



MIC 2019
Cartagena - Colombia

XIII Metaheuristics International Conference

Conference Program





XIII METAHEURISTICS INTERNATIONAL CONFERENCE

CONFERENCE PROGRAM

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AGENDA

Sunday 28 July	Monday 29 July	Tuesday 30 July	Wednesday 31 July
		8:00 – 9:00 T0: Plenary	8:30 – 9:00 Registration
		9:00-10:30 T1: Parallel tracks	9:00-10:30 W1: Parallel tracks
		10:30-11:00 Coffee break	10:30-11:00 Coffee break
		11:00-12:30 T2: Plenary	11:00-12:30 W2: Plenary
	14:00-14:30 Opening session	12:30-14:00 Lunch	12:30-14:00 Lunch
	14:30-16:00 M3: Tutorial & parallel tracks	14:00-15:30 T3: Tutorial and parallel tracks	14:00-15:30 W3: Tutorial and parallel tracks
	16:00-16:30 Coffee Break	15:30-16:00 Coffee Break	15:30-16:00 Coffee Break
	16:30-18:00 M4: Parallel tracks	16:00-17:30 T4: Parallel tracks	16:00-17:30 W4: Parallel tracks
17:00-19:00 Registration and social (welcome) event	18:00-20:00 Dinner	20:00-00:00 Dinner	17:30-18:30 Closing session

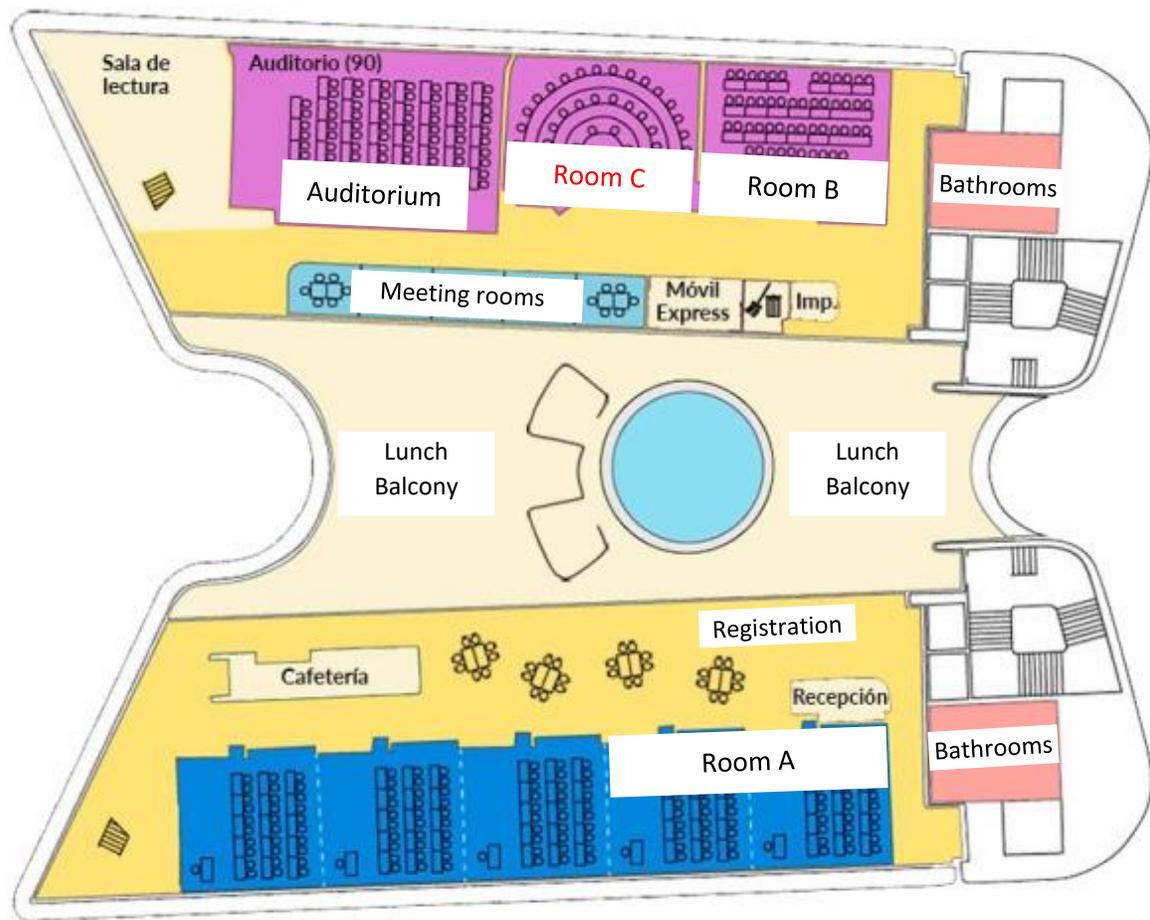
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VENUE

Universidad de los Andes, Sede Caribe, Cartagena, Colombia

Km. 8 Vía al Mar, Serena del Mar, Third floor

Location link: <https://goo.gl/maps/gU9qfKKFkKYL6tsF8>



SPEAKERS GUIDELINES

Audio/Visual equipment

Every room will be equipped with a projector and a PC. Please follow these guidelines to insure a successful presentation:

- We supply both projector and laptop to every session.
- Bring your presentation with you on a USB drive, please back up your presentation on an e-mail to yourself ahead of time in case of loss or failure.
- Arrive at your session at least 15 minutes before it begins. All presenters in session should set up before the session begins.

Guidelines for speakers

The room and location of sessions are listed in the Technical Session section and in the Plenaries and Tutorials section. Please be on time for your presentation and check in with the session chair. Presentations should be limited to key issues with a brief summary. Time your presentation to fit within your designated time span and leave an opportunity for questions and audience participation.

Guidelines for session chairs

The role of the chair is to coordinate the smooth running of the session. The chair:

- Begins and end each session on time. Each session lasts 90 minutes, with the time per presentation determined by the number of papers in the session. Equal time should be given to each paper.
- Introduces each presentation (just the title of the paper and the name of the presenting author).
- Ensures that presentations are made in the order shown in program. This allows for “session jumping”. If a speaker cancels or does not attend, the original time schedule should be adhered to rather than sliding every talk forward.

PLENARIES & TUTORIALS

Monday, 14:30 - 16:00 (Auditorium)

Chair : Juan G. Villegas R.

Routing and scheduling: real-world applications in the context of a city

Luciana Buriol (buriol@inf.ufrgs.br, Universidade Federal do Rio Grande do Sul, Brazil)

There are many routing and scheduling problems being solved everyday in everyone's life. These problems are easily found in real-world applications, and in many cases they are still solved manually. Often these problems are only identified inside an institution when they not small anymore. In this talk, I will describe four applications that resulted from the interaction from my research group at the University with different institutions of the city of Porto Alegre, Brazil. The applications are related to physician rostering in a hospital, products delivering within time windows, planning homecare attendance, and optimizing a local bike-sharing system. Solving these... ■ [\[Read more online\]](#)

Tuesday, 8:00 - 9:00 (Auditorium)

Chair : Andrés L. Medaglia

Twenty years of the Handbook of Metaheuristics: A retrospective

Michel Gendreau (michel.gendreau@polymtl.ca, École Polytechnique Montréal, Canada)

The publication of the first edition of the Handbook of Metaheuristics back in 2003 was an important event for the metaheuristics community, since, for the first time, one could find solid introductions to all major families of metaheuristics, written by top experts, in a single volume. The second and the third editions of the Handbook, published respectively in 2010 and 2019, have seen updated versions of most chapters, as well as new ones covering other facets of the field, thus keeping this important reference book current. In this talk, I will try to provide a guided tour of the three editions of the Handbook... ■ [\[Read more online\]](#)

Tuesday, 11:00 - 12:30 (Auditorium)

Chair : Jorge E. Mendoza

Network Polarization reduction by minimum edge additions

Celso Ribeiro (celso.ribeiro@gmail.com, Universidade Federal Fluminense, Brazil)

Polarization is the division into sharply contrasting groups or sets of opinions or beliefs. The issue of polarization has been widely discussed by politicians, media, and researchers. Polarized networks are divided into two or more strongly connected groups, with few edges between vertices belonging to different groups. We illustrate this discussion considering a short real-life polarized network extracted from Research Gate, involving the optimization community and, in particular, the area of metaheuristics. New tools for evaluating the polarization of a network are described. We characterize the homophily of each node individually. In order to address the polarization of the network... ■ [\[Read more online\]](#)

Tuesday, 14:00 – 15:30 (Auditorium)

Chair : Rubén Ruiz

Solving routing problems with realistic packing constraints

Ramón Álvarez-Valdez (ramon.alvarez@uv.es, Universitat de València, Spain)

In this talk, I will first review the work on Container Loading Problems with practical constraints developed in recent years. Next, I will show how these restrictions have been introduced when solving combined routing/packing problems. The focus will be on how metaheuristics have helped to solve these problems and on the challenges that still lie ahead to produce useful solutions to practical problems. [[Read online](#)]

Wednesday, 11:00 – 12:30 (Auditorium)

Chair : Andrés L. Medaglia

On the use of Machine Learning in Discrete Optimization

Andrea Lodi (andrea.lodi@polymtl.ca, École Polytechnique Montréal, Canada)

In this talk, I will review the use of Machine Learning (ML) in Discrete Optimization (DO). The talks covers a wide range of methods. At the extremes, on the one side, I will discuss the use of ML directly as a way of generating heuristic solutions for DO problems for which I will try to highlight the connections among known exact and heuristic paradigms like dynamic programming, reinforcement learning and agent-based metaheuristics. On the other side, I will discuss the more capillary use of ML techniques to replace DO algorithmic blocks that are either too time consuming or would benefit... ■ [[Read more online](#)]

Wednesday, 14:00 – 15:30 (Auditorium)

Chair : Jorge E. Mendoza

Tackling uncertainty in combinatorial optimization problems: using metaheuristics to efficiently co-generate scenarios and solutions

José Fernando Oliveira (jfo@fe.up.pt, Universidade do Porto, Portugal)

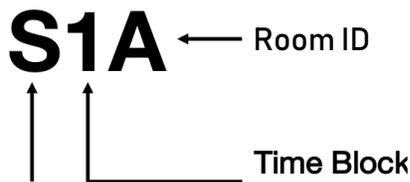
Uncertainty is receiving increasing attention, in the past years, from the Operational Research community. Methods that acknowledge uncertainty and incompleteness of information are an important research trend. Scenarios arise as key components in many of these methods, as instruments to deal with uncertainty. However, the scenario generation process is often unrealistically simplified. We propose that metaheuristics, namely based on genetic algorithms, can generate relevant and complex scenarios, without requiring a priori probability distributions. This is of particular interest in practical applications where there are many uncertain parameters, and it is significantly difficult to define their characteristics accurately. To address two-stage stochastic problems... ■ [[Read more online](#)]

TECHNICAL SESSIONS

How to navigate the technical sessions?

There are four primary resources navigate the technical sessions. The listing is presented by day, time and space.

Session Codes



Time Blocks

- 1 - 09:00 - 10:30
- 2 - 11:00 - 12:30
- 3 - 14:00 - 15:30
- 4 - 16:00 - 17:30

Room ID

- A - Room A
 - B - Room B
 - C - Room C**
 - P - Auditorium
- (See p. 3 for map)

Monday, 14:30 - 16:00

■ M3P (Auditorium) – Tutorial

Chair: Juan G. Villegas R.

- 1- Routing and scheduling: real-world applications in the context of a city
Luciana Buriol (buriol@inf.ufrgs.br, Universidade Federal do Rio Grande do Sul)

There are many routing and scheduling problems being solved everyday in everyone's life. These problems are easily found in real-world applications, and in many cases they are still solved manually. Often these problems are only identified inside an institution when they not small anymore. In this talk, I will describe four applications that resulted from the interaction from my research group at the University with different institutions of the city of Porto Alegre, Brazil. The applications are related to physician rostering in a hospital, products delivering within time windows, planning homecare attendance, and

optimizing a local bike-sharing system. Solving these... ■ [\[Read more online\]](#)

■ M3A (Room A) – Scheduling 1

Chair: Carlos Paternina

- 1- An optimization and pattern mining based approach for solving the RCPSP
Benjamin Dalmas (benjamin.dalmas@emse.fr, Mines Saint-Etienne), Damien Lamy, Arnaud Laurent and Vincent Clerc

In this paper, we introduce a new approach to solve the RCPSP based on an optimization and pattern mining based coupling. The objective is to extract frequent dependencies between tasks in good solutions and use them to guide the search phase into generating better solutions faster. The first results obtained tend to validate our hypothesis. [\[Read online\]](#)

- 2- Adaptative bacterial foraging optimization for solving the multi-mode resource constrained project scheduling problem
Luis Fernando Machado Dominguez (lfmachado@uninorte.edu.co, Universidad del Norte), Carlos Daniel Paternina Arboleda (cpaterni@uninorte.edu.co, Universidad del Norte) and Agustín Barrios Sarmiento

In this paper, a metaheuristic solution procedure for the multi-mode resource-constrained project scheduling problem is proposed. The problem consists of determining a schedule such that the project is completed, minimizing the total duration of the project and the project net present value (NPV) is maximized. The adaptative bacterial foraging optimization (ABFO) is a variation of the original bacterial foraging optimization (BFO) which is a nature-inspired metaheuristic optimization algorithm. The ABFO employing the adaptive foraging strategies to improve the performance of the original BFO. This metaheuristic has been tested in two benchmark datasets available in the literature, the PSPLIB and MMLIB... ■ [\[Read more online\]](#)

- 3- A harmony search approach for a dynamic cell formation problem
Laura Y. Escobar-Rodríguez (laura_escobar@correo.uis.edu.co, Universidad Industrial de Santander), Edwin A. Garavito-Hernandez and Leonardo H. Talero-Sarmiento

This document addresses a harmony search approach for a dynamic cell formation problem presented as a mixed-integer linear model aiming to minimize the total costs associated with the production process. The mathematical model takes into account changing demand and part mix, machine relocation and machine sequence. [\[Read online\]](#)

- 4- Complex production scheduling: case studies from various industries

Marco Better (better@opttek.com, OptTek Systems) and Fred Glover (fredwglover@yahoo.com, University of Colorado)

Manufacturing companies often involve processes that exhibit high levels of complexity and operate in an environment where optimal production schedules can provide a source of competitive advantage. Features commonly shared by these companies include: (1) production costs represent a significant portion of total product price, (2) multiple products share manufacturing infrastructure and resources, and (3) production schedules are required on a timely basis. We have developed a sophisticated production scheduling solution approach that combines mathematical programming, metaheuristic optimization, and simulation to craft optimal or near-optimal production schedules that perform in a reliable and effective manner. In this paper, we describe... ■ [\[Read more online\]](#)

■ **M3B (Room B) - Clustering and assignment**
Chair: Thibaut Vidal

1- The magnifying glass heuristic for the generalized quadratic assignment problem

Peter Greistorfer (peter.greistorfer@uni-graz.at, University of Graz), Rostislav Stanek and Vittorio Maniezzo

We investigate the generalized quadratic assignment problem and introduce a number of mat- and metaheuristic algorithms. Especially highlighted is an improvement procedure, a so-called magnifying glass heuristic, which has already proved to be successful for the solving of traveling salesman problems. All approaches are validated on test instances from the literature and on a generated set of random instances. Results demonstrate a very appealing computational performance, offering a promising foundation for further developments of the base concept in different contexts. [\[Read online\]](#)

2- Model-based capacitated clustering with posterior regularization

Feng Mai, Michael Fry and Jeffrey Ohlmann (Jeffrey-ohlmann@uiowa.edu, University of Iowa)

We propose a heuristic approach to address the general class of optimization problems involving the capacitated clustering of observations consisting of variable values that are realizations from respective probability distributions. Based on the expectation-maximization algorithm, our approach unifies Gaussian mixture modeling for clustering analysis and cluster capacity constraints using a posterior regularization framework. To test our algorithm, we consider the capacitated p-median problem in which the observations consist of geographic locations of customers and the corresponding demand of these customers. Our heuristic has superior performance compared to classic geometrical clustering heuristics, with robust performance over a collection of instance types. [\[Read online\]](#)

3- A heuristic for the minimum cost chromatic partition problem

Celso Ribeiro (celso.ribeiro@gmail.com, Universidade Federal Fluminense) and Philippe dos Santos

The minimum cost chromatic partition problem is a variant of the graph coloring problem in which there are costs associated with the colors and we seek a vertex coloring minimizing the sum of the costs of the colors used in each vertex. It finds applications in VLSI design and some scheduling problems modeled on interval graphs. We propose a trajectory search heuristic using local search, path-relinking, perturbations, and restarts for solving the problem and discuss numerical results. [\[Read online\]](#)

4- Minimum sum-of-squares clustering, metaheuristics and clustering validity

Daniel Gribel and Thibaut Vidal (vidalt@inf.puc-rio.br, PUC-Rio)

Minimum sum of squares clustering (MSSC) is a widely used clustering model, of which the popular K-means algorithm constitutes a local minimizer. It is well known that the solutions of K-means can be arbitrarily distant from the true MSSC global optimum, and dozens of alternative heuristics have been proposed for this problem. However, no other algorithm has been predominantly adopted in the literature. This may be related to differences of computational effort, or to the assumption that a near-optimal solution of the MSSC has only a marginal impact on clustering validity. In this presentation, we dispute this belief. We introduce... ■ [\[Read more online\]](#)

Monday, 16:30 - 18:00

■ **M4A (Room A) - Cutting and Packing**
Chair: Luciana Pessoa

1- Revisiting the Set k-Covering Problem

Thiago Virgilio, Anderson Ramos, Amanda Silva and Luciana Pessoa (lpessoa@gmail.com, PUC-Rio)

The set k-covering problem is an extension of the well studied set covering problem in which, given a binary matrix 0-1 with costs linked to the columns, each row is required to be covered at least k times, by choosing a minimum cost subset of columns. Since the development of the first metaheuristic for this problem, in 2011, some progress has been reached for solving it and harder instances have been proposed. This short work in progress aims to bring a new application of the Iterated Local Search (ILS) metaheuristics to explore the set k-covering problem. Some experiments were carried... ■ [\[Read more online\]](#)

2- A sim-heuristic approach for the 3D irregular packing problem

Germán Fernando Pantoja Benavides (gfpantoja10@uniandes.edu.co, Universidad de los Andes) and David Álvarez Martínez (d.alvarezm@uniandes.edu.co, Universidad de los Andes)

"The 3D irregular packing problems are part of the combinatorial optimization problems (COP) [1], which have a high mathematical and computational complexity. In addition, these problems have a wide spectrum of applications in the industry where their solutions require to be of high quality and to be obtained in short computational times [2]. The problem to tackle in this work is to minimize the volume of a cuboid in which three-dimensional concave polyhedrons of different types are packed, and free rotation of the pieces is allowed. In the typology proposed by Wäsher et al. [3], this problem can be classified... ■ [\[Read more online\]](#)

3- An exact and heuristic approach for the sequencing cutting problem

Daniel Cuellar Usaquén (dh.cuellar@uniandes.edu.co, Universidad de Los Andes), David Alvarez Martinez (d.alvarezm@uniandes.edu.co, Universidad de los Andes), Alejandro Palacio Alvarez (a.palacio10@uniandes.edu.co, Universidad de los Andes), Marcelo Botero Gomez (m.botero15@uniandes.edu.co, Universidad de los Andes) and Emilia Ospina Arango

The material cutting process consists of two highly complex problems: First, it is necessary to find the optimal cutting pattern or location of the pieces within the plate such that the used area is maximized. Second, it is necessary to find the cutting sequence over the plate so that the pieces are extracted in the shortest possible time. The structure of the sequencing cutting problem can vary according to the technology used in the process. In the literature, this problem is addressed through exact and approximate optimization. In industries where material can be considered a commodity, the sequencing phase is... ■ [\[Read more online\]](#)

■ M4B (Room B) - Supply Chain and Logistics Chair: Jorge E. Mendoza

1- A hybrid decision support system for supplier selection: an integration of simheuristics and MCDM

Mohammad Dehghanimohammadabadi (m.dehghani@northeastern.edu, Northeastern University)

Supplier selection plays a key role in achieving the objectives of a supply chain system. Multiple strategic, operational, quantitative, and qualitative criteria influence the supplier selection process. A wide spectrum of criteria have been introduced, classified, and used by researchers and practitioners to evaluate the suppliers' performance; however, measuring and employment of all of these criteria is impractical in real-world scenarios due to the budget, time, and information limitations. In this study, a Decision Support System (DSS) is proposed to help managers identify the most significant criteria for the supplier selection process. This DSS is a two-fold integration of Multi-Criteria... ■ [\[Read more online\]](#)

2- Minimization of the picking time of a warehouse in the batch assignment and sequencing problem with a simulation model

Liany Tobon-Castro and Daniel Mendoza-Caseres

This paper addresses the Batch Assignment and Sequencing problem considering multiple pickers and due dates of the orders that must be delivered in a warehouse. Order-picking systems in warehouses have been widely studied in the literature given their importance of making them more efficient due to the high costs and consumption of resources. In the process the orders are grouped in batches to be assigned and sequenced by the pickers equipped with a roll cage that will make tours through the warehouse where they must make stops in each of the storage locations of the items found in the batch... ■ [\[Read more online\]](#)

3- A matheuristic for order picking problems in e-commerce warehouses

Mustapha Haouassi (mustapha.haouassi@polymtl.ca, Ecole polytechnique de Montréal), Yannick Kergosien, Jorge E. Mendoza (jorge.mendoza@hec.ca, HEC Montréal) and Louis-Martin Rousseau

Fast delivery is one of the most popular services in e-commerce retail. It consists in shipping the items ordered on-line in short times (1h, 2h, or same day). The customer orders thus come with due dates, and respecting this latter is pivotal to ensure a high service quality. We focus through this work on the order picking process. In a nutshell, order picking consists in regrouping orders into batches, assigning batches to order pickers, sequencing the batches assigned to each order picker, and designing the picking tours of each order picker to retrieve the assigned items. To deal with the... ■ [\[Read more online\]](#)

4- Internal logistics routing optimization

Marcelus Fabri and Helena Ramalhinho (helena.ramalhinho@upf.edu, Universitat Pompeu Fabra)

The internal logistics in a car manufacture company is an important activity that can lead to improve the efficiency of the production and cost reduction. In this work we describe an internal logistics routing problem in important automotive company and propose an Iterated Local Search algorithm to solve this problem in a realistic environment. This algorithm will be incorporated by the company change the actual static system to a more dynamic and automatic one. We study also the impact of this new system in the company enable the managers to make better decisions and make easier the implementation. [\[Read online\]](#)

■ M4C (Room C) - Vehicle Routing Chair: Juan G. Villegas R.

1- A GRASP metaheuristic for a districting problem arising in urban distribution

Andrés Tejada, Olga Usuga and Juan G. Villegas R. (juan.villegas@udea.edu.co, Universidad de Antioquia)

This paper presents a simple greedy randomized adaptive search procedure (GRASP) embedded in a decision support system for the design of delivery districts in urban distribution. The proposed GRASP aims at balancing the workload of delivery routes by considering both the travel time within customers and the service time at the customers. To compute travel times we use a continuous approximation of the length of a travelling salesman tour for each district. Computational experiments, with the data of a major Colombian company serving hundreds of stores a day, reveal a potential reduction of the workload imbalance of their routes by more than 50% [\[Read online\]](#)

2- A practical application of a long haul freight transportation problem with transshipments

Jorge Isaac Pemberthy R. (jorgepemberthy@itm.edu.co, Instituto Tecnológico Metropolitano), Juan Esteban Muriel Villegas and Juan Gabriel Villada O.

This work faces a long-haul, transnational, cross-border transportation problem with transshipments applied to a transportation carrier in Colombia, Latin America. The case study company has a combination of challenges that are still rare in the literature, such as time windows, a vast fleet and different transport regulations between different countries. The problem involves a combination of different variants of the Vehicle Routing Problem (VRP), including the Pickup and delivery problem (PDVRP), the Vehicle Routing Problem with Time Windows (VRPTW), the Heterogeneous Fleet Vehicle Routing Problem (HFVPR), the Multi Depot Vehicle Routing Problem (MDVRP), the Vehicle Routing Problem with Backhauls (VRPB) ... [\[Read more online\]](#)

3- A simulated annealing approach to the combined maintenance routing optimization problem for vehicles subject to failures

Eduyn López-Santana (erlopezs@udistrital.edu.co, Universidad Distrital Francisco José de Caldas), Carlos Franco (ca.franco48@uniandes.edu.co, Universidad del Rosario) and German Mendez Giraldo.

This work focuses on the problem of planning and scheduling preventive maintenance operations for a set of vehicles subject to non-deterministic failures where the set of vehicles serve a set of geographically distributed customers. This problem has real world application where the vehicles travel over long distances between cities in a difficult environment favoring a non-negligible probability of failure of critical components. To solve this problem, we propose a method that combine a simulated annealing metaheuristic and a maintenance model for a single vehicle. The maintenance model consists in a replacement model that determine the number of preventive maintenance operations... [\[Read more online\]](#)

4- An iterated local search algorithm for solving a practical rich location routing problem

Raphael Kramer (raphaelharry@gmail.com, Universidade Federal de Pernambuco), Nilson Felipe Matos Mendes, Giorgio Zucchi and Manuel Iori.

We present and solve a rich vehicle routing problem (RVRP) derived from two realistic cases involving the delivery of pharmaceuticals to healthcare establishments, in Italy. The studied problem is characterized by having many features and constraints, such as multiple depots, multiple periods, heterogeneous fleet, time-windows, and site-dependency (i.e., customer-vehicle incompatibilities). In addition, decisions related to the supply and the location of the depots, and the installation of warehouses in the hospitals are considered. To solve the problem we propose an iterated local search (ILS) algorithm enhanced with classical neighborhoods and auxiliary data structures from the literature. The proposed algorithm is... [\[Read more online\]](#)

Tuesday, 09:00 – 10:30

■ T1A (Room A) - Methodology Chair: Raymond Kwan

1. A heuristic oriented racing algorithm for the fine-tuning of metaheuristics

Eduardo B. M. Barbosa (eduardo.barbosa@inpe.br, Brazilian National Institute for Space Research) and Edson L. F. Senne

The metaheuristics have become a powerful tool to solve real-world optimization problems. Its ease adaptability, usually demands effort to correctly define the design options and parameters to achieve their best performance. Thus, this paper aims to present an approach on the fine-tuning of metaheuristics combining Design of Experiments and Racing algorithms. The key idea is a heuristic method, which explores a search space of parameters, looking for candidate configurations near of a promising alternative and consistently finds the good ones. To confirm this approach, we present a case study for fine-tuning a VNS metaheuristic on the classical Traveling Salesman Problem... [\[Read more online\]](#)

2. Evaluation of objective function designs through an auxiliary heuristic scheme

Li Lei (scll@LEEDS.AC.UK, University of Leeds) and Raymond Kwan (r.s.kwan@leeds.ac.uk, University of Leeds)

Exact integer linear programming (ILP) models and their solvers have the advantage of delivering optimal results for complex real-life scheduling problems. However, they are often computationally practical only for relatively small problem instances. Furthermore, it is not easy to establish high confidence in the effectiveness of an objective function design, which is vital for yielding good-quality schedules in practice. For example, suppose a train unit schedule needs 50 train units to cover a timetable. The workings of individual train units cannot be all efficient because of the timing connections of the trips served. The objective function is therefore a tradeoff... [\[Read more online\]](#)

3. Deterministic multi-objective fractal decomposition algorithm

Léo Souquet (leo@dsti.co, UPEC), Amir Nakib and El Ghazali Talbi

This paper presents a new deterministic multiobjective optimization called "Multiobjective Fractal Decomposition Algorithm" (Mo-FDA). The original FDA was designed for mono-objective large-scale continuous optimization problems. It is based on a "divide-and-conquer" strategy and a geometric fractal decomposition of the search space using hyperspheres. In our work, a scalarization approach is used to deal with MO problems. The performance of Mo-FDA was compared to state of the art algorithms from the literature on classical benchmark of multi-objective optimization. [\[Read online\]](#)

■ T1B (Room B) - Timetabling and staffing

Chair: Carlos Eduardo Montoya Casas

1- A task planning problem in a home care business

Isabel Méndez-Fernández (isabel.mendez.fernandez@udc.es, Universidade da Coruña), Silvia Lorenzo-Freire (silvia.lorenzo@udc.es, Universidade da Coruña), Ignacio García-Jurado, Julián Costa and Luisa Carpenté

In this work we present a task planning problem for a home care business. The company has a set of nurses in charge of visiting the users' homes and it wants to solve the problem that consists of scheduling the nurses working days in order to correctly attend all the clients. The real cases the company faces are of great size and can't be solved in an exact way, therefore we propose a heuristic algorithm to solve the incidents, the company addresses, in short computational times. In order to validate the behaviour of the heuristic algorithm we use it to... ■ [\[Read more online\]](#)

2- A solution approach to the multi activity combined timetabling and crew scheduling problem considering a heterogeneous workforce with hierarchical skills and stochastic travel times

Brian Sebastián Álvarez, Diego René Vásquez, David Barrera and Carlos Eduardo Montoya Casas (c_montoya@javeriana.edu.co, Universidad Javeriana)

This paper introduces an extension to the Multi-Activity Combined Timetabling and Crew Scheduling problem which considers heterogeneous personnel with hierarchical skills, multiple work shifts and stochastic travel times. The goal of this problem is to define the number of workers and to establish a schedule that fulfills customer's requirements in order to minimize a total cost objective function. As a solution approach, a Genetic Algorithm (GA) was proposed for the deterministic version of the problem. Thereafter, a sim-heuristic was developed for solving the problem with stochastic travel times. The algorithms were tested on randomly generated instances. Obtained results show a... ■ [\[Read more online\]](#)

3- A scalable method to solve the call center staffing with service-level agreement under uncertainty

Gianmaria Leo (gianmaria.leo@ibm.com, IBM), Renzo Benavente Sotelo, Julio C. Casas Quiroz and Victor Terpstra

The call center staffing is a complex planning problem that many firms deal with. The entire decision-making process usually aims to achieve the right trade-off between cost efficiency and a proper workforce planning that ensures the committed service level. This practice turns out to be challenging due to the presence of relevant stochastic factors impacting decisions, like arrival and duration of calls, waiting time and abandonment. Another important challenge arises from the restricted lead time to deliver the staff plans, whereas common solution approaches are usually computationally intensive or require exhaustive testing to validate assumptions and parameters. Our work focuses... ■ [\[Read more online\]](#)

Tuesday, 14:00 – 15:30

■ T3P (Auditorium) – Tutorial

Chair: Rubén Ruiz

1- Solving routing problems with realistic packing constraints

Ramón Álvarez-Valdez (ramon.alvarez@uv.es, Universitat de València)

In this talk, I will first review the work on Container Loading Problems with practical constraints developed in recent years. Next, I will show how these restrictions have been introduced when solving combined routing/packing problems. The focus will be on how metaheuristics have helped to solve these problems and on the challenges that still lie ahead to produce useful solutions to practical problems. [\[Read online\]](#)

■ T3B (Room B) – Mobility

Chair: Pablo Andrés Maya Duque

1- An hybrid VNS and Mathematical Programming Algorithm for a Public Bicycles-Sharing System

Anibal Álvarez, Guillermo Cabrera (guillermo.cabrera@pucv.cl, Pontificia Universidad Católica de Valparaíso) and Pablo Andrés Maya Duque (pablo.maya@udea.edu.co, University of Antioquia)

A matheuristic approach that combines the well-known variable neighbourhood search (VNS) algorithm and a mathematical programming (MP) solver to solve a novel model for a Public Bicycles-Sharing System is presented. The problem is modelled as an integer programming problem. While the VNS algorithm aims to find the set of optimal repositioning centres, the MP solver computes the optimal allocation network for a given set of repositioning centres. The proposed approach obtains very promising results, specially for

those instances where the solver by itself is not able to find feasible solutions within acceptable times. [\[Read online\]](#)

- 2- A hybrid algorithm for the multi-depot vehicle scheduling problem arising in public transportation César Augusto Marín Moreno (cmarin@integra.com.co, Integra S.A.), Luis Miguel Escobar Falcón, Ruben Iván Bolaños (rbolanos@integra.com.co, Integra S.A.), Anand Subramanian, Antonio Escobar and Mauricio Granada

In this article, a hybrid algorithm is proposed to solve the Vehicle Scheduling Problem with Multiple Depots. The proposed methodology uses a genetic algorithm, initialized with three specialized constructive procedures. The solution generated by this first approach is then refined by means of a Set Partitioning (SP) model, whose variables (columns) correspond to the current itineraries of the final population. The SP approach possibly improves the incumbent solution which is then provided as an initial point to a well-known MDVSP model. Both the SP and MDVSP models are solved with the help of a mixed integer programming (MIP) solver. The... [\[Read more online\]](#)

- 3- Nested genetic algorithm to collaborative school buses routing problem
Marcela Torne-Acosta, Juan P. Orejuela-Cabrera (jporejuelac@unal.edu.co, Universidad del Valle, Universidad Nacional de Colombia) and Claudia C. Pena -Montoya

This document presents a methodology based on nested genetic algorithms to solve collaborative school buses routing problem. In this problem, there are a set of parents who are willing to send their children to a set node to be picked up by the bus. This set node represents the location of a sub-set of parents that are trust and are willing to receive the children and take them to the route. Parents who send and receive the children have a discount in the transport rate as a collaboration strategy, which reduce the number of nodes to visit and the total... [\[Read more online\]](#)

- 4- An effective tabu search method with a limited search space for carpooling optimization problems
Kosei Takahashi (kousei.takahashi.25@gmail.com, Nippon institute of technology), Toshichika Aoki (toshichika.aoki@gmail.com, Nippon Institute of Technology), Takayuki Kimura (tkimura@nit.ac.jp, Nippon Institute of Technology) and Tohru Ikeguchi (tohru@rs.tus.ac.jp, Tokyo University of Science)

Carpooling systems are one of the effective means of reducing traffic congestion. Recently, many carpool matching services, such as Carpool Global and Share Your Ride, have arisen to match passengers as carpool members. Such carpool matching services require high-speed matching of carpool groups, while considering the distances between drivers and the pick-up and drop-off points of passengers. Constructing an efficient route in a carpooling system is called the carpooling optimization problem (COP). To solve the COP, an

approximate solution method has been proposed using tabu search. However, this method fully searches all routes between the passengers and drivers in possible... [\[Read more online\]](#)

Tuesday, 16:00 - 17:30

- T4A (Room A) - Vehicle Routing 2
Chair: Greet Vanden Berghe

- 1- A matheuristic for the multi-period electric vehicle routing problem
Laura Catalina Echeverri Guzmán (laura.echeverriguzman@etu.univ-tours.fr, Université de Tours), Aurélien Froger, Jorge E. Mendoza (jorge.mendoza@hec.ca, HEC Montréal) and Emmanuel Neron

The multi-period electric vehicle routing problem (MP-E-VRP) consists on designing routes to be performed by a fleet of electric vehicles (EVs) to serve a set of customers over a planning horizon of several periods. EVs are charged at the depot at any time, subject to the charging infrastructure capacity constraints (e.g., number of available chargers, power grid constraints, duration of the charging operations). Due to the impact of charging and routing practices on EVs battery aging, degradation costs are associated with charging operations and routes. The MP-E-VRP integrates EV routing and depot charging scheduling, and has coupling constraints between days... [\[Read more online\]](#)

- 2- A matheuristic framework for profitable tour problem with electric vehicles and mandatory stops
David Cortés-Murcia (david.cortes_murcia@utt.fr, Université de technologie de Troyes), Caroline Prodhon and H. Murat Afsar

In this paper, a generalization of the capacitated profitable tour problem with electric vehicles is presented. The aim here is to synchronize the lunch break and the recharging activities by choosing clusters of restaurants where electric vehicles can be charged. Due to the fact that having an agreement with restaurant chains has an associated cost, the problem can also be seen as a problem with location aspects. This variant is pertinent especially in a city logistics context. A matheuristic framework is implemented which is able to solve instances with up to 100 customers and 6 clusters of restaurants in... [\[Read more online\]](#)

- 3- An n log n heuristic for the TSP
Éric Taillard (eric.taillard@heig-vd.ch, Univ. Appl. Sciences W. Switzerland)

An n log n randomized method based on POPMUSIC meta-heuristic is proposed for generating reasonably good solutions to the traveling salesman problem. The method improves a previous work which algorithmic complexity was in $n^{1.6}$. The method has been tested on instances with billions of cities. Few dozens of runs are able to generate a very high proportion of the edges of the best solutions known. This

characteristic is exploited in a new release of the Helsgaun's implementation of Lin-Kernighan heuristic (LKH) [[Read online](#)]

4- Slack induction by string removals for vehicle routing problems

Jan Christiaens and Greet Vanden Berghe
(greet.vandenbergh@cs.kuleuven.be, KU Leuven)

Dedicated algorithm and modelling improvements continue to advance the state-of-the-art with respect to vehicle routing problems (VRPs). Despite these academic achievements, solving large VRP instances sufficiently fast for real-life applicability remains challenging. By exploiting VRP solution characteristics in an effective manner, this paper arrives at a powerful and fast optimization heuristic. Its primary contributions are threefold: a ruin method, a recreate method and a fleet minimization procedure. The ruin method functions via adjacent string removal, introducing with it a novel property regarding vehicle routing problems which we term spatial slack, while the recreate method is categorised as greedy insertion with... ■ [[Read more online](#)]

■ T4B (Room B) - Novel Applications 1

Chair: lago A. Carvalho

1- Optimization of synchronizability in power grids using a second-order kuramoto model

Toshichika Aoki (toshichika.aoki@gmail.com, Nippon Institute of Technology), Hideyuki Kato, Takayuki Kimura (tkimura@nit.ac.jp, Nippon Institute of Technology) and Tohru Ikeguchi (tohru@rs.tus.ac.jp, Tokyo University of Science)

The synchronization of power grids is an important task for their safe operation. If the power grid enters an asynchronous state, its operation becomes unstable, which in the worst case may lead to cascading failures. Therefore, investigations on the types of power grid structures that are resistant to power outages or cascading failures are necessary to build reliable systems. A previous study investigated the optimum structure of centralized and/or decentralized power grids using the greedy algorithm; this structure is obtained by reconnections of edges while maximizing the synchronous area. However, the solution of this algorithm easily reaches the local minima... ■ [[Read more online](#)]

2- Planning of 'last-mile' delivery for a Colombian dairy company using a biased-randomized multi-start algorithm

Carlos L. Quintero-Araujo (carlosqa@unisabana.edu.co, Universidad de La Sabana), Carlos Vega-Mejía (carlosvega@unisabana.edu.co, Universidad de La Sabana) and Andrés Muñoz-Villamizar

This document focuses on the 'last-mile' distribution of dairy products of a company in Colombia. To improve the current operational and economic performance of the company a heuristic solution method is

proposed to solve a Vehicle Routing Problem with Time Windows. This problem characterizes the 'last-mile' delivery problem that the dairy company faces on its day-to-day operation. The proposed heuristic method consists of a multi-start algorithm with biased randomization and is validated utilizing historical data from the Company. Computational results show that, employing the proposed heuristic method, a more accurate planning of delivery routes can be achieved in a shorter... ■ [[Read more online](#)]

3- Cuckoo search algorithms for the cardinality portfolio optimization problem

Ibrahim Osman (io00@aub.edu.lb, American University of Beirut), Soha Maad and Karl Sawaya

This paper presents Cuckoo Search (CS) Algorithms for solving approximately the cardinality portfolio optimization (CPO) problem. The paper presents a review on existing literature on both CPO and CS to highlight area of concern. A hybrid combination of CS method and an exact method is proposed where CS explores the cardinality search space using Levy flights to select the desired assets while exact method determines the optimal allocation of investments for the selected assets. The main contributions include the introduction of a new mapping between the CS continuous search space and the integer sequencing search space to guide the selection... ■ [[Read more online](#)]

4- Algorithms the min-max regret 0-1 integer linear programming problem with interval data

Lago A. Carvalho (iago.august@gmail.com, Universidade Federal de Minas Gerais), Thiago Noronha and Christophe Duhamel

We address the Interval Data Min-Max Regret 0-1 Integer Linear Programming problem (MMR-ILP), a variant of the 0-1 Integer Linear Programming problem where the objective function coefficients are uncertain. We solve MMR-ILP using a Benders-like Decomposition Algorithm and two metaheuristics for min-max regret problems with interval data. Computational experiments developed on variations of MIPLIB instances show that the heuristics obtain good results in a reasonable computational time when compared to the Benders-like Decomposition algorithm. [[Read online](#)]

Wednesday, 09:00 – 10:30

■ W1A (Room A) -Vehicle Routing 3

Chair: Carlos Quintero-Araujo

1- Iterated local search for the periodic location routing problem with fixed customer-depot assignment.

Hadir A. G. Castro (hadir.garcia@usp.br, University of Sao Paulo), André B. Mendes and Yue Wu.

This research proposes an iterated local search (ILS) algorithm for solving the periodic location routing problem, with the additional consideration that each customer must remain assigned to the same depot throughout the planning horizon. This is a practical consideration found in many real-world applications, that has not been properly considered in existing methods. The ILS algorithm will be solved for different network configurations, generated by a MIP assignment model. Instances from the literature will be solved and indicates that the proposed solution method is effective in dealing with this problem. [\[Read online\]](#)

2- A heuristic approach for the combined inventory routing and crew scheduling problems

Carlos Franco (ca.franco48@uniandes.edu.co, Universidad del Rosario) and Eduyn López-Santan (erlopezs@udistrital.edu.co, Universidad Distrital Francisco José de Caldas)

We study the problem of combined inventory routing and crew scheduling problems. To solve, we propose a heuristic that consists in solving three mathematical models: inventory model, vehicle routing model and personnel allocation model. We state the general algorithm and main assumptions for our method and present preliminary results of a set of instances. [\[Read online\]](#)

3- A simheuristic algorithm for the capacitated location routing problem with stochastic demands

Carlos Quintero-Araujo (carlosqa@unisabana.edu.co, Universidad de La Sabana), Daniel Guimarans () and Angel A. Juan.

The capacitated location routing problem (CLRP) integrates a facility location problem with a multi-depot vehicle routing problem. In this paper, we consider the CLRP with stochastic demands, whose specific values are only revealed once a vehicle visits each customer. The main goal is then to minimize the expected total cost, which includes not only the costs of opening facilities, using a fleet of vehicles, and executing a routing plan, but also the cost of applying corrective actions. These actions are required whenever a route failure occurs due to unexpectedly high demands in a route. To solve this stochastic and NP-hard... ■ [\[Read more online\]](#)

■ W1B (Room B) - Scheduling 2

Chair: Taha Arbaoui

1- A biased random key genetic algorithm for the flexible job shop problem with transportation

Dalila B. M. M. Fontes (dfontes@fep.pt, Universidade do Porto), S. Mahdi Homayouni and Fernando A C C Fontes (faf@fe.up.pt, Universidade do Porto)

This work addresses the Flexible Job Shop Scheduling Problem with Transportation resources (FJSPT), which can be seen as an extension of both the Flexible Job Shop Scheduling Problem and the Job Shop Scheduling Problem with Transportation resources (JSPT). Regarding the former case, the FJSPT additionally considers that the jobs need to be transported to the machines they are processed in; while regarding the latter, in the FJSPT the specific machine processing each operation also needs to be decided. The FJSPT is NP-hard since it extends NP-hard problems. In here, we propose a biased random key genetic algorithm to efficiently find... ■ [\[Read more online\]](#)

2- Memory and feasibility indicators in GRASP for multi-skill project scheduling with partial preemption

Oliver Polo-Mejia (oliver.polo-mejia@laas.fr, Laboratoire d'analyse et d'architecture des systèmes), Christian Artigues, Pierre Lopez and Lars Mönch

This paper describes a GRASP algorithm aiming to solve a new scheduling problem known as the Multi-Skill Project Scheduling Problem with Partial Preemption, in which not all resources are released during preemption periods. We use a self-adaptive strategy for fixing the cardinality of the restricted candidate list in the greedy phase of the GRASP. We also propose an adaptive evaluation function that includes memory-based intensification, exploiting the characteristics of the best solutions, and a feasibility element for increasing the number of feasible solutions visited. Numerical experiments show the interest of the proposed approach. [\[Read online\]](#)

3- The flexible job shop scheduling problem with non-fixed availability constraints: a late-acceptance hill climbing approach

Adrien Wartelle and Taha Arbaoui (taha.arbaoui@utt.fr, University of Technology of Troyes)

With the surge of smart manufacturing and automation, production systems require sophisticated methods and approaches to solve complex scheduling problems. Within this context, we address the flexible job shop scheduling problem with non-fixed unavailability constraints. This problem is an extension of the classical flexible job shop scheduling in which machines have a non-fixed unavailability period that should be scheduled within a time window. This may correspond to a preventive maintenance activity or a technological upgrade that should be scheduled within a determined period. To solve the problem, we propose a fast and efficient late-acceptance hill climbing approach based on an effective... ■ [\[Read more online\]](#)

Wednesday, 14:00 – 15:30

■ W3P (Auditorium) – Tutorial

Chair: Jorge E. Mendoza

- 1- Tackling uncertainty in combinatorial optimization problems: using metaheuristics to efficiently co-generate scenarios and solutions
José Fernando Oliveira (jfo@fe.up.pt, Universidade do Porto)

Uncertainty is receiving increasing attention, in the past years, from the Operational Research community. Methods that acknowledge uncertainty and incompleteness of information are an important research trend. Scenarios arise as key components in many of these methods, as instruments to deal with uncertainty. However, the scenario generation process is often unrealistically simplified. We propose that metaheuristics, namely based on genetic algorithms, can generate relevant and complex scenarios, without requiring a priori probability distributions. This is of particular interest in practical applications where there are many uncertain parameters, and it is significantly difficult to define their characteristics accurately. To address two-stage stochastic problems... ■ [\[Read more online\]](#)

- W3A (Room A) - Novel applications 2
Chair: Oscar Guaje

- 1- Optimization in Sanger sequencing
Silvia Lorenzo-Freire (silvia.lorenzo@udc.es, Universidade da Coruña), Luisa Carpena, Ana Cerdeira-Pena and Ángeles S. Places

The main objective of this paper is to solve the optimization problem that is associated with classification of DNA samples in PCR plates for Sanger sequencing. To achieve this goal, we design an integer linear programming model that can only be solved for small instances. Since it is necessary to find feasible and reasonable solutions to the problem for real instances, which involve the classification of thousands of samples, we also propose a heuristic algorithm based on the simulated annealing technique. This algorithm obtains satisfactory solutions in a short amount of time. It has been tested with real data and... ■ [\[Read more online\]](#)

- 2- A multi-objective variable neighbourhood search for the beam angle selection problem in radiation therapy
Guillermo Cabrera-Guerrero (guillermo.cabrera@pucv.cl, Pontificia Universidad Católica de Valparaíso), Maicholl Gutiérrez, Gustavo Gatica (ggatica@unab.cl) and José-Miguel Rubio

In this paper, a novel multi-objective variable neighbourhood search algorithm (MO-VNS) is applied to a problem arising in radiation therapy called beam angle optimization. The MO-VNS implements two different neighbourhood moves: the first one is focused on the exploration of the search space while the second one is more focused on the exploitation of the search space. Further, the algorithm implements some problem-specific rules to guide its search. The algorithm is applied to a prostate case and compared to a Pareto local search algorithm previously proposed in the literature. Results show that our MO-VNS algorithm is quite competitive in terms... ■ [\[Read more online\]](#)

- 3- A metaheuristic approach for correlated random vector generation
Edgard Mauricio Hurtado Medina, Oscar Guaje (oo.guaje10@uniandes.edu.co, Universidad de los Andes), Andrés L. Medaglia (andres.medaglia@uniandes.edu.co, Universidad de los Andes) and Jorge Sefair

The generation of correlated random variables is relevant in the stochastic simulation of financial and manufacturing systems, among many other applications. The generally accepted techniques to generate correlated multivariate observations rely on the mathematical attributes of the probability density functions of the random variables. In this paper, we propose a new approach based on Iterative Local Search (ILS) that induces a desired correlation structure to multivariate random data independently of the probability density function of the input variables. The proposed methodology is able to improve the quality of the results found by the Iman & Conover method - currently used in... ■ [\[Read more online\]](#)

Wednesday, 16:00 - 17:30

- W4A (Room A) - Vehicle Routing 4
Chair: Camilo Gómez

- 1- The Sustainable Store Selection and VRP: a Math-Heuristic Approach and User Application
Paulo Bautista, Brian Rozo and Camilo Gomez (gomez.ch@uniandes.edu.co, Universidad de los Andes)

We introduce the Sustainable Store Selection and Vehicle Routing Problem (S3-VRP), in which a user specifies a set of products to be purchased, and needs to decide in which store to buy each product, aiming to minimize economic, social, and environmental costs. In this paper we provide a mathematical formulation for the S3-VRP and two solution strategies: a network flows based exact approach, and a metaheuristic approach based on the implementation of GRASP and Genetic Algorithms. We test our strategies with instances in Bogotá (Colombia) and deliver a prototype of an interactive user application. The obtained solutions are satisfactory at... ■ [\[Read more online\]](#)

- 2- Bi-Objective CVRP solved using a novel metaheuristic ILS Based on Decomposition
Luis Galindres (lugal@utp.edu.co, Universidad Tecnológica De Pereira), Ramón Gallego and Frederico Guimaraes

Vehicle routing (VRP) has usually been studied with a single objective function, which is defined by the distances associated with the routing of vehicles. The goal is to design a route or set of routes to meet the demands of customers at minimum cost. However, in real life, it is necessary to consider other objective functions as well, such as social aspects related functions, which take into account equity considerations such as drivers' workload balance. This has allowed a growth in both the formulation of multi-objective models and in the exact and approximate solution techniques. In particular, in this paper... ■ [\[Read more online\]](#)

3- Applying speed-up techniques to local search and solving the traveling salesman problem

Maša Avakumović (masa.avakumovic@hsu-hh.de, Helmut Schmidt University) and Martin Josef Geiger

The main goal of our work is to quickly find a high-quality approximation for a Traveling Salesman Problem (TSP) solution. In our approach we used the logic of the Iterated Local Search (ILS) with adequate initialization methods and efficient implementation techniques, which contribute to the faster convergence towards the optimal solution. An independent assessment and comparison with other implementation methods was carried out on the opti.io platform, where we currently hold the top 2 positions. [\[Read online\]](#)

4- A vehicle routing problem with periodic replanning

Guido Ignacio Novoa-Flores (guido.novoa@udc.es, Universidade da Coruña), Luisa Carpenente and Silvia Lorenzo-Freire (silvia.lorenzo@udc.es, Universidade da Coruña)

In this work we focus on the problem of truck fleet management of the company GESUGA. This company is responsible of the collection and proper treatment of animals not intended for human consumption in Galicia (Spain). On a daily basis, the company must design routes for the following day with the uncollected orders until that moment. However, these routes may be replanned during their execution as new orders appear from customers and the company is interested in collecting it. Thus, the aim of this work is to provide a tool that computes good quality solutions in short time. The problem... ■ [\[Read more online\]](#)

■ W4B (Room B) – Networks

Chair: Jorge Huertas

1- An iterated greedy heuristic for the minimum-cardinality balanced edge addition problem

Ruben Interian and Celso Ribeiro (celso.ribeiro@gmail.com, Universidade Federal Fluminense)

The Minimum-Cardinality Balanced Edge Addition Problem (MinCBEAP) appears in the context of polarized networks as a strategy to reduce polarization by external interventions using the minimum number of edges. We show that every instance of MinCBEAP can be reduced to an instance of the Minimum-Cardinality-Bounded-Eccentricity Edge Addition Problem (MCBE). A restarted iterated greedy heuristic is developed for solving MinCBEAP via the transformed MCBE. Preliminary computational results are reports. [\[Read online\]](#)

2- Multi-objective tabu search to balance multihoming loads in heterogeneous wireless networks

Jorge Huertas (huertas.ja@uniandes.edu.co, Universidad de los Andes) and Yezid Donoso

The advantages of the increasing usage of mobile devices that operate under the multihoming scheme are changing the communications world drastically. Therefore, next generation networks operators have the challenging task to distribute connections of mobile devices efficiently over their access networks, creating a big heterogeneous wireless network for telecommunications. We present a mixed integerlinear programming (MILP) model to balance the load of multiple services over wireless networks taking into account three key indicators: connection loads of access networks, connection costs, and battery consumption of connections. To solve the multi-objective problem, we propose a multi-objective Tabu Search procedure that is capable... ■ [\[Read more online\]](#)

3- A GRASP with path-relinking heuristic for the prize-collecting generalized minimum spanning tree problem

Ruslán Marzo (ruslangm@id.uff.br, Universidade Federal Fluminense) and Celso Ribeiro (celso.ribeiro@gmail.com, Universidade Federal Fluminense), Ibrahim Osman (io00@aub.edu.lb, American University of Beirut), Soha Maad and Karl Sawaya

The prize-collecting generalized minimum spanning tree problem is a generalization of the NP-hard generalized minimum spanning tree optimization problem. We propose a GRASP (Greedy Randomized Adaptive Search Procedure) heuristic for its approximate solution. The computational experiments showed that the heuristic developed in this work found very good optimal and suboptimal solutions for test problems with up to 439 vertices. Furthermore, we also showed that path-relinking and restart strategies consistently improved the more basic version of GRASP algorithm. [\[Read online\]](#)

4- Efficient algorithm for packet routing problems using transmission history information

Akinori Yoshida (akinori.yoshida0125@gmail.com, Nippon institute of technology), Masaya Kaneko, Toshichika Aoki (toshichika.aoki@gmail.com, Nippon Institute of Technology), Takayuki Kimura (tkimura@nit.ac.jp, Nippon Institute of Technology) and Tohru Ikeguchi (tohru@rs.tus.ac.jp, Tokyo University of Science).

The simplest shortest path problem in a network whose weights of edges are static can be solved easily using the well-known Dijkstra algorithm. However, in practical cases such as packet communication networks, the weights of edges are fluctuated by flowing packets or queuing packets at nodes (for example, routers). Obtaining the shortest paths of the packets from their sources to destinations in communication networks is called a packet routing problem. In the packet routing problems, both the optimum routes of packets at the current time are that at the next time cannot be guaranteed because the distributions of packets changes... ■ [\[Read more online\]](#)