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TuA1. Invited Lecture 1

Recent Algorithms for the Dial-a-Ride Problem

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In the dial-a-ride problem (DAPR), the aim is to determine a set least cost vehicle routes to serve a number of pickup and delivery requests, subject to side constraints. The most common constraints are capacity constraints, time windows, and maximum ride time constraints. The latter constraints specify that no passenger should remain aboard the vehicle more than a preset time.

This presentation surveys some of the work done by our research team over the past eight years. This includes the development of exact and heuristic algorithms, solution strategies for the dynamic DARP in which some of the requests are revealed in real-time, a version of the stochastic DARP in which the arrival time of passengers at their origin is uncertain, and a multi-criteria algorithm for a version of the DARP in which the aim is to jointly minimize solution cost and maximize the quality of service.

TuB1. PRIN project – Nonlinear Optimization 1

Hybrid Proximal Methods for Equilibrium Problems

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This talk concerns developing two hybrid proximal point methods (PPMs) for finding a common solution of some optimization-related problems. First, we construct an algorithm to solve simultaneously an equilibrium problem and a variational inequality problem, combing the extragradient method for variational inequalities with an approximate PPM for equilibrium problems. Next, we develop another algorithm based on an alternate approximate PPM for finding a common solution of two different equilibrium problems. We prove the global convergence of both algorithms under pseudomonotonicity assumptions.

Keywords: Equilibrium problem, proximal point method, pseudomonotonicity

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Prediction of ozone pollutant using Neural Networks and Support Vector Machines

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The aim of this work is to obtain a tool to realize a short to medium term forecast of the hourly behavior of the ozone pollutant's levels. Neural Networks (NN) and Support Vector Machines (SVM) are used to model the interactions that occur between ozone pollutant and suitable input variables. Several sets of variables were considered: meteorological data, pollutant data and calendar variables. The data used in this work covered one year of ozone recorded in the urban area of Rome. Suitable optimization procedures were used both in training and in selection of parameters in NN and SVM. Finally we will confront our results with the ones obtained by traditional methods.

Keywords: Support Vector Machines, Neural network, Ozone forecasting,

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Feature selection of classification and regression models via concave programming and support vector machines

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Feature selection represents a very important step in the learning process and, in the last decades, has been the object of deep studies in various fields such as Bioinformatics, Optimization and Machine Learning. Feature selection methods constitute a key aspect in the analysis of high dimensional datasets. These methods basically consist in eliminating as many features as possible in a given problem, while still carrying out a certain task with good accuracy. An important survey on this topic can be found in [2].

Feature selection involves two competing objectives: the prediction capability (to be maximized) of the mathematical model, the number of features (to be minimized) employed by the model. In order to take into account both the objectives, we propose a feature selection strategy based on the combination of Support Vector Machines (for obtaining good classifiers) [4] with a concave optimization approach (for finding sparse solutions) [1], [3].

We report results of an extensive computational experience showing the efficiency of the proposed methodology.

Keywords: Zero-norm, concave programming, support vector machines

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Models for spherical separation with margin

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We consider the strict separation of two classes of points by means of a sphere. In particular, we define a nonconvex and nonsmooth error function, which can be expressed in a DC (Difference of two Convex) form. Then we tackle the problem of its minimization by adopting the DC-Algorithm. We also propose a very fast solution method to face the case where the center of the sphere is given.

Some numerical results on classical binary datasets are reported.

Keywords: Spherical separation, DC functions, DC-Algorithm

TuB2. Scheduling 1

The Resource Constrained Project Scheduling Problem with Generalized Precedence Relations: A New Exact Algorithm to Minimize the Makespan

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Generalized Precedence Relations (GPRs) are temporal constraints whose introduction has been stimulated by many practical applications. In fact, in some assembling problems or in the construction industry, it happens that the starting/finishing times of pairs of activities have to be separated by at least or at most an amount of time denoted as time-lag (minimum time lag and maximum time lag, respectively). GPRs can be classified into Start-to-Start, Start-to-Finish, Finish-to-Start and Finish-to-Finish relations. Each one of them may be associated with either a minimum or a maximum time lag t, which specify that an activity can start (or finish) only if its predecessor has started (or finished) at least or at most t time units before.

In this paper, we study the Resource Constrained Project Scheduling Problem (RCPSP) with GPRs. From the complexity viewpoint, the problem is strongly NP-hard and also the easier problem of detecting whether a feasible solution exists is NP-complete (Bartusch et al., 1988). To the best of our knowledge, the exact procedures presented in the literature for such a problem are the branch-and-bound algorithms by Bartusch et al. (1988), Demeulemeester and Herroelen (1997), and De Reyck and Herroelen (1998).

In this paper, we propose a new mathematical formulation of the RCPSP with GPRs in terms of mixed integer programming. A branch and bound algorithm exploiting both the latter formulation and a lower bound based on a Lagrangian relaxation of the same mathematical formulation has been designed. In particular, the lower bound is characterized by a fast method to compute an estimate of the optimal Lagrangian multipliers; this avoids the use of more complex approaches to estimate the Lagrangian multipliers, like the subgradient optimization. We provide an extensive experimentation, and a comparison with both known lower bounds and the exact algorithm by De Reyck and Herroelen (1998).

Keywords: Project scheduling, Generalized precedence relationships, Branch and bound

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Hybrid Flowshop scheduling problem optimization

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The hybrid (or flexible) flowshop problem consists to deal with two decisions scheme at once. The first concerns the jobs assignment to parallel machines sets and the second considers the processing sequence of the jobs per machine.

In this paper, we consider a hybrid flowshop problem subject to particular constraints. Indeed, we assume that the assignment of the jobs on the machines is known at advance and some jobs can not be processed through some stages. The objective function is to minimize the total tardiness. The problem of total tardiness on flowshop is proved to be NP-hard, thus the problem considered here is also NP-hard.

We propose an exact and heuristic resolution. The first one is based on the mixed integer linear programming method solved by Cplex solver ILOG software. The second one is an adapted genetic algorithm. Based on Koulams [1] adapted computational test the obtained results are interesting.

Keywords: Hybrid Flowshop Scheduling, Mixed Integer Linear Programming, Pre Assignment

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A matheuristic approach for the total completion time permutation flow shop problem

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The total completion time permutation flow shop problem can be stated as follows. A set of n jobs is available at time 0 to be processed by m machines. Every job consists of m operations where the k-th operation must be processed on machine k. For each job, the k-th operation cannot begin before the $(k-1)$-th operation completes. Preemption on all machines is not allowed. The objective is to minimize the sum of completion times. In this work the search for the optimal solution is restricted to the set of permutation schedules, namely schedules in which every machine has the same job sequence.

We propose a matheuristic post processing procedure that constantly improves the objective function value with respect to the solutions provided by state of the art procedures such as the ones proposed in [1,3] for the 2-machine problem and in [2] for the m-machine problem. The proposed procedure is based on the positional completion times integer programming formulation of the problem with $O(n^2)$ variables and $O(m+n)$ constraints.

Keywords: Flow Shop, Heuristics, Integer Programming

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An iterated greedy algorithm for the job shop scheduling problem with blocking constraints

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The job shop scheduling problem with blocking constraints (BJSS) is receiving an increasing interest in the recent literature. Blocking constraints model the absence of buffers, that in the traditional job shop scheduling model have infinite capacity.

There are two known variants of this problem, namely the BJSS with swap allowed and the BJSS with no-swap. A swap operation is necessary to solve a deadlock, i.e., a cycle of two or more jobs each waiting for the machine occupied by the next job in the cycle. With the swap every operation in the cycle move simultaneously to the subsequent machine. Clearly, if the swap is not allowed the deadlock is infeasible. While the feasibility problem for the BJSS with swap allowed is polynomially solvable, it is NP-complete for the no-swap variant.

We model both variants by means of an alternative graph formulation and solve them with an Iterated Greedy (IG) algorithm. The IG is a constructive metaheuristic based on the repetition of a destruction phase, which removes part of the solution, and a construction phase, in which a new solution is obtained by applying the underlying greedy algorithm. Although very simple and easy to implement, IG algorithms provide state-of-the-art results for the flow shop scheduling problem. In this work we apply this framework to the more challenging BJSS.

Comparison with recent published and unpublished results shows that the iterated greedy outperforms other state-of-the-art algorithms on benchmark instances, is conceptually easy to implement and have a broad applicability to other constrained scheduling problems.

Keywords: Job shop scheduling, blocking, iterated greedy

TuB3. Integer and Combinatorial Optimization 1

Cutting planes for the Stable Set Problem by Semidefinite Programming

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The stable set problem on a graph $G = (V, E)$ is a well-known, strongly NP-hard combinatorial optimization problem, hard even to approximate. The stable set polytope STAB(G), defined in the "natural" (linear) space $R|V|$, where variables are associated to vertices, has been researched extensively. However, many relevant theoretical results on its structure have not led to significant computational success. Upper bounds obtained with linear programming in the linear space tend to be rather weak, often leading to excessively large branch-and-bound trees.

The Lovász theta relaxation [4] is a Semidefinite Programming (SDP) relaxation defined in the quadratic space, where variables associated to pairs of vertices are also included. The resulting upper bound, called the Lovász theta bound, is quite strong in practice. The projection of the feasible region of the Lovász theta relaxation onto the original (linear) space is defined by an infinite family of linear inequalities, called orthonormal representation inequalities (ORIs) [4]. The separation problem for ORIs can be solved in polynomial time with arbitrary precision by SDP. However, to our knowledge, nobody has conducted extensive experiments on such inequalities. A lot of effort has been also devoted to improving the Lovász theta bound [1–3]. The resulting upper bounds tend to be impressively strong, but, unfortunately, computing them is quite challenging.

We show how SDP can even be used to strengthen the ORIs. The resulting cutting plane algorithms are tested on standard benchmark instances and the results are presented. Remarkably, the upper bounds obtained are stronger than those obtained with standard SDP techniques. Even if running times are very large, the proposed algorithms are much faster than other methods improving the Lovász theta bound.

Keywords: Stable Set Problem, Integer Programming, Semidefinite Programming

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The stable set polytope of claw-free graphs with stability number greater than 3

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Chudnovsky and Seymour [1] proved that every claw-free graph with stability number greater than 3 and with no 1-join is either a fuzzy circular interval graph or a striped graph, that is the composition of 5 types of graphs called stripes. In Eisenbrand et al. [2] an explicit description of the stable set polytope of fuzzy circular interval graphs has been given.

Here we give an explicit description of the stable set polytope of striped graphs, thus completing the polyhedral description for all claw-free graphs with stability number greater than 3 with no 1-join.

Keywords: stable set, polyhedral combinatorics, claw-free graphs

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Efficient deterministic algorithms for finding a minimum cycle basis in graphs

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Consider a connected undirected graph $G = (V, E)$ without loops and multiple edges. A (generalized) cycle is a subset of edges C such that every vertex of V is incident to an even number of edges in C. The edge incidence vectors of all cycles of G form a vector space over $GF(2)$, called the cycle space. Given an undirected graph G with a nonnegative weight assigned to each edge, we wish to find a basis of the cycle space of G with minimum total weight, where the weight of the basis is the sum of the weights of all its cycles. Minimum cycle bases are of interest in a variety of fields including, for instance, electrical networks, periodic event scheduling, chemistry and biochemistry.

The problem has been attracting a growing attention. In [1] Horton proposed a first polynomial-time algorithm where a minimum cycle basis is extracted from a polynomial-size subset of candidate cycles in $O(m^3n)$, by using Gaussian elimination. In a different approach, due to de Pina [2] and refined in [3], the cycles of a minimum cycle basis are determined sequentially; the overall complexity is $O(m^2n + mn^2 \log n)$. A more sophisticated hybrid algorithm proposed in [4] has the best complexity of $O(m^2n/\log n + mn^2)$.

In this work we propose a simple hybrid algorithm which improves the best worst-case complexity to $\mathrm{O}(m^2n/\log n)$. This is achieved by restricting attention to the so-called isometric cycles, i.e., those which cannot be decomposed into two cycles of smaller weight. We also propose a variant of this algorithm that relies on a very efficient adaptive independence test à la de Pina. Computational results on a wide set of instances indicate that our algorithm outperforms the previous algorithms by one or two order of magnitude on medium-size instances and allows to solve insatnces with up to 3000 vertices in a reasonable time.

Keywords: Undirected graphs, Cycles, Cycle basis

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When is it sufficient to intersect mixing sets?

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We investigate the polyhedral structure of a family of mixed-integer sets that generalizes the mixing set studied by Günlük and Pochet [1]. These sets can be interpreted as the feasible regions of vertex cover problems, where some of the variables are continuous and the other variables are integer. Furthermore, this family of sets includes as special case a lot-sizing model with sale variables.

We show that the convex hull of any set in the family is given by the intersection of an exponential number of mixing sets, each of which can be obtained as a simple relaxation of the initial set. We also show how to solve the separation problem in polynomial time. We conclude by illustrating how these results suggest a conjecture concerning the polyhedral structure of a more general class of mixed-integer sets.

Keywords: Convex hulls, mixing sets, lot-sizing

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TuB4. Urban Transportation

On Designing Home-to-Job Transportation Service Plans

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We present a mathematical model and a metaheuristic algorithm to design a bus service plan for the home-to-job transportation of a large research center in Italy. The ENEA Casaccia Research Center is located in the outskirts of Rome, and around 1500 people work there with a full term contract. Currently, the bus service plan consists of 22 bus routes with 300 bus stops in the Rome metropolitan area. Each bus ends its morning route at the center at 08:00 AM, and it follows the reverse route job-to-home leaving the center at 04:00 PM. ENEA does not own the buses and the bus service is outsourced. The bus stops and the bus routes are the specifications of the bus service plan. Transportation companies make their proposals according to this plan. The bus service plan must determine both the location of the bus stops, and the bus routes. A specific characteristic of this problem is that a bus stop can be equivalently located at several nodes in the road network. The number and the candidate locations of bus stops are long-term decisions and are considered as given in this study.

The Home-to-Job Transportation Problem (HJTP) focus on the route design, i.e choosing where bus stops are placed among equivalent locations, and determing their routing. The objective is to minimize total cost and maximizing passenger perceived quality of service in order to attain the largest modal shift from cars.

Keywords: Generalized vehicle routing problem, time windows, tabu search

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Control strategies in managing congested urban networks

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Modern cities, due to the increasing numbers of vehicles circulating on road infrastructures, have to face congestion problems and their negative social, economic and environmental consequences as travel times delays, impossibility to forecast them, fuel consumptions and pollution, car accidents, etc. Unfortunately, since the opening of new roads and/or the increasing of urban infrastructures capacities could be expensive solutions, a lot of control techniques have been developed and integrated in last years in order to realize decision support systems able to regulate and improve traffic flows and increase safety.

The aim of this talk is to present techniques to optimize the viability conditions on some portions of Salerno urban network, in Italy, characterized by heavy traffic. For the description of cars behaviour, we use a fluid dynamic model, based on the conservation of the cars mean number and on the dynamics resolution at intersections by linear programming problems [3]. In order to control traffic flows, two performance indices, measuring the kinetic energy and the average travelling time of drivers, weighted with the number of cars moving on roads, are maximized and minimized, respectively, with respect to distribution coefficients and right of way parameters at junctions [1, 2]. Numerical results on complex networks prove that a total decongestion effect on roads is possible when local optimal traffic coefficients are used. To discriminate among different optimization policies, the stop and go waves functional, measuring the velocity variation, is considered.

Keywords: Congestion, conservation laws, local optimization

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A multiscale approach to capture crowds dynamics

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Aggregation points such as squares, stations and airports, are usually characterized by crowds, complex systems in which group dynamics and interactions plays an essential role. The scientific community is making a lot of efforts in order to define models able to capture the behaviour of people flows. The comprehension of crowds dynamic is crucial in exits planning or to individuate counter-measures, which can improve people safety in the case of events which can attract a lot of people.

The aim of this talk is to present a macroscopic model, based on the measure and optimal transport theories, for the dynamic behaviour of crowds. We assume that pedestrians are in motion within a bounded area Ω with a target to reach. It can be an exit or a passage, identified by a portion of the boundary of Ω. The space filled by pedestrians is described by a sequence of Radon positive measures, obtained by recursive relation of push – forward type (see [1], [2]). For pedestrians, it is defined a velocity, consisting of two components: the desired velocity, that each individual has in the walking area toward her/his target; the interaction velocity, which represents the pedestrians trajectories modification to avoid crowding. Dirichlet and Neumann boundary conditions are used to define a unique solution to the equation of the desired velocity. Fixing some parameters as the initial density and the exit position, different scenarios are simulated changing the position of one or two obstacles inside Ω, in order to find the obstacle configuration which minimizes the pedestrian average exit time.

Keywords: Pedestrian flow, crowd dynamics, exiting times optimization

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Optimal paths selection based on traffic load and/or security indices

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In this talk we present an algorithm that, given origin and destination, is able to individuate the best route on graphs, in accordance to the user preferences. The user can require a support in selecting the route which avoid critical areas (such us areas subjects to landslides, earthquakes, flash floods) and/or the route that permits him/her to reach the destination with the minimum travelling time.

The aim is achieved combining a fluid-dynamic model for road networks [2] and Operational Research techniques for optimal paths on graphs. The fluid dynamic model, according to initial car densities on roads and traffic coefficients at junctions, forecasts the future density, giving dynamical weights to a constrained K shortest path algorithm. Beside travelling times weights, security indices are considered. In particular, the chosen approach for the solution of the problem, is based on a modification of that proposed in [1], adapted in sight of constraints. So, it is proposed a mark correction method for identifying constrained K shortest path which are also Pareto-efficient.

Keywords: Constrained Shortest Paths, traffic evolution , security weights

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TuC1. PRIN project – Enhancing the European Air Transportation System 1

Fleet Quickest Routing on Grid Subgraphs

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We consider a routing network where a fleet of vehicles have to move from their origin to their destination. Network nodes correspond to vehicle origins and destinations, route crossing points or points where vehicles are allowed to stop and stay idle. Arcs correspond to directed or undirected routes between couples of nodes. For each arc/node a capacity is given, corresponding to the maximum number of vehicles that can move/stay idle on it. For each arc, a fixed traversal time is also given.

The Fleet Quickest Routing (FQR) problem consists in determining a route for each vehicle in order to let it reach the desired destination as quickly as possible, e.g. minimizing the sum over all the arrival times. The problem arises in many contexts: the coordination of automated guided vehicles, the management of airport groundside traffic etc [2, 4]. A possible solution is to route vehicles on shortest paths. However, conflicts may arise, as several vehicles may need the same node or arc at the same time and capacity constraints might be violated. To avoid conflicts, vehicles may stay idle at some nodes for some time, waiting for the next arcs to become available. It follows that moving on a set of shortest paths may not be the optimal choice. Actually, FQR is NP-Hard on general networks [1, 3], while a polynomial Dispatching Algorithm (DA) [1] solves it on grids with equal arc traversal times and simultaneous vehicle starts.

In this work, we propose an analysis toward fast heuristic solutions to more general FQR problems, based on modifications of DA. We consider non-complete grids, with arbitrary traversal time and arbitrary vehicle starting positions and times, and we compare different methods. Proposed methods apply the basic DA and use priority rules to solve detected conflicts. A simulation model is used to analyse the performance and compare different conflict management strategies.

Keywords: Fleet routing, Quickest paths, Simulation

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A branch-and-price algorithm for the Airport Equipment Allocation problem

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The development of air traffic has increased the congestion of major airports. Indeed, sensible delays may be caused by ground operations and tools are needed to increase the efficiency and the safety of the apron area, as pointed out by the European sponsored project AAS-Integrated Airport Safety Fleet Management. This work addresses the problem of efficiently providing the operations taking place in the airport apron with necessary ground service-support equipment (GSE). We are given a set of GSE (stairs, tow-trucks, baggage dollies etc.) and a set of tasks located in space (aircraft location) and in time (as from schedule), together with compatibility rules and allocation costs. A fast heuristic is available [1].

In this paper we propose an exact approach based on a Mixed Integer Linear Programming formulation. As in [2], we consider a partitioning model based on path variables and we apply a solution strategy based on column generation. The problem is modelled on a task-graph: nodes are associated to tasks, and oriented arcs represent time compatibility between pair of tasks (a GSE cannot serve more than one task simultaneously). Arc costs depend on GSEs and give the cost incurred if a GSE is allocated to a task and then to another one, based on distance, fuel-consumption, emissions etc. Each variable represent a path from the source of a GSE to its destination, through a set of compatible task-nodes. The minimum cost solution is determined by a Branch-and-price algorithm [3,4], considering branching on arcs. The column-generation sub-problem can be efficiently solved as a shortest path problem on the acyclic network obtained by suitably modifying the task graph.

The algorithm has been implemented using SCIP (1.2.0) and computational test show that the algorithm can very efficiently solve instances of up to one hundred nodes in a few minutes.

Keywords: Airport Apron Optimization, Vehicle Allocation, Branch-and-Price

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Market Mechanisms for Airport Slot Allocation in Europe

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The predicted growth in air traffic sets major challenges for the European Air Traffic Management over the next years. For being able to cope efficiently with the increasing demand, several changes will need to be implemented in the current system. In this study we propose a novel procedure for the allocation of slots at airports and en-route sectors. Currently, this allocation is performed following the guidelines defined by International Air Transport Association [2]. It is based on three main points: enforcement of grandfather rights; use-it-or-lose-it rule; new-entrant rule. After a primary allocation airlines can exchange slots on a one-to-one basis. The resulting procedure is generally recognized not to favor competition, and not to provide incentives to maximize efficiency in the use of slots. Moreover, airspace congestion is not taken into account. This implies that any lack of airspace capacity is not identified early enough for coping with it without incurring delays.

We propose two mixed-integer programming formulations, one for tackling the primary allocation and one for formalizing the secondary slot market. The former is a variant of a model proposed in the literature for tackling the Air Traffic Flow Management problem in the tactical phase, i.e., few hours before the actual execution of flights

[1]. The latter represents a combinatorial exchange market, in which multiple airlines can be both buyers or sellers [3].

We test these models on 100 randomly generated instances, simulating traffic over a portion of Europe in 5 hours. We consider 2200 flights of 20 airlines on a network of 60 airports, 4 of which hubs, and 300 sectors. We evaluate the cost implied by three main characteristics of the current system: first we assess the impact of not taking into account en-route capacity constraints; second we measure the positive effect of formalizing the secondary market; third we calculate the inefficiency of the system based on grandfather rights.

Keywords: Air Traffic Management, Slot Allocation, Combinatorial Exchange

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Airport master plan: environmental analysis tools integrated with a fast-time simulation model

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Civil Aviation is one of the major growing components in the transport sector and in the next ten years airport's facilities will be required to adapt and enhance. In Europe some of the already congested airports are working on new masterplans to increase efficiency and expand their capacity. In Italy, Rome Fiumicino and Milan Malpensa, the biggest national airport operators lately stated their intention to build at least one more runway. It's widely agreed that a sustainable development process must be undertaken in order to enable the foreseen economic growth consistently with required environmental quality standards either on local basis (noise and pollutants), considering people living near the airports, and on global basis to contain the emissions of carbon dioxide. Cooperation among all the stakeholders is required in the project phase, the airport analyst

is put in charge of designing the key technical aspects. On the basis of the master plan the airport operator has identified, and of a hypothetical fleet mix, the analysts in fact elaborates scenarios with the lowest impacts on the environment using environmental simulations models, both for noise and for air quality analysis, integrating them with a fast-time simulation tool.

In this talk we present a thorough study on the environment impact of airport operations. This study required the integration of several tools; more specifically the Integrated Noise Model (INM) for the calculation of noise levels; and the Emissions and Dispersion Modeling System (EDMS) for the inventory of pollutants' emissions and the calculation of their concentrations in the surrounding areas of the airport. SIMMOD PLUS is used as simulation engine. This integrated approach provides a methodology for the assessment of environment impacts in airport operations. It may also be used to evaluate the effect of environment policies, limitations imposed on air traffic to mitigate their environment impact in tems of efficiency and capacity

Keywords: Environment, airport capacity, simulation

TuC2. PRIN project – Multimodal Freight Transportation 1

On some Generalized Nash equilibrium problems in freight distribution environment: properties and existence conditions

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A game theoretic approach for pricing decisions in the context of freight transportation is considered in this talk, by taking into account the interactions among three different classes of actors involved in the process of freights distribution on the same distribution network, i.e. receivers, sellers and transporters, that are modelled as non-cooperative Cournot-Nash agents. In our setting, sellers can fix the prices and the production quantities in order to maximize their profits, while receivers are characterized by a given level of demand that is divided among the different sellers depending on their associated delivered price, which includes both purchasing and transportation costs. The transporters are the agents who operate the transfer of goods from sellers to receivers, by defining a transportation price in such a way to maximize their own profits.

The focus of this talk is on the study of the relevant properties of the Generalized Nash Equilibrium Problem arising from all the interactions among the players. In particular, sufficient conditions for the existence of a Generalized Nash Equilibrium for the given problem are derived, imposing additional mild assumptions on the parameters of the demand functions, consistently with the hypotheses on the underlying oligopolistic context.

Keywords: Freight distribution, Game Theory, Generalized Nash Equilibrium Problem

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Ship stowage planning via simulation-optimization

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Ship stowage planning is a two-step process. The first step is executed by the shipping line, which has to design the stowage plan for all ports of a vessel's rotation on the basis of container groups or "classes", rather than single containers. According to this plan drawn by the shipping line, in the second step the terminal's shipping planner has to assign exactly one container of a given class, selected in the yard, to a suitable ship slot. Here we consider the terminal planner's point of view and concentrate on the ship stowage planning problem as it arises at a transshipment container terminal. Furthermore, we consider an extensive yard, where containers are moved by a fleet of straddle carriers. The strong interaction between the problem under consideration and the yard layout and equipment is evident. The contribution to the ship's berthing time related to the loading process is given by two terms: the total transportation time of containers from yard to quay, including the time wasted by reshuffles (unproductive moves), and the total loading time.

Within the global aim of reducing the time to perform loading operations, we propose a simulation-optimization solution methodology which uses a tabu search algorithm to explore the solution space combined with a discrete-event simulation model to estimate the cost of each solution, i.e. container handling and transfer time from the yard to the ship.

Keywords: Simulation Optimization, Container Terminal Logistics, Heuristics

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Import flow analysis in maritime terminals using Petri Nets

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Since the last three decades the noticeable raise in the standardization of goods has increased the intermodal transportation system; this represents a very important change for ports to increase their traffic, but can lead to congestion problems with a subsequent relapsed on port competitiveness. Companies managing maritime terminals have hence the need of optimizing all the operations involved in the container flow in order to achieve the maximal global productivity. Moreover, nowadays port competitiveness more than ever depends on the quality of services provided by the terminal operators, which are required to reduce the overall costs through an adequate and efficient organization in handling and moving containers. Therefore, handling operations and their connections with the transportation system and the marine interfaces are now a crucial factor for the economic survival of maritime terminals. For these reasons, a noticeable effort has been devoted in the recent operations research literature to the application of either discrete event simulation techniques or heuristics for optimizing in/out-flow terminals operations [1,2].

Having in mind the above competitive key factors, in this work we focus on the analysis of the import flow of containers at maritime terminals, from the quay to the gates and the connections to inland modalities. We represent routes of containers and their interaction with both structural components and equipments by Petri Net (PN) models. Our main aim is to determine handling resource assignments and control policies that can prevent inoperability of both the transfer and handling system, due, for instance, to a non-synchronization between quay and yard equipments, as well as yard and gate ones. Preliminary results confirm that PN models are particularly suitable for capturing the concurrent and conflicting processes that frequently arise in maritime terminals and for detecting and avoiding potential deadlocks.

Keywords: Resource assignments, Deadlock, Petri Net

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A mixed integer linear programming model for crossdocking platform freight flow optimization

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Crossdocking is a logistics strategy used to improve the effectiveness of goods distribution by aiming to decrease inventories and transportation supply chain costs. A distribution network is an integrated set of suppliers, distribution platforms and customers where strategic, tactical and operating decisions related to a single player could produce effects on some (or many) others. However in a starting phase of analysis we decided to isolate from the context and address the distribution problem related to a sole crossdock. A crossdocking platform is characterized by several aspects which do not allow to represent it in a single transshipment node. For example in a crossdock many operations such as labelling, consolidating are handled and, in order to take into account the related costs, it is necessary modelling it through a transshipment nodes network. We have proposed a model which brings in these aspects.

The modelling idea is that the crossdocking, with appropriate differences, can be formulated as a Fixed Charge Network Flow Problem, well-known NP-hard problem. To solve the model two exact approaches, a Branch and Bound and a Branch and Cut algorithm, have been developed. Xpress-MP has been chosen as optimization software. Moreover we have proposed a Branch and Bound different from the default software procedure and a Branch and Cut with customized valid inequalities. For large scale instances a heuristic procedure has been added in the root node to help the algorithm in finding an integer feasible solution. The results obtained using standard and customized procedures have been compared. The future development of this study is connected with the application of the proposed model to the management of a terminal container.

Keywords: Crossdocking, Flow-distribution, Exact Algorithm

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TuC3. Game Theory and Nonlinear Optimization

Copositivity detection by difference-of-convex decomposition and omega-subdivision

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Copositive programming is a conic optimization technique to solve several NP-hard problems, among them mixed-binary QPs or Standard QPs. Applications range from machine learning to several combinatorial optimization problems, among them the maximum-clique problem or the max-cut problem. Copositive programs have linear objective and linear constraints, and in this formulation the complexity of the problem is shifted entirely to the feasibility question.

Here we present three new copositivity tests based upon difference-of-convex (d.c.) decompositions, and combine them to a branch-and-bound algorithm of omega-subdivision type. The tests employ LP or convex QP techniques, but also can be used heuristically if educated guesses are available and preferred. We also discuss the selection of efficient d.c.-decompositions and propose some preprocessing ideas based on the spectral d.c.-decomposition. We report on first numerical experience with this procedure which are very promising.

Keywords: Conic programming, Mixed-integer QP

Decentralized Optimization Problems with Cooperating Decision Makers

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Optimization problems are investigated, in which a group of decision makers (DMs), each having at disposal some information (obtained, e.g., by measurement devices or exit polls) and various possibilities of decisions, coordinate their efforts to achieve a common goal, expressed via a team utility function. Decisions are generated by the DMs via

strategies, on the basis of the information available to each of them and in the presence of uncertainties in the external world, which the DMs do not control.

In general, one centralized DM that, relying on the whole available information, maximizes a common goal, provides a better performance than a set of decentralized DMs, each of them having partial information. However, often centralization is not feasible, e.g., when the DMs have access to local information that cannot be exchanged instantaneously. In other cases, the cost of making the whole information available to a unique DM may be too high with respect to having several DMs with different available information. Team organizations abound in science, engineering, and everyday's life: communication and computer networks extending in large geographical areas, production plants, energy distribution systems, traffic systems in large metropolitan areas divided into sectors, freeway systems, etc.

In the team optimization problems that we address, the information of each DM depends on a random variable, called "state of the world". A "statistical information structure", is given, i.e., the information available to each DM is expressed via a probability density function. Properties of the optimal solutions to such problems are investigated. Certain approximation schemes are considered to derive suboptimal solutions, whose accuracy is estimated. As an application, optimal production in a multidivisional firm is considered and numerical results are presented.

Keywords: Cooperative games, information structure, approximation schemes

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A clique algorithm for finding all local, global, and cardinality constrained optima in Standard Quadratic Programming

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One of the simplest, but still NP-hard, nonconvex quadratic problems is that of minimizing a quadratic function on the standard simplex (StQP). This problem has many applications, including finding a maximum (weight) clique in a graph, testing copositivity of a matrix, and finding optimal mean-variance portfolios.

We present here a method for finding all local and global solutions to a StQP that is based on new theoretical results for quadratic programming and on a reduction to a nonlinear maximum weight clique problem. Our method also has the advantage of being able to solve the cardinality constrained version of the problem with no additional computational effort.

The algorithms based on our approach are considerably more efficient than those reported in the literature for this problem and can also be applied to minimize a quadratic function on more general polytopes when the number of their vertices is not too large.

Keywords: Nonconvex quadratic programming, Maximum clique, Global optimization

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Auctions as allocation tools

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In this paper we face the problem of the allocation of different typologies of items from one actor to one actor to be chosen in some way from a certain number of other actors. In order to solve this problem we describe the possible uses of various types of auctions of which we give the rules, the best strategies and the properties we wish they satisfy. The properties are expressed through classical performance criteria such as: guaranteed success, Pareto efficiency, individual rationality, stability, and simplicity. The items that are exchanged within the proposed auctions types can have either positive values (so that they are seen as goods) or negative values (so that they are seen as bads or chores) for all the involved actors and can concern also the exchange of services among them.

With these aims we build on classical auction types (both open cry and sealed bid auctions) and classical auction theory results (such as the "Revenue Equivalence Principle" and the "Revenue Ranking Principle") but rapidly divert from the classical path and present both positive auctions (where the bidders bid to get the auctioned items) and negative auctions (where they bid for not getting such items).

Within the former type we consider variations of Dutch and English auctions as well as variations of candle auctions (with a random termination time). Within the latter type we propose a mechanism based on the compensation to the bidder who gets the auctioned item (the losing bidder) from the other (winning) bidders. The various mechanisms are presented in their basic versions though for each of them we present the possible extensions and the possibilities of interactions among the bidders through side effects and post auction redistributions and possible compensations.

Keywords: Auctions, allocation tools, compensations

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TuC4. Healthcare Management

Solutions for the Master Surgical Schedule and Case Assignment Problem

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Given an hospital department made up of different surgical specialties sharing a given number of Operating Rooms (ORs), the Master Surgical Schedule Problem (MSSP) consists in determining, over a given planning horizon, the allocation of OR blocks time to surgical specialties, while the Case Assignment Problem (CAP) gives together with the subsets of patients to be operated on each block time. Different resource constraints related to operating block time length, maximum OR overtime allowable by collective labor agreement and legislation, patient length of stay (LOS), available OR equipment, number of surgeons, number of stay and ICU beds, are also considered [1].

The problem was previously addressed in [2] where the authors proposed a 0-1 linear programming model which minimizes a cost function based on a priority score taking into account both the waiting time and the urgency status of each patient. Moreover, in [3] an heuristic algorithm, based on some pre-assignment rules, has been successfully tested on small real instances to reduce the time complexity of this NP combinatorial optimization problem.

In this paper, we discuss how to take into account two key issues strongly influencing the economic sustainability of a MSSP solution: the costs of extra bed occupation and the cost of OR overtime. We introduce a new 0-1 linear program model and we discuss the development of a local search metaheuristic algorithm to find solutions for the extended MSSP. Moreover, we discuss also the use of our metaheuristic algorithm in order to find a solution for larger instances with respect to those solved in [3]. The proposed approach can be also discussed as a tools for supporting decisions through a scenario analysis: we can show the welfare implication of available budget variations.

Keywords: Healthcare, 0-1 linear programming, metaheuristics

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Operating Room Planning and Scheduling: a Multiobjective Model solved via Genetic Algorithm

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In recent years, increasing interest of Operation Researchers community has been devoted to the domain of operating room planning and scheduling. Within this complex and broad context, since the conflicting nature of several goals, we have developed an optimization model formulation whose main aim it to assign surgeries of different surgical specialties to multiple operating rooms in a block system based strategy. The model determines the assignment of time slots to the surgical teams and schedules the elective inpatient surgical operations on the basis of clinical priorities. The model is based on a multi-objective approach and solved by a suitable implementation of genetic algorithm. The proposed multi-objective approach takes into account and suitable balances some strategic and conflicting goals, related to the improvement of resources utilization and considering patient's priority value. The set of efficient solutions have been obtained on several scenarios, based on both real-life data and random data.

Preliminary results demonstrate the effectiveness of the proposed approach and confirm the strategic impact of optimization quantitative approaches as effective and efficient tools for complex decision making problems in the organization and management of health care delivery.

Keywords: Operating Room Management, Multiobjective Programming, Metaheuristics

Scheduling operating rooms under uncertainty: a stochastic programming approach

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Operating theatre planning aims at optimally scheduling the surgical operations that will be performed in a considered planning horizon (one or two weeks), together with the date of the intervention and the operating room (OR) in which the surgical case will be performed. The scheduling should take into account human, material constraints and surgical resources constraints as well as the inherent stochasticity characterizing the operating theatre environment (i.e . random surgical durations and random emergency patient arrival process). This clearly implies possible disruptions on the elective surgeries scheduled on that day that may cause confusion in the daily work. Therefore, it is of paramount importance to take uncertainty into account in the planning phase.

The aim of this paper is to develop stochastic mixed integer programming models to solve the advance scheduling problem in the presence of uncertainty. In particular, a novel stochastic two-stage mathematical model is proposed for the scheduling both elective and emergency cases under the hypothesis that ORs are identically equipped and no special OR exists for the emergency cases, both elective and emergency operations have stochastic duration, and each surgical case can be assigned to any OR. In the proposed model decisions concerning the set of elective cases to be performed in each period over the planning horizon are taken "here and now" to hedge against all the future circumstances that may occur, whereas corrective actions that might postpone some scheduled surgery to a later date are taken in the second stage. The model objective aims not only at maximizing utilization of operating rooms, but also at minimizing both over-utilization and under-utilization of ORs, as well as the penalty of delaying surgery to a later date.

Keywords: Operating room management, stochastic programming

Week Hospital Inpatient Flow Management

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Week Hospital is an innovative inpatient health care organization and management, by which hospital services are planned in advance and delivered on week-time basis for

elective patients. In this context, a strategic decision making problem is related to the optimal clinical management of patients, and, in particular, to the implementation of efficient and effective admission and scheduling procedures, by tackling different requirements (e.g., beds' availability, diagnostic resources and treatment capabilities). The main aim is to maximize the patient flow, by ensuring that for each admitted patient all the required clinical services are delivered during the week.

In this work, the optimal management of Week Hospital patients is considered, by developing and validating an innovative integer programming model, based on clinical resources allocation and beds utilization. In particular, the proposed optimisation model aims at scheduling, in an effective and efficient way, Week Hospital patients' admission/discharge, possibly reducing the length of stay on the basis of an available timetable of clinical services. The performance of the model is evaluated, in terms of efficiency and robustness, by considering real data coming from a Week Hospital Rheumatology Division.

The experimental results seem satisfactory and demonstrate the effectiveness of the proposed approach.

Keywords: Patient Flow Management, Integer Linear Programming

WeA1. PRIN project – Enhancing the European Air Transportation System 2

Computational experience on a detereministic model for air trafic flow management

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This work develops a complete version of the Air Traffic Flow Management (ATFM) problem on a short term policy. The problem objective is to decide, for each flight, how to develop the route to follow and cancellation, if any, according to company priorities. The problem restrictions are due to capacities of departures and arrivals in airports and the number of flights that may fly within a sector, at a given time. As a distinguishing feature, we have also considered rerouting decisions in the problem.

The model that we present achives an optimal combination of flow management actions, including ground-holding, rerouting, speed control and airborne holding on a flight-by-flight basis. Mathematically, we create an air network divided on a set of sectors. Its nodes are the airports and waypoints while its links describe all given possible routes, alternative routes to the main one are allowed. We represent rerouting options in the model by only introducing some new constraints which implement local routing conditions. The problem is modeled as a tight large-scale pure 0-1 model.

Extensive computational experience is reported.

Keywords: Air traffic flow, ground holding and air delays, mixed 0-1 optimization model

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Network effects in air traffic congestion: a simulation approach.

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In this talk we present a simulation model to study network effects in air traffic congestion. More specifically, we evaluate the propagation effects of hub-to-hub delays on the whole network. This work is inspired by the recent studies of Odoni and his collaborators who investigate a similar problem for the continental US air traffic.

However, with respect to mentioned work by Odoni, the simulation model herein proposed considers as process of arrivals a particular stochastic process, named pre-scheduled random arrivals. This process with respect to the standard Poisson process used in this type of applications has the following features:

i) it is close to the Poisson process (which fits well with the actual interarrival time data) if compared on short time scales,

ii) it is much more accurate of the Poisson process to give an a-priori estimate of the distribution on the length of the queue in the air traffic.

iii) it is suitable to incorporate the details of the random delays of the aircrafts into the arrival process.

Finally, we compared the simulation results with those obtained with a simplified stochastic model of the entire network.

Keywords: Air Traffic Management, Simulation, Stochastic Process

Optimal scheduling for aircraft departures

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The major aviation entities are concentrating their efforts on issues regarding the negative consequences due to delays in ground operations. Hence, many researchers are analyzing different methodologies to minimize the effects that generate such delays.

This talk concerns the formulation of a mathematical model for a Departure Management system [1] planned to support the air controllers work, minimizing delays in departure operations. The followed approach is based on a two stage algorithm [2] to schedule take-offs, in which only two main objectives and some hard constraints are considered. So, a complex problem dealing with multi-objective functions [3] is split into two inter-connected one-dimensional problems. In the first stage, the aim is to maximize the throughput, defined as the number of aircraft in the time unit, subject to Wake Vortex Separations constraint and mixing the landing operation of arrivals with an "ad hoc" heuristic. In the second stage, the class sequence, generated by the first one, is computed in order to minimize the delays between the actual and estimated take-off time of each departing aircraft, subject to fixed CTOTs (Calculated Take-Off Time) at which each flight is assigned. The result of such elaborations is the optimal take-off sequence in some referred time window.

Simulations on typical flight strips from Milano Malpensa airport are shown.

Keywords: Air controllers, Departure Management System, optimal take-off sequence

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Critical flights and airspace resources in air traffic flow management

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The Contact-based Air Transportation System research project proposes a formal commitment (Contract of Objectives) among airspace users, airport and air navigation service providers for the conduction of each flight. This contract consists of a sequence of spatial and temporal constraints (Target Windows) inside which each air traffic actor engages in delivering its services during the flight execution. By only considering the temporal dimension, this paper defines a set of intervals, called time windows, whose size is variable as it reflects all known constraints, such as punctuality at destination, runway capacities or congested en-route areas that the flight will cross. Once a time window is defined, all the air traffic actors are committed to guarantee that all flight operations are executed within this time window.

We propose a two-step approach based on a mixed integer programming formulation. The first step determines a set of time windows such that the overall cost of delay is minimized. Then in the second step we choose the set of optimal time windows which also maximizes the overall time window size. In such a way, we provide to all air traffic stakeholders the largest degree of flexibility to perform their operations under the constraint that the minimum achievable delay is kept constant. We also gain information on the critical flights of the system: if the optimal width of a time window is equal to its minimum available value, any disruption that may cause the flight not to meet it may produce undesired downstream effects. Our preliminary computational experience confirms that the flexibility granted to flights increases with the capacity while the system delay simultaneously decreases. We also show that when there is no congestion a non negligible share of small size time windows may exist, thus indicating the existence of bottlenecks and critical flights.

Keywords: Air Traffic Flow and Capacity Management, Time Windows, Air Transport

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WeA2. Maritime Terminals 1

A comparison of different management policies for train load planning in seaport container terminals

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In this work we deal with one of the landside transport optimization problem faced in seaport container terminals that is the train load planning problem. According with [1], the problem under investigation can be defined as follows: given a set of C containers in the stocking area and a set of W wagons for one train, given the length and the weight of each container, the loading plan problem consists in determining on which wagon each container has to be placed in such a way to respect some structural constraints of both the train and the wagons and to optimize the load of the train. The train load plan depends on many factors, among others on the containers location in the storage area, the destination, type and weight of the container, the load of the wagon and the wagon's position in the train. Also the management policies of handling operations affect the load planning. Presently, we consider a simple scenario where train load planning of import containers on one track must be defined. We assume to plan the train loading operations for trains one by one. Moreover, we assume that the transfer of containers from the stocking area to the train is realized by reach stackers, tractors and overhead traveling cranes.

We analyse and compare two different management policies of handling operations. In the first case we suppose that the overhead travelling crane loads the train sequentially (starting from the first wagon onwards) and some rehandling operations in the stocking area are allowed, whilst in the second case no rehandling operations in the stocking area are permitted but we admit that the overhead travelling crane does not load the train sequentially.

Two mathematical programming formulations referring to these management policies are proposed. The cost terms to be minimized are related to the cost associated with a penalty cost of not loading containers, plus the cost associated with unproductive movements. Preliminary results are given.

Keywords: Train load planning, maritime container terminal, mathematical programming

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Some optimization models in management of automobile-dedicated seaport terminals

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Operational management issues of the automobile-dedicated seaports exhibit relevant similarities to those of the maritime container terminals. In fact the core of the processes are in both cases related to transshipment operations. On the other hand significant differences are due to the following points: each car move requires a dedicated driver; maintenance and customisation activities must take place for at least a subset of the stored cars.

In the talk we survey the main characteristics of the ICO BLG terminal at Gioia Tauro, focussing on the operational decision making processes for the cars that do not require mere transshipment, but are also subject to maintenance/customisation operations and, consequently, to housekeeping moves. We describe some optimisation models aimed at modelling both the yard reconfiguration and the maintenance/customisation operations scheduling.

Keywords: Maritime terminal management, Yard planning, Transshipment

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Optimizing Yard Assignment at an Automotive Transshipment Terminal

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We discuss an operational problem arising in an automotive transshipment terminal. Maritime automotive transportation is developing along lines similar to container transportation where the hub and spoke arrangement is widely adopted. Automotive

transshipment terminals manage large flows of incoming and outgoing cars. Unlike containers, cars are "fragile" objects that require careful and consequently labour intensive handling. Cars cannot be stacked and this results in larger yards with respect to container terminals. Once assigned to parking rows, the cars are not relocated inside the yard, i.e. their initial yard position is not modified during their duration of stay. The reason is that a re-handling process will augment the risk of damage which has to be kept at the lowest possible level. This "no-relocation" rule, combined with the low density yard, augments the importance of optimal yard assignment. In fact, the total traveled distance becomes a critical issue in such a low density yard. The transport of a car from the quay to the parking slot is performed by a driver. In the following we will indicate as a group a set of cars that arrive and depart by the same pair of vessels, and are of the same type (car model and brand). In order to facilitate the yard management and the driver gathering process, a group is allocated to a set of adjacent parking rows. The number of required parking rows depends upon the car length, and upon the row length since the rows have variable lengths in the yard. Yard managers prefer not to share a row between different groups. Therefore, partially empty rows are possible.

We present an optimization model and a metaheuristic algorithms for the yard allocation process. The model has been implemented in a commercial integer linear programming solver (CPLEX). The metaheuristic algorithm is inspired by the well-known Adaptive Large Neighborhood Search (ALNS) framework.

Keywords: Automotive transshipment terminal, Adaptive Large Neighborhood Search

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Optimizing berth allocation in a real container terminal

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The Berth Allocation Problem (BAP) (Lim 1998) is receiving an increasing attention at the port of Gioia Tauro. The problem concerns the optimal matching between a set of

space slots available along the quay and a second set of incoming vessels to be berthed in these slots along a fixed time horizon. It has been tackled by discrete-event simulation (Legato et al. 2008) to evaluate policies of dedicated allocation and what-if analysis have been linked to the best practices. The simulated key feature is that each group of (adjacent) slots is assigned to one vessel and is held for a variable time length, within a fixed time window. With the aim of minimizing the time elapsed between the occurrence of a vessel request for berth space (upon arrival) and the time when the assigned space is released by the same vessel, the whole quay length is represented as a continuous sequence of variable berthing segments and vessel length can be considered explicitly.

This work is motivated by the Terminal Manager's demand for an optimization tool to support berthing decisions by a what-to approach within a simulation-based optimization procedure. Research effort was mainly required to face the long continuous quay under some real constraints (elbow-bended quay, different drafts along the quay). We have extended a promising stochastic beam search approach (Wang and Lim 2007) to capture these constraints. Once a good feasible solution has been provided, we apply a scatter search technique to achieve significant improvements in a reasonable computing time.

Numerical results, on real instances, are compared against a tabu search heuristics previously developed (Cordeau et al. 2005) to establish which algorithm to embed in the simulation tool.

Keywords: Port logistics, assignment, heuristics

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WeA3. Logistics and Transportation

A Multi-Robot Allocation Approach for a Dynamically Reconfigurable Production System

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In this paper, a factory producing a set of distinct goods is considered. It is assumed that the operations are executed through a set of mobile production units (robots). These units can dynamically change their location to respond to the demand and production costs fluctuations during a given time horizon. This particularly flexible layout requires the definition and the solution of a complex scheduling problem involving, for each period of the planning time horizon, the determination of the position of the robots in order to minimize all the production costs.

We propose a two-level decentralized multi-agent system (MAS) production scheduling architecture: at the first level the agents are the tasks which compete for the robots (resources at this level); at the second level the agents are the robots which reallocate themselves among different tasks to satisfy the requests coming from the first level. An iterative auction based negotiation protocol to coordinate the agents' decisions is used at the first level while the second level resolves a Multi-Robot Task Allocation problem (MRTA) through a distributed version of the Hungarian method. Experimentation of the architecture and a comparison of the results with a centralized solution of the problem is presented.

Keywords: Production scheduling, multi-robot task allocation, multi-agent system

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Service Network Design Models for Two-tier City Logistics

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This talk focuses on two-tier City Logistics systems for advanced management of urban freight activities and, in particular, on the first layer of such systems where freight is moved from distributions centers on the outskirts of the city to satellite platforms by urban vehicles, from where it will be distributed to customers by other, dedicated vehicles. We address the issue of planning the services of this first tier system, that is, select services, their routes and schedules, and determine the itineraries of the customer-demand flows through these facilities and services.

We propose a general scheduled service network design modeling framework that captures the fundamental concepts related to the definition of urban-vehicle tactical plans within a two-tier distribution network. We examine several operational assumptions regarding the management of the urban-vehicle fleet, the flexibility associated with the delivery of goods, and the impact of the freight transfer operations at satellites, and show how the proposed modeling framework can evolve to represent an increasing level of detail. A discussion of algorithmic perspectives completes the talk.

Keywords: City Logistics, Urban Freight Transportation, Fixed Charge Network Design

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A Lagrangian-based Algorithm for a Short-haul and Long-haul Logistics Network

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In networked production environments and globalized economy an efficient, high quality and sustainable freight transport represents a crucial challenge nowadays. In this context, intermodality can reduce the environmental and social impacts of transportation operations. The paper faces the problem of freight transportation planning of logistics platforms in a multimodal network. Generally, these complex problems are approached in the literature through their decomposition into sub-problems that are individually solved.

The paper presents a comprehensive model and a solution method based on Lagrangian relaxation in order to consider simultaneously the features and constraints related to short-haul and long-haul transportation. In the proposed approach a decision maker coordinates logistics platforms and aims at optimizing the transportation plans on a determined time horizon.

Keywords: Multimodal Transportation, Integration, Logistics

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An optimization algorithm for integrated warehouse and transportation management

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In this work we present a collaborative model for logistics process management addressing the problem of the integration of activities of a 3rd party logistics (3PL) operator. The scope of a 3PL operator is to achieve a balance between the warehouse and transportation costs and customer service level. The operative activities of the logistics activities is supported by IT tools covering different areas of the supply chain, such as the warehouse management system and the transportation management systems. Often this tools exchange data to solve the global supply chain following fixed rules.

In our model we define a collaborative network in which the 3PL operator interacts with subcontractors such as manpower suppliers and transporters, and the relationships are governed by contracts. Our approach considers a multi agent model representing the activities associated with logistics management providing more flexibility than the traditional methods. The model supports a negotiation mechanism among actors and a cooperation system among macro modules in order to find optimal combined logistics and distribution plans. The architecture of the collaborative model is organized in operational modules and elements to support a chain's dynamic execution.

Keywords: SCM, optimization, integrated logistics

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WeA4. Electoral Systems

Axioms for apportionment methods

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Over more than 200 years, two types methods of apportioning the seats of an assembly to political parties (or to states or regions) as a function of their votes (or their populations) have been considered: (1) those based on quotas (or proportional shares) and their remainders (e.g., Hare's method also known as Hamilton's or largest remainders); (2) divisor methods (e.g., Saint Laguë's or Webster's, D'Hondt's or Jefferson's). Inconsistencies and paradoxes of the quota-based methods exclude them from the set of possible methods. This leaves only the divisor methods.

A divisor method is defined by setting a rounding threshold for each interval bounded by two consecutive integers, dividing each party's vote by a common divisor, rounding the quotient up if it is at or above the threshold, rounding down if it is at or below the threshold. The divisor is chosen so that the sum of the results equals the number of seats of the house. Since each threshold may be set individually, peculiar methods may be defined that behave in strange ways.

A parametric divisor method's thresholds in every interval $[n, n+1]$ are $n+t$ for the same fixed t between 0 and 1. Adams's ($t = 0$), Webster's ($t = 1/2$) and Jefferson's ($t = 1$) are parametric methods. The United States uses Hill's method. But why geometric means or square roots? Why harmonic means? Does this make any sense? A method of apportionment transfers seats fairly if when the votes of one party are transferred one by one to a second party, at some stage an apportionment must be found where the first party's allocation decreases by exactly 1 seat, the second party's increases by exactly 1 seat and all the others remain the same.

Theorem: A divisor method transfers seats fairly if and only if it is parametric.
Transferring seats fairly is a natural idea. It turns out that using it together with several traditional axioms leads to a very simple proof to characterize parametric divisors.

Keywords: Proportional representation, elections, apportionment.

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Current European Parliament elections: 27 ways to convert votes into seats

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Although the 2009 elections to the European Parliament constitute the biggest transnational elections in history, they nevertheless were governed by distinct national electoral provisions of the European Union's 27 Member States.

An overview is presented focusing on such aspects that determine the actual calculations to convert votes into seats. We cover electoral thresholds and effective votes, the establishment of constituencies, the subdivision into districts, the formation of electoral alliances, and the proportional representation formulas used, such as divisor methods, quota methods, or simple transferable vote systems. It transpires that it is more than appropriate to always refer in the plural to the 2009 election"s": The 27 national electoral provisions are quite different indeed, and some even violate the common electoral principles as laid down in the 2002 European Election Act.

Keywords: Proportional representation systems, Divisor and quota methods of seat apportionment

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Future European Parliament elections: Uniformity via biproportionality?

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For electing the European Parliament by direct universal suffrage, the precursor institutions of the European Union intended to set up a "uniform electoral procedure" already in 1951. In 1997 the goal was moderated, to conduct elections "in accordance with principles common to all Member States".

Moving beyond current common principles toward a future uniform electoral procedure we propose a biproportional formula for the conversion of votes into seats, achieving proportionality relative to the Member States' population sizes as well as relative to the vote totals of political parties. Today's European party system is too weak, however, to provide a frame for totaling party votes across the whole Union. To strengthen its role, ballot papers should exhibit the European affiliation of national contenders, with the electoral threshold based on the European parties' transnational support. This would set the stage to properly install a biproportional system.

Keywords: Proportional representation systems, Divisor and quota methods of seat apportionment

Error minimization methods in biproportional apportionment

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One of the most active research lines in the area of electoral systems to date deals with the Biproportional Apportionment Problem (BAP), which arises in those proportional systems where seats must be allocated to parties within districts. In BAP a matrix of the vote counts of the parties within the districts is given. One has to convert the vote matrix into an (integer) matrix of seats as proportional as possible to it – subject to the constraints that each district be granted its pre-specified number of seats, and each party be allotted the total number of seats it is entitled to on the basis of its national vote count. The main difficulty in solving BAP is to simultaneously meet the proportionality requirement and the integrality of the solution; this not infrequently gives rise to self-contradictory procedures in the electoral laws of some countries.

Here we discuss a class of methods for BAP characterized by an error minimization approach. If the integrality requirement is relaxed, fractional seat apportionments (target quotas) can be obtained so as to achieve proportionality at least in theory. In order to restore integrality, one then looks for integral apportionments that are as close as possible to the ideal ones in a suitable metric. Historically the first such method is Cox and Ernst's Controlled Rounding one which finds an integral apportionment by optimally rounding the target quotas. The rounding problem can be formulated as a capacitated transportation one. Recently, the $L_{\inf}$-distance case was investigated by Serafini and Simeone (2010) who showed how to reduce the problem to a parametric maximum flow one solvable in strongly polynomial time. We discuss here also the L_1 - and L_2 - distance cases. A common feature of such error minimization models is that they are solvable in polynomial time via the solution of a sequence of linear network flow problems–often a single one.

Keywords: Biproportional seat apportionment, metric spaces, network flows

WeB1. Invited Lecture 2

Cutting planes for Mixed Integer Programs: Instructions for use

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Cutting plane methods are widely used for solving convex optimization problems and are of fundamental importance, e.g., to provide tight bounds for Mixed Integer (Linear) Programs (MIPs). These methods are made by two equally important components: (i) the separation procedure (oracle) that produces the cut(s) used to tighten the current relaxation, and (ii) the overall search framework that actually uses the generated cuts and determines the next point to cut.

In the last 50 years, a considerable research effort has been devoted to the study of effective families of MIP cutting planes, as well as to the definition of sound separation procedures and cut selection criteria. However, the search component has been much less studied, at least in the MIP context where one typically cuts a vertex of the current LP relaxation, and then reoptimizes the new LP to get a new vertex to cut.

In this talk we argue that many known issues with general-purpose MIP cutting plane methods (numerical instability, bound saturation due to shallow cuts, etc.) are largely due to the search framework where the cuts are used, rather than to the cuts themselves. This is because the two main cutting plane modules (the LP solver and the cut generator) form a closed-loop system that is intrinsically prone to instability, unless a kind of filter is introduced in the loop to control the feedback. Hence it makes sense to invest more research effort in the design of a better framework where the cuts are actually embedded – the underlying claim being that even "old" families of cuts can be much more powerful if used in a sound shell.

WeC1. PRIN project – Nonlinear Optimization 2

On the solution of mathematical programs with performance constraints via simulation-based MINLP

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Several optimization problems arise where the decision maker must ensure that cost minimization is not achieved at the expense of deteriorating system performance. Hence, any such problem has to embed a set of performance constraints, whose role is to enforce a measure of system performance to exceed a given threshold. Because of the uncertainty that usually affects many such problems arising in real-world applications, like design and planning of service and production systems, a mathematical program with performance constraints (MPPC) can be formulated as a stochastic mixed-integer program. Recently, some interest has been devoted to sample average approximation of such formulations, especially in the context of call center manpower management, see [1]. From this viewpoint, an MPPC is a mixed-integer nonlinear program embedding a set of constraints which can only be estimated via simulation, see [2–4]. By exploiting (pseudo-)concavity properties of the performance measure, simulation-based outer approximation methods have been introduced and tested. We review such methods, and propose some extensions with the aim of reducing the requested computational effort.

Keywords: Mixed-integer nonlinear programming, simulation-based optimization, cutting planes

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Black box optimization of discrete events simulation models

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Many real-world problems can only be represented by means of complex discrete-events simulation models where the system parameters can assume integer or real values. To deal with this kind of problems, black-box optimization approaches are usually needed.

In this work, we propose a black-box approach able to tackle the difficulties of the considered class of optimization problems, namely the lack of the mathematical representation of the problem, the fact that function evaluations are expensive and can be affected by noise, and the presence of both integer and real variables.

We combine the proposed approach with the recently developed SIMIO simulation software.

Keywords: Black box optimization, discrete event simulation

SpeeDP: a fast method for solving the SDP relaxation of Max Cut

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We consider low-rank semidefinite programming (LRSDP) relaxations of -1,1 quadratic problems such as Max-Cut. We prove the equivalence of the LRSDP problem with the unconstrained minimization of a merit function and we define an efficient and globally convergent algorithm for finding critical points of the LRSDP problem.

We present numerical performance on an extended set of instances of the Max-Cut problem.

Keywords: Low rank SDP, max cut

Generalized Bundle Methods for Decomposable Functions

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Many large-scale optimization problems exhibit a block-structure that can be algorithmically exploited by means of decomposition approaches. We propose a modification to the (generalized) bundle scheme for minimization of a decomposable nonsmooth convex function. In particular, we focus our attention on how to handle the components which are easy convex programs. For this special case, we construct a suitably modified master problem, providing it with "exact" information about "easy" components of the function to be minimized.

We report numerical results for Network Design problem.

Keywords: NonDifferentiable Optimization, Bundle Methods, Lagrangian Relaxation

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WeC2. PRIN project – Multimodal Freight Transportation 2

On the spatial equity of flows in transportation network optimization.

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In this talk we consider the problem of routing flows on a transportation network in such a way to obtain a balanced spatial distribution of the flows, while satisfying given amounts of supply and demand at some nodes of the network. The concept of path dissimilarity was recently introduced with the aim of equally distributing the total risk among the exposed population in the context of hazardous materials transportation. In the literature, the attention was mainly focused on multicriteria path-based approaches, in which the scope is to reduce the total risk related to the shipping of freights on a network, considering at the same time the dissimilarity among the support paths, in such a way to spread the flows in an equitable way over the transportation network area. Some of the contributions on this topic suggested a combined use of Geographic Information System (GIS) software and optimization methodologies in order to find the best choices among a set of alternative paths. In general, the adopted optimization scheme is the following: a set of interesting paths is generated by means of different approaches. By defining measures of dissimilarity between couples of support paths, the problem of equitably spread the flow on p out of the k available support paths is formulated as a discrete p-dispersion problem, and then solved by heuristic approaches. Recently, a GRASP procedure was proposed for the bi-objective optimization problem, considering performance and dissimilarity of the selected paths.

In this talk we describe a novel methodology based on the definition of vectorial polygons covering the geographic area of the transportation network. The overall impact of the flows interesting those arcs embedded in each polygon of the vectorial set is considered as an optimization driver. We formulate the problem and present the results of the related algorithmic approaches. Then further developments, concerning a multi-level use of this methodology, are proposed.

Keywords: Network Flows, Spatial Equity, Path Dissimilarity.

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A Tabu Search algorithm applied to the berth allocation-scheduling problem: the case of a terminal container operating in Naples (Italy)

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We have analysed the Co.Na.Te.Co, port terminal container located in Naples (Italy), one of the top-twenty in the Mediterranean sea. It's evident that, due to the limited available resources the terminal often works under congested conditions.

With the aim to understand the process, we collected and analyzed historical data on performance indices. We have then realized and calibrated a discrete event simulation model, developed in Rockwell Arena environment, able to reproduce the current functioning of the system. The simulation model has been used to individuate bottleneck factors mainly affecting the terminal performances. The conducted study stressed how the berth allocation-scheduling problem represents a critical issue for the terminal. Starting from this assumption we focused our study on this problem. Firstly we developed a procedure to handle the problem, apparently dynamic, with a static scheduling approach based on a rolling horizon criterion to identify independent vessels clusters. Afterwards we developed an algorithm to allocate and schedule the vessels of each independent cluster to the available berths with the objective of minimize the makespan. In order to solve it we used a Tabu Search algorithm.

Finally we implemented the developed procedure within the simulation model and then we compared the outcomes of the simulation model with the current performances of the terminal container. The obtained results demonstrate how the application of an optimization rule could improve the terminal performances providing insights for a better management of terminal operations.

Keywords: Terminal Container, Berth allocation, Scheduling

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A Two-Phase Mathematical Programming Approach to the Multi-Port Master Bay Plan Problem

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We face the line planner problem, denoted as Multi-Port Master Bay Plan Problem (MP-MBPP), of determining aggregate stowage plans for containerships to satisfy transportation demand. The problem consists in determining the stowage plan for each port on the route so that stability and capacity constraints are satisfied and objectives relevant to port operations are optimized. Each port is characterized by import and export demand, corresponding to subsets of containers of different types and classes of weight to be unloaded and loaded. Handling operations should be executed minimizing possible non-productive movements (unloading and reloading of containers), while balancing the workload for the quay cranes. The present problem is an extension of the NP-hard [1] single port MBPP faced in [2, 3, 4], but differently MP-MBPP focuses on planning on a multi-port route taking into account aggregated capacity constraints.

We define an exact MIP model which assigns a single destination to the portions of stowage locations associated with ship hatches, determines the type of containers (20' or 40') for the bays and an aggregate stowage plan which satisfies the resulting capacities. The dimension of the problem generally prevents finding any feasible solution in acceptable CPU times.

Therefore we propose a two-phase mathematical programming approach based on the solution of two MIP models. First, a 0-1 IP model is used to determine the binary destination assignment variables having relaxed the integrality of stowage allocation variables and imposing only aggregate TEU-based capacity constraints. Then, the exact MIP model is run fixing the binary destination assignment variables to the values found in the first model. Computational test are performed on a set of instances both for a real medium size ship and a fictitious large size ship on a seven ports route; results show that the proposed e strategy is able to obtain good quality solutions within a reasonable computation time.

Keywords: Maritime logistics, stowage plans, mathematical programming

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The Monochromatic Set Partitioning problem

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On the last few years several problems have been studied on a particular class of graphs, where each edge has a label (color) assigned to it. Real applications for this class of problems arise in fields such as telecommunication or multimodal transport networks (edges of the same color can model transportation lines of the same type, or connections belonging to the same company). Moreover, the edge-labeled graphs can be of interest whenever we need some measure of homogeneity (or heterogeneity) regarding the edges in the solution we are looking for.

In this context we focalize our attention on the "monochromatic set partitioning problem" (MSP). Let $G = (V, E)$ be an edge-colored graph. A sub-graph H of G is said to be monochromatic if all the edges of H have the same color and multicolored if no two edges of H have the same color. A feasible solution for the MSP is a partitioning of G in monochromatic sub-graph. We look for a feasible solution containing the minimum number of such monochromatic sub-graph.

In our work we first prove the complexity of this problem. Then we propose a mathematical formulation and a polynomial case. Finally we present a meta-heuristic approach to solve the problem and show some preliminary computational results.

Keywords: Labeld Graph, Spanning Tree, Monochromatic Partitioning

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WeC3. PRIN project – Combinatorial Optimization for Transportation Systems

A branch-and-price algorithm for the multi-depot pickup and delivery problem with heterogeneous fleet and soft time windows

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The multi-depot pickup and delivery problem with heterogeneous fleet and soft time windows arises in short-haul transportation and its optimal or near-optimal solution is crucial to make transportation actvities sustainable, mainly for small and very small transportation enterprises, that are experiencing very high market pressure due to increased fragmentation of the demand, increased service level requirements and increase in fuel costs.

The problem consists in finding a minimum cost set of routes for a fleet of vehicles with different capacities and based at different depots, satisfying a given set of customers. For each customer a set of items must be picked up at a given source and delivered at a given destination to be visited in the same route. Each location has a time window for the service that can be violated at the cost given by a penalty function.

We present a branch-and-price algorithm, where the pricing problem is solved through bi-directional dynamic programming with decremental state space relaxation and we discuss the usefulness of this approach on real instances provided by a consortium of small transportation enterprises. Effects on traffic and the environment are also evaluated.

Keywords: Combinatorial optimization, vehicle routing, branch-and-price

On the Capacitated Arc Routing Problem with Stochastic Demands

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The Capacitated Arc Routing Problem with Stochastic Demands (CARPSD) is an extension of the well known Capacitated Arc Routing Problem (CARP) in which demands are stochastic. This leads to the possibility of route failures whenever the realized demand exceeds the vehicle capacity.

We present the CARPSD in the context of garbage collection and describe an adaptive large scale neighbourhood search heuristic for the problem.

Computational results show the superiority of this algorithm over an alternative solution approach.

Keywords: Capacitated arc routing problem, Stochastic programming with recourse, Adaptive large neighbourhood search

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New Tour Relaxations for Solving the Traveling Salesman Problem with Time Windows

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The Traveling Salesman Problem with Time Windows (tsptw) is the problem of finding in a weighted directed graph a least cost tour starting from a selected vertex, visiting each vertex of the graph exactly once within its time window, and returning back to the starting vertex. This NP-hard problem arises in several routing and scheduling applications.

In this talk, we present two new tour relaxations, called ng-tour and ngL-tour, to compute via column generation valid lower bounds on the tsptw obtained as the costs of near optimal dual solutions of a problem that seeks a minimum-weight convex combination of tours. The tour relaxations and the dual solutions obtained are used to solve to optimality the problem using dynamic programming.

We present an extensive computational analysis on several classes of both real-world and random instances taken from the literature, showing that the proposed algorithm outperforms other exact methods.

Keywords: Traveling salesman problem, time windows, state space relaxation

Perfect Formulations for Mixed-Integer Programs

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We model a mixed-integer set S as a pure integer set by expressing each continuous variable as the average of k integral variables. We use these additional integral variables to strengthen the inequalities that describe S. For selected mixed-integer sets, like mixed-integer vertex covers in bipartite graphs, this strengthening yields an extended formulation for the convex hull of the feasible solutions.

We discuss special cases for which we can explicitly project our extended formulation to yield a formulation in the original space. In particular we provide a characterization of the convex hull of the continuous mixing set with flows.

Keywords: Mixed-Integer Programming, Perfect Formulations

WeC4. Logistics and Location

Optimization of a cross docking terminal using micro-simulation tools

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The success of a commercial product depends on the possibility to quickly and effectively manage its supply chain. This requires a well structured organization of the factory and of freights interchange centres, reliable logistic services and flexible and reactive transport systems. Among freights interchange centres, the cross-docking terminal takes form of a intermediate node in the distribution network, a terminal where activities of goods "groupage/degroupage" are operated with the objective to manage the routes and the service times and to increase the load factor of transport means. A cross docking terminal can produce interesting impacts in dynamics of freight distribution, but its success is connected to many problems: an appropriate location on territory; a balanced measuring of spaces and equipments; an efficient and effectiveness organization of internal services; a management structure able to answer to different demands.

The paper focus on problems related to organization of internal functionality of a cross docking terminal. The operative activities are: scheduling and assignment to doors of vehicles in input/output from the node; management and handling of the goods crossing the node (loaded/unloaded, scanning, sorting, possible storage, handling between different functional areas of the node). In particular the paper proposes a procedure to optimize the internal operations of cross-docking node concerning the freights management. The problem is formulated as a problem of linear programming, dealt with a discrete stochastic micro-simulation approach and resolved by using heuristic techniques (simulated annealing and tabu search with elements of reactive thermo-statistical search using an adaptive cooling schedule).

The procedure has been applied in a specific cross docking terminal located into the industrial and logistic district of Gioia Tauro (Italy).

Keywords: Optimization, Cross docking terminal, Micro simulation

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On some variants of the shortest path tour problem as facility location problems

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The shortest path tour problem (SPTP) consists of finding a shortest path from a given origin node s to a given destination node d in a directed graph with nonnegative arc lengths with the constraint that the optimal path P should successively and sequentially pass through at least one node from given didjpint node subsets.

It has been recently shown that the SPTP belongs to the complexity class P. Nevertheless, in this talk we will discuss on some variants of the SPTP and we will prove that they are special facility location problems.

Keywords: Shortest path, Facility location

Embedment of a GIS in a bicriteria DSS for location problems

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SABILOC (Captivo et al., 2008) is a Decision Support System aimed at supporting decision making concerning bicriteria location models. It is an interactive system where the preferences of the decision-maker are progressively articulated to search for a satisfactory solution. We believe that multiobjective interactive approaches are the most adequate in many applications especially if they are thought as learning procedures (progressively improving the knowledge about the problem) and not as procedures seeking for some 'optimal' solution. Namely, the interactive process looks for a progressive and selective learning of the non-dominated solutions set (solutions for which there is no

other feasible solution improving the values of all the objectives) clarifying the criteria (objective) values aggregation meaning and its consequences.

In this paper we describe and exemplify the embedment of a Geographical Information System (GIS) platform in SABILOC. When the facilities to be located have environmental effects, they usually depend on different factors like the altitude and the morphology, the winds, the temperature, the humidity, etc, most of which can be more easily evaluated with a GIS. GIS can be used to manipulate different kind of data from various sources. They can be a significant aid to obtain and manage information quite useful in location problems, particularly for facilities with environmental effects, which can be more easily evaluated with a GIS. The embedment of GIS in SABILOC presents a positive feedback in both ways. SABILOC has clearly improved through the use of the GIS tools since data/information can be fed quite efficiently and the end users of the GIS gain several potentialities. Besides gaining more experience in the practical use of this system, we foresee the usefulness of implementing a multicriteria analysis tool dedicated to discrete problems or the embedment of an existing tool if one is considered adequate to our purposes.

Keywords: DSS, Location, GIS

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An integrated optimization-simulation approach for facility location problem with service level considerations

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In this work we consider a Facility Location Problem for consolidation of shipments between production facilities and end customers in a supply network. We consider a logistic network composed of several plants each producing a single product for shipment to final retail outlets (or urban centers). Potential sites for opening warehouses/distribution centers that can consolidate shipments from multiple plants and respond quickly to demand requests from customers are considered. Shipment costs are based on load size and distance. Inventory stocking requirements depend on replenishment lead time. Initially

deterministic demand is assumed for each product at each customer location. The proposed model allows solving in an optimal manner the location/allocation problem taking into account information about lead-time, transportation cost, storage cost and fixed cost to open each facility.

The optimization model has been verified and evaluated through a CPLEX application and total cost has been minimized obtaining the best solution in terms of:

(i) warehouses opened

(ii) quantity of products shipped at each period

(iii) quantity of products stocked at each warehouse and customer

(iv) number and kind of used trucks.

The output of optimization tool is taken as an input for the Simio simulation model. At this step we introduce variability in the data of customer's demand and lead-time evaluating the goodness of solution changing these problem's parameter. The optimization model is used to determine the dynamic distribution network structure. Subsequently, the simulation model is applied to determine the best capabilities and to evaluate the scenario under condition of variable demand and lead-time. A recursive procedure is performed in way that the simulation results are incorporated into the optimization model.

Future work foresees the implementation of a genetic algorithm able to solve instances comparable with real scenarios for the part relative to optimization process.

Keywords: Optimization-Simulation, Supply Chain Management, Facilities Location Problem

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WeD1. Routing and Scheduling

A Hybrid Integer Programming Model for Multi-Activity Shift Scheduling

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Shift scheduling problems arise in all organizations, such as airlines, railways and public transport, industries, hospitals and call centers. Constructing shifts consists in defining a start and finish working time and in specifying the activities to be performed during each shift. The selection of activities must respect several constraints coming from organizational and work agreements.

In this paper, we deal with a multi-activity shift scheduling problem which can be defined as follows. Consider a set of time slots obtained by dividing a planning horizon of one day into time intervals of equal length, and a parameter specifying the staffing levels required in each interval. Given a set of activities (work tasks and breaks), a set of all feasible shifts and a set of available employees, the goal consists in assigning a shift to each agent to minimize the deviation from the expected staffing levels. A classical set-covering formulation has been first obtained by Dantzig [1] by explicitly including all the variables associated with the feasible shifts. Alternatively, implicit models have been proposed [2–4], yielding compact ILP formulations. However, implicit formulations may not be flexible enough to accurately represent real multi-activity scenarios.

In this paper, we propose a hybrid ILP formulation which combines an adequate modeling flexibility with a computationally tractable size. The hybrid formulation has been tested on instances arising in managing the call center of one major Italian telephone Company. Results are compared with those obtained by the explicit formulation.

Keywords: Shift Scheduling, Integer Programming.

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An Enhanced Ant Colony System for the Sequential Ordering Problem

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Ant Colony System is a well-known metaheuristic metaphore, and has been succesfully applied to many combinatorial optimization problems.

In this work some weaknesses of the original ACS method are identified, and some improvements are introduced, leading to the Enhanced Ant Colony System (EACS). The EACS algorithm is then applied to the sequential ordering problem, an optimization problem used to model many real applications such as production planning, single vehicle routing problems with pick-up and delivery constraints and transportation problems in flexible manufacturing systems.

The computational experiments, carried out on the publicly available SOPLIB06 instances, show the effectiveness of the enhancements introduced: EACS clearly dominates ACS. Moreover, when compared with the state-of-the-art algorithms available in the literature, EACS is able to improve 32 best known results over 48 problems, while matching the remaining 16 best known solutions.

Keywords: Ant Colony Optimization, Sequential Ordering Problem

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Enhanced Branch-and-Price-and-Cut for Vehicle Routing with Split Deliveries and Time Windows

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The vehicle routing problem (VRP) is one of the most famous combinatorial optimization problem and consists in finding a set of minimum cost vehicle routes that serve a set of customers such that the demand collected by each vehicle does not exceed the vehicle capacity. A classical assumption of the VRP is that each customer is served by exactly one vehicle. In the split delivery vehicle routing problem (SDVRP) this assumption is relaxed, thus each customer can be served by different vehicles. The SDVRP has been introduced in Dror and Trudeau (1989) who showed that allowing split deliveries can result in remarkable savings both in the number of vehicles needed to serve the customers and in the total distance traveled. In effect, this savings can go up to 50% as shown by Archetti et al. (2006) and is strongly related to the configuration of the demands of the customers, as shown in Archetti et al (2008).

In this paper we are going to focus on the SDVRP with Time Windows (SDVRPTW). Recently, Desaulniers (2010) proposed a branch-and-price-and-cut algorithm which proved to be remarkably effective being able to solve instances with up to 100 customers. In this paper we are going to propose some enhancement procedures applied to the approach proposed by Desaulniers (2010) in order to be able to solve a larger number of instances. In particular, we introduce new procedures to speed up the solution of the subproblem, on one side, and strengthen the lower bound, on the other side. As far as the solution of the subproblem, we developed a tabu search algorithm which proved to be a powerful tool for the solution of the subproblem in VRPTW applications. To improve the lower bound we instead proposed new classes of valid inequalities and a new heuristic algorithm to separate the k-path inequalities.

Keywords: Vehicle routing with split deliveries, Branch-and-price-and-cut algorithm

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New families of valid inequalities for the Vehicle Routing Problem with Time Windows

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The Vehicle Routing Problem with Time Windows (VRPTW) is the problem of designing minimum cost routes for a fleet of vehicles with identical capacities to serve a set of customers within given time windows and without exceeding the capacity of the vehicles. Each customer must be visited exactly once.

We introduce two new families of valid inequalities and their separation algorithms. Then we present computational results with a cutting plane algorithm on some of the Extended Solomon's VRPTW benchmark instances.

Keywords: VRPTW, Cutting planes

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Single-depot Unit-capacity Vehicle Scheduling with Pickup and Backhaul

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A good trucker never goes around empty: this statement informs a vehicle scheduling problem arising in a magazine operated by BLG Logistics. An L/U station continuously receives packages from production, to be stocked into the magazine, and packages from the magazine, to be shipped outside the plant. Handling is done by q forklifts that shuttle between cells in the magazine and the L/U station. Shipping lists give the addresses of the cells holding packages to be shipped to distinct destinations, and each list is associated with a due date. A mission is a single station-magazine-station tour that follows storage indications. Due to packages size, a forklift cannot carry more than one package at a time: hence, a mission can either be a single delivery (D-mission), or a single pickup (P-mission), or consist of a delivery followed by a pickup (DP-mission). A duty is a set of missions that fulfils the whole pickup and delivery demand of a day, and its length sums up the length of the missions it consists of.

We aim at finding a duty of acceptable length, and a schedule of its missions that minimizes the maximum lateness while balancing workloads. The problem is decomposed into a q-machine parallel scheduling problem and an integer program that reschedules mission so as to shorten the duty length while not increasing lateness. Problem properties are investigated.

Keywords: Vehicle routing, 0-1 linear programming

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WeD2. Variational Inequalities and Equilibrium Problems

Generalized Nash equilibrium and joint implementation of pollution control projects

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The 1997 Kyoto Protocol prescribes that some industrialized, labeled as "Annex I Parties", must reduce their greenhouse gas emissions at least 5 per cent below the 1990 levels for the 2008–2012 period. Under the Treaty countries must meet their targets primarily through national measures, however some other market-based mechanisms are offered. In this paper we focus on the so-called joint implementation (JI), a mechanism that allows Parties, with emission reduction or limitation commitments, to collect rewards in the form of emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex I Party, where the abatement costs are lower.

Our aim is to show how the JI mechanism can be transformed into and studied as a generalized Nash equilibrium problem. We develop a time-dependent pollution control model in which different countries aim to determine the optimal investment allocation in environmental projects and the tolerable pollutant emissions, so as to maximize their welfare. We provide the equilibrium conditions governing the model and derive the characterization in terms of an infinite dimensional quasi-variational inequality problem. The existence of solutions is then investigated.

Keywords: Generalized Nash equilibrium, Quasi-variational inequality, Kyoto Protocol.

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Characterization of a dynamic economic equilibrium in terms of Lagrangean multipliers and calculus

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The talk is devoted to provide a more realistic model for a Walrasian equilibrium problem. In particular, the data are considered to depend on time t in $[0, T]$. The equilibrium problem is studied by an evolutionary quasi-variational inequality which in the Lebesgue space $L_2([0, T], R)$ is set.

Our aim is to provide a computation procedure for the calculus of equilibrium solution. To this aim it is important to observe that in our model it is not possible to obtain equivalence between the evolutionary problem and a pointwise problem. We take advantage of duality theory in infinite dimensional spaces which allow us to characterize the equilibrium in terms of Lagrangean multipliers.

Keywords: Lagrangean and duality theory, evolutionary variational inequalities, Walrasian equilibrium.

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Weighted Traffic Equilibrium Problem in Non Pivot Hilbert Spaces

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The traffic equilibrium problem on weighted networks is analyzed by means of an evolutionary traffic model weighted by a real time traffic density. The framework is Non Pivot Hilbert Spaces in which an equivalence result between a weighted Wardrop

condition and a variational inequality is provided. Moreover we explain a possible way to obtain the weights and finally we propose a numerical method for the calculus of the solution.

Keywords: Equilibrium problem, Non Pivot Hilbert Spaces, Wardrop Condition

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An application of variational theory to an economic equilibrium problem

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The aim of this talk is to present an application of variational theory to an economic equilibrium problem. In particular a general economic market consisting of two types of agents is considered; the agents act to exchange, consume and product the different goods. The economic equilibrium problem is characterized as a quasi-variational inequality. The existence of at least an equilibrium solution is obtained by using the variational theory.

Keywords: Variational inequalities, Walrasian equilibrium

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Evolutionary Variational Inequalities and the Internet

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We develop an evolutionary variational inequality model of the Internet with multiple classes of traffic and demonstrate its utility through the formulation and solution of a time-dependent Braess paradox. The model can handle time-dependent changes in demand as a consequence of developing news stories, following, for example, natural disasters or catastrophes or major media events. The model can also capture the time-varying demand for Internet resources during a regular weekday with its more regular rhythm of work and breaks. In addition, the model includes time-varying capacities on the route flows due to, for example, government interventions or network-type failures.

Keywords: Equilibrium problems, Network models

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WeD3. PRIN project – Integrated Logistic Networks

Management of an intermodal logistic node through Neuro-Dynamic Programming

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We consider the dynamic model of a logistic node of a transportation network. A necessary and sufficient condition for the existence of a stable feedback policy is given. Optimal dispatching rules can be derived in the case of small instances either by solving an integer programming problem or by considering a dynamic programming approach. Both methods present a combinatorial complexity which makes them not viable in realistic scenarios. For this reason, a neuro–dynamic programming (NDP) approach is introduced and used to refine a heuristic solution of the problem. The solution computed through the NDP approach aligns with the decisions given by a sub–optimal control policy inspired by the literature available for manufacturing systems.

Keywords: Neuro-dynamic-programming, Logistic system

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Tools for analyzing and managing complex systems

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The aim of this work is to present methodologies for analyzing and managing complex systems. These methodologies can be applied to general systems but, as examples, we consider two particular cases: a practical one, the transportation of Hazardous Material (HAZMAT) on congested motorway and a theoretical one, the management of the worst case demand on a network.

The main objective of the first example is to show how to assess quantitatively the acceptability of the Individual and Societal Risks connected with the transportation of HAZMATs. In addition, we propose a real time model of a Decision Support System (DSS) for HAZMAT transportation on a motorway. The DSS monitors the traffic of HAZMAT and calculates in real time the risk indexes. These indexes are compared with the thresholds from the literature to assess whether the risks are acceptable or not. If they are not acceptable, an alarm notifies it to the decision maker. Finally, we offer an application of the proposed model. The case study involves a stretch of A4 motorway in the North–East of Italy. From this case study it can be noted that even if the number of means transporting HAZMAT is small, the risk indexes may exceed the thresholds of acceptability.

The aim of the second example is to introduce a set of methodologies, framed within the game theory and robust optimization, to be used for the management of complex systems. We consider systems governed by a set of decentralized decision makers each of whom has only a partial knowledge on the state of the system and on the decision taken by the other decision makers. In particular, we present an application of such methodologies to the problem of the management of the worst case demand on a network.

Keywords: Hazardous material transportation, Risk assessment, Network management

Modelling and simulation of intermodal logistic systems

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The increasing complexity of the Intermodal Logistic Systems (ILS) and the availability of Information and Communication Technologies (ICT) require the definition of new models and management problems. Moreover, different hierarchical/functional levels are identified such as the tactical level, related on middle-short term decisions and the operational level, which includes real-time decisional processes. This contribution addresses the management of ILS at the tactical and operational level focusing on the impact of ICT tools on the management and control of the intermodal chain. To this aim we present two approaches. The first one describes the ILS in a Timed Petri Net framework and applies a top-down and modular description of the subsystems composing it [1]. The second approach is based on a metamodeling technique that provides an accurate description of the construct and rules needed to obtain semantic models [2], [3]. More in detail, the considered metamodeling approach is a top down procedure based on the Unified Modeling Language (UML) formalism that is a graphic and textual modeling language intended to understand and describe systems from various viewpoints. The metamodel enables us to specifies an Integrated System (IS) for ILS decision making that can work in two alternative ways, respectively devoted to the on-line management and off-line planning of the ILS. First, for the tactical level decisions, the IS bases on the reference model simulation the detection of the anomalies and bottlenecks of the system. Second, the IS takes real-time operational decisions and the reference model is updated on the basis of data and information obtained in real time by using modern ICT tools. Accordingly, such a model provides the control module with the knowledge base necessary for decisions in real time. In order to show the effectiveness of the application of the presented IS, some a real case studies involving ILS are modeled and analyzed.

Keywords: Logistics, Modelling, Simulation.

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Automated negotiation for transshipment coordination at a maritime terminal: protocol design and simulation analysis

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In multi-agent approaches to resource allocation problems, automated negotiation protocols [1] – as opposed to centralized approaches – can allow to determine good quality solutions in reasonable computational times, without requiring the disclosure of a large amount of information among the agents.

In this work we present the design of a synchronous, automated negotiation protocol based on a proposal evaluation mechanism and its application for transshipment coordination at a seaport. The general high level framework implements a negotiation process, which is performed among any number of agents sharing any number of resources [2,3]. Such process is supervised by an "Arbitrator", who generates and dispatches the proposals, collects the agents' evaluations and drives the negotiation process. Then, the protocol has been specialized to model and implement a negotiation scenario for a transshipment problem characterized by several navigation companies sharing a set of docks in a seaport served by a terrestrial transportation service, composed of multiple sets of trucks. To guarantee overall minimal costs, the navigation companies and the terrestrial transportation services need to coordinate their operations. The proposed approach can be extended to consider the effect of (possible) uncertainties, adopting different simulation methods and analysis.

A preliminary computational experience shows promising results with respect to both efficiency and fairness.

Keywords: Multi-agent systems, Automated negotiation, Seaport operations management

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Definition and development of decision models for logistic systems

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The purpose of the presentation is the description of the main activities developed within the PRIN project on "Decision models for design and management of logistic networks characterized by high interoperability and information integration". This project aims at the development of appropriate approaches and methodologies for the definition of decision/information architectures devoted to the real-time management of logistic systems. In such systems many decision makers are involved and in general they can interact in different ways (by cooperating, or competing, or interacting, and so on). Moreover, information flows are generally available in real time and, then, the decisions must be often taken on line.

A specific model will be described in detail, concerning a railway network provided with rapid transhipment terminals that allow boxes (containers or swap bodies) to change different trains in their route to destination. The transportation demand is given by a set of orders, characterized by origin and destination, release time and deadline, number of boxes (each one characterized by length and weight). The purpose of the work is the definition of a planning procedure in order to determine the optimal sequence of trains and train changes at terminals for each single box of each order and the optimal box-wagon assignment, so that the box can reach its destination from its origin within the requested deadline and by minimizing the total transportation cost. This planning problem is faced in two phases: in the former, all the sequences of trains available for serving each order are computed by applying a specific algorithm; the latter phase corresponds to the solution of a 0-1 linear mathematical programming.

A Math–Heuristic approach is proposed in order to solve the proposed programming problem in case of large problem instances. Some experimental results will be provided in order to show the effectiveness of the proposed procedure.

Keywords: Modellling; Planning; Logistic systems

WeD4. Applications of Operations Research

Unit commitment and economic dispatch in a domestic microgrid

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We address the unit commitment and economic dispatch problem for a residential microgrid. The microgrid includes electrical and thermal loads, electrical and thermal storage devices, and electrical and thermal generation units which are typical for domestic applications. This study considers fluctuation in loads, renewable energy resources, and energy prices. These fluctuations are modeled by time series which are based on existing measurements. The microgrid operates in grid-connected mode and trading electricity with the main grid is possible. The electrical energy balance and the thermal energy balance are interdependent due to combined heat and power generation.

Beside the stationary electrical and thermal energy storages, we model a battery-powered automobile as intermittent storage and load. Loads caused by certain domestic appliances are modeled as schedulable load jobs. The model results in mixed integer nonlinear optimization problem which has been linearized and solved within a rolling horizon framework. Results for different pricing policies are compared.

Keywords: Microgrid, Unit Commitment, Economic Dispatch

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A MILP Model for Analysing Investment Decisions in a Zonal Electricity Market with a Dominant Producer

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We introduce a model for analysing the behaviour of market prices in electricity markets where a large dimensional producer operates. The electricity markets are supposed to be divided in zones interconnected by capacitated transmission lines. The model determines the optimal medium-term resource scheduling of the large dimensional producer, so as to maximize his own market share while garanteeing a minimum preassigned profit level and satisfying technical constraints. The model also includes constraints representing the Market Operator clearing process and therefore it yields the hourly zonal electricity prices. The nonlinearities of the constraints representing the market clearing rules, are linearized by means of binary variables.

The model can be used by investors as a simulation tool for analysing both impact on the market and profitability of investment decisions in the zonal electricity market. A case study related to the Italian electricity market is discussed.

Keywords: Electricity markets modeling, Market power, Simulation

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Robotic systems optimization using an ant colony algorithm with a guided local search

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This work deals with the optimization of a pick and place robotic system. The use of robots in nowadays industrial systems is in a continuous increase due their efficiency and their flexibility. The system studied in this work consists of picking products on a moving conveyor and place them on specific deposit points. To optimize the performances of the system, we try to find the best scheduling rule of each robot in order to define in the best way which products have to be picked. Four scheduling rules were proposed by Mattone

et al. in [1] and are as follows: first in first out, shortest processing time, enhanced first in first out and enhanced shortest processing time. A fifth rule is tested here and was inspired from an industrial application.

The objective of our study is to minimize the number of non-seized products. For that, we first develop an ant colony optimization algorithm which was first developed by Dorigo in [2]. Then, we propose to hybrid the latter algorithm with a guided local search in order to enhance the performances. Indeed, the guided local search, first developed by Voudouris and Tsang in [3], allows avoiding local optimum solutions. This is the first application on the considered problem of this hybrid algorithm which was efficiently applied in different fields as shown in the paper of Chehade et al. in [4]. Computational results are carried out on different structures of the system by changing at each time the number of robots in the system. Several tests are also applied on each structure with different speeds of the moving conveyor.

The numerical results show the advantages of the new proposed algorithm compared to the classical ant colony optimization algorithm.

Keywords: Robotic systems, Ant colony, Guided local search

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Stopping for Perpetual American Options in Discrete Time

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An American option entitles the holder to buy or sell an asset at a pre-determined price at any time within the period of the option contract. A perpetual American option does not have an expiration date. In this study, we solve the optimal stopping problem of a perpetual American option using (infinite-dimensional) linear programming duality under the assumption that underlying stock price follows a discrete time and discrete state Markov process. We obtain an optimal stopping strategy showing the set of stock-prices for which the option should be exercised under two different stock-price movement scenarios: (a) a simple random walk model and (b) a geometric random walk model.

Keywords: Perpetual American Options, Markov process, infinite-dimensional LP duality

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Performance Assessment and Optimization of HSE-IMS by Fuzzy DEA- The Case of a holding company in power plant industries

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The literary works in performance assessment provides a variety of assessment approaches in Health, Safety, and Environment (HSE) contexts. Researchers have been continuously trying to improve performance of HSE. Sophisticated expert system methods (e.g., fuzzy logic), score-based models (e.g., BSC, EFQM), and statistical techniques (e.g., Spearman Correlation, Safety Culture Checklists Analysis) have been effectively adopted to further enrich this area of study. Each of these methodologies has its strength as well as major limitations. However, despite the growing need for optimization- and process-based methods as well as standard-based indicators, which simultaneously consider inputs

and outputs; this discipline, is yet to enjoy effective methods to reduce the human error, to interpret the large amount of vague data, and to recommend improvement and system optimization solutions. Through FDEA (Fuzzy Data Envelopment Analysis), a multivariate method based on linear programming, this study assesses the HSE-IMS (Health, Safety, and Environment Integrated Management System) performance of a holding company in power plant industries. In doing so, it integrates Health, Safety, and Environment Management System (HSE-MS) specifically with Occupational Health and Safety Management System (OHSAS 18001:1999) as well as Environmental Management System (ISO 14001:1996) to collectively analyze the inputs and outputs of over thirty (30) subsidiary HSE departments, as Decision-Making Units (DMUs), with equivalent mission and objectives. DMUs consume budgetary, training, and human resources as the main input factors to produce output factors that meet the HSE-IMS requirements (clauses) including leadership and commitment; policy and strategic objectives; organization, resources, and documentation; evaluations and risk management; planning; implementation and monitoring; and review. These outputs are gathered through observations of the certified HSE auditors and are scored on th

Keywords: HSE-MS, Performance assessment, Fuzzy DEA

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ThA1. Invited Lecture 3

Green Logistics for Surface Intermodal Transport

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Green logistics is defined as an attempt to attain an acceptable environmental performance of the intermodal supply chain, while at the same time respecting traditional economic performance criteria. The concept of "Green Corridors" is being analyzed in many circles, notably in Europe, as flows of cargoes that achieve a desirable environmental performance while at the same time being efficient logistics-wise.

This paper focuses on surface transport and looks at greenhouse gas (GHG) emissions, which are currently the subject of intense scrutiny. To that effect, a spectrum of measures to reduce GHG emissions are being contemplated. It is seen that such measures may have important side–effects as regards the logistical supply chain, and vice-versa. For instance, in the maritime mode, measures such as slow steaming, the most obvious measure to reduce GHG emissions, will generally impact logistical and cost-effectiveness attributes such as fleet size and in-transit inventory and other costs. It may also have side effects vis-à-vis modal split, by inducing cargoes to shift to land–based modes that eventually emit more GHGs. This paper takes a look at various tradeoffs that are at stake in the goal for greener intermodal transport and may impact the cost-effectiveness of the logistical supply chain and presents some models that can be used to evaluate these tradeoffs. Some examples are presented and policy implications are discussed.

ThB1. PRIN project – Nonlinear Optimization 3

Global optimization for expensive black box problems

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In many practical situations we need to optimize a function for which only function values can be obtained and each function evaluation is extremely expensive. As an example, parameter calibration in discrete event simulation systems requires the user to perform expensive simulation runs until the simulated behaviour of a system is similar to a real observed one.

In this talk we will outline the basics of black box optimization based upon surrogate models and we will outline some novel extension to cope with the situation in which some information is available on the black box.

Keywords: Global optimization, Surrogate models, Radial basis

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A method for global minimization with Lipschitz first derivatives

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In this talk, the problem of global minimization of multidimensional multiextremal "black-box" function with Lipschitzian first derivatives is considered. Various approaches for obtaining the Lipschitz constant of the first derivative are compared: e.g., it can be given a priori, its adaptive estimates can be used, local Lipschitz constants can be estimated, or its estimates can be chosen from a set of possible values (see [1–4]). A new method for solving the stated problem is presented and discussed from both the theoretical and numerical viewpoints. The proposed algorithm is based on efficient diagonal partitions and uses smooth auxiliary functions to approximate the objective function behavior at different parts of the search domain.

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Keywords: Global optimization, Lipschitz derivatives, Numerical methods

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A DIRECT-type algorithm exploiting information on the objective function

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DIRECT (DIviding RECTangles) is a very popular algorithm for box-constrained global optimization problems, very simple to be implemented, and therefore widely used in several applications. DIRECT is based on a partitioning strategy in which the feasible domain is iteratively divided into hyperrectangles. At each iteration, the selection of the hyperectangles to be further partitioned is performed by taking into account both the size of the hyperrectangles and the value of the objective function in their centroids. As

a pure partitioning-based algorithm, DIRECT does not exploit a priori knowledge on the objective function; this makes the algorithm suitable for black-box optimization, but at the cost of a quite slow convergence. To deal which such drawback, several modifications have been proposed to the original version of DIRECT, which try to exploit either a priori information on the objective function or information gathered during the algorithm (see [1] and the references therein).

In this work we describe a modification of DIRECT for a global optimization problem arising in the detection of gravitational waves [2]. The modification uses knowledge on the physics of the problem; a suitable sampling strategy of the feasible domain is available from theory that suggests a definition of the hyperrectangle "size" different from the classical geometric one. Computational experiments demonstrate strong improvements with respect to the classical DIRECT algorithm, especially on the most difficult instances of the problem, thus showing the robustness of the proposed approach in terms of accuracy and speed of convergence. The results also show that the algorithm, although deterministic, is competitive with the average behaviour of the genetic algorithm in [2], which is tailored to the problem at hand. Finally, some suggestions about the generalization of our modified version of DIRECT to more general problems are given.

Keywords: Global optimization, DIRECT algorithm, Detection of gravitational waves

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Preconditioner updates for shifted and KKT systems

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The solution of sequences of symmetric linear systems, whose matrices differ only for the diagonal entries, is a main computational kernel in many optimization methods, such as in trust-region and regularization subproblems or in interior point algorithms for linear

and quadratic programming. Our interest is in large-scale optimization, where these systems are usually solved by preconditioned Krylov methods. The spectral properties of the matrices in the sequence may be very different, thus a suitable preconditioner for each system has usually to be computed; on the other hand, the computational cost of building each preconditioner from scratch may be too high. Therefore, techniques for updating the preconditioners at a reasonable cost have been developed (see, e.g., [1,2]).

We present a novel update technique, which is based on a cheap and easy-to-implement modification of a preconditioner computed for a previous matrix in the sequence, available as an LDL' factorization. We provide a theoretical justification of our approach and show the results of numerical experiments, carried out by using matrices from well-known matrix collections as well as by applying the update technique within the PRQP interior point code for quadratic programming [3,4].

Keywords: Shifted and KKT linear systems, Preconditioning

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ThB2. Maritime Terminals 2

Exploiting discrete-event simulation at the port of Gioia Tauro

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Discrete-event simulation (DES) is widely used to model maritime container terminals and evaluate their performance by enabling scenario analysis in a stochastic-dynamic context. In the last decade, Medcenter Container Terminal SpA (MCT), the company that operates the terminal in the port of Gioia Tauro, Italy, has recognized the leading role covered by simulation in supporting decisional processes. Several simulators have been developed and exploited to solve their operational problems: an overall evaluation of the vessel sojourn time considering vessel arrival, berthing and departure is described in (Legato et al. 2001); an integrated model for channel contention and berth management under an aggregated representation of the discharge/loading operations is proposed in (Legato et al. 2007); on the yard side, alternative policies for the assignment and deployment of rubber tired gantry cranes among yard blocks are evaluated in (Legato et al. 2009); container flow stemming from discharge/loading operations and transfer to the yard blocks and vice versa is represented in (Legato et al. 2010). Currently, another simulator is under development in cooperation with MCT. It is based on a DES model that focuses on terminal activities as a whole by reproducing the terminal's best practices on resource allocation. In particular, the DES model integrates quay and yard operations enhancing both vessel and container life cycles. Quay crane allocation is considered by taking into account operational requirements (e.g., gangs availability and vessels workload). Yard block policies are considered for modelling container flow between the yard and quay areas. The simulator uses input data provided by MCT (e.g., arrival time and berthing position of incoming vessels) to estimate key terminal performance measures (e.g., quay cranes throughput, gangs utilization and yard occupancy factor).

Keywords: Port logistics, Discrete event simulation, Simulation–based optimization

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The quay crane scheduling problem: simulation and optimization

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The Quay Crane Scheduling Problem (QCSP) is a complex scheduling problem that arises in maritime container terminals during the handling operations of containers laying in the bays of a vessel. Containers are usually arranged in groups and each bay can include several groups. Quay cranes (QCs) are devoted to container discharge/loading (D/L) operations. The service level of a QC is affected by simultaneous activities occurring during the D/L process: on the vessel side, a QC performs the tasks according to a sequence provided by solving the QCSP and considering operational constraints (e.g. tasks precedence); on the quay side, a QC interacts with a pool of shuttle vehicles that cycle between the assigned QC location and the yard for container transfer. During the past years, the QCSP has been dealt by using all the available techniques in Operations Research. On the simulation side, a queuing network model for the evaluation of a specific task-sequence has been proposed (Canonaco et al. 2008). On the optimization side, several integer programming models and heuristics have been proposed (Kim and Park 2004; Legato et al. 2008). The simulation approach, through "what if" experiments, has confirmed that the performance of QCs is affected by the congestion phenomena occurring during the container transfer process. On the other side, optimization has proved its capability in seeking for optimal schedules, but at the price of a simplified representation of the problem. In (Legato et al. 2010) a Simulated Annealing that uses simulation for a correct estimation of QC service levels has been proposed.

Here the QCSP has been dealt by considering the so called unidirectional schedules, as suggested by the current practice in the Gioia Tauro terminal. Starting by these

experiences, new lower bounds for the QCSP are currently under development for use in a solution method meant to solve the QCSP on large vessels.

Keywords: Port logistics, Scheduling, Heuristics

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Manpower daily planning at a Maritime Container Terminal

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The manpower planning at a maritime container terminal concerns the management of the ground crew, i.e. high skilled workers involved in the handling of containers both at the quay and the yard. We refer to the Gioia Tauro Container Terminal, where workers are organised in teams, called gangs, and each gang has to fit in with a suitable skill-mix. Workers can have one or more skills; so they are able to perform one or more tasks, with different degrees of priority. For each worker a monthly schedule, that is a sequence of working and rest days, is given (long term planning). The monthly schedule is determined on the basis of a forecasted workload demand. In particular it assigns a working shift to each worker. To face the uncertainty in the workload demand, some workers are scheduled to be available for each shift of the working day (flexible duty),

some others could work for two consecutive shifts (double duty). Moreover, the terminal planners can make use of subcontracted workers, mainly raisers. The long term panning does not take care about the tasks the workers will perform during their working shifts. These decisions are actually taken by the daily planning, which is the subject of this talk. Basically, as described in (Legato and Monaco 2004), the manpower daily planning problem is the problem of assigning a shift to workers scheduled for a flexible duty, the possible additional shift to those scheduled for a double duty, and a task to each worker. Here we also consider further decisions which consist in setting up the gangs, for quay and yard operations, and determining the number of subcontracted workers to engage. As regards this last issue, at the Gioia Tauro Terminal raiser teams working on the same ship must be homogeneous, meaning that all risers must be either subcontracted workers or employees. For the problem just described, we present a Linear Integer Model and a decomposition heuristic.

Keywords: Combinatorial optimization, Heuristics

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Maritime Repositioning of Empty Containers under Uncertainty

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Directional imbalance in container-based transportation is a major problem for shipping companies, because they are requested to reposition empty containers in order to meet future transportation opportunities. Many parameters are typically uncertain when repositioning decisions must be made. For example, empty container demand is typically imprecise, because unexpected transportation demands may arise. To address this problem, we generate a set of scenarios, which are collected in a time-extended optimization model and linked by non-anticipativity constraints, so that current decisions do not take advantage of information not yet available. During the talk, we will show why multi-scenario optimization models provide better repositioning with respect to standard deterministic ones. The effect of multi-scenario optimization is investigated under a wide array of uncertain parameters.

Keywords: Empty Container Logistics, Optimization under uncertainty

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ThB3. PRIN project – Distribution Logistics

Side-dependent Prize-collecting Rural Postman Problem with Fixed Costs

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The problem dealt with in this paper, called the Fixed-cost Side-dependent Prize-collecting Rural Postman Problem (FSP-RPP), combines facility location and arc routing with profits. The problem is defined as follows. Let $G = (V, A)$ be a directed graph with V and A vertex and arc set, respectively. Vertex 0 is the depot, and arcs are represented as ordered pairs (u, v). A tour T on G is a sequence of arcs not necessarily simple, that is, T can contain repeated arcs. For T being feasible, facilities must be appropriately located at vertices of G. Let $A(T)$ denote the set of arcs traversed by T: we say that T is supported by (the facilities located in) if $A(T)$ is contained in the subgraph induced by U. Installing a facility on costs. Non-negative costs and profits are also associated with arc traversal. If the tour traverses a profitable arc, then a profit is gained: but unlike costs, which are paid whenever an arc (u, v) is traversed, a profit can be collected only a limited number of times; moreover, the profit is side-dependent: that is, if u and v are connected in both directions, the profit gained when traversing (u, v) differs in general from that gained when traversing (v, u). The FSP-RPP consists in finding a tour T supported by some so as to maximize the total net profit.

The FSP-RPP belongs to the class of arc routing problems (see Eiselt et al. (1995), Fernández et al. (2003) and Ghiani and Laporte (2000)) and is a generalisation of the Prize-collecting Rural Postman Problem proposed by Aráoz et al. (2009) where an undirected graph $G = (V, E)$ is considered and a profit is associated to a subset of the edges. The objective is to find a tour that maximize the total net profit.

We propose a mathematical formulation for the FSP-RPP together with a set of valid inequalities. A branch and cut algorithm is then implemented to solve the problem to optimality

Keywords: Arc routing, Rural Postman Problem

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The Capacitated Team Orienteering Problem with Split Deliveries

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In most of the routing problems addressed in the literature, the set of customers to serve is known in advance (see Toth and Vigo, 2002). Only recently it is growing up the interest for routing problems where a non-negative value is associated with each customer and gained when the customer is visited. In these problems, called routing problems with profits, it is necessary to select the subset of customers to visit which allows to optimize the objective function while satisfying a given set of constraints (see Feillet et al., 2005).

In this work, we consider the Capacitated Team Orienteering Problem where split deliveries are allowed. A set of potential customers is given, each with associated profit. A subset of customers has to be served by a fleet of capacitated vehicles in such a way that the profit collected is maximized, while satisfying constraints on the length of each route and the capacity of the vehicles. Each customer may be served by more than one vehicle. We show that the profit collected by allowing split deliveries may be as large as twice the profit collected under the constraint that each customer is served by one vehicle at most. Then, we present an exact branch-and-price algorithm for the problem. The approach is similar to the one proposed in Archetti et al. (2009) for the Split Delivery Vehicle Routing Problem. We show the effectiveness of the solution approach on benchmark instances and on a new set of instances that allow us to computationally evaluate the impact of split deliveries. The technique adopted to define the new instances is the one used in Belenguer et al. (2000) to derive benchmark instances for the Split Delivery Vehicle Routing Problem.

Keywords: Capacitated team orienteering problem, Split deliveries, Branch-and-Price

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A Branch-and-Cut approach for bi-objective combinatorial optimization problems and its application to the Traveling Salesman Problem with Profits

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We describe a new type of procedure to solve exactly bi-objective combinatorial optimization problems.

We introduce a branch-and-bound algorithm that generates all (supported and non-supported) efficient points in the objective space with respect to both criteria. The developed procedure recalls the algorithm proposed by Ledesma and Salazar [3] for the bi-objective Traveling Purchaser Problem. Our method embeds a cutting plane generation in a branch-and-bound scheme to find a Pareto optimal solution in the decision space for each efficient point in the objective space of the bi-objective combinatorial optimization problem. The objective space is explored iteratively; each new efficient point computed by the procedure divides the objective space in two new sub-areas that must be explored. We show how this approach can be adapted to develop approximation schemes.

We used this method to compute the entire efficient frontier for the Traveling Salesman Problem with Profits (TSPP) [2]. This is a generalization of the well known Traveling Salesman Problem where a specific profit is associated with each node and can be gained if that node is visited, while reaching a node from another one has a known cost. The objective is the simultaneous maximization of the collected total profit and the minimization of the total traveling cost.

To analyze the performaces of our algorithm, we used two types of instances: the first ones use points that are randomly generated in a square according to a uniform distribution; the second ones are taken from TSPLIB library. We discuss the advantages and the disadvantages of our procedure with respect to the epsilon-constraint method presented by Bèrube et al. [1] which, as far as we know, is the unique exact approach proposed for the same problem. Finally, we evaluate the quality of the solutions obtained by the proposed approximated schemes.

Keywords: Bi-objective combinatorial optimization, Branch-and-cut, Traveling Salesman Problem with Profits

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Optimal solutions for routing problems with profits

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A directed graph is given, where a vertex represents the depot and the other vertices represent potential customers. A travel time is associated with each arc, whereas a nonnegative demand and a nonnegative profit are associated with each potential customer. A fleet of vehicles is available to visit the customers. A time limit is set on the tour of each vehicle. Moreover, the total demand served by a vehicle cannot exceed the vehicle capacity. The profit of each customer can be collected by one vehicle at most. We assume that each customer is served by one vehicle only. The objective of the Capacitated Team Orienteering Problem (CTOP) is to maximize the total collected profit while satisfying, for each vehicle, the time limit on the tour duration and the capacity limit on the total demand served. The objective of the Capacitated Profitable Tour Problem (CPTP) is to maximize the difference between the collected profit and the distance travelled by the vehicles while satisfying, for each vehicle, the capacity limit.

We present a branch-and-price algorithm for the solution of the Capacitated Team Orienteering Problem and of the Capacitated Profitable Tour Problem. A high quality

heuristic solution is also obtained during the search for an optimal solution through the identification of promising sets of columns. Several unsolved benchmark instances are solved to optimality.

Keywords: Routing problems, Branch-and-Price algorithm, Heuristic

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ThB4. OR and Data Mining

SVM for Emotion Recognition in Judicial Proceedings

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Emotional states represent a bit of knowledge embedded into courtroom media streams. The possibility for the end user to consult the transcriptions, also by considering the associated semantics, represents an important achievement that allow them to retrieve an enriched written sentence instead of a flat one.

In order to address the problem of identifying emotional states embedded into courtroom events, an emotion recognition system based on Multi-layer Support Vector Machines has been developed [1]. At the first layer a Gender Recognizer model is trained to determine the gender of the speaker, for distinguishing the "male" speakers from the "female" ones. In order to avoid overlapping with other emotional states, at the second layer gender-dependent models are trained. In particular, Male and Female Emotion Detectors are induced to discriminate the "excited" emotional states by the neutral one. At the third layer an emotional space discrimination is performed. Male and Female Emotional Space Discriminators are trained to distinguish between negative and positive affective states. Finally, the last layer recognizes different emotional state according to the positive or negative context: Male and Female Emotion Recognizer models (both for positive and for negative emotions) are induced by using only those sentences uttered as "excited-positive" and "excited-negative". Since SVMs are a linear learning machine able to find the optimal hyperplane separating two classes of examples and in our final layer we have a multi-class problem, we adopted the "pairwise classification" approach [2]. In this case, one binary SVMs for each pair of classes is learned to estimate the "posterior probability" to assign an instance to a given class label.

The experimental results indicate that the proposed method provides successful emotional classification performance as 77% over six emotional states, showing its applicability to both benchmark and real-life data.

Keywords: Support Vector Machines, Emotion Recognition, Hierarchical Classification

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Data Mining for the Analysis of Psycho-Physiological Variations to Stimuli in Vegetative State Patients

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Data mining represents a crucial approach in healthcare and biomedicine, with effective applications in information management within healthcare organisation, patient monitoring and clinical management, image and signal analyses. It provides a variety of methods and techniques to support health care operators in decision making, identifying relevant sets of parameters or their combinations for more correct diagnosis, more reliable prediction of disease progression and prognosis, or a more effective and efficient therapy planning and patient management. In last years, an increasingly challenging medical application of data mining has been the analysis of biomedical signals within the Neurology domain, which may reflect both internal regulation and response to stimulus conditions. Under this respect, detailed knowledge about interactions among different subsystems is lacking and standard statistical analysis may result ineffective, especially in case of non-linear associations among parameters. On the other hand, data mining techniques allow to identify relationship among continuous data, such as biomedical signals acquired on patients in the Intensive Care Units. Furthermore, data mining may offer a support in identifying reliable relationship among patient profiling and therapy versus outcome.

We describe our recent research experience related to the use of data mining approaches for studying relationship between changes in psycho-physiological parameters (mainly from Heart Rate Variability Analysis and Galvanic Skin Response) of vegetative state patients in response to suitable selected stimuli, such as the presence of a close relative, music and visual stimuli.

The preliminary results confirm that data mining proves to be effective in sort out new biomedical knowledge, potentially useful for medical doctors in order to consolidate a more deep comprehension of the psycho-physiological mechanisms in vegetative state patients during guided stimulation.

Keywords: Data Mining, Neurology, Vegetative State

Information extraction through constrained inference in Conditional Random Fields

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The discovering of semantic information embedded within natural language documents can be viewed as a decision making process aimed at assigning a sequence of semantic labels to a set of interdependent variables. This problem can be modelled through a stochastic process involving both hidden variables (semantic labels) and observed variables (textual cues). In this work we investigated one of the most recent and promising learning approach for semantic labelling, named Conditional Random Fields (CRFs) [1, 2, 4].

We propose a two stages approach to improve the performance of the inference procedure in CFR, where the inclusion of both specific domain knowledge and context knowledge learned from data is possible. To do so we adopt a inference engine based on Integer Linear Programming that, although more complex than the Viterbi Algorithm usually adopted for CRF inference, makes it possible to incorporate extra knowledge, in the form of logic rules, into the system (similarly to [3]). Such knowledge is, in the experiments conducted, extracted from training data with ad hoc logic mining methods. Experimental results over real data will show the potentiality of constrained inference on CRFs.

Keywords: CRF, Mining, Optimization

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ANN Inference System for Gas Turbine Failure Diagnosis to Optimize Energy Consumption by Analysis of the Reliability: The Case of a Gas Industry

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During recent decades, machines like: ovens, boilers, turbines, compressors and pumps have taken the largest amount of energy, so evaluation of this reliability of machines should be the first priority to identify the sensitive parts, reliability indicators and the methods of improving it in order to decrease the use of energy.

Gas turbines operating problems may be either instrument, electrical or mechanical and there is interdependence between the failure diagnoses of these three categories. Consequently, a correct diagnosis of a gas turbines failure needs to consider many symptoms and causes. But, due to nonlinear, time-varying behavior is difficult to deal with gas turbines failures with precise mathematical equations, while human operators with the aid of their practical experience can handle these complex situations, with only a set of imprecise linguistic if-then rules and imprecise system state, but this procedure is time consuming and needs the knowledge of human experts and experienced maintenance personnel.

The purpose of this study is to provide a correct and timely diagnosis mechanism of gas turbine failures by Artificial Neural Network which could approximate human. The proposed Neural Network by:

1. reduction of human error,
2. reduction of repair time
3. creation of expert knowledge which could be used for training
4. reduction of unnecessary expenditures for upgrades and finally,
5. reduction of maintenance costs,

will improve the maintenance process and reliability then it is caused to optimize energy. The novelty of this work is the knowledge acquisition (the extraction of linguistic rules) through the interactive impact of the critical failure modes on the all instrument, electrical and mechanical operating parameters. We used of a gas turbine in gas industry as a case study, in order to test presented intelligence system for failure diagnosis.

Then results of train data are compared with results of test data by ANN and the proposed approach is applied.

Keywords: Artificial Neural Network, Gas Turbine, Optimizing energ

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ThC1. Invited Lecture 4

Derivative-free Methods using Linesearch Techniques

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Many real world problems arising in industrial and scientific applications can be modeled as nonlinear optimization problems in which the first order derivatives of the objective function and constraints can be neither calculated nor approximated explicitly. This has motivated an increasing interest in the study of globally convergent derivative-free methods, namely in methods that are able to produce sequences of points converging towards stationary points of the considered minimization problem by employing only the information deriving from the function values.

This talk considers a particular class of derivative free methods which have the common feature of enforce the global convergence by using line search techniques along suitable search directions. The main ideas and results of these methods are briefly recalled and some recent algorithms for nonlinear constrained problems and nonlinear mixed problems are described.

Keywords: Derivative–free methods, Nonlinerar programming algorithms

ThD2. EWGT 1 – Advanced Methods in Transportation Analysis

Functional design and check of railway stations based on operational quality.

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The method illustrated is a synthetic method to calculate railway-stations capacity depending on a fixed traffic quality level, such as the highway-engineering methods. The capacity is in term of minimal number of truck that guarantees the fixed traffic quality level. The method is a railway application of "Filling-up curves theory". The elaboration of traffic data (timetables: arrival flows, service-time in the station, departure flows) is based on a statistical approach. The service-time of the train in the station is based on the train-categories (goods train, passenger train, HS train, local train, etc.) and station-parameters.

The results are scheduled depending on two traffic quality level. The results are also compared with queuing theory adapted to railway system. Real cases about some Italian stations are analyzed.

Keywords: Railway-station capacity, Filling-up curves, Traffic quality.

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A new microsimulation model for the evaluation of traffic safety performances

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Some papers have been recently presented (Cunto and Saccomanno 2007, Cunto and Saccomanno 2008, Saccomanno et al. 2008) on the potential of traffic microsimulation for the analysis of road safety. In particular, studies have confirmed that the reproduction by simulation of user behaviour under different flow and geometry conditions, can identify a potential incident hazard and allow to take appropriate countermeasures at specific points of the road network.

The objective of this paper is to asses the validity of this approach, for this reason a microsimulation model and an automatic video detection system has been developed. The microscopic model allows the estimation of road safety performance through a series of indicators (Crash Potential Index, Rate Deceleration to Avoid Crash, Available Maximum Deceleration Rate, Time to Collision, etc..) , representing interactions in real time, between different pairs of vehicles belonging to the traffic stream. When these indicators take a certain critical value, a possible accident scenario is identified. The validation of the proposed methodology is done by comparing the value assumed by the indicators of safety performance in simulated and real scenarios.

The microscopic simulation model is used combined with a new video image traffic detection algorithm to calculate vehicle trajectories. Microscopic traffic flow parameters obtained by video detection are used to calibrate the microsimulation model and the safety performance indicators obtained by the real vehicles trajectories can be compared with simulated scenarios where safety performance indicators are obtained on the simulated trajectories. The above described procedure has been applied in the analysis of overtaking manoeuvres on single lane for direction fast rural roads.

Results indicate that the methodology can be useful in the estimation of safety performance indicators and in evaluating traffic control measures.

Keywords: Traffic simulation, Road safety, Video traffic detection

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A dynamic formulation for discrete choice models

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In the literature, models simulating alternative choice probabilities aren't generally suitable to explicitly simulate the variation in choice probability, due to a variety of events that affect the system characteristics of users and the transportation network. These aspects must be explicitly considered in order to simulate several choices such as path choice for high frequency service; evacuation, when a population has to evacuate due to a forthcoming disaster; vehicle ownership, when socio-economic properties of families and technical characteristics of vehicles change in time. The problem is mainly set with the situations in which in the time new choices are born. In these cases, dynamic models should be adopted. Among dynamic models, a very important role is of the sequential models, a special class of dynamic models resulting from sequential analysis, which can provided an additional level of information about whatever behaviour in comparison with non-sequential analysis. Sequential analysis application, in fact, allow to discover stochastic patterns among data collected in the time. The join between discrete choice models and sequential analysis generate discrete sequential models, which allow to:

- analyze current behavioural in time t, in relation to the previous decisions in time t-1;
- forecast user behavioural in time t+1.

In this work, sequential techniques are applied to several databases in order to simulate vehicle ownership choices in time. The first step of our work is to verify if the data are characterized by a sequential structure. Results obtained by sequential tests justify the proposed dynamic formulation, which we have named as discrete sequential models. Proposed models have been estimated using a database relative to the socio-economic evolution of a sample family and also using two databases relative to the technical-performances characteristics of vehicles. Results obtained by model experimentation are presented in the paper.

Keywords: Demand, Dynamic, Sequential

The UNIMOB project: Mobility Management of the University of Trieste. Preliminary results

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The aim of this work consists in presenting the preliminary results of the project UNIMOB: the Mobility Management of the University of Trieste. This applied research program aims at monitoring, interpreting, computerizing, modeling and optimizing of movement of staff and especially students of the University of Trieste. It is an ongoing project started in September 2009 and it is characterized by a strong multi-disciplinary approach.

The core of Mobility Management (MM) is the identification and the definition of measures such as information and communication tools, organizing services and coordinating activities of different users. MM deals with individuals, who have different needs and wishes. However, for rational reasons, it is recommendable to cluster them into target groups. There are various desirable effects of MM on the target groups: they may change their attitudes towards sustainable modes, feel valued as potential customers of sustainable modes of transport and change their mobility behavior without feeling restricted or less comfortable. They can participate in optimizing mobility services, and, as a result of MM, it should become easier for them to make use of the existing services.

Preliminary results will be presented in the context of the wide background of initiatives dealing with the MM topic. In particular, this analysis starts from an examination of academic work on this subject. Subsequently the focus is on the classification of the past and ongoing projects at European level on the basis of the target groups of end users to be addressed. Moreover, the results of the first qualitative survey of staff and students responses about travel behavior, positioning of transport modes and some proposals will be presented.

Keywords: Mobility Management, Travel behavior, Commuter plan

Performance indicators for evaluating transit services

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The measurement of transit performance has been, and will continue to be, an important concern for allocating resources among competing transit agencies. Performance measurement is fundamental as a monitoring tool for improving the service. A transit performance measure is defined as a quantitative or qualitative factor used to evaluate a particular service aspect [1]. Each measure has its own series of indicators. Indeed, scientific research is ever more oriented towards the establishment of appropriate transit performance indicators. Many researchers consider the customer's point of view the most relevant for evaluating transit performance and service quality. Service quality can be evaluated by considering customer perceptions and expectations, or by a range of disaggregate performance measures which can be used for measuring the ability of the transit agency to offer services that meet customer expectations [1]. These measures are objective measures expressed as a numerical value, which must be compared with a fixed standard or past performance. The Transportation Research Board developed interesting researches about service quality measures, summarized in some reports in which the different transit service aspects are widely and fully described [1–3].

In this work, the issue of measuring service quality by objective indicators is approached. The aim of the work is to analyse the different ways to measure the quality level of some service aspects (e.g. service availability and reliability, safety and security, comfort and convenience) and to identify the most suitable indicators for each aspect.

Keywords: Transit performance, Service quality, Indicators

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A fuzzy expert system for ranking hub container terminals

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The potential and critical aspects of any transport service can be highlighted through the estimation of appropriate performance indicators of the examined system. Commonly, container terminal analysis are based first on the evaluation and comparison of quantitative parameters that describe the level of service of the terminal and, on the other side by means of performance indicators related to the terminal productivity. Researchers have been studying methods that can provide a synthetic performance measure of ports facility, in order to asses and compare service performances offered by different maritime terminals.

In this paper we propose a Fuzzy Inference System to evaluate a synthetic performance indicator, that could help planners and managers in terminals performances analysis and ranking as well as in assessing the effects of possible intervention and measure on the systems. This approach is suitable in the case of hub container ports. In fact this system is characterised by significant uncertainties and it is not always governed by certain rules, rational behavior, so that it cannot be easily represented by traditional mathematical techniques and models. In our opinion, could be convenient to define the values of the considered parameters by explicitly define them in an approximate way, that is to say by fuzzy sets.

In the proposed method a Fuzzy Inference System (FIS) simulates the behaviour of a human decision maker thought a set of logic rules such as "if I is X, then O is Y" that in the fuzzy logic framework could be red as "the more I is X, the more O is Y". The variables X and Y can assume linguistic or approximate values such as "low", "high" etc. The input I and the output O values belong to those sets with a membership grade specifiable by membership functions. The proposed approach is useful also to evaluate possible changes of the hub terminal level of service and to assess competitiveness of the terminals in the foreseen scenario.

Keywords: Fuzzy Inference System, Terminal Ranking, Performance Analysis

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ThD3. Maximal Software Tutorial

Why Python is such a cool language for optimization and scientific computing

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When writing optimization applications, often the easiest part is actually the formulation of the optimization model. Modeling Languages today are very advanced and take good care of this task.

Instead, the real challenge will frequently be, how to collect and prepare the data, design a nice GUI interface, and provide graphical visualization to the end-user, in order to make the optimization results look good and easy to understand.

Modeling Languages, such as MPL, AMPL, and GAMS, although providing excellent features for formulating optimization models, typically do not offer many advanced capabilities when dealing with data management and GUI interfaces, which subsequently often requires additional programming. There are of course many good programming languages to choose from: C/C++, Visual Basic, CSharp, Java, but these are not necessarily the easiest languages to work with for optimization and often require strong background in computer science.

This is where the scripting language Python can come to the rescue. In recent years, it has been making steady inroads into the world of mathematics and scientific computing. With its numerous mathematical libraries, for example Numpy, Scipy, and Matplotlib, it offers much of the same functionality as MATLAB, basically for free (as Python is open-source). For optimization there are also now many libraries available to choose from: Gurobi, CPLEX, LPSolve, MPL, COIN, Pyomo, Pulp-OR, many of which offer seamless integration of optimization and modeling with Python.

For those that have not seen or used Python before, we will start the presentation with a short hands-on tutorial, that demonstrates the many features of Python that make it such a cool language for optimization and scientific computing. We will cover how Python can be used as an interactive calculator, command language, scripting language, web language, as well as a full-featured application framework. We will also demonstrate some of the advanced features of the Python language, such as lists, tuples, dictionaries, string handling, slicing, iterators, list comprehensions, magic methods, objects, standard libraries, and import modules.

In the second part of the presentation, we will demonstrate several examples on to how to build and deploy optimization applications with Python. Many of the examples will be based on our own library "MPL for Python" from Maximal Software, but we will also be showing examples with other Python libraries, such as GUROBI, CPLEX and Pulp-OR, while pointing out the differences between them.

In the final part of the presentation, we will cover several major news and noteworthy trends in optimization that occurred during the past year, including: Free software now being offered for Academics by most major optimization vendors. Purchase of ILOG and DASH by IBM and FICO. New solvers from GUROBI and Microsoft. Major changes in distribution, licensing and pricing of optimization software. And finally, emergence of grids, clouds and virtual machines and their impact on the field of optimization.

ThD4. PhD Thesis

The bi-objective traveling salesman problem with profits and its connections with computer networks

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In the Ph.D. thesis we study an extension of the well known Traveling Salesman Problem: the Traveling Salesman Problem with Profits (TSPP) [1]. In this generalization, a profit is associated with each vertex and it is not necessary to visit all vertices. The goal is to determine a route through a subset of nodes that simultaneously minimizes the travel cost and maximizes the collected profit.

The aim of the work is to study new ways to solve the problem in both the exact and the approximated settings, giving all feasible instruments that can help to solve it. We start studying TSPP from a bi-objective point of view, focusing on the case where the underlying graph is a tree, in particular we develop a so-called FPTAS to find an epsilon-approximate Pareto curve for the problem. The TSPP is also analyzed under simple metrics, such as a cycle, or a star, and some algorithms are developed to find the exact set of efficient solutions [2]. Then, we introduced a branch-and-cut that computes the exact efficient set for TSPP. We used this procedure to develop some approximation schemes of the Pareto frontier. This topic is detailed in the talk "A Branch-and-Cut approach for bi-objective combinatorial optimization problems and its application to the Traveling Salesman Problem with Profits". Further, we introduce a second exact approach for the TSPP. The algorithm we propose derives from a dynamic programming approach for the Cycle Problem. The iteration formula is linear and simple: even if the method is inefficient from a computational viewpoint, its simplicity suggests that we could use it to develop some heuristic approaches to solve the TSPP. Finally we analyze an extension of TSPP, studying the problem with the time window restriction on the nodes. In particular, feasible resolution approaches are developed when the underlying metric is a line.

It is interesting to see how different can be the computational complexity for small changes in the starting hypotheses.

Keywords: Bi-objective combinatorial optimization, Branch-and-cut, Traveling Salesman Problem with Profits

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A Hyper-Solution Framework for SVM Classification based on Metaheuristic Approach

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In real world classification tasks, two strategies are usually applied: searching for the most performing configuration of a single classifier (Model Selection) or combining several basic classifiers resulting from a previous learning task (Classifiers Ensemble Learning). Indeed, such two strategies define two distinct streams in the classification learning research domain, even though performing simple combination strategies at the end of large classification learning tasks is often quite useful, such as Simple or Weighted Voting Systems. Searching for the most reliable setting up, either for one or an ensemble of classifiers, usually requires to select several parameter values to be tested and build a grid by which testing all possible available configurations, both for single classifiers and the ensembles (this strategy is also known as "grid-approach"). For any kernel-based learning strategy, such as Support Vector Machines (SVM) classification, another crucial issue has to point out: selecting a suitable combination of basic kernels (typically linear combination); this specific aspect may be considered an extension of Model Selection and is usually known as Multiple Kernel Learning.

This work deals with the development and implementation of a high-level classification framework which combines parameters optimization of a single classifier with classifiers ensemble optimization, through meta-heuristics. Support Vector Machines (SVM) is used for learning while the meta-heuristics adopted and compared are Genetic-Algorithms (GA), Tabu-Search (TS) and Ant Colony Optimization (ACO). Adopting meta-heuristics avoids to perform time consuming grid-approach for testing several classifier configurations. Proposed solution has been tested on 8 classification datasets (5 of them are of public domain) providing reliable solutions and showing to be effective.

Keywords: Machine Learning, Support Vector Machine, Metaheuristics

OMEGA Our Multi Ethnic Genetic Algorithm

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Whenever there is scarce hope to find an optimal solution to a combinatorial optimization problem under given constraints (of time, space etc.), heuristic approaches are typically used. A metaheuristic is a heuristic method for solving a very general class of computational problems by combining user-given black-box procedures, usually heuristics themselves, in the hope of obtaining a more efficient or more robust procedure. The genetic algorithms are one of the most effective and widely used metaheuristic approaches to solve optimization problems. These algorithms are a population based search technique that use an ever changing neighbourhood structure, based on population evolution and genetic operators, in order to take into account different points in the search space.

In my dissertation I focus my attention on four different optimization problems defined on graphs. Each one is proved to be NP-COMPLETE. I analyse each problem from different points of view, and for each one I define and implement a genetic algorithm. The final aim of this work is to show our variant of the classical GA, called OMEGA (Our Multi Ethnic Genetic Algorithm). In order to reduce the probability of remaining trapped at a local minimum we don't enforce in any way the basic scheme of GA but starting with an initial population we produce, one by one, k different populations, and we define k different evolution environments in which we let to evolve independently the k populations that, following a merging scheme, occasionally interact with each other. In the thesis the results of many numerical experiments demonstrating the effectiveness of the proposed method are reported.

Keywords: Genetic Algorithm, Parallel Programming, MLST

ThE2. EWGT 2 – Methodologies for Evacuation Conditions Management

A methodology for transportation planning to evacuation conditions: product evaluations

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A generic transportation plan is a result of a planning process. The planning process can be characterized by different planning dimensions and interactions among subjects involved. Planning can concern ordinary or emergency conditions of transport system. In this paper we will refer to emergency condition. To plan a system in emergency condition it's necessary to value risk and relative components: probability (or frequency); vulnerability; exposure, that is considered in the following. The main measure to reduce exposure is evacuation. In recent years, some modelling tools, real experimentations (or exercises) to simulate and to implement an evacuation have been developed to assist decision makers in preparing evacuation plans.

Main problems relative to evacuation planning, discussed in this paper, are: 1) there is no standard as yet for structuring planning process; 2) traditional evaluation methods, as cost-benefit analysis, have some limitations.

In the first part of the paper a process to plan an urban system in emergency conditions is presented. In particular we proposed an internal process structured according to the Logical Framework Approach (LFA). In the paper, adopting the LFA, a generic plan can be represented by the following components: inputs; activities; outputs; outcomes; goals. Each component is measured by a set of indicators estimated and validated with specific means of verification. Each component may be influenced by external factors. In the second part of the paper, based on LFA components and relative indicators, a method to compare different evacuation plans is proposed. Efficiency criterion is adopted and Data Envelopment Analysis, in the field of non parametric methods, is proposed to compare different evacuation plans. We use as DEA_inputs the LFA_inputs and we consider a multiple level for efficiency using LFA_outputs, LFA_outcomes and LFA_goals. A test application is illustrated.

Keywords: Evacuation planning, LFA, DEA

A methodology for demand simulation to evacuation conditions

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Demand models are a fundamental tool for solving most problems in transport systems planning and management. Several mathematical models to simulate transport demand are proposed in the literature. When a dangerous event occurs, in evacuation conditions, demand models specified and calibrated in ordinary conditions cannot be directly applied for several elements, such as multiplicity of decision-makers, definition of choice set, statistical and probabilistic aspects. Moreover, in evacuation conditions the analyst must consider possible targets set by the public decision-maker, in order to reduce system management costs, maximize the system utility (safety, security) and reduce traffic incidents. When a dangerous event occurs, in some emergency conditions, a variety of events affects the system characteristics of users and of the transportation network in the time. In order to simulate evacuation demand, the use of dynamic models, able to simulate variation in choice probability from one time to another time, considering temporal evolution of user characteristics and of dangerous event, could be required.

This work is subdivided in five sections:

- in the first section an analysis of dangerous events is proposed, considering its effects in the time and in the space regarding transport demand;
- in the second section, given a type of dangerous event, a system of model, able to simulate mobility demand in evacuation conditions and classified as static, is proposed;
- in the third section an analysis of software simulating demand in evacuation conditions is introduced;
- in the fourth section a sequential dynamic model to simulate evacuation condition is proposed;
- in the last section main results obtained by a real experimentation carried out in the urban area of Melito Porto Salvo (Italy), in relation to the research project SICURO, organized by Laboratory for Transport Systems Analysis, are presented, considering both static and dynamic approaches to the simulation.

Keywords: Demand, Evacuation, Dynamic

A methodology for emergency vehicles path design to evacuation conditions

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Transportation systems analysis in emergency conditions implies the necessity to tackle several issues connected to evacuation planning. Among these issues, the paths/routes design for emergency vehicles (e.g. ambulances, civil protection vehicles and so on) on a road transportation network have become increasingly relevant. The best paths/routes configuration for emergency vehicles can be tackled with a design approach. This approach is proposed in order to define optimal emergency vehicle distribution, in terms of vehicle number, weak users sequence to visit and hence paths/routes design to optimize an objective function. The design problem allows rescuing the emergency vehicles to weak people in the shortest time possible. A classical approach is the solution to a Vehicle Routing Problem (VRP). In the proposed approach, the routes are the output of a process and the whole methodology can be summarized in three main levels:

1. System Performances Estimation (SPE);
2. One-to-One Problem (OOP) solution;
3. Many-to-one problem solution (VRP) solution.

The equations linking the problem variables allow to take account of changes in the transport system to the occurrence of the emergency (i.e. changes in supply and demand) in term of supply performances and users behaviours. Two classes of users could be considered: the independent users who in disaster case follow the path of maximum perceived utility (User Equilibrium in static approach or Dynamic Process in dynamic approach) and the weak users who are brought in the refuge areas with emergency vehicles (System Optimum approach).

The proposed approach has been applied on the transport system of the central area of Melito di Porto Salvo. The road transport system was monitored during the evacuation and the survey data collected regarding the rescue of five weak users. The model described was specified, calibrated and validated.

Keywords: Road evacuation, Shortest paths, Vehicle routing problem

A methodology for road transport network design to evacuation conditions

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The paper describes research activities finalized to the development of a system of models and procedures for road transport network design in order to support transport planning in evacuation conditions. Activities are executed inside a research project titled SICURO, which general objective is risk reduction in urban areas in terms of exposure through the definition and implementation of evacuation procedures. The expected results concern the development of models, procedures and guidelines that support transport planning in evacuation conditions. Specific research lines concern travel demand, planning processes and guidelines, paths of emergency vehicles, pedestrian outflow from buildings, demand-supply interaction simulation and road transport network design.

In the sphere of the general objective and expected results of SICURO, the authors developed the last research line, which may be summarized through the following four steps presented in the paper.

- Literature review on existing decision support systems and demand-supply interaction models.
- Specification, calibration and validation of a DTA model. A microscopic DTA model is specified in its three components which are supply, demand and demand-supply interaction.
- Specification of a system of models and procedures for signal setting design.
- Design of signal setting scenarios and simulation of effects on travel demand.

The proposed system of models and procedures for signal setting design on a road network has been applied on the experimental test site with the objectives to validate the modelling components and to minimize evacuation times. The results are compared with the ones obtained from the simulation of the network topology scenarios; showing that interventions on signal setting parameters could be more effective than interventions on network topology for the examined experimental test site.

Keywords: Transport simulation models, Network design, Evacuation conditions

Planning and management of actions on transport system to address extraordinary events in post-emergency situations. A multidisciplinary approach

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The main objective of the work is the design and implementation of an integrated process for the identification of optimum action plans (expenditure constraints permitting) for a road transport system such as will minimize the impact produced on a land use/transport system by extraordinary events occurring across wider areas, in particular earthquakes.

The attention is focused particularly on post-emergency situations related with effects on transport networks caused by extraordinary events; the effects is considered with reference to bridges. Addressing the transition from physical effects to functional effects (relating to mobility) on the single infrastructure element calls for a commitment which has appeared challenging in view of the strongly innovative content involved.

The analysis process consists in different steps. In the first step an effort must be made in order to acquire knowledge about the characteristics of the set of infrastructures (bridges) and from a set of possible seismic scenarios. By using fragility curves of bridges, the damage state of the network links (in which bridges are included) can be obtained. By making a series of hypotheses on how a bridge damage state can influence links functionality, a set of "damaged" (lower capacity) road network models has been carried out. In the next step of the process, interaction between transport supply and demand, by way the application of static equilibrium models and/or of mesoscopic simulation models, allows to measure the performance of the system, or rather, its overall response to extraordinary events using suitable performance indicators (in this case a total travel time over the net). At the next step of the process the network risk curve (probability of the seismic action vs. total travel time) is derived. At the end of the process a cost-effective structures retrofit strategy has been identified. The procedure has been applied to a test network at regional scale in the north-east of Italy.

Keywords: Earthquake, Road network capacity, Vulnerability

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FrA1. Routing Problems

Multiobjective Undirected Capacitated Arc Routing Problem

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The Undirected Capacitated Arc Routing Problem (UCARP) is a classical arc routing problem minimizing the total transportation cost of a set of routes that service a subset of required edges (i.e., customers) under capacity constraints. In real life, some logistic companies want to minimize also the duration of the longest trip (in order to not exceed an upper time limit) and to satisfy all the customers by considering a limited number of vehicles at the depot.

Thus, in this work the Multi-objective UCARP is defined and studied considering three objectives to be minimized: the total transportation cost, the longest route (i.e., makespan) and the number of vehicle used to service the customers (i.e., the total number of routes). To find a set of solutions belonging to the optimal Pareto front, an optimization model-based heuristic procedure is proposed and tested on a set of benchmark instances.

Keywords: Undirected Capacitated Arc Routing Problem, Multiobjective Optimization, Pareto Front

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A tabu search procedure for the TSP with time windows

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In this work we describe a tabu search procedure for the TSP with time windows (TSPTW) with respect to the minimization of either the makespan or the total traveling distance. The search exploits an effective method to visit the neighborhoods defined by insertion, 2-opt and swap moves in $O(n^2)$ that generalizes a method proposed by Savelsbergh [2] for the 2-opt neighborhood. This method is extended in two directions. First, we consider a solution space containing also infeasible solutions and penalize possible violations of the time windows constraints in the objective function. Secondly, as required by the tabu search approach, the procedure looks for the best solution in each neighborhood, not just for any solution better than the current one. In order to speed-up the computation, suitable dominance rules are also introduced.

The procedure has been tested on the large set of benchmark instances available in [3] and its performance has been compared with the best known results for these instances reported in [1]. We are currently investigating the use of this procedure within an algorithm for the solution of the TSP with multiple time windows.

Keywords: TSP, Time windows constraints, Tabu search

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Mixed Capacitated General Routing Investigations

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We tackle the Mixed Capacitated General Routing Problem (MCGRP) which generalizes many other problems. Very few papers have been devoted to this argument, in spite of interesting real-world applications. For the MCGRP we propose a three-index integer programming model. We study the MCGRP polyhedron by extending to it a class of well-known valid inequalities and the related separation procedures.

A branch-and-cut algorithm has been developed and tested for a set of MCGRP-instances. Extensive numerical experiments indicate that our algorithm is capable of solving to optimality the most instances or, at least, providing strong lower bounds within limited computational times.

Keywords: Routing Problem, Mixed Graph

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The Multicolor Traveling Salesman Problem

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The problem addressed in this paper is a new interesting variant of the classical traveling salesman problem. The set of nodes to visit is obtained by joining clusters of nodes, each one characterized by a color. Two nodes of the same color must be separated in the optimal sequence by at least Alpha and at most Beta nodes of the other colors. The problem consists in finding the optimal Hamiltonian cycle, respecting all the different separation constraints.

We present formulations, exacts and heuristics approaches. The computational results prove the effectiveness of the proposed algorithms.

Keywords: TSP, Branch & Cut, MIP

A Benders decomposition approach for the General Minimum Latency Problem

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The General Minimum Latency Problem (GMLP) generalizes a number of well known routing problems such as the Symmetric Traveling Salesman Problem and the Minimum Latency Problem. The GMLP naturally arises in the design of traditional and flexible transit systems. However, similarly to the problems it generalizes, the GMLP has a potential for application in many different fields. The GMLP could be described as follows: given a set of locations which are origins and/or destinations of demand for transportation, find a simple cycle passing by every location in such a way a combination of routing costs and the average distribution time is minimized.

For this problem we propose a multicommodity flow formulation where flows represent movements of demand over a network. The design of the network is constrained to be

a Hamiltonian cycle. Demand flows are allowed to distribute along the most convenient direction (the less costly one) of the designed cycle.

For the solution of the GMLP we propose a B&C algorithm based on Benders decomposition. In a classical Benders decomposition scheme a MIP, called Master Problem (MP), is iteratively solved. At every iteration, a separation procedure checks whether the current MP solution is feasible and possibly optimal for the original problem. In case at least one of the two checks fails, the separation procedure identifies "feasibility" and / and "optimality" Benders cuts to be added to the MP. The algorithm we propose follows only partially the Benders decomposition scheme. We solve the linear relaxation of the MP. As a consequence, we generate feasibility and optimality cuts also at non integer master solutions. Furthermore, valid inequalities from TSP are used instead of Benders feasibility cut because they are more stable and tighter. We recover integrality embedding the relaxed MP in a B&B scheme. Results show that the lower bounds obtained at root node as well as the overall performance of the algorithm are very satisfactory.

Keywords: Benders Secomposition, Latency, Traveling Salesman Problem

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FrA2. Scheduling 2

On interval scheduling with a resource constraint

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Consider a flexible manufacturing system where a buffer area, organized in several independent lanes of limited capacity, is used to store work-in-process (WIP) lots of different sizes. WIP items of the same lot are typically processed as a whole and stored on the same lane. Furthermore, the arrival and departure times of each WIP lot are precisely determined by the production plan. Motivated by this kind of application, we analyse the following scheduling environment.

Jobs have to be processed by parallel identical machines in a non-preemptive way. The attributes of a job j are: a fixed start time $s(j)$, a fixed finish time $f(j)$, a value $v(j)$ representing the job priority, and a resource requirement $r(j)$. Every machine owns R units of the renewable resource necessary to carry out jobs. A machine can process more than one job at a time, provided the total resource requirement does not exceed R. Within this setting a decision problem and an optimization problem naturally arise: Does a feasible schedule for all jobs exist? Which is a subset of jobs of maximum total value such that a feasible schedule exist?

We show that the decision problem is NP-complete even when $R = 2$; we suggest an implicit enumeration algorithm which has linear time complexity in the number n of jobs when the number m of machines and the number R of resource units per machine are fixed. Similarly, the optimization problem is NP-hard even when $R = 2$ or even on a single machine for general R. We propose a compact integer linear programming formulation and an effective heuristic based on the algorithm suggested for the decision problem. We show on randomly generated instances that in most cases the results obtained by our heuristic are very close to the optimum.

Keywords: Interval scheduling, Fixed job scheduling, Resource constraints

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Scheduling problems with unreliable jobs and machines

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In this talk we address a relatively novel class of scheduling problems, arising in various different contexts, in which jobs are characterized by a certain revenue (if successfully carried out) and a certain chance of success. If revenues and success probabilities are independent, the problem of allocating and sequencing the jobs in order to maximize expected revenue can be seen as equivalent to a problem which was introduced long time ago, but did not receive much attention in the literature so far, namely the total weighted discounted completion time problem [1]. Such problem, in turn, is a strict generalization of the classical total weighted completion time problem, which is solved by Smith's rule for a single machine, and for which, in the case of m parallel identical machines, Kawaguchi and Kyan [2] proved that any list scheduling algorithm cannot provide a solution better than 1.207-approximate in the worst case.

Here we elaborate on some bounds for the problem of maximizing expected revenue with two parallel machines, and discuss some special cases. A different but related scenario is that in which success probabilities depend on the machine, that can fail according to some failure probability distribution. Also for this scenario we give some preliminary results and point out possible directions for future research.

Keywords: Parallel machines, Total weighted discounted completion time, Approximation algorithms

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Models and Policies for the TV Commercials Scheduling Problem

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We study the problem of a TV broadcasting that has to organize its programs schedule. The TV schedules its advertises on a given planning horizon. Each commercial break is composed by spots and there is a time limit on the breaks that can be aired on a day. The objective of the TV is to accept requests (consisting of a given audience to be reached) coming from different advertisers and to schedule each spot in the most profitable way. We present several formulations of the problem by considering additional features that take into account different aspects of the real process, like compatibility between spots and breaks (spots have to be scheduled in specific breaks while ensuring a given target in terms of number and type of customers); compatibility between competing spots; dependence of spots' price from breaks and position within the break; etc.

Based on the solution of the introduced formulations, and borrowing some revenue management techniques, we propose policies that support decision makers in defining appropriate programs schedule. Policies take into account the real decision process based on reallocate, after a negotiation phase, advertisers requests rather than refuse them.

Numerical results are presented based on some real data.

Keywords: Commercials Scheduling Problem, Revenue Management.

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Scheduling the Argentine volleyball league: A real-world application of the Traveling Tournament Problem with couples of teams

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Since the scheduling of sports leagues involves many kinds of constraints and the minimization of costs or travel distances, sports scheduling has become a very active field, providing both interesting and challenging problems to the combinatorial optimization community.

In this work we describe the process for scheduling the Argentine first division volleyball league. This league is composed by 11 or 12 teams grouped into couples of teams. Matches are held on Thursdays and Saturdays, and in every pair of consecutive Thursday-Saturday matches the two teams from each couple play against the two teams from another couple. The minimization of the travel distances is an important task, since the teams are located throughout the country, hence this problem is a variation of the well-known Traveling Tournament Problem (Easton, 2001).

The coupled format gives rise to two key decisions: (a) how to couple the teams and (b) how to schedule the matches. We have applied integer programming techniques and a tabu search heuristic to tackle these issues, and the resulting schedules have been successfully used in the 2007/2008, 2008/2009, and 2009/2010 leagues, reducing the total travel distances while meeting all the requirements. To the best of our knowledge, this is the first application of the Traveling Tournament Problem to a real-world league reported in the optimization literature.

Keywords: Traveling Tournament Problem, Tabu Search

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Tri-directional Scheduling Scheme: Theory and Computation

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In this paper we introduce a new scheduling scheme based on so called tri-directional scheduling strategy to solve the well known resource constrained project scheduling problem. In order to demonstrate the effectiveness of tri-directional scheduling scheme, it is incorporated into a priority rule based parallel scheduling scheme. Theoretical and numerical investigations show that the tri-directional scheduling scheme outperforms forward, backward and even bidirectional schemes depending on the problem structure and the priority rule used. Based on empirical evidence, it seems that as the number of activities are increased, the tri-directional scheduling scheme performs better irrespective of the priority rule used. This suggests that tri-directional scheme should also be applied within the category of heuristics methods.

Keywords: Project management, Scheduling schemes, Heuristic algorithms

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FrA3. Stochastic Models

Support Vector Machine for Time Series Regression

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Support Vector Machines (SVMs) have been extensively used in classification and regression. In this talk we will show how SVMs can be used to predict spcific aggregated values from a time series. Applications in finance will also be discussed.

Keywords: Time series, Neural Networks, SVM

An individual ALM Model for Lifetime Asset-Liability Management

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In this paper we develop a scenario-based, stochastic programming optimization model in discrete time to provide an approach to individual asset/liability modeling over time as presented in [1]. This model allows to evaluate different individuals, and family office's lifetime asset-liabilities situations to determine their chance of achieving their preferred targets, given their asset mix and liabilitiy committments. Since both assets and liabilities are stochastic, exact targets cannot be determined with certainty. The model gives advice regarding the characteristics of the life plan and the chance of achieving these targets.

Keywords: Stochastic programming, Individual asset-liability management

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Evaluating security-based policies in logistics via simulation

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Quality and security issues in logistics have certainly paved the road to attaining effective and reliable services, while also providing the means to reduce the related costs. The adoption of international standards and company procedures complying with them represent a concrete possibility towards the achievement of the above objectives. In this work, we have first mapped the operational work-flow at the basis of an import/export agency located in Southern Italy and then investigated via discrete-event simulation security-based issues dealing with information and data integrity. The aim is to design, evaluate and, thus, decide which organizational procedures and operational mechanisms can lead to a significant reduction of the controls performed on the documentation required to run the company business. In particular, a simulation model in Rockwell's Arena has been developed to emigrate from the actual "as is" information security-based solutions to the "will be" situations via scenario analysis. As a result, process re-engineering has been built around some key security issues involving i) personnel training activities meant to cut-down interpretation errors related to customs operations and ii) software update and maintenance according to a regular company-planned schedule. The simulation model has been verified and validated on and in cooperation with MTA Srl. Numerical experiments in the form of confidence intervals generated for the performance measures of interest are presented afterwards.

Keywords: Security, Logistics, Simulation

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Stochastic second-order cone programming in mobile ad hoc networks: sensitivity analysis and quality of the expected value solution

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We propose a two-stage stochastic second-order cone programming formulation (see Maggioni et al. 2009) of the semi-definite stochastic location-aided routing (SLAR) model, described in Ariyawansa and Zhu (2006). The aim is to provide a sender node S, with an algorithm for optimally determining a region that is expected to contain a destination node D (the expected zone). The movements of the destination node are represented by ellipsoid scenarios, randomly generated by uniform and normal distributions in a neighborhood of the starting position of the destination node. By using a second-order cone model, we are able to solve problems with a much larger number of scenarios (20250) than it is possible with the semi-definite model (500). The use of a large number of scenarios, allows for the computation of a new expected zone, that may be very effective in practical applications, and for obtaining performance measures for the optimal cost function values. Properties of the stochastic expected zone inherited from the derministic solution is discussed and sensitivity analysis on VSS and EVPI against the latency penalty to reveal the stochasticity of the problem is included.

Keywords: Stochastic Programming, Mobile ad-hoc Network, Expected value solution

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The efficiency of search strategies

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Since Stigler's well known artic!el a variety of papers have been published on the economics of information. Important and well known applications of this theory are consumer search for information in price and quality of goods, search of unemployed workers for a job in the labor market and the search of unwed individuals searching for a marriage partner. In economics less well known is the application of search models in the design of randomized algorithms. Rather independently of the majority of the literature on optimal search several articles have been published analyzing the optimal policy of search if we assume that only ordinal utility can be assigned to the objects found. This work usually does not consider search costs and concentrates on asymptotic considerations. The results are thus hardly to compare with the results in the economics of information literature. We shall in this paper try to compare the efficiency of search strategies. To compare ordinal utility oriented methods (rank models) with cardinal utility oriented methods we have to violate some of the basic assumptions of ordinal utility theory introducing search costs which are deductible from the ordinal utility indices. Despite this effect which makes the interpretation of the results more difficult these results yield some insight into the efficiency of drawing without and with recall having linear utility functions and a limited number of observations of discrete and uniformly distributed utility (loss) without being able to observe the actual value of an observation.

Keywords: Comparison of costly search policies

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FrA4. Machine Learning and Bioinformatics

Greedy Randomized Algorithms with Probability Learning for Classification in Bioinformatics

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In recent works [2,4] we have proposed an automated method that integrates a well known classification method based on logic formulas and on Minimum Cost Satisfiability [5] problems with a Feature Selection model based on Integer Programming. Such approach presents several advantages as it is completely based on a logic representation of the samples and of the separating rules. Its application in the analysis of biological and genetic data has been considered particularly interesting in different contexts [1,3]. The method requires the solution of many very large NP-complete problems and quite efficient greedy randomized procedures have been proposed in the recent papers to obtain solution of good quality for problems of considerable size.

In this paper we propose a significant enhancement to the greedy search procedure, where a set of probabilities on the rows and the columns of the integer matrix that represent the problem are adjusted during the search and are shown to foster the exploration of new portions of the solution space and, moreover, to increase the probability of convergence towards the optimal solution. Such enhancement, combined with a proper preprocessing based on data clustering, enables to solve quicker and better larger instances - as shown by the preliminary experimental results reported.

Keywords: Classification, Bioinformatics, Greedy Search

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A decision support system for the evaluation of the health impact of air pollution

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The evaluation of the quality of the environment is important for health impact assessment, which in turn is crucial for taking actions for protecting the public health. Many epidemiological studies have shown that acute or chronic health effects can be associated with high concentrations of environment pollutants. This paper stems from the european research project LENVIS (Localised ENVironmental and health Information Services for all) aimed at designing a Decision Support System (DSS) based on statistical learning. The algorithmic core of our system is the forecasting engine based on probabilistic state-space models, namely Hidden Markov Models (HMM). A HMM is a stochastic process whose evolution is governed by a Markov Chain whose state variable can assume a finite number of values s_j, $j = 1, 2, .., N$, which are often called states and cannot been directly observed. Each sj corresponds to one of the possible "conditions" in which the process can be. The model is characterized by a probability distribution for the initial value of the state $\pi(s_j)$, a set of state transition probabilities A whose elements $a_{ij} = P(s_j|s_i)$ measure the probability of being in state s_i at time t and s_j at $t + 1$. We apply Autoregressive HMM (AHMM), a class of HMM which assumes that an observation depends on the current state and also on the previous p values. The formulation of the model is completed by a set B of Probability Density Functions which describe the generation (emission) of the observed values.

We selected as case study the metropolitan area of Milan, which has very high population density and it is affected by air stagnation. We analyzed time series of about 3000 values. We determined experimentally the optimal structure of the AHMM, which achieves highest model likelihood with respect to training data, having 2 states, 5 mixture components and an autoregression process with order variable from 2 to 5.

Keywords: Decision Support System, Autoregressive Hidden Markov Model, Air Pollution Health Impact

A dynamic dosing approach based on genetic profiling of warfarin treated patients

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Oral anticoagulation therapy, largely performed by warfarin-based drugs, is commonly used for patients with a high risk of blood clotting which can lead to stroke or thrombosis. The state of the patient, with respect to anticoagulation, is captured by the index INR, which is to be kept within a therapeutic range. The patient's response is marked by high inter-individual and inter-temporal variability, which can lead to serious adverse events. In the last years genetic testing has been argued as a base for personalized dosing: indeed polymorphisms of two genes CYP2C9 and VKORC1 are markers of lower dosing requirements, but still account for a relatively minor part of this variability. The complete database has 3900 patients. For each patient we have personal, therapeutic and clinical information. A subset of 1300 patients has been genotyped, in particular for the polymorphisms of CYP2C9 and VKRC01.

This paper has two objectives:

- Use data mining techniques in order to characterize patients according to their warfarin metabolism and hence their sensitivity to different doses. We introduce a particular index, called drug sensitivity (Dsens) to capture the dose-INR relationships which better characterizes the patient behaviour. We train and test, using 10-fold cross validation, two different machine learning classification algorithms: Support Vector Machines (SVM) and Bayesian Networks (BN).
- Develop a Markov model to capture the dynamics of the patients response over the years. The simplest possible model of our problem considers: three states (HIGH (over range), IN (in range), LOW (under range)); three dosing actions (dose decrease, increase and constant) and a different transition probability matrix for each drug sensitivity class in order to formulate a Markov Decision Process for the identification of the optima dynamic therapy.

Keywords: Oral Anticoagulation Therapy, Patient profiling, Markov Models

Drug Profiling via Classification Method

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The goal of this research is to apply supervised learning of the SVM-type to classify and predict the drug outcome for oncological patients, on the basis of gene expressions collected from microarrays. Known sets of data are used to train the machine learning protocols to categorize patients according to their response. In particular, the study is focused on twenty-one patients with colorectal cancer who underwent to irinotecan-based chemotherapy were enrolled in the study. Irinotecan (CPT-11), a topoisomerase I inhibitor, is a cytotoxic agent used in the treatment of colorectal cancer. DNA was extracted from peripheral blood and 1 mcg of dsDNA was genotyped by drug-metabolizing enzyme and transporter (DMET) genotyping platform (Affymetrix,Inc., Santa Clara, CA, USA), which tests for 1936 genetic variations in 225 drug disposition genes. The genotyping profiles generated were analyzed and performed a pharmacogenetic DMET microarray profiling to identify new polymorphic variants in ADME enzymes correlated to irinotecan associated gastrointestinal adverse events. The SVM is trained to discriminate between patients who exhibit positive response and those who are subject to various type of intoxication.

Keywords: Classification, Pharmacogenomics, SVM

A radial-basis function neural network for indication of revascularisation for chronic limb ischemia

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Accurate classification of indications is a major problem in medical studies. A large number of recent research studies investigate the use of artificial neural network based decision making systems for classification or diagnosis of medical disorders. In this study, a radial-basis function (RBF) network is proposed for better classification of revascularisation plus medical treatment or pure medical treatment for patients having chronic limb ischemia. In the design of such a RBF network, to determine the function centers and the spread of Gaussian transfer functions, K-means clustering and k-nearest neighborhood procedures are used respectively. The results of the tests conducted on over hundred patients' data, demonstrate that the proposed classification approach is accurate and effective.

Keywords: Neural Networks, Radial Basis Function, Chronic Limb Ischemia

FrB1. PRIN project – Nonlinear Optimization 4

Convergence of dual ascent methods in Lagrangian relaxation of integer programs

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Lagrangian relaxation is a widely used tool to obtain a lower bound for hard integer programming minimization problems. In such a context solving the Lagrangian dual consists in finding the best set of multipliers, that is those multipliers which ensure maximization of the lower bound. To this aim, a piecewise affine concave function is to be maximized and several methods (subgradient, cutting plane, bundle, incremental etc.) are traditionally available. On the other hand, very often it is relatively simple to devise an "ad hoc" technique, based on the specific features of the problem in consideration, which allows us to increase the lower bound (dual ascent) by just updating one multiplier at a time. Methods of such type fall into the class of coordinate search algorithms. While they exhibit, in general, good properties in terms of ascent speed, they often suffer premature stopping at a point which is far from being optimal for the Lagrangian dual.

We introduce a hybrid coordinate search-subgradient method which consists in occasionally introducing a subgradient step into a one-multiplier-at-a-time updating procedure.

Convergence of the method is studied and some numerical results are reported.

Keywords: Lagrangian relaxation, Dual ascent, Subgradient method

Convex envelopes and underestimators for bivariate functions

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In this talk we will propose a technique to compute the value at some point of the convex envelope over a general two-dimensional polytope, together with a supporting hyperplane of the convex envelope at that point. Noting that the envelopes might be of quite complicated form and their computation not easy, we will move later on to the discussion of a method, based on the solution of a semidefinite program, to derive convex underestimators (not necessarily convex envelopes) of simple enough form for bivariate quadratic functions over general two-dimensional polytopes.

Keywords: Convex Envelopes, Convex Underestimators, Semidefinite Programming

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Derivative-free methods for mixed-integer optimization

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We consider the problem of minimizing a continuously differentiable function of several variables subject to simple bound constraints where some of the variables are restricted to take integer values. We assume that the first order derivatives of the objective function can be neither calculated nor approximated explicitly. This class of mixed integer nonlinear optimization problems arises frequently in many industrial and scientific applications and this motivates the increasing interest in the study of derivative-free methods for their solution.

We propose an algorithm convergent to points satisfying suitable stationarity conditions. The integer variables are tackled by using a local search-type approach. In the paper we extend the proposed approach to consider also the presence of nonlinear constraints. Numerical results on a difficult real application are presented and sustain the proposed method.

Keywords: Derivative-Free Methods, Mixed-Integer Optimization

New concave penalty functions for improving the Feasibility Pump

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Mixed-Integer optimization represents a powerful tool for modeling many optimization problems arising from real-world applications. The feasibility pump is a heuristic for finding feasible solutions to mixed integer linear problems. In this work, we propose a new feasibility pump approach using concave non-differentiable penalty functions for measuring solution integrality. We present extensive computational results on binary MILP problems from the MIPLIB library showing the effectiveness of our approach.

Keywords: Mixed-Integer programming, Feasibility Pump heuristic, Frank-Wolfe algorithm

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FrB2. Integer and Combinatorial Optimization 2

An Exact Algorithm for the Steiner Tree Problem with Delay Constraints

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In this talk we deal with the Steiner Tree Problem with Delays (STPD) in which the links of the network are assigned not only a cost, but also an integer coefficient that represents the delay in passing through the links. We want to find a minimum cost arborescence, rooted at one specific node and spanning all the destination nodes within a given maximal delay. We propose a directed cut-based formulation with lifted MTZ type constraints. We compare the LP relaxations of such a formulation and a shortest spanning arborescence formulation with side-constraints. Moreover, we present several valid inequalities that are embedded in a branch and cut method produces the exact solution of this NP-hard problem. Extensive computational experiments are reported and discussed.

Keywords: Steiner tree problem, Delay constraints, Branch and cut method

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CORAL: An exact algorithm for the Multidimensional Knapsack Problem

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The Multidimensional Knapsack Problem (MKP) is a well-known strongly NP-hard problem and one of the most challenging problems in the class of the knapsack problems. In the last years it has been a favorite playground for meta-heuristics (see Angelelli et al. [1] and references therein) while very few contributions have appeared on exact methods (see Kellerer et al. [3]).

In this paper we introduce an exact approach based on the optimal solution of subproblems limited to a subset of variables. Each subproblem is faced through a recursive variables fixing process that continues until the number of variables decreases below a

given threshold (Restricted Core problem). The solution space of the Restricted Core problem is split in subspaces, each containing solutions of a given cardinality. Each subspace is then explored with a branch-and-bound algorithm. Cuts are introduced to improve the efficiency of the branch-and-bound algorithm.

In all the tested instances, the proposed method has shown to be, on average, more efficient with respect to the recent branch-and-bound proposed by Vimont et al. [4] and against CPLEX 10. Experimentally, we have been able to improve known solutions on the largest and more difficult instances from OR-LIBRARY data set (Chu, Beasley [2]).

Keywords: Multidimensional Knapsack Problem, exact algorithm, reduced costs

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The Bin Packing Problem with Precedence Constraints

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Given a set of identical capacitated bins, a set of weighted items and a set of precedences among such items, we are interested in determining the minimum number of bins that can accommodate all items and can be ordered in such a way that all precedences are satisfied. The problem is denoted as the Bin Packing Problem with Precedence Constraints (BPP-P). The BPP-P has a very intriguing combinatorial structure and models many packing, assembly and scheduling issues.

According to our knowledge, the problem has been almost neglected in the literature, apart from a seminal paper by Garey et al. [1]. In this paper we present for the first time exact solution methods and computational results for the BPP-P. In particular, we

develop reduction criteria, a large set of lower bounds, a Variable Neighborhood Search upper bounding technique, and a branch-and-bound algorithm. We show the effectiveness of the proposed algorithms by means of extensive tests on benchmark instances.

Keywords: Bin Packing Problem, Precedence Constraints, Branch-and-Bound

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Experimenting with cost-driven multi-row cuts

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Gomory Mixed Integer (GMI [4]) cuts are one of the most important features in state-of-the-art Mixed-Integer Linear Programming (MILP) solvers. Each GMI cut is generated by one row of the simplex tableau of the LP relaxation, relative to some integer variables with fractional value in the current solution. The idea of generalizing GMI cuts by considering cuts that can be derived by several rows of the simplex tableau has recently garnered significant attention, and has spurned several theoretical papers showing the connection between multi-row cuts and lattice theory [1,2]. In particular, multi-row cuts can be derived from maximal lattice-free convex set (i.e., inclusion-wise maximal convex sets with respect to the property that they do not contain any integer point in their interior). However, relatively few papers have tested these multi-row cuts computationally, and so far the results do not give clear indications about their effectiveness [3]. One of the main problems seems to be "cut selection", since the number of possible cuts one could consider is unbounded. The lattice-free convex set we use to generate cuts is derived from the "continuous relaxation", that is, the problem including a subset of the rows and relaxing the integrality of non basic variables and the nonnegativity of the basic ones. The vertices of this convex set are determined by rescaling the columns of the semi-continuous relaxation by a factor depending on the reduced costs and the value of the semi-continuous relaxation. This set is then blown-up to a maximal lattice-free convex set. In ongoing work, we are testing the effectiveness of the family of cuts determined by these "cost-driven" lattice-free sets.

Keywords: Mixed Integer Programming, Cutting Planes, Lattice-free sets

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FrB3. City Logistics

Multi-Start Heuristics for the Two-Echelon Vehicle Routing Problem

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In Multi-Echelon Vehicle Routing Problems, delivery from one or several depots to customers is managed by routing and consolidating the freight through intermediate depots. This approach is closely connected to the design of City Logistics systems for large cities, where it provides the means of efficiently keep large trucks out of city centers, while the last leg of the distribution activities is provided by small and environmental-friendly vehicles [1, 2].

In this paper, we address the Two-Echelon Vehicle Routing Problem (2E-VRP), which is characterized by a single depot and a set of customers. The delivery of the freight to the customers is not managed by direct shipping from the depot, but by consolidating the freight in intermediate depots, called satellites. The first level routing problem addresses depot-to-satellites delivery, while the satellite-to-customer delivery routes are considered in the second level. The goal is to ensure an efficient and low-cost operation of the system, where all the demand is delivered and the total cost of the traffic on the overall transportation network is minimized. The 2E-VRP is solved by means of Multi-Start heuristics based on separating the depot-to-satellite transfer and the satellite-to-customer delivery. Two different perturbation strategies and six different methods for returning to feasibility if the perturbed solution is unfeasible are provided.

Computational results on a wide set of instances up to 50 customers and 5 satellites and a detailed comparison with the literature are provided, showing how the new methods outperform previously defined heuristic methods, both in efficiency and accuracy [3, 4].

Keywords: Multi-start heuristics, Two-Echelon VRP, City Logistics

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Modelling Uncertainty in Two - Tier City Logistics Systems

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City Logistics systems aim to reduce the impact of freight transportation on the city traffic, environment, and living conditions. A major instrument in achieving this goal is the consolidation of loads of different shippers, consignees and carriers into the same vehicles and the coordination of the movements of these vehicles.

We focus on City Logistics systems appropriate for large urban areas, where consolidation and coordination activities are performed at facilities organized into a hierarchical, two tired structure with major terminals sited at the city limits and satellite facilities strategically located close to or within the city-center area, and particular vehicle fleets dedicated to each system tier [2]. Similarly to any complex transportation system, City Logistics systems require planning at strategic, tactic and operational levels [1,4]. Tactical planning aims to provide the means to consolidation-based carriers and their customers for cost and service-quality efficient resource allocation and operations, through a transportation plan and schedule to be operated repetitively over a given planning horizon. For City Logistics, this efficiency must also be achieved for the city traffic and environmental conditions. A modeling framework for City Logistics tactical planning was introduced in [3], where the main focus was on building a detailed plan for the "next-day" activities specifying the urban vehicle and city freighter routes and schedules, as well as the delivery routes from the major terminals, through satellites, to the final customers. Similar to most of the City Logistics literature, the authors did not address uncertainty issues, nor did they study in any detail the broader issue of defining a tactical plan for regular operations. Our goal is to start filling this gap and present processes and models to build tactical plans for two-tiered City Logistics systems that account for the uncertainty in transportation demand.

Keywords: City logistics, Uncertainty, Integrated short-term planning

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Experimental results of a tabu search heuristic for a two-echelon location-routing problem

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Freight transportation in urban and regional areas is generally performed through intermodal platforms, also referred as City Distribution Centers (CDC). In last years the opportunity of designing a multilevel freight distribution system has been highlighted. A two-echelon freight distribution system has been proposed, based on the utilization of intermediate facilities, satellites or transit points, between platforms and final customers (Crainic et al. 2009). At these facilities freight coming from the CDCs are consolidated into vehicles of smaller sizes more suitable for the final distribution in the city center. Already existing infrastructures as underground parking slots or bus depots could be exploited for their location. Two fleets of dedicated vehicles are used on the two echelons, referred respectively as urban-trucks and city-freighters. Urban-trucks move freight from a platform to one or more satellites, whereas city-freighters perform the distribution from the satellites to the final customers. In this two-echelon freight distribution system, a two-echelon location-routing problem (2E-LRP) can be defined, aimed at finding the

location and the number of CDCs and satellites, the size of the two different vehicle fleets and the related routes on each echelon. Exact models for multi-echelon location-routing problem have been proposed in Ambrosino and Scutellà (2005) and Baldacci et al. (2010).

In this work we present a tabu search heuristic (Boccia et al. 2010) and the results obtained on test instances of varying dimensions (up to 5 CDCs, 20 satellites and 200 customers), comparing them with those obtained by exact models in terms of quality of solution and computation time. Moreover an analysis of these results with respect to distribution of platforms and satellites, capacity and costs of facilities and vehicles is provided.

Keywords: Location-routing, freight distribution

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Flexible services for people transportation: a simulation model in congested area

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The realization of innovative transport services, require increasingly greater flexibility and inexpensiveness of the service. In many cases the solution is to realize demand responsive transportation system. A Demand Responsive Transport System (DRTS) requires the planning of travel paths (routing) and customer pick-up and drop-off times

(scheduling) on the basis of received requests. In particular, the problem has to deal with multiple vehicles, limited capacity of the fleet vehicles and temporal constraints (time windows). A DRTS may operate according to a static or to a dynamic mode. In the static setting, all the customer requests are known beforehand, and the DRTS produces, by solving a Dial-a-Ride Problem (DaRP) instance, the tour each bus has to make, respecting the pick up and delivery time windows while minimising the solution cost. In the dynamic mode, the customer requests arrive over time to a control station and, consequently, the solution may also change over time.

In this work, we address a Demand Responsive Transport System capable of managing incoming transport demand using a solution based on a two-stage algorithm to solve a DaRP instance. The solutions provided by the heuristics are simulated in a discrete events environment in which it is possible to reproduce the movement of the buses, the passengers' arrival to the stops, the delays due to the traffic congestion and possible anomalies in the behaviour of the passengers. Finally, at the end of the simulation, a set of performance indicators evaluate the solution planned by the heuristics.

Keywords: Discrete event simulation, Dial-a-Ride Problem, Heuristics

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FrB4. Network Design

Scheduling Sensors in Wireless Networks to Extend Lifetime and Maintain Connectivity

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Wireless Sensor Networks are generally characterized by a large number of small sensing devices (sensors), often randomly disposed all over the region of interest in order to perform a monitoring activity on a set of target points. One of the key issues in this scenario involves the maximization of the amount of time in which this activity can be carried on and it is usually known as Maximum Network Lifetime Problem (MNLP), under the constraint given by the limited power of the batteries contained in the sensors.

In most of the works on the subject available in the literature, MNLP is faced by scheduling the sensors in subsets (covers) that are individually able to cover the whole set of targets. Exact and heuristic methods to build such covers and assign to them appropriate activation times have been presented in several works, and also some variants of the problem solved in a similar way have been proposed. A drawback of such approaches is that the amount of energy that is needed to deliver the sensed data is not modeled; individual sensors inside a cover might be very far from each other and from wherever the information needs to be sent. For this reason, in some contexts the solutions of the MNLP problem could be inaccurate with respect to the corresponding real-world applications. To overcome this drawback and take into account communication costs, we look for a solution composed by connected covers. In particular, let us consider an additional node (sink) representing a central processing station; let us also say that there exists a communication link among each couple of sensors (or sensor and sink) if they are close enough to communicate directly between each other. A solution composed by connected covers is such that for each of its covers its sensors and the sink constitute a connected structure using communication links.

In this work we present an exact approach for the problem and for some variants of it, as well as some preliminary results.

Keywords: Wireless Sensor Network

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A Genetic Approach for Bounded Degree Spanning Tree Problems

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Bounded Degree Problems have met a growing interest in the last years, due to their importance in fields such optical networks or network design. In this context many applications, such as World Wide Web browsing and video conferences among others, require the individuation of connected sub-networks (e.g. Steiner or Spanning Trees) to send and receive information between the nodes. Moreover, these networks require specific constraints to be modeled in order to take into account their particular physical characteristics, such as the propagation of the light in the optical fiber. In particular, the wave division multiplexing technology allows to propagate different light beams on the same optical fiber, as long as they use a different fixed wavelength. In this kind of networks multicast technology permits to replicate the optical signal from one source to many destination nodes by means of a network device (switch) that allows to replicate a signal, splitting light. Such devices are required in vertices with a degree greater than 2, usually defined branch vertices. However, it is important to minimize the number of required switches for both cost and signal quality preservation reasons. In the literature this objective has been faced by defining two different problems, the Minimum Branch Vertices (MBV) Problem, where we look for the Spanning Tree with the minimum number of branch vertices, and the Minimum Degree Sum (MDS) Problem, where the aim is to find a Spanning Tree such that the degree sum of the branch vertices is minimized. Previous studies on these problems can be found in [3] and [2]. Also some variants have been proposed, such as the Minimum Crossing Spanning Tree [1].

In this work we show that the objective can be better achieved with the problem of finding the Spanning Tree with the minimum number of leaves [4]. We also present a

genetic scheme that can be applied to solve the three problems and show some preliminary computational results.

Keywords: Spanning tree, bounded degree, network design

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Models and algorithms for the fiber-to-the-home network design with tree access network

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In this talk we consider a location problem arising in telecommunication networks, namely the Two-level Hierarchical Capacitated Facility Location Problem (TLHCFLP): two sets of facilities have to be located, and different devices can be installed in each site, providing different capacities at different costs; single source restrictions enforce each client to be assigned to exactly one facility; location and dimensioning of the facilities have to be optimized simultaneously.

The TLHCFLP has already been tackled with both exact and heuristic algorithms. In order to move towards more realistic models, we introduce two important features of real applications. First, we evaluate the option of organizing the network connecting clients to facilities as a tree. Second, we face the problem of survivability of the network

among higher level facilities. We present models and algorithms, providing experimental results on datasets of instances from the literature.

Keywords: Telecommunications, Facility location, Branch-and-price

A multi-source supply chain network design problem under stochastic processing costs

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Efficient architecture of supply chain networks (SCN) leads to outstanding accomplishments throughout the whole chain. As the supply chains (SC) are influenced by uncertain environment and parameters, we are supposed to involve risk-generating sources into the structure of mathematical formulations. In this paper, we considered the environments in which the process and throughput costs face with uncertainty with respect to two different sources of fluctuations. Our model objective function (OF) encompasses investment costs and the costs incurred by processing and transportation activities. We have applied Value-at-Risk (VaR) strategy as the solution methodology to let the practitioners to choose the most satisfactory service level. At the end of the paper, some numerical examples have been solved to test the validity of the developed model.

Moving towards drastically competitive markets and its fundamental prerequisites such as high reliability, faster response to demands, and higher flexibility led to a substantial focus on the problem of SCNs design during two past decades (Azaron et al, 2008). To do so, we have developed a model which is associated with the category of multi-stage, multi-source, multi-product, single-period problems with capacitated plants and distributors. It encompasses both the decision planning in strategic level as it deals with the affairs like location, number of facilities, and capacities (network configuration) and both the tactical level as it deals with the products processing, distribution, and quantities issue (Tang, 2006). On the other hand,VaR approach has many advantages that make it distinctive from other methods. For example, if we used the mere expected value (EV) of a stochastic variable, we could just manage the short-term fluctuations (Birge & Louveaux, 2007) Or it can govern the risk as a p median model (Wagner et al, 2009) which is of a great importance.

Keywords: Supply Chain Networks, Uncertain Environment, Value-at-Risk

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