorithm for Finding the Minimum Cut in a Graph, Proceedings of the 3rd Annual ACM-SIAM Symposium on Discrete Algorithms, Orlando, Florida, pp. 165-174.
[5] H. Shen, W. Liang, Efficient enumeration of all minimal separators in a graph, Theoretical computer science 180 (1997), pp. 169-180.
[6] M. Stoer, G. Dahl, A polyhedral approach to multicommodity survivable network design, Numerische Mathematik 68 (1994), pp.149-167.

The Internet protocol network design problem with reliability and routing constraints

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A telecommunication network is given in terms of a set of nodes, a set of traffic demands, a matrix of routing weights between pairs of nodes (links) and a matrix of capacity installation costs between links; we want to define the minimum cost capacity installation such that all the traffic is routed and a predefined subset of the traffic demands is routed even under fault scenarios. Capacity is provided by installing an integer number of links of a given capacity between pairs of nodes and traffic must be loaded on the network according to the OSPF-ECM (Open Shortest Path First Equal Commodity Multi-path) protocol according to the given routing weights, with additional constraints on the maximum number of hops (arcs) allowed in the routes of each traffic demand. The problem is NP-Hard and literature mainly proposes local search based heuristics which do not take the reliability and max-hop requirements into account ([2]), or assumes a simplified OSPF routing ([1]). We propose a Tabu Search approach with link based neighbourhood and both intensification and diversification steps. The core of the proposed Tabu Search procedure is the network loading algorithm which evaluates the neighbour solution costs. It presents some critical aspects concerning computational efficiency and memory requirements, because of the huge amount of hop-constrained shortest paths to take into account. Some properties of the network loading problem has been derived and exploited by an efficient solution evaluation procedure, based on the results presented in [3]. The overall performances are improved by an incremental solution evaluation and by the definition of neighbourhoods of reduced size which do not affect the quality of the solutions and allow us to obtain good results on real-life networks and to deal with instances with up to hundreds of nodes.

Keywords: Network design, Internet Protocol, Tabu Search.
References:
[1] Bley, A., M. Grötchel, and R. Wessäly. “Design of broadband virtual private networks: Model and heuristics for the BWiN”. Technical Report SC 9813, Konrad ZuseZentrum für Informationstechnik Berlin. To appear in “Proc. DIMACS Workshop on Robust Communication Networks and Survivability”, AMSDIMACS Series. 1998
[2] Holberg K. and D. Yuan, “Optimization of Internet Protocol Network Design and Routing”, EURO 2001, Rotterdam, The Netherlands. 2001
[3] L. De Giovanni, F. Della Croce, R. Tadei, “On the impact of the solution representation for the Internet Protocol Network Design Problem with max-hop constraints”, Networks (forthcoming).

VEHICLE ROUTING II

Chairperson: D. Vigo

Bidirectional bounded dynamic programming for shortest path problems with resource constraints

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When vehicle routing problems are attacked with branch-and-price algorithms, the pricing subroutine must solve shortest path problems with resource constraints,possiblywith negative arc costs. This problem is strongly NP-hard and its effective solution is critical for the success ofbranch-and-price approaches to vehicle routing problems. We present an algorithm based on bidirectional dynamic programming, that allows to solve to optimality a large number of vehicle routing instances of various size and different kinds, namely with time windows, with capacity constraints and with simultaneous pick-up and delivery

requirements.

Computing Good Allocations for Combinatorial Optimization Games

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Much of the literature on cooperative games associated with combinatorial optimization problems is concerned with only one question: whether or not the core is empty. In this paper however we are concerned with the related question of finding a cost allocation whose value is as large as possible. It is well known that this amounts to solving an LP with exponentially many constraints, whose spectrum of applications goes well beyond cooperative game theory. To the best of our knowledge, the only known approach to tackle this LP is by finding an optimal solution using some method to (exactly) separate over this set of constraints, which on the other hand often turns out to be an NP-complete problem. The only exception are some classes of games for which there are simpler LPs equivalent to the one above. Here, we give a characterization of the value of the optimal allocation for a much broader class of games, along with a general technique, based on polyhedral combinatorics and LP duality, for finding "good" (sometimes optimal) allocations. The technique is illustrated on a number of variants of the well-known traveling salesman and vehicle routing games.

A VNS for the optimal sequencing of skip collections and deliveries

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We consider the collection of recyclable waste, where some collection points are located in the city suburbs or at some other strategic sites. Several containers are present at each collection point, one container for each type of collected waste material. Users bring their waste and dispose it into the appropriate container. Containers are of different type, depending on the access side or on the presence of a compacting equipment, and this varies from collection point to collection point. Once a container is full, a disposal request is issued, consisting of the following two actions, to be carried out not necessarily in this order: i) the full container is brought to a disposal plant to be emptied; ii) an empty container of the same kind is brought to the collection point. A fleet of homogeneous vehicles is available. Each vehicle can carry a single container at a time, either empty or full. The problem addressed in this paper is the following. Given a set of service requests, a fleet of vehicles and a number of additional empty containers available at the depot, the aim is to determine vehicle routes starting and ending at the depot involving pick-up of full containers at collection points, dumping operations at appropriate disposal plants, delivery of empty containers where required, while minimizing the number of vehicles and the global traveled time. The problem can be seen as a particular Asymmetric Vehicle Routing Problem on a suitable graph whose peculiar structure suggests several types of neighborhood. In the present work we exploit these neighborhoods within a Variable Neighborhood Search framework, starting from a solution yielded by a modified Clarke and

Wright algorithm. We compare the results of the VNS both with those currently implemented in some real life cases and, when possible, with the optimal solutions.

Genetic local search for the capacitated vehicle routing problem

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Capacitated Vehicle Routing Problem (CVRP) is a well-known NP-hard in the strong sense problem. Tabu Search (TS) is an effective local search algorithm for the vehicle routing problem, but the quality of the best solution found depends on the initial solution. On the other hand, Genetic Algorithms (GAs) are able to spread the solution space, but their convergence can be slow. To overcome both these problems, we present a new heuristic called Genetic Local Search (GLS). Genetic Local Search algorithm consists of a GA with the addition of a TS optimisation phase applied to each new individual created either in the initial population or during the evolutionary process. On one hand, we can see the TS as a smart mutation mechanism. On the other hand, GA can be considered a structured multi-start mechanism for TS. Extensive computational tests show that GLS outperforms both TS and GA separatly, producing good quality solutions in short time. Moreover, the results are comparable with the ones obtained by state-of-the-art algorithms.

Keywords: Capacitated VRP, Tabu Search, Genetic Algorithms.

An ant colony system approach for variants of the traveling salesman problem with time windows

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The Traveling Salesman Problem with Time Windows has important applications in routing and scheduling and has been extensively studied in literature. The objective of the problem is usually to minimize the total length of the tour. In this paper, the classical formulation of TSPTW is considered and a variant of the problem is proposed, called *temporal-TSPTW*. The difference between the two problems consists in the objective functions. In the temporal-TSPTW, the total weighted time, traveling and waiting time, has to be minimized. The TSPTW has been solved in literature both by exact algorithms and heuristics. In this paper, a meta-heuristics based on Ant Colony System is proposed and implemented for both the Traveling Salesman Problem with Time Windows and the *temporal*-Traveling Salesman Problem with Time Windows (TACS). Computational experience is presented solving instances of a benchmark proposed in literature. The instances of the benchmark have been tested for both SACS and TACS as will be discussed in the following. Moreover, a case study is also analyzed. For it, satisfactory results are obtained in comparison with the solution proposed by the firm.

MEDICAL DECISION MAKING: PROBLEMS, METHODS AND APPLICATIONS

Chairperson: D. Conforti

Modelling waiting list prioritisation via simulation

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The question of excessive waiting times and waiting lists are amongst the most debated issues in many publicly funded health systems. To guarantee patients being treated in order of agreed need criteria, rather than according to arbitrary maximum waiting times, recent years have seen an increasing interest on waiting list prioritisation. By an operational research point of view, waiting lists to get elective surgery, can be framed as queueing systems, depending upon the stochastic nature of the patients' arrival rate and the finite capacity of two types of resource: hospital beds and operating rooms. Therefore, we develop a discrete-event simulation model to be used as a planning tool for evaluating the impact of the introduction of prioritisation scoring systems in clinical practice. A case study about a Surgery Unit in a public hospital in the city of Genoa is presented. First, we analyse the arrival processes of the patients belonging to different classes of urgency using empirical data collected over two years. Successively, we use the validated simulation model to compare and evaluate the use of priority algorithms for determining the order of each patient in the list, instead of admitting following a first in first served (Fifo) queue discipline, considered as a rough approximation of the current clinical practice. In addition, an innovative set of performance indexes, based on the prioritisation system implemented, is proposed for the output analysis. Steady-state computational experiments are performed together with a sensitivity analysis on the impact of variations in the input data, changes on the structure and scale of the system. Furthermore, we propose some alternative scenarios, obtained by allocating different combinations of hospital resources. The corresponding performance indices are compared with the aim of computing both technical efficiency and equity.

Keywords: Queueing systems, Simulation, Health Care management.
References:
[1] Everett J.E. (2002). A decision support simulation model for management of an elective surgery waiting system, Health Care Management Science, 5(2), 89-95.
[2] Jun J.B., Jacobson S.H., Swisher J.R. (1999). Application of discrete-event simulation in health care clinics: A survey, Journal of Operational Research Society, 50, 109-123.
[3] Kusters R.J., Groot P.M.A. (1996). Modelling resource availability in general hospitals. Design and implementation of a decision support model, European Journal of Operational Research, 88, 428-445.
[4] Mullen P.M. (2003). Prioritising waiting lists: How and why?, European Journal of Operational Research, 150 (1), 32-45.
[5] Testi A. (1998). On planning the optimal supply of hospital beds, Ricerca Operativa, 28(85/86), 47-61.

A patient adaptable ECG beat classifier based on neural networks

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In recent years, artificial neural networks, fuzzy logic and other signal analysis techniques have been successfully applied to the electrocardiographic (ECG) diagnosis of coronary artery disease as well as to the detection of arrhythmias ([1]-[2]). Such tools perform better than conventional, rule-based, ECG interpretation programs, in the detection of ischemic episodes in long duration ECG recordings. In any case, the most difficult problem in automatic ECG analysis is related to the largevariation in the morphology of ECG waveforms, not only of different patients, but even within the same patient. In this work, a novel supervised neural network-based algorithm is designed to reliably distinguish in electrocardiographic records between normal and ischemic beats of the same patient. The proposed approach is based on the idea of defining the ECG digital recording of two consecutive R-wave segments (RRR interval) as the pattern under classification. In particular, the strategy is that of considering the RRR interval recording as a noisy sample of an underlying function, which is approximated by means of an a-priori defined number of Radial Basis Functions (RBF). The coefficients of the linear expansion constitute the features extracted from the RRR interval, and become the input signal of a feed-forward neural network classifier, which provides an output of zero for the normal one and one for the ischemic case. The whole system has been evaluated using several patient records taken from the European ST-T database. The experimental results show that the proposed beat classifier is very reliable, and that it may be a useful practical tool for the automatic detection of ischemic episodes.

Keywords: electrocardiogram, radial basis functions, neural network classifier
References:
[1] W.G. Baxt, F.S. Shofer, F.D. Sites, J.E. Hollander, A neural network aid for the early diagnosis of cardiac ischemia in patients presenting to the emergency department with chest pain, Ann. Emerg. Med., vol. 40 (6), pp. 575--83, 2002.
[2] C. Papaloukas, D.I. Fotiadis, A Likas, L.K. Michalis, An ischemia detection method based on artificial neural networks, Artificial Intelligence in Medicine, 24 2002, pp. 167--178.

Quantitative methods for adverse drug reaction signalling

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Adverse Drug Reactions (ADRs) signalling has been recently recognized to be a central issue in health care and there is an increasing need for accurate and comprehensive detection, evaluation and prevention of ADRs. The process of scrutinizing spontaneous adverse events (AE) case reports data, for hazards, is known as ADR signalling. When the AE is a rare disease a suspected ADR signal may be generated by a small number of case reports ranging from 3 to 5 units. However, in general, there is no easy and unique answer to the following question [01] “How many AE reports constitute a suspected ADR signal?”. Answer to the above question involves judgements based on both the number and quality of case reports, the nature of the AE, type of drug and its level of usage. In this context, the continuously increasing amount of received case reports requires the development of active methods that could run on huge databases to the extent of detecting and evaluating suspected ADRs ensuring that their recognition is not delayed. In order to judge whether

the number of AE reports exceeds what might be expected through a combination of "pure chance" and "background noise" several approaches have been proposed in the specialized literature [02, 03]. In this contribution the authors present and analyze two quantitative methods for ADRs signalling, namely the Gamma Poisson Shrinkage (GPS) [04, 05] and the Bayesian Confidence Propagation Neural Network (BCPNN) [06, 07]. In particular, the study is concerned with the application of the GPS and BCPNN quantitative methods in the case when the Adverse Event (AE) database contains data related to products form one manufacturer only. The study results have been validated through two independent information sources, namely the Bracco drug core labelings and the medical literature. No difference in signal detection between the BCPNN and the GPS methods was detected. However, the BCPNN method appears to be more stable from the estimation point of view than the GPS.

References:
[1] Evans SJV, Waller PC and Davis S. Use of proportional reporting ratios (PRRs) for signal generation from spontaneous adverse drug reactions reports. Pharmacoepidemiology 2001; 10: 483-486.
[2] Clark JA, Klincewicz SL and Stang PE. Spontaneous adverse event signalling methods: classification and use with health treatment products. Epidemiologic Reviews 2001; 23:191-210.
[3] Lanctot KL, Kwok MCO and Naranjo CA. Computerized Bayesian evaluation of adverse events. Drug Information Journal 1995; 29: 319-325.
[4] DuMouchel W. Bayesian data mining in large frequency tables, with an application to the FDA Spontaneous Reporting System. American Statistician 1999; 53:177-90.
[5] Szarfman, Machado and O'Neill. Use of screening algorithms and computer systems to efficiently signal higher than expected combinations of drugs and events in the US FDA's SR database. Drug Safety 2002. 25:381-392.
[6] Bate A, Lindquist M, Edwards R, Olsson S, Orre R, Lansner A and De Freitas R. A Bayesian neural network method for adverse drug reaction signal generation. European Journal of Clinical Pharmacology 1998; 54:315-21.
[7] Orre R, Lansner A, Bate A and Lindquist M. Bayesian neural networks with confidence estimations applied to data mining. Computational Statistics and Data Analysis 2000; 34: 473-493.

Stochastic Models for Some Medical Decision Making Problems

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In this paper, a problem of medical decision making is considered by using two types of models (i) dynamic programming model and (ii) a random walk type model. By defining three states and four alternative treatments for breast cancer, a recurrent relation is formulated and a method of solution of dynamic programming model is given. By giving the numerical values of transition probabilities, we study policy improvement method for the model that has been considered in this paper. The medical decision making problem is also investigated in the frame work of random walk model by using probability generating functions. In order to give an illustration, geometric probability distributions are used. Since geometric probability distribution is mathematically intractable, the problem leads to some exact results which are useful for medical decision making.

Key words: Stochastic Dynamic Programs, Random Walk Type Model, Medical Decision Making
References:
[1] Andrew J. Schaefer, Matthew D. Bailey, Steven M. Shechter and Mark S. Roberts: "Medical Decisions using Markov Decision Processes". Handbook of Operations Research/Management Science Applications in Health Care, pg 1-23

[2] Baily. Z, "Elements of Stochastic Processes", Z. Wiely Press, 1978.
[3] Bertsekas D. P, "Dynamic Programming and Optimal Control", Athena Scientific, Belmont, Mass. 2nd Edition, 2001.
[4] Farias D.P. de and B. Van Roy,"The Linear Programming Approach to Approximate Dynamic Programming", Operations Research, 2002
[5] Howard.R.A ,"Dynamic Programming and Markov Process", Technology Press of Massachusetts Institute of Technology, Cambridge,1960.
[6] Lee. Y.J, O.L. Mangsarian and W.H.Wolberg, "Survival-Time Classification of Breast Cancer Patients". Data Mining Institute Report 01-03, 2002.
[7] Puterman M. L, "Markov Decision Processes: Discrete Stochastic Dynamic Programming", John Wiley & Sons, New York, 1994.
[8] Sharma, J. K, "Operations Research: Theory and Applications", Macmillan India Limited, 2000.
[9] Van Roy B,"Neuro-dynamic programming: overview and recent trends", in: Handbook of Markov decision processes: methods and applications, E. Feinberg and A. Schwartz, (Eds.), Kluwer Academic Press, Boston, 2002.

Machine learning approches for kidney transplant decision making

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The aim of this paper is to analyze and validate advanced machine learning methods as basic tools for developing decision support systems which can aid the nephrologists in the evaluation of the candidate to kidney transplant. Generally, an accurate and reliable selection of the patient candidate to kidney transplant is required, together with a definition and periodical upgrading of the set of patient suitable for the transplant. The underlying decision is based on quite complex protocols and guide lines, with the assessment of clinical data collected from almost the apparatus and systems of the patient. The evaluation process is typically based on general information coming from the relevant patient (anamnesis and risk factors), biochemical and haematological analysis and histo-pathological examinations. This medical decision problem can be formulated within the framework of classification problem, that is the decision of assigning an object (the patient) to one of two classes (class A+ suitable patients and class A- not suitable patients), based on a set of features describing the same object and related to the characteristics of the class. If we model the object as a vector of variables, each representing a specific feature, then the classification problem becomes discriminating the belonging of a new vector of variables (a new patient) on the basis of the "training data", that is the set of historically observed instances of the target vector of variables, which can be considered, to some extent, the medical knowledge base. Obviously, since our aim is to develop effective decision support systems suitable for the medical domain, we strictly require that classifiers be able to correctly recognize a new and unseen case; this is called "generalization" property. Hence, we seek classifiers with very good generalization property. To this end, we considered the following learning methodologies: Decision Trees, Bayesian classifiers, Neural Networks, Radial Basis Function Network, Kernel based Support Vector Machine. In order to apply these methodologies to support the evaluation of the patient candidate to the kidney transplant, we developed a "training set" by selecting 119 well differentiated cases, 54 belonging to the A+ suitable patients class and 65 belonging to the A- not suitable patients. Each case has been described by 107 features extracted from tests and patient examinations. Testing and validation of the selected classifiers have been carried out by the well known 10-fold cross validation procedure. The overall numerical results demonstrate

the good behavior of the machine learning methodologies in effectively facing the relevant medical decision making problem.

LOGISTICS I

Chairperson: L. Bertazzi

Approximation algorithms for the traveling salesman reoptimization problem

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We study the reoptimization of the traveling salesman problem when, given an optimal solution on a certain number of nodes, a new node is added or a node is removed. This problem has many practical applications in situations where it is convenient, or necessary, to build partial tours before all the information on the instance becomes known and the information on the problem instance becomes known during the construction of the tour. Practical situations are, for example, the on-line optimization of the tour of a truck or of a courier through a dispatching center. Both problems of adding and removing a node have been studied in Archetti, Bertazzi and Speranza (2003) where the authors show that these problems are NP-hard. Moreover they propose two simple approximation algorithms for, respectively, the problem where one node is added and the problem where one node is removed. The algorithm for the addition of a node uses the cheapest insertion criterion. The algorithm for the removal of a node simply removes the node from the tour and joins its predecessor with its successor. The authors show that both algorithms have a worst-case error of 3/2. We now show that no polynomial time approximation algorithm can do better than the algorithms proposed in Archetti, Bertazzi and Speranza (2003) for both problems, i.e, no polynomial time approximation algorithm can have a worst case ratio less than 3/2, unless P = NP. We also present some computational tests to show the experimental performance of both algorithms. Finally, we consider the case where more than one vertex has to be added or removed from the optimal tour. We consider simple heuristics and present some computational results showing their performance.

Keywords: Reoptimization; Traveling Salesman Problem; Worst-case analysis.
References:
[1] Archetti, C., Bertazzi, L., Speranza, M.G. (2003), Reoptimizing the Travelling Salesman Problem, Networks 42, 154-159.
[2] Christofides, N. (1976),Worst-case Analysis of a New Heuristic for the Traveling Salesman Problem, Report 388, Graduate School of Industrial Administration, Carnegie Mellon University.
[3] Garey, M.R., Johnson, D.S. (1979), Computers and Intractability: a Guide to the Theory of NP–Completeness, W.H. Freeman, New York.
[4] Rosenkrantz, D.J., Stearns, R.E., Lewis, P.M. (1977), An Analysis of Several Heuristics for the Traveling Salesman Problem, SIAM Journal on Computing 6, 563-581.

Heuristic algorithms for the TSP with rear-loading

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The TSP with rear-loading is a variation of the classical Traveling Salesman Problem (TSP) with pick-up and delivery between given origin/destination pairs, in which the load on the vehicle must be managed according to LIFO policy. This constraint models the

situation of a rear-loaded vehicle, in which the packages picked-up must be delivered in reverse order. We present computational results with both constructive and local search approximation algorithms.

Keywords: traveling salesman problem, pick-up and delivery, heuristic algorithms.

Efficient neighborhood search for the probabilistic pickup and delivery travelling salesman problem

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In this paper the probabilistic Pick-up and Delivery Travelling Salesman Problem is studied and an efficient neighborhood search procedure is developed. This procedure requires an $O(n^3)$ of computations for the evaluation of the neighborhood of a given solution while the straightforward approach has a $O(n^5)$ complexity. Computational results show that, if embedded in a local search or Tabu Search framework, our neighborhood evaluation technique results in an impressive computation time reduction.

A tabu search approach for no-wait job-shop scheduling with alternative routes

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In this paper we address the no-wait job-shop scheduling problem with the makespan minimization in which for each job a set of alternative chains of operations is given. This problem differs from the classical job-shop scheduling problem (JSP) (e.g., see Blazewicz et. al (2001)) since it considers no-wait in-process constraints, and for each job different alternative processing routes are available. No-wait constraints force any two consecutive operations of a job to be processed without waiting time between their operations. The latter assumption refers to the availability of different chains of operations for each job that can be selected in order to perform the job, and only one of them has to be chosen. During the last years, different extension of the JSP have been proposed in the literature, and two main threads of research may be underlined in which interesting theoretical results have been obtained concerning the makespan minimization. The first research thread concerns the possibility of considering machine alternatives for individual operations (e.g., see Brucker and Neyer (1998)), while the latter one extends classical job-shop model with respect to the job routings, from the basic case in which they are chains of operations to the more general case in which job routings are general direct acyclic graphs (e.g., see Kis (2003)). In Kis (2003), the author studies the job-shop scheduling with processing alternatives (AJSP), where job routings are directed acyclic graphs recursively formed by sequence of graphs, and-subgraphs, and or-subgraphs. We study a special case of the AJSP where job routings are or-subgraphs, and each one of them is formed by different chains of operations (e.g., branches). The problem consists in assigning a route for each job by selecting one of the available chains of operations, by defining a starting time for each job,

and then scheduling consecutively its selected chain operations with no waiting time between consecutive operations, while minimizing the makespan. For this problem, we provide a tabu search algorithm. Preliminary results are given by testing the algorithm on a set of randomly generated instances.

Keywords: job-shop, no-wait, alternative routes, tabu search algorithm.
References:
[1] Blazewicz, J., Ecker, K.H., Pesch, E., Schmidt, G., and J. Weglarz (2001). Scheduling Computer and Manufacturing Processes, second ed., Springer-Verlag, Berlin.
[2]Brucker, P., and Neyer, J. (1998). Tabu search for the multi-mode job-shop problem, OR-Spektrum, 20, 21–28.
[3] Kis, T. (2003). Job-shop scheduling with processing alternatives. Eur. J. of Oper. Res., 151, 307–332.

NONLINEAR PROGRAMMING I

Chairperson: A. Fuduli

Stabilization in column generation

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Column Generation (CG) algorithms are instrumental in many areas of applied optimization, where Linear Programs with an enormous number of columns need to be solved. Although succesfully used in many application, the standard CG algorithm suffers from well-known ``instability'' issues that somewhat limit its efficiency and usability. Building on the theory developed for NonDifferentiable Optimization algorithm, we propose a large class of Stabilized Column Generation (SCG) algorithms which avoid the instability problems of the standard approach by using an explicit stabilising term in the dual; this amounts at considering a (generalized) Augmented Lagrangian of the primal Master Problem. Since the theory allows a great degree of flexibility in the choice and in the management of the stabilizing term, we can use piecewise-linear functions that can be efficiently dealt with with off-the-shelf LP technology, as well as being related in interesting ways with some previous attempt at stabilizing the CG algorithm. The effectiveness in practice of this approach is demonstrated by computational experiments on different applications, such as large-scale Multi-Depot Vehicle Scheduling (MDVSP) problems.

Exploiting convergence of multipliers of NLP methods embedded in decomposition methods for MPCC

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We consider mathematical programs with complementarity constraints (MPCC) where we assume that the objective function is continuously differentiable. Local piecewise decomposition methods for MPCCs are based on the observation that the feasible set of an MPCC, locally around any feasible point, looks like the union of a finite but possibly huge number of ordinary nonlinear program (NLP) feasible sets. Therefore the stationarity properties of any feasible point can be stated relative to its stationarity properties in the finitely many NLPs ("pieces" of the MPCC) that are adjacent to it. Under a commonly held linear independence condition, "MPCC-LICQ", it is possible to check piecewise stationarity by looking at the KKT conditions for a single piece. This stationarity characterisation is naturally associated with descent methods: under MPCC-LICQ, if a feasible point is stationary for one piece but not for the MPCC, then a certain multiplier component can be identified and this indicates another adjacent piece for which the point is nonstationary, indeed a particular active constraint that we should relax (in the second piece) to decrease the objective. This gives strong motivation for decomposition schemes for MPCCs, where one step of a classical NLP method is applied to a particular piece of the MPCC to update the current estimate of both the solution vector and an associated multiplier, using the latter to update the current piece before applying the NLP method again. Hence we are interested in NLP methods which not only converge to stationary points but also give convergent multiplier estimates. We show a new multiplier convergence result for a linear trust region scheme for linearly constrained NLPs. We then embed this trust region scheme into a decomposition method for mathematical programs with linear complementarity constraints to obtain global convergence under typical assumptions like MPCC-LICQ.

An extension of the fundamental theorems of linear and quadratic programming and applications

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We describe a common extension of the fundamental theorem of Linear Programming on the existence of a global minimum in a vertex for lower bounded linear programs, and of the Frank-Wolfe (fundamental) theorem on the existence of the minimum of a lower bounded quadratic programming problem. We then show that several known and new results providing continuous formulations for discrete optimization problems can be easily derived and generalized with our result. These include the Quadratic Programming formulation of the maximum clique problem by Motzkin and Straus and its weighted extension by Gibbons et al., the equivalence between the minimization of a multilinear function on the continuous and discrete unit hypercube by Rosenberg, and a recent continuous polynomial formulation of the maximum independent set problem by Abello et al. Furthermore, we use our extension of the fundamental theorem of Linear Programming to obtain combinatorial formulations and polynomiality results for some nonlinear problems with simple polyhedral constraints.

Keywords: Fundamental theorem of LP, Frank-Wolfe theorem, maximum weighted clique.

A new bundle update procedure for convex minimization

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We propose a variant of bundle methods for minimizing convex not necessarily smooth functions. Bundle methods [3] have been conceived as a stabilized version of the cutting plane method proposed independently by Cheney and Goldstein in [2] and by Kelley in [4]. At each iteration of the cutting plane method, we maintain a bundle, i.e. a set of triplets, each of them being constituted by a point generated during a previous iteration, together with the corresponding objective function value and a subgradient. The new iterate is generated by minimizing the cutting plane function, obtained as the pointwise maximum of the linearizations rooted at the points of the bundle. It is well known that the cutting plane method suffers from numerical instability and moreover the linear program, corresponding to the minimization of the cutting plane function, may be unbounded. In order to avoid these drawbacks, the concept of stability center has been introduced. It is a point close to which we compute the next iterate, minimizing at the same time the cutting plane function. Generally it coincides with the best point in the bundle in terms of objective function value and it is updated whenever a sufficient decrease condition is satisfied. Starting from some considerations reported in [1] for the cutting plane method, we present a new bundle algorithm based on the idea of improving the quality of the bundle by substituting, whenever the stability center is updated, the points of the bundle by new points characterized by a better objective function value. Convergence of such a method is discussed and numerical results are presented.

Key words: nonsmooth optimization, cutting plane method, bundle methods.
References:
[1] V.Capalbo, R.De Leone and M.Gaudioso, The cobweb method for minimizing convex functions, in High performance algorithms and software in nonlinear optimization, vol.24 of Applied Optimization, Kluwer Academicm Publisher, Dordrecht, Netherlands, 1998, pp.101-108.
[2] E.W. Cheney and A.A. Goldstein, Newton's method for convex programming and Tchebycheff approximation, Numerische Mathematik, 1 (1959), pp.253-268.
[3] J-B.Hiriart-Urruty and C.Lemarchal, Convex analysis and minimization algorithms Vol. I-II, Springer-Verlag, 1993.
[4] J.E. Kelley, The cutting-plane method for solving convex programs, Journal of SIAM, 8 (1960), pp.703-712.

PROGRAMMING UNDER UNCERTAINTY

Chairperson: P. Beraldi

Stochastic programming and scenario generation within a simulation framework: an information systems perspective.

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Stochastic Programming brings together models of optimum resource allocation and models of randomness to create a robust decision making framework. The models of randomness with their finite, discrete realisations are called Scenario Generators. In a compendium report we have considered the modelling perspective of Scenario Generation and its integration within Stochastic Programming. In this paper we investigate the role of such a tool within the context of a combined information and decision support system. We analyse the roles of decision models and descriptive models, and also examine how these can be integrated with data marts of analytic organisational data and decision data. Recent developments in On-Line Analytical Processing (OLAP) tools and multidimensional data

viewing are taken into consideration. We finally introduce illustrative examples of optimisation, simulation models and results analysis to explain our multifaceted view of modelling.

Keywords : Scenario Generation, Stochastic Programming, DSS , OLAP.

Mortgage loan portfolio optimization using multi stage stochastic programming

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The Danish mortgage loan system is among the most complex of its kind in the world. Purchase of most properties in Denmark is financed either by issuing fixed–rate callable mortgage bonds or through issuing non–callable short or medium–term bullet bonds. Such loans may be refinanced at the marked rate on an ongoing basis. The complexity of the mortgage loan system makes it a non–trivial task to decide on an initial choice of mortgage loan portfolio and on finding a continuing plan to readjust the portfolio optimally. There exists as of today no functional optimization model to provide decision support for the individual mortgagor on his choice of loan. We consider the dynamics of the Danish mortgage loan system and propose several models to reflect the choices of a mortgagor as well as his attitude towards risk. The models are formulated as multi stage stochastic integer programs, which are difficult to solve for more than 10 stages. Scenario reduction and LP–approximation are used to obtain near optimal solutions for problems up to 30 stages. Our results show that the standard Danish mortgagor should hold a more diversified portfolio of mortgage loans, and that he should rebalance the portfolio more frequently than current practice.

Keywords: Stochastic programming, modeling risk, scenario reduction.

A decomposition coordination approach for solving nonlinear mixed integer stochastic programs

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In this talk, we present a new approach for solving nonlinear mixed integer stochastic programming problems. In particular, we consider two stage stochastic problem with nonlinearities both in the objective function and constraints, pure integer first stage and mixed-integer second stage variables. We formulate the problem by a scenario based representation, adding linear nonanticipativity constraints coming from splitting the first stage decision variables. In the separation phase we fully exploit the partial decomposable structure of SMINLPs. This allows to deal with a separable nondifferentiable problem, which can be solved by Lagrangian dual based procedure. In particular, we propose a specialization of the Randomized Incremental subgradient Method recently proposed by Bertsekas which takes dynamically into account the information relative to the scenarios. The coordination phase is aimed at enforcing coordination among the solutions of the scenario subproblems. More specifically, we use a Branch and Bound in order to enforce the feasibility of the relaxed nonanticipativity constraints. In order to make more efficient the overall method, we embed the Lagrangian iteration in a Branch and Bound scheme, by avoiding the exact solution of the dual problem and we propose an early branching rule and a warm start procedure to use within the Branch and Bound tree. Although SMINLPs have

many application contexts (for instance optimal design of chemical plants, minimization of waste in paper cutting, airline crew scheduling), this class of problem has not been adequately addressed in the literature. We propose a stochastic formulation of the Trim Loss Problem and we test our method over this SMINLP. Some preliminary computational experiments show the effectiveness of the proposed approach that is able to solve instances of the problem intractable with conventional approaches.

Scenario optimization and decomposition methods: an application to air traffic flow management

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In this paper we present a scenario analysis approach to air traffic delay congestion problem. In 2003, 45% of the total ATFM delay in the ECAC region was due to regulations put in place to protect airports because of lack of capacity, parking problems, low visibility, etc. Compared with last year, the amount of delay due to these regulations went up by almost half a million minutes, an increase of 7%. Weather accounted for 40% of airport-related ATFM delay, followed by airport capacity (31%) and ATC staffing issues (7%), but the main real increase was in the delay due to Airport Capacity congestion. The first way to reduce the congestion of the ATC System was to modify the structure of the airspace in order to increase its capacity and to adopt new technology instruments, but this is a long range option due to the cost involved by new facilities. For short-term decision making, to reduce congestion, a tactical optimization model suggests modifying flight plans, in order to adapt the demand to the available capacity. So, the ATFM tries to reduce the number of aircrafts waiting at each single facility, finding a good trade off between airborne hold and air ground delay. In this context, scenario approach may be trustworthy because it permits decision makers to select the scenarios, and useful because it quickly provides a good solution, considering a future distribution of probability regarding runway capacity which is unknown in practice. We focused on the ground delay problem and we present a lagrangian decomposition approach to scenario optimization based on a dynamic space-time network flow model where some arcs have uncertainty capacity representing different choices of the same runway capacity at a given time.

Keywords: scenario analysis, optimization under uncertainty, air traffic flow management.
References:
[1] Glockner, G. D., 1996. Effects of air traffic congestion delays under several flow management policies. Transportation Research Record 1517, 29-36.
[2] Glockner, G. D., Nemhauser G. L., 2000. A dynamic network flow problem with uncertain arc capacity: formulation and problems structure. Operations Research 48 (2), 233-242.
[3] Rockafellar, R. T., Wets, R. J. B., 1991. Scenarios and policy aggregation in optimisation under uncertainty. Mathematics of Operations Research 16, 119-147.
[4] Ruszczynski, A., 1997. Decomposition methods in stochastic programming. Mathematical Programming 79, 333-353.

RAILWAY OPTIMIZATION

Chairperson: P. Toth

The train platforming problem

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We address the so-called “train platforming problem”, a specific scheduling application which regards the assignment of trains to tracks (platforms) in a railway station or similar transport installations. The problem concerns the planning activitiy of large railway stations – either terminus (terminal) or through-pass stations – in order to realize an overall feasible timetable schedule, subject to various infrastructure and operational constraints (e.g. number and length of available tracks, arrival and departure times of trains, …). In addition to track capacity constraints, train movements must comply with rules imposed by signalling and safety interlockings. These rules set up itineraries (routings) between railway lines and platforms, and therefore limit the available number of routes which can be concurrently reserved and used by in-and-outcoming trains. In operational service, platforming can be a yearly, seasonal or even daily exercise, according to traffic variations and contingency planning. The basic problem aims to find a schedule which minimizes the number of platforms used, so that each platform is used by one train for its service window, and each train is routed through one itinerary, compatible with all others used at the same time (i.e. running or "dynamic" interval). If a feasible set of compatible itineraries cannot be found, the problem requires to minimize the penalties associated with the infeasibilities of the schedule. Additional constraints can be included in the model, e.g. preference platforms, multiple train assignment to one platform, according to departure lines and other service rules, while the decision to assign a train to one track also constrains the departure choices. The real-life problem is highly combinatorial and may be tackled through different approaches. We present a heuristic algorithm based on the iterative computation of shortest paths. A prototype has been developed to prove the feasibility of the approach in the case of large stations of the Italian railway network (Rete Ferroviaria Italiana, RFI), having more than 600 train movements per day and more than 20 platforms. Comparative analysis with current traditional methods has been performed. Finally the algorithm has become part of a real-life application - VIP (Verification Informatics Platforming) – which has been implemented as software package and made recently available to final users within the RFI organization, as working tool of the station planners.

Keywords: Railways, scheduling, platforming.

Relevant parameters in designing railway infrastructure access fees

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Università di Genova

After the European Community directive 440/91 that allows competition in the railway sector in order to increase efficiency, the European network was made accessible to railway

undertakers, given that they are charged with a suitable non discriminatory access fee. As the objectives for the infrastructure managers are different, each country fixed the tariffs according different rules. The increasing level of integration among the different states of the European Union, suggests to look for a unified system of charging fees. A starting point for this process is, clearly, the analysis of the fees actually used in the various countries. In such a way, it is possible to collect information on the relevance that each state has attributed to different parameters, in order to compute the fee. The aim of this preliminary work is to find out a unified "formula" with characteristics of fairness and efficiency, that can represent the essential features of the present system of tariffs in the various countries. In this work we present the results of an analysis on the network statements that the European countries have made public, looking for similar elements and evaluating when the differences can be considered not strongly relevant in the final amount paid by a railway undertaker.

A linear programming approach to the train timetabling problem

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We consider the Train Timetabling Problem, which aims at determining an optimal timetable for a set of trains which does not violate track capacity. In particular, a minimum time interval between two consecutive departures and arrivals in the same station must be respected; moreover, trains can overtake each other only in correspondence of a station, as we are considering a single one-way track. Given a so-called ideal timetable on input, which is typically infeasible, we have to change it so as to obtain a feasible timetable, by changing the departure time of some trains from their first station and/or increase the minimum stopping time in some of the intermediate stations. Trains can also be canceled. The objective is to maximize the overall profit of the trains scheduled, the profit of each train being given by an ideal profit, that is achieved if the train is scheduled according to its ideal timetable, minus the penalties for the changes with respect to this timetable. We propose a set packing model based on the representation of the problem on a directed acyclic graph, in which (binary) variables are associated with paths from the source to the sink in the graph, each corresponding to a feasible timetable for some train. There are polynomially many clique inequalities to guarantee the minimum time interval between consecutive arrivals and departures, and exponentially many clique inequalities to prevent train overtakings between consecutive stations. As the number of variables and constraints is huge for real world instances the associated linear programming relaxation is solved using column generation and separation. We describe a branch-and-cut-and-price algorithm as well as some constructive and local search heuristic algorithms based on this linear programming relaxation, showing their results on a wide set of real-world instances.

Key words: train timetabling, column generation, separation.
References:
[1] A. Caprara, M. Fischetti and P. Toth, "Modelling and solving the Train Timetabling Problem", Operations Research 50, 851-861 (2002).
[2] A. Caprara, M. Monaci, P. Toth and P.L. Guida, "A Lagrangian Heuristic Algorithm for a Real-World Train Timetabling Problem", to appear in Discrete Applied Mathematics (2004).

Perché la ricerca operativa è trascurata dalle imprese ferroviarie europee? Focus sul settore del traffico merci europeo

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La ferrovia è senza dubbio una delle tecnologie di trasporto più mature, ma, almeno nel trasporto merci, non ha ancora attivato tutte le opzioni tecnologiche per lo sviluppo dei processi di produzione. Motivazioni storiche di diverso tipo ne hanno impedito e tuttora rallentano una rapida trasformazione, prima fra tutte la lunga storia di aziende monopolistiche nazionali, situazione tipica del sistema europeo. Per fortuna il mondo è cambiato ed anche le ferrovia sta cambiando con passi sempre più rapidi ! Il progressivo ed irreversibile avvento di un sistema competitivo negli ultimi 10 anni ha obbligato le grandi imprese ferroviarie nazionali ad avere le esigenze del Cliente come motore ed obiettivo dell'Azienda. In questa fase l'uso dell'informatica sta a sua volta evolvendo: da una fase iniziale nella quale era mero supporto ai processi, si è passati ad un suo utilizzo quale motore/integratore/riorganizzatore dei processi stessi, fino ad aprire una nuova fase nella quale la ricerca operativa dovrà supportare le decisioni. Trenitalia / Div.Cargo sta affrontando da almeno tre anni la fase dell'integrazione dei sistemi utilizzando l'informatica come strumento per "far entrare in Azienda il Cliente". Il metodo di lavoro che promuove è l'inserimento di algoritmi complessi all'interno dei sistemi informativi quotidianamente utilizzati nei processi di produzione e vendita, al fine di fornire alcune opzioni di scelta agli operatori, lasciando comunque l'ultima decisione all'uomo. Gli ambiti di applicazione della ricerca operativa internamente all'Azienda sono sostanzialmente orientati a supportare i principali processi: la pianificazione, la programmazione, la gestione operativa, nonché l'interfaccia intelligente con il Cliente. Siamo ancora in una fase iniziale e con obiettivi ambiziosi, ma anche qualche importante realizzazione, certi che la ricerca operativa deve essere uno dei tool a disposizione dell'impresa ferroviaria per affrontare una nuova fase evolutiva. Ma per questo abbiamo anche bisogno di un po' di attenzione del mondo della Ricerca Operativa per trasferire processi già consolidati in altri settori all'interno di un mondo che sino a ieri era profondamente diverso.

MATHEMATICAL METHODS FOR LEARNING I

Chairperson: C. Vercellis

Mathematical methods for learning: an overview

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The idea of building models and algorithms capable of learning from past experience is both fascinating from the intellectual point of view and relevant for many practical applications. Early approaches, largely influenced by computer science, were mostly based on heuristic methods. Since the last ten years, learning theory is a well established discipline founded on solid mathematical grounds. It encompasses different problems in knowledge discovery, such as pattern recognition, regression estimation, density estimation; it highlighted deeper perspectives on previous techniques, such as neural networks; it originated new powerful methods, such as support vector machines and kernel-based techniques. In this context, optimization and mathematical programming theory play a key role. The aim of this talk is to present a taxonomy of mathematical methods for learning, to overview the state of the art in the field and to highlight some future perspectives.

Hard separation in binary and multicategory discrete support vector machines

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Discrete support vector machines (DSVM) are models for classification recently introduced [2] as a family of effective models for binary and multicategory classification problems. Their distinctive feature is the formulation of mixed integer programming problems aimed at deriving optimal soft margin separating hyperplanes with minimum empirical error and maximum generalization capability. In this paper we propose a new variant of DSVM, for which the optimal discriminating hyperplane establishes a *hard separation* between distinct classes. This differs from the traditional *soft margin* considered by SVMs [3], [4] and by previous DSVMs models, since points laying between the canonical hyperplanes are considered as misclassified, even if they fall on the correct side of the separating linear surface. Theoretical bounds are also derived to finely tune the parameters of the optimization problem. Classification algorithms based on the new model are then formulated by making use of the hard separation hyperplane as a linear perceptron for solving binary and multicategory problems. In this case, three different frameworks are developed; two are based on the solution of a set of binary discrimination problems. The third is obtained by deriving different separating hyperplanes simultaneously, one for each class. Computational results on benchmark datasets [1] indicate the effectiveness of the proposed approach.

Keywords: classification; support vector machines; statistical learning theory
References:
[1] Lim, T.S., Loh, W.Y., Shih, Y.S., 2000. A comparison of prediction accuracy, complexity, and training time of thirty-three old and new classification algorithms. Machine Learning 40, 203-229.
[2] Orsenigo, C., Vercellis, C., 2003. Multivariate classification trees based on minimum features discrete support vector machines. IMA Journal of Management Mathematics 14, 221-234.
[3] Schölkopf, B., Smola, A.J., 2002. Learning with kernels. Support vector machines, regularization, optimization and beyond. MIT Press, Cambridge, USA.
[4] Vapnik, V., 1998. Statistical Learning Theory. Wiley, New York, USA.

Learning and generalization by kernel methods with bounded complexity

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Many learning tasks can be formalized as the reconstruction of an unknown functional relationship between inputs and outputs on the basis of a sample of input/output pairs of empirical data. Generalization capabilities allow one to utilize a “device’’ trained on a certain sample of data for processing new data, which were not used for training. Such capabilities are obtained by means of partial knowledge on the functional relationship generating the data, such as smoothness and lack of high frequency oscillations [1]. These requirements can be expressed via norms on Hilbert spaces of a special type, called reproducing kernel Hilbert spaces, and the overall learning task can be modeled as minimization of a functional called regularized empirical error, which expresses a trade-off between fitting to the empirical data and generalization capabilities. The Representer Theorem [2, p.42] shows that in such cases there exists a unique minimum of the regularized empirical error, having the form of a one-hidden layer network with a linear output and hidden units dependent on the type of kernel (e.g., for the Gaussian kernel the

solution is a Gaussian radial-basis function network with centroids at the data points). The output weights of such a network can be computed by solving a well-posed linear system of equations. We discuss two drawbacks of the algorithm based on the Representer Theorem: 1) The number of hidden units in the network has to be equal to the number data. For large data sets, such a network might not be efficiently implementable 2) Practical applications are limited by the speed of convergence of iterative algorithms solving the linear system of equations and by the size of the condition number of the matrix defining the linear system. Then, taking the hint from recent results [3,4,5], we show how to model a typical neural network learning by minimization of the regularized empirical error functional over sets of functions computable by networks with a number of hidden units imposed by feasibility of implementation. We describe upper bounds on rates of convergence of sequences of suboptimal solutions achievable over neural networks with increasing number of hidden units and on the corresponding values of the regularized empirical error functional.

Keywords: complexity of kernel methods, upper bounds on the learning error, neural networks.
References:
[1] N. Cristianini and J. Shawe-Taylor. An Introduction to Support Vector Machines and Other Kernel-Based Learning Methods, Cambridge University Press, 2000.
[2] F. Cucker and S. Smale, ``On the mathematical foundations of learning'', Bulletin of AMS, vol. 39, pp. 1-49, 2001.
[3] V. Kůrková and M. Sanguineti, ``Learning from data by neural networks with limited complexity '', Proc. First IAPR-TC3 Workshop ``Artificial Neural Networks in Pattern Recognition",(M. Gori and S. Marinai, Eds., pp. 146-151, 2003.
[4] P. C. Kainen, V. Kůrková, and M. Sanguineti, ``Minimization of error functionals over variable-basis functions'', SIAM Journal on Optimization, vol. 14, pp. 732-742, 2003.
[5] V. Kůrková and M. Sanguineti, ``Error estimates for approximate optimization by the Extended Ritz Method", SIAM Journal on Optimization, to appear.

Fast classification of large data sets using binary knapsack

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Given a set of data already grouped into classes, the problem of predicting whose class each new data belongs to is often referred to as classification problem. The first set of data is generally called training set, while the second one test set [1]. Classification problems are of fundamental relevance in the fields of data analysis, data mining, etc., and are moreover able to represent several other interesting practical problems. As a consequence, many classification models and algorithms have been proposed in the literature (see e.g. [2]). However, a substantial tradeoff between classification accuracy and computational efficiency exists. We propose here an approach having a very reduced computational burden. Such approach appears therefore suitable for very large data-sets, in particular for those which are so large that cannot be tackled by other approaches (e.g. database streaming). Data records may be composed by both qualitative and quantitative fields. The proposed approach is based on the selection of a set of values for each field. The classification capability of each of such values is computed on the basis of information directly extractable from the training set. Without a priori assumptions on the meaning of the data-set, except that it represents some real-world phenomenon (either physical or sociological or economical, etc.), we carry out a general statistical evaluation, and specialize it to the cases of numerical fields having normal (Gaussian) distribution or binomial (Bernoulli) distribution [3]. The so computed classification capabilities are used for modeling the choice of a tractable number of such values as a binary knapsack problem with unitary weighs. Such version of the problem can be solved in polynomial-time. The

selected values are then used for performing a discretization of the data-set and for its classification. Results of the proposed procedure on several data-sets, including some of the UCI repository [4], are presented and discussed.

Keywords: Classification, Data Mining, Massive Data Sets, Binary Knapsack.
References:
[1] T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer, New York, 2001.
[2] U.M. Fayyad, G. Piatetsky-Shapiro, P. Smyth, R. Uthurusamy (Eds.). Advances in Knowledge Discovery and Data Mining. AAAI Press / The MIT Press, Menlo Park, CA, 1996.
[3] M. Evans, N. Hastings, B. Peacock. Statistical Distributions (3rd edition). Wiley series in Probability and Statistics, New York, 2000.
[4] C. Blake and C.J. Merz. UCI Repository of machine learning databases. Univ. of California, Irvine, Dep. of Information and Computer Science, 1998.
http://www.ics.uci.edu/~mlearn/MLRepository.html.

LOGISTICS II

Chairperson: R. Musmanno

New optimization models and algorithms in management of container terminals

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We propose models and algorithms for three problems arising in the management of the Gioia Tauro maritime terminal. The first is the berth allocation problem (BAP) which consists of scheduling berthing operations in order to minimize the total length of stay of ships in the port. We have studied two formulations. The Dynamic Berth Allocation Problem proposed by Imai et al. [2] and the Multi-Depot Vehicle Routing Problem with Time Windows (MDVRPTW) formulation [1],[3]. A tabu search heuristic was developed to solve the BAP as a variant of the MDVRPTW. After assessing the efficacy of the tabu search heuristic on a formulation exclusively based on time constraints, we extend the same search mechanism to consider also the space constraint arising from sharing the portion of the berth available between ships of variable lengths. The second is the Service Allocation Problem. It consists of suitably locating groups of containers in order to minimize movements between their locations. The problem can be formulated as a quadratic assignment problem with capacity constraints on the slots. A memetic heuristic approach is presented. A memetic heuristic combines genetic search and tabu search. The genetic component is derived from a method proposed by Drezner for the quadratic assignment problem [4]. The third is the quay crane scheduling. The quay crane scheduling problem consists in deciding the sequence of discharging and loading operations that the cranes assigned to a vessel will perform in order to minimize the vessel completion time as well as the crane idle times. We present a MILP formulation that computationally is much more effective of the formulation presented in [5]. The problem has been formulated as a VRP with side constraints. Precedence relations between tasks are an important characteristic.

We developed a branch-and-cut algorithm which takes into account these precedence constraints.

Keywords: maritime container terminal, berth allocation, quay crane scheduling.
References:
[1] J-F. Cordeau, G. Laporte and A. Mercier, "A unified Tabu Search heuristic for vehicle routing problems with time windows", Journal of the Operational Research Society 52: 928-936 (2001).
[2] A. Imai, E. Nishimura and S. Papadimitriou, "The Dynamic Berth Allocation Problem for a container Port", Transportation Research 35-B: 401-417 (2001).
[3] P. Legato, R.M. Mazza, "Berth planning and resources optimisation at a container terminal via discrete event simulation", European Journal of Operational Research 133/3: 537-547, (2001).
[4] Z. Drezner, "A New Genetic Algorithm for the Quadratic Assignment Problem", INFORMS Journal on Computing, 15: 320-330, (2003)
[5] K. H. Kim and Y.-M.Park, "A crane scheduling method for port container terminals", European Journal of Operational Research, 156/3:752-768, (2004).

Modelli integrati per raccolta ordini e consegne nei supermercati on-line

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I supermercati on-line, realtà in espansione nel panorama dell'e-commerce, prevedono normalmente la consegna a domicilio della spesa, ordinata a distanza dal cliente, all'interno di una finestra temporale scelta dal cliente stesso in un insieme di possibili intervalli proposti dall'azienda. Una volta fissate le consegne, il problema di distribuzione risultante è classificabile come Vehicle Routing Problem with Time Windows, ma prima di disporre delle richieste è l'azienda a dover proporre al potenziale cliente un insieme di intervalli disponibili per la consegna. Il problema complessivo dal punto di vista del supermercato consiste quindi nel proporre ai propri clienti un insieme di finestre temporali all'interno delle quali potrà garantire la consegna. Tale problema non risulta attualmente affrontato in letteratura. Si tratta di un problema di tipo "on-line" non solo per il significato che il termine assume per la definizione dei supermercati virtuali ma anche in quanto i clienti pongono i loro ordini indipendentemente e nel momento per loro preferito e non sono quindi noti a priori. In questo lavoro vengono innanzitutto analizzati alcuni portali di supermercati on-line e le soluzioni da questi offerte, introducendo di seguito alcuni modelli integrati utilizzabili per affrontare il problema complessivo della raccolta e successiva consegna degli ordini posti dai clienti. Sono quindi discusse le possibilità attualmente offerte rispetto ai modelli proposti e poste le basi per la risoluzione del problema complessivo.

Keywords: VRPTW; Supermercati on-line; on-line VRPTW.

An empty containers management dynamic model

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Empty container management is creating a significant logistic challenge for the freight transportation industry. The directional imbalances in trade activities result indeed in ports and depots having strong surplus of empty containers, while others require them. In order to tackle this problem, we propose a mathematical programming model having a network structure, whose arcs represent services routes, inventory links and decisions concerning when and where lease containers from external sources. The implementation by effective algorithms is also presented. We show as such a model provides decision-makers with a

simple tool by means of which they can be guided in their choices, thus optimizing the management of their containerized fleet over a given planning horizon.

Keywords: Empty containers; Intermodal transportation; Mathematical programming
References:
[1] Crainic, T.G., 2002. Long-haul Freight transportation. Handbook of Transportation Science, R.W.Hall (Ed.), 2nd Edition, Kluwer Academic Publishers.
[2] Jarman, M.V., 1999. Empty containers-full of problems. Containerization International. April.
[3] Dejax, P.J., Crainic, T.G., 1987. A Review of Empty Flows and Fleet Management Models in Freight Transportation. Transportation Science 21(4), 227-247.
[4] Crainic, T.G., Dejax, P., and Delorme, L., 1989. Models for Multimode Multicommodity Location Problems with Interdepot Balancing Requirements. Annals of Operations Research 18, 279-302.

A new pattern of industrial logistics for management control: from the activity based costing the activity based management

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The high speed of variation of markets, where firms are called today to compete, determines the necessity to understand in a proper way the effective competitive approach in which firm works. In this contest hence, logistics puts itself as strategic opportunity for levers that it offers to concern in pursueing the objectives of *continuos improvement,* in an optics of optimizzation of business organizzation. The complexity of the scenery is enormously increased and the traditional instruments of business analisys and control are not able to support adequately concerns that must work in this new environment. The model that better reflects the necessity of firms is *The Activity Management* that uses these advanced techniques: Activity Based Costing (ABC) and Activity Based Management (ABM). The ABM introduces a new management philosophy that renews the way to see the business performances. Object of control changes completely and the vision for centers of cost is integrated from an analysis based on activities and processes. It's essential hence, for the attainment of competitive advantage, to overcame the optics of product studing how activities consume resources in the productive process (value chain). The problem is to understand no more the where but why resources are consummate, individuating quantitative references (cost driver) that represent the quantity and quality of activities. The ABC measures for every awarded resource, the efficiency and efficacy in coherence with general objectives. The ABM, instead, carries out the continuos improvement of key factors of business management, connected with the main principle of the ISO 9001 (VISION 2000), that is the instrument for the execution of Total Quality Management (TQM). The practical realization of management model is been effected at the Group FAAM S.p.A. that produce electric accumulators and ecological vehicles. Starting from the certifications of series ISO (9000 e 14000) is been created a pilot integrated model, based on procedures ABC-ABM, removing activities not value added. The focus of the work is consisted in individuating performances indicators to value the firm governability, in accordance with a preventive-consumptive scheme (feedback), for pursueing economics-financial objectives.

Keywords: logistics, Activity Based Costing, Activity Based Management.
References:
[1] Azzone G., "Innovare il sistema di controllo di gestione" ,Etas Libri, Milano, 2000.
[2] Falasco M., "Logistica e nuove tecnologie nella catena della fornitura" in atti conferenza annuale AIRO 2002, Università degli Studi dell'Aquila.

[3] Cardinali M., “Il Total Quality Management e la gestione per attività –Un modello di reengineering con procedura Activity Based Costing nel gruppo FAAM S.p.A.-“ Tesi di laurea Anno Accademico 2003-2004.
[4] Lavacca C., e A.A.V.V. “Che cos’è l’Activity Based Management”, Il Sole 24 Ore Libri, Milano, 1994.
[5] Porter M. “Il Vantaggio Competitivo” Ed. Comunità, Milano, 1995.

NONLINEAR PROGRAMMING II

Chairperson: R. Zoppoli

An algorithm for parameters estimation: bounds on the estimation error and application to time-series prediction

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The Extended Kalman Filter (EKF, for short) is a classical tool for parameters estimation [1]. The interest in the EKF emerges also in the area of recursive optimization, well-suited to dealing with a large amount of on-line available data. In this context, the EKF-based approach provides a particularly useful framework to perform optimization incrementally, i.e., one data block at a time [2,3,4]. This work aims at presenting an EKF-based learning algorithm for parameters estimation. We show that the algorithm’s estimation error is exponentially bounded in mean square and we point out differences with respect to the standard EKF algorithm. To illustrate numerically the performance of the proposed algorithm, we consider its application to a problem of prediction for chaotic time series [5], which is a quite standard benchmark. A nonlinearly parametrized input-output mapping is used to perform the prediction task. The nonlinear programming problem of determining the optimal parameters’ values is stated as an estimation problem, whose solution via the proposed algorithm is compared with the solutions derived via other widely used algorithms. Advantages of our approach are discussed.

Keywords: upper bounds on estimation error, nonlinear programming, time-series prediction.
References:
[1] B. D. O. Anderson and J. B. Moore, Optimal Filtering, Prentice Hall, New York, 1979.
[2] D. P. Bertsekas, ``Incremental least-squares methods and the extended Kalman filter", SIAM Journal on Optimization, vol. 6, pp. 807-822, 1996.
[3] A. Alessandri, M. Sanguineti, and M. Maggiore, ``Optimization-based learning with bounded error for feedforward neural networks", IEEE Trans. on Neural Networks, vol. 13, pp. 261-273, 2002.
[4] A. Alessandri, M. Cuneo, S. Pagnan, and M. Sanguineti, ``On the convergence EKF-based parameters optimization for neural networks", Proc. 42nd Conference on Decision and Control, pp. 5825-5830, 2003.
[5] M. C. Mackey and L. Glass, ``Oscillation and chaos in physiological control systems", Science, vol. 197, pp. 287-289, 1977.

Efficient approximation schemes for functional optimization

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In functional optimization problems one has to minimize (or maximize) a functional with respect to admissible decision strategies belonging to an infinite-dimensional space of functions, often dependent on a large number d of variables. This is the case, for example, in large-scale packet-switching communication networks, when one has to find the routing strategies as functions of the packets' buffers in the d nodes of the network [1]. Infinite dimension makes inapplicable many mathematical tools typically used in nonlinear programming. This, together with the arising of applications involving an ever-increasing number of variables, motivates the development of new tools based on theory and techniques from functional analysis. When optimal solutions to functional optimization problems cannot be found analytically or numerical solutions are not easily implementable, approximation schemes searching for suboptimal solutions expressible as convex combinations of n-tuples from a basis set of simple computational units have provided effective experimental performances and desirable theoretical properties [2-5]. Here we compare various choices of basis sets and families of decision strategies dependent on a large number d of variables that can be approximated by using a "moderate" number of such basis functions. We show that error bounds growing at most polynomially with d can be obtained by using different kinds of computational units in the basis, for various sets of admissible solutions to functional optimization problems. Families of functions belonging to some of the above-mentioned sets but not to others are exhibited. When decision strategies belong to these sets and an approximate solution is searched for by suitable approximation schemes of this type, an arbitrary accuracy can be obtained by using a number of basis functions that grows polynomially with d, sometimes even only linearly. In these cases the curse of dimensionality, which often makes unfeasible traditional linear approximation techniques for functional optimization, is avoided. Our results give theoretical insights into the effective performance showed by certain approximation schemes in a variety of applications entailing functional optimization tasks.

Keywords: approximation schemes, polynomial error bounds, multivariable decision strategies.
References:
[1] M. Baglietto, M. Sanguineti, and R. Zoppoli, ``The Extended Ritz Method in stochastic functional optimization: an example of dynamic routing in traffic networks", in High Performance Algorithms and Software for Nonlinear Optimization, G. Di Pillo e A. Murli, Eds., Kluwer Academic Publishers, pp. 23-56, 2003.
[2] R. Zoppoli, M. Sanguineti, and T. Parisini, ``Approximating networks and Extended Ritz Method for the solution of functional optimization problems", Journal of Optimization Theory and Applications, vol. 112, pp. 403-440, 2002.
[3] P. C. Kainen, V. Kůrková, and M. Sanguineti, ``Minimization of error functionals over variable-basis functions'', SIAM Journal on Optimization, vol. 14, pp. 732-742, 2003.
[4] V. Kůrková and M. Sanguineti, ``Error estimates for approximate optimization by the Extended Ritz Method", SIAM Journal on Optimization, to appear.
[5] A. Alessandri and M. Sanguineti, ``Optimization of approximating networks for optimal fault diagnosis", Optimization Methods and Software, to appear.

Towards efficient and cheap bounds for StQPs

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A standard quadratic optimization problem (StQP) consists of minimizing a quadratic form over a simplex [2]. If we want to find a lower bound for the optimal value, we may decompose the objective into a sum of two quadratic functions, each of which is easy to minimize. The most popular way to do so is the difference-of-convex (d.c.) approach [3,4]. There are many possible d.c. decompositions and recently Anstreicher and Burer [1] have shown that the best d.c. bound is obtained by solving a semidefinite program. The presented work offers an alternative interpretation of this result, and goes beyond by leaving the d.c. domain.

References:
[1] Anstreicher, K., S.Burer: D.C. Versus Copositive Bounds for Standard QP, to appear in J.Global Optimization.
[2] Bomze, I.: On Standard Quadratic Optimization Problems. Journal of Global Optimization 13, 369-387 (1998).
[3] Bomze, I.: Branch-and-Bound Approaches to Standard Quadratic Optimization Problems. Journal of Global Optimization 22, 17-37 (2002).
[4] Bomze, I., Locatelli, M.: A characterization of undominated d.c. decompositions of quadratic functions. To appear in: Computational Optimization and Applications (2004).

Linear complementarity system formulation of combinatorial problems

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Combinatorial Optimization studies how to solve optimization problems over a discrete structure, but here, only problems with a linear objective function and linear constraints, for which a minimum must be found, subject to a set of variables assuming integer values (usually restricted to binary values, 0 and 1) de_ned over a polyhedral set will be examined, [3] . The aim of this paper is to present a general linear complementarity algorithm to solve some important combinatorial problems in this restricted class, as continuous problems, by embedding them into an appropriate space of variables, so that at the solution, the variables will only assume the permitted integer values, see [5]. The advantage of this method is that all the results of Mathematical Analysis can be used to obtain the solution fast, while combinatorial solution approaches, must usually consider heuristic procedures, or implicit enumeration schemes [4], [2]. The outline of this paper is the following. In the next section a characterization of combinatorial problems will be given, the transformations of these problems to continuous problems will be described and their equivalence proved, see [1]. The solution algorithm for these classes of problems will be speci_ed in section 3 and its general convergence conditions proved. It is then possible in section 4 to proceed to solve instances of combinatorial problems of various types and present comparative results with other well known routines. Finally in section 5 the relevant conclusions will be drawn.

Key words: Linear Complementary Problems, Combinatorial problem solution.
References:
[1] F. Giannessi and F. Nicolucci. Connections between nonlinear and integer programming problems. In Istituto Nazionale di Alta Matematica, editor, Symposia Mathematica, volume XIX. Adademic Press, New York, 1976.
[2] D. S. Hochbaum. Approxiamtion Algorithms for NP-hard Problems. Int. PWS Publ., Boston, '97.
[3] J. E. Mitchell and M. J. Todd. Solving combinatorial problems using karmarkar's algorithm. Mathematical Programming, 56:245- 284, 1992.
[4] G. L. Nemhauser and L. A. Wolsey. Integer and Combinatorial Optimization. Wiley, NY, 1988.
[5] G. Patrizi. The equivalence of an lcp to a parametric linear program with a scalar parameter. E.J.O.R., 51:367{386, 1991.

NETWORK OPTIMIZATION I
In memory of Stefano Pallottino

Chairperson: G. Gallo

A new framework for experimental study of graph algorithms

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The experimental analysis of graph algorithms is a complex process that suffers from the lack of a standard approach. Many of the experiences conducted so far in this area have proposed different solutions to this end thus producing a proliferation of methodologies, software libraries and testing environments. In this paper we propose a new software framework that aims at being a first step toward the definition of an unified environment for simplifying the experimentation of graph algorithms. Our framework comes complete with a library of commonly used data sets, algorithms template implementations and performance analysis scripts that cover the whole experimental process and that support several domains of graph problems such as the static single source shortest path problem and the dynamic minimum spanning tree problem. In addition, the framework can be easily extended to support other domains of problems. Finally, our frameworks permits to inspect the experimental performance of an algorithm with different levels of details, ranging from the evaluation of the overall running time to lower level statistics such as the number of cache that are generated. The process of experimenting a set of algorithms with our framework requires four phases. In the first phase, the implementation of each considered algorithm is encapsulated in a C++ template class provided by our framework. The resulting class is then transformed in a ready-to-be-tested program using a companion graphical tool. The transformation adds, to the algorithm, the ability to read data sets provided with our framework and the ability to produce statistics about its performance. In the second phase, it is chosen which experiment is to be ran among the available ones, which algorithms are to be included in the experimentation, which data sets are to be used and which type of performance should be monitored. In the third phase, the experiments are ran while the performance statistics are automatically collected in a log file. In the last phase, standard performance analysis scripts are used in order to automatically aggregate and summarize in a graphical chart the performance statistics obtained in the previous phase.

Keywords: Experimental Analysis, Graph Algorithms, Implementation, Methodology, Shortest Path, Minimum Spanning Tree

References:

[1] "A software library of dynamic graph algorithms". D. Alberts G. Cattaneo, G. F. Italiano, U. Nanni C. D. Zaroliagis. In proceeding of "Algorithms and Experiments (ALEX '98), Trieste, 1998

[2] "A Practical Shortest Path Algorithm with Linear Expected Time". A. V. Goldberg. SIAM Journal on Computing (2002)

[3] "Towards a discipline of experimental algorithmics". B.M.E. Moret. In Data Structures, Near Neighbor Searches, and Methodology: Fifth and Sixth DIMACS Implementation Challenges, M.H. Goldwasser, D.S. Johnson, and C.C. McGeoch, eds, DIMACS Monographs 59, 197-213, American Mathematical Society, Providence, 2002.

[4] "Maintaining Dynamic Minimum Spanning Trees: An Experimental Study". G. Cattaneo, P. Faruolo, U. Ferraro Petrillo and G. F. Italiano. In Proceeding 4th Int. Worksh. Algorithm Engineering

& Experiments (ALENEX 2002), Lecture Notes in Computer Science 2409, ed., Springer-Verlag, 2002, pp. 111–125.

Efficient Visiting Strategy and Data Structures for SPT Algorithms

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In this work we present both a new strategy (T.P.pre-processing) to speedup shortest path tree "label correcting" algorithms and a new "label setting" algorithm. T.P.pre-processing strategy is based on two ideas: "ancestor checking" and "modified topological sort". We applied this strategy on TWO_Q algorithm [1], creating the PRE_TWO_Q algorithm, even if the T.P.pre-processing strategy can be applied on any "label correcting" algorithm (e.g., Pape-Levit algorithm [2]). LH is a "label setting" algorithm, it uses simultaneously two data structures to implement the priority queue Q: an heap and a list structure. The algorithm uses also the caliber's heuristic, introduced by Goldberg in his data structure "smart queue" [3], to detect at every iteration some nodes with exact label. Our computational results, compared with some of the best existing algorithms, show that PRE_TWO_Q results fastest in four of fifteen family graphs used for the tests, while H is always faster than Dijkstra's algorithm with heap and is the fastest in five of twelve family graphs.

Keywords: Shortest path, Priority Queue, data structures implementation.
References:
[1] Pallottino S., "Shortest-Path Methods: Complexity,Interrelations and New Propositions". Networks, 14:257-267, 1984.
[2] Pape U., "Implementation and Efficiency of Moore Algorithms for the Shortest Root Problem". Math. Prog., 7:212-222, 1974. 18. B. Ju. Levit and B. N. Livshits.
[3] Goldberg A. V., "A Simple Shortest Path Algorithm with Linear Average Time". STAR Laboratory, InterTrust Technologies Corp.4750 Patrick Henry Dr., Santa Clara, CA 95054, USA.

Finding Spatial Dissimilar Paths for HazMat Shipments

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We study the problem of finding hazmat road transportation paths minimizing both the whole risk of hazmat shipments and the total transportation cost, meanwhile guaranteeing a certain level of risk equity over the population. We try to address risk equity, by taking into account the risk induced by a path also on populated links in the neighborhood of the path; that is, we consider the risk coming from incident effect propagation. In particular, we introduce a new similarity index based on an extension of the known path similarity concept, in order to consider in some sense similar also paths that are very close, and we try to guarantee an equitable risk spreading by searching for paths fulfilling a certain threshold level of dissimilarity. The problem is heuristically solved, and the proposed model and algorithm are evaluated on realistic problem instances.

Keywords: hazardous materials transportation; risk equity; heuristic algorithm.
References:
[1] M. Abkovitz, M. Eiger and S. Srinivasan, Estimating the Release Rates and Costs of Transporting Hazardous Waste, Transp. Res. Record 977 (1984) 22–30.
[2] M. H. Patel and A J. Horowitz, Optimal Routing of Hazardous Materials Considering Risk of Spill, Transp. Res. 28A (1994) 119–132.

[3] E. Erkut and V. Verter, Modeling of Transport Risk for Hazardous Materials, Oper. Res. 46 (1998) 625–642.
R.L. Keeney, Equity and Public Risk, Oper. Res. 28 (1980) 527–534.
[4] V. Akgün, E. Erkut and R. Batta, On Finding Dissimilar Paths, European Journal of Operational Research 121 (2000) 232–246.
[5] E. Erkut, The discrete p-dispersion problem, Eur. J. of Oper. Res. 46 (1990) 48–60.
[6] J.Y. Yen, Finding the K Shortest Loopless Paths in a Network, Manag. Sci. 17 (1971) 712–716.
[7] E. Martins and M. Pascoal, A new implementation of Yen's ranking loopless paths algorithm, Optimization 2001, Aveiro, July 2001.

A routing problem arising in flexible manufacturing systems

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In this paper, a particular Pickup and Delivery Vehicle Routing Problem (PDVRP) related to the optimal storage management problem for a Flexible Manufacturing System (FMS) is described. Given a list of different types of items, the problem consists of picking them from a set of locations where items are stored in given quantities. This is accomplished through a set of tours traveled by a vehicle of fixed capacity. Each tour starts and ends at the same given location (depot) and the goal is to minimize the total length of all traveled tours. The problem includes as subproblem the Traveling Salesman Problem (TSP) and is NP-hard. In this paper, we provide two different integer programming formulations of the problem and propose a *Branch and Bound* approach for solving it when its size is small. Two heuristic approaches following the *cluster-first route-second* schema are proposed for solving real world sized problems. Numerical results obtained using the proposed heuristics are presented. We compare objective function values to lower bounds on the optimal solutions.

Keywords: Vehicle Routing Problem, Shortest path, Network optimization, FMS.
References:
[1] Bramel J. and D. Simchi-Levi . Logic of Logistics: Theory, Algorithms, and Applications for Logistics Management, Springer-Verlag, New York. 1997.
[2] Cormier, G., E.A. Gunn. "A review of warehouse models," European Journal of Operational Research 58, 3-13, 1992.
[3] Crainic T.G. and G. Laporte, Fleet Management and Logistics, Kluwer Academic Publishers, 1998.
[4] Gray, A.E., U.S. Karmarkar, and A. Seidmann. "Design and operation of an order-consolidation warehouse: Models and application," European Journal of Operational Research 58, 14-36, 1992.
[5] Laporte, G., M. Gendreau, J.Y. Potvin, and F. Semet. "Classical and modern heuristics for the Vehicle Routing Problem," Intl. Trans. in Op. Res", 7, 285-300, 2000.
[6] Laporte G. and F. Semet, "Classical heuristics for the capacitated VRP", in SIAM Monographs on Discrete Mathematics and Applications, Toth P. and D. Vigo (eds.). Philadelphia 2002, 109-128.
[7]Toth P. and D. Vigo eds., "The Vehicle Routing Problem", SIAM Monographs on Discrete Mathematics and Applications, Philadelphia 2002.

TRANSPORTATION I (PRIN PROJECT)

Chairperson: P. Dell'Olmo

Infomobility and Design of Integrated Urban Transportation Systems

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In this talk the main issues of the PRIN project n°: 2003095533 (MIUR) involving several Italian university research departments as well as mobility agencies of most large Italian urban cities. The project studies the basic components of an integrated system for planning and managing transport networks, in particular urban traffic networks equipped with telecommunication technologies and new mobility services. In the perspective of a single system, we foresee to face some of the main problems arising in the management of a urban transportation system by means of adequate mathematical formulations and the design of corresponding solution algorithms. We propose also to verify on the field the results, involving in this phase the partners of city agencies.

The social and environmental effects of congestion affecting our traffic networks are well known . Yet, suitable solutions to meet rising demand are not easy to identify so that to be realistic in cost and time required. Indeed, in many cases the transportation system has already a residual capacity which cannot be utilized by the users, mainly for the lack of right information in the proper place and in the right time. This holds both for private traffic, when the new demand remains concentrated on the same road rather than being re-routed on alternative paths, and for public or multi-modal transportation where the information for travellers can regard also the availability of other infrastructure (e.g. exchange parking services).

Currently, in a number of our cities telecommunication infrastructure both for monitoring and for transmitting and visualizing information to travellers. As a matter of fact, their impact on the existing management traffic system is very limited, as the decision models adequate to the new dynamics of the demand, to the new kind of transportation services (car pooling, car sharing, and the like) and to the full utilization of data provided by the new technologies.

Among the research topics: reliable network design models, to get road networks capable of well absorbing both capacity reduction and significant increases of demand; identification of re-routing strategies; new models for representing the network condition which override the problems of different data format and sampling rates, of non complete covering of the networks so to support the definition of performance indices, measure of congestion, and traffic scenarios classification; models and algorithms for locating infrastructure both for flow monitoring and for travellers information taking into account network structure and flows volumes; models and algorithms for coordination and optimisation transportation services, (multimodal transportation, innovative services, public and emergency services).

Keywords: Intelligent Transportation Systems, Traffic Flow Optimization, Telecommunication Systems.

Evaluation of intermodal nodes in urban networks

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In this work multimodal shortest path problems in urban transportation networks are addressed. The main aim is to evaluate the effectiveness of multimodal nodes in urban areas in order to improve accessibility and environmental quality of urban centres. The first part of this work is devoted to understand the multimodality phenomenon in urban areas. Then, we focus on the problem of determining the attractive capacity of each nodes of the network, with the aim of defining strategic nodes (i.e. nodes where locate informative panels), and choosing "optimal" nodes that can become attractive poles and can be considered as places for modal exchanges (e.g. parking, bus stop). In particular, we propose an algorithm which is based on gravitational models, more generally used in the competitive location problems, and analyse their behaviour when varying the most important parameters, such as attractivity and distance. We report on some data related to the city of Genoa, collecting and giving a mathematical representation of the drivers' perceptions and preferences. In particular, we look at the different components of the generalized transportation costs, such as transfer time, monetary cost and discomfort during the travel. An algorithm that relies on the use of a preference function in the form of a linear utility function and gives the shortest multimodal origin-destination path, that is that minimizes the expected users' disutility, is presented. We propose a global network model of the urban area under consideration for evaluating, by analysing different scenarios, the effect of some modifications of the mobility and transport offers in the viability, taking into account the trade-off between costs for the users and advantages for the society.

References:

[1] E. Miller-Hooks, H. Mahmassani: Path comparisons for a priori and time-adaptive decisions in stochastic time-varying networks, European Journal of Operational Research, 146, 1, 67-82, 2003.
[2] P. Modesti, A. Sciomachen: A utility measure for finding multiobjective shortest paths in urban multimodal transportation networks, European Journal of Operational Research, 111/3, 1998.
[3] J. Mote, I. Murthy, D.L. Olson: A parametric approach to solving bicriterion shortest path in urban multimodal transportation networks, European Journal of Operational Research, 53, 81-92, 1991.
[4] S. Pallottino, A. Sciomachen: Trasporto urbano e parcheggio, in Scienze delle decisioni per i trasporti, S. Pallottino, A. Sciomachen (eds.), Franco Angeli, 1999.

A multi-source shortest path algorithm

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In many transportation problems, it is necessary to compute many times shortest paths among particular nodes (denoted in general as *centroids*) in a directed and weighted graph $G = (N, A, c)$, where $n = |N|$ is the number of nodes, $m = |A|$ is the number of arcs, and c_{ij} denotes the *cost* of arc $(i,j) \in A$. By R we denote the set of centroids, of cardinality $k = |R|$. The k to k shortest path problem, which we call for short as "k^2sp" problem, can be solved by solving k "shortest path tree" problems, one for each centroid either as origin or as destination of the paths [1]. An alternative approach to solve k^2sp problem, especially when $k = O(n)$, is to solve the "all pairs shortest path" problem, which requires to handle an n-order matrix of distances [2]. This memory requirement, in general, prevents to use such kind of approach since the current size of transportation networks reaches thousands of

nodes and arcs (for some problems the size of the network can reach million of nodes). Another approach proposed in literature is based on the reoptimization approach, where one can exploit the optimal tree found for the *i*-th centroid to compute the shortest path tree of the *i*+1-th centroid [3, 4, 5]. In this paper we want to show how it is convenient to simultaneously compute *k* shortest path trees (or a portion of them in case of lack of memory), by proposing a general approach, which we call *multisource*, that combines simplicity of the algorithm with its efficiency. The first experimental results obtained show how promising the *multisource* approach is, and suggest to deeply investigate the *multisource* shortest path algorithms efficiency to provide a powerful tool for transportation models and software. In fact, in principle, it is possible to generalize any existent shortest path tree algorithm to a similar *multisource* algorithm.

Keywords: Shortest path, Transportation Problem, Reoptimization.
References:
[1] R. K. Ahuja, T.L. Magnanti, and J.B. Orlin, Network Flows: Theory, Algorithms and Applications, Prentice-Hall Englewood Cliffs, NJ, 1993.
[2] R. W. Floyd, Algorithm 97: Shortest path, Communications of the A.C.M. 5 (1962) 345.
[3] M. Florian, S. Nguyen and S. Pallottino, A dual simplex algorithm for finding all shortest path, Networks 11 (1981) 367-378.
[4] G. Gallo and S. Pallottino, A new algorithm to find the shortest paths between all pairs of nodes, Discrete Applied Mathematics 4 (1982). 23-35.
[5] S. Nguyen, S. Pallottino and M. G. Scutellà, A new dual algorithm for shortest path reoptimization, in (M. Gendreau and P. Marcotte, eds.), Transportation and Network Analysis: Current Trends, Kluwer (2002) 221-235.

Optimal location of VMSs for urban traffic management

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Urban traffic management (UTM) has changed greatly in the last 20 years. A large contribution to this change has been made by the development of telematics, which has led to the installation of traffic monitoring systems (sensors, cameras), capable of detecting in real time the flows on relevant road links, and information systems (variable message signal, VMS) capable of informing users about the network state in terms of congestion level, opening/closure of roads and convenient paths. The development of these technologies has changed UTM from a classical static approach to an innovative dynamic one, based on ATIS (Advanced Traveller Information System) and ATMS (Advanced Traffic Management System). In this context, models and methods for optimal location of traffic sensors (or cameras) and VMS could play a relevant role. Effective location of traffic sensors allows a good estimate of o/d matrix from the counted flows. Effective location of VMSs allows traffic flows on available paths to be re-routed or, better, to induce users to park and ride, thus reducing network traffic congestion. In the last case the need arises to determine the optimal location of "flow intercepting facilities". The objective can be to locate *m* VMSs on the network so as to maximise, for example, the intercepted flow. Another objective could be to minimise the number of facilities needed to intercept an assigned percent of total flow. The problem can be viewed in a static way to locate fixed VMSs and in a dynamic way to locate mobile VMS units. In the second case a multistage approach can be adopted to evaluate the re-location cost of the mobile units expressed in terms of travel cost. The presentation describes the state of the art of these location models and methods, together with some preliminary results obtained on test networks.

Keywords: Intelligent transportation systems, VMS, network location.
References:
[1] Berman O., Larson R.C., Fouska N.. Optimal location of discretionary service facilities. Transportation Science, 26, 201-211. 1992.
[2] Berman O., Krass D., Xu C.V.. Locating discretionary service facilities based on probabilistic customer flows. Transportation Science, 29, 276-290. 1995.
[3] Berman O., Krass D.. Locating discretionary service facilities based on probabilistic customer flows. Location Science, 6, 41-65. 1998.
[4] Bianco L., Confessore G., Reverberi P.. A network based model for traffic sensor location with implications on o/d matrix estimates. Transportation Science, 35, 50-60. 2001.
[5] Yang H., Zhou J.. Optimal traffic counting locations for origin-destination matrix estimation. Transportation Research, 32, 109-126. 1998.

MATHEMATICAL METHODS FOR LEARNING II

Chairperson: C. Vercellis

Model localization in classification and data mining

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Classification and Learning problems play a relevant role in Data Mining and Knowledge Discovery. Models, techniques, and algorithms have been developed and successfully employed to solve the classic learning problem of providing a synthetical and meaningful separation between the positive and the negative examples that compose the training set. Such separations may then be employed to represent the underlying knowledge or to forecast the class of new examples. Often the available data cannot be separated with the desired precision and simplicity, resulting on the one hand in misclassification error on training data, or, on the other hand, in excessively complex separating schemes. In this work we consider an extension of the classic learning scheme**,** the Model Localization Problem (MLP). Given a 2-class training set, our aim is to simultaneuously determine two interconnected classification rules, a *filtering* rule and a *classification* rule. The filtering rule has the role of partitioning the training data into two subsets, one where the classification rule performs very well and one where the classification rule cannot be considered as a good explanatory and/or predictive model. Given the form of the filtering and classification functions, the objective is then to maximize both the size of the separable subset and the performances of the classification function on such subset. This classification scheme may result appropriate in many realistic settings, and, in particular, when one restricts the filtering function to be defined on a particular subset of the variables, for instance the standard segmentation variables in marketing or social data. This approach would then be able to identify stronger local models as opposed to weaker global ones. In this presentation we discuss several aspects of this problem according to different types of filtering and classification functions, and present Integer Programming formulations for particular cases where the data may be represented by means of logic variables and both the filtering and the classification functions are conjunctive clauses in propositional logic. Some preliminary computational results are given; extensions and future work are discussed.

Keywords: Data Mining, Classification, Integer Programming.

A supervised clustering technique based on clique partitioning problem

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Clustering is the process which groups objects with common properties into a number of disjoint and homogeneous subsets (*clusters*) according on some similarity measurement defined on pairs of patterns. Cluster Analysis is useful for discovering and understanding hidden structural information in large amount of data and represents a very challenging problem in Machine Learning. In this paper we address the supervised learning problem on sets of data represented by both continuous and discrete features. The contribution has two purposes. The major one is a novel approach to the *distance metric learning* problem. Our approach exploits a *training set* of pre-classified patterns to learn a similarity measure represented by a distance defined on the labelled patterns. The distance function is determined by solving a linear program, which minimizes the distances between *dissimilar* patterns while keeping "sufficiently apart" the *similar* ones. The second purpose of this paper is that of exploiting the learned distance to solve the *supervised learning* problem using a graph theoretic approach to clustering. To this end, we represent the set of patterns as a complete graph, set arc weights equal to the learned distance and solve the Clique Partitioning Problem (CPP) by a Branch-and-Cut algorithm which exploits recent advances in the knowledge of the CPP Polytope and effective heuristics. Results on some data sets of practical size and related predictive accuracies are compared with other Machine Learning approaches.

Keywords: Data Clustering, Supervised Learning, Metric Learning.

An iterative kernel clustering algorithm for pattern recognition

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In the past few years there has been a flurry of activity in trying to apply kernel methods to clustering and classification algorithms (see for instance [1][2]). The basic idea behind kernel methods relies in the possibility to increase the separability of classes of objects by increasing the dimension of the vector-space (feature space) describing the dataset, which could also be infinite dimensional [3]. Computational issues involved into an infinite dimensional space are overcome by using only objective functions depending on the inner product of the feature vector. The aim of this paper is to present a kernel extension of an iterative k-mean-like algorithm which has already been successfully used in various occasions for supervised classification problems [4]. The experimental results obtained with the new algorithm are usually better then the previous one. As a byproduct of the new version of the algorithm, the increased degree of separability ends up into a more computationally efficient classification techinique allowing the algorithm to converge in fewer iterations.

Keywords: kernel methods, classification, clustering.
References:
[1] R. Zhang and A. I. Rudnicky A Large Scale Clustering Scheme for Kernel K-Means. In ICPR02, pages IV: 289-292, 2002.
[2] Kai Yu, Liang Ji and Xuegong Zhang Kernel Nearest-Neighbor Algorithm Neural Processing Letters 15: 147-156, 2002
[3] V.N. Vapnik. The nature of statistical learning theory. Springer Verlag, New York, 1995

[4] L.Nieddu e G.Patrizi. Formal methods in pattern recognition: A review. Europea Journal of Operational Research 120(2000) 459-495.

Image mining for car tracking

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The problem of locating and tracking the space-temporal evolution of objects in a given scene is considered to be a difficult task within the research area of Computer Vision [01]. In particular, given a sequence of video images provided by mean of a camera it is required to locate and subsequently track the movements of objects animating a scene. In this contribution the authors are concerned with the case when travelling vehicles have to be located and tracked in urban areas eventually characterized by intersections regulated by means of traffic lights. The proposed approach, to location and tracking of vehicles, relies upon image mining in the sense that non-parametric models are trained, using simulated data, to accomplish the required tasks of location and tracking. The computational device allowing for location and tracking belong to the Data Mining tool known as Artificial Neural Network with specific reference to Radial Basis Function Network (RBFN) [02]. The contribution will introduce the conceptual description of the location and tracking problems and will show how it is possible to train a RBFN capable to efficiently locate and track vehicles in a real-time environment. The results of a set of numerical experiments will be presented and commented. The empirical evidence witnesses the effective capability of the proposed image mining approach to locate and track vehicles even in the case when complex scenes are considered.

References:

[1] Duda R.O. And Hart P.E., Pattern classification and scene analysis, John Wiley & Sons, 1973.
[2] Hertz, J., Krogh, A. and Palmer R.G. Introduction to the Theory of Neural Computation. Addison Wesley, Reedwood City, CA, 1991.

LOGISTICS III

Chairperson: P. Dell'Olmo

Stochastic and dynamic methods for managing uncertainties of e-commerce logistics

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In the area of e-commerce a new typology of distribution problem arises: optimizing freight flows in a more flexible environment with the possibility to use telematic auctions, opened as soon as transport need rises up, giving transport management to the best offer. In this scenario, a transportation agency has to decide, in real time, whether it can be profitable or not to make a challenging proposal for the auction. That is, given a pair (p,d) of pick up and delivery points for a new transport, knowing the a priori duties, the actual position of its fleet and the residual capacity of the vehicles, dispatching agencies should be able to

evaluate very quickly the minimum additional cost to be sustained in order to satisfy the new demand. We focus our work on the analysis of this above mentioned problem, taking into account the chance for an agency to choose an anticipatory approach, based on demand forecasting and stochastic routing policies. A two-phases iterative decision process for the planning and management of the fleet vehicles is described. A two-phase policy to support the decision maker (dispatching agency) to define an offer for the e-auction is shown and embedded into the whole process. Experimental results comparing different scenarios are presented.

Keywords: Distribution Problem, Pick up and delivery, Decision Process, Logistics, Auctions.

Equilibria in competitive assignment

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A new assignment problem is introduced where two users (referred to as players A and B in the sequel) compete for a set of resources on which each user assign its own set of jobs. Such model could have several applications such as (i) two competing firms assigning their jobs to processors (or servers or machines) available to them, some of which are shared; (ii) assigning a pool of secretaries to two functional groups within an organization and (iii) assigning gates to competing airline companies. Formally, player *A* has a set of n_A jobs $J_A = \{a_1, a_2, ..., a_{n_A}\}$ each to be assigned to one processor in the set $M = \{m_1, m_2, ...m_n\}$ where the cost of assigning job a_i to machine m_j is c_{ij}^A. Likewise, player *B* has a set of n_B jobs $J_B = \{b_1, b_2, ..., b_{n_B}\}$ to be assigned to processors in the same set *M* and the cost of assigning job b_i to machine m_j is n this case c_{ij}^B. Each player wishes to minimize its total cost. If there was a hierarchical structure among players, then the problem is simply of assigning jobs J_A to *M* using the classical bipartite assignment model, and subsequently optimally assigning jobs J_B to the remaining processors. However, when players compete, then either an algorithm must be developed that provides useful non-dominated solutions or some transfer mechanism must be implemented. This work focuses on the issues and problems related to the first approach. We show that the problem of finding all non-dominated solutions is NP-Hard, and also the problem of finding the optimal solution for one player, conditioning the cost of the other player to be less than a given threshold, is NP-Hard. Suppose that the optimal cost for player *A* (without considering *B*) is c_A^* and for *B* the corresponding cost is c_B^*; while, the conditional optimal cost for a player, given the optimal solution for the other, is $c_{A|B}^\circ$ for player *A* and $c_{B|A}^\circ$ for player *B*. The paper considers the following *equilibrium problem*: ***min. ratio*** $r = r_A = r_B$, where $r_A = \frac{c_A(x) - c_A^*}{c_{A|B}^\circ - c_A^*}$, $r_B = \frac{c_B(x) - c_B^*}{c_{B|A}^\circ - c_B^*}$ and x_{ij} are the (0,1) assignment variables. In general there is no feasible solution for this.

However, by relaxing the assignment variables to $0 \le x_{ij} \le 1$ we obtain a lower bound to the equilibrium problem. By rounding the relaxed solution, we get a (0,1) feasible solution that provides an upper bound. The paper addresses the problem of using these bounds to find the optimal solution to a *min-max version of the equilibrium problem*; to which the Lagrangean relaxation approach is also studied. Some computational results are presented.

Metropolitan hazardous materials transportation corridors

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This is a methodological approach to determine the main corridors for the transport of dangerous materials in a metropolitan area densely populated. The considered area in our study is the Metropolitan Zone of Mexico City (MZMC). In literature it is possible to find many studies for determine safety paths for the transport of dangerous materials in areas few urbanized and/or among two or more cities avoiding crossing the center. In our case we are obliged to cross both the down town and areas densely populated. For the detection of a set of paths 'enough' safety we propose a three levels procedure. The first level consists in a reduction of the graph with the purpose to determine the only paths physically usable, in the second and in the third phases, through two models of ILP we want, at the first, to minimize the exposed population and therefore to distribute in equitable way the risk.

Keywords: Hazardous material; corridors; urban network

Mathematical models for empty freight car distribution

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In this talk, we consider the problem of distributing empty freight cars in a railway company. We describe and analyse the current planning process, identify the shortcomings of the process, and stress the importance of a reliable distribution process for satisfying customer demand and reduce capital costs. In particular, we identify two level of decisions: a strategic level where a schedule of empty train has to be defined according to the demand, and a tactical one in order to handle real-time decisions. Mathematical models which satisfy the appropriate criteria of robustness, to handle uncertainty and variability of data, are presented for both the decision levels. Computational tests on real data are also provided.

Temporal-dissimilar paths for hazardous materials transportation

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We consider the problem of transporting hazardous materials from one or a set of origin and destination sites on a given transportation network. What differentiates the problem of shipping dangerous goods from common transportation problems is the risk associated to the materials shipped [4]. Some papers in the literature try to find safe routes minimizing a given risk function [2]. Other papers deal with finding spatially dissimilar paths referring to the fundamental argument that the concentration of an hazardous activity on one route, violates the principle of equity in the spatial distribution of risk [1,3]. All these papers suppose that, given an O/D pair, all the paths of the network can be used for routing an hazardous material. Unfortunately, the topology of real transportation networks does not allow to use all the paths from an origin to a destination but only a given limited subset of paths. The problem now is how to sequence the fleet of vehicles along these paths and, in particular, along their shared arcs. Thus, the problem we consider in this paper can be stated as follows: Given a set of paths P between one or a set of O/D places, for all $p \in P$ find starting times and an assignment of flows such that i) the schedule will be feasible ii) the total assignment cost will be minimum and satisfies a given equilibrium condition. We consider a schedule feasible if, for each path, the transportation time is within a maximum allowed time. If the cost of each path depends on the flow assigned to it, we refer to the second Wardrop equilibrium principle which requires that the sum of all the path costs will be as low as possible. We provide both a mathematical programming formulation of the above problem, and some experimental results.

Keywords: Transportation; Scheduling; Hazardous materials;
References:
[1] Akgün V., Erkut E., Batta R. On finding dissimilar paths. European Journal of Operational Research 2000;121: 232-246.
[2] Cox R.G. Routing and scheduling of hazardous materials shipments: Algorithmic approaches to managing Spent Nuclear fuel transportation. Ph.D. dissertation, Cornell University, Ithaca, NY, 1984.
[3] Dell'Olmo P., Gentili M., Scozzari A. Finding Dissimilar Pareto-Optimal Paths, to appear European Journal of Operational research.
[4] List G.F., Mirchandani P.B., Turnquist M.A., Zografos K.G. Modeling and analysis for hazardous materials transportation: Risk analysis, Routing/Scheduling and Facility Location. Transportation Science 1991;2: 100-114.

SCHEDULING I

Chairperson: F. Rossi

An asymptotically exact solution to an assortment problem

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We address an assortment problem arising in an industrial plant producing glass for the automotive industry. One process step is to cut glass items from larger parts (stocks), also produced in the plant. Two objectives are considered: limiting the amount of the different stock sizes produced, and minimizing the trim loss. We solve this problem, which is trivially NP-hard, by a particular p-median model and show that the solution obtained in this way approximates the optimum by a factor which asymptotically goes to zero as the production volumes increase. Although we can show that the p-median problem introduced is as well NP-hard, tests carried out on a significant sample of real instances show that the method is very efficient and effective.

IRUP and MIRUP in the bin packing with a fixed number of item types

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An integer programming problem has the Integer Round-Up Property (IRUP) if its optimal value is obtained by rounding up the optimal value of its linear relaxation [1]. An integer programming problem has the Modified Integer Round-Up Property (MIRUP) if its optimal value is not greater than the value obtained rounding up the optimal value of its linear relaxation plus one. IRUP and MIRUP have been mainly studied in connection with the one-dimensional Cutting Stock (1CS) problem (see, e.g., [3] and [4]). Here we consider a special case of the Bin Packing problem, where the weights of the items that have to be packed can take only a fixed number K of different values. We denote BPK such a problem. Note that BPK is equivalent to a 1CS problem where the number of different item types is fixed. In the natural integer programming formulation of BPK the number of required variables is equal to the number of possible bin patterns, and thus it is not polynomial in K. In fact, it is not even known if BP3 is in NP. Note that an instance of BPK is described by only 2K+1 integers. Recently we showed that, despite the compactness of the input, an approximate solution of BPK with Absolute Error Bound (AEB) equal to K-2 can be found in polynomial time [2]. In this talk, revising some results by Scheitauer and Terno on IRUP and MIRUP for 1CS problems [4], we show that a slight modification of the algorithm proposed in [2] achieves a better error bound, described as follows: AEB = 0 if K=2; AEB = 1 if 2 < K <=5; and AEB = K-4 if k > 5. Furthermore, we investigate how the same algorithm is related to standard approaches to 1CS.

Keywords: Bin packing, Cutting stock, High multiplicity.
References:
[1] S. Baum and L. E. Trotter Jr., Integer rounding for polymatroid and branching optimization problems, SIAM Journal on Algorithmic Discrete Methods, 4 (1981) 416-425.
[2] C. Filippi and A. Agnetis, An asymptotically exact algorithm for the high multiplicity bin packing problem, Technical Report N. 4/03, Department of Information Engineering, University of Siena, Italy, June 2003. (Submitted)
[3] O. Marcotte, The cutting stock problem and integer rounding, Mathematical Programming, 33 (1985) 82-92.
[4] G. Scheithauer and J. Terno, Theoretical investigations on the modified integer round-up property for the one-dimensional cutting stock problem, Operations Research Letters, 20 (1997) 93-100.

Packet scheduling in UMTS

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In Universal Mobile Telecommunication Systems (UMTS), multiple radio access of different users and services is realized by the adoption of Code Division Multiple Access (CDMA) protocol and, in most cases, by Time Division Duplexing (TDD). In this context, one of the most interesting and critical problems is the scheduling of information packets from a base station to the clients. The scheduling problem requires to seek a solution that maximizes the radio interface throughput in each radio frame, while respecting given

Quality of Service constraints. Several approaches have been proposed for this problem, but because of tight computation time requirements, only in very particular cases they produce exact solutions (for example, when only few different service type are considered). In this work, we address the general packet scheduling problem in TDD-UMTS, for any number of different service types, by formulating the problem as a multiple resource Constrained Shortest Path (CSP) problem on a suitable graph. The algorithm we propose is based on a hull approach for CSP, and we show computational results that prove its effectiveness in real applications.

An exact algorithm for a two-agent scheduling problem with different objective functions

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We address a scheduling problem in which two agents have to negotiate the use of a common machine. Each agent owns a set of jobs and has a cost function which depends on its jobs only. Agent 1 is concerned with respecting the due dates of its own jobs, Agent 2 with minimizing total flow time of its own jobs. In order to generate Pareto-optimal schedules, we consider the problem in which Agent 2 optimizes its objective function, with a constraint on the maximum lateness of Agent 1's jobs. The problem is NP-hard, even if Agent 1 has only one job. We present an implicit enumeration algorithm based on Lagrangean approach which exploits the very special structure of the optimal solutions of the Lagrangean dual. Computational results are presented, showing the effectiveness of the approach on medium-size instances.

NETWORK OPTIMIZATION II

Chairperson: F. Guerriero

The determination of the hyper-network and of the hyper-paths in a direct hypergraph

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Recent developments in ICT allow organizing cooperation forms among economic actors geographically scattered so that, through the composition of varied competences and experiences new market opportunities can be gathered. This tendency has come out in various economic fields originating clusters, or virtual enterprises, in fields such as Supply Chain Management [1], the design of innovative products [2], the performance/management of Open-Source Software projects [3]. The necessity of having logical/formal structures, to represent the competitive inter-cluster and intra-cluster cooperative relations, brought to propose ([2]): A directed hyper graph [4], as a structure to model relations among economic actors and entities involved in a process of forming of virtual enterprises; The hyper-network, as a minimal substructure of the hypergraph able to represent all and only the relations and economic entities strictly necessary for the forming of the virtual clusters; A hyper-path, as an underlying structure a cluster of enterprises potentially able to catch the market opportunities. In this work, starting from the above mentioned logical structures, we will introduce theoretic results and algorithms for the spotting of the hyper-network inside a given hyper-graph. In addition, we propose a

technique which, starting from the hyper-network, allows the determination of all the hyper-paths present. The aim is to provide a contribution for a technological architecture of a virtual organization able to support the coming out of clusters of enterprises "business opportunity driven".

Keywords: Hyper-network, Hyper-paths, cluster of enterprises.
References:
[1] Lamming R. C. , Squaring lean supply with supply chain management, Int. Journal of Operations & Production Management, vol .16, n. 2, pp 183-196, 1996.
[2] Volpentesta A., Muzzupappa M., Generation and selection of a conceptual design chain in Network Environment, Atti della XIV riunione scientifica AIIG, pp. 207-213, Bergamo, 2003.
[3] Nakakoji K., Yamamoto Y., Nishinaka Y., KishidaK., Ye Y., Evolution Patterns of Open-Source Software Systems and Communities, International Workshop on Principles of Software Evolution 2002 (IWPSE2002), Orlando, FL, May 19-20, 2002.
[4] Gallo G., Longo G., Nguyen S., Pallottino S., Directed Hypergraphs and Applications, Discrete Applied Mathematics, vol. 42, 1993.

Quickest path algorithms and an application to Internet packet routing

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The quickest path problem is related to the classical shortest path problem, but its objective function concerns the transmission time of a given amount of data through a path, which involves both, cost and capacity. We review the quickest path problem and its generalization to find K-quickest simple paths, and we present the application of a recent K-quickest simple paths algorithm to data packets routing in Internet networks. We describe a test environment for this later K-quickest simple paths algorithm when applied to Internet packet routing, based on the use of a truncated Pareto distribution to simulate the IP packets sizes and on two randomly generated undirected network topologies. Finally computational results are reported and discussed.

Keywords: Quickest path, simple paths ranking, telecommunication networks.

References:
[1] Y. L. Chen and Y. H. Chin. The quickest path problem. Computers & Operations Research, 17(2):153-161, 1990.
[2] J. C. N. Clímaco, J. M. F. Craveirinha, M. M. B. Pascoal and M. E. V. Captivo. Internet packet routing: application of a K-quickest path algorithm. In Proc. of the III International Conference on Decision Support for Telecommunications and Information Society 2003, Warsaw, Poland, pages 29-36, September 2003
[3] R. Girão-Silva and J. M. F. Craveirinha. Study on simulation models for self-similar traffic. In Proc. of the 6-th IEEE International Conference High-Speed Networks and Multimedia Communications, 2003, pages 571-580. Springer-Verlag, 2003.
[4] M. M. B. Pascoal, M. E. V. Captivo, and J. C. N. Clímaco. An algorithm for ranking quickest simple paths. To appear in Computers & Operations Research.

New results about the parametric maximum flow problem and some related reoptimization issues

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In this work, we will extend the results about the parametric maximum flow problem to networks in which the parametrization of the arc capacities involves both the source and the sink, as in (Gallo et al., 1989), and also an additional node. We will show that the minimum cuts of the investigated networks satisfy a relaxed form of the generalized nesting property (Arai et al., 1993). A consequence is that the corresponding parametric maximum flow value function has at most n-1 breakpoints. All the minimum cut capacities can therefore be computed by O(1) maximum flow computations. We will show then that, given O(n) increasing values of the parameter, it is possible to compute the corresponding maximum flows by O(1) maximum flow computations, by suitably extending Goldberg and Tarjan's maximum flow algorithm. The proposed parametric algorithm can be useful within a reoptimization context, when some arc capacities are modified for some arcs incident the source, the sink, and a certain critical node, and the maximum flow has to be computed for O(n) changes of the arc capacities. Provided that the arc capacities vary along the scheme addressed in this work, the parametric maximum flow algorithm allows in fact to solve this kind of maximum flow reoptimization in O(nmlogn) time.

Keywords: maximum flow, parametric arc capacity, reoptimization
References :
[1] Ahuja, R.K., T.L. Magnanti and J.B. Orlin. (1993). Network Flows: Theory, Algorithms and Applications. Prentice Hall, Englewood Cliffs, NJ.
[2] Arai, T., S. Ueno and Y. Kajitani. (1993). ``Generalization of a theorem on the parametric maximum flow problem." Discrete Applied Mathematics 41, 69-74.
[3]Gallo, G., M.D. Grigoriadis and R.E. Tarjan. (1989). ``A fast parametric maximum flow algorithm and applications." SIAM J. Comp. 18 (1), 30-55.
[4]Goldberg, A.V. and R.E. Tarjan. (1988). ``A new approach to the maximum flow problem." JACM 35 (4), 921-940.

Shortest paths reoptimization: an auction algorithm

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Shortest paths reoptimization problems are sequences of shortest path problems. Each problem differs slightly from the previous one and can be solved by applying an algorithm that efficiently uses information resulting from previous computation. For example, in case of increasing of arc costs, the optimal solution of the previous problem is dual feasible, but can be primal infeasible. In this talk, shortest path reoptimization methods for arc cost increases and origin changes are reviewed, and the collection of dual ascent approaches is enlarged by including an auction algorithm. Preliminary computational results obtained by comparing different implementations will be presented.

Keywords: Shortest Paths Reoptimization.
References:
[1] Bertsekas D.P., An Auction Algorithm for Shortest Paths, SIAM Journal on Optimization, 1, 425--447, 1991.

[2] Cerulli R., P. Festa, and G. Raiconi, Graph collapsing in shortest path Auction algorithms, Computational Optimization and Applications, 18, 199--220, 2001.
[3] Cerulli R., P. Festa, and G. Raiconi, Shortest path Auction algorithm without contractions using virtual source concept, Computational Optimization and Applications, 26, 191--208, 2003.
[4] Nguyen S., S. Pallottino, and M.G. Scutellà, A new dual algorithm for shortest path reoptimization, in (M. Gendreau and P. Marcotte, eds.), Transportation and Network Analysis: Current Trends, 221--235, 2002.
[5] Pallottino S. and M.G. Scutellà,A new algorithm for reoptimizing shortest paths when the arc costs change, Operations Research Letters, 31, 149--160, 2003.

TRANSPORTATION II (PRIN PROJECT)

Chairperson: P. Mirchandani

Constructive heuristics for the dial-a-ride problem

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Dail-A-Ride (DAR) is a system of innovative public transportation demand-driven in which the vehicles are not constrained to an a-priori route and schedule. On the contrary, scheduling and routing of vehicles are based on the individual request of the final user. In this talk we present constructive heuristics for DAR with applications to real-world problems.

Key words: Dial-a-Ride, heuristic algorithms.

Solving the on-line dial-a-ride problem

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The Dial-a-Ride (*DaR*) system concerns the management of a fleet of vehicles in order to satisfy transport demands. The customers demand the service in calling a central unit and in specifying: the desired pick-up point, the delivery point (respectively, *origin* and *destination*), the number of passengers and some limitation on the service time (e. g., the earliest departure time). The *DaR* is suited to service sparsely populated areas, or densely populated areas during weak demand periods or special classes of passengers with specific requirements (elderly, disabled). Several models of the *DaR* service have been proposed in the literature: with or without time windows, with a fixed or unlimited fleet of vehicles, and so on. In the "static" *DaR*, the customers ask for service in advance and the plan is made before the system starts; in the "dynamic" *DaR*, the customers can call during the service time (see [1]) and the solution is updated on-line. Different objective functions have been taken into account. For a recent overview on the DaR Problem see [2]. This paper addresses the dynamic *DaR* problem with time windows and a fleet of fixed size. Each request corresponds to a single passenger, and the objective function maximizes firstly the number of customers served, then it maximizes the level of service provided on average to the customers. In this paper a very fast and effective heuristic to solve the on-line DaR is described. The on-line version is characterized by the time dependent travel time and by the dynamic arrival of the requests. Moreover, in the considered real-life case study, the

requests have to be accepted or rejected in real time without any additional phone call. Thus, the heuristic is based on the idea of inserting each request with a simple and straightforward insertion procedure. Then, during the interval between two successive requests, the solution is optimized in order to create the greatest space for future customers. The improvement phase is based on a granular tabu search. One of the interesting feature of the proposed algorithm is the method to obtain the sparse (granular) graph.

References:
[1] M. W. P. Savelsbergh and M. Sol. The general pickup and delivery problem. 29(1):17–29, 1995.
[2] J.-F. Cordeau and G. Laporte. The dial-a-ride problem (darp): Variants, modeling issues and algorithms. 4OR-Quaterly Journal of theBelgian, French and Italian Operations Research Societies, 1:89–101, 2003.

Models Integration in Rome Intelligence Transportation System

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In the last five years the Mobility Agency of city of Rome addressed problems regarding data monitoring, fusion and analysis of traffic flows from several origin/destination points. The system was shown to be already effective for the planning of mobility policies of flow management. In this talk we present how the Intelligence Transportation System of Rome can provide data, and, successively, be integrated with analytical models to support planning and management.

Keywords: Transportation, ITS, Models Integration

Models and methods for the evacuation problem

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The evacuation problem can be defined as the removal of residents from a given area that has been considered as a danger zone to safety as quickly as possible and with reliability. This problem may arise in different types of systems (e.g. buildings, cities or regions) or transportation carriers (e.g. train, ship and airplane). Starting from a set of basic information (e.g. system layout, residents distribution and characteristics, type and location of hazard, behaviour model under panic situation), the objective consists of determining the operations planning in order to minimize the evacuation time, that is the time needed to complete an evacuation. Different models which derive from network flow optimization can be used to describe evacuation (e.g quickest path, quickest flow). In this paper an analysis of models proposed in literature which can have practical applications in evacuation problems is illustrated and the characteristics of a new model which aims to provide a more realistic description of the problem is then shown.

Keywords: evacuation, network flow optimization.

COMBINATORIAL OPTIMIZATION I (SORSA PROJECT)

Chairperson: A. Lodi

New bounds and optimal solutions for VRP

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The Capacitated Vehicle Routing Problem is one of the most studied problems in Combinatorial Optimization. It consists in finding a given number of routes of minimum total distance covered by identical vehicles of fixed capacity. The route associated to each vehicle is a tour passing through a given depot. The vehicles must satisfy the demands of a given set of clients and the total demand of clients served by one vehicle cannot exceed its capacity. The VRP can be viewed as a generalization of the Traveling Salesman Problem. Moreover, it is somehow ``harder'' than the TSP: in fact, while it is now possible to solve TSP instances with several thousands nodes to optimality, there are VRP instances with one hundred nodes still not solved. From a polyhedral point of view, the main difference between TSP and VRP lies in the fact that, while for the Traveling Salesman Polytope many valid inequalities have been defined and studied in the literature, this is not the case for the Vehicle Routing Polytope, whose structure is strictly dependent on the input data: the capacity of the vehicles and the demands of the clients. For this reason, we decided to face the problem using, beside the Capacity Constraints for VRP, only cutting planes defined for very general Linear Integer Problems (as the Chvatal-Gomory inequalities). On the other side, we focused our attention on the enumeration strategies to find feasible solutions; we propose here a new approach to this problem based on the solution of a minimum cut problem in the support graph of the current fractional solution. This technique allows us to branch the original problem into two subproblems of smaller dimension. This new approach allows us to solve very difficult problems in the VRP library with reasonably small resources in terms of CPU time and memory.

A set-covering based heuristic approach for the vertex coloring problem

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In the Vertex Coloring Problem (VCP) one is required to assign a label to each vertex of a given undirected graph G=(V,E) in such a way that the labels on adjacent nodes are different and that the number of different labels in minimized. VCP is known to be NP-complete, and has several real-world applications, such as timetabling, register allocation, frequency assignment and scheduling. We present a two-phase approach to VCP based on the "set-covering" formulation in which variables are associated with feasible assignments of a color (i.e., each column corresponds to a stable set). In the first phase (column generation) we generate a large set of columns using (in an iterative way) fast greedy heuristics from the literature; by changing some input parameters of such algorithms, different solutions are produced. In the second phase (column optimization) an associated set-covering instance is solved by using a Lagrangian-based heuristic algorithm from the literature. In many cases, this phase is able to improve the best solution found by the greedy heuristics, showing that judiciously combining some efficient heuristics for this problem can lead to a more effective heuristic algorithm. Extensive computational results on the

DIMACS test instances are reported. In particular, the algorithm was able to solve to optimality a couple of geometrical graph which, to the best of our knownledge, were never solved before.

On traveling salesman compatible tours

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In this paper we are concerned with specific Symmetric Traveling Salesman Problem (STSP) tours which are strongly related to points of SEP(n), i.e., the so-called Subtour Elimination Polytope. Definition 1: given a point in SEP(n), we say that a vertex set is "tight" at such a point if the subtour elimination constraint associated with such a set has exactly value 2 for this point. Definition2: given a point of SEP(n), we say that a tour of STSP is "compatible" with respect to such a point if every vertex set which is tight at the point (as in Definition 1) is also tight for the tour. (Recall that every tour is also a feasible point of SEP(n).) Specifically, we are interested in tours compatible with vertices of SEP(n), and both theoretical and computational issues on such compatible tours will be discussed.

A multi-agent model for distribution problems in logistics systems

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Global competitiveness, in conjunction with advances in communications and transportation technologies, imposes cost reduction in logistics systems and, in particular, in the distribution phase. It is usual to represent distribution problems as vehicle routing problems, widely studied in literature. In this paper, we study a capacitated vehicle routing problem with time windows as a multi-decision makers problem and represent it by a multi-agent model. We consider the presence of three categories of decision makers (or actors) involved in the distribution process: logistics operators, truck operators and customers. In our scenario, we consider one logistics operator, a set of vehicles each one considers as a truck operator, and, a set of customers. For each decision maker we can define a (local) optimization problem. In particular, the Logistic operator ships goods to each customer using the minimum number of Truck Operators, assuring that each customer is served. Each Truck Operator selected from the Logistic operator has to minimize the cost of serving assigned customers. Each customer has to minimize its cost for receiving goods. Then, each decision maker has to find a feasible solution for its optimization problem by considering that, due to the information exchange between decision makers, the parameters of each local optimization problem could be changed. We describe the architecture of the multi-agent model, the local optimization problems solved by each agent, the parameters negotiation between agents, and the issues related to the convergence toward a feasible solution. Moreover, we analyze the proposed architecture on a real Italian scenario.

Keywords:Vehicle routing problem, multi-agent model, logisitics.
References:
[1] O. Bräysy and M. Gendreau, "Vehicle Routing Problem with Time Windows, Part I: Route Construction and Local Search Algorithms", Forthcoming in Transportation Science (2003a).
[2] O. Bräysy and M. Gendreau, "Vehicle Routing Problem with Time Windows, Part II: Metaheuristics", Forthcoming in Transportation Science (2003b).
[3] G. Laporte, M. Gendreau, J.Y. Potvin and F. Semet, "Classical and Modern heuristics for the vehicle routing problem", International Transactions In Operational Research 7, 285-300 (2000).
[4] Q. Hao, W. Shen, G. Stecca and L. Wang, "Towards an internet enabled cooperative manufacturing management framework", in Processes and Foundations for Virtual Organizations, L.M. Camarinha-Matos and H. Afsarmanesh (eds.), 191-200, Kluwer Academic publishers, 2003.

FINANCE

Chairperson: R. Mansini

Evolutionary variational inequalities applied to financial equilibrium problems in an environment of risk and uncertainty

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We study a financial economy consisting of m sectors and with n financial instruments in the period $T = [0, T]$. We denote by $s_i(t)$ the total financial volume held by sector i at the time t, which is considered to depend on the time $t \in [0,T]$. Since we are working in the presence of uncertainty and of risk perspectives, the volume s_i held by each sector cannot be considered stable and may decrease or increase depending on unfavourable or favourable economic conditions. As a consequence, the amounts of the assets and of the liabilities of the sectors will depend on time. For this reason, at time t, we denote the amount of instrument j held in sector i's portfolio as an asset by $x_{ij}(t)$ and as a liability by $y_{ij}(t)$. We denote the price of instrument j at the time t by $r_j(t)$. In our problem the prices of each instrument appear as variable. Under the assumption of perfect competition, each sector will behave as if it has no influence on the instrument prices or on the behavior of the other sectors. Also the variance-covariance matrices or, more generally, the utility function associated with risk perception are time-dependent. We state the equilibrium conditions for this evolutionary model and, assuming as functional setting the Lebesgue space $L^2([0,T], \boldsymbol{R}^p)$, we give an equivalent formulation in terms of evolutionary variational inequality. Then we explain how to solve the evolutionary variational inequalities associated to the financial equilibrium problem by means of the Projected Dynamical System **(**PDS**)** theory.

Keyword: evolutionary variational inequalities, projectd dynamical systems,
References:
[1] P. Daniele, "Variational Inequalities for Evolutionary Financial Equilibrium", Innovations in Financial and Economic Networks, A. Nagurney Ed. (2003), 84-108.
[2] A. Nagurney, "Finance and Variational Inequalities", Quantitative Finance, 1, (2001), 309-317.
[3] M.G. Cojocaru, P. Daniele and A. Nagurney, "Projected dynamical systems and evolutionary (time-dependent) variational inequalities via Hilbert spaces with applications", to appear.

Mixtures and constant rebalanced portfolios

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The authors propose a mathematical formulation and treatment of the portfolio sequential selection problem in the case when side-information is available [01]. In particular, the attention is focused to State-Constant Rebalanced Portfolios [02] and to efficiently approximate such investment schemes. The contribution concerns the theoretical comparison between the Constant Rebalanced Portfolio and State-Constant Rebalanced Portfolio and proposes a sequential investment algorithm approximating the State-Constant Rebalanced Portfolio. Bounds related to the rate of growth for the wealth in the case when Constant Rebalanced Portfolio, State-Constant Rebalanced Portfolio and an approximated State-Constant Rebalanced Portfolio algorithm are obtained. The contribution introduces the notation and main definitions concerning Constant Rebalanced Portfolio, State-Constant Rebalanced Portfolio and Side-Information. The mathematical analysis and comparison, of the wealth, for Constant Rebalanced Portfolio, State-Constant Rebalanced Portfolio and the proposed approximated State-Constant Rebalanced Portfolio algorithm are introduced and discussed. Finally, a set of numerical experiments concerning some of the main financial market datasets, namely the NYSE, DJIA, TSE and S&P500 as described in [03, 04]. The numerical results indicate that the proposed sequential investment scheme lead to an extra wealth that is exponential with respect to the number of trading periods and to the performance of the classification model used to process the side-information.

References:

[1] Thomas M. Cover and Erik Ordentlich. Universal portfolios with side information. IEEE Transactions on Information Theory 2(42) (March 1996).
[2] Allan Borodin, Ran El-Yaniv, and Vincent Gogan. On the competitive theory and practice of portfolio selection. In "Proceedings of the Latin American Theoretical Informatics (Latin)" (2000).
[3] Thomas M. Cover. "Elements of Infromation Theory, Chapter 15, Information Theory and the Stock Market". John Wiley, New York (1991).
[4] David P. Helmbold, Robert E. Schapire, Yoram Singer, and Manfred K. Warmuth. On-line portfolio selection using multiplicative updates. In "International Conference on Machine Learning", pages 243-251 (1996).

Evaluation of financial technical analysis by logic data mining

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The analysis of financial data is a very challenging subject for scientists and practioners alike, and it plays a relevant role in the design of the investment strategies of most financial operators. Two main approaches are normally adopted: the so-called Fundamental Analysis, that considers the general and specific economic conditions to establish whether a stock is overpriced or underpriced, and the Technical Analysis, which studies the trends of a security trying to understand, and then predict, the variations of its price. The possibility of systematically creating returns superior to the market average is in contradiction with the Efficient Market Hypothesis (EMH), stated by Fama already in 1970 ([1], [2]). Nevertheless, weaker forms of the EMH, combined with a sufficiently short term timing, may result in good investment strategies. We have investigated the validity of a large number of indicators and their variations, that are normally used in the framework of

Technical Analysis, amongst which are, for example, Moving Averages, and Relative Strengh Indeces. Such instruments have been used as input data for the Logic Data Miner Lsquare [3], a learning tool that operates in the logic domain and learns logic explanatory formulas by solving a sequence of minimum cost satisfiability problems. The main advantage of this tool is that it learns formulas that are easy and understandable by domain experts, and can then be validated not only by empirical evidence, but also by human experience. Based on Lsquare, we have tested different investing and timing strategies that, starting from a selected operational horizon, indicate to buy or sell a certain security. Such strategies have proven to give returns that are, in most cases, significantly above the market average, both in up-trend and down-trend time windows. Some computational experience will also be reported.

Keywords: Financial Data Mining, Technical Analysis, Logic Learning
References:
[1] E. Fama, Efficient Capital Markets: A Review of Theory and Empirical Work, Journal of Finance, XXV, N° 2 (March 1970) - pp 383-417III).
[2] E. Fama, J. MacBeth, Risk, Return and Equilibrium: Empirical Tests, Journal of Political Economy, 81 N° 3, (May/June 73) .
[3] G. Felici, K. Truemper, A Minsat Approach for Learning in Logic Domains, INFORMS Journal on Computing, volume 14, number 1, winter 2002, 20-36 .

Autoregression and artificial neural networks for financial market forecast

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In the last years the interest of the investor has grown in methods for efficient forecast of price trend [1,4] of a share in financial markets. The aim is to accurately forecast the future behaviour of the market and make accurate decisions. In this talk we analyze two different approaches for the forecast of financial quantities: Autoregression [2] and Artificial Neural Networks [3] combined with Support Vector Machines. We will estimate limits and potentials of these methods and an application to Italian Financial Market is presented.

Key words: Technical Analysis , Autoregression, Support Vector Machine, Neural Networks
References:
[1] F. Caparrelli Il Mercato Azionario: Operatività ed Analisi, Edizioni Nuova Cultura, 1992.
[2] G. M. Jenkings and G. E. P. Box. Time Series Analysis: Forecasting and Control,, Holden-Day, San Francisco, 1976.
[3] S. Haykin. Neural Networks, A Comprehensive Foundation (2nd edition) Prentice Hall International, 1998.
[4] W. H. Green. Econometric Analysis Prentill Hall, 2000.

SCHEDULING II

Chairperson: G. Ghiani

Optimal scheduling of a two-stage hybrid flow shop

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We present an exact branch-and-bound algorithm for the two-stage hybrid flow shop problem with multiple identical machines in each stage. The objective is to schedule a set

of jobs so as to minimize the makespan. This is the first exact procedure which has been specifically designed for this strongly NP}-hard problem. Among other features, our algorithm is based on the exact solution of identical parallel machine scheduling problems with heads and tails. We report the results of extensive computational experiments on instances, with up to 1000 jobs, which show that the proposed algorithm solves large-scale instances in moderate CPU time.

Two-machine flow shop with an operator

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In this paper we deal with a two-machine flow shop problem with an additional resource. More precisely, we consider that each operation requires an operator during the set-up time of the operation that is included in the processing time. Therefore the data associated to each operation i are (ai, bi, sai, sbi) where ai (respectively bi) denotes the processing time of job i on machine 1 (respectively on machine 2) and sai (respectively sbi) denotes the set-up time of the operation on machine 1 (respectively on machine 2) of job i on the additional resource. We assume that $0 \leq sai \leq ai$ and $0 \leq sbi \leq bi$. Note that both the machine and the operator are needed during the set-up. This problem is a special case of scheduling "multi-processor tasks" and a neighbour problem of flow shop scheduling with a server. The aim is to determine the sequence of operations on the operator resource so as to minimize the completion time of the last operation of the schedule. We firstly show the NP-hardness of the problem by a reduction of 3-PARTITION problem. Then, we show that permutation schedules are not dominant, it means that the optimal solution can be obtained with two different sequences of jobs on machine 1 and machine 2. In order to solve this problem we propose exact and approximated resolution methods. Exact algorithms are a MILP formulation that is solved by using CPLEX software and a branch-and-bound procedure. Heuristic algorithms are some simple greedy algorithms and a recovering beam search. Computational tests are conducted and discussed.

Keywords: flow-shop scheduling, recovering beam search.

Taboo algorithm for the jobshop problem with time lags : $JM|L_{I,SJ(I)}|C_{MAX}$

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N. Tchernev
CRSG - Université d'Auvergne, Clermont-Ferrand

The problem of interest is the makespan minimization for the jobshop problem with time lags between consecutive operations. The time lags are additive restrictions on the starting time of operations introduced by Mitten [2] : the considered restrictions are a minimum and a maximum delay between consecutive operations of the same job. The studied jobshop problem with time lags generalizes three problems : the classical jobshop problem, the nowait jobshop problem and the jobshop problem with delayed precedence between consecutive operations of the same job. We extend the widespread framework used for the jobshop problem to the jobshop problem with time lag between consecutive operations of the jobshop. This framework is composed of three parts : a disjunctive graph for problem representation, a sequence generation algorithm, and a longest path algorithm for makespan evaluation. The classical jobshop disjunctive graph is completed with positive and negative weighted arcs for the time lags modelization. The proposed sequence generation algorithm

is a taboo search algorithm based on the well-known algorithm proposed by Nowicki and Smutnicki [1] for the jobshop problem. Good quality results have been obtained by allowing transitions to infeasible solutions. A modified version of the Ford longest path algorithm is used for the makespan evaluation. This algorithm provides optimal schedules when the sequence of operations is fixed: only semi active solutions are investigated. The framework has been successfully benchmarked on small and medium scale instances built from instances of the JSP library (ft06, car5-8, la01-05). Different values of time lags are investigated including but not limited to: nowait instances, jobshop and delayed precedence. Framework performances are evaluated for small scale instances using the average gap between the optimal solutions provided by CPLEX and the solution obtained with the taboo search algorithm. On no wait instances, this gap is about 18%. When maximum time lags increases, the gap is quickly decreasing and finally it reaches 1.47% for the jobshop problem.

Keywords: jobshop, time lags, taboo search
References:
[1] E. Nowicki and Smutnicki (1996). A fast taboo search algorithm for the jobshop scheduling problem. Management Science, 42: 797-813.
[2] L.G. Mitten (1959). Sequencing n jobs in two machines with arbitrary time lags. Management Science, 5: 293-298.

Scheduling parallel machines by the dynamic Newsboy problem

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This paper focuses on a dynamic, continuous-time generalization of the single period newsboy problem. Similar to the classical newsboy problem, the model may represent the inventory of an item that becomes obsolete quickly, spoils quickly, or has a future that is uncertain beyond a single period. The problem is characterized by a number of newsboys (machines) whose operations are organized and controlled in parallel. The objective is to minimize shortage and surplus costs occurring at the end of the period as in the classical newsboy problem, as well as intermediate production and surplus costs that are incurred at each time point along the period. We prove that this continuous-time problem can be reduced to a number of discrete-time problems which are determined by loose, balanced and pressing production conditions. As a result, a polynomial-time combinatorial algorithm is derived in order to find globally optimal solutions.

Keywords: Single-period Inventory Control, Random Demand, Continuous-time Optimization.

NETWORK OPTIMIZATION III (SORSA PROJECT)

Chairperson: M.G. Scutellà

Routing in dynamic networks: schemes, models and algorithms

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In a random time dependent network (RTDN) travel times on arcs are random variables whose distributions depend on the leaving times. In general, an optimal origin-destination route in an RTDN is not a path, but rather a "strategy" that allows a traveller to choose an

optimal successor arc for each given node and leaving time. Different scenarios may arise here, depending on: 1) different assumptions on the on-line availability of relevant information, e.g. the actual realizations of travel times; 2) the possibility of adapting the strategy "en-route", in response to informations made available on-line. Accordingly, different schemes of either "a-priori" or "adaptive" routing have been proposed in the literature [3,4]. As long as discrete RTDN are considered (i.e., leaving and arrival times are integers in a given interval) an optimal adaptive strategy can be found in polynomial time, by solving a shortest hyperpath problem in a suitable time expanded hypergraph (see [2]). Finding an optimal "a-priori" strategy is NP-hard, however, it can be solved efficiently by suitable K-shortest hyperpath methods [1,5]. A further generalization arises if we consider bicriterion routing problems. Most (but not all) of the proposed schemes have a natural counterpart in the bicriterion case. Moreover, new specific schemes can be conceived when two criteria are involved. From a theoretical point of view, each scheme can be modeled as a particular variant of the bicriterion shortest hyperpath problem. However, from a computational point of view, complexity can vary substantially from one model to the other [2,5]. In this talk, we provide an overview of past and current research on this topic. Different routing models are presented and discussed, pointing out the different trade-offs between flexibility (in terms of traveler choice) and solvability (efficiency of solution methods).

Keywords: random time dependent networks, bicriterion shortest paths, directed hypergraphs
References:
[1] K. A. Andersen, L. R. Nielsen and D. Pretolani, "Finding the K shortest hyperpaths", accepted for publication on Comp. and Op. Res.
[2] K. A. Andersen, L. R. Nielsen and D. Pretolani, "Bicriterion Shortest Hyperpaths in Random Time-Dependent Networks", to appear in IMA Journal of Management Mathematics 14 N. 3 (2004).
[3] L. Fu, "An adaptive routing algorithm for in-vehicle route guidance systems with real-time information", Trans. Research Part B 35 (2001) 749-765.
[4] R.W. Hall, "The Fastest Path Through a Network with Random Time-Dependent Travel Times", Transportation Science 20, N. 3 (1986) 182-188.
[5] L. R. Nielsen, "Route Choice in Stochastic Time-Dependent Networks", Ph.D. Thesis, Department of Operations Research, University of Aarhus, December 2003 (http://home.imf.au.dk/relund/).

Efficient preflow push algorithms for the maximum flow problem

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The algorithms for the max flow problem can be grouped in two categories: augmenting path algorithms of Ford and Fulkerson , and preflow push algorithms of Goldberg and Tarjan. The preflow push algorithms are characterized by a drawback known as ping pong effect. In this paper we present two different techniques to avoid this problem. The first, called exact-relabel, allows to go out of this phenomenon when it happens. The second technique, on the other hand, enables to avoid that ping pong arises and can be considered an approach combining the augmenting path and the preflow push methods.

Keywords: Maximum flow, preflow push
References:
[1] R. K. Ahuja, T. L. Magnanti, and J. B. Orlin. Network Flows: theory,algorithms, and applications. Prentice Hall, 1993.
[2] L. R. Ford, Jr. and D. R. Fulkerson. Flows in Networks. Princeton University Press, Princeton, N J, 1962.

[3] A. V. Goldberg and R. E. Tarjan. A New Approach to the Maximum Flow Problem. In Proc. 18th Annual ACM Symposium on Theory of Computing, pages 136-146, 1986.
[4] G. Mazzoni, S. Pallottino, M.G. Scutella'. The maximum flow problem: A max-preflow approach. In European Journal of Operational Research, 53 (1991), pp. 257-278.
[5] Edmonds J., Karp R. M. Theoretical improvements in algorithmic efficiency for networks flow problem. Journal of the ACM 19 (1972), pp 248-264.

Combining interior point and reoptimization techniques for building efficient min-cost flow algorithms

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Within the Research Line 2.4 of the SORSA Project we have investigated two apparently completely disjoint subjects: how to construct efficient specialized implementations of Interior Point algorithms for Min-Cost Flow (MCF) problems, and how to efficiently reoptimize, within simplex or primal-dual combinatorial approaches to (MCF), after data changes. After briefly recalling the obtained results we will illustrate the current status of our work aimed at bringing the two research lines together by constructing hybrid Interior Point + combinatorial approaches, where the Interior Point algorithm quickly provides good primal and/or dual solution information from which the combinatorial one efficiently "reoptimizes", finally finding an optimal solution.

Keywords: Min-Cost Flow, Interior Point methods, reoptimization
References:
[1] A. Frangioni, A. Manca "A Computational Study of Cost Reoptimization for Min Cost Flow Problems" INFORMS Journal On Computing, to appear, 2004
[2] A. Frangioni, C. Gentile "New Preconditioners for KKT Systems of Network Flow Problems" SIAM Journal on Optimization, 14(3), p. 894 - 913, 2004
[3] M. Resende, P. Pardalos "Interior point algorithms for network þow problems", in Advances in Linear and Integer Programming, J. Beasley, ed., Oxford University Press, Oxford, UK, pp. 147-187, 1996.

Balanced paths in acyclic networks

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Given a weighted acyclic network G and two nodes s and t in G, we consider the problem of computing k balanced paths from s to t, i.e., k paths such that the difference between the longest and the shortest path is minimized. The problem has several variants. Whereas the general problem is solvable in pseudo-polynomial time, both the arc-disjoint and the node-disjoint variants (i.e., the variants where the k paths are required to be arc-disjoint and node-disjoint, respectively) are strongly NP-Hard. Balanced path problems generalize other interesting path problems already addressed in the literature. One such problem has been addressed by Li, McCormick and Simchi-Levi [3]; it differs from the Balanced path problem in the objective function, which has a min-max form; that is, it is required to compute k (arc-disjoint or node-disjoint) paths, in such a way to minimize the cost of the longest path. Another problem, specifically formulated on layered networks, and characterized, too, by a min-max objective function, was addressed by Carraresi and Gallo [2]. Balanced optimization problems on graphs have also been studied by Martello et al. [4], Camerini et al. [1] and Scutella' [5]. In this paper we address some significant special

cases of the Balanced path problem, and propose exact as well as approximate algorithms for their solution. The proposed approaches are also able to solve the versions of the problem in which k origin-destination pairs are provided, and a set of k paths linking the origin-destination pairs has to be computed in such a way to minimize the difference between the longest and the shortest path in the set.

Keywords: Layered networks -- Balanced paths
References:
[1] Camerini, P.M., F. Maffioli, S. Martello and P. Toth. (1986). ``Most and least uniform spanning trees". Discrete Applied Mathematics 15, 181-197.
[2] Carraresi, P. and G. Gallo. (1984). ``A multi-level bottleneck assignment approach to the bus drivers' rostering problem". European Journal of Operational Research 16, 163-173.
[3] Li, C-L., S.T. McCormick and D. Simchi-Levi. (1990). ``The complexity of finding two disjoint paths with min-max objective function". Discrete Applied Mathematics 26, 105-115
[4] Martello, S., W.R. Pulleyblank, P. Toth and D. de Werra. (1984). ``Balanced optimization problems". Operations Research Letters 5(3), 275-278.
[5] Scutella', M.G. (1998). ``A strongly polynomial algorithm for the uniform balanced network flow problem". Discrete Applied Mathematics 81, 123-131.

TRANSPORTATION III (SESSION JOINTLY ORGANIZED WITH SIDT)

Chairperson: A. Sforza

A heuristic algorithm for the immediate-request dial-a-ride problem with time windows and energy constraints

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In this paper we describe an insertion algorithm for the immediate-request version of the multi-vehicle, many-to-many, dial-a-ride problem with time windows and energy constraints. This problem is concerned with developing a set of routes for a fleet of electrical vehicles serving customers demanding in real-time to be picked up from a specified origin and delivered to a specified destination. In general, the customers can call an operating agency specifying a desired pickup or delivery time, however in the application of the model here presented they require the service directly at a stop and as soon as possible. To guarantee a good quality of the service, time constraints are considered assuring that (1) customer’s ride time will not exceed a given proportion of the direct ride time, and (2) the time of pickup will not deviate from the call time by more than a specified amount. Several operational and technical constraints are also to be satisfied: we assume that vehicle load capacity is limited; each vehicle has a battery with a limited energy capacity; precedence relations must be considered in the off-line simulation of the service. The proposed algorithm builds up dynamically the vehicle tours by means of sequential insertions guided by a non-linear objective function, extending the method presented in Jaw et al. (1986) to the case of immediate-requests and energy constraints. Because electrical vehicles have a limited energy reserve, they need to be recharged during the service. The energetic consumption of a vehicle depends on the actual load transported and on the slope of the network links utilized. The insertion of a new customer into the work schedule of a vehicle is unfeasible if it causes the violation of the energy capacity during any task already assigned to that vehicle, including the return to the depot at the end of the schedule. When the performed insertion is such that at some point during the resulting vehicle route the reserve of energy is lower than a specified threshold, the algorithm tries to insert in the

schedule a *recharge* (that is a detour to a charging station and a charging period), searching among all the available *slack times* (that are the periods when the vehicle idles with no customers on-board) in chronological order between the threshold violation and the previous recharge. The duration of the charging period depends on the maximum amount of energy that can be refilled and on the vehicle recharging speed, consistently with the upper bound due the tasks already assigned. Some computational experiments with randomly generated requests, performed for a feasibility study within the European Project Cybermove concerning a dial-a-ride service using *cybercars* in the city of Nancy, allowed us to estimate the effect of the energy constraints on the system performances. Moreover we proved that our algorithm is capable of solving in a few minutes huge instances of the dial-a-ride problem with more than 11,000 requests by means of a standard personal computer.

Keywords: dial-a-ride, energy constraints, insertion heuristic.
References:
[1] Cordeau J.-F., Laporte G. (2003) A tabu search heuristic for the static multi-vehicle dial-a-ride problem. Transportation Research B 37, 579-594.
[2] Dumas Y., Desrosiers J., Soumis F. (1991) The pickup and delivery problem with time windows, European Journal of Operational Research 54, 7-22.
[3] Jaw J., Odoni A., Psaraftis H., Wilson N. (1986). A heuristic algorithm for the multiple-vehicle advance request dial-a-ride problem with time windows, Transportation Research B 20, 243-257.
[4] Toth P., Vigo D. (1997) Heuristic algorithms for the handicapped persons transportation problem, Transportation Science 31, 60-71.

Fast heuristics for continuous dynamic shortest paths and all-or-nothing assignment

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The many-to-one dynamic shortest path problem and the corresponding all-or-nothing assignment lie at the heart of the Dynamic Traffic Assignment problem; for this reason, much effort has been spent by researches for their solution. In particular, Chabini (1997) proposed an algorithm to determine the *time-discrete* minimum tree for a given destination considering at once all departure times, which is valid only in presence of time-varying travel times having integer-valued domain and range, and time-varying costs having integer-valued domain and real range. Exploiting the acyclic property characterizing the time-space expansion of any discrete dynamic network, this algorithm solves both the fastest and the minimum cost path problems with optimal running time complexity. Alternatively, if FIFO rule holds and costs are proportional to travel times, a dynamic version of any classical static shortest path algorithm may also be employed on the time-space expanded network in order to solve the above problems, as in Kaufman and Smith (1993). In this paper we are interested in solving the same problems in presence of travel time and cost functions having real domain and range, and being thus represented as temporal profiles, that are piece-wise linear on a given set of instants. The main advantage of our *time-continuous* approach is the possibility to define time intervals of any suitable length (5-15 minutes, instead of 1-10 seconds). In this case, however, it is no longer possible to utilize Chabini's algorithm, since the acyclic property is not guaranteed; but the static shortest path algorithms may be anyhow extended to solve also this case (Bellei et al., 2003). We recall here this method for determining a dynamic minimum travel time tree in presence of continuous time-variable travel times. This algorithm determines the minimum travel time trajectories from all origins to a given destination exploiting the inverse of the

continuous travel time function. Then, by extending the results achieved by Chabini (1997), in this paper we present two new algorithms for the dynamic minimum cost and minimum travel time tree problems in presence of continuous time-varying travel times and costs. The first, which is label correcting, exploits the re-optimization of trees to each destination already evaluated for different departure time instants; the second, which is label setting and has a linear run time with the number of nodes, is based on an approximation of the problem guaranteeing the acyclic property. The three proposed algorithms are then compared in terms of results and computational times obtained performing a within day dynamic traffic assignment on a real network.

Keywords: temporal profiles, dynamic shortest paths, dynamic traffic assignment
References:
[1] Bellei G., Gentile G., Meschini L. (2003) Un nuovo algoritmo per il problema dell'equilibrio dinamico deterministico. to be published in Metodi e Tecnologie dell'Ingegneria dei Trasporti. Seminario 2002;.
[2] Chabini I. (1997) Discrete dynamic shortest path problems in transportation applications: complexity and algorithms with optimal run time, Transportation Research Record 1645, 170-175.
[3] Kaufman D., Smith R. (1993) Fastest path in time dependent networks for intelligent vehicle-highway system applications, IVHS Journal 1, 1-11.

A bi-level approach for solving the urban transportation network design problem.

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The Urban Transportation Network Design Problem (UTNDP) consists in optimizing the configuration of the supply so to minimize the total travel time of the users; unlike other network design problems, generally in this case it is not possible to build new facilities or to enlarge the road widths, but the problem is managing the available resources. In the UTNDP the decisional variables can be classified in: topological variables: road way directions (two-way or one-way); performance variables: signal settings (cycle length, green times, etc.). While the first ones have to be assumed as discrete, the second ones can be, generally, assumed as continuous. Other variables are the traffic flows; they are (continuous) descriptive variables (on them the designer cannot directly operate). These variables are strictly related to the decisional ones: under some assumptions on the travel time functions, it is possible to state that one and only one traffic flow configuration corresponds at each network configuration. This relation can be expressed by a constraint. In this paper a bi-level model for solving the UTNDP is proposed. At the first level the topological variables are optimized; at the second one the signal setting are optimized jointly with the calculation of traffic flows, adopting an asymmetric assignment model. Even if the paper focuses mainly on the model, a meta-heuristic algorithm is proposed for solving it and some results obtained on a test network are summarized.

Analysis of urban traffic emissions: a case study

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The polluting substances coming from transport systems constitute an important quota of the damaging emissions that accumulate in the atmosphere. The circulating vehicles are,

nearly in the totality, driven by traction systems with thermal engines that, during the combustion of fuel, release a series of harmful substances, that can become particularly dangerous in high concentrations. For this reason urban areas, characterized by elevated traffic flow rates and a settling mesh that does not allow sufficient infiltration of circulating air masses, are subject to air pollution with values that periodically exceed the maximum limits. Considering both the reference standards on the polluting emissions from motor vehicles and the limits set on concentrations of the main polluting substances in the atmosphere, the present work has faced the study of real conditions developing in urban congested areas through an analysis of traffic components. In order to get reference information for the study a series of traffic surveys have been first made in a well specified area of the city of Rende (CS), Italy, chosen as area of study. Such data have been used to create the origin/destination demand matrix and, subsequently, employed for the simulation, through mathematical models of microscopic simulation implemented on specific software (the Integration software). This paper, besides being useful in the understanding of local dynamics that regulate the spread of the pollutants and of wider scale dynamics that involve the climatic changes due to greenhouse gas emissions, can be taken as an example for the definition and characterization of the strategies and the priorities to be used in town planning design, therefore representing an effective support for the Local Agencies.

Keywords:Air Quality Control; Data Acquisition; Simulation Modeling.
References:
[1] M. C. Bell et al., Estimation and prediction of roadside pollution using SCOOT and ADMS (Urban) Model, Proceedings of the Air and Waste Manegement Association 93rd Annual Conference and Exhibition, Salt Lake City, Utah, 2000.
[2] H. Rakha et al., A Comparison of Two Alternative Traffic Simulation Models: TRANSYT vs. INTEGRATION, Proceedings of the Canadian Institute of Transportation Engineers Annual Meeting, Edmonton, Alberta, 1993.
[3] M. Van Aerde, Integration - User's Guide. Volume I, II, Kingston: M. Van Aerde and Assoc., 1995.

COMBINATORIAL OPTIMIZATION II

Chairperson: F. Tardella

The Boolean Probability Bounding Problem

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In portfolio selection problems the goal is to reduce the overall risk of a portfolio while still maintaining its yield. Thus, the problem is to find stock prices estimates based on some information on their probability distribution [4]. This is an example of a problem that can be formulated as the Boolean Probability Bounding Problem (BPBP). Let $A_1,\ldots,A_n$ be a set of events in a finite probability space, and assume that the probability of the single events and the probability of all the intersections of up to $m < n$ events are known. The BPBP searches for upper and lower bounds (bounds of order m) for the probability of the union of the n events. The complexity status of BPBP has not yet been established. However, some polynomially computable second and third order bounds has been provided by means of Linear Programming and graph techniques [1,2,3,5]. Let G be the complete graph associated to $A_1,\ldots,A_n$, with vertex set $1,\ldots,n$, and edge weights representing the probability of the intersection of a pair of events. The Hunter-Worsley [3,5] second order upper bound

is obtained by finding the maximum spanning tree *T* of *G*. In the case of a third order upper bound, Bukszàr and Prèkopa [2], introduced a new type of graph called *cherry tree*, and show that a valid upper bound is provided by a heaviest cherry tree. They provide a polynomial time algorithm for finding a heavy cherry tree in *G*, but, they do not show how to find the heaviest one, nor they discuss the complexity of such problem. In this paper we prove that the problem of finding the heaviest cherry tree on a complete graph *G* is NP-Complete and we propose a new polynomial time upper bound based on the dual of the LP formulation of BPBP.

Keywords: Bonferroni-type Bounds, cherry trees, submodular functions.
References:
[1] Boros G., Veneziani P., Bounds of degree 3 for the probability of the union of events, Rutcor Research Report, RRR 3-2002, 1-21.
[2] Bukszàr J., Prèkopa A., Probability bounds with cherry trees, Mathematics of Operations Research, 26 2001, 174-192.
[3] Hunter D., An upper bound for the probability of a union, Journal of Applied Probability, 13 1976, 597-603.
[4] Popescu I., Bertsimas D., On the relation between option and stock prices: A convex optimization approach, forthcoming in Operation Research.
[5] Worsley, K. J., An improved Bonferroni inequality and applications. Biometrika 69 1982, 297–302.

Randomized relaxation methods for the maximum feasible subsystem problem

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The Maximum Feasible Subsystem (MaxFS) problem is defined as follows: given an infeasible linear system Ax >= b, find a Feasible Subsystem containing as many inequalities as possible. This problem, which admits no polynomial-time approximation scheme unless P=NP, has interesting applications in a variety of fields such as operations research, statistical discriminant analysis and radiation therapy. The growing interest for MaxFS is due to the fact that many complex phenomena that can be well approximated with linear models yield formulations involving large and generally infeasible linear systems for which approximate solutions in terms of l_1 or l_2 norms are not appropriate. In some recent and challenging applications to telecommunications (planning digital audio and video broadcasting networks) and to computational biology (modeling the energy function underlying the folding of proteins) one faces very large MaxFS instances with tens of thousands up to millions of inequalities in hundreds up to thousands of variables. We propose to tackle large-scale instances of MaxFS by using Thermal and Randomized variants of the classical Relaxation method for solving systems of linear inequalities. Under certain conditions, these TRR methods are guaranteed to find with probability one an optimal solution within a finite number of iterations. Efficient TRR versions are presented and computational results are reported for large-scale instances arising from the above-mentioned applications.

Keywords: infeasible linear systems, feasible subsystems, randomized relaxation methods.

Reducing the k-mer diversity of a string.

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For a string s and a number k, let K(s) be the set of k-mers of s (substrings of length k). There are some special strings (e.g., some genomic sequences) for which the number of different k-mers is expected to be "small", although sequencing errors may lead to many k-mers. Motivated by this, we investigate the following problem: given a budget D, change at most D letters of s so as to obtain s' for which K(s') has minimum size. We discuss the (parametrized) complexity of the problem, and describe exact and heuristic algorithms for its solution.

Keywords: string processing, parametrized complexity, shift register graph.

The knapsack container loading problem: an updated view of Pisinger's approach.

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This paper deals with the knapsack container loading problem that consists in loading a subset of rectangular boxes into a rectangular container of fixed dimensions so that the engaged volume of the container is maximized. In particular in this paper it is analyzed the problem of loading irregular steel pieces in a container of known dimensions. This is a problem that often has to be solved for business requirements. First of all it has been used a "cuboid arrangement approach" to create basic modules of rectangular shape, starting from the irregular objects. After having defined a "filling ratio", the modules with the biggest coefficient have been chosen among all the ones that have been created. Then a new application-oriented software has been developed, modifying another one already existent, so that it is possible to insert as input the dimensions of the boxes and of the container. The modified program, proposed by Pisinger (2002), is based on the "wall building approach", that decomposes the container into a number of vertical layers which again are split into vertical or horizontal strips. The program run many times, supposing that the cargo, to be positioned in the container, was constituted by the chosen modules, that form a "weakly heterogeneous" cargo. A lot of tests have been executed with the developed program and interesting results have been reached both in the number of pieces loaded in the container and in the stability of the cargo. Besides the software is useful because it takes real business problems into consideration, so that it can be simply used by every firm that deals with a similar problem.

Keywords: knapsack loading problem, cuboid arrangement approach, wall building.

LOCATION

Chairperson: G. Righini

A branch-and-price algorithm for the Multi-Weber Problem

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We present a branch-and-price algorithm to solve to optimality the problem of locating a given number of facilities in the Euclidean plane, in order to minimize the sum of the distances between each point from a given set to the facility closest to it. This NP-hard optimization problem is known as the Multi-Weber Problem (MWP) and it is non-linear,

due to Euclidean distances. However a branch-and-price approach allows to put all non-linearities into the pricing problem, and to solve the MWP as a Set Covering Problem. We present computational results, showing that our algorithm can solve to optimality the largest instances so far considered in the literature.

Keywords: Location, Weber problem, branch-and-price.

Heuristic for the generalized quadratic assignment problem with quadratic capacity constraints.

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The Generalized Quadratic Assignment Problem (GQAP) may be seen as a Quadratic Assignment Problem (QAP) in which, given a set of located capacitated facilities and a set of weighted customers to be assigned to the facilities, more than one customer can be assigned to one facility, provided that the capacity is not violated. In the considered GQAP, the capacity constraints are quadratic, because, besides the single customer weight, a weight for each couple of customers not assigned to the same facility must be considered. As in QAP, both non-negative assignment costs and inter-facilities flow costs are considered. In our version of the GQAP, inter-facilities flow costs depend in a stepwise way on the flow between customers assigned to different facilities. The problem is to assign each customer to one facility without violating the capacity constraints, with the goal of minimizing the total cost. The Generalized Assignment Problem (GAP) and the GQAP arise as allocation subproblems in many location problems, e.g. hub location problems. Although the GAP and the QAP are, separately, well studied, to the best of our knowledge only two works ([1], [2]) deal with GQAPs similar to the one considered in this work. However, none of them faces with quadratic capacity constraints. For this problem a heuristic is proposed and some preliminary results are given.

Keywords: Generalized Quadratic Assignment Problem, quadratic constraints, location.
References:
[1] Cordeau J., Gaudioso M., Laporte G., Moccia L. "A Memetic Heuristic for the Generalized Quadratic Assignment Problem", 2003, submitted to INFORMS Journal on Computing.
[2] Lee C., Ma Z. "The Generalized Quadratic Assignment Problem", 2003, submitted to Discrete Applied Mathematics.

Locational decisions for barge-tracking radars

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A set of radars need to be located over a river so that every point on the river is covered by at least one radar. It is assumed that the radars have a field of view defined by a distance r and a given angle of view (a pie-shaped coverage). We discuss some locational decision models using the following simplifying assumptions and ideal scenarios: (i) There are different types of radar sensors, where the area covered is pie-shaped with radius r that depends on its power. In this research, we have simplified the above generalizations by assuming a circular coverage area (i.e., a "full pie"). (ii) The cost of locating a radar of type

i includes a fixed cost fi and a variable cost that, for the purpose of the model development, may be approximated as a convex function g(ri). (iii) The river is modeled as a tree network embedded on a Euclidean plane. The problem we present is therefore: Locate facilities on a tree network, and select their covering radii so that the network is fully covered and total radars' cost is minimized.We show that the problem with p radar types is NP-hard even on a tree network with a single link (i.e. a single line segment) and quadratic cost functions. Several special polynomially-solvable cases and configurations are also illustrated, which have been useful to devise a heuristic algorithm for the general problem. Finally, we present such heuristic and its preliminary results.

References:
[1] Church, R.L. and M. Meadows, "Location Modeling Utilizing Maximum Service Distance Criteria", Geographical Analysis, 11, 358-379, 1979.
[2] Daskin, M.S., "A Maximum Expected Covering Location Model: Formulation, Properties and Heuristic Solution", Transportation Science, 17, 48-70, 1983.
[3] Daskin, M.S., Network and Discrete Location: Models, Algorithms, and Applications, John Wiley & Sons, Inc., New York, 1995.
[4] Kolen, A., and A. Tamir, "Covering Problems", Discrete Location Theory, John Wiley & Sons, Inc., New York, 1990.

Mathematical models for critical infrastructure protection planning

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Many systems contain bottlenecks, critical linkages and key facilities. Such components when lost due to a man-made or natural disaster may imperil a system in performing its intended function. Loss of critical components of a system can lead to increased risk to the health and safety of populations, loss of well-being, loss of or degraded levels of services, economic losses, and may require significant time to recover to normal operations. The impacts of intentional sabotage of infrastructure components can be mitigated through efficient security investment decisions, including intelligence, surveillance and fortification. The objective of this work is to devise new mathematical models for allocating fortification resources among system facilities so that the impact of man-made/terrorist losses is minimized. The basic modeling approach draws on location allocation theory. More specifically, we consider an existing service/supply system where user demands for service are entirely supplied by their closest facility. The loss of one or more facilities due to some kind of interdiction forces the reassignment of the users to more distant facilities, with a commensurate reduction of overall system efficiency. In a recent paper, Church et al. (2004) introduced a spatial optimization model capable of identifying the most critical set of *r* facilities in such a system. The model is referred to as the *r*-interdiction median problem. In this study, we extend that model to address the option of fortifying facilities so that the efficiency loss due to the worst-case interdiction of *r* facilities is minimized. First, we prove that the optimal fortification set includes at least one of the facilities identified by the *r*-interdiction median model, but not necessarily all of them. Then, we provide different formulations of the *r*-interdiction median model with fortification. Computational results are presented in using these models for several hypothetical problems.

Keywords: location theory, critical infrastructure, integer programming.
References:
[1] R.L. Church, M.P. Scaparra, and R.S., Middleton (2004). Identifying critical infrastructure: The median and covering facility interdiction problems. Annals of the Association of American Geographers (2004), to appear.

SCHEDULING III

Chirman: M. Paolucci

A genetic algorithm for distributed and flexible job-shop scheduling problems

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During the last decade, the manufacturing environment has evolved from traditional single factory concepts to the current decentralized multi-factory concepts and from traditional job-shop scheduling to flexible job-shop scheduling as occurring in flexible manufacturing systems. In the modern manufacturing environment, the manufacturing operations of jobs must be carefully planned and scheduled. The distributed job-shop scheduling involves the assignment of jobs to the most suitable factory that is available and the scheduling of the operations on machines in all the factories within the distributed manufacturing environment. The flexible job-shop scheduling involves the assignment of operations to a multi-purpose machines selected from a set of available machines capable of performing them and the scheduling of the operations on machines. Traditionally, assignment and scheduling decisions are made separately at different levels of production management. In this work, a new approach to solve jointly the assignment and the job-shop scheduling problems in order to minimize makespan is analysed. A modified genetic algorithm is proposed, which is capable of solving distributed scheduling problems as well as flexible job-shop scheduling problems. In a distributed manufacturing environment, the different jobs have to be dispatched to several factories, then encoding of the scheduling problem becomes very complex since the chromosomes have to include a larger number of information, among those which the selected factory for every job and the job operation sequence. The first generation of chromosomes is formed by combining the two kinds of information. Before generating a new chromosome population, the algorithm tries to improve the best chromosome found. It defines the factory with the biggest value of makespan (critical factory) and reduces it by exchanging the operation positions of that critical factory. The performances of the proposed genetic algorithm, that was also tested for handling the distributed scheduling problems, have been evaluated with satisfactory results through several classical flexible job-shop scheduling benchmarks.

Keywords: Genetic algorithms, distributed scheduling, flexible job-shop scheduling.

References:

[1] M.Mastrolilli e L.M.Gambardella L.M., "Effective Neighbourhood Functions for the Flexible Job Shop Problem", Journal of Scheduling, Vol.3, Issue 1, 2000, pp. 3-20
[2] Chen H., Ihlow J., Lehmann C., "A genetic algorithm for flexible job-shop scheduling", Proceedings of the 1999 IEEE, International Conference on Robotics & Automation, pp. 1120-1124
[3] Kacem I., Hammadi S., Borne P., "Approach by localization and multiobjective evolutionary optimisation for flexible job-shop scheduling problems", Systems, Man and Cybernetics, IEEE Transactions, Vol. 32, Issue 1, 2002, pp. 1-13
[4] Jia H.Z., Nee A.Y.C., Fuh J.Y.H., Zhang Y.F., "A modified genetic algorithm for distributed scheduling problems", Journal of Intelligent Manufacturing, Vol. 14, 2003, pp. 351-362.

A production scheduling problem as a time dependent TSP: a case study

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We consider a firm which faces a single machine scheduling problem where set up is sequence dependent and time dependent. More precisely the processing time of each job is a non continuous (and not step) function of the starting time of the process. The problem has been formulated as a particular Time Dependent TSP, i.e. a TSP in which the cost of each arc is time dependent. In order to solve the problem we propose an heuristic algorithm, which combines restricted dynamic programming, as suggested by Malandraki and Dial [2], with a local search approach. Some production periods are scheduled and the results are compared with the ones obtained by the firm, showing a better performance.

Keywords: single machine scheduling, Time Dependent TSP, time dependent set up.
References:
[1] C. Malandraki and M. Daskin, "Time dependent vehicle routing problems: formulations, properties and heuristic algorithms", Transportation Science, 26 (1992), 185-200.
[2] C. Malandraki and R.B. Dial, "A restricted dynamic programming heuristic algorithm for the time dependent travelling salesman problem", European Journal of Operational Research, 90 (1996), 45-55.

Greedy algorithms for planning and scheduling operations on Earth observing satellites

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We describe a complex optimization problem, arising from the COSMO SkyMed project. It consists of the selection of fragments of the Earth surface to be observed by a fleet of satellites equipped with SAR (Synthetic Aperture Radar) instruments. After taking an image of the ground, the satellite can store it in a memory device on board and downlink it to a ground station. This poses the problem of scheduling the transmission of images to ground stations. We describe some greedy algorithms enriched with backtracking and look-ahead capabilities, to take into account a number of non-local constraints due to resource limits and operational constraints.

Keywords: Planning and scheduling, greedy algorithms.

Analysis of heuristic approaches for the on-line earliness-tardiness parallel machine scheduling problem

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The class of problems characterized by the on-line scheduling of independent jobs a set of parallel machines in order to minimize the weighted deviation from the jobs' due dates is considered. Although many parallel machines models have been dealt with in the literature, few of them take also into account the minimization of both earliness and tardiness (E/T scheduling) in an on-line scenario. E/T scheduling has received an increasing interest due to its relevance for the just-in-time production. The peculiarity of E/T scheduling is that, due to the non-regularity of the objective, the optimal schedule usually requires the insertion of idle times, i.e., it may not be semi-active [1]. Recent papers for this class of problems propose MIP-based approaches which take into account also machine setups (e.g. [2]), but

only instances of quite limited size can be solved. Whenever the knowledge about the jobs is not a priori but only over-time available in correspondence of the jobs' ready times, the scheduling problems are faced on-line by means of heuristic dispatching rules. Nandkeolyar et al. [3] and Sridharan and Zhou [4] analyse respectively a modular scheduling approach and a decision-making-based procedure for the single machine E/T scheduling in two nearly on-line scenarios: both the approaches incorporate a sort of look-ahead feature as some information about the next jobs' arrivals has been assumed available; in such a particular dynamic setting, the procedure in [4] outperformed the EXP-E/T rule designed by Ow and Morton [5] for the single machine case on the basis of local optimality conditions and with the assumption of no idle times inserted. The purpose of this work is to analyse and compare through an experimental campaign several heuristic rules for the considered problem. For this reason, some of the approaches proposed in the literature have been adapted to the on-line parallel machine case and their performance have been statistically compared with other original heuristics, in particular with approaches based on negotiation protocols among autonomous agents associated with the jobs and the machines.

Keywords: Parallel machine scheduling, on-line scheduling, earliness and tardiness penalties.
References:
[1] Kanet, J.J. and Sridharan, V.,"Scheduling with Inserted Idle Time: Problem Taxonomy and Literature Review," Operations Research, vol.48, 1, 2000, pp.99-110.
[2] Zhu, Z., and Heady, R.B., "Minimizing the sum of earliness/tardiness in multi-machine scheduling: a mixed integer programming approach", Computers & Industrial Engineering, vol.38, 2000, pp.297-305.
[3] Nandkeolyar, U., Ahmed M.U., and Sundararaghavan, P.S., "Dynamic single machine weighted absolute deviation problem: predictive heuristics and evaluation", International Journal of Production Research, vol.31, 6, 1993, pp.1453–1466.
[4] Sridharan, V., and Zhou, Z., "A decision theory based scheduling procedure for single machine weighted earliness and tardiness problems", European Journal of Operational Research, vol. 94, 1996, pp.292–301.
[5] Ow, P.S., and Morton T.E., "The single machine early/tardy problem", Management Science, vol.35, 1989, pp.177–191.

GRAPH ALGORITHMS I

Chairperson: P. Dell'Olmo

On the maximum concurrent flow problem with bounded number of paths

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The problem of allocating flows over a network with the constraint of using at most a given number of paths is known in the literature as the *k*-splittable flow problem, and arises in ICT network optimization, as well as in logistics and trasportation. There are many variants of this problem, depending on the number of flow sources and destinations, on the nature of the objective function and other specific constraints that can be considered, such as assigning an equal flow value for each path, or using exactly *k* paths for each commodity. In this work we propose an arc-flow based mathematical formulation for the *k*-splittable multicommodity flow problem. In particular, we consider the maximum concurrent flow problem, in which, given a set of *origin-destination* pairs and a flow request for each of

them, the issue is to find the maximum routable flow fraction – equal for all the commodities - without violating arc capacities and *k*-splittability constraints. A combinatorial and MIP-based integrated approach is proposed for this problem, and some experimental results are presented.

Keywords: k-splittable flow, maximum concurrent flow, network optimization, multicommodity.

A linear time algorithm for the minimum weighted feedback vertex set on diamonds

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Given an undirected and vertex weighted graph G, the Weighted Feedback Vertex Problem (WFVP) consists in finding a subset F of V of vertices of minimum weight such that each cycle in G contains at least one vertex in F. The WFVP on general graph is known to be NP-hard. In this paper we introduce a new class of graphs, namely the diamond graphs, and give a linear time algorithm to solve WFVP on it. We will discuss, moreover, how this result could be used to improve the approximated solution of any known heuristic to solve WFVP on a general graph.

Keywords: Weighted Feedback Vertex Set, Dynamic Programming,Diamond Graphs.

The on-demand tourist paths problem

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Aim of this paper is to study how to organize the flows of tourist in artistic towns, with the objective of satisfying the visit demand. Museums, churches and other places of interest have been considered and for all these places of attraction. In order to define a score of "desirability", parameters such as importance, popularity, place typology, the average visiting time have been considered. Two different types of paths may be required: *Sequential-activity paths*, where each of the main activity specified by the user have to be performed separately and in the order given by the user; e.g., museum visiting, lunch, shopping and *Mixed-activity paths*, where there is no particular order on activities. The actual city representation has to be processed such that on each of the links of the resulting network only one instance of each visiting type of monument (activity) is defined. Thus, if there are three museums on a street, the street will be represented as a sequence of three links, the two added nodes separating the museums. The resulting network is then composed of a set of nodes that includes street junctions and separating nodes, and a set of directed links. A set of attributes is associated to each link. Attributes are of two types. Descriptive, such as length, walking travel time, global interest, main type of activity and so on, and touristic. The goal is to find, simultaneously, the best paths in each of the specified categories according to the user-specified preferences. The label of each activity is updated using the usual shortest path labelling techniques, possibly adjusted to account for the type of path computed. To compute path labels for mixed-activity paths, a simple sum on the appropriate activities should be sufficient.

The multicriteria routing problems in the telecommunications networks

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The advances in development of complex telecommunications services, growing number of users and increasing requirements for the quality of services force the telecommunications operators to significantly improve the methods of designing and management of telecommunications networks. In this paper, we are focusing on enhancements of the routing algorithms. In the routing problems, we usually have to consider several criteria, like: cost, bandwidth, delay, jitter, packet loss (cell loss), and error rate. The offered algorithms apriori aggregate these metrics and then apply single-criteria optimization algorithms or chose one of them and set up bounds for other metrics. For example, in the IGRP (Interior Gateway Routing Protocol) algorithm the optimization metric depend on topological delay time, the bandwidth of the narrowest bandwidth segment of the path, the channel occupancy of the path, the reliability of the path (error rate). In the OSPF (Open Shortest Path First) routing algorithm the costs is an optimization criterion but delay, throughput and connectivity is considered as additional constraints. Other existing algorithms are formulated as the single-criteria optimization problems.In this paper we will show how more advanced multicriteria analysis methods might improve the solutions of the routing problems. We will present the overview of various approaches to formulations and solutions of the multicriteria routing problems. We will formulate multicriteria routing problem based on reference point approach [2,3]. The efficient algorithms to solve this problem will be discussed (e.g. [1]).

Keywords: routing in telecommunications networks, multicriteria analysis, network management.
References:
[1] Granat J., F. Guerriero, The Interactive Analysis of the Multicriteria Shortest Path Problem by the Reference Point Method",
European Journal of Operational Research, 51, pp. 103-118, 2003.
[2] Granat, J., M. Makowski, ISAAP - Interactive Specification and Analysis of Aspiration-Based Preferences,
European Journal of Operational Research, 122, pp. 469-485, 2000.
[3] Wierzbicki, A.P., M.Makowski and J.Wessels, Model-Based Decision Support Methodology with Environmental Applications, IIASA-Kluwer, Dortrecht, 2000.

TRANSPORTATION IV

Chairperson: G. Improta

The estimation of traffic flow parameters from instrumented vehicles counts

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In this paper the estimation of traffic flow parameters from instrumented vehicles counts is investigated. The procedure investigates the estimation of traffic flow parameters based on the hypothesis that only a fraction of the total flow is composed of “instrumented” vehicles: "instrumented” vehicles are vehicles with any electronic or non electronic device, that can

be counted at specific road sections by a centralized system. In the recent years there has been a widespread use of radio communications tools in the majority of developed countries, and an increasing numbers of customers using mobile phones that allow the exchange of large quantities of data and continuously updated information (Nilsson 1999). There are many possibilities that stem from the use of these technologies; among them, fundamental for the development of improved transport system management and control, is the estimation of traffic flow parameters. The deployment of widespread information and communication networks may now facilitate the extraction of detailed, accurate information on traveler position from the localization of mobile phones and electronic payment tags used in automatic toll collection. Intelligent transportation systems (ITS) include applications of new technologies to traffic management and control. Experience has shown that it is difficult to accurately estimate the true system traffic state and the estimation of traffic flow parameters remains a fundamental objective in the development of new ITS. Vehicular traffic flow is a complicated random process, described with parameters that depend on space and time. Information on mobile phones or electronic tags is handled by different organization and different situation can be found in different countries so in this paper some specific situation are framed and analyzed by supposing that some specific information are at disposal of one single organization for the estimation of traffic flow. The objective of this paper is to frame some specific situations and, after having analytically investigated the corresponding estimation problem, propose and evaluate some algorithms for the estimation of traffic flow parameters. The situations analyzed are among the possible scenarios obtained by any combination of the following: Simple network (as in a motorway network) with multiple o/d pairs or complete network with multiple o/d pairs. Rate of instrumented vehicles stable in time and among o/d pair, rate of instrumented vehicles stable in time but different among o/d pair or rate of instrumented vehicles different in time and among o/d pairs. Information also obtained from real time traffic counts at motorway entrances, exits and at some specific location; information obtained from real time traffic counts at motorway entrances and at some specific locations or information obtained from real time traffic counts only at specific locations. The above mentioned situation have been studied with an increased deepening where more information is available. The analyzed scenario with the greatest amount of information is: a simple network (as in a motorway network) with multiple o/d pairs, rate of instrumented vehicles stable in time and among o/d pair, information also obtained from real time traffic counts at motorway entrances, exits and at some specific location. The large amount of information at disposal in a scenario of this kind may seem unrealistic, but it is exactly what is possible to collect on italian toll motorways where some of the vehicles are instrumented by using an electronic payment tag and where all the vehicles are counted at entrance and exit toll stations establishing also vehicle identification (the tolls change depending on o/d pair and all non-instrumented vehicles at exit toll stations are identified by a non-electronic tag that confirms the entrance location and time of entrance). For some of the simple network scenarios the motorway is subdivided into cells, assuming that “instrumented” vehicles entering and exiting every cell can be counted during the observation period. Moreover, the number of vehicles that enter the first cell of the network and the number that enter and exit on ramps can also be known depending on the situation. The “instrumented” vehicle concentration is obtained and propagated over the network in time and space. This allows one to estimate traffic flow parameters by sampling “instrumented” traffic flow parameters using a concentration propagation mechanism. Some calculation algorithms are introduced for the estimation of traffic flow parameters within the theoretical framework introduced. The presented algorithms are based on numerical methods for the solution of partial differential equations. Results are compared and discussed using test scenarios reproduced with a traffic microsimulation model. The algorithms introduced in

this paper are the result of the interaction between the classical theory of traffic flow and the sampling of data that can be allowed by telecommunication technologies applied to the traffic systems. The results produced result from the combination of traditional traffic counts with the counting of instrumented vehicles on specific sections of the network. Results of the new methodology appear promising, in some cases, with minimal differences between estimated density values and observed density values. Of course the accuracy of the estimate improves with an increase in the ratio between instrumented vehicles (mobile phone on board) and total vehicles on the network. Some of the algorithms proposed in this paper assume that the propagation of the concentration of instrumented vehicles only happens in the same direction of the flow, other algorithms consider the specific conditions at the boundaries of the final cell of the network taking advantage of information in a mixed propagation of concentration. The use of new communication technologies, in Italy as in nearly all the industrialized countries, is clearly rising and directives have been supplied, also in Italy, in a recent "Piano Nazionale dei Trasporti" which proposes data transmission to be increasingly present in applications for the study and management of the transport system. Models such as the one proposed in this article can be useful for analysis and simulation of many situations on our roads. Customers and managers of the transportion system would find, in the application of these new methodologies, a valid contribution to the resolution of problems relative to road traffic. Further research efforts should be devoted to an application of the methodology to real traffic data. In this paper only the main theoretical aspects of the problem have been presented opening the road for additional on field research. Many ITS have been applied and designed in recent years, but the great upcoming challenge is to combine different sources of information, already owned by different entities, and to extract what may be relevant to various control systems, with the aim of supplying better, more efficient transportation services to road travelers.

Keywords:Transportation, Traffic flow, Simulation.
References:
[1] DAGANZO C., Fundamentals of Transportation and Traffic Operations, Pergamon-Elsevier, Oxford, U.K. (1997).
[2] LOVELL D. J., Accuracy of Speed Measurements from Cellular Phone Vehicle Location Systems, ITS Journal, 2002.
[3] PACK M. L., LOVELL D. J., SERMONS M. W., Transportation management applications of anonymous mobile call sampling, in «Proceedings of the 11th Annual Meeting of ITS America», Miami, 2001.

La distribuzione urbana delle merci: modalità operative e stima delle qualità movimentate

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Nella nota viene presentato uno studio effettuato nell'ambito di un progetto di interesse comunitario, realizzato al fine di quantificare la movimentazione delle merci nella città di Cosenza, un'area urbana di circa 80.000 abitanti. L'indagine è stata condotta presso un campione rappresentativo degli esercenti, costituito da 291 tra unità di vendita al dettaglio e pubblici esercizi (su un totale di 2.117 unità), e presso le imprese di spedizione e le strutture logistiche operanti nell'area oggetto di studio. Il questionario proposto consente di raccogliere informazioni sulle imprese di spedizione e sulle strutture logistiche (modalità di spedizione e consegna delle merci) e sulle unità di vendita (modalità di approvvigionamento e operazioni di consegna delle merci). In aggiunta, è stato formulato un questionario per valutare l'efficacia di alcune strategie di intervento, quali

provvedimenti di regolazione del traffico merci, provvedimenti di restrizione ed oneri finanziari a carico delle unità locali, offerta di servizi logistici aggiuntivi. Queste valutazioni sono state effettuate utilizzando tecniche di indagine di tipo SP (*Stated Preferences*). Lo studio ha consentito la stima delle quantità movimentate e la definizione delle modalità di approvvigionamento delle merci e delle caratteristiche operative delle consegne, oltre che la caratterizzazione delle filiere logistiche esistenti nell'area urbana in esame. I dati raccolti sono stati, inoltre, utilizzati per calcolare indicatori parametrici che possono essere adottati per la stima della movimentazione delle merci alla scala urbana.

Keywords: Trasporto merci, Distribuzione urbana delle merci.
References:
[1] CORDA G.P., RINELLI S., Primo censimento della distribuzione urbana delle merci, in «Le Strade» No 9, pp. 92-103, 2001.
[2] DA RIOS G., GATTUSO D., La mobilità delle merci nell'area metropolitana milanese, FrancoAngeli, Milano, 2003.
[3] MALGIERI P., GALLI G., La distribuzione delle merci in città, Quaderno RT No 3, Collana editoriale a cura di TRT Trasporti e Territorio s.r.l., Milano, 2002.
[4] RUSSO F., CARTISANO A.G., COMI A., Modelli per l'analisi degli anelli finali della distribuzione delle merci, in CANTARELLA G.E., RUSSO F. (a cura di), «Metodi e tecnologie dell'ingegneria dei trasporti - Seminario 2000», FrancoAngeli, Milano, 2002.

Car pooling: a possible solution to traffic problem

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The increased needs of movement in our cities, combined with the excessive use of private cars, create issues about our quality of life. Parking problems, high levels of environmental and noise pollution, traffic congestion are the results of this abuse of private cars. Joined with other political programs (e.g. car sharing, transit point, etc...), an alternative transport system is the so called Car Pooling, a collective transport system based on the sharing of private cars. The goal is to reduce the number used cars, gathering more peoples on each car; it's an effective system for many situations, especially for commuters. To build such a system, gathering a lot of information about the users is needed to provide a solution such that it does not reduce the comfort of each user and that the users perceive a personal profit, in order to induce them to keep using the service. Car Pooling consists of determining matches between the users, the routes of the vehicles and related timings, in order to satisfy the requests of *n* users that need a ride. The goal is to decide a set of routes of minimal cost (in terms of money, time expended in the ride and polluting emissions) in order to satisfy as many requests as possible, given a set of constraints. We are building a system based on a two phases algorithm which constructs a "quasi feasible" solution. Our model tries to gather as many users as possible on every car, according to the driver's shortest path. Then we refine it by relaxing the shortest path condition and allowing little detours to pick up new users; in this way we avoid further charge on the driver. This is a reasonable condition in a system based on voluntary sharing.

Keywords: Car pooling, Shortest Path, VRP.

Hölderian stability for a time-dependent traffic network model

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This paper aims to present traffic network equilibrium problems modelled as quasi-variational inequalities. In particular, we want to investigate the stability analysis for such models. Up to now, only few efforts have been devoted to the stability analysis for quasi-variational inequalities, whereas this topic has been extensively studied for variational inequalities. The usual approach for the study of stability is geometrical, in the sense that the used tools are the projections on opportune sets. Nevertheless, due to the motion of the constraints not only with respect to parameters but also to solutions, the geometrical scheme does not seem to be efficient for quasi-variational inequalities. Therefore, we suggest a different approach and discuss the stability analysis for a class of quasi-variational inequalities modelling problems of traffic theory, in both the static and the time-dependent case. In fact, under opportune hypotheses, we are able to ensure the hölderian continuity of the equilibrium solution. Moreover, we present some applications of the theoretical results and, by means of a projection-type method, we provide some numerical experiences.

Keywords: quasi-variational inequality, hölderian stability, Hausdorff distance.
References:
[1] R. L. Tobin, Sensitivity analysis for variational inequalities, Optim. Theory Appl., 48 (1986) 191-204.
[2] R. L. Tobin and T. L. Friesz, Sensitivity analysis for equilibrium network flow, Transportation Science, 22 (4) (1988) 242-250.
[3] N. D. Yen, Hölder continuity of solutions to a parametric variational inequality, Appl. Math. Optim., 31 (1995) 245-255.
[4]N. D. Yen, Lipschitz continuity of solutions of variational inequalities with a parametric polyhedral constraint, Math. Oper. Res., 20 (3) (1995), 695-707.
[5]N. D. Yen and G. M. Lee, Solutions sensitivity of a class of variational inequalities, J. Math. Anal. Appl., 215 (1997), 48-55.

COMBINATORIAL OPTIMIZATION III

Chairperson: G. Felici

Solving the set partitioning problem using lagrangean relaxation and column generation

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The set partitioning problem is a fundamental model for many important real-life transportation problems, including airline crew and bus driver scheduling and vehicle routing. In this paper we propose a new dual heuristic and an exact method for the set partitioning problem. The dual heuristic combines Lagrangean relaxation and column generation and uses subgradient optimization to find an effective dual solution of the linear relaxation of the set partitioning problem. This procedure is faster than traditional simplex

based methods, moreover, we show that the lower bound achieved dominates the bound obtained by the classic Lagrangean relaxation of the set partitioning constraints. The exact method iteratively solves a sequence of reduced set partitioning problems using a general purpose integer programming solver. Our computational results indicate that the new bounding procedure is fast and produces very good dual solutions. Moreover, the exact method is easy to implement and it is competitive with the best branch and cut algorithms.

Keywords: Set Partitioning, Column Generation, Lagrangean Relaxation.

Finding minimum fundamental cycle bases in undirected graphs

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We consider the problem of finding a fundamental cycle basis of minimum total weight in the cycle space associated with an undirected biconnected graph G, where a nonnegative weight is assigned to each edge of G and the total weight of a basis is defined as the sum of the weights of all the cycles in the basis. This problem (called the MinFCB problem) is NP-hard [1], and it has been shown recently that it is also MAXSNP-hard (hence it does not admit a polynomial-time approximation scheme unless P=NP) [2]. Fundamental cycle bases have been used in the field of electrical networks since the time of Kirchoff; interest in minimum FCBs arises in a variety of application fields, such as electrical circuit testing [3], periodic timetable planning [4], and generating minimal perfect hash functions [5]. Since fundamental cycle bases correspond to spanning trees, we propose new heuristics (local search and metaheuristics) where edge swaps are iteratively applied to a current spanning tree. Structural properties that make the heuristics efficient are established. We also present a mixed integer programming formulation of the problem whose linear relaxation yields tighter lower bounds than known formulations. Computational results obtained with our heuristics are compared with those from existing constructive heuristics on several classes of graphs (bounded square mesh graphs, random euclidean weighted graphs, graphs resulting from a real-life application in periodic timetable planning [4]).

References:

[1] Deo, N., Prabhu, G., Krishnamoorthy, M.: Algorithms for generating fundamental cycles in a graph. ACM Transactions on Mathematical Software 8 (1982): 26-42.
[2] Galbiati, G., Amaldi, E.: On the approximability of the minimum fundamental cycle basis problem, in K. Jansen, R. Solis-Oba (Eds.): Approximation and Online Algorithms, LNCS 2909, Springer-Verlag (2004).
[3] Brambilla, A., Premoli, A.: Rigorous event-driven (red) analysis of large-scale nonlinear rc circuits. IEEE Transactions on Circuits and Systems--I: Fundamental Theory and Applications 48 (2001): 938-946.
[4] Liebchen, C., Moehring, R.H.: A case study in periodic timetabling, in Wagner, D. (Ed.): Electronic Notes in Theoretical Computer Science, Volume 66., Elsevier (2002).
[5] Deo, N., Kumar, N., Parsons, J.: Minimum-length fundamental-cycle set problem: New heuristics and an empirical
investigation. Congressus Numerantium 107 (1995): 141-154.

The air traffic flow management problem, constraint programming versus integer programming, a comparative study

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The airspace capacity is limited due to sector capacity limits. There is then a limit on the number of possible simultaneous flights inside an airspace sector. In order to match those capacities and reduce airspace congestion the flight plans must be changed according to spatial and/or time dimension (route and/or slot allocation). One of the most popular and used models are the Mixed Integer Programming (MIP) ones [1, 2, 3], which were applied to several versions of the problem. MIP was firstly applied to the single airport problem and to the multi-airport Problem [4]. The main difference between the two problems is the propagation of the delay as the aircraft can perform multiple flights. The airspace capacity (between airports) was then introduced as the Air Traffic Flow Management Problem [2]. The air traffic flow management problem when modeled as a MIP is solved using mathematical programming solvers that are based on numerical algorithms. It can also be solved using constraint programming techniques [5] that combine modeling and adequate search strategies. The two techniques that require different modeling and resolution strategies will be discussed and compared using OPL (optimization programming language), a mathematical modeling language.

Keywords: Integer programming, Constraint programming, Air traffic flow management
References :
[1] A.R Odoni. The flow management problem in air traffic control. In A.R Odoni et al, editor, Flow Control of Congested Networks, volume F38 of ASI Series, pages 269-288. NATO, 1987.
[2] D Bertsimas and S Stock Patterson. The air traffic flow management problem with enroute capacities. Operations Research B, 46(3):406-422, 1998.
[3] S Oussedik, D Delahaye and M Schoenauer. Air Traffic Management by Stochastic Optimization. In Proceedings of the Air Traffic Management Seminar, FAA / Eurocontrol, 1998.
[4] P.B.M Vranas, D Bertsimas, and A.R Odoni. Dynamic ground-holding policies for a network of airports. Transportation Science, 28(4):275-291, 1994.
[5] N. Barnier, P. Brisset and T. Riviere, Slot Allocation with Constraint Programming: Models and Results. In Proceedings of the Air Traffic Management Seminar, FAA / Eurocontrol, 2001.

A simulated annealing algorithm for the computation of the maximum clique of a graph.

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We present a stochastic algorithm, based on ideas mutuated from statistical mechanics, for the computation of the maximum clique of a graph. Defining a configuration on the graph as a subset of the vertex set, we define an energy on the space of the configurations in such a way that the energy reaches its (local) minima when the configuration coincides with a clique. The absolute minimum is reached by the maximal clique. Then we let the configurations evolve according to a Markov process that has its stationary distribution concentrated on the minima of the energy. A free parameter (called the temperature of the system) gives us the possibility to allow the evolution of the system far from its minima

(high temperature) or to confine the system on a local minimum (low temperature). In this way the Markov chain explores the space of the local minima, with a sequence of "annealing" (rapid decreasing of the temperature). The algorithm is very efficient and rapid, and analytical estimates of the probability to find the global minimum (i.e. the maximal clique) are discussed.

Keywords: stochastic optimization, maximum clique, simulated annealing.

KNAPSACK AND KNAPSACK-LIKE PROBLEMS

Chairperson: G. Righini

On solving a 0-1 knapsack problem with a demand constraint

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We address a variant of the classical 0-1 knapsack problem in which an additional demand constraint must be satisfied by the selected items. The demand constraint is a greater than equal constraint whose coefficients are all greater than equal to zero. In this variant even testing for the existence of a feasible solution is an NP-complete problem. We present a branch and bound algorithm and a computational experience on a set of benchmark instances.

Keywords: 0-1 knapsack problem, integer programming, branch and bound.

An exact algorithm for the 0-1 penalized knapsack problem

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The 0-1 penalized knapsack problem (PKP) is a variation of the 0-1 knapsack problem (KP) in which each item has a profit, a weight and a height. As in the KP, a subset of items has to be selected, whose sum of weights does not exceed a given capacity. The sum of the profits of the selected items has to be maximized. Furthermore, the objective function is penalized by the maximum height of a selected item. The PKP arises as a subproblem in a branch-and-price algorithm for the two dimensional strip packing problem (2SP). In this talk we outline our solution strategy for the 2SP and we describe an exact branch-and-bound algorithm for the PKP. Then we compare the performance of the branch-and-bound for PKP with that of a general purpose solver for a range of random instances with various size, analyzing how different type of correlation between profits, weights and heights affects the efficacy of both methods.

Keywords: knapsack problems, strip packing, branch-and-bound.

Greedy and local search algorithms for a bidimensional covering problem

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In this talk we address a bidimensional covering problem derived from a real-world industrial application. A metal pipe must be covered with rectangular resistors taken from a warehouse (at no cost) or acquired (at a positive cost). The resistors can be rotated. The number of resistors available in the warehouse is limited while the number of purchased resistors is not. An industrial standard states that a minimal width of the pipe must be covered. We describe and compare some constructive algorithms and local search algorithms.

Keywords:heuristic algorithms, knapsack problem.

Knapsack problems and securitization of financial assets

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Asset-Backed Securitization (ABS) is an emerging sector of today banks' business. It represents an effective tool to turn unrated assets, such as commercial papers or lease contracts, into marketable financial products through the issuance of special notes, namely the asset-backed securities. In [5] we analyze the problem of optimally selecting the assets to be converted into notes with respect to scenarios motivated by real-world problems. More precisely, we study the case of assets with constant periodic principal installments and show the computational advantages and the practical implications of this choice. Many papers dealing with ABS from a modelling point of view appeared in the last years (see, for instance, [1] and [2]). More recently, Mansini and Speranza [4] studied the problem of selecting assets at a unique date and modeled it as a d-dimensional knapsack problem by proposing constructive heuristics for its solution (see [3] for a general introduction to knapsack problems). With respect to [4] we introduce a more general model which selects assets at different dates, provided that all assets are available at the initial date of the securitization. Four approximation algorithms, based on LP-relaxation and on the implicit knapsack structure of the problem, are proposed for this general model. From a theoretical point of view we analyze the exact worst-case behavior of these algorithms compared to the optimal solution. Extensive computational results show that the proposed approximation algorithms are, on average, highly efficient and effective. Finally, according to the fact that the selection of assets at the initial date is the most important in terms of contribution to the objective function, the authors are investigating the scenario in which only two points are available for selection. In this special case the problem is a generalization of a two-dimensional knapsack problem with additional XOR-conditions between pairs of variables and a special structure of the data so that more sophisticated solution algorithms can be constructed.

Keywords: Asset-Backed Securitization, Approximation algorithms, Knapsack Problems.
References:
[1] P. Kang, S.A. Zenios, Complete prepayment models for mortgage-backed securities, Management Science 38, 1665-1685, (1992).
[2] P. Kang, S.A. Zenios, Mean-absolute deviation portfolio optimization for mortgage-backed securities, Annals of Operations Research 45, 433-450, (1993).
[3] H. Kellerer, U. Pferschy, D. Pisinger, Knapsack Problems, Springer, 2004.
[4] R. Mansini, M.G. Speranza, A multidimensional knapsack model for the Asset-Backed Securitization, Journal of the Operational Research Society 53, 822-832, (2002).
[5] R. Mansini, U. Pferschy, Securitization of Financial Assets: Approximation in Theory and Practice, (2004) accepted for publication in Computational Optimization and Applications.

SCHEDULING IV

Chairperson: G. Romanin Jacur

Improved bounds for a semi on-line scheduling problem on two parallel processors

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The multiprocessor scheduling problem, where *m* parallel processors are available for processing *n* tasks with the objective of minimizing the makespan, is one of the most studied scheduling problems. This classical problem is known to be solvable in pseudo-polynomial time with fixed m, but NP-hard when *m* is arbitrary. In this problem, as in all the classical scheduling problems, it is assumed that the instance - number of machines, number of tasks and size of each task - is completely known and that an algorithm for the assignment of the tasks to the processors can be designed on the basis of the complete information on the instance. In fact, in real-world scheduling applications, this is not the case. The most realistic situation, where partial information on the instance is known, is called semi on-line. Many on-line and semi on-line scheduling problems have been studied, see Sgall (1998) for a survey. In this paper we consider the semi on-line problem on two processors with known sum of tasks and known upper bound *gamma* on the size of tasks.
The semi on-line multiprocessor scheduling problem with known upper bound on the tasks is formulated as follows. Two processors P1 and P2 are available to process a set of tasks I={p1, p2, ..., pn}. For the sake of simplicity, we identify each task with its processing time. The number *n* of the tasks and their sizes pi are unknown. The total size of all the tasks is assumed to be known and normalized, without loss of generality, to 2. A fixed upper bound *gamma* on the sizes of the tasks, pi <= *gamma*, for all *i*, is also known to hold. The tasks arrive and become known one at a time, and, as soon as they arrive, they have to be assigned to a processor. The objective of the problem is the minimization of the makespan. Objective of the paper is to generalize the bounds presented by the same authors, Angelelli et al. (2003), for *gamma* in [1/2, 1] to every interval [1/n, 1/(n-1)] with n>1.

References:
[1] Angelelli E., M.G. Speranza and Zs. Tuza. (2003): Semi on-line scheduling on two parallel processors with upper bound on the items". Algorithmica, 37, 243-262.
[2] Sgall J. (1998): On-line scheduling. In: A. Fiat, G.J. Woeginger, (Eds.): On-line Algorithms: The State of the Art. Lecture Notes in Computer Science, Springer-Verlag, 196-231.

Parallel machine scheduling with sequence setups, lot splitting, release and due dates: a heuristic approach

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In an industrial environment both economical-financial reasons and technical-operational ones justify resorting to parallel machines. These are often unrelated, i.e., production times depend on the machine-product pair. Moreover, in many situations large lots of identical

items have to be processed; every such lot may be fractionated among machines and processed either in different times or simultaneously [1]. In this talk we focus on a problem where unrelated parallel machines have to process fractinable lots; non-negligible setup times are assumed which depends on the machine and the job sequence; for every lot a release date, a due date with related unit delay cost, and a dead line are given; for every machine a release date may be given. The objective is to minimize total weighted tardiness by respecting all constraints. We show that the problem is strongly NP-hard and we suggest a MILP model. As we observe that a general exact method to solve such a model requires huge computing time, then a heuristic procedure is suggested. We propose a local search algorithm which combines different greedy strategies to generate a set of initial solutions. Each initial solution is then improved by iterated application of three move types, following differentiated criteria, so that a new enlarged set of 36 final solutions is obtained. From the final set the best solution is selected. Computational experiments many actual size instances show the efficiency and effectiveness of the approach.

Keywords: Parallel machine scheduling, Lot splitting, Sequence setups.
References:
[1] Forza C., Romanin Jacur G.: "Batch parallel working: a new class of scheduling problems", in EURO XIV - 14th European Conference of Operations Research, Jerusalem, Israel, 1995, p. 32.
[2] Pinedo M.: "Scheduling: theory, algorithms, and systems", Second edition, Prentice Hall, New York, USA, 2001.

Minimizing the number of tool switches in a NC machine

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This paper considers the job sequencing problem in a NC machine with automated tool magazine. It has been assumed that N jobs must be processed on a single NC machine. The NC machine is equipped by a tool magazine with C independent locations and it is assumed that no jobs requires more than C different tools to be completed machined. The decisional problem may be refereed to as the Tool Loading Problem (TLP) and may be stated as the problem to find the jobs sequence as well as the set of tools to load into the machine tool magazine before to start the working phase on each job. Moreover it is assumed that the working phase cannot start before all the different tools have been loaded. When the tool exchange time is both significant relative to job processing time and proportional to the number of tool switches, the criterion in order to maximize the production performance is the minimization of the number of tool switches. In literature several papers propose heuristic approaches to the Tool Loading Problem [1]. Tang et al. [2] proposed a PLI formulation and demonstrated that, given a job sequence, the KTNS (Keep Tool Needed Soonest) policy is optimal. Laporte et al. [3] proposed a heuristic based on the following statement: if each job requires exactly C tools the TLP problem is equivalent to the TSP, otherwise the TSP-cost matrix is solution dependent and it has to be estimated. This paper proposes an exact algorithm for the TLP problem referred to the general case with at most C tools required for each job. A symmetric TSP formulation is used as lower bounding scheme. The formulation significantly reduces the LP relaxation gap respect to the problem formulation reported in [2]. The authors propose a branch and bound algorithm making use of a KTNS-based updating cost procedure to solve the problem optimally. Computational experiments show that the proposed algorithm outperforms the commercial solvers.

References:
[1] Ben-Daya, M., 1995. FMS short term planning problems: A review. In: Raouf, A., Ben-Daya, M. (Eds.), Flexible Manufacturing Systems: Recent Developments. Elsevier Science, Amsterdam.
[2] Tang, C.S. and Denardo, V. 1988 Models arising from a flexible manufacturing machine. Part I: minimizing the number of tool switches. Operations Research, 36, 767-777.
[3] Alain Hertz, Gilbert Laporte, Michel Mittaz and Kathryn E. Stecke, 1998 Heuristics for minimizing tool switches when scheduling part types on a flexible machine, IIE Transactions 30, 689-694.

GRAPH APPLICATIONS

Chairperson: C. Meloni

Bi-criteria setup coordination in a two stage serial production system

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In the material flow of a two-stage industrial plant, parts are processed in batches, each having two distinct attributes. Due to limited interstage buffering between the two stages we analyze the case in which the two departments follow the same common sequence of batches. In one department, a set-up occurs every time the first attribute of the new batch is different from the previous one. In a downstream department, there is a set-up when the second characteristic of the new batch is different from the previous one. Since a unique sequence of batches must be established, the problem consists in finding such a common sequence optimizing some overall utility index. Our aim is to find in reasonable time a good approximation of the Pareto-optimal front. Thus, in general, a solution of the problem is a set of tradeoff solutions, i.e., non dominated solutions. The problem is known to be NP-hard even when only one objective is considered and it calls for a heuristic solution approach. Here we propose a metaheuristic approach to the bi-criteria problem of minimizing the total number of set-ups and the maximum number of set-ups between the two departments.

Evolutionary approach to sequencing problems with setups

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This work deals with a problem of real-life manufacturing interest: the coordination of two consecutive production stages. This kind of problem is inherently multi-objective because each department has to organize his internal work taking into account the requirements of the other one. Each department consists of a flexible machine, the first one deals in shaping raw wooden panels; the second concerns the painting of the just shaped lots. To avoid unnecessary costs, in fact, each department works with batches of jobs, in which every element has the same properties in terms of shape and colour. Since it is not possible for a job to change its own route in the production chain, as well as for a department to re-schedule the sequence of incoming batches, this problem belongs to the class of Permutation Scheduling. In literature the NP-Hard nature of this combinatorial manufacturing optimization problem was demonstrated. We tackled this multi-criteria

problem using an evolutionary approach. A new algorithm named LNPB (Light Non-dominated Pareto Based) has been proposed to minimize a couple of objectives, i.e. the setup costs for both the stages. The basic structure of the algorithm has a good behaviour also in different cases. For example we considered as targets the minimization of the whole production setup cost and the balancing of the production load among the stages. Moreover, to cover a wide range of situations, we made use of three setup cost classes. A wide campaign of tests has been carried out on real industrial instances; while experiments on small instances have highlighted some geometrical properties about the set of problem solutions in the phenotypic space.

Aircraft scheduling in a busy airport

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The main purpose of optimized sequencing of landing/taking-off operations is to obtain a better exploitation of the existing airport infrastructure, thus improving the performances of the entire ATC system. In this talk we deal with innovative sequencing models for managing arrivals and departures times of the aircraft at an airport. These models are based on the so-called alternative graph formulation, which resulted very effective for modeling and solving the traffic control problem of large railway networks. We show that the alternative graph model allows a detailed formulation of the air traffic control problem. Bottleneck situations may happens not only on the runway complex but even in the air segments close to the airport. Therefore a simplified model which does not take into account the dynamics of the aircraft flows near the airport may fail to correctly represent the problem. We propose a metaheuristic algorithm to tackle the Aircraft Sequencing Problem modeled in details by means of the alternative graph formulation.

A new approach to deadlock prevention in manufacturing systems

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In manufacturing systems a deadlock occurs between parts competing for resources when a finite set of parts are permanently blocked because each of them requires resources held by other parts in the same set. Prevention is based on off-line identification of all possible deadlocks. A controller prevents the system from entering these states, based on a model of deadlock. Most models use Petri nets (PNs) or digraphs. In a PN places and transitions are linked by arcs to represent how the system state changes, as tokens, representing resource-units or parts in process, flow through the net. Places model part activities or resource availability. Transitions model events changing the state, defined by the tokens marking the places. Each deadlock is associated to a particular set of unmarked places, an empty siphon. But even simple systems give rise to complex PNs, whose number of states is combinatorial exploding. Then, algorithms for deadlock detection in PNs are not easily implemented. This motivates digraphs, which are simpler than PNs: the number of vertices and edges in a working procedure digraph D is much lower than in PNs. The vertices represent resources while each edge represents a precedence relation between two resources in a procedure. All possible deadlocks correspond to particular strong components, which are obtained from D. These components must be closed and contain resources which are completely occupied by parts. The developed hybrid approach for deadlock prevention use digraphs to identify

deadlock configurations and PNs for control purposes. Digraph deadlock states are mapped to PN empty siphons. Then, a prevention controller guarantees that tokens mark siphons in all reachable states.

OR IN PRACTICE I
In memory of Tito A. Ciriani

Chairperson: G. Perboli

A combinatorial auction model for the integration of procurement, production planning and inventory management processes

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Negotiation is a basic process for the enterprise activities. With new organization paradigms such as virtual organizations, negotiation process is becoming more and more important and a supporting tool linking the negotiation with other company processes is needed. In this paper, we study the problem of creating a tool that allows a manufacturing enterprise to integrate the negotiation related to the procurement process with the production planning, and stock processes. We formulate the procurement problem as a reverse combinatorial auction, and we provide a new mathematical formulation that considers procurement, production, and stock costs. We specialized the model for Snaidero R. S.p.A, that is one of the most important kitchen furniture enterprise in Europe. This model refers to an assembly based production system in which the manufacturing enterprises usually have the necessity of manage a huge number of production parts to be combined in order to obtain the end products. In order to purchase the required production parts, the enterprise sends to its suppliers a call for offer that contains some specification as the quantity, the price, and the preferred delivery date of the productions parts, it wants to buy. The suppliers can exploit complementary properties in order to define their offers. In this context, we propose a model in which the objective function is given by the minimization of total costs due to the purchased quantity and typology of production parts, the stock levels, and the production variations with respect to the production plan. The winner combination will produce new production plan in future periods. Therefore, it will be effect on the production parts requirement in the following periods, on the stock level, and consequently on the costs. Information elaborated by the developed tool can be also used for procurement strategy. In this paper we show the architecture and the information exchange underlying the model. The model will be then validated by using a standard solver.

Keywords: processes integration, combinatorial auction, production planning, inventory managemnt.

Fail management in post trading environment

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The Italian stock exchange post trading infrastructure was completely renewed in the last January, introducing new concepts as collateralization to obtain liquidity and fail management for transaction not covered by both securities & cash. The mathematical core of the application is a tool of combinatorial search having the scope to identify combinations of transaction covered by both securities & cash .Using greedy techniques, evaluating the single transaction, gives poor results (less than 90% settled instructions). A Mixed Integer Programming Model has been defined and implemented, so all the transactions are evaluated analyzing the complete set of them. Instances larger than 20.000 rows, 60.000 columns, of which 25.000 integers/Booleans are modeled and solved. A large number of presolving steps are used both for matrix reduction and selected condition treatment. The application is running every night, usually giving a very good optimized solution (over 98% of instructions settled).

The determination of districts in an emergency service

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In an emergency health service, it is fundamental for the efficiency of the service to determine which available ambulance must be dispatched to a demand point. The optimal allocation of users to servers in an emergency health service is investigated in order to determine the optimal boundaries in the case in which service is provided by three cooperating ambulances, varying the utilization ratio ρ and home locations of servers. The problem is investigated using queueing theory and Manhattan metric. It is also analysed assuming Euclidean metric, and two servers. Moreover, a classification of allocation models of users to servers in four classes is given. In fact, the same meaning of boundaries (and of districts!) changes depending on different assumptions taken for the model.

Keywords: emergency service, allocation problems.
References:
[1] Bassetto T, Mason F (2003) Sulla determinazione delle zone di competenza in un servizio di emergenza medica. Quaderni di dipartimento di matematica applicata dell'Università "Ca' Foscari" di Venezia n.118.
[2] Carter GM, Chaiken JM, Ignall E (1972) Response areas for two emergency units. Operations Research 20:571-594.
[3] Cuninghame-Green RA, Harries G (1988) Nearest-Neighbour rules for emergency services. Zeitschrift für Operations Research 32:299-306.
[4] Larson RC (1974) A hypercube queueing model for facility location and redistricting in urban emergency services. Computers and operations research 1:67-95.
[5] Larson RC, Odoni AR (1981) Urban operations research. Prentice-Hall, Englewood Cliffs NJ.

A production problem solved by a network optimisation approach as a specially structured very large scale *p*-median problem

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In car production each car can be provided with a different set of options. It may (or not) contains airbags, ABS, air-conditioner etc. According to options, a certain configuration of electric wiring must be installed, which contains the possibility to attach the chosen options. The number of options can be several dozens and the number of electric wiring configuration can be several thousands. Only a limited number (namely p) of wiring configuration can be available at the assembly line. If the needed wiring configuration is not available, it can be replaced by a compatible one. A configuration can be replaced by another if the latter contains all the options of the former. It implies that a customer is "gifted" with some unused options of electric wiring. This implies a production overcost, which has to be minimised. Briant and Naddef [2004] introduced this problem and called it *Optimal Diversity Management Problem* (ODM). The characteristic property of this problem is that it can be defined on a not-complete acyclic graph and solved in terms of p-median of the graph. We adopted this approach to solve a real case. The peculiarity of our real case is that the graph is not-connected, i.e. it consists of several not connected components. We take advantage of this property in developing a decomposition approach. We shall show that the p-Median problem can be decomposed into a series of p-Median subproblems for each component and a sort of assignment problem, to retrieve the solution of the problem from the solutions of the subproblems. Using this decomposition approach we work with subproblems substantially smaller. Therefore, we can deal with instances on graph with more than 80,000 nodes and 6,000,000 arcs. Suitable greedy and lagrangean heuristics can solve them to 1%-optimality in reasonable computation time on a personal computer.

Keywords:Optimal diversity management problem, p-median, lagrangean heuristic
References:
[1] Avella P., Sassano A., Vasil'ev I.. Computational study of large-scale p-median problems. Technical Report 08-03, DIS – Università di Roma "La Sapienza". 2003.
[2] Avella P., Sforza A.. Logical reduction tests for the p-median problems. Annals of Operations Research, 86, 105-115. 1999.
[3] Briant O., Naddef D.. The optimal diversity management problem. Forthcoming on Operations Research. 2004.
[4] Hansen P., Mladenovic N., Perez-Brito D.. Variable neighbourhood decomposition search. Journal of Heuristics, 7, 335-350. 2001.
[5] Resende M.G.C., Werneck R.F.. A grasp with path-relinking for the p-median problem. Technical Report TD-5E53XL, AT&T Labs. 2002a.

COMBINATORIAL OPTIMIZATION IV

Chairperson: P. Nobili

Operations research methods and models for conflict prevention

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Security is one particular global challenge that has recently come to the fore due to world events and societal changes. Within this context, one of the areas in which Operations Research can give an important contribution is the area of 'early warning and crisis prevention'. This is a challenging research area requiring a multidisciplinary approach,

which has enjoyed an increased interest in recent years. Here, we focus on 'early warning', trying to highlight the main problems which can be tackled by O.R. techniques. Historically, early warning approaches which rely, in all or in part, on quantitative methods, can be classified into two main categories: 'structural' and 'dynamic'. In the 'structural' approaches, models are built in which variables representing potential or actual conflict events, are linked to variables representing the structural conditions of the system under analysis. Although most often regression techniques have been used so far in these approaches, we believe that there is space for system modeling methods of the type used in OR. An interesting example is due to Wils, Kamiyaa and Choucri (1998). This last approach is particularly interesting because of the capability of analyzing the dynamic behavior of the relevant variable and of determining the points in the system where to act to try to prevent the outbreak of the conflict. Very different is the so called 'dynamic' approach. Here large quantity of data, (related to violent actions, tensions, dialogue and cooperation activities, diplomatic meetings, etc. are collected on a daily, weekly or monthly base. They are usually coded according to some criteria and thereafter aggregated into one or more indicators (Goldstein, 1992). Once the indicators have been built, statistical, pattern recognition or clustering techniques are used to identify the patterns over time which characterize situations of instability and high risk of conflict and violence. In this approach there is the need of efficient online clustering and classification algorithms. An important role can also be played by multicriteria analysis techniques.

References:
[1]J. S. Goldstein, "A Conflict-Cooperation Scale for WEIS Events Data", Journal of Conflict Resolution, 36 (1992) 369-385
[2]A. Wilsa, M. Kamiyaa, N. Choucri, "Threats to sustainability: simulating conflict within and between nations", System Dynamics Review, Vol.14 (1998) 128162.

Probabilistic coloring of bipartite and split graphs

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We revisit in this paper the probabilistic coloring problem (PROBABILISTIC COLORING) and focus ourselves on bipartite graphs. We first give some general properties dealing with the optimal solution. We then show that the unique 2-coloring achieves approximation ratio 2 in bipartite graphs under any system of vertex-probabilities and propose a polynomial algorithm achieving tight approximation ratio 8/7 under identical vertex-probabilities. Then we deal with restricted cases of bipartite graphs. Main results for these cases are the following: PROBABILISTIC COLORING is polynomial for stars under non-identical vertex-probabilities, for paths with a fixed number of distinct vertex-probabilities, and, under identical vertex-probabilities, for chains, even and odd cycles, trees all leaves of which are either at even or at odd levels and trees with bounded degree and a fixed number of distinct vertex-probabilities. Next, we deal with split graphs and show that PROBABILISTIC COLORING is NP-hard, even under identical vertex-probabilities. Finally, we study approximation in split graphs and provide a 2 approximation algorithm for the case of distinct probabilities and a polynomial time approximation schema when vertex-probabilities are identical.

Keywords: Probabilistic coloring, bipartite graphs, approximation algorithms.

A 5/6-approximation algorithm for max vertex cover

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The *maximum vertex cover* problem is the following problem: given a graph G=(V,E) with weights on the edges and a positive integer p, find p vertices of G such that the total weight of edges covered by these vertices is maximized. This problem is NP-hard, in general, and the best known algorithm to solve it achieves an approximation factor of 3/4. In this paper, we provide 5/6-approximation algorithm for the maximum vertex cover problem provided that the edge weighting satisfies some ”partitioning” property.

The minimum power broadcast problem in wireless networks: a simulated annealing approach

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Broadcasting in wireless networks, unlike wired networks, inherently reaches several nodes with a single transmission. For omnidirectional wireless broadcast to a node, all nodes closer will also be reached. When a message has to be sent from a designated node to all the others, this property can be used to regulate transmission powers in such a way that the total power consumption over the network is minimized, while a broadcasting tree still exists. After having formally described the problem, we propose a simulated annealing algorithm (see Montemanni et al. [2]). It is compared with the state-of-the-art approach, which is represented by a cluster-merge algorithm based on an ant colony system (see Das et al. [1]). The simulated annealing algorithm is capable of improving the results of the cluster-merge approach for most of the problems considered.

Keywords: Wireless networks, minimum power broadcast, simulated annealing.
References:
[1] A.K. Das, R.J. Marks, M. El-Sharkawi, P. Arabshahi, A. Gray. A cluster-merge algorithm for solving the minimum power broadcast problem in large scale wireless networks. In Proceedings of the Milcom 2003 Conference, Boston, U.S.A., October 2003.
[2] R. Montemanni, L.M. Gambardella, A.K. Das. The minimum power broadcast problem in wireless networks: a simulated annealing approach. Submitted for publication (Available at http://www.cs.unibo.it/bison/publications/SAmpb3.pdf).

SOLID WASTE MANAGEMENT

Chairperson: D. Favaretto

A decision support system for waste collection management problem

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According to the current Italian legislation the industries are obliged to take care their products during the whole life cycle including the correct disposal of them. Nevertheless most industries have not on-site treatment installation for their industrial waste, and must outsource agencies for their collection and treatment. We consider a Collection Treatment Centre and a collection waste agency. The main goal of this work is to provide a tool that supports a collection agency to undertake strategic and tactical decisions either in standard and unusual scenarios concerning the industrial waste collection. The waste collection agency has to manage a fleet of vehicles and to define the routes of them considering a set of ecological islands. In this setting, we model the road network as a graph G=(N,A) where N represents the set locations and A the set of direct links. Let I and C be respectively the set of the ecological islands and the Collection Treatment Centre (*CTC*) in N. For each ecological island a daily demand is given with a preferred time windows in which the agency has to pick up the items, the agency stores them in its warehouse, and then it deliveries the items to the CTC using a dedicated fleet of vehicles. We propose a two-stage approach, in the first one we solve the problem of the waste collection with the goal of costs minimization. The tours have to be defined in order to respect pick up time windows, this problem is model as a Vehicle Routing Problem with Time Windows [1]. The second stage considers different scenarios where special events occur and provides a decision support system in order to undertake higher profitable actions. The model validate with real data coming from a treatment centre, Marangoni Tyre S.p.a. that is a chemical industry.

Keywords:Vehicle routing with time windows; heuristic algorithm, decision support system.
References:
[1] Cordeau, J.F., G. Desaulniers, J. Desrosiers, M. M. Solomon and F. Soumis (2001), “The VRP with Time Windows”, in The Vehicle Routing Problem, SIAM Monographs on Discrete Mathematics and Applications, P. Toth and D. Vigo (eds), 157–194, SIAM, Philadelphia.

Powering a local energy system by optimal solid waste management

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Waste flow management is one of the more important issues concerning governments, especially in Europe [3]. In order to reach an acceptable level of environmental sustainability, a common belief is that recycling is probably the best option to manage waste flow, see e.g. [1]. On the contrary, other studies have proved that recycling is not always the best option: in the case of wastepaper, Leach et al. [4] show that incineration is better than recycling since it imposes lower environmental costs. As discussed in [2], the combination of incineration with other energy resources can supply efficient local energy supply systems. From a general point of view, given a small area in which some energy resources are available and some energy demands should be satisfied, we consider the problem of exploiting such energy resources (e.g. solid and urban waste, geothermal sources, biomasses etc.) installing one or more new energy production plants in order to satisfy all energy demands. The problem, say Energy Supply Problem (ESP), concerns the design of the energy production plant network, the planning of the resource collection and the energy distribution systems. We discuss a mathematical model for ESP. For its solution, we propose the Enumeration Over Paths Algorithm, which is based on a Benders Decomposition reformulation.

Keywords: Solid Waste Management, Enumeration Algorithm, Benders Decomposition

References:
[1] A. P. Antunes. Location analysis helps manage solid waste in central Portugal. Interfaces, 29(4):32-43, 1999.
[2] R. Aringhieri and F. Malucelli. Optimal Operations Management and Network Planning of a District Heating System with a Combined Heat and Power Plant. Annals of Operations Research, 120:173-199, 2003.
[3] G. Ghiani, R. Musmanno, and D. Vigo. Operations Research in Solid Waste Management: a Survey. Technical report, 2003
[4] M. Leach, A. Bauen, and N. Lucas. A system approach to material flow in sustainable cities: A case study of paper. Journal of Environmental Planning and Management, 40(5):705-723, 1997.

An optimization model for services scheduling of a waste management company

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Efficient management of waste collection and disposal services are important and complex decisional problems with high logistic costs. The case examined concerns ACIAM S.p.A., a waste management company located in the Marsica area in Abruzzo (Italy). In that context, vehicles, operators and services are characterized by a large number of highly coupled constraints. Non homogeneous fleets, levels of employee competence and community characteristics (kg of waste produced, accessibility, etc.) determine the relations of "incompatibility" between services and vehicles, between vehicles and employees, and between services and employees. Furthermore, duration and frequency (daily, weekly, etc.) also characterize each service. The project in question concerns the definition of short-term (monthly) scheduling of services and employee shifts respecting all compatibility constraints and frequencies defined by contracts. The overall objective is both (i) the minimization of the required work force in order to guarantee the maximum number of free resources in case of unexpected events such as short but frequent private interventions, the unavailability of vehicles (due to breakdown or maintenance) or employees (on sick leave or vacation) and (ii) the selection of the best vehicle/employee configuration.

Keywords: Waste management, Services scheduling, logistic applications.

GRAPH ALGORITHMS

Chairperson: F. Mason

A weighted Voronoi diagram approach to political districting

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The design of electoral districts is one of the critical issues in political elections. Political districting can be modelled as multiobjective partitioning of a graph G into connected components, where population equality and compactness must hold if a majority voting rule is adopted. This leads to the formulation of problems extremely hard to solve exactly.
A broad survey of political districting algorithms is given in [3]. Later work focuses on local search (e.g., [5], [2]). It is also worth mentioning the branch-and-price approach in [4]. Here we propose a novel approach based on weighted Voronoi regions (or diagrams). This notion is not new in the literature, especially in the area of computational geometry (see,

e.g., [1]). What we believe to be new, besides the specific application to political districting, is our iterative updating of node weights to achieve population balance. We propose two different versions of the weighted Voronoi algorithm: in the *full transfer* version many sites migrate from a district to another one simultaneously, while in the *single transfer* algorithm only one site at a time migrates. Moreover, we consider both *dynamic* and *static* updating of node weights. We define four desirable properties to be met by weighted Voronoi algorithms – or at least by some variants of them: *order invariance*; *re-balancing*; *geodesic consistency*, *finite termination*. Finite termination in general is not guaranteed, as shown by counterexamples. However, one can prove that, under suitable conditions, the single transfer dynamic weighted Voronoi algorithm enjoys finite termination. We also show that, under the assumption that distances are geometric ones in *G*, order invariance, re-balancing and geodesic consistency properties hold for the same algorithm. The performance of our algorithms was tested on real benchmarks, providing some experimental results.

Keywords: Political districting, weighted Voronoi regions, graph partitioning.
References:
[1] F. Aurenhammer and H. Edelsbrunner (1984), An optimal algorithm for constructing the weighted Voronoi diagram in the plane, Pattern Recognition 17, 251-257
[2] B. Bozkaya, E. Erkut, and G. Laporte (2003), A tabu search heuristic and adaptive memory procedure for political districting, European Journal of Operational Research 144, 12 – 26
[3] P. Grilli di Cortona, C. Manzi, A. Pennisi, F. Ricca, B. Simeone (1999) Evaluation and Optimization of Electoral Systems, SIAM Monographs in Discrete Mathematics, SIAM, Philadelphia
[4] A. Mehrotra, E.L. Johnson, G.L. Nemhauser (1998), An optimization based heuristic for political districting, Management Science 44, 1100-1114
[5] F. Ricca, B. Simeone (2000), Local search heuristics for political districting, Technical Report, Dipartimento di Statistica, Probabilità e Statistiche Applicate, Università "La Sapienza", Roma, Ser. A, n. 11- 2000, submitted for publication.

Mathematical models of smart obstacles

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Smart (or active) obstacles are obstacles that when illuminated by an incoming field react actuating a policy in order to pursue an assigned goal. The development and dissemination of recent innovations in sensors, electronic chips, and actuators technologies have made possible the realization of smart objects in many practical situations. The design of smart objects can be improved by the availability of satisfactory mathematical models. We propose the use of models based on optimal control problems to describe the behaviour of smart objects. Let us restrict our attention to the context of time dependent electromagnetic scattering. In this context the smart obstacle in order to pursue its goal circulates on its boundary a surface electric current density. The optimal control problems associated to these obstacles give a way of characterizing and computing the current densities needed as optimal solutions of the mathematical problems considered. Recently the modeling of smart obstacles in acoustic and electromagnetic scattering has been addressed in [1], [2], [3], [4], [5] (see also the websites:http://www.econ.unian.it/recchioni/w6, http://www.econ.unian.it/recchioni/w8, http://www.econ.unian.it/recchioni/w9, http://www.econ.unian.it/recchioni/w10). The goal pursued by the smart obstacles considered in the papers mentioned above is one of the following: to be undetectable (i.e. furtivity problem), to appear with a shape different from its actual shape (i.e. masking problem), to appear in a location in space different from its actual location (i.e.ghost obstacle problem), one of the previous goals restricted to a limited band in the frequency

space. The corresponding optimal control problems for the wave equation (acoustic case) or for the Maxwell equations (electromagnetic case) are formulated. The relevant first order optimality condition for these problems is derived using the Pontryagin maximum principle and a numerical method to solve it is suggested. Numerical experiments on test problems validate the approach proposed.

References:
[1] F. Mariani, M.C. Recchioni, F. Zirilli: "The use of the Pontryagin maximum principle in a furtivity problem in time dependent acoustic obstacle scattering", Waves in Random Media 11, (2001), 549-575.
[2] L. Fatone, M.C. Recchioni, F. Zirilli: "Furtivity and masking problems in time dependent acoustic obstacle scattering", in H.G. Begehr, R.P. Gilbert, M.W. Wong editors, "Progress in Analysis" Volume II pages 1347-1358, Singapore 2003, World Scientific Publishing.
[3] L. Fatone, M.C. Recchioni, F. Zirilli: "A masking problem in time dependent acoustic obstacle scattering", to appear in ARLO-Acoustic Research Letters Online.
[4] L. Fatone, M.C. Recchioni, F. Zirilli: "Some control problems for the Maxwell equations related to furtivity and masking problems in electromagnetic obstacle scattering", in G.C. Cohen, E. Heikkola, P. Joly, and P. Neittaannaki editors, "Mathematical and Numerical Aspects of Wave Propagation. Waves 2003", pages 189-194, Berlin, 2003, Springer Verlag.
[5] L. Fatone, M.C. Recchioni, F. Zirilli: "Furtivity and masking problems in time dependent electromagnetic obstacle scattering", to appear in Journal of Optimization Theory and Applications.

Location of an urban logistic platform in Cosenza

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A logistic platform can improve the distribution process of goods. Moreover, a good location of logistic platform can enhance traffic conditions and reduce environmental impact of freight transportation. In fact, auto-organized freight distribution is responsible for about 10% of pollutant emissions and it contributes to increase traffic congestion in urban areas. In this paper a multicriteria analysis application is presented to determine optimal location of an urban logistic platform. This study's data are taken from Merope Final Report (fortcoming), an EU Project under Interreg III B and Medocc Programme. Two available areas are predisposed by Urban Traffic General Plan of Cosenza, a middle-sized city in Calabria. The first one is located near the access to "A3" motorway, while the second area is situated in the proximity of the rail station. Several measures of "goodness-of-location" have been considered for the two available areas. Some of these measures concern physical characteristics of the two areas (i.e. morphology, width, ecc.), while others regard site location (i.e. accessibility for freight vehicles, proximity to commercial land uses, average length of freight vehicles's tour, etc.) and were computed using a GIS software. Literature shows various methodologies and criteria to use these measures, but only few of these criteria are here used for identifying the best site. Ultimately, a comparison of results is showed and some additional comments and suggestions on different used criteria's data-adapability are proposed.

Keywords: Location Theory, Multi-Criteria Analysis (MCA), urban logistic platform.
References:
[1] De Luca M. (2000) Manuale di pianificazione dei trasporti, FrancoAngeli, Milano.

SIMULATION AND SIMULATION OPTIMIZATION

Chairperson: P. Legato

Simulation and optimization for the design of plant layout and material flows: an integrated approach

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Group Technology concepts were introduced by Mitrofanov (1959). Cellular Manufacturing is a successful application of these concepts: we want to group parts into families with similar characteristics and identify dedicated set of machines (cells) to process the different families while minimizing the number of parts that need to be processed by machines placed in different cells (Inter-Cell Flow). We propose a novel integrated approach. The basic procedure consists of the iterative execution of a standard greedy-like algorithm for the cell formation. The algorithm relies on the definition of machine-pair similarity coefficients and clustering techniques for the solution of a special graph partitioning problem (Optimization Phase). At each iteration we consider similarity coefficients modified on the ground of performance indicator (feedback indicator) obtained from the analysis of the simulation run (Simulation Phase). Depending on the performance indicator used as feedback, we may converge more or less rapidly to the best layout. On the other hand, simulation are performed varying demand scenarios, and, more importantly, different material flow management rules. The analysis of results shows that one feedback indicator is directly related to the performance we want to improve (Inter-cell flow) which dramatically decreases in the successive iterations. Concurrently, other performance indicators, Mean WIP or Mean Flow Time or Mean and Max Tardy Parts Rate, get better.
In conclusion we adopt an integrated optimization/simulation approach in order to design the layout of a cellular manufacturing system. The novelty of this approach, based on the definition of machine-pair similarity coefficients and clustering techniques, consists of iteratively re-defining the similarity coefficient on the ground of the results of a simulation test. Further developments of this research may include:- New similarity coefficients and algorithms to redesign coefficients after the simulation phase.- Application of DOE techniques.

Keywords: Group Technology, Optimization, Simulation.
References:
[1] Askin R. and C., 1993, Standridge, Modeling and Analysis of Manufacturing Systems, John Wiley & Sons, Inc.
[2] Yong Yin, 2002, Heuristic Approach to Solving Part Family/Machine Group Formation Problem in Cellular Manufacturing, Ph.D. dissertation in Industrial and Management Science, Graduate School of Economics and Management, Tohoku University, Japan.
[3] Malakooti B. and Ziyong Yang, 2002 Multiple criteria approach and generation of efficient alternatives form machine-part family formation in group technology, IIE Transaction 34, 837-846.

Heuristic procedures for discrete simulation-optimization

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This paper addresses the problem of optimizing a function over a finite or countably infinite set of alternatives, in situations where this objective function cannot be evaluated exactly, but has to be estimated via simulation. We present a new iterative method, based on the simulated annealing framework, for solving such discrete stochastic optimization problems. In each iteration of the proposed method, we decide (i) how many neighbors of the current solution have to be examined; (ii) how many simulation runs have to be performed for each selected neighbor. In addition, we present a parallelization strategy for allocating simulation runs on computing resources. Computational results show that a major strength of the method is its ability to provide superior solutions in a limited amount of time.

Steady state simulation of queuing network models of manufacturing systems for purposes of ranking and selection of the best configuration

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Queuing networks are well suited as modelling tool of modern manufacturing systems, but real features usually require to use stochastic, discrete-event simulation as solution method. Solving a queuing network means computing an estimate of some steady state measures of system performance, such as throughput and lead time. Different, alternative configurations of the system of interest are compared on the basis of average values of the above measures of performance with the goal of detecting significant differences among the configurations and selecting the best one. At the opposite sides of the simulation based methodology for the analysis of a queuing network there is the idea of producing either one very long sample path (replication) of the stochastic processes representing the customer sojourn time and the customer count at the exit point or multiple independent sample paths. The statistical computations for throughput and lead time are based upon the issue of batching of elementary observations either within the same replication or across multiple simulation replications. The first batching mode is aimed to minimize the initialisation bias throughout the gathered observations at the price of dealing with correlations among them, while the second batching mode is aimed to do the vice versa. Finding the optimal compromise between the number of replications and the number of batches per replication is the problem focused in this paper, taking as queuing network of reference the so called Central Server Model. Since the sample average performance measures from alternative system's configurations should be compared for ranking and selection, attention is paid to the properties of the variance estimator for the stationary process of interest. Extensive simulation experiments aimed to evaluate the true probability of correct selection will be carried out. Both the analytic solution of the Central Server Model and the regenerative simulation are considered for numerical comparisons.

References:

[1] Alexopoulos C. and Seila A.F. "Output Data Analysis" Chapter 7 in Handbook of Simulation, John Wiley and Sons, Inc. New York 1998.
[2] Alexopoulos C. and Goldsmann D., "To batch or not to Batch", Proceedings of the 2003 Winter Simulation Conference, Chick S. et al eds., luogo 2003
[3]Andradottir S. Argon N.T. "Variance Estimation Using Replicated batch Means", Proceedings of the 2001 Winter Simulation Conference, Peters B.A. et al eds, luogo 2001
[4] Goldsmann D, et al." Ranking and Selection for Steady State Simulation: Problems and Perspectives ", INFORMS Journal on Computing, 14/1 Winter 2002.
[5] Legato P. , "Approximate Solution of a Dynamic Job Shop with Several Job Classes ", EJOR 1993

[6] Shedler G. “Regenerative Stochastic Simulation“, Academic Press 1993
[7] Steiger N. M. and Wilson J.R. “ Convergence Properties of the Batch Means Method for Simulation Output Analysis“, INFORMS Journal on Computing, 13/4 Fall 2001.

Formulation issues on multidisciplinary optimization

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In this work we consider some key aspects of general frameworks on Multidisciplinary Design Optimization (MDO). The latter approaches include several formulation problems, along with challenging issues of design optimization and convergence analysis [1,3]. MDO methodologies naturally arise in a wide range of aircraft, spacecraft, engines and ships applications, whenever the assessment of design variables requires the deep interaction and coupling of different disciplines. Each discipline usually provides an independent optimization problem with its own formulation; however single-objective or even classical multi-objective optimization may be inadequate in case of heterogeneous constraints.
Moreover, each discipline usually handles a subset of variables and uses specific solvers. Therefore, a general "collaborative" analysis, which rigorously formalizes and manages the different approaches, is definitely indispensable for the overall convergence. We investigate some general results about nonlinear programming reformulations of MDO problems [2], on which there is not yet a general agreement in literature. In our work we also discuss some aspects of convergence analysis for these optimization frameworks.

Keywords: multidisciplinary design optimization, nonlinear programming, convergence analysis.
References:
[1] N.M.Alexandrov, R.M.Lewis "Analytical and Computational Properties of Distributed Approaches to MDO", AIAA 2000-4718.
[2] N.M.Alexandrov, R.M.Lewis "Algorithmic Perspectives on Problem Formulations in MDO", AIAA 2000-4719.
[3] E.Cramer, J.E.Dennis, P.D.Frank, R.M.Lewis, G.R.Shubin "Problem Formulation for Multidisciplinary Optimization", SIAM J. on Optim., vol. 4, pp 754-776.

OR IN PRACTICE II

Chairperson: M. Haouari

Formulating stochastic programs using the SPInE Stochastic Extensions for the MPL Modeling System.

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Stochastic Programming (SP) has become an established modeling paradigm for a wide range of applications where contingent decisions are made taking into consideration future uncertainties. Until now, the most common format for specifying stochastic models has been the SMPS format, which has to be accurately generated, either through specific coding or manual entry. Integrating stochastic elements directly into a modeling language can lead to more natural and easily maintainable model formulations for stochastic programs. In this presentation we will present an implementation of stochastic extensions for the MPL Modeling System, called MPL/SPInE. This work results from collaboration between Brunel University, OptiRisk Systems and Maximal Software. MPL/SPInE supports

scenario based recourse problems and handles both two-stage and multi-stage problems. Several stochastic models will be demonstrated and solved using the system.

Evaluating the role of decision makers within small-sized companies by using a viable system model

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Decision-makers within companies face relatively complex strategic planning assignments in terms of assessing the external environment, market attractiveness and competitiveness, and internal organizational variables. Within a larger company, the decision-making process to "go global" would probably be a group activity whereas, within a small-sized company, the decision often arises as a result of the personal decision of an entrepreneur owner or manager. The owners/managers of small-sized companies, as the key players in initiating business decisions, are not homogeneous: they vary in the way they interact and deal with decision uncertainties. Therefore, the behaviour, personality, educational background, experiences and ambition of the owners/managers will affect the interpretation of outside threats and uncertainties and thus the performance of the companies. So, a new decision support tool would aid decision makers in small-sized companies in evaluating alternatives for international expansion, enabling them more accurately to read the environment and the market. This paper argues about the overwhelming influence of these owners/managers on company decision-making and how to avoid the risk associated with it. To illustrate the key issues involved, a decision support model was developed. The proposed model could lead to lowering the risk of inappropriate decisions being made by the owner and/or the senior managers of small-sized companies or at least help them in exploring further knowledge that would assist them in making better decisions. Beer's Viable System Model (VSM), Viplan learning software, and Expert Choice software were used to understand and evaluate the activities of the small-sized company and the roles of their owners/managers. Finally, an evaluation procedure framework is proposed to improve the decision-making process and to solve any problems that might be encountered when small-sized companies wish to expand their operations into international markets.

Keywords:Small-sized companies, Entrepreneurs, Viable System Model, International Expansion.

Compair group decision making mathod and statistical approach on ranking alternatives

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To compare the statistical methods and MADM in classification of alternatives The measurment of the varieties and the norms of tendency to their center, have been a problem for the researchers. In this way , a lot of researchers have studied about the parametric and non parametric statistical relationships between different variables. On the other hand ,some others have worked on the group dicision making. In this article , we have tried to compare the results of the priority base on concentration on center in the above mentioned methodes, it means the statistical methodes and group decision making.

Key words: Group decision making, statistics, ranking.

Programmazione Lineare 2002: il paradosso dell'aumento

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Il Paradosso dell'Aumento consiste di: Trovi prima, la massima soluzione di un problema della programmazione lineare. Poi aggiungere un nuovo vettore colonna al problema originale. finalmente, risolvere il problema cambiato. Il problema cambiato mantiene le stesse c_j della funzione obiettiva e le stesse b_i delle costanti della mano destra. Anche il c_j del vettore colonna deve essere zero o negativo. Il risultato finale avrà un nuovo incremento nella soluzione ottima della funzione obiettiva. Esempi risolti con EXCEL 2000 e usando la versione del Metodo del Simplesso due fasi c'aiuterà a capire la bontà del Paradosso dell'Aumento. Esempi. a) Una compagnia produce tre prodotti con guadagno in ciascuno. È aggiunto un quarto e quinto prodotto con zero guadagno. Risultato: il beneficio finale è un incremento di 30% (da 81.43 a 115). b) Una compagnia produce tre prodotti con guadagno in ciascuno. Un quarto prodotto che è aggiunto con un'unità di perdita genererà un incremento finale. c) Una compagnia produce tre prodotti con guadagno in ciascuno. È aggiunto un quarto e un quinto prodotto con zero guadagno. Il Proprietario vuole produrre tutti i cinque prodotti e la necessità che il Ricercatore Operativo ottenga una soluzione valida. Finalmente, il caso di ottenere $m+k$ variabile di base invece delle m aspettate.

COMBINATORIAL OPTIMIZATION V

Chairperson: P. Avella

PBC: a parallel branch-and-cut framework

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The simple Branch-and-Bound algorithm has a natural parallel structure and it can be easily parallelized. In more sophisticated variant, such as B&C&P, large amount of data must be shared among the processors, resulting in increasing parallel overhead and unbalancing of workload. We want to introduce a framework for a parallel implementation of Branch-and-Cut algorithm. Analyzing and testing different possibilities, we decided to implement a parallel model which consists of workers. The worker is a sequential solver and they work asynchronous and independent. So, on the sequential layer, they work like a sequential solver. Upon the sequential layer, we built a parallel layer, where the workers communicated between each others. They can share their statuses, solutions and subproblems. Preliminary computation results are introduced on an example of generic MIP solver. We are able achieve the linear speedup on moderate difficult MIPLIB instances.

Disjunctive cuts through projection for set covering problems

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Several reduction operations have been described in the literature in relation to combinatorial optimization problems. Examples are blossom shrinking in matching, shrinking in TSP, edge and clique reduction in vertex packing. Besides their theoretical relevance, such reduction operations have also been successfully used as a tool for the solution of practical instances of the problems. The main idea behind this approach is that a solution to the original problem (a good cutting plane for its linear description), can be easily obtained from the solution to (a cutting plane for) the reduced one. From a computational point of view, good results have been obtained, for example, in the realms of vertex packing and TSP. For set covering problems, a "projection" operation have been introduced by Nobili and Sassano without providing computational results. In this work we describe a solution method for set covering which integrates the projection operation with another successful tool for generating cuts, namely disjunctive programming, in a branch-and-cut enviroment. We also report on preliminary computational experiments which show promising results.

Balancing workers' shifts in a junk removal company through a multicommodity multilevel bottleneck assignment approach

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The rostering of workers' shifts for the junk removal company of Crema, in Italy, provides an interesting variant of the classical Multilevel Bottleneck Assignment Problem introduced by Carraresi and Gallo [1]: given a weighted graph of L levels find L-1 complete matchings between contiguous levels, such that the heaviest path formed by the arcs in the matchings has a minimum weight. The problem strives to achieve an even balance of the workload among the workers. To face the present case, in which each worker is qualified to perform only a subset of the possible shifts, the model is generalized with multicommodity features. We propose a Lagrangean Decomposition approach [2]: since the Lagrangean subproblem is not trivial, we introduce upper and lower bounding procedures which generalize the ideas in [1] to a wider framework.

Keywords: Crew Rostering, Bottleneck Assignment, Lagrangean Decomposition
References:
[1] P. Carraresi and G. Gallo, "A Multi-level Bottleneck Assignment Approach to the bus drivers' rostering problem", European Journal of Operational Research 16, 163-173 (1984).
[2] M. Guignard and S. Kim, "Lagrangean decomposition: a model yielding stronger Lagrangean bounds", Mathematical Programming 39, 215-228 (1987).

The comparison of the results of ranking with linear assignment method in job satisfaction and staff performance appraisal

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Lots of researches has been done about the relation of staff performance or personnel efficiency with their satisfaction. These researches are mostly based upon the usage of vote taking methods and statistical analysis for examining the hypothesizes. In this article with usage of multicriterion decision making with persisting on linear assignment.The satisfaction of organization personnel in the presence of different indexes of ranking and their efficiency according to the indexes are ranked and at the end with the help of correlation analysis this relation is studied in decision making perspective.

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