Chair: Oya Ekin-Karasan
    Bilkent University

1 : Integer Linear Programming Formulation of the General-ized Vehicle Routing Problem. İmdat Kara, Başkent University; Bektaş, Tolga.

The Generalized Vehicle Routing Problem is an extension of the VRP where the nodes are grouped into a given number of mutu-ally exclusive and exhaustive clusters. The problem consists of determining optimal routes starting and ending at the depot, with each cluster visited exactly once, such that demands are satisfied and vehicle capacities are respected. In this paper, we model the GVRP as an integer linear program with $O(n^2)$ binary variables and $O(n^2)$ constraints. It is shown that, the proposed model reduces to the Generalized mTSP and the Generalized TSP, as well as the classical VRP, mTSP and the TSP.

2 : Polyhedral Analysis of the Uncapacitated Concentrator Location Problem with Star Routing. Hande Yaman, Universite Libre de Bruxelles; Labbé, Martine.

We consider the problem of locating concentrators in a tele-communication network. Given a set of terminals, we choose a subset to be concentrator locations and assign each remaining terminal to a concentrator. A concentrator is connected to a root node by a direct link. This leads to a network with a star backbone and star access networks. The aim is to minimize the cost of location, assignment and routing. This problem is called the "Uncapacitated Concentrator Location Problem with Star Routing". We study its polyhedral properties. We present a branch and cut algorithm to solve it and computational results.

3 : Placement of Wavelength Converters in Optical Net-works. Oya Ekin-Karasan, Bilkent University; Karasan, Ezhan; Erdoğan, Güneş.

The placement of wavelength converters in wavelength division multiplexing (WDM) optical networks is studied. With sparse wavelength conversion, the problem of routing and wavelength assignment has to be considered in conjunction with the con-verter placement problem. Due to computational challenge, we decouple this problem into two sub problems. In the first stage, under the assumption of full wavelength conversion, routes are determined such that total fiber cost is minimized. In the second stage, using the fixed routes we jointly solve the interchanger placement and wavelength assignment problems that achieve the same fiber cost as the first stage. Numerical studies are provided.

: TC05   **Fleet Management**

Invited Session   Room: JB B

Chair: Walter Ukovich
    University of Trieste

1 : Efficient Fleet Management for a Container Road Carrier. Luca Coslovich, University of Trieste; Pesenti, Raffaele; Ukov-ich, Walter.

A fleet management problem that occurs in container transpor-tation industry is presented. From the carrier perspective, the incurred operations costs to minimize can be divided in three components: the routing costs, the resource (i.e., driver and

truck) assignment costs and the container repositioning costs (i.e., the costs of restoring a given container fleet distribution over the served territory, as expected by the shipper that owns the containers). Our solution approach is based on the relax-ation of this problem in three separate simpler sub-problems associated to each of the costs considered above.

2 : A System for Reprogramming Load Vehicle Routes. Vania Barcellos Gouvêa Campos, Instituto Militar de Engenharia; Ri-beiro, Glaydston.

This paper presents a system for rescheduling vehicle routes for collecting and distributing fractioned load in urban areas. This system has been developed in order to aid the transportations companies to solve the problem of solicitations for new collect-ing services when the collecting/delivery load vehicle is already in operation. This system associates Geographic Information Systems-GIS and Global Positioning Systems- GPS technologies and utilizes a procedure that evaluates the inclusion of a new pick up in one of the several routes. This system allows deciding which vehicle route gives the best solution by analyzing all the vehicle capacity and routes.

3 : Containers Distribution Planning when Zone Tariffs Exist. Milorad Vidovic, University of Belgrade; Kim, Kap Hwan; Kalic, Milica.

Containers' flows may exist between port and several types of inland origins and destinations. Also, those flows may be flows of empty and/or loaded containers. Specificity of those distri-bution (collecting) problems lies in fact that truck may carry simultaneously only one 40ft, or two 20ft containers. Hence, mentioned problem may be, generally, considered as a special case of the routing problem with multiple use of vehicles. In addition, the problem studied here comprises case with "zone tariff system", where price for delivering goods inside zone is the same, and does not depend on distance.

4 : Multi-Depot Bus Scheduling: Exact and Heuristic Ap-proaches and Model Variations. Natalia Kliewer, University of Paderborn; Gintner, Vitali; Koberstein, Achim.

This work presents exact and heuristic network-flow based methods for the bus scheduling problem with consideration of multiple depots and vehicle types. We analyse a number of model variations such as depot groups and different cost struc-tures. Computational experiments are carried out on large-scale real world instances.

: TC06   **Scheduling - C1**

Contributed Session   Room: M30

Chair: Aslı Erdiller
    Uludağ University

1 : A Literature Survey of Deterministic Job Shop Scheduling using Genetic Algorithms and Simulated Annealing by means of Local Search Algorithms. Mehmet Mutlu Yenisey, İstanbul Technical University; Şevkli, Mehmet.

Job-shop scheduling problem is one of the well-known hardest combinatorial optimization problems. A lot of literature has been published, but no efficient solution algorithm has been found yet for solving it to optimality in polynomial time. As a re-

sult much effort has recently been concentrated on meta-strategy which guides the search out of local optima. The purpose of this study is to give a survey of recent works on deterministic job shop scheduling by local search techniques. The impact of the major contributions is indicated by applying these techniques to a set of standard benchmark problems.

2 : A Hybrid Genetic Algorithm for the Early/Tardy Scheduling Problem. Rui Alves, Universidade do Porto; Valente, Jorge; Gonçalves, Jose.

This paper presents a hybrid genetic algorithm for the Early/Tardy scheduling problem in which no unforced idle time may be inserted. The chromosome representation is based on random keys. The genetic algorithm is used to establish the order in which the jobs are initially scheduled, and a local search procedure is subsequently applied to detect possible improvements. The approach is tested on a set of randomly generated problems and compared with existing procedures based on dispatch rules and local search. The computational results show that this new approach, although requiring slightly longer computing times, outperforms the previous algorithms.

3 : A Genetic Algorithm for Parallel Machine Total Tardiness Problem. Furkan Kıraç, Boğaziçi University; Bilge, Ümit; Kurtulan, Müjde.

A Genetic Algorithm (GA) approach is employed to solve a generalized version of Parallel Machine Total Tardiness problem where a set of independent jobs with sequence dependent setups, non-identical due dates and arrival times are to be sequenced on a set of uniform parallel machines. Several adaptive control mechanisms that try to control the population diversity in order to overcome premature convergence are developed and incorporated in GA. Extensıve tests on a set of problems obtained from the literature not only yield very good results with respect to the best-known values, but also further improve some of these best-known solutions.

4 : A Genetic Algorithm based Approach for the Integrated Job Shop Scheduling and Operations Planning Problem. Aslı Erdiller, Uludağ University; Orbak, Ali Yurdun.

In job shop scheduling problems, it's difficult to prepare applicable schedules with the dynamic constraints of the job shop, such as machine breakdowns, dynamic change of demand, etc. Thus, techniques that produce flexible and rapid response are desirable. In this paper, a genetic algorithm based approach will be illustrated and analyzed for the solution of scheduling and operations planning problem for job shop. The schedules that are obtained with this approach are active and non-delay. In addition, high fitness valued schedules constitutes alternative operation plans. With the proposed approach, near optimal solutions are obtained in a very short computation time.

: TC07   **Spare Parts Management - II**

Invited Session   Room: M31

Chair: Geert-Jan van Houtum
        Eindhoven University of Technology

1 : Availability of a k-out-of-N System Given the Number of Spares, Repair Capacity and a Condition based Maintenance

Strategy. Karin de Smidt-Destombes, TNO-FEL.

We consider a k-out-of-N system, with identical components. Given a maintenance strategy, number of spares and repair capacity, we determine the availability. The system's condition initiates maintenance, components need to be replaced and failed ones restored. For the availability of spares we also include their repair cycle.

2 : Determining Component and Finished Goods Inventory Levels in Large-Scale Capacitated Repair Systems. James Rappold, University of Wisconsin-Madison; Resnick, Adam; Shi, Leyuan.

We present a periodic-review production and inventory planning model that determines component and finished product inventory levels when demand is highly uncertain and repair capacity is finite. We compare the performance of our solution approach to management practices currently used in the firm that motivated our research.

3 : Performance Optimization in Multi-Echelon, Multi-Indenture Systems for Repairable Spare Parts with Capacity Restrictions at Repair Facilities. Andrei Sleptchenko, University of Twente; Van Der Heijden, Matthieu; Van Harten, Aart.

The existing methods for repairable spare parts supply models either ignore server capacities at repair facilities or use methods inappropriate for big systems. We present here models, which encounter repair capacities, can be applied to big systems and can use more parameters (number of servers and repair priorities) for optimization.

4 : Multi-Echelon Repairable Item Systems, Modeled as Closed Queueing Networks. Henk Zijm, University of Twente; van Ommeren, Jan-Kees; Daryanto, Ahmad.

Repairable item systems with multiple repair facilities and stock locations are modeled as multi-echelon closed queueing networks where at each echelon items can be stocked. We present an algorithm based on approximations that exploit Norton's theorem. Examples and numerical results are presented. In addition, multi-indenture models are briefly discussed.

: TC08   **GDN Keynote Session - II**

Invited Session   Room: M32

Chair: Gregory Kersten
        University of Ottawa

1 : Systems and Right Problem Solving in Group Decision and Negotiation. Melvin Shakun, New York University.

The paper discusses right problem solving and in so doing considers operationally purposeful complex adaptive systems (PCAS), Evolutionary Systems Design (ESD), group/negotiation support systems, consciousness, connectedness, spirituality, rationality, problems, and right rationality in theory and practice. System agents may be natural (human) and/or artificial.

2 : The Graph Model for Conflict Resolution: Past, Present, and Future. Marc Kilgour, Wilfrid Laurier University.

The history and development of the graph model for conflict resolution is reviewed. New ways of structuring and analyzing a

2 : Reverse Logistics in Saturated Markets. Alexander Wutz, University of Siegen.

In saturated markets, product life-cycles (PLC) are getting shorter. Short PLC generally are considered as ecologically harmful, since more and more natural resources are used within each period. Replacing a one-way economy with both material cycles and longer PLC could be a solution. This contribution focuses on shortened PLC and their impact on planning used product flows in a reverse logistics context. It is shown that the ability to plan and control reverse product flows depend on past sales. In a simulation model, the consequences of shortening PLC for controlling and planning reverse product flows are examined.

3 : Emission Trading and Technical Progress from the Firm's Perspective. Peter Letmathe, University of Siegen.

In the European emission trading system, the affected firms will obtain yearly allowances to emit a given amount of CO_2. The firms can trade these allowances and may invest in technical progress leading to fewer emissions. The presentation examines how companies can adjust to the trading system. The theoretical background builds Solow's hypothesis that technical progress is embodied in capital goods which leads to different production functions in each period. In combination with the putty-clay model, it is shown that technical progress rates, timing of investment and prices of allowances play an important role in coping with the trading system.

4 : Environment Oriented Reverse Logistics by using Vehicle Routing Planning. Frank Schultmann, University of Karlsruhe; Rentz, Otto.

In this contribution, the peculiarities of establishing a Closed Loop Supply Chain (CLSC) are presented, based on an example considering the end-of-life vehicle (ELV) treatment. Different design options for a CLSC are put up, concentrating on how reverse material flows can be integrated in supply chains. Reverse logistics aspects are modeled with vehicle routing planning. Introducing a problem-tailored algorithm, results of several closed loop supply chain scenarios are discussed which are based on real case data, depicting measures from German ELV stakeholders.

: WA27   **ESIGMA - I**

Invited Session   Room: L11

Chair: Theodor Stewart
          University of Cape Town

1 : Adding Transparency to MCDA Methods. K. Nadia Papamichail, University of Manchester; French, Simon.

This work describes a methodology for automatically generating explanations in MCDA applications. We have developed an expert system that justifies the advice of a decision support system for nuclear emergencies. This explanation system adds transparency to the ranking process by applying natural language generation techniques to produce two reports: first, a comparative report that contrasts two alternatives and second, a sensitivity analysis report that interprets the variation of outputs in response to changes in the inputs. A validation study

indicates that the generation of explanations improves the performance of the users and facilitates their understanding of the decision process.

2 : A Case of Confrontation: Insights from MCDA and Conflict Analysis. Valerie Belton, University of Strathclyde; Losa, Fabio.

This paper explores the integrated use of MCDA and conflict analysis, in particular drama theory, to improve understanding of decision contexts characterized by conflicting objectives and complex, multi-party interactions. We aim to demonstrate the potential for synergy between the two approaches through one or more case studies. In particular we illustrate how a multi-criteria perspective can enhance understanding of the credibility of threats, promises and the ensuing dilemmas of rational choice, consequently highlighting possible ways in which these may be resolved.

3 : Aggregation of Preferences with Inconsistencies in a Pairwise Comparisons Scenario. Jacinto González-Pachón, Universidad Politécnica de Madrid; Romero, Carlos.

Let us consider n decision makers that have to rank m alternatives. The decision makers show their preferences through n pairwise comparison matrices that are not necessarily reciprocal and/or consistent. A proposed preference aggregation procedure is divided into two phases. First, from n pairwise comparison matrices an aggregate distance-consensus matrix is obtained. Second, this consensus matrix is minimally modified while simultaneously holding "as much as possible" the reciprocity and consistency properties. A balance between normative and descriptive aspects of the decision making process is thus established. In both phases, Goal Programming reveals as a powerful approach for dealing with the underlying optimisation problems.

4 : A Simple Common Framework/Interface for MCDM. Ignacy Kaliszewski, Systems Research Institute.

A rough taxonomy of interactive Multiple Criteria Decision Making methods distinguishes two major classes, namely the weight methods and reference point methods. All methods of these classes amount to a partial, decision maker guided search of the set of efficient decisions. The dichotomy is based on which elements are manipulated to capture DM's preferences. The purpose of this paper is to show that in some technical terms, reference point methods are equivalent to weight methods. With such an interpretation provided, it is possible to implement methods of these two classes in the same technical framework.

: WA28   **Geometric Search**

Invited Session   Room: L12

Chair: Patrick Jaillet
          Massachusetts Institute of Technology

1 : Parallel Online Search of Concurrent Lines. Patrick Jaillet, Massachusetts Institute of Technology; Stafford, Matthew.

We consider various problems where p searchers explore m>p half-lines, all joined at a common origin. We propose optimal deterministic on-line strategies for solving a version of the time-competitive problem, and compare with results obtained on other variants of time-competitive problems. We also discuss

results associated with distance-competitive ratio, and with the value of additional information.

2 : Geometric Search and Its Application to Limited Broadcasting in Peer-to-Peer Ad Hoc and Radio Networks. Mikael Hammar, University of Salerno; Gargano, Luisa; Östlin, Anna.

A new class of on-demand protocols for mobile ad hoc networks has been proposed for their low routing overhead. However, to find a destination node, these protocols flood the network, resulting in overuse of bandwidth. We analyze a method called limited broadcasting that terminates a broadcast as soon as the destination is found. The analysis uses techniques developed for geometric search problems. In particular, we use results for parallel searching on rays to obtain tight bounds for limited broadcasting in both ad hoc and radio networks.

3 : Application of Genetic Algorithms to Scheduling Problems. Ali Yurdun Orbak, Uludağ University; Erdiller, Aslı.

Genetic algorithms are mostly applied to problems that are difficult or impossible to solve with classical techniques in polynomial time. Scheduling problems are one of these NP-hard problems. In this paper, a modified new version of Simple Genetic Algorithm (SGA) is applied and illustrated to scheduling problem. The modifications include the subroutines for the construction of the objective functions, calculation of objective function values and fitness values. As objective functions makespan, number of tardy jobs, and total tardiness are chosen. With these modifications, active, non-delay and near-optimal schedules are obtained in a very short computation time.

4 : The Dynamic TSPTW on a Line: Do Preprocessing so that Insertion of a New Location into an Existing Route may be Done in Sublinear Time. Binay Bhattacharya, Simon Fraser University; Mitrovic-Minic, Snezana.

The Traveling Salesman Problem with Time Windows (TSPTW) deals with finding a shortest route in order to visit a set of locations each within a specified time window. When all locations are positioned on a straight line the problem is the TSPTW on a line. The dynamic TSPTW arises when not all locations are known in advance. This talk focuses on improving complexity of inserting a new location into an existing route by using a certain preprocessing. Straightforward linear-time algorithm explores all slots of a route. We would present a way to do insertion in sublinear time.

: WA29   **Dynamic Programming - I**

Invited Session   Room: L13

Chair: Seiichi Iwamoto
Kyushu University

1 : A Primitive Dynamic Programming. Seiichi Iwamoto, Kyushu University.

What is dynamic programming? This presentation is concerned with the class of all dynamic programmings - with or without optimization. Where is an origin in the class? What is it? The talk is a travel which leads to the origin. We present a primitive form of dynamic programming. It is a non-deterministic dynamic programming, which generates stochastic dynamic programming, which in turn reduces to deterministic dynamic programming.

Thus we propose the non-deterministic dynamic programming as a primitive dynamic programming.

2 : Maximizing Order Probabilities on Markov Chains. Seiichi Iwamoto, Kyushu University; Ueno, Takayuki.

It is natural to consider expectation criteria in stochastic decision problems. In particular, both discounted expected value of total reward and average value per stage are well studied criteria in Markov decision processes. However, in this paper we consider a probability criterion that the reward is nondecreasing in time- an order probability. We maximize the order probability on finite-horizon controlled Markov chains. We show that the policy class for maximization depends upon reward function's dependence on today's state, today's decision and tomorrow's state.

3 : On Splitting Problem. Seiichi Iwamoto, Kyushu University; Fujita, Toshiharu.

We consider an iterative splitting of a finite set of consecutive integers. Any split yields two consecutive parts with a splitting cost. Each of splitted-parts is also splitted into two parts. The splitting is repeated until each splitted-part contains only two consecutive integers. The two consecutive integers incur a terminal cost. The problem is to find a sequence of splittings which minimizes the total cost of all splitting costs and of all terminal costs. This problem is solved through a nondeterministic dynamic programming.

: WA30   **Finance & Banking - C1**

Contributed Session   Room: L14

Chair: Zdravka Aljinovic
University of Split

1 : The Interdependence of the Accounting Variables and Market Measures of Risk: A GARCH Model of the Japanese Banking Institutions. Iqbal Mansur, Widener University; Elyasiani, Elyas.

This study attempts to establish whether equity prices of the Japanese banking institutions impound information contained in the balance sheet and income statement. A three-index model, the indices being the Market Index, Interest Rate Index and the Foreign Exchange Rate, within the GARCH framework is utilized. This paper extends the literature by investigating the determinants of market and exchange rate risks. To this end, the beta measures derived from the GARCH model are regressed against the corporate decision variables. The Japanese bank data provides an international comparison of the systematic risk and exchange rate risk sensitivities.

2 : Shadow Riskless Returns and Maximin Portfolios: A Robust Hedging Approach to Interest Rate Risk. Alfredo Ibáñez, ITAM; Balbas, Alejandro; Romera, Rosario.

This paper addresses the hedging of bond portfolios interest rate risk by drawing on the classical "one period no-arbitrage" approach of Financial Economics. Under realistic and weak assumptions on the instantaneous shifts (or shocks) on the yield curve, several "Shadow Riskless Assets" are introduced by means of linear semi-infinite mathematical programming problems and maximin portfolios. Our technique is general. Finally,