TECHNICAL SESSIONS

Thursday, 9:30-10:30

■ TA-01

Thursday, 9:30-10:30
Room A

Plenary Talk 1

Stream: Plenary Lectures
Plenary session

Chair: *Silvano Martello*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, silvano.martello@unibo.it

1 - A Match Made in Heaven: Semidefinite Optimization and Combinatorial Optimization

Miguel Anjos, Mathematics and Industrial Engineering & GERAD, Ecole Polytechnique de Montreal, Montreal, Quebec, Canada, anjos@stanfordalumni.org

The relationship between semidefinite optimization (SDO) and combinatorial optimization (CO) budded more than three decades ago: it dates back at least to the groundbreaking work of Lovász on the Shannon capacity of graphs. It then blossomed in the mid-1990s with the advent of the maximum-cut approximation algorithm of Goemans and Williamson. Since then, the applications of SDO in CO have continued to grow, and the bond between these two areas is as strong as ever. We will survey important CO problems on which SDO has recently made a significant impact, and we'll highlight reasons to believe that this fruitful match will last.

Thursday, 10:50-12:30

■ TB-01

Thursday, 10:50-12:30
Room A

Computational Optimization

Stream: Algorithm and Computational Design
Invited session

Chair: *Basak Akteke-Ozturk*, Department of Industrial Engineering, Middle East Technical University, 06531, Ankara, Turkey, bozturk@metu.edu.tr

1 - The Dynamic p-Median Problem

Huseyin Guden, Industrial Engineering, Baskent University, 06531, Ankara, Turkey, hsyngdn@yahoo.com, *Haldun Sural*

In the dynamic p-median problem demand amounts for customers can change over the horizon. Also in any period new facilities can be opened in addition to the operating ones or some of them can be abolished. One can barely find a comprehensive study on the dynamic problem in the literature. We define the core dynamic problem and develop a branch-and-price algorithm using its reduced size integer programming formulation. We also develop an effective column generation strategy to enhance the algorithm. Our computational results on test instances derived from the p-median literature are presented.

2 - The Foraging Search for Combinatorial Optimization Problems

Ayca Altay, Industrial Engineering Department, Istanbul Technical University, ITU Isletme Fakultesi Macka, 34367, Istanbul, aycaaltay@yahoo.com, *Gulgun Kayakutlu*

Nature-based metaheuristics have been successfully implemented for many types of optimization problems. As a novel nature-based metaheuristic, the Foraging Search imitates the Animal Food Chain in nature and produces robust and effective results for non-linear problems. However, the robustness of the algorithm has not been tested on Combinatorial Optimization problems. In this study, the Foraging Search Algorithm will be tested on various Travelling Salesman Problems. The results will be compared with Particle Swarm Optimization and Predator-Prey Particle Swarm Optimization algorithms.

3 - Can we really ignore time in simple plant location problems?

Joana Matos Dias, FEUC / INESCC, University of Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, Portugal, joana@fe.uc.pt

In simple plant location problems (SPLP), the time dimension is not explicitly considered, either because there are not significant costs for relocating facilities, or because the assignment costs are not expected to change significantly as time goes by. Nevertheless, location problems are strategic decisions by nature. In this work, we will show how the explicit consideration of a planning horizon, as well as the explicit definition of time dependent assumptions, is essential in the definition and application of SPLPs because they can influence significantly the optimal decision.

4 - A Parallel Algorithm for Solving Quadratic Assignment Problem on GPUs

Erdener Özçetin, Industrial Engineering, Anadolu University, Iki Eylül Kamp., MMF END 107, 26000,

Eskişehir, Turkey, eozcetin@gmail.com, *Gurkan Ozturk*

Quadratic Assignment Problem (QAP) is a difficult combinatorial optimization problem. To get a solution with exact methods is extremely hard, several meta-heuristics have been proposed. Enhanced graphics card with hundreds of graphics processing units (GPUs) are used to solve hard computational problems by parallelizing. Parallelization of the algorithms by using GPUs are getting more popular. In this paper, a parallel algorithm has been proposed for QAP with shorter execution time than sequential one. The performance of the algorithm has been shown by solving literature test problems.

5 - How to benefit from Algorithm Engineering in areas of departmental research and applications

Basak Akteke-Ozturk, Department of Industrial Engineering, Middle East Technical University, 06531, Ankara, Turkey, bozturk@metu.edu.tr, *Haldun Sural*

Research is conducted at student and faculty levels of the Industrial Engineering Department of METU. This study discusses the efforts and activities within the Design and Optimization Lab called TOL that aims to support education and research at all levels of the department. We concentrate on examples from implementation and empirical investigation guidelines and test instance collections to systems of software reusing and application development. We illustrate how to benefit from algorithm engineering (or experimental algorithmics) in these examples to enhance collaborative computing.

■ TB-02

Thursday, 10:50-12:30
Room B

Global Optimization

Stream: Global Optimization

Contributed session

Chair: *Tugba Saraç*, Department of Industrial Engineering, Eskisehir Osmangazi University, Meselik Kampusu, 26480, Eskisehir, Turkey, tsarac@ogu.edu.tr

1 - Mixed Convexity and Optimization

Emre Tokgoz, School of Industrial Engineering, University of Oklahoma, 229 Overton Drive, 73071, Norman, OK, United States, Emre.Tokgoz-1@ou.edu

Discrete variable L and L# functions are introduced by Fujishige and Murota, and related separation and Fenchel-type duality theorems are obtained by Murota by using combinatorial properties. In this work, by using the definitions and results obtained for real and discrete L/L# convex analysis, mixed T, T*, T1, and T1 convex - concave function definitions and corresponding separation and Fenchel-type duality results are obtained for mixed integer programming problems.

2 - Global Optimization of Mixed-Integer Bilevel Programming Problems

Zhaohui Xu, Technische Universität Chemnitz Fakultät für Mathematik, Technische Universität Chemnitz Fakultät für Mathematik, 09127, Chemnitz, Sachsen, Germany, zhaohui.xu@mathematik.tu-chemnitz.de

This paper is concerned with mixed-integer nonlinear bilevel programming problem, which has a quadratic objective function and one parameter on the right-hand sides of the constraints in the lower level problem. We propose an algorithm via an approximation of the optimal value function of the lower level problem to solve the bilevel programming problem globally.

3 - QMIST - An algorithm for solving non-convex quadratic mixed-integer problems

Angelika Wiegele, Mathematik, Alpen-Adria-Universitaet Klagenfurt, Universitätsstr. 65-67, 9020, Klagenfurt, Austria, angelika.wiegele@aau.at, *Christoph Buchheim*

We present an algorithm based on semidefinite relaxations for solving unconstrained non-convex quadratic mixed-integer optimization problems. The relaxations yield tight bounds and are computationally easy to solve for medium-sized instances, even if some of the variables are integer and unbounded. In this case, the problem contains an infinite number of linear constraints; these constraints are separated dynamically. We use this approach as a bounding routine in an SDP-based branch-and-bound framework. Numerical experiments show that our algorithm performs well on various types of non-convex instances.

4 - An extended cutting plane method for mixed integer nonconvex programming

Linh Nguyen, International University, Vietnam National University, Quarter 6, Linh Trung Ward,, Thu Duc District, 70000, Ho Chi Minh City, Ho Chi Minh City, Viet Nam, honglinh98t1@yahoo.com, *Ho Phong*

In this paper, we extend the cutting plane method for a class of nonconvex problems. Our study focuses on a cutting plane method for a problem with bi-convex set of constraints and an objective which is a generalized convex function. We apply the method to constrained nonlinear optimization problems and mixed integer nonlinear optimization problems involving pseudoconvex functions. The problem of optimizing a nonconvex function over a given bi-convex set or compact set frequently occurs in theory, as well as industrial applications.

5 - Modified subgradient based hybrid algorithm for solving binary quadratic programming problems

Tugba Saraç, Industrial Engineering Department, Eskisehir Osmangazi University, Meselik Kampüsü M3, 26480, Eskisehir, Turkey, tsarac@ogu.edu.tr, *Nergiz Kasimbeyli*, *Refail Kasimbeyli*

In this paper we use a new hybrid version of the modified subgradient (MSG) algorithm previously suggested by Gasimov for solving the sharp augmented Lagrangian dual problems. The most important features of this algorithm are those it guarantees a global optimum for a wide class of non-convex optimization problems, generates a strictly increasing sequence of dual values and guarantees convergence. In this study we develop a new tabu search algorithm for finding most efficient values of step size parameters and combine it with MSG algorithm for solving binary quadratic programming problems.

■ TB-03

Thursday, 10:50-12:30
Room C

Constraint Programming and Combinatorial Optimization

Stream: Constraint Programming and Combinatorial Optimization

Invited session

Chair: *Arslan Ornek*, Industrial Systems Engineering Department, Izmir University of Economics, Balcova, 35330, Izmir, Turkey, arslan.ornek@ieu.edu.tr

1 - Models for Working Time Determination Problem in Interval Scheduling

Güvenç Dik, Industrial Systems Engineering, Izmir University of Economics, Izmir University of Economics, Sakarya Cad. No:156, 35330, Izmir, Turkey, guvencdik@gmail.com, *Gamze Mat*, *Deniz Türsel Eliiyi*, *Brahim Hnich*

We consider the novel working time determination problem in an interval scheduling environment.Each of the identical parallel machines has a unit-time operating cost and each processed job brings a given profit. Jobs have fixed ready times and deadlines; a job is lost if it does not start processing at its ready time.The objective is to select a subset of jobs to be processed and a subset of machines to use in order to maximize the total net profit.The working time of each used machine is also determined.Performances of mip and cp models are compared via computational experiments.

2 - A MIP/CP approach for production scheduling at a major European dairy company

Onur A. Kilic, Department of Management, Hacettepe University, Turkey, onuralp@hacettepe.edu.tr, *Dirk Pieter Van Donk*

This paper addresses a process scheduling problem originating from a production system specialized in evaporated milk products. The layout of the system involves processing and packaging. The processed materials are batch-wise standardized in between these continuous production stages. The traceability requirements and time and sequence-dependent cleaning of production units lead to a challenging scheduling problem. A two-phase mixed-integer programming model is presented, which successively determines the specifications regarding material flows and builds a complete production schedule by employing a constraint programming model. The approach is shown to be efficient by means of a numerical study based on the data collected from a real-life evaporated milk plant.

3 - Rex-2: an efficient algorithm for automatic knowledge acquision in inductive learning

Filiz Şenyüzlüler, Industrial Engineering, Zirve University, Zirve Üniversitesi Mühendislik Fakültesi, Kızılhisar Kampüsü 27260 Gaziantep, 27260, Gaziantep, Turkey, filissen@gmail.com, *Ömer Akgöbek*, *Emre Yakut*

Rule induction are two important methods/processes to extract knowledge from data. In rule induction, the representation of knowledge is defined as IF-THEN rules which are easily understandable and applicable by problem-domain experts. Classification is to organize a large data set objects into predefined classes, described by a set of attributes, using supervised learning methods. For this purpose, it uses a set of examples to induce general rules. In this study, the rule base is created through the knowledge discovery by employing REX-2 algorithm, an inductive learning technique.

4 - Computing Optimal (s,S) Policy Parameters Under Service Level Constraints

Brahim Hnich, Computer Engineering, İzmir University of Economics, Sakaraya Cadessi No:156, Balcova, Izmir, 35330, Izmir, Turkey, hnich.brahim@gmail.com, *Imen Zghidi*, *Roberto Rossi*, *Armagan Tarim*, *Habib Chabchoub*

We address an interesting class of inventory/production control problems that considers the multi-period, single-location, single-product case under non-stationary stochastic demand and service-level constraints. The approach we take in this paper is a Stochastic Constraint Programming (SCP) approach. SCP combines together the best features of Constraint Programming and of Stochastic Programming. The main contribution, of this paper, is a novel SCP model that computes for the first time the optimal control policy parameters for such a problem.

5 - A Constraint Based Heuristic To Solve Advanced Planning and Scheduling Problems

Arslan Ornek, Industrial Systems Engineering Department, Izmir University of Economics, Balcova, 35330, Izmir, Turkey, arslan.ornek@ieu.edu.tr, *Cemalettin Öztürk*

We present a two-phase heuristic based on constraint propagation to solve an Advanced Planning and Scheduling (APS) problem. Products with multi-level structures have items with precedence relations among them. Each item may require different operations on eligible machines. In the first phase, Operation Assignment Heuristic (OAH) assigns operations to eligible machines with the objective of allocating balanced workloads to the machines. Once operations are assigned then Slack Based Scheduling Heuristic (SBSH) schedules operations considering conjunctive and disjunctive relations. The objective is to minimize makespan. Finally, we provide our conclusions and possible future directions for further study.

■ TB-04

Thursday, 10:50-12:30
Room D

Supply Chain Optimization

Stream: Combinatorial Optimization in Suppy Chain Management

Invited session

Chair: *Edwin Romeijn*, Department of Industrial and Operations Engineering, University of Michigan, 48109-2117, Ann Arbor, Michigan, United States, romeijn@umich.edu

1 - Internet Shopping with Additional Variables

Jedrzej Musial, Computer Science and Communications Research Unit, University of Luxembourg, Luxembourg, jedrzej.musial@ext.uni.lu, *Jacek Blazewicz*, *Pascal Bouvry*

Internet Shopping Optimization Problem (ISOP) is a brand-new problem defined recently by the same authors. It answers the question of how to manage a multiple-item shopping list over several shopping locations. ISOP problem is also very interesting from the practical point of view since it concerns shopping optimization for all the users of the Internet. The main goal of this research is to extend the ISOP model to a wider class of problems including additional variables and characteristics (e.g. expiration dates, product priorities).

2 - Cost Effective and Environmentally Friendly Hybrid Energy Model: The Case of Turkey

Buse Aras, Industrial Engineering, Koc University, Rumeli Feneri Yolu, Koc Universitesi, 34450, Istanbul, Sariyer, Turkey, baras@ku.edu.tr, *Metin Turkay*

The role of energy economics and green energy systems become remarkable due to the increasing population and the consequent growing demand for energy. In this research, we derived a Mixed Integer Linear Programming model whose main objective is to minimize the total cost of the system and also carbon dioxide emissions while making the best allocation of energy resources and electricity generation options. Communities are divided into four main sectors (industry, houses, agriculture and transportation) and decommissioning costs of both renewable and non-renewable electricity generation options are considered in the model. Also, we demonstrated the applicability of the model using GAMS.

3 - Retailing Shelf Space Allocation: A Critical Review

Mehmet Erdem Coskun, DeGroote School of Business, McMaster University, 385 Herkimer Street, L8P2J2, Hamilton, Ontario, Canada, mehmeterdemcoskun@gmail.com, *Elkafi Hassini*

There are many products under various brands in a product category which are competing for a limited space in a retailer's shelves. We conduct an extensive review of the existing literature. We focus on how demand is being modelled in this context and present the major optimization models that have been used as well as the different solution approaches that have been employed. We conclude by proposing a practical and general space allocation optimization model and a research agenda in this field.

4 - Approximation algorithms for selective newsvendor problems

Edwin Romeijn, Department of Industrial and Operations Engineering, University of Michigan, 48109-2117, Ann Arbor, Michigan, United States, romeijn@umich.edu, *Zohar Strinka*

A selective newsvendor chooses a set of markets to serve as well as an order quantity, with the objective of optimizing a cost-based objective. For example, we consider expected cost or a risk measure associated with cost such as Conditional Value-at-Risk. We provide an algorithmic approach that yields a solution that, with high probability, has objective value bounded by an affine function of the optimum when the vector of market demands has nonnegative support.

Thursday, 13:30-15:10

■ TC-01

Thursday, 13:30-15:10
Room A

Integer and Combinatorial Optimization

Stream: Integer and Combinatorial Optimization
Invited session

Chair: *Xiaoling Sun*, School of Management, Fudan University, 670 Guoshun Road, 200433, Shanghai, China, xls@fudan.edu.cn

1 - Optimal cardinality constrained portfolio selection

Duan Li, Systems Engineering & Engineering Management Dept., The Chinese University of Hong Kong, Shatin, NT, Hong Kong, dli@se.cuhk.edu.hk, *Jianjun Gao*

We consider the cardinality constrained mean-variance portfolio selection problem and explore its special structure and rich geometric properties. We consider modifying the primal objective function to some separable relaxations, which are immune to the hard cardinality constraint, and develop efficient lower bounding schemes by using the axisaligned ellipsoids to approximate the objective contour of the problem, leading to a semidefinite programming (SDP) formulation with a sharp bound and high quality feasible solution.

2 - Approximation Algorithms for Single Vehicle Scheduling Problems with Release and Service Times on a Tree or Cycle

Zhaohui Liu, Mathematics, East China University of Science and Technology, 200237, Shanghai, China, zhliu@ecust.edu.cn

We consider the single vehicle scheduling problem with release and service time constraints. The objective is to minimize the makespan. In the tour-version the makespan means the time when the vehicle returns to its initial location after serving all customers, and in the path-version the makespan refers to the maximum completion time of all customers. For the problem on a tree, we give a 9/5-approximation algorithm for the tour-version and a 27/14-approximation algorithm for the path-version. For the problem on a cycle, we give 12/7-approximation algorithms for both versions.

3 - On-Line Scheduling on Batch Machines with Delivery Times

Xiwen Lu, Dept. of Math, East China University of Science & Technology, 200237, Shanghai, China, xwlu@ecust.edu.cn, *Peihai Liu*

We consider the on-line scheduling on m batch machines with delivery times. In this paper on-line means that jobs arrive over time and the characteristics of jobs are unknown until their arrival times. Once the processing of a job is completed it is delivered to the destination. The objective is to minimize the time by which all jobs have been delivered. For each job J_j, its processing time and delivery time are denoted by p_j and q_j, respectively. We first consider a restricted model: the jobs have agreeable processing and delivery times, i.e., for any two jobs J_i and J_j, p_i > p_j implies q_i >= q_j. We provide a best possible on-line algorithm for the restrict case, and present the competitive ratios for both the restrict and general cases.

4 - The role of diversification when solving dispersion problems

Roberto Aringhieri, Computer Science Department, University of Torino, Corso Svizzera 185, 10149, Torino, Italy, roberto.aringhieri@unito.it, *Roberto Cordone*, *Andrea Grosso*

Dispersion Problems (DP) consists in extracting from N a subset M of cardinality m, so as to optimize a suitable function of the distances between elements in M. Modeling equity requirements, max-minsum DP and min-diffsum DP extend the family of quadratic binary problems derived by specifying the function.
Our purpose is to extend the main ideas behind the state-of-the-art methods proposed by the authors for max-sum DP and max-min DP to the new problems, evaluating whether their effectiveness is confirmed, and whether the reasons for their good performance remain valid in the new context.

5 - A primal heuristic for several quadratic pure 0-1 models

Monique Guignard-Spielberg, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard_monique@yahoo.fr, *Aykut Ahlatcioglu*, *Lucas Létocart*, *Gérard Plateau*

The Convex Hull Relaxation method for pure integer nonlinear optimization problems with linear constraints can be used as a heuristic for convex or nonconvex problems if such formulations with a linear objective are easy to solve. We will describe the method and present computational experiments with different quadratic 0-1 models, showing that one can obtain almost optimal solutions very quickly, in particular for assignment- and knapsack-type problems.

■ TC-02

Thursday, 13:30-15:10
Room B

New scheduling models

Stream: Recent Advances in Scheduling
Invited session

Chair: *Erwin Pesch*, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de

1 - Algorithms for the uncertain version of 2 machines flow shop problem with interval processing times

Marcin Siepak, Institute of Informatics, Wroclaw Univesity of Technology, Wybrzeze Wyspianskiego 27, 50-370, Wroclaw, Poland, marcin.siepak@pwr.wroc.pl, *Jerzy Jozefczyk*

An uncertain version of two machines flow shop is considered. It is assumed that the processing times of tasks are not known a priori, but they belong to the intervals of known bounds. The absolute regret based approach for coping with such an uncertainty is applied. This problem is known to be NP-hard, therefore approximate and heuristic solution algorithms have been developed. The results of computational experiments are reported in order to compare the elaborated algorithms.

2 - Flowshop Scheduling with Flexible Operations on 2 Adjacent Machines

Hakan Gultekin, Industrial Engineering, TOBB-University of Economics and Technology, Endustri Muhendisligi Bolumu, TOBB Ekonomi ve Teknoloji Universitesi, Sogutozu Cad. No:43, 06560, Ankara, Turkey, hgultekin@etu.edu.tr, *Hatice Hande Demirtaş*

We consider throughput maximization in an m-machine flowshop. Each of the identical parts to be processed has an operation to be performed on a specific machine. There is another operation that can be performed by two of the adjacent machines, as a consequence of the flexibility of these machines. The problem is to determine the machine to perform the flexible operation for each part. Such situations arise in many practical applications especially in metal cutting industry where CNC machines are used. We develop a dynamic programming algorithm that solves the problem in pseudo polynomial time.

3 - The VNS metaheuristic for the buffer-constrained two-machine flowshop problem

Yury Kochetov, Information Technology, Novosibirsk State University, aven. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, jkochet@math.nsc.ru, *Polina Kononova*

We consider a two-machine flowshop scheduling problem originating in the multimedia industry. It is known that the problem is strongly NP-hard. We present some ILP-reformulations to get lower bounds and VNS-metaheuristic to find optimal or near optimal solutions. The Kernighan-Lin neighborhoods and job-window neighborhoods are used in the VNS framework. For experiments we generate large scale instances with known global optima. Computational results and some open questions are discussed.

4 - An Integer Linear Programming Model for the Optimal Assignment of Referees: the Italian Volleyball Championships Case

Paolo Toth, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it, *Andrea Tramontani*, *Rodrigo Linfati*

In this paper we address a real-world problem concerning the optimal assignment of the referees to the matches for the Italian Volleyball Championships.The objective function takes into account both the technical quality of the assignment and the corresponding travel and accommodation costs. The problem is tackled by exactly solving an Integer Linear Programming (ILP) model and by using a clique based decomposition procedure for improving the computing time.Extensive computational experiments on real-world instances have been performed to evaluate the effectiveness of the proposed approach.

5 - Truck Scheduling Problem in Intermodal Container Transportation

Erwin Pesch, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de, *Jenny Nossack*

We address a truck scheduling problem where containers need to be transported between customers and container terminals. The transportation requests are handled by a trucking company which operates several depots and a fleet of trucks that must be routed to minimize the total truck operating time under hard time window constraints. Empty containers are considered as transportation resources and are provided by the trucking company for freight transportation. The truck scheduling problem is solved by a 2-stage heuristic solution approach.

■ TC-03

Thursday, 13:30-15:10
Room C

Combinatorial Optimization in Computational Biology, Bioinformatics and Medicine

Stream: Combinatorial Optimization in Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Jacek Blazewicz*, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

1 - The novel approach for building models of protein structure

Piotr Lukasiak, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, Piotr.Lukasiak@cs.put.poznan.pl

Proteins are molecules involved in all important processes that occur in any organism. Here, we propose new algorithm for building 3D model of protein structure from sequence using previously generated set of small substructures based on known protein structures. First step is to find correct assignment between unknown sequence and substructures. After that, these small geometrical shapes are joined together in space to reconstruct original protein structure based on sequence similarity and secondary structures of protein. Our approach rebuild the core of protein molecule with high quality.

2 - Construction of signaling pathways from PPI and RNAi data using Linear Programming

Oyku Eren Ozsoy, Informatics Institute, Middle East Technical University, Turkey, oykueren@gmail.com, *Tolga Can*

For the reconstruction of signaling pathways from RNAi data, an integer linear optimization model is proposed. The aim is to reconstruct the signaling network from the given protein protein interaction (PPI) network satisfying RNAi data by making minimum changes on the given network. For evaluation, 1000 reference PPI networks each with seven, eight, or nine proteins, and RNAi data for each of the regular proteins in the network were generated randomly. The solution was examined to have a general overview about reconstruction of signaling networks from RNAi data by using the proposed method.

3 - A novel graph theoretical approach for reconstruction of signalling pathways by genetic algorithm

Sureyya Ozogur-Akyuz, Department of Mathematics and Computer Science, Bahcesehir University, Bahcesehir University, Dept of Mathematics and Computer Science, Cıragan cad. Besiktas, 34353, Istanbul, Turkey, sureyya.akyuz@bahcesehir.edu.tr, *Atabey Kaygun*, *İrem Karaduman*

Cell signalling is the list of chemical reactions that are used for intracellular communication. Signalling pathways denote these chemical reactions. Signaling pathways can be constructed by using RNAi data. Constructing the topologies of signal pathways by using Boolean RNAi knockdown data is an inverse problem that has a large solution space. In this study, a novel graph theoretical solution is developed by using Genetic Algorithm which finds the topologies compatible with single Boolean RNAi knockdown experiments and reduces the dimension of solution space.

4 - Mixed Integer Optimization Approach for Fragment Based Design of Drug Candidates

Zeynep Ozsarp, Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, Koc Universitesi, 34450, Istanbul, – Select –, Turkey, zeynepozsarp@gmail.com, *Metin Turkay*

Developing computational methods for drug design has become one of the most widely studied areas of life sciences in the past two decades. In this work, we developed a computational model which includes both training and design parts. Firts, we apply a training problem known results which includes the discovery of the topological properties that predict the IC50 value, binding energy and docking energy reliably. Then, in the design part, the regression model is formed based on the results obtained in the first step, to predict the contribution of each group and individual fragment in IC50 value, docking energy and binding energy and finall designs entirely new molecules based on the fragments available.

5 - The tool for automatic prediction of RNA tertiary structures.

Jacek Blazewicz, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl, *Mariusz Popenda*, *Maciej Antczak*, *Marta Szachniuk*, *Piotr Lukasiak*, *Ryszard Adamiak*, *Natalia Bartol*, *Katarzyna Purzycka*

In the paper a novel approach to modeling RNA tertiary structures is presented. The method combines comparative modeling and de novo approach. It is based on RNA fragment matching and assembling. The results of first computational tests of our software have shown its very good performance both in time of computation and the quality of prediction.

■ TC-04

Thursday, 13:30-15:10
Room D

Mixed Approaches for Mixed Problems

Stream: Emerging Applications of Combinatorial Optimization

Invited session

Chair: *Patrick De Causmaecker*, Computer Science/CODeS, Katholieke Universiteit Leuven, Campus Kortrijk, Etienne Sabbelaan 53, BE-8500, Kortrijk, Flanders, Belgium, Patrick.DeCausmaecker@kuleuven-kortrijk.be

1 - Mixed Objectives and Solution Fairness

Andrew J. Parkes, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG9 1BB, Nottingham, United Kingdom, ajp@cs.nott.ac.uk, *Adam Letchford*, *Tolga Bektas*

A deficiency in many problem domains is that optimal solutions have an unfair division of labour between different resources. In particular, in a capacitated vehicle routing problem some drivers might end up travelling much further than others. We show how to adjust the objective functions so as to give a greater balance between drivers. In random Euclidean problems we find that relatively small adjustments, by using sums of p'th powers of costs, can lead to much better balance. We relate this to p-order cone programming, and show that even values close to 1, such as p=1.05, can be effective.

2 - Heuristic and exact algorithms for the interval min-max regret knapsack problem

Silvano Martello, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, silvano.martello@unibo.it, *Fabio Furini*, *Manuel Iori*, *Mutsunori Yagiura*

In this generalization of the 0-1 knapsack problem the profit of each item can take any value between a minimum and a maximum. Each feasible solution value for a scenario has a regret, given by the difference between the optimum and the value itself, and we want to find a solution minimizing the maximum regret over all scenarios. The problem is extremely challenging both theoretically (it is most probably not in NP) and practically (even computing the regret of a solution for a scenario requires the solution of an NP-hard problem). We present an iterated local search approach and a branch-and-cut-and-bound algorithm, and evaluate their performance through extensive computational experiments.

3 - Round-robin strategy-based selection hyper-heuristic

Ender Özcan, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, exo@cs.nott.ac.uk, *Ahmed Kheiri*

A class of hyper-heuristics aims to provide solutions across a range of problem domains by selecting/mixing a set of low level heuristics during the search process. This study presents an effective hyper-heuristic based on a round robin heuristic selection which allocates equal time for each low level heuristic to process a solution in hand. HyFlex is a tool for hyper-heuristic development and research which provides implementation of six problem domains. The proposed hyper-heuristic is tested on the HyFlex domains and the results will be reported at the conference.

4 - A Time-Complexity Analysis of Hyper-Heuristics

Per Kristian Lehre, School of Computer Science, University of Nottingham, Jubilee campus, Nottingham, United Kingdom, PerKristian.Lehre@nottingham.ac.uk, *Ender Özcan*

Hyper-heuristics are methodologies that perform search over the space of heuristics for solving hard computational problems. An iterative hyper-heuristic combines heuristic selection and acceptance criteria from a set of low level heuristics in each iteration. Hyper-heuristics have traditionally been evaluated empirically. We introduce formal time-complexity analysis of hyper-heuristics. A theorem is presented which shows that using only a single instead of multiple low-level heuristics, can slow down the search process exponentially. This is a theoretical justification for hyper-heuristics.

5 - Applications of combinatorial optimisation are not unisided

Patrick De Causmaecker, Computer Science/CODeS, Katholieke Universiteit Leuven, Campus Kortrijk, Etienne Sabbelaan 53, BE-8500, Kortrijk, Flanders, Belgium, Patrick.DeCausmaecker@kuleuven-kortrijk.be

For many problems in operational research (OR) one technique is not everything. The interaction between constraint programming (CP) and OR has been subject to several studies. Metaheuristics and hyperheuristics often build on techniques from machine learning. The design of portfolio algorithms builds on predictors for algorithm behaviour. Other techniques from artificial intelligence (AI) can be applied to OR problems. We discuss the potential and give an example where data mining on the behaviour of an algorithm supports higher level decision making.

Thursday, 15:30-17:10

■ TD-01

Thursday, 15:30-17:10
Room A

Applications of MCDM in Combinatorial Optimization

Stream: Multiple Criteria Decision Making and Combinatorial Optimization (MCDM Invited Stream)

Invited session

Chair: *Vladimir Korotkov*, Belarusian State University, Belarus, wladko@tut.by

1 - Finding Pareto optimal solutions in scheduling deteriorating jobs

Krzysztof Ocetkiewicz, Department of Algorithms and System Modelling, Gdansk University of Technology, 11/12 Gabriela Narutowicza Street, 80-233, Gdańsk, Poland, Krzysztof.Ocetkiewicz@eti.pg.gda.pl, *Marek Kubale*

We will consider single machine scheduling problems such that the processing time of a job is given by a linear function of its starting time. We will employ the idea of dominated partial schedules to design an exact algorithm for the NP-hard problem of minimizing weighted mean flow time and show that it can also be used to find all Pareto optimal solutions with respect to the mean flow time and the makespan criteria. Then we will optimize it for solving a problem of minimizing mean flow time and finding all Pareto optimal solutions minimizing both the total completion time and the makespan.

2 - Pseudo-Automatic Beam's Eye View for Multi-criteria Intensity-Modulated Radiation Therapy

Ahmad-Saher Azizi-Sultan, Taibah University, Saudi Arabia, sultansaher@hotmail.com

Planning beam orientations in multicriteria intensity-modulated radiation therapy (IMRT) is an important but large-scale optimization problem with impractical excessive time complexity. Selecting suitable beam directions in IMRT is still a time consuming manual trial-and-error search procedure that depends on intuition and empirical knowledge. This work shows that the problem of beam orientations in multicriteria IMRT is NP-hard and presents a non brute force heuristic algorithm that aims at determining an appropriate set of beam orientations for multicriteria IMRT in clinical practical time.

3 - On some models of energy-aware computing

Jan Weglarz, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, jan.weglarz@cs.put.poznan.pl

We consider the green computing problem in which a limited amount of energy and power is to be allocated among preemptive jobs executed in a computer system with a multicore processor to minimize schedule length. The speed of each core may be controlled separately on the operating system level. We compare two processing models: a "classical " one (power vs. speed), and a dynamic one used in project scheduling for allocating a continuous, doubly constrained resource. On the basis of the latter model we formulated mathematical programming problems to find optimal power/energy allocations.

4 - A multi objective decision making problem in an open and distance learning system

Zehra Kamisli Ozturk, Open Education Faculty, Anadolu University, Anadolu University, Faculty of

Open Education Yunusemre Campuse No: 318, 26470, Eskisehir, Turkey, zkamisli@anadolu.edu.tr, *Gurkan Ozturk*

This study is concerned with an assignment system proposal for a teaching program in an open and distance learning (ODL) system. This program has different practice courses in the senior years along with theoretical courses. Here, we discuss the frequently encountered decision problem of a multi objective learner-practice course assignment problem in ODL teaching program. We consider a solution to the problem with a genetic algorithm of NSGA-II and compare the obtained results with a mathematical modeling approach based on conic scalarization.

5 - Stability analysis of multiple criteria investment Boolean problem with Wald's criteria

Vladimir Korotkov, Belarusian State University, Belarus, wladko@tut.by, *Vladimir Emelichev*

In the framework of Markowitz's portfolio theory we formulate a multiple criteria Boolean problem with Wald's maximin criteria and Pareto optimality principle. This problem creates an investment portfolio, maximizing the different types of portfolios effectiveness in conditions of unstable economic situations and uncertainty of input data. We present lower and upper not improving bounds of the stability radius, which is supremum level of initial date perturbation, when new Pareto optimal portfolios does not appear.

■ TD-02

Thursday, 15:30-17:10
Room B

Scheduling I

Stream: Scheduling
Contributed session

Chair: *Ante Custic*, Institute of Optimisation and Discrete Mathematics (Math B), Graz University of Technology, Steyrergasse 30/II, 8010, Graz, Austria, custic@opt.math.tugraz.at

1 - Discrete-continuous project scheduling problems with discounted cash flows and progress payments

Grzegorz Waligora, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Wielkopolska, Poland, grzegorz.waligora@cs.put.poznan.pl

Discrete-continuous project scheduling problems with discounted cash flows are considered, in which the number of discrete resources is arbitrary, and there is one continuous, renewable and limited resource. The processing rate of each nonpreemptable activity is a continuous, increasing function of the amount of the continuous resource allotted to the activity at a time. A positive cash flow is associated with each activity. Progress payments over the project are assumed, and the objective is to maximize the net present value (NPV). Metaheuristic approach to the considered problem is proposed.

2 - Quadratic assignment problem with partition size weights

Maciej Drwal, Institute of Informatics, Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370, Wroclaw, Poland, maciej.drwal@pwr.wroc.pl

We consider a variant of assignment problem of N tasks to M related machines, with the objective to minimize the sum of completion times. Machines work in parallel, however, a task is released from a machine after all the assigned tasks on that machine are also processed. Such problem can be seen as minimizing the sum of total weights of blocks of M-partition multiplied by the sizes of blocks. We prove that the problem can be solved in polynomial time in number of tasks, and present an exact combinatorial backward induction algorithm, based on iterative reduction of hyperplanes dimension.

3 - Optimization-simulation approach for job shop scheduling problem with random processing time

Quoc Ho Doan, Industrial & Systems Engineering, International University Ho Chi Minh City- National University Ho Chi Minh City, KP6, Linh Trung, Thu Duc, Ho Chi Minh, Viet Nam, hdquoc@hcmiu.edu.vn, *Ho Phong*, *Minh Nguyen*, *Do Vinh Truc*

Scheduling a job shop has not been completely solved when processing time is probabilistic. This paper proposed an approach using Genetic Algorithms and simulation to get the optimal solution for job shop scheduling problem with random processing time. The objective is to minimize the completion time of job shop system. While Genetics Algorithm optimization generates solutions, simulation mechanism is adopted to evaluate the performance of each solution. The model is then tested with non-stop scheduling and sequencing.

4 - Age-dependent Selective Maintenance

Huy Truong Ba, Industrial & Systems Engineering, International University Ho Chi Minh City- National University Ho Chi Minh City, KP6, Linh Trung, Thu Duc, Ho Chi Minh, Viet Nam, tbhuy@hcmiu.edu.vn

Selective maintenance is to choose the most appropriate set of machines of a production system to be maintained, as well as the suitable maintenance actions in the time limitation. This study focuses on developing the mathematical selective maintenance models to maximize the reliability, the availability or both of them in the constraints of time and budget. In the models, the maintenance actions, i.e., replacement with identical item, replacement with upgraded item or rehabilitation are considered for each machine. The illustrative numerical examples are proposed and solved by Lingo program.

5 - Special Cases of the Planar 3-index Assignment Problem

Ante Custic, Institute of Optimisation and Discrete Mathematics (Math B), Graz University of Technology, Steyrergasse 30/II, 8010, Graz, Austria, custic@opt.math.tugraz.at, *Bettina Klinz*

Given a three dimensional cost array of order n, the planar 3-index assignment problem (P3AP) is to choose n2 elements from the cost array such that exactly one entry is chosen from each line (two fixed indices) and such that the sum of the chosen cost entries is minimal. The bottleneck version aims at minimizing the largest cost among the chosen elements. Both versions are known to be NP-hard. This motivates to consider special cases resulting from imposing addition conditions on the cost array. In this talk we will consider special cases with the emphasis on Monge-like conditions.

■ TD-03

Thursday, 15:30-17:10
Room C

Data Mining

Stream: Combinatorial Optimization in Data Mining

Invited session

Chair: *Cem Iyigun*, Industrial Engineering, Middle East Technical University, Turkey, iyigun@ie.metu.edu.tr

1 - Biclustering on Microarray Gene Expression Data

Ozan Cinar, Statistics, Middle East Technical University, Turkey, ocinar@metu.edu.tr, *Ozlem Ilk*, *Cem Iyigun*

Microarray gene expression arrays are widely used in biological researches. When the genes are followed at several time points, those arrays would give a time-series for each gene. Usual clustering methods, such as k-means or hierarchical clustering methods cannot be applied on time-series, since they do not consider the dependence between the values at different time points for a specific gene. We propose a method which takes this dependence into consider, and moreover, finds the interesting genes which show different patterns in different samples or conditions (e.g. control and treatment).

2 - Spectral Clustering on Time Series Data

Sipan Aslan, Statistics, Middle East Technical University, Turkey, sipan@metu.edu.tr, *Cem Iyigun*

In order to clustering of spatial time series data using the idea of determining similarity points via using spectrum of similarity matrix is the subject matter of the study.We used turkish meteorological time series data for specifying climate regimes of Turkey. We have reported spectral clustering results on monthly total precipitation and monthly average temperature time series data obtained from Turkish State Meteorological Service of Turkey.

3 - Contour Approximation of Data and a New Validity Index for Clustering

Cem Iyigun, Industrial Engineering, Middle East Technical University, Turkey, iyigun@ie.metu.edu.tr

Probabilistic D-clustering, receently proposed, is a probabilistic approach for clustering of data, using soft assignments of points to clusters, with membership probabilities depending on distances. We study a distance function called joint distance function (JDF), a measure of distance from all cluster centers, which monitors the progress of the algorithm evolves during the iterations. This function captures the data in its low contours and it can be a measure for finding the right number of clusters in a given dataset.

4 - A new multivariate regression spline algorithm for classification problems

Elcin Kartal Koc, Statistics, Middle East Technical University, Department of Statistics, No:234, 06800, Ankara, Turkey, kartalelcin@gmail.com, *Cem Iyigun*

SMARS is a kind of multivariate adaptive regression spline algorithm which uses a nonlinear mapping approach for the knot selection procedure in forward stepwise step of multivariate regression spline algorithms such as MARS. The procedure leads time efficient model construction and the models obtained become less sensitive to noisy settings. In this study, SMARS, proposed for prediction problems, is now adapted to classification problems and its performance is evaluated via some performance measures and computing time.

5 - Investigating the seasonal patterns of continental central anatolia by clustering

Tülay Akal, Statistics, Middle East Technical University, Turkey, tulay_210@yahoo.com.tr, *Vilda Purutcuoglu Gazi*, *Inci Batmaz*, *Elcin Kartal Koc*, *Cem Iyigun*, *Ceylan Yozgatligil*

We investigate the effect of climate change on the seasonal patterns of Continental Central Anatolia region of Turkey. For this purpose, 13 different meteorological variables including total precipitation, average pressure, average vapour pressure, average cloudiness, average relative humidity and various temperatures such as minimum, maximum and average temperature recorded monthly at 52 stations from 1950 to 2010 are clustered individually and altogether as one using the hierarchical and partition around medoits (PAM) methods. Results are reported in seasonal patterns in the region.

■ TD-04

Thursday, 15:30-17:10
Room D

Graph Eigenvalues and Combinatorial Optimization

Stream: Spectral Graph Theory Techniques and Applications in Combinatorial Optimization

Invited session

Chair: *Domingos Cardoso*, Departamento de Matematica, Universidade de Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, dcardoso@ua.pt

1 - A generalization of Fiedler's lemma and its application on graph energy

Enide Martins, Mathematics, University of Aveiro, University of Aveiro, Campus Universitário de Santiago, 3810-193 , Aveiro, Aveiro, Portugal, enide@ua.pt

In this work we present a generalization of a Fiedler's lemma introduced in [M. Fiedler, Eigenvalues of nonnegative symmetric matrices, Linear Algebra Appl. 9 (1974): 119-142] and this generalization is applied to the determination of eigenvalues of graphs belonging to a particular family and also to the determination of the graph energy (including lower and upper bounds).

2 - Bounds for the Generalized Krein Parameters of Strongly Regular Graphs

Vasco Mano, Mathematics, Faculty of Sciences of University of Porto, Rua António Fragoso, 386 Custóias, 4460-669, Custóias, Portugal, vascomocomano@gmail.com, *Enide Martins*, *Luís Vieira*

We consider a strongly regular graph G with adjacency matrix A with three distinct eigenvalues. By associating a real Euclidean Jordan algebra to G we generalize the Krein parameters of a strongly regular graph and obtain some new generalized Krein conditions over the parameters of G. Finally, new upper bounds for some of the "classical" Krein parameters are obtained.

3 - On the spread of the line graph and applications

Helena Gomes, Mathematics, University of Aveiro, 3810-100, Aveiro, Portugal, hgomes@ua.pt

In D. A. Gregory, D. Heshkowitz, S. J. Kirkland, the spread of the spectrum of a graph, Linear Algebra Appl., (2001), namely the upper and lower bounds are obtained for the spread lambda_1...lambda_n of the eigenvalues lambda_1 >= lambda_2 >= ... >= lambda_n of the adjacency matrix of a simple graph. Here we are concerned to obtain upper and lower bounds for the spread of the adjacency of a graph which is the line graph of a simple graph.

4 - Star Sets and Graphs with Convex Quadratic Stability Number

Carlos J. Luz, Polytechnic Institute of Setubal, Campus do IPS, Estefanilha, 2910-761, Setúbal, Portugal, carlos.luz@estsetubal.ips.pt

This talk reports on an application of the theory of star complements to the so called graphs with convex-QP stability number (which are graphs whose stability number can be determined by solving a convex quadratic programming problem). Specifically, the graphs with convex-QP stability number are characterized as those for which there exists a star set for their least eigenvalue such that the optimal values of quadratic programs associated with the graph and with the star complement corresponding to that star set coincide.

5 - Maximum matching by convex quadratic programming based on an adverse graph conjecture

Maria F Pacheco, Instituto Politécnico de Bragança - ESTiG, Quinta de Santa Apolónia, Gab. 112, 5301-857, Bragança, Portugal, pacheco@ipb.pt, *Domingos Cardoso*, *Carlos J. Luz*

We describe a procedure for determining a maximum stable set in a graph with convex-QP stability number, unless there is a subgraph for which neither the optimal value of the convex quadratic program, nor the least adjacency eigenvalue changes when the neighborhood of any vertex is deleted. Assuming the trueness of the conjecture, that every such adverse graph has convex-QP stability number, we introduce an algorithm for the recognition of graphs with convex-QP stability number and apply it to determine a maximum matching. Thus, we can decide if a graph has convex-QP stability number or not. So far, no counterexample for the conjecture has been found.

Thursday, 17:30-19:10

■ TE-01

Thursday, 17:30-19:10
Room A

Vehicle Routing and TSP Problems I

Stream: Vehicle Routing and TSP
Contributed session

Chair: *Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it

1 - The Traveling Visitor Problem and the Koper Algorithm for Solving It

Milan Djordjevic, DIST, UP FAMNIT, Glagoljaska 8, 6000, Koper, Slovenia, milandjo@gmail.com, *Andrej Brodnik*

We consider the problem when a visitor wants to visit all interesting sites in a city exactly once and to come back to his hotel. Since the visitors use streets, walking trails and pedestrian zones, the goal is to minimize the visitor's traveling. A new problem the Traveling Visitor Problem (TVP) is then similar to the Traveling Salesman Problem (TSP) with a difference that the traveling visitors cannot fly over buildings in the city, but instead they have to go around these obstacles. The tested benchmarks are combined from three real instances made using tourist maps of cities of Koper, Belgrade and Venice and two instances of modified cases from TSPLIB. We compare two methods for solving the TVP. In all tested cases the Koper Algorithm significantly outperforms the Naive Algorithm for solving the TVP.

2 - Variants of 2-opt approach for The Generalized Traveling Salesman Problem

Thanh Luu Van, Industrial & Systems Engineering, International University, Vietnam National University - HCM city, Quarter 6, Linh Trung ward, Thu Duc district, HCM city, 1017/45 lac Long Quan street, ward 11, Tan Binh district, HCMC, Ho Chi Minh city, Viet Nam, lvthanh@hcmiu.edu.vn

The paper introduces a composite heuristics for solving the generalized traveling salesman problem. The heuristics composes of two broad classes: (1) the constructive algorithm, and (2) the improved algorithms combined the well-known 2-opt search with the nearest neighbor heuristic and the shortest path approach. The computation results on thirty six TSPLIB problems up to 442 nodes are presented wherein the problems up to 300 nodes have been solved with computation time shorter than previous results. The author also suggests some algorithms to construct more efficient heuristics.

3 - On the polytope of Bipartite TSP

Hajieh Jabbari, IE, EMU, Cyprus, Magusa, IE. dept., Cyprus, hajieh_jabbari@yahoo.com, *Bela Vizvari*

Facet defining inequalities have great algorithmic importance. All of them are based on the relaxation of TSP. If optimal solution of the relaxation is not the characteristic vector of a tour then the bound can be improved by introducing a violated facet defining inequality. This paper proposes that the polytope of bipartite TSP is significantly different from that of the general TSP. Comb inequalities as facet defining inequalities of TSP are satisfied in the bipartite TSP if all degree and subtour elimination constraints are satisfied, i.e. they are not facet defining.

4 - New heuristic algorithms for travelling salesman problem

Fidan Nuriyeva, Mathematics, Ege University, Ege Üniversitesi, 35040, İzmir, Bornova, Turkey, nuriyevafidan@gmail.com

Traveling salesman problem is one of the most attractive problems of the combinatorial optimization due to richness of its applications. Since it's an NP-hard class problem, many heuristic and meta-heuristic algorithms are developed to solve it. In this study, three new heuristic algorithms are proposed, different combinations of these algorithms are covered, their programs are developed and experimented. Algorithms are based on comparison of the maximum and minimum values of the distances between the each city. Experiments show that the proposed algorithms are efficient.

5 - A mathematical model to improve city transportation by using flexible work hour approach

Zehra Durak, Industrial Engineering, Pamukkale University, Pamukkale Üniversitesi, Endüstri Mühendisliği Bölümü, Kınıklı Denizli, Denizli, Turkey, ztasci@pau.edu.tr, *Özcan Mutlu*, *Olcay Polat*, *Hasan Akyer*

Traffic congestion is a major problem in today's metropolitan areas. In this study, we offer a new mathematical model in order to reduce traffic congestion during peak hours by adjusting the work start times of the public bodies such as schools, hospitals etc. We assume that there are two or more alternative work start times that can be determined by local authority. The problem is to find the work start times of the public bodies so that the traffic congestion is reduced. We use a heuristic method in order to solve this problem.

■ TE-02

Thursday, 17:30-19:10

Room B

Various Applications in Combinatorial Optimization

Stream: Various Applications in Combinatorial Optimization

Contributed session

Chair: *Philipp Hungerländer*, University of Klagenfurt, Austria, philipp.hungerlaender@uni-klu.ac.at

1 - Face recognition via genetic algorithms

Ayse Ozturk, Computer Engineering, Yalova University, Ataturk Stadyum Karsisi No:1 Yalova, 77200, yalova, Turkey, ayseozt@gmail.com, *Aysenur Erdil*

Face recognition is vital for real-time applications such as recognizing human face in dynamic images like video. In this study, the aim is getting local feature vectors and eigen faces of raw images without any pre-decision for face recognition. Opposite to grid-based and face-network approach, every single point in the face image is used to increase search size. Search space is combination of N, the number of points in the face image. The best sub-space needs to be searched within the search space. Since the complexity of the problem is high, a genetic algorithm with optimized performance is preferred. The independance of the points is assumed in the study.

2 - A vehicle routing solution for the reduction of transportation costs incurred by the suppliers of Istanbul's first 100% organic market

A. Yonca Demir, Business Administration, Istanbul Bilgi University, Istanbul, Turkey, ydemir@bilgi.edu.tr, *Mert C. Demir*

Our goal is to reduce the transportation costs incurred by the farmers shipping organic produce to an organic market in Istanbul. To design an efficient transportation system to be used by organic farmers, we propose a vehicle routing formulation. We formulate it using GAMS modeling system and solve it with CPLEX solver for representative weeks. A solution less than 10% away from the optimal solution of the LP relaxation is found in 1 h on a decent PC configuration. We also consider different scenarios. The results show the economic impact of a collective transportation arrangement.

3 - Criticality Index of Locating Domination and Locating Domination Edge Adding Critical Graph

Widad Dali, University of Algiers, Algiers, Algeria, widdal@yahoo.fr

A dominating set S of a graph G=(V,E) is a locating dominating set if for any two vertices u, v in V-S the neighborhood of u in S and of v in S are different. The minimum cardinality of a locating dominating set is denoted by L(G). We show that adding an edge can increase or decrease L(G) by at most one. Let H the complement of G. We characterize graphs which satisfy L(G+e)=L(G)+1 for any e in H. We define the criticality index of e in H as ci(e)=L(G)-L(G+e) and the criticality index of G as ci(G)=the sum of all ci(e)/ the size of H. We determine ci(G) for some graphs.

4 - Special colorings for channel assignment in cellular mobile networks

Rosiane de Freitas Rodrigues, Institute of Computing, UFAM / UFRJ, Brazil, rosiane@icomp.ufam.edu.br, *Flavio Mendes Coelho*, *Bruno Cardoso Dias*, *Aldemir Malveira de Oliveira*, *Nelson Maculan*

Variants of the classical graph coloring problem arises when some constraints should be met, both on vertices and edges. In cellular mobile networks, an interesting problem consists in channel assignment to antennas to optimize some criteria, as minimizing signal interference, minimizing the interval and the number of used channels, and so on. The correlation among channel assignment problems in wireless networks and coloring problems in graphs is well known in the literature, but with strong potential not yet fully explored. The purpose of this paper is to present the application of new special colorings to support features not yet covered by existing works, in such a way to get better results.

5 - A Semidefinite Optimization Approach to Single-Row and Space-Free Multi-Row Facility Layout

Philipp Hungerländer, University of Klagenfurt, Austria, philipp.hungerlaender@uni-klu.ac.at, *Franz Rendl*, *Miguel Anjos*

The multi-row facility layout problem is concerned with optimizing the palcement of departments along one or several rows. We present a semidefinite programming approach to both single-row layout and the special case of multi-row layout in which all the rows have a common left origin and no empty space is allowed between departments. We report optimal solutions for several single-row instances from the literature with up to 42 departments that remained unsolved so far. For space-free double-row instances we provide high-quality global bounds for instances with up to 15 departments.

■ TE-03

Thursday, 17:30-19:10
Room C

Regularity systems, optimization and scheduling

Stream: Combinatorial and Hybrid Regulatory Systems - Game Theory

Invited session

Chair: *Sirma Zeynep Alparslan Gok*, Mathematics, Faculty of Arts and Sciences, Suleyman Demirel University, Faculty of Arts and Sciences, Suleyman Demirel University, Department of Mathematics, 32260, Isparta, Turkey, zeynepalparslan@yahoo.com

1 - Combinatorial Aspects of Revenue Management in Broadcasting Advertisements - Solving the Dynamic Stochastic On-line Multi-Knapsack Problem with Assignment Restrictions

Michael Mohaupt, Dresden University of Technology, Germany, michael.mohaupt@mailbox.tu-dresden.de, *Andreas Hilbert*

In broadcasting advertisements, commercial breaks are offered to heterogeneous clients with uncertain demand. The efficient resource allocation by accepting or rejecting requests leads to a multi-knapsack problem with assignment restrictions as clients may have preferences for specific ad slots with cancellation rates depending on the provider's slot assignment decisions. The goal is to maximize total revenues, given a penalty for overbooking. We provide a greedy-type heuristic and successive knapsack approximation algorithm to account for combinatorial aspects and said customer preferences.

2 - Selection of Event Tickets for Bundling in Sports and Entertainment Industry

Serhan Duran, Industrial Engineering, Middle East Technical University, Orta Dogu Teknik Universitesi, Endustri Muh. Bolumu, 06531, Ankara, Turkey, sduran@ie.metu.edu.tr, *Okan Ozener*, *Ertan Yakici*

Most sports and entertainment firms offer season tickets first, and they allow purchasing single tickets at a later date. The decision problem here is which event tickets to include into the bundle. For a given schedule of events, the tickets of some events are bundled and a discount is applied to the prices of these bundled tickets, with the aim of increasing total revenue. We have found increase and decrease patterns in total revenue as the time slots of bundled events change. We have developed heuristic approaches in order to make profitable bundles from a given schedule of events.

3 - Improving Delinquent Loan Processing Efficiency via Efficient Assignments in a Large US Bank

Aysegul Peker, R&D, SAS Institute, R5103 SAS Campus Drive, 27513, Cary, NC, United States, Aysegul.Peker@sas.com, *Ivan Oliveira*

Due to recent regulation changes in the US, the number and variety of processes Customer Relationship Managers (CRMs) need to perform for delinquent mortgage loans has increased. In this talk, we investigate the assignment problem of a variety of processes to a variety of resources to improve loan processing in a large US bank. We present a model and different approaches to solve this model. We show improvements of this approach compared the traditional manual processes.

4 - Online Conversion Algorithms with Price Updates

Günter Schmidt, Saarland University, Box 151150, 66041, Saarbrücken, Germany, gs@itm.uni-sb.de, *Iftikhar Ahmad*

El-Yaniv et al.(2001) present two types of online algorithms for uni-directional non-preemptive and preemptive price search. They assume that lower and upper bounds of offered prices are known and fixed for the entire search period. Here we assume that prices do not change arbitrarily, but are based on some constant factor constituting lower and upper bounds, so that we can improve the performance of the algorithms. For example in Bangkok stock market, a circuit break rule enforces a 10% fluctuation as reported in Chen et al.(2001). We update the model and modify the uni-directional non-preemptive and preemptive algorithms. For both algorithms, we show the minimum and maximum improvements possible in terms of terminal wealth and competitive ratio, and evaluate them with real world data.

5 - Reconstruction of a Complex Biochemical System and Forecasting Its Behaviour

Vilda Purutcuoglu Gazi, Statistics, Middle East Technical University, Department of Statistics, Middle East Technical University, 06531, Ankara, Turkey, vpurutcu@metu.edu.tr, *Ozlem Defterli*, *Armin Fügenschuh*, *Gerhard-Wilhelm Weber*

We model a realistic complex system as both stochastic and deterministic, we combine the results to assess the performance of the estimated structure and evaluate validity. In stochastic modelling, we investigate the random feature of biochemical process when the exact number of molecules from each species is known. The diffusion approximation is a stochastic model derived from Ito diffusion of Fokker-Planck equation. By two sources of information we infer network structure with MIP for deterministic modelling via time autonomous ODEs. We apply the estimated network to forecast behaviour.

■ TE-04

Thursday, 17:30-19:10
Room D

Applications of Partitioning and Ranking

Stream: Emerging Applications of Combinatorial Optimization

Invited session

Chair: *Pelin Canbolat*, Technion - Israel Institute of Technology, 32000, Haifa, Israel, canbolat.pg@gmail.com

Chair: *Peter Gritzmann*, Mathematics, TU München, Arcisstr. 21, D-80290, Munich, Germany, gritzman@ma.tum.de

1 - Constrained Clustering and its Applications

Peter Gritzmann, Mathematics, TU München, Arcisstr. 21, D-80290, Munich, Germany, gritzman@ma.tum.de, *Andreas Brieden*

We study weighted clustering problems in Minkowski spaces under balancing constraints that were initially motivated by their applications in agriculture. In many regions farmers cultivate a number of small lots that are distributed over a wider area, leading to high overhead costs and economically prohibit use of high tech machinery that results in a non-favorable cost-structure of production. The classical form of land consolidation is typically too expensive and rigid, whence consolidation based on lend-lease agreements has been suggested. We introduce a mathematical model and study its properties. We show that optimal clusterings correspond to strongly feasible power diagrams, certain specific cell complexes, whose defining polyhedra contain these clusters. Further, we show how and why the model leads to efficient algorithms, and discuss other applications like the prediction of insurance or credit risk.

2 - Partition Polytopes in Constrained Clustering

Steffen Borgwardt, Fakultät für Mathematik, Technische Universität München, Boltzmannstr. 3, 85748, Garching, Bayern, Germany, borgwardt@ma.tum.de

We study properties of special transportation polytopes called 'partition polytopes', which are associated to partitioning a set of items into clusters of prescribed sizes. We show that their combinatorial diameter is independent of the total number of items to be clustered. This allows us to derive an efficient algorithm for finding a small set of 'cyclical exchanges' to transfer a partition into another one. Further, we show that even though the underlying clustering problem becomes NP-hard if the items are weighted, the vertices of a corresponding partition polytope belong to clusterings for which a provably low number of items is not assigned to a single cluster. This yields a basis for efficient approximation algorithms, which are successfully applied to real-world problems in the consolidation of farmland and woodland.

3 - Thompson Sampling for Complex Bandit Problems

Aditya Gopalan, Technion, 1, Haifa, Israel, aditya.gopalan@gmail.com, *Shie Mannor*, *Yishay Mansour*

We study stochastic multi-armed bandit settings with complex actions involving the basic arms, where the decision maker has to select a subset of the basic arms or a partition of the basic arms at every round. The reward of the complex action is some function of the basic arms' rewards, and the feedback observed may not necessarily be the reward per-arm. We use Thompson sampling — an algorithmic idea dating back to the 1930s — to decide which complex action to select. We prove a general theorem indicating that if the action feedback contains enough information to shrink the posterior arms estimation, then Thompson sampling obtains sublinear regret. Using particle filters for computing the posterior, we devise and numerically evaluate the Thompson sampling algorithm for complex subset-selection and job-scheduling problems.

4 - Mean-Variance Efficiency in the Equilibrium of a Stochastic Competitive R&D Race

Pelin Canbolat, Technion - Israel Institute of Technology, 32000, Haifa, Israel, canbolat.pg@gmail.com, *Boaz Golany*, *Uriel G. Rothblum*

This talk focuses on the decision-making problem of an investor who wishes to choose one of several firms in a certain market and buy that firm out. The firms are involved in a stochastic R&D race, where each firm decides on its effort for developing a new product. The first firm that completes the development of the novelty collects the associated revenues whereas the other firms earn nothing. In a recent work, we provided explicit representations for the investments and expected net profits of firms in the unique Nash equilibrium of this race. In this current work, we discuss the problem of picking one of these firms to optimize a function of the expected net profits and their variances. In particular, we show that finitely many intervals of interest rates correspond to distinct rankings. We provide sufficient conditions assuring that on each interval, the ranking of firms with respect to expected net profits is same as their ranking with respect to variances.

Friday, 9:00-10:40

■ FA-01

Friday, 9:00-10:40
Room A

Network Design

Stream: Graph Theory and Network Problems
Contributed session

Chair: *Edward Gimadi*, Discrete Optimization in Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

1 - Sensor Networks and Min-Density Covering of Plane Regions by Ellipses

Adil Erzin, Sobolev Institute of Mathematics, 4 Acad. Koptyug avenue, 630090, Novosibirsk, Russian Federation, adilerzin@math.nsc.ru, *Ruslan Zainutdinov*

Modern sensor networks consist of the sensors with adjustable sensing ranges. In "disk model" each sensor covers a disk. Since sensing energy consumption proportional to the covered space, a problem of power efficient sensing of a plane region can be reduced to the well studied problem of the min-density covering of the region by disks. In reality, sensor can be placed above-ground level, and then the covered surface is an ellipse. We consider a little-studied problem of min-density covering of a plane and a stripe by ellipses and have proposed several new efficient regular covers.

2 - Reconfiguration of distribution systems with distributed generation(dg) by bender's decomposition: an application to electrical distribution networks

Salman Khodayifar, school of mathematical, university of Tehran, Iran, Iran, Islamic Republic Of, s.khodayifar@gmail.com, *Hassan Salehi Fathabadi*, *Mohammad Ali Raayatpanah*

Distribution system companies intend to supply commodity to its customers in an economical manner, whereas customers in most distribution systems are outspread and connect to distribution systems with different type of equipments. These equipments have various types that produce highest loss. Distributed Generation(DG)is the best reliable solution for this problem if is allocated appropriately in the distribution system. DG facility installed near customer zones. We present a MINP model and an exact approach based on Bender's decomposition for optimal location DGs.

3 - Marhematical Measure at Vulnerability of Communication Networks

Mehmet Ali Balcı, Mathematics, Ege University, İzmir, Turkey, mali6254@gmail.com

The vulnerability is one of the most important concepts in network design. Vulnerability can be considered as the resistance of the network after any breakdown in its any nodes or links. Since any network can be modelled by a graph, vulnerability measures on graphs also work on network types. . In this work, we mention about some well-known vulnerability measures and we mention about some measures which defined by us called medium domination number, solitude number and average edge domination number.

4 - Efficient Monitoring of a Stripe by Outside Sensors with Adjustable Sensing Ranges

Sergey Astrakov, Design Technological Institute of Digital Techniques, Acad. Rjanov, 6, 630090, Novosibirsk, Russian Federation, astrakov90@gmail.com, *Adil Erzin*

In "disk model" each sensor covers a disk which is centered in the sensor. Several covers of plane regions with sensors deployed inside the region were proposed earlier. But sometimes it is impossible to place the sensors inside the region, and it is necessary to perform an "outside monitoring" with sensors placed at the region boundary or outside the region. We gave a classification of the covers and have proposed several new "outside covers" of a stripe, have calculated the density of these covers and have defined the best ones in the different classes.

5 - On effecive algorithms with performance guarantees for some hard-to-solve routing problems

Edward Gimadi, Discrete Optimization in Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

Efficient algorithms with performance guarantees for some hard-to-solve discrete routing problems are presented. We consider results for a problem of finding several edge-disjoint Hamiltonian circuits in complete weighted graph that is known as Peripatetic Salesman Problem also. We present some results for the Vehicle Routing Problem on random instances also. Particular attention is paid to asymptotically exact approach to solving some considered problems on deterministic input data, as well as on random inputs. The work is supported by RFBR (projects 12-01-00093 and 10-07-00195).

■ FA-02

Friday, 9:00-10:40
Room B

Scheduling II

Stream: Scheduling
Contributed session

Chair: *Rafal Rozycki*, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, rafal.rozycki@cs.put.poznan.pl

1 - Sample Average Appoximation with Ranking and Selection for the Parallel Machine Scheduling Problem.

Talal Alkhamis, Statistics and OR, Kuwait University, Box 5969 safat, Faculty of Science, 13055, kuwait, Kuwait, Kuwait, talalohoud@gmail.com

This paper proposes a two-stage programming model for the parallel machine scheduling problem. The model decomposes the problem into two stages: The first determines the optimal capacities of the machines whereas the second computes an estimate of the expected profit of the on-time jobs. The first stage is solved using a sample average approximation approach. In this implementation, SAA applies a ranking and selection procedure to obtain a good estimate of the expected profit with a reduced number of random samples.

2 - Sorting Common Operations to Minimize Tardy Jobs

Claudio Arbib, Computer Science, University of L'Aquila, via Vetoio (Coppito), 67010, L'Aquila, Italy, arbib@di.univaq.it

We study an operation scheduling problem where a set J of m jobs with due dates d1,...,dm must be completed by one machine. Job j is completed as soon as a subset Sj of operations is done. One wants to schedule operations in a way that minimizes the (weighted) number of tardy jobs. Jobs share common operations, i.e., once operation i is completed, it is completed for all the jobs that require i: this is typical of industrial cutting processes (pattern sequencing). We formulate the problem as stable set, and derive a polyhedral method that uses both specialised valid inequalities and rank inequalities of the job conflict graph. A computational study is provided with both industrial and artificial instances.

3 - Ant Colony Optimization Algorithm for the Parallel Machine Scheduling Problem with Due Date Window and Release Times

Sezgin Kaplan, Turkish Air Force Academy, Turkey, skaplan@hho.edu.tr, *Sezgin Kilic*

Parallel machine scheduling problem with due date-to-deadline windows and release times (PMS-DDWR) that was defined by Kaplan and Rabadi (2012) is examined in this work. PMS-DDWR assumes that the jobs have different release times and time windows between due date and deadline. The objective is to minimize the piece-wise weighted tardiness to have higher customer satisfaction. An ant colony optimization (ACO) algorithm is proposed and results have been compared with the simulated annealing (SA) algorithm solutions obtained by the previous work for small size problems. Nonparametric tests show that ACO performs significantly better than SA in terms of average relative error from the optimal solution.

4 - Lower bounds for the parallel machine problem with multiprocessor tasks

Wafa Omezine, Tunis College of Sciences and Techniques, Tunisia, omezine.wafa@gmail.com, *Lotfi Hidri*

The parallel machine scheduling problem with multiprocessor tasks is investigated. In this problem a set of jobs has to be processed on identical parallel processors. Each job is characterized by: a release date, a processing time, a delivery time, and a resources demand. The purpose is to minimize the makespan. We present two lower bounds. The first one is a preemptive one and the second lower bound is a destructive one, based on the concept of energetic reasoning. The performance of the proposed lower bounds is assessed over experimental tests. The experimental results are reported.

5 - Exact and heuristic approaches for server scheduling problem

Rafal Rozycki, Institute of Computing Science, Poznan University of Technology, 2 Piotrowo St., 60-965, Poznan, rrozycki@cs.put.poznan.pl

We consider a server scheduling problem for a system with a multicore processor, where the speed of each core may be controlled separately. The processing rate of a job is related to a temporary amount of (limited) power allocated to this job at the moment. A common due date is given for the set of independent, preemptive jobs. The problem is modeled as a (deterministic) problem of minimizing energy used by jobs performed on parallel identical machines with the given common duedate. We present an exact approach and various heuristic ones to solve the problem.

■ FA-03

Friday, 9:00-10:40

Room C

Graph Theory and Applications

Stream: PASCAL 2 Stream: Machine Learning and Combinatorial Optimization

Invited session

Chair: *Janez Zerovnik*, FME, University of Ljubljana, Askerčeva 6, si-2000, Ljubljana, Slovenia, janez.zerovnik@imfm.uni-lj.si

1 - Minimum-cost Multicast over Coded Packet Networks with Uncertain Rate Demands

Mohammad Ali Raayatpanah, Islamic Azad University, Kashan, Iran, Islamic Republic Of, Raayatpanah@gmail.com, *Hassan Salehi Fathabadi*, *Babak Khalaj*, *Salman Khodayifar*

Network coding offers new capabilities for efficient information multicasting in communication networks. However, a major challenge in network communications is dealing with uncertainty of demands. In this paper, we consider the problem of capacity provisioning in multicast connection over coded packet networks subject to demand uncertainty with a limited total budget. We propose a robust optimization model to obtain capacity expansion solutions by optimizing the worst-case system performance. The robustness and effectiveness of the developed model are demonstrated by numerical results.

2 - On the solution approaches of the combinatorial bandpass problem in telecommunication

Arif Gürsoy, Mathematics, Ege University, Ege University, Faculty of Science, Department of Mathematics, 35100 , Izmir, Turkey, arif.gursoy@ege.edu.tr, *Mehmet Kurt*, *Murat Erşen Berberler*, *Urfat Nuriyev*

Bandpass Problem (BP) is the problem of finding an optimal packing of information flows on different wavelengths in the telecommunication networks. BP is a combinatorial optimization problem and there are no polynomial algorithms to solve it exactly for n>3. In this paper, the methods presented are divided into two parts as heuristic and meta-heuristic algorithms. The meta-heuristic method supported with the heuristic algorithm has 4 different types of genetic algorithm. These algorithms have polynomial complexity. The algorithms were run on BP library problems and the results were discussed.

3 - Wavelength assignment algorithms for wavelength-routed networks with sparse wavelength conversion

Tam Nguyen, BioMedical Engineering Department, International University, VNU-HCM, Ho Chi Minh City, Viet Nam, nhmtam@hcmiu.edu.vn, *Linh Nguyen*

We proposed wavelength assignment algorithms, one based on the destination initiated reservation signaling and the other based on the intermediate-node initiated reservation signaling to setup in a wavelength- routed network with sparse wavelength conversion. Compared with the previously proposed algorithms by mathematical models and simulation results, the proposed algorithms offer two advantages: the number of wavelength conversions in the lightpath is always the minimum; and the complexity of proposed algorithm is always less those of previously proposed ones.

4 - Proof of McDiarmid-Reed conjecture for a subclass of triangle-free hexagonal graph

Rafał Witkowski, Discrete Mathematics, Adam Mickiewicz University, Wydzial Matematyki i

Informatyki UAM, ul. Umultowska 87, 61-614, Poznan, Wielkopolska, Poland, rmiw@amu.edu.pl, *Janez Zerovnik*

Channel assignment on hexagonal graphs appears as an important optimization problem in the design of wireless interconnection networks. Colin McDiarmid and Bruce Reed in paper "Channel assignment and weighted coloring" [Networks 36 (2000) 114-117] asked the following question: is the ratio 9/8 of multichromatic number to weighted clique number asymptotically the worst (greatest) possible for hexagonal graphs. We give a positive answer to this question for a large class of triangle-free hexagonal graphs introduced previously by Janez Zerovnik and Petra Sparl.

5 - A 3/2 approximation algorithm for cardinality constrained bin packing problem

Janez Zerovnik, FME, University of Ljubljana, Askerčeva 6, si-2000, Ljubljana, Slovenia, janez.zerovnik@imfm.uni-lj.si, *Gasper Zerovnik*

Bin packing is an NP-hard optimization problem of packing items of given sizes into minimum number of capacity limited bins. Besides the basic problem, numerous other variants of bin packing exist. The cardinality constrained bin packing adds an additional constraint that the number of items in a bin must not exceed a given limit N_max. The problme appeared as "Canister filling problem" in work on optimal deposition of spent nuclear fuel. Here we show that a heuristics that proved interestingly efficient on the real datasets is 3/2-approcximation algorithm.

■ FA-04

Friday, 9:00-10:40
Room D

Supply Chain Management: Production/Distribution Networks

Stream: Combinatorial Optimization in Suppy Chain Management

Invited session

Chair: *E. Alper Yildirim*, Industrial Engineering, Koc University, 34450, Sariyer, Istanbul, Turkey, alperyildirim@ku.edu.tr

1 - Modeling the Efficiency of Energy Generation/Distribution Networks

Yigit Can Oren, Koc University, 34450, Istanbul, Turkey, canoren@ku.edu.tr, *Metin Turkay*

As population of the World has been increasing, importance of the energy increases. With the help of the improving technology, efficiency of the energy usage has become one of the most critical issues. The main objective is to minimize the total energy loss in the energy generation/distribution network. We focus on the electricity generation/distribution networks, which consists of power generation plants, transformers, customers and transmission lines. In 2009, in Turkey energy loss was approximately fifteen percent of the total electricity generation. Electrical properties of power generation plants and transformers are considered in modeling energy losses. Also in transmission, cables are the main factor of the energy loss. Corona loss and skin loss are the two types of losses which happen during transmission.

2 - Lattice, modularity, and optimization of remanufacturing systems

Xiuli Chao, IOE, University of Michigan, 1205 Beal Ave, 48109, Ann Arbor, MI, United States, xchao@umich.edu, *Shaohui Zheng*

Using lattice, submodularity, and L-natural convexity, we study the optimal control policy for capacitated remanufacturing systems with product returns (cores). The demand and returns are random and the serviceable product to satisfy demand can be either manufactured from raw materials or remanufactured from returned products. The system may have finite capacities in manufacturing, remanufacturing, or in total operations in each period. We show that the firm's optimal policies in each period are characterized by a modified remanufacture-down-to policy and a modified total-up-to policy, and that the optimal control policies for capacitated systems have the same structure for backlog and lost-sales models. We also discuss the extensions of these results to the case of price-sensitive demand.

3 - Performance characteristics of an integrated procurement-production-distribution plan in multinational supply chains

Masoud Mohammad Esmaeil, Aerospace, Mechanical and Manufacturing Engineering, RMIT University, 2/18 Bedford Street, Reservoir, 3073, Melbourne, Victoria, Australia, s3186701@student.rmit.edu.au, *Arun Kumar*

Motivated by a real-world case problem, this study aims to examine the performance of a multinational supply chain (MNSC) facing volatile exchange rates and multiple economies-of-scale options. We develop a unified optimisation model using mixed-integer linear programming for procurement-production-distribution planning in the MNSC. A novel enhanced Cross-Entropy approach is developed to cope with the large number of continuous and binary variables and constraints. Practical implications are drawn from the numerical results obtained from various exchange rate and economies-of-scale scenarios.

4 - Scheduling for Disassembly Systems

Burak Gokgur, Industrial Systems Engineering, Izmir University of Economics, Sakarya Cad. No:156 Balçova / İzmir, İzmir, Turkey, burak.gokgur@ieu.edu.tr, *Mahmut Ali Gokce*, *Selin Ozpeynirci*

This study deals with disassembly scheduling and presents a mixed integer programming model. Disassembly scheduling is the problem of determining quantity and schedule of items disassembled, held, sold, and incinerated over a planning horizon while satisfying min service levels. This problem can be seen as a reverse MRP, which gets more complicated as number of demand points increase by disassembly. The model includes a number of novelties such as consideration of capacitated resources, environmental concepts and demand for items at all levels. Results from an experimental design are presented

5 - A Hierarchical Solution Approach for a Multicommodity Distribution Problem Under a Special Cost Structure

E. Alper Yildirim, Industrial Engineering, Koc University, 34450, Sariyer, Istanbul, Turkey, alperyildirim@ku.edu.tr, *Esra Koca*

Motivated by the spare parts distribution system of a major automotive manufacturer in Turkey, we consider a multicommodity distribution problem under a special cost structure. We present a novel integer linear programming formulation of the problem. For larger problems, we propose a Hierarchical Approach that is aimed at solving the problem in two stages using partial demand aggregation followed by a disaggregation scheme. Our computational results reveal that the Hierarchical Approach significantly outperforms the direct formulation approach especially on large instances.

Friday, 11:00-12:00

■ FB-01

Friday, 11:00-12:00
Room A

Plenary Talk 2

Stream: Plenary Lectures

Plenary session

Chair: *Arslan Ornek*, Industrial Systems Engineering Department, Izmir University of Economics, Balcova, 35330, Izmir, Turkey, arslan.ornek@ieu.edu.tr

1 - Why Some Vertices/Edges Are More Important Than Others

Bernard Ries, LAMSADE, Université Paris- Dauphine, F75775, Paris, France, bernard.ries@dauphine.fr

Problems of safety and reliability occur in many practical contexts and adequate formulations of such issues have opened the way to possible treatments by mathematical optimization procedures. It is in particular the case in situations where a complex system has to be protected against attacks and for this purpose one may have to identify the "most important" elements of the system. To be concrete, assume we have a finite system S (collection of components) which can be operated in different ways. Each operating mode s is characterized by the subsets of components it uses. In order to find the most important components of S we may want to identify a smallest possible subset T of components in S which is such that every operating mode s has at least d components in T. In this talk, I will present results concerning several cases where S is a (weighted) graph and each operating mode s is associated with a combinatorial structure like for instance a matching, or a stable set, or a vertex cover, etc..

Friday. 13:00-14:40

■ FC-01

Friday. 13:00-14:40
Room A

Vehicle Routing and TSP Problems II

Stream: Vehicle Routing and TSP

Contributed session

Chair: *Jussi Rasku*, Department of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35, FI-40014, Jyväskylä, Finland, jussi.rasku@jyu.fi

1 - Comparing iterated local search procedures to solve the profitable vehicle routing problem with multiple trips

Ahlem Chbichib, GIAD, FSEG Sfax, Tunisia, ahlemchbichib@yahoo.fr, *Racem Mellouli*, *Habib Chabchoub*

In this paper, constructive heuristic and an algorithm based on three iterated local search procedures are developed for the Profitable Vehicle Routing Problem with Multiple trips. To see the performance of our algorithm, we conduct computational experiments on adapted benchmark instances of the VRPMT (Taillard 1996) and on small size instances generated randomly. Based on the ILS performance, in terms of the solution quality, computational effort and the iterations number, the three structures of neighborhood are compared.

2 - Analytic Center Stabilization of Column Generation Algorithms for solving the Capacitated Vehicle Routing Problem

Hadi Karimi, Industrial Engineering Department, Amirkabir University of Technology (Tehran Polytechnic), Tehran, Iran, 424 Hafez Ave, 15875-4413, Tehran, Iran, Islamic Republic Of, hadi.karimi@aut.ac.ir, *Abbas Seifi*

Two major drawbacks of exact solution methods for capacitated vehicle routing problems (CVRP) related to column generation (CG) are slow convergence and degenerate solutions. The main reason for these issues is excessive reliance on Simplex-based solvers. To overcome these problems we will introduce analytic center stabilization technique to improve CG algorithm specialized for CVRP. In particular, we use the analytic center cutting plane method (ACCPM). In computational results comparisons will be made between this method, Bundle method and a hybrid method combining the first two methods.

3 - A mixed integer model for the truck-to-door assignment

Beyzanur Cayir, Industrial Engineering, Anadolu University, Iki Eylul Kampusu 26555, Eskisehir, Turkey, beyzanur_cayir@hotmail.com, *Nil Aras*

Warehouses are an essential component of any supply chain. This study proposes a mixed integer programming approach to help warehouse authorities to efficiently and effectively solve truck scheduling and truck-to-door assignment problems. The problem is similar to the problem of gate assignments in airports. In our model, we consider the truck docks assignment problem with time window, operational time, and the loading capacity constraint in a warehouse where the number of trucks exceed the number of doors available. The two objectives are combined into one term to minimize: the overall flow time and total penalty cost for the time delay for delivery.

4 - New Integer Linear Programming Formulations for Traveling Salesman Problem with Time Windows: Minimizing Tour Duration with Waiting Times

Ozge N. Koc, Industrial Engineering, Baskent University, Başkent Üniversitesi, Bağlıca Kampüsü, Eskişehir Yolu 20. km., Bağlıca, 06810, Ankara, Turkey, ozgekoc@hotmail.com, *Imdat Kara*, *Fulya Altiparmak*, *Berna Dengiz*

The Traveling Salesman Problem (TSP) is one of the most attractive combinatorial optimization problems. One of the many variants is the "Traveling Salesman Problem with Time Windows (TSPTW)'. To the best of our knowledge, there exists only one formulation that can be used directly by an optimizer. For this purpose, we propose two new integer linear programming formulations having O(n2) binary variables and O(n2) constraints where n is the number of the nodes of the underlying graph. A computational comparison is made on a suit of test problems from TSPLIB using CPLEX 12.0. We analyze the performances of the proposed and existing formulations with respect to linear programming relaxations and CPU times, and expand the proposed formulations considering more than one traveler.

5 - Visualizing Vehicle Route Optimization Solution Space with Multidimensional Scaling

Jussi Rasku, Department of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35, FI-40014, Jyväskylä, Finland, jussi.rasku@jyu.fi, *Pekka Hotokka*

Understanding the exploration of search space in vehicle routing problems is important in designing efficient algorithms. These spaces are multidimensional and hard to visualize, which makes it difficult to examine the trajectories of the search. We use a multidimensional scaling based technique which allows us to visualize objective function surfaces for such problems. The technique is used to examine the neighborhood observed by heuristic search algorithms. A union of the inspected points from two search algorithms is used to visualize the differences in their search space exploration.

■ FC-02

Friday. 13:00-14:40
Room B

Metaheuristics

Stream: Metaheuristics

Contributed session

Chair: *Arif Gürsoy*, Mathematics, Ege University, Ege University, Faculty of Science, Department of Mathematics, 35100 , Izmir, Turkey, arif.gursoy@ege.edu.tr

1 - Artificial bee colony optimization algorithm for TS-type fuzzy systems learning

Ahcene Habbi, Applied Automation Laboratory, University of Boumerdès, Avenue de l'indépendance, 35000, Boumerdès, Algeria, habbi_hacene@hotmail.com

The design of data-driven fuzzy models can be efficiently solved using metaheuristic algorithms. This paper proposes a methodology for extracting TS fuzzy models from data using the artificial bee colony algorithm. The fuzzy model extraction procedure aims at finding the structure and the parameters of the optimal fuzzy model simultaneously. The parameters are encoded in a population of individuals and evolve together so that optimal solutions are achieved. Simulations on benchmark fuzzy modeling problems are performed to check the effectiveness of the methodology.

2 - A comparative study of boundary violation handling techniques for Electromagnetism-like Algorithm

Alkin Yurtkuran, Industrial Engineering Department, Uludag University, Uludag University, Industrial Engineering Department, 16059, Bursa, Turkey, alkin@uludag.edu.tr, *Erdal Emel*

Metaheuristic algorithms have been extensively used for solving combinatorial and continuous optimization problems in recent years. On the other hand, the effect of different methods to prevent boundary violations has not attracted that much of interest. Boundary violation handling is essential as real-coded population members may easily violate the boundary and fly outside the limits. Electromagnetism-like algorithm is a population based algorithm which mimics the behavior of charged particles in an electrical field. In this study, we analyze the effect of different boundary violation handling methods on the solution quality and computational times, and consider random, absorbing, mirror and linear bound-handling schemes. Several experiments reveal that boundary violation handling methods significantly affects the performance of electromagnetism-like algorithm.

3 - Analyzing The Performance of Modified Marriage in Honey Bees Optimization (MBO) Algorithm Using The Unconstrained Test Functions

Yuksel Celik, Computer, Istitute of Science, Turkey, celik_yuksel@hotmail.com, *Erkan Ülker*

Marriage in Honey Bees Optimization (MBO) is a meta-heuristic optimization algorithm developed by inspiration of the mating and fertilization process of honey bees and is a kind of swarm intelligence optimizations. In this study we propose modified MBO by adding Levy Flight algorithm for Queen Mating Flight and neighboring for worker drone improving. The modified MBO algorithm's performance and its success is tested on the well-known five unconstrained test functions and compared with Particle Swarm Optimization (PSO).

4 - Examination timetable program solving with quantum genetic algorithms

Cevriye Altıntaş, Computer Engineering, Süleyman Demirel University, Süleyman Demirel University Information Technologies Department, Isparte, Turkey, cevriyealtintas@sdu.edu.tr, *Tuncay Yigit*

Examination timetable problem(ETP) is a non-polimal(NP) problem which can't be solved by clasical mathematical methods. Genetic Algorithm (GA) is a method which is used to solve NP problems like ETP. We propose a solving of ETP based on the use of Quantum Genetic Algorithm(QGA). To find better solution in QGA, quantum gate operators based on q-bits are used instead of variation operators which are applied to individuals. Expermental results show better performance for the QGA than the GA.

5 - Genetic Incremental Clustering Algorithm

Burak Ordin, Mathematics, Ege University, Ege University Science Faculty, Department of Mathematics, 232, izmir, bornova, Turkey, burak.ordin@ege.edu.tr, *Arif Gürsoy*

The cluster analysis deals with the problems of organization of a collection of patterns into clusters based on similarity. It can be formulated as a global optimization problem which is challenging for existing conventional global optimization techniques. So different heuristics and metaheuristics have been developed, which are far more efficient than most of global optimization techniques applied to the problem. Global k-means and Modified Global k-means algorithms are such heuristics, which have incremental nature. Namely, they build clusters incrementally adding one cluster center at a time ensuring an advantage for finding good initial solutions. In this work, a genetic incremental global k-means algorithm is proposed. We present the results of numerical experiments on some real-world datasets in literature, which demonstrate the superiority of the new algorithm in finding global solutions to the clustering problem.

■ FC-03

Friday. 13:00-14:40
Room C

Combinatorial Optimization in Finance 1

Stream: Combinatorial Optimization in the Financial Sector

Invited session

Chair: *Nina Kajiji*, The NKD Group, Inc. and The University of Rhode Island, USA, United States, nina@nkd-group.com

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Pricing and hedging multiple exercise American options in incomplete markets

Mustafa Pinar, Department of Industrial Engineering, Bilkent University, Department of Industrial Engineering, Bilkent University, Turkey, Ankara, Turkey, mustafap@bilkent.edu.tr

In incomplete markets described by non-recombinant trees we that the problem of pricing and hedging American options with multiple exercise rights. For the case of binomial and financial trees we prove that the mixed integer linear program giving the no-arbitrage buyer price has an exact LP relaxation who we treat call or put type options in the presence of zero interest rate. The result is based on the fact that an optimal policy is to delay exercise until the last two periods.

2 - Portfolio Optimization using Multi-Objective Mathematical Programming

Bartosz Sawik, Department of Applied Computer Science, AGH University of Science & Technology, Faculty of Management, Al. Mickiewicza 30, PL-30-059, Kraków, Poland, b_sawik@yahoo.com

This paper deals with the problem of selection of methods and numerical tools for solving portfolio optimization problems with different objectives. The research efforts were concentrated on mixed integer programming formulations. The need for solving multi-objective portfolio optimization models by MIP can be illustrated for the portfolio models with VaR as a risk measure, as well as, when the investment ventures is one of the optimal criteria. An alternative, multi-objective portfolio optimization problems is formulated with CVaR as a risk measure or with symmetric measure of risk.

3 - The Effect of Asset Liquidation on the (Bad Banks) Stability in Times of Crisis

Bernhard Kronfellner, Vienna University of Technology, Austria, kronfellner.bernhard@bcg.com, *Wolfgang Aussenegg*

As a consequence of the financial crisis many banks have to restructure their assets and big parts of their organisation. Both asset and organizational restructuring have an impact on P&L and stability of the corresponding company. In this paper we derive an optimal asset liquida-tion strategy that incorporates indicators of organizational stability. Especially, given a fixed amount of assets to be cut down within a fixed timeframe, we obtain the optimal sequence of trades that optimize expected P&L and the stability of the organizational restructuring process over the liquidation period.

4 - Nonlinear Combinatorial Optimization for High Frequency Hedging and Mean-Variance Optimization in Automated Neuro Stock Trading

Gordon Dash, College of Business Administration, University of Rhode Island, 7 Lippitt Road, 02881, Kingston, Rhode Island, United States, GHDash@uri.edu, *Nina Kajiji*

Technological advances have fostered a shift to new and effective automated trading algorithms. Yet to be demonstrated in sequential automated trading is how to simultaneously derive a high frequency mean-variance set and, when necessary, a signal to implement a derivative security hedge. This paper embeds a combinatorial nonlinear multiple-objective optimization within a neuro-stochastic automated trading algorithm to rebalance a high-frequency hedged mean-variance portfolio. The empirical results compare risk-adjusted portfolio returns against non-optimized algorithmic trading results.

5 - Recent Advances on Stochastic Hybrid Dynamical Financial Systems: Discrete and Continuous, and Their Optimization

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr, *Azar Karimov*, *Efsun Kürüm*, *Çigdem Güleroglu*

We represent dynamics in finance under uncertainty and covariance. An emerging representation tool for this is Stochastic Differential Equations. Is has become acknowledged that additionally an impulsive part is needed, together amounting for Levy processes. Even these are often composed piecewise with changes happening at thresholds. We present several classes of these Hybrid Systems, discuss problems of identification, keeping them between barriers and optimizing portfolios with regard to them, discussing approaches of Hamilton-Jacobi-Bellman and Maximum Principle.

■ FC-04

Friday. 13:00-14:40
Room D

Transportation and Logistics: Algorithms

Stream: Combinatorial Optimization in Suppy Chain Management

Invited session

Chair: *Bülent Çatay*, Faculty of Eng. & Natural Sciences, Sabanci University, Tuzla, 34956, Istanbul, Turkey, catay@sabanciuniv.edu

1 - A Bilevel Programming Model for Transportation of a Perishable Item with Stochastic Lifetime

Hande Günay Akdemir, Vize Vocational College, Kirklareli University, Kırklareli Üniversitesi Vize

Meslek Yüksekokulu Müdürlüğü, Devlet Mah. 8 nolu Cad. No:30, 39400, Kirklareli, Turkey, handegunay@kirklareli.edu.tr, *Fatma Tiryaki*

This paper focuses on transportation of a perishable item with stochastic lifetime in a hierarchical supply chain. Since perishables deteriorate and become useless when they have reached their lifetime, they must be handled in time. A bilevel programming model is proposed to coordinate suppliers and distribution centers. Customer demands and travel times are considered to be deterministic. Our proposed model is transformed into a single level nonlinear programming by using its Karush-Kuhn-Tucker (KKT) conditions. A small numerical example is also given to illustrate our model.

2 - Minimizing the consumed electric energy for personal rapid transition transportation system

Lotfi Hidri, operational research, polytechnic school of Tunisia, 30 rue mohamed el azdi cité Folla den den, 2011, Tunis, Tunis, Tunisia, hidri.lotfi20@gmail.com, *Mrad Mahdi*

The objective is to minimize the consumed electric energy, for a personal rapid transition transportation system, to fulfil a list of trips, using a set of powered-batteries vehicles. The trips are represented by a network. The nodes are the trips and the consumed electric energy is the arcs' cost. Based on this representation, a mixed integer programming formulation, minimizing the consumed energy is developed, and solved directly using a state-of-the-art LP solver. Extensive computational experiments are presented and provide evidence that the proposed procedures are effective.

3 - A Comparison of Two Evolutionary Algorithms on the Cumulative Capacitated Vehicle Routing Problem

Aydin Sipahioglu, Industrial Engineering, Osmangazi University, Meselik, 26480, Eskisehir, Turkey, asipahi@ogu.edu.tr, *Burcin Ozsoydan*

Cumulative Capacitated Vehicle Routing Problem (CCVRP) is a recent extension of VRP and the aim of it is to minimize total arrival times at nodes. In this study, a Genetic Algorithm and a GA based evolutionary algorithm which uses a cross-over scale, are implemented as solution techniques due to its Np-hard nature. The performances of developed algorithms are tested on 39 benchmark instances taken from the literature and the results are compared in terms of objective function value, and CPU time. It is shown that the better results can be obtained by using the GA based evolutionary algorithm.

4 - A Variable Neighborhood Descent For Solving The Multi Objective Vehicle Routing Problem

Hacer Yumurtaci, Endustri Muh. Bolumu, Istanbul Universitesi Muhendislik Fakultesi, Turkey, hacer913@istanbul.edu.tr, *Alp Baray*

The Variable Neighborhood Search (VNS) (Mladenovic and Hansen, 1997), is one of the local search based metaheuristic.VNS is a recent metaheuristic for solving combinatorial problems and based on the concept of systematic change of neighborhoods.Because of multi-objective optimization is attracting more and more attention, in this paper, a variable neighborhood descent (VND) is used for solving the multi objective vehicle routing problem.The performance of VND has been tested on VRP benchmark problems and it shows that VND performs well and is quite competitive with other heuristics.

5 - Greenest Paths in Time-Dependent Transportation Networks

U.Mahir Yildirim, Industrial Engineering, Sabanci University, Sabanci University, Faculty of Engineering and Natural Sciences, Tuzla, 34956, Istanbul, Turkey, mahiryldrm@sabanciuniv.edu, *Bülent Çatay*

The existing shortest path algorithms (SPA) on time-dependent networks aim at finding the fastest (minimum time) path. However, these algorithms cannot be applied to determine greenest (minimum greenhouse gas emitting/fuel consuming) path on a real transportation network. We discuss new approaches to find the greenest path given the speed profile of the network and an appropriate emission function of speed using a discrete time-space expansion. Computational test using random data show the potential savings and sustainability benefits of the new approaches over the existing time-dependent SPA.

Saturday. 9:00-10:40

■ SA-01

Saturday. 9:00-10:40
Room A

Graph Theory I

Stream: Graph Theory and Network Problems
Contributed session
Chair: *Derya Doğan*, Mathematics, Ege University, C Blok, 35100, İzmir, Turkey, dryadogan@gmail.com

1 - Approximation algorithms for independent dominating sets in odd graphs

Ahmed Al-Herz, ICS, KFUPM, POBox 766, KFUPM, 31261, Dhahran, Saudi Arabia, alherz@kfupm.edu.sa, *M. H. Alsuwaiyel*

In this paper, the first approximation algorithms for independent dominating sets in odd graphs are introduced. Our approach is based on partitioning the graph to different sets in order to simplify the complexity of the graph and finding an independent dominating set in each part, then merging the sets while resolving any violation in the independence or domination properties. Also, we present experimental results and comparisons between the proposed algorithms and greedy and randomized algorithms. The results show that the proposed algorithms give the best approximation quality.

2 - New Heuristic Methods for Unit Disk Graph Coloring and Its Reoptimization

Arman Boyaci, Bogazici University, Turkey, arman.boyaci@boun.edu.tr, *Tinaz Ekim*

Motivated by the frequency assignment problem in telecommunication, we propose new simple heuristic methods for minimum vertex coloring in unit disk graphs and the related vertex adding/removing reoptimization problems. We describe an improvement heuristic, called KEMPEIMP, based on Kempe's exchange method. We reveal the practical performance of the suggested methods through a series of computational experiments. Results show that simple heuristic methods followed by our improvement heuristic method find almost all the time the optimal value on unit disk graphs, certifying that KEMPEIMP is a very appropriate heuristic for coloring unit disk graphs.

3 - Spectral Graph Drawing

Navid Rezaie Melal, mathematics, zanjan university, zanjan, Iran, Islamic Republic Of, navid.melal@gmail.com, *Mohammadreza Ghaemi*, *Shokoofe Hosseinnia*

The spectral approach for graph visualization computes the layout of a graph using certain eigenvectors of related matrices. Some important advantages of this approach are an ability to compute optimal layouts (according to specific requirements) and a very rapid computation time. In this paper we suggest a new matrix that reproduces well the same structure and those ones with not drawn by the adjacency matrix and Laplacian matrix. We also write a MATLAB program to draw the plot of the graphs.

4 - Average Covering Numbers of Some Special Graphs

Derya Doğan, Mathematics, Ege University, C Blok, 35100, İzmir, Turkey, dryadogan@gmail.com, *Pinar Dundar*

In a communication network, the vulnerability measures the resistance of the network to disruption of operation after the failure of certain stations or communication links. If we think of a graph as modeling a network, we can use vulnerability measures to investigate vulnerability of network. Most studied and best known vulnerability measures in graph theory are connectivity, integrity, etc. In this paper, we mention about a new vulnerability measure which defined by us, called average covering number of a graph and also show that average covering number of some special classes of graphs.

5 - Center Coloring of Graphs and Spanning Trees

Zeynep Örs Yorgancıoğlu, Mathematics, Yasar University, Yaşar Üniversitesi Selçuk Yaşar Kampüsü Üniversite Caddesi No:35-37 Ağaçlı Yol Bornova, İzmir, Turkey, zeynep.ors@yasar.edu.tr, *Pinar Dundar*, *Murat Erşen Berberler*

Center coloring of a graph G is a coloring that is to color the vertices of a graph beginning from the center vertex and color the 1-distance vertices from the center with a color, 2-distance vertices from the center with an other color,... and n-distance vertices from the center with a different color. The minimum number of colors for center coloring is called center coloring number Cc(G). In this talk we give some bounds for the center coloring number of graphs and mininum diameter spanning graphs,and an algorithm to calculate the center coloring number and to find a minimum diameter spanning tree.

■ SA-02

Saturday. 9:00-10:40
Room B

Scheduling III

Stream: Scheduling
Contributed session
Chair: *Claudio Arbib*, Computer Science, University of L'Aquila, via Vetoio (Coppito), 67010, L'Aquila, Italy, arbib@di.univaq.it

1 - Scheduling pharmacy openings

Paolo Serafini, Dept. of Mathematics and Computer Science, University of Udine, Via delle Scienze 206, 33100, Udine, Italy, paolo.serafini@uniud.it, *Giovanni Andreatta*, *Luigi De Giovanni*

The pharmacy service requires that some must be always open and shifts lasting one week have to be organized, so that each pharmacy is always open in exactly one shift, and users minimize the distance to the closest open pharmacy. We present a set-covering formulation of the problem with a column generation approach, where rows correspond to pharmacies and columns to shifts (pharmacies open in the same week). Pricing is NP-hard and we present both an integer linear programming exact method and a local search heuristic. Computational results on random and real instances are satisfactory.

2 - A mathematical model for project team formation problem in report writing course

Feristah Ozcelik, Industrial Engineering Department, Eskisehir Osmangazi University, Meselik, 26480, Eskisehir, Turkey, fdurmaz@ogu.edu.tr, *Tugba Saraç*

In this study, a mathematical model for project team formation problem in teaching institutions is presented. Although self-selection is a common practice, students tend to form the teams due to their friendship by ignoring their skills, which results in unbalanced teams for skill. With the proposed model, balanced teams are formed as compatible with the preferences of students to team members. The proposed model is applied to a real problem: project team formation problem in report writing course in Eskisehir Osmangazi University, Turkey.

3 - Mathematical Models for Pharmacy Duty Scheduling Problems

Ozgur Ozpeynirci, Department of Logistics Management, Izmir University of Economics, Sakarya Cad. No:156, Balcova, 35330, Izmir, Turkey, ozgur.ozpeynirci@ieu.edu.tr, *Ebru Aglamaz*

In this study, we define the pharmacy duty scheduling (PDS) problem, where a subset of pharmacies should be on duty on national holidays, at weekends and at nights in order to be able to satisfy the emergency drug needs of the society. The PDS problem is a multi-period facility location problem with special side constraints. We propose two mathematical programming models. We analyze the computational complexity and test the performance of mathematical models on randomly generated instances. The study is supported by the Scientific and Technological Council of Turkey (TUBITAK).

4 - Heuristics for the parallel machine problem with unavailability constraints

Ilyes Karoui, Polytechnic School of Tunisia, Tunisia, ilyes.karoui@gmail.com, *Lotfi Hidri*

We address the parallel machine scheduling problem with unavailability constraints, where a set of jobs has to be processed on identical parallel machines. Each job has a release date, a processing time and a delivery time. Each machine is unavailable during a period of time. The objective is to minimize the makespan. In this work we present a set of heuristics which are based on an exact solution of the parallel machine problem and on a greedy algorithm. The performance of this heuristics is assessed over an experimental investigation using a set of randomly generated instances.

5 - Sorting Common Operations to Minimize Tardy Jobs

Claudio Arbib, Computer Science, Università dell'Aquila, via Vetoio, Coppito, 67010, L'Aquila, Italy, claudio.arbib@univaq.it, *Giovanni Felici*, *Mara Servilio*

We study an operation scheduling problem where a set J of m jobs with due dates d1, . . . , dm must be completed by one machine. Job j is completed as soon as a subset Sj of operations is done. One wants to schedule operations in a way that minimizes the (weighted) number of tardy jobs. Jobs share common operations, i.e., once operation i is completed, it is completed for all the jobs that require i: this is typical of industrial cutting processes (pattern sequencing). We formulate the problem as stable set, and derive a polyhedral method that uses both specialised valid inequalities and rank inequalities of the job conflict graph. A computational study is provided with both industrial and artificial instances.

■ SA-03

Saturday. 9:00-10:40

Room C

Allocation problems 1

Stream: Combinatorial and Hybrid Regulatory Systems - Game Theory

Invited session

Chair: *Ipek Ozkal-Sanver*, Bilgi University, Turkey, isanver@bilgi.edu.tr

1 - Egalitarianism Under Earmark Constraints

Rahmi Ilkilic, Department of Economics, Bilkent University, Turkey, rahmi.ilkilic@bilkent.edu.tr

We consider a model in which a resource is shared by several agents with single-peaked preferences and the resource is coming from different suppliers under arbitrary bilateral feasibility constraints: each supplier can only deliver to a certain subset of agents. We identify the over-demanded and the under-demanded side of the market. Like in the one supplier model, there is a Lorenz dominant Pareto optimal allocation. We call it the egalitarian solution, and characterize it, by the combination of Strategyproofnes, Pareto Optimality, and Equal Treatment of Equals.

2 - Random Paths to Stability in Complete Matching Problems

Elena Molis, Economics, Universidad de Granada, Facultad de Ciencias Económicas y Empresariales, Cuesta de Hospicio s/n, 18071, Granada, Spain, emolis@ugr.es, *Elena Inarra*

Knuth (1976) whether a decentralized process of successive blocking pairs leads to stability matching in complete matchings. By assuming that agents abandoned by a blocking pair are forced to be matched, the answer is negative. Roth and Vande Vate (1991), by assuming that abandoned agents may remain single in the matching answered in the affirmative. This binary relation, however, is too much flexible in many situations in which agents need to be paired to participate in the market. We introduce a new binary relation which guarantees the convergence to stability in complete matching problems.

3 - A Characterization of the Extended Serial Correspondence

Ozgur Yilmaz, Economics, Koc University, Koc University, College of Administrative Sciences and Economics, Sariyer, 34450, Istanbul, Turkey, ozyilmaz@ku.edu.tr

We study the problem of assigning objects to a group of agents, when each agent reports ordinal preferences over the objects. We allow for indifference among objects. We focus on probabilistic methods, in particular, the extended serial correspondence, introduced by Katta and Sethuraman (2006). Our main result is a characterization of the extended serial correspondence in welfare terms by means of stochastic dominance efficiency, stochastic dominance no-envy and bounded invariance.

4 - Consistent Core Enlargements in Roommate Problems

Ipek Ozkal-Sanver, Bilgi University, Turkey, isanver@bilgi.edu.tr

We consider roommate (one-sided matching) problems where, as Gale and Shapley (1962) show, the core may be empty. Core extensions are solutions coinciding with the core whenever it is non-empty. Ozkal-Sanver (2010) show that there exists no refinement of a core extension which is consistent, a fortiori no consistent core extension. In that study, we consider core enlargements which are solutions including the core for any problem. For instance, the pareto optimal solution is a consistent core enlargement. Our aim is to characterize the class of consistent core enlargements and compute the minimal consistent core enlargement.

■ SA-04

Saturday. 9:00-10:40
Room D

Airline and Crew Scheduling

Stream: Combinatorial Optimization in Aviation Applications

Contributed session

Chair: *Andreas Klinkert*, Institute of Data Analysis and Process Design, Zurich University of Applied Sciences, Rosenstrasse 3, P.O. Box, CH-8401, Winterthur, ZH, Switzerland, andreas.klinkert@zhaw.ch

1 - Pickup and delivery problem in risky environment for air transportation in the turkish air force

Özgür Aksoy, Industrial Engineering, Osmangazi University, Dikmen Cd., No:143/7, 06450, Ankara, Turkey, ozgur_134@hotmail.com, *Muzaffer Kapanoglu*

This study deals with Turkish Air Force's air transportation in risky environment. In the problem, there are different kind of cargo aircraft according to capacity, flight duration, cost, air speed and home base. There are several operational constraints and different kind of risk factors. Objective is to minimize the overall cost subject to all requests are serviced, acceptable risk factors are not violated and all constraints are satisfied. Problem is modeled as multi depot, multi product, heterogeneous vehicle pickup and delivery problem. Proposed mixed integer model solved by IBM ILOG CPLEX solver. Solutions are compared to actual transportation cost and found that the new solutions are cost effective.

2 - Solving the Turkish crew scheduling problem

Melda Ormeci Matoglu, Ozyegin University, Turkey, melda.ormeci@ozyegin.edu.tr, *Okan Ozener*, *Gunes Erdogan*, *Mohamed Haouari*

Crew scheduling problem is considered to be one of the most challenging problems in airline planning. Standard and complex solution methodologies for North American and European airlines exist in the literature. However these problems are different than the one Turkish companies face as the Turkish crew scheduling problem has its specific properties (e.g. fixed crew salaries, only one crew base, round trip type flight schedules, several considerations besides cost minimization). We develop heuristic based novel solution methods to address Turkish non-generic crew scheduling problem.

3 - Airport Staff Scheduling: A Large-Scale Real World Application

Andreas Klinkert, Institute of Data Analysis and Process Design, Zurich University of Applied Sciences, Rosenstrasse 3, P.O. Box, CH-8401, Winterthur, ZH, Switzerland, andreas.klinkert@zhaw.ch

We present a research and business project aimed at developing software for automated airport staff rostering. Industrial partner is a large international ground handling company, and pilot site is Zurich Airport. The monthly planning involves hundreds of shift types and thousands of employees with various skills, and features demand-driven rostering and shift bidding. After discussing the project's planning context, we give insights into the solution approach which involves decomposition, integer programming and (meta-)heuristics, and show operational impacts and bottom-line benefits.

4 - Aircraft and Passenger Recovery with Cruise Speed Control

Ugur Arikan, Department of Industrial Engineering, Middle East Technical University, Ankara, Turkey, arikan@ie.metu.edu.tr, *Sinan Gürel*, *M. Selim Akturk*

Given an airline schedule and passenger itineraries we consider a schedule recovery problem against disruptions. Different than the literature, we consider that aircraft cruise speeds can be adjusted. Moreover, we consider passenger related disruption costs in detail. There is a nonlinear relation between the cruise speed and fuel cost which is handled using second-order cone programming inequalities in this work. We provide a mathematical model for the problem. In test problems retrieved form real schedules, our model achieved optimal solutions within 5 min. cpu time as required in practice.

Saturday. 11:00-12:00

■ SB-01

Saturday. 11:00-12:00
Room A

Plenary Talk 3

Stream: Plenary Lectures
Plenary session

Chair: *Janez Zerovnik*, FME, University of Ljubljana, Askerčeva 6, si-2000, Ljubljana, Slovenia, janez.zerovnik@imfm.uni-lj.si

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Adapting Representations for Specific Tasks

John Shawe-Taylor, Department of Computer Science, University College London, Gower Street, CW1E 6BT, London, United Kingdom, jst@cs.ucl.ac.uk

Practical learning systems can interact with each other such as when one system is attempting to learn a function, while another is simultaneously adapting the representation of the inputs to the function. This is an example of a much more general phenomenon where the properties of a complex system are inherited from a number of adaptive components. The presentation will describe a case study of such an interaction in which a function is learnt in a feature space defined by an adapting combination of kernels. This situation is known as multiple kernel learning in machine learning and is closely related to the group Lasso models studied in statistics. The analysis of this interaction is furthered by casting the problem as a global optimisation. This ensures that the two learning components do not induce instabilities in each others' convergence and that their interaction can be effected through a simple protocol. The global optimisation while ensuring stable convergence does not guarantee the statistical properties of the estimated function. We will present results that bound the statistical reliability of the resulting classifiers indicating that the extra flexibility implied by the adapting representation comes at a modest cost. Extension of the ideas to regression (group Lasso) will also be presented as will combinations between more complex learning tasks such as Bandit algorithms and more complex classes of representations such as those arising from Hidden Markov Model derived kernels.

Saturday. 13:00-14:40

■ SC-01

Saturday. 13:00-14:40
Room A

Graph Theory II

Stream: Graph Theory and Network Problems
Contributed session

Chair: *Mikhail Goubko*, Institute of Control Sciences RAS, Russian Federation, mgoubko@mail.ru

1 - A new method for solving constrained bi-objective shortest-path flow problem

Neda Zarayeneh, Mathematics, statistics and computer science, University of Tehran, Iran, Islamic Republic Of, nz957@yahoo.com, *Hassan Salehi Fathabadi*, *Ali Moallemi*

In this paper, we have developed an algorithm for solving constrained biobjective shortest-path problem. To solve the problem, at first, we use an algorithm to construct a new network from the original network, then we apply biobjective label correcting method to find a complete set of efficient solutions for biobjective shortest path problem, also we apply a modified version of this algorithm to increase the rate of convergence.

2 - Complexity Results of the Variations of the Edge Search Problem

Oznur Yasar Diner, Informations Technology, Kadir Has University, Cibali Kampusu, Balat, 34083, Istanbul, Turkey, oznur.yasar@khas.edu.tr

Edge Searching is a combinatorial game played on graphs. Assume that we want to secure a system of tunnels from a hidden intruder. We assume that every edge of G is contaminated initially and our aim is to clean the whole graph by a sequence of steps using the minimum number of searchers. For a given integer k, deciding whether k searchers suffice to search a given graph G is an NP-complete problem. In this talk we give complexity results on two variants of the edge search problem: Weighted Search and Fast Search.

3 - Determining the Shortest Path with Improved All-Pairs Generic Algorithm

Sabahattin Kerem Aytulun, Industrial Engineering, Turkish Air Force Academy, Turkish Air Force Academy, Yeşilyurt / Bakırköy, 34149, İstanbul, Turkey, k.aytulun@hho.edu.tr

Triple operations used in Floyd-Warshall Algorithm generates shortest paths between each pair of nodes in a network. In this study, some operations that causes redundant calculations are eliminated and an improved all-pairs generic Floyd based algorithm is proposed using some properties in pivot rows and columns. Improved algorithm is validated by n-node randomly generated sample networks and its performance is compared with regular Floyd-Warshall and other shortest path algorithms. It has shown that suggested algorithm concludes final matrix with less computation.

4 - Analysis of Discrete Structures via Complementary Problems

Asli Guler, Mathematics, Yasar University, Matematik Bölümü, Yasar Üniversitesi, 35100, Izmir, Bornova, Turkey, asli.guler@yasar.edu.tr, *Urfat Nuriyev*

It is observed most of discrete problems are NP-complete.The common property of these problems is that it requires a long time to find an exact solution;because time complexities of the algorithms are exponentially related to the problem size. In this study,it is aimed to compose complementary problems for discrete problems and examine main problems via these problems.Mathematical models of complementary problems are examined,some solution algorithms are proposed.Moreover,it is searched how the proposed algorithm for one of main problem or complementary problem can be used for the other one.

5 - Heuristic algorithm for optimal tree search

Mikhail Goubko, Institute of Control Sciences RAS, Russian Federation, mgoubko@mail.ru

Many combinatorial problems reduce to the optimal tree problem (OTP) — that of minimizing a cost function over a set of rooted trees with given leaves. No polynomial (by the number of leaves) approximation for OTP exists, but lower-bound estimates (LBE) are developed for many special cases. We propose a polynomial heuristic algorithm that employs these LBE. It combines greedy top-down tree construction with local search and parameters adjustment. The algorithm was successfully applied to the problems of decision tree growing and user interface structure optimization.

■ SC-02

Saturday. 13:00-14:40
Room B

Combinatorial Optimization and Reformulations

Stream: Integer and Combinatorial Optimization

Invited session

Chair: *Monique Guignard-Spielberg*, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard_monique@yahoo.fr

1 - Optimal Weighted Votes with Minimal Weights

Lee Papayanopoulos, MSIS, Rutgers University, RBS, 1 Washington Park, 07102, Newark, NJ, United States, lp1@business.rutgers.edu

With the advent of "One-Man, One-Vote" more than four decades ago, the task of allocating weighted votes to legislators became the first application of IP/MIP in the legislative sector and a recurring activity after every census since then. The objective is to obtain votes that render the power distribution (a combinatorial vector function) near collinear with the population vector of constituencies. We describe the model that meets legal standards, search methods that lead to optimal allocation, and a post-optimization procedure that reduces the norm of the optimal vote vector.

2 - SDP reformulation within a surrogate dual heuristic for the 0-1 exact k-item quadratic knapsack problem

Lucas Létocart, LIPN UMR CNRS 7030, Institut Galilée - Université Paris 13, 99 avenue J-B. Clément, 93430, Villetaneuse, France, lucas.letocart@lipn.univ-paris13.fr, *Marie-Christine Plateau*, *Gérard Plateau*

We consider a 0-1 quadratic knapsack problem with an extra constraint fixing the number of items in the knapsack. Most instances with more than forty variables cannot be solved within one hour by a state-of-the-art software such as cplex 12.1. We propose a fast heuristic method which produces both good lower and upper bounds on the value of the problem. It integrates a semidefinite programming reduction phase within a surrogate dual heuristic. Computational experiments with up to 200 variables yield known optima (and prove optimality) in 82% (resp. 63%) within about 100 seconds.

3 - Efficient formulation of 0-1 integer program using exact 0-1 knapsack separation

Saïd Hanafi, ISTV2, LAMIH-SIADE, University of Valenciennes, Le Mont Houy, 59313, Valenciennes, France, said.hanafi@univ-valenciennes.fr, *Igor Vasiliev*, *Maurizio Boccia*

Exploiting advances on the 0-1 knapsack problem, we investigate an efficient approach for 0-1 programs with knapsack constraints as local structure. Our approach is based on an efficient implementation of knapsack separation problem in four phases: preprocessing, row generation, controlling numerical errors and sequential lifting. This approach can be used independently to improve formulations with cutting planes generated or incorporated in Branch and cut. It allows to solve efficiently large-scale instances of generalized assignment problem and capacited p-median problem to optimality.

4 - Improved 0-1 Convex QP Reformulations for Quadratic Knapsack Problems

Xiaoling Sun, School of Management, Fudan University, 670 Guoshun Road, 200433, Shanghai, China, xls@fudan.edu.cn, *Shuhui Ji*, *Xiaojin Zheng*

We present in this talk a new convex 0-1 QP reformulation for quadratic knapsack problems (QKP). This new reformulation improves the existing reformulation based on diagonal perturbation in the sense that the continuous relaxation of the new reformulation is tighter than or at least as tight as that of the existing reformulation. The improved reformulation is derived from matrix decomposition of the objective function and piecewise linearization of quadratic terms on 0,1n. We also discuss the extensions of the reformulation to k-item QKP and chance-constrained QKP.

■ SC-03

Saturday. 13:00-14:40
Room C

Ergonomics and Layouts

Stream: Combinatorial Optimization in Ergonomics

Invited session

Chair: *Bela Vizvari*, Industrial Engineering, Eastern Mediterranean University, Gazimagusa, Mersin 10, Turkey, vizvaribela@gmail.com

1 - Design of Virtual Complete Turkish Keyboard

Süleyman Mete, Industrial Engineering, University of Gaziantep, 27310, Gaziantep, ?ahinbey, Turkey, smete@gantep.edu.tr, *Kursad Agpak*

Text input for mobile or handheld devices is broad and growing research area. One of the promising methods is the virtual keyboard for touch screens. Developing improved keyboard layouts and design makes data entry more efficient, time saving and ergonomic. Therefore, in this study a new virtual keyboard design for the Turkish language is presented. The mathematical model is developed for the underlying optimization problem which is a generalization of the well known Quadratic Assignment Problem.
Keywords: Virtual keyboard, optimization

2 - Evaluating office layouts by considering ergonomic principles

N.Fırat Özkan, Department of Industrial Engineering, Eskisehir Osmangazi University, ESOGU Endustri Muhendisligi Bolumu Meselik Kampusu, 26480, Eskisehir, Turkey, fozkan@ogu.edu.tr, *Berna Ulutas*

The workplace design generally considers the physical requirements and building constraints. However, ergonomic principles may be overlooked. This study focuses on the office layout in higher education departments because the positioning of equipments may influence the performance of faculty members. By considering form of the building, lighting sources, and air-conditioning a multiobjective mathematical model is developed for a university department's offices. Current layouts are assessed based on the basic layout and ergonomic principles. Then, optimum office layouts are generated.

3 - Optimal Supermarket Layout

Sadegh Niroomand, Industrial Engineering, Easterm Mediterranean University, Turkey, sadegh.niroomand@cc.emu.edu.tr, *Bela Vizvari*

The layout of departments in a supermarket are optimized. It is experienced that the amount of sales is an increasing function of the length of the customer's path. To increase the sales, the objective is to increase the shortest traveled path of the customers within the supermarket. Based on real life observations, customers are classified into 16 classes. It is supposed that each customer uses the optimal solution of relevant TSP when visits departments. The mathematical model maximizes the total weighted length of the 16 TSPs' optimal solutions. The model uses the dual of DFJ model.

4 - On Multi-Dimensional Scaling

Bela Vizvari, Industrial Engineering, Eastern Mediterranean University, Gazimagusa, Mersin 10, Turkey, vizvaribela@gmail.com, *Sadegh Niroomand*

Multi-Dimensional Scaling (MDS) is a geometric method of statistics to uncover hidden relation among objects. The similarities of objects are described by a matrix. MDS finds points in a low dimensional space such that their distances are close to the similarity values. In this study, MDS is applied for reconstruction the original geometric configuration of some layout problems. MDS can distinguish real layout problems from artificial ones. The type of distance used in MDS as distance of points and discrepancy of distances and similarities is of l_2. MDS can be generalized by using MILP models for l_1 and l_inf distances.

■ SC-04

Saturday. 13:00-14:40

Room D

Transportation and Logistics: Network Planning

Stream: Combinatorial Optimization in Suppy Chain Management

Invited session

Chair: *A. Cetin Suyabatmaz*, Industrial Engineering, Sabanci University, Sabanci University, MS/IE Department, Orhanli, Tuzla, 34956, Istanbul, Turkey, csuyabatmaz@sabanciuniv.edu

1 - Railway Freight Transportation: Models and Algorithms

Alexander Lazarev, Institute of Control Sciences, Profsoyuznaya st. 65, 117997 Moscow, Russia, 117997, Moscow, Russian Federation, jobmath@mail.ru, *Elena Musatova*

There is set of railway stations and set of freight cars which are characterized by departures and destinations, weight and significance. Each car arrives to the departure in some release time and should be delivered to the destination before a due date. There are some restrictions on number of cars in a train, its total weight, capacity of a classification yard. It is necessary to form trains and schedules that minimize a cost function. It is proposed to select basic models (with two stations, chain of stations, star of stations) that gives us an opportunity to develop special algorithms.

2 - Using mathematical models for the design of the logistic network of a company

Everton da Silveira Farias, Management Science, Universidade Federal do Rio Grande do Sul - UFRGS, Rua Bagé, 94 Apto 402, Petropoli - Porto Alegre, RS - BRAZIL, 90460080, Porto Alegre, Rio Grande do Sul, Brazil, esfarias@ea.ufrgs.br, *Denis Borenstein*

We present two different models for the Supply Chain Network Design of a company responsible for producing and distributing several different types of the same commodity. The study was motivated by the company's investment in a new production plant. A multi-commodity approach is used that implements two different strategies considering the single-source supply, or not. The problems are formulated as mixed integer-linear programming models based on previous formulations developed by Jayaraman and Pirkul (2001). The models were developed, implemented, and validated on two stages. They were implemented on AMPL and solved using Cplex solver. The results were extremely significant, and contributed to setting the new logistic system of the company.

3 - Selection of resilient supply portfolio in supply chains with disruption risks

Tadeusz Sawik, Operations Research & Information Technology, AGH University of Science & Technology, Faculty of Management, Al.Mickiewicza 30, 30-059, Krakow, Poland, ghsawik@cyf-kr.edu.pl

A mixed integer programming approach is proposed for selection and protection of part suppliers and order quantity allocation in supply chains with disruption risks. The objective is to select suppliers and allocate order quantity among the suppliers, and decide which supplier to protect against disruptions and how to allocate emergency inventory among the protected suppliers so as to minimize cost of protection, inventory holding, ordering, purchasing and shortage of parts. To mitigate the impact of disruption risks, conditional value-at-risk is applied. Computational results are reported.

4 - Selective And Periodic Inventory Routing Problem

Özge Tüncel, Industrial Engineering, Koc University, Koc University Rumelifeneri Yolu, Sarıyer, 34450, İstanbul, Turkey, otuncel@ku.edu.tr, *Sibel Salman*

A biodiesel production facility collecting waste vegetable oil from source nodes uses the collected waste as raw material for biodiesel production. The manager needs to decide which of the source points to include in the collection program, which of them to visit on each day, which periodic routing schedule to repeat over an infinite horizon and how many vehicles to operate such that the total cost is minimized while the production requirements and operational constraints are met. A heuristic model is constructed in order to find near optimal solutions for small and large sets of instances.

5 - A Network Flow Formulation for a Crew Planning Problem in Railways

A. Cetin Suyabatmaz, Industrial Engineering, Sabanci University, Sabanci University, MS/IE Department,

Orhanli, Tuzla, 34956, Istanbul, Turkey, csuyabatmaz@sabanciuniv.edu, *Guvenc Sahin*

During the last decade, crew-related costs outweigh energy expenditures and constitute more than one third of general expenditures of the Turkish State Railways (TCDD). Hence, the number of crew members under long-term contracts in an important decision to be made. In this study, we develop a network flow formulation for a crew planning problem that determines the minimum sufficient crew size for a region over a finite horizon where the periodic repeatability of crew schedules is considered as well. We present the computational study on a real-life data set acquired from TCDD.

Saturday. 15:00-16:40

■ SD-01

Saturday. 15:00-16:40

Room A

Multiple Criteria Decision Making and Combinatorial Optimization

Stream: Multiple Criteria Decision Making and Combinatorial Optimization (MCDM Invited Stream)

Invited session

Chair: *Ozgur Ozpeynirci*, Department of Logistics Management, Izmir University of Economics, Sakarya Cad. No:156, Balcova, 35330, Izmir, Turkey, ozgur.ozpeynirci@ieu.edu.tr

1 - An algorithm for the bi-objective integer minimum cost flow problem

Salima Nait Belkacem, Economy and Commercialisation des Hydrocarbures, University of M'hamed Bougara, 1 avenue de l'indépendance, 35000, Boumerdès, Algeria, naitsali@yahoo.fr, *Moncef Abbas*

In this paper, we propose an algorithm that finds more efficient integer non-extreme points for a bi-objective integer minimum cost flow problem in the objective space. This algorithm is based on the method of Sedeno-Noda and Gonzalez-Martin's published on 2001. Our alternative method improves the second phase of the old method particularity by using the idea of upper and lower bounds among efficient extreme points which are found in the first phase of the old method. We show that our method gives more efficient points in the objective space and illustrate the method by an example.

2 - Multiobjective Facility Layout Problem: An Optimization - Simulation approach

Ho Phong, Industrial & Systems Engineering, International University, KP 6, Linh Trung, Thu Duc, Ho Chi Minh City, Viet Nam, htphong@hcmiu.edu.vn, *Thao Ho*

In this paper, the authors use multiobjective for the facility layout to meet the nature of the manufacturing systems. In addition to two common objectives of minimizing the total transport distance and maximizing the total closeness rating scores, the objective of maximizing "reachability' is introduced. The reachability is the flexibility of the system when the default facility is down. The research aimed at integrating multiobjective optimization into a simulation environment in solving a factory layout problem.

3 - Multi-choice goal programming approach to university exam timetabling problem

Emre Ozel, Industrial Engineering Department, Dumlupinar University, Central Campus, Kutahya, Turkey, eozel@dpu.edu.tr, *Ozden Ustun*, *Safak Kiris*, *Ilker Ozan Koc*

In this study, a multi-choice goal programming (MCGP)approach is proposed to university exam timetabling problem. The aim is to achieve multi-choice goals such as balancing of the workloads, minimizing the number of sessions, and minimizing the deviations of the exam durations in the same sessions by considering the constraints. A multi-objective mathematical model is built to satisfy the expectations of the invigilators, the students and the management. Then MCGP is used to handle the multiple aspiration levels. Finally the proposed approach is applied to a make-up examination problem.

4 - Dealer selection for an automotive company using ELECTRE I and TOPSIS methodologies

Elif Maç, Industrial Engineering, Kocaeli University / Natural and Applied Sciences, Turkey, ellyfkaraca@gmail.com, *Zerrin Aladag*

Sales and Aftersales network has vital importance as of customer satisfaction for automotive companies. Although the new technologies, competitive price and charming vehicle design increase new customer potential and customer satisfaction, these key points are not enough alone to sustain long term customer satisfaction and loyalty. Customer satisfaction is mainly based on the nearest experience of the service or product. Therefore, the automotive companies have to select accurate contacts for dealer roles. Dealer evaluation processes do not usually involve any scientific selection methodologies. For this reason, we propose to use multicriteria analysis methodologies to choose a dealer for an automotive company. The research relies both on quantitative data produced within the framework of the Sales and Aftersales Region Managers, and qualitative information about applicants.

5 - A Solvable Order Picking Problem and Multiple Objectives

Cansu Kandemir, Logistics Management, Izmir University of Economics, Sakarya Cad. No:156 Balcova, 35330, Izmir, Turkey, cansu.kandemir@ieu.edu.tr, *Ozgur Ozpeynirci*

In this study, we work on the order picking problem (OPP) in a special warehouse with one picker. Although OPP is NP-Hard in general, the special structure of the warehouse and using one picker lead to a polynomially solvable case. We address the multiobjective version of this special case and investigate the properties of the nondominated points. We show that the algorithm designed for single objective OPP is not capable of finding all nondominated points. We develop a pseudo-polynomial algorithm to find a nondominated point and we propose an approach to generate all nondominated points.

■ SD-02

Saturday. 15:00-16:40

Room B

Combinatorial Optimisation in Lot Sizing and Scheduling

Stream: Material Flows in Production Networks

Invited session

Chair: *Simone Göttlich*, School of Business Informatics and Mathematics, University of Mannheim, A 5, 6, Mannheim, 68131, Germany, goettlich@uni-mannheim.de

1 - A Hyper-heuristic Approach to Parallel Assembly Line Balancing Problems

Gokhan Secme, Nevsehir University, Nevsehir, Turkey, gsecme@gmail.com, *Lale Özbakır*, *Ender Özcan*

Parallel assembly line balancing problem (PALBP) is an NP-hard problem, which requires balancing of multiple parallel assembly lines, simultaneously via assignment of operations to the workstations according to the precedence relations and cycle time restrictions. Hyper-heuristics are high level problem solving methodologies that explore the search space of heuristics rather than solutions directly. In this study, a simulated annealing based hyper-heuristic is tested for solving PALBP over a set of benchmark instances, yielding success in obtaining optimal solutions for most of the cases.

2 - A comparative study of heuristic algorithms on buffer allocation problem

Leyla Demir, Industrial Engineering, Pamukkale University, Pamukkale University College of Engineering Department of Industrial Engineering, 20070 , Denizli, Turkey, ldemir@pau.edu.tr, *Semra Tunali*, *Deniz Türsel Eliiyi*

We propose an integrated approach to solve the buffer allocation problem in unreliable production lines to maximize the throughput rate of the line with minimum total buffer size. The proposed approach has two control loops, and these nested loops aim to minimize the total buffer size of the line to achieve the desired throughput rate. As an inner loop, we employ an adaptive tabu search algorithm proposed by Demir et al. (2012). On the other hand, three different algorithms, i.e., binary search, tabu search, and simulated annealing are proposed for the outer loop. A series of computational experiments are carried out to test the performances of the proposed algorithms.

3 - Integrating Tactical and Operational Decisions in Parallel Machine Scheduling with Time Windows

Uğur Eliiyi, Industrial Systems Engineering, Izmir University of Economics, Sakarya Cd. No:156 Balcova, 35330, Izmir, Turkey, ugur.eliiyi@ieu.edu.tr, *Deniz Türsel Eliiyi*

We integrate the tactical and operational decisions in parallel machine scheduling with jobs having time windows. Each machine has an associated fixed cost of usage, and each job has a weight. We aim to maximize the profit, namely the total weight of the processed job subset less the total cost of used machines. Our model concurrently determines the capacity level of the system and the schedule for the processed jobs. A randomized algorithm is developed for near-optimal solutions. This study is the first to consider this integrated problem. The study is supported by the Scientific and Technological Research Council of Turkey.

4 - New modelling approaches for production networks

Simone Göttlich, School of Business Informatics and Mathematics, University of Mannheim, A 5, 6, Mannheim, 68131, Germany, goettlich@uni-mannheim.de

Many phenomena appearing in economics can be described by continuous models consisting of ordinary and partial differential equations. Typical application areas include supply chain management, scheduling problems and network flow problems in general. The focus is on the mathematical modelling as well as on techniques for simulation and optimization purposes. In fact, in various cases those models can be related to mixed-integer programming models. To ensure feasibility and to reduce the computational effort of large-scale instances, there is evidently need for suitable algorithms.

■ SD-03

Saturday. 15:00-16:40

Room C

Allocation problems 2

Stream: Combinatorial and Hybrid Regulatory Systems - Game Theory

Invited session

Chair: *Ahmet Alkan*, Economics, Sabanci University, Sabanci Univ. Orhanlı, Tuzla, 34956, Istanbul, Turkey, alkan@sabanciuniv.edu

1 - Solving the unsolvable roommate problems

Elena Inarra, University of the Basque Country, Avda L Agirre 83, 48111, Bilbao, Bizkaia, Spain, elena.inarra@ehu.es

To propose a new solution for the unsolvable roommate problem based on two criteria: stability and Pareto optimality. We also give an algorithm to compute the solution.

2 - Production Economies with Single Peaked Preferences: Pareto Optimal and Strategy Proof Rules

Ipek Gursel Tapki, Economics, Kadir Has University, Kadir Has University Faculty of Economics and Administrative Sciences, Fatih Istanbul, Istanbul, Turkey, ipek.tapki@khas.edu.tr

We analyze production economies with a linear technology and single peaked preferences. We first characterize the class of Pareto optimal (allocation) rules. We then characterize the subclass that additionally satisfies strategy proofness. Finally, we show that a uniform production rule uniquely satisfies Pareto optimality, strategy proofness, and equal treatment of equals and also a stronger fairness property, no-envy. Our results can be applied to the problem of allocating central government funds among regional development agencies.

3 - Characterization of the Core in Full Domain Marriage Problems

Duygu Nizamogullari, Economics, İstanbul Bilgi University, Kurtulus Deresi Cad. No: 47, Dolapdere, 10340, İstanbul, Turkey, dsalar@bilgi.edu.tr

Sasaki and Toda (1992) characterize the core of two-sided matching problems using a model where agents have strict preferences over their potential mates, and no agent is allowed to stay single. We study whether their results can be carried to a more general domain of preferences. We show that, if agents are allowed to stay single, the core is no more the unique solution which satisfies (individual rationality), Pareto optimality, anonymity, consistency and converse consistency. We characterize the core via replacing anonymity with gender fairness. Next, relaxing the constraint that agents have strict preferences over their potential mates, we show that there exists no solution satisfying Pareto optimality, anonymity and converse consistency.

4 - An axiomatic characterization of the interval Baker Thompson rule

Sirma Zeynep Alparslan Gok, Mathematics, Faculty of Arts and Sciences, Suleyman Demirel University, Faculty of Arts and Sciences, Suleyman Demirel University, Department of Mathematics, 32260, Isparta, Turkey, zeynepalparslan@yahoo.com

We deal with the research area of cooperative interval games arising from airport situations with interval data. The main result of this study is to give an axiomatic characterization of the interval Baker-Thompson allocation rule.

5 - On Information Acquisition in Matching Markets

Ahmet Alkan, Economics, Sabanci University, Sabanci Univ. Orhanlı, Tuzla, 34956, Istanbul, Turkey, alkan@sabanciuniv.edu, *Zeynel Harun*

In a Market, each student has known ranking over colleges, a score, and a good or bad attribute known only by interview. Colleges prefer high score, but reverse the order of two consecutive students if good follows bad. In Shortlist Game, colleges interview at most two students, and submit a ranking to a Center implementing the college optimal matching. We show that there may be a unique NE where a college submits a ranking other than updated one, and randomizes over shortlists (submitting updated). We identify a preference domain where NE shortlists each contain two consecutive students.

■ SD-04

Saturday. 15:00-16:40
Room D

Layout and Location Problems

Stream: Graph Theory and Network Problems
Contributed session

Chair: *Serap Ulusam Seckiner*, Industrial Engineering, University of Gaziantep, Sahinbey Street, 27310, Gaziantep, Turkey, sermarko@yahoo.com

Chair: *Yunus Eroğlu*, Industrial Engineering, University of Gaziantep, Kat 2. No 219, 27370, Gaziantep, Turkey, erogluyunus@hotmail.com

1 - The quadratic assignment problem with imprecise data: the case of job assignment requiring coordination

Chiang Kao, Industrial and Information Management, National Cheng Kung University, 1 University Road, 701, Tainan, Taiwan, Taiwan, ckao@mail.ncku.edu.tw

The classic quadratic assignment problem (QAP) is concerned with assigning facilities to locations. The costs involved are related to location distances and facility interactions. Due to a lack of precise measurement, the observations are not known exactly, and this paper uses fuzzy numbers to represent the imprecise values. By applying the Yager ranking technique for fuzzy numbers, the fuzzy QAP is transformed into the conventional QAP. An example of assigning the starting basketball players is used to illustrate the transformation process and the characteristics of the optimal solution.

2 - Simple dynamic location problem with uncertainty: a primal-dual heuristic approach

Maria do Céu Marques, Engineering Institute of Coimbra, Rua Pedro Nunes, 3020-199, Coimbra, Portugal, cmarques@isec.pt, *Joana Matos Dias*

We consider a dynamic facility location problem where uncertainty regarding future facility locations, clients and costs is explicitly considered through the use of scenarios. Whilst assignment decisions can be scenario dependent, location decisions (when and where to open facilities) have to take into account all possible scenarios and cannot be changed according to each scenario in particular. We present a mixed linear programming formulation, considering the minimization of expected total costs, and develop a primal-dual heuristic. The first computational results are shown.

3 - Effective Algorithms for Some Hard Facility Location Problems

Alexander Kurochkin, mechanic-mathematical, Novosibirsk State University, Pirogova, 2, 630090, Novosibirsk, Russian Federation, alkurochkin@ngs.ru, *Edward Gimadi*

Two cases of Facility Location Problems are considered. The first case is Facility Location Problem with Uniform Capacities on a path graph. Polynomial exact algorithm for solving this problem with running time O(m4n2) is presented. The algorithm has smaller complexity than the best previous known. The second case is Multilevel Facility Location Problem on a tree network. The authors are unaware of any effective algorithm for this case. In this work, the polynomial exact algorithm for solving 2-level FLP on a tree network which requires O(m3n) operations is constructed. This research was supported by the Russian Foundation for Basic Research (RFBR grants 08-01-00516 and 10-07-00195).

4 - Wind Farm Layout Design Optimization: Discrete versus Continuous Search Spaces

Yunus Eroğlu, Industrial Engineering, University of Gaziantep, Kat 2. No 219, 27370, Gaziantep, Turkey, erogluyunus@hotmail.com, *Serap Ulusam Seckiner*

In this study, optimal layout configurations of multiple wind turbines in a wind farm were considered. The objective was to find placements of turbines while maximizing the total power generation of all turbines in the same area. Wind farm area was defined as discrete structure. Because of computational complexity of the problem, ant colony algorithm was developed to determine optimal layouts of turbines. Three different scenarios included wind speeds and its direction distributions were tested. The results of discrete structure were compared with existing results of continuous wind farm area.

Algorithm and Computational Design
Invited

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Track(s): 1
1 session

Combinatorial and Hybrid Regulatory Systems - Game Theory
Invited

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Track(s): 3
3 sessions

Combinatorial Optimization in Aviation Applications
Contributed
Track(s): 4
1 session

Combinatorial Optimization in Computational Biology, Bioinformatics and Medicine
Invited

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Track(s): 3
1 session

Combinatorial Optimization in Data Mining
Invited

Cem Iyigun
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Track(s): 3
1 session

Combinatorial Optimization in Ergonomics
Invited

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Track(s): 3
1 session

Combinatorial Optimization in Suppy Chain Management
Invited

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Track(s): 4
4 sessions

Combinatorial Optimization in the Financial Sector
Invited

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Kasirga Yildirak
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Track(s): 3
1 session

Constraint Programming and Combinatorial Optimization
Invited

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Track(s): 3
1 session

Emerging Applications of Combinatorial Optimization
Invited

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Track(s): 4
2 sessions

Global Optimization
Contributed
Track(s): 2
1 session

Graph Theory and Network Problems
Contributed
Track(s): 1 4
4 sessions

Integer and Combinatorial Optimization
Invited

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Monique Guignard-Spielberg
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Track(s): 1 2
2 sessions

Material Flows in Production Networks
Invited

Simone Göttlich
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Track(s): 2
1 session

Metaheuristics
Contributed
Track(s): 2
1 session

Multiple Criteria Decision Making and Combinatorial Optimization (MCDM Invited Stream)
Invited

Kaisa Miettinen
University of Jyvaskyla
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Track(s): 1
2 sessions

PASCAL 2 Stream: Machine Learning and Combinatorial Optimization
Invited

Janez Zerovnik
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Track(s): 3
1 session

Plenary Lectures
Invited

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Arslan Ornek
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Track(s): 1
3 sessions

Recent Advances in Scheduling
Invited

Erwin Pesch
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Track(s): 2
1 session

Scheduling
Contributed
Track(s): 2
3 sessions

Spectral Graph Theory Techniques and Applications in Combinatorial Optimization
Invited

Domingos Cardoso
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Track(s): 4
1 session

Various Applications in Combinatorial Optimization
Contributed
Track(s): 2
1 session

Vehicle Routing and TSP
Contributed
Track(s): 1
2 sessions

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