MIC 2022

14th Metaheuristics International Conference

11-14 July 2022 - Ortigia-Syracuse, Italy

Conference Program

&

List of Abstracts

Welcome to MIC 2022

Welcome to the 14th edition of the MIC conference. As you may know, the MIC conference is traditionally held in odd years, therefore it should have taken place in 2021. However, due to the pandemic situation and given the tradition of the MIC as an event to bring together the *"metaheuristic family"*, in accord with the Steering Committee, we decided to postpone the conference to 2022 with the hope –and the bet– that it could be held mostly in person. We won our bet and we are really pleased to welcome you in Ortigia–Syracuse for this edition of the Metaheuristic International Conference.

This year we received a very high number of valid submissions, of which 70 were selected. Among those accepted submissions, 34 were of regular papers, 23 of short papers and 15 consist of oral presentations of recently published works. The papers were reviewed by a team of 102 PC members and reviewers that we deeply thank for their contribution to MIC success.

The conference is held over four days and consists of 8 parallel sessions of oral presentations, and 6 plenary talks given by reputable researchers which will provide a broad view of the state of the art in the metaheuristics and in related fields. The topics of the presentation sessions range from the foundation of metaheuristic techniques to their application in the solution of combinatorial problems arising in many real-world domains. A number of satellite social events are also planned, with the purpose of giving the conference delegates the opportunity to finally interact in person after this long pandemic time.

As organizers of the current edition, we are very happy and proud to have 150 participants in the overall of which more than 100 in presence. We would like therefore to thank all members of the local organizing committee, plenary speakers, all authors, all reviewers for their hard work that has been crucial for the conference, and all sponsors that have supported the event and allow us in organize a successful conference. Finally, a special thank is for the steering committee members for their helpful advice and support. Without all these components we would not have been able to organize a successful scientific congress.

Ortigia-Syracuse, 11th July 2022.

The MIC 2022 Chairs

Luca Di Gaspero
University of Udine

Paola Festa
University of Naples

Amir Nakib
Universite Paris Est Créteil

Mario Pavone
University of Catania

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The MIC 2022 Chairs would like to acknowledge those all have supported the conference:

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ENTANGLEMENT

The MIC 2022 Program Overview

Monday 11 July	Tuesday 12 July	Wednesday 13 July	Thursday 14 July
Registration (10:00 – 12:00) & (14:15 – 15:00)	Registration (8:30 – 9:00)	Registration (8:30 – 9:00)	Fred Glover & Gary Kochenberger (9:00 – 10:00)
	El-Ghazali Talbi (9:00 – 10:00)	Kalyanmoy Deb (9:00 – 10:00)	
	Parallel Sessions B1, B2 & B3 (10:05 – 11:05)	Parallel Sessions C1, C2 & C3 (10:05 – 11:05)	Parallel Sessions D1 (10:05 – 11:05)
	Coffee Break (11:05 – 11:30)	Coffee Break (11:05 – 11:30)	Coffee Break (11:05 – 11:30)
	Parallel Sessions B4, B5 & B6 (11:30 – 12:50)	Parallel Sessions C4, C5 & C6 (11:30 – 12:50)	Parallel Sessions D2 & D3 (11:30 – 12:50)
Opening Ceremony (15:00 – 15:15)	Lunch (12:50 – 15:00)	Lunch (12:50 – 14:30)	Closing Remarks (12:50 – 13:10)
Holger H. Hoos (15:15 – 16:15)	Christian Blum (15:00 – 16:00)	Group Photo (14:30 – 15:00)	
	Coffee Break (16:00 – 16:25)	Social Tour & Dinner (15:00 – 23:30)	
Parallel Sessions A1 & A2 (16:20 – 17:20)	Salvatore Greco (16:25 – 17:25)		
Welcome Cocktail (19:00 – 22:00)	Parallel Sessions B7 & B8 (17:30 – 18:30)		

The MIC 2022 Plenary Speakers

Monday, July 11 ***15:15 – 16:15***

Holger H. Hoos

Leiden University, The Netherlands

Cooperative Competition: A New Way of Solving Computationally Challenging Problems in AI and Beyond

"Progress in solving challenging problems in artificial intelligence, computer science at large, and beyond is driven, to a significant extent, by competition - regular algorithm competitions as well as comparative performance evaluation against state-of-the-art methods from the literature. A prominent example for this is the satisfiability problem in propositional logic (SAT), an NP-hard problem that not only lies at the foundations of computer science, but also plays a key role in many real-world applications, notably in ensuring the correctness of hard- and software. In this presentation, I will argue that it is time to rethink the way we assess the state of the art in solving problems such as SAT and the incentives for improving it. I will demonstrate how automated algorithm selection and configuration techniques based on sophisticated machine learning and optimisation methods have fundamentally changed not only the state of the art in solving SAT and many other NP-hard problems, but also provide a natural basis for cooperative competition - a new approach for achieving and assessing progress not merely in solving these problems, but also in the way we approach them as a scientific community."

Tuesday, July 12 ***9:00 – 10:00***

El-Ghazali Talbi

University of Lille1, France

How Machine Learning Can Help Metaheuristics?

"During the last years, research in applying machine learning (ML) to design efficient, effective and robust metaheuristics became increasingly popular. Many of those machine learning-supported metaheuristics have generated high quality results and represent state-of-the-art optimization algorithms. Although various approaches have been proposed, there is a lack of a comprehensive survey and taxonomy on this research topic. In this talk we will investigate different opportunities for using ML into metaheuristics. We define uniformly the various ways synergies which might be achieved. A detailed taxonomy is proposed according to the concerned search component: target optimization problem, low-level and high-level components of metaheuristics. Our goal is also to motivate researchers in optimization to include ideas from ML into metaheuristics. We identify some open research issues in this topic which needs further in-depth investigations."

Tuesday, July 12 *15:00 – 16:00*

Christian Blum

Spanish National Research Council, Spain

Recent Hybrid Techniques for Solving Large-Scale Combinatorial Optimization Problems

"In this talk, I will present two successful examples of our recent work on developing efficient algorithms for solving large-scale combinatorial optimization problems. Both algorithms belong to the class of hybrid metaheuristics, as they make use of exact techniques for solving reduced problem instances at each algorithm iteration. The first example concerns an extension of the metaheuristic ant colony optimization by a negative learning mechanism. The second example is about an award-winning algorithm known as construct, merge, solve & adapt (CMSA). Example applications of both algorithms will be presented. Finally, we will shortly present a new tool for visualizing algorithm behaviour based on search trajectory networks (STNs). This tool potentially helps to understand algorithm behaviour and can be downloaded by anyone interested in using it."

Tuesday, July 12 *16:25 – 17:25*

Salvatore Greco

University of Catania, Italy

Interactive Evolutionary MultiObjective Optimization

"In multiobjective optimization, in general does not exist a solution that is preferred to all the others with respect to all objective functions. Indeed, in general, to improve the performances on one objective one has to accept a deterioration with respect to one or more other objectives. In this perspective, very often a set of Pareto optimal solutions is computed and presented to the decision maker. However, this is not completely satisficing because the Decision Maker (DM) has to select one solution being the most preferred. Based on this consideration, interactive evolutionary multiobjective optimization methods have been proposed with the aim to handle the search of the most interesting part of the Pareto front taking into account some preferences provided by the DM during the decision support procedure. In this talk we shall present two interactive evolutionary multiobjective optimization methods: NEMOIICh and XIMEA-DRSA. Both of them take into account the DM's preferences to construct a decision model in terms of value functions and "if..., then..." decision rules, respectively."

Wednesday, July 13 ***9:00 – 10:00***

Kalyanmoy Deb

Michigan State University, USA

Making Metaheuristics More Powerful Using Human and Machine-Learnt Knowledge

"Metaheuristics-based search and optimization algorithms have clearly demonstrated their worth in solving complex practical problems due to their flexible framework, population approach, and implicit parallel processing of promising search regions. With an increasing need for solving more practical and more challenging problems, metaheuristics researchers are seeking help from contemporary computing fields and human experts. In this lecture, we shall highlight a few such efforts involving machine learning based and human-driven metaheuristics to tackle large-scale and challenging problems involving multiple conflicting objectives, non-linear constraints, and interlinked variables. Case studies from practical search and optimization problems will be presented to demonstrate effective merging of machine learning, metaheuristics, and human expertise."

Thursday, July 14 ***9:00 – 10:00***

Fred Glover

Entanglement, Inc., USA

Gary Kochenberger

Entanglement, Inc., USA

New Advances for Quantum -Inspired Optimization

"In recent years we have discovered that a mathematical formulation known as QUBO, an acronym for a Quadratic Unconstrained Binary Optimization problem, can embrace an exceptional variety of important optimization problems found in industry, science, and government. The QUBO model has emerged as an underpinning of the quantum computing areas known as quantum annealing and digital annealing and has become a subject of study in neuromorphic computing. Through these connections, QUBO models lie at the heart of experimentation carried out with quantum computers developed by D-Wave Systems and neuromorphic computers developed by IBM. New discoveries linking QUBO models to quantum computing are being explored in initiatives by organizations such as IBM, Google, Amazon, Microsoft, D-Wave and Lockheed Martin in the commercial realm and Los Alamos National Laboratory, Oak Ridge National Laboratory, Lawrence Livermore National Laboratory and NASA's Ames Research Center in the public sector. Computational experience is being amassed by both the classical and the quantum computing communities that highlights not only the potential of the QUBO model but also its effectiveness as an alternative to traditional modeling and solution methodologies.

The significance of the ability of the QUBO model to encompass many models in combinatorial optimization is enhanced by the fact that the QUBO model can be shown to be equivalent to the Ising model that plays a prominent role in physics. Consequently, the broad range of optimization problems solved effectively by state-of-the-art QUBO solution methods are joined by an important domain of problems arising in physics applications. We illustrate the process of reformulating important optimization problems as QUBO models through a series of explicit examples. We disclose the unexpected advantages of modeling a wide range of problems in a form that differs from the linear models classically adopted in the optimization community. We then go farther by describing important QUBO-Plus and PUBO models (where "P" stands for "Polynomial") that go beyond QUBO models to embrace a wide range of additional important applications. Each step of generating such models is illustrated in detail by simple numerical examples, to highlight the convenience of using these models in numerous settings. Beyond the modeling component, an extremely significant dimension lies in the development of powerful algorithms and efficient computer implementations. We describe recent algorithmic innovations that offer a fertile avenue for integrating classical and quantum computing and for applying these models. These innovations, embodied in software made available through Entanglement, Inc., have produced an ability to solve dramatically larger problems and to obtain significantly better solutions than software being offered through D-Wave, IBM, Microsoft, Fujitsu and other groups pursuing this area. Some of the major applications addressed with these innovations include those in: (1) Classical Combinatorial Optimization; (2) Financial Services; (3) Transportation; (4) Manufacturing; (5) Pharmaceuticals and Related; (6) Network and Energy; and (7) Machine learning."

The MIC 2022 Program in Full

Monday 11th July

10:00 – 12:00	Registration		
14:15 – 15:00			
15:00 – 15:15	Opening Ceremony by MIC 2022 Chairs		
15:15 – 16:15	**Plenary Speaker: Holger H. Hoos** Cooperative Competition: A New Way of Solving Computationally Challenging Problems in AI and Beyond		
16:20 – 17:20	Session #A1 (Apollo Room)	Session #A2 (Arethusa Room)	
19:00 – 22:00	Welcome Cocktail at the *Zefiro Solarium*		

Tuesday 12th July

8:30 – 9:00	Registration		
9:00 – 10:00	**Plenary Speaker: El-Ghazali Talbi** How Machine Learning Can Help Metaheuristics		
10:05 – 11:05	Session #B1 (Apollo Room)	Session #B2 (Arethusa Room)	Session #B3 (Dionysius Room)
11:05 – 11:30	Coffee Break		
11:30 – 12:50	Session #B4 (Apollo Room)	Session #B5 (Arethusa Room)	Session #B6 (Dionysius Room)
12:50 – 15:00	Lunch		

15:00 – 16:00	**Plenary Speaker: Christian Blum** Recent Hybrid Techniques for Solving Large-Scale Combinatorial Optimization Problems		
16:00 – 16:25	Coffee Break		
16:25 – 17:25	**Plenary Speaker: Salvatore Greco** Interactive Evolutionary Multiobjective Optimization		
17:30 – 18:30	Session #B7 (Apollo Room)	Session #B8 (Arethusa Room)	

Wednesday 13th July

8:30 – 9:00	Registration		
9:00 – 10:00	**Plenary Speaker: Kalyanmoy Deb** Making Metaheuristics More Powerful Using Human and Machine-Learnt Knowledge		
10:05 – 11:05	Session #C1 (Apollo Room)	Session #C2 (Arethusa Room)	Session #C3 (Dionysius Room)
11:05 – 11:30	Coffee Break		
11:30 – 12:50	Session #C4 (Apollo Room)	Session #C5 (Arethusa Room)	Session #C6 (Dionysius Room)
12:50 – 14:30	Lunch		
14:30 – 15:00	Group Photo		
15:00 – 23:30	Social Tour & Banquet		

Thursday 14th July

8:30 – 9:00	Registration	
9:00 – 10:00	**Plenary Speakers: Fred Glover and Gary Kochenberger** New Advances for Quantum-Inspired Optimization	
10:05 – 11:05	Session #D1 (Apollo Room)	
11:05 – 11:30	Coffee Break	
11:30 – 12:50	Session #D2 (Apollo Room)	Session #D3 (Arethusa Room)
12:50 – 13:10	Closing Remarks	

The MIC 2022 Oral Presentations Agenda

Monday, July 11th ***16:20 – 17:20***

Session A1	Vehicle Routing Chair: Hanafi Said	Apollo Room
16:20 – 16:40	***A BRKGA with Implicit Path-Relinking for the Vehicle Routing Problem with Occasional Drivers and Time Windows*** Paola Festa, Francesca Guerriero, Mauricio G. C. Resende and Edoardo Scalzo	
16:40 – 17:00	***Application of CMSA to the Electric Vehicle Routing Problem with Time Windows, Simultaneous Pickup and Deliveries, and Partial Vehicle Charging*** Mehmet Anil Akbay, Can Berk Kalayci and Christian Blum	
17:00 – 17:20	***A Matheuristic for Multi-Depot Multi-Trip Vehicle Routing Problems*** Tiziana Calamoneri, Federico Corò and Simona Mancini	

Session A2	Miscellaneous Problems Chair: Eric Thaillard	Arethusa Room
16:20 – 16:40	***A Scatter Search approach for the Parallel Row Ordering Problem*** Raúl Martín-Santamaría, José Manuel Colmenar and Abraham Duarte	
16:40 – 17:00	***Comparing QUBO Models of the Magic Square Problem for Quantum Annealing*** Philippe Codognet	
17:00 – 17:20	***Variable Neighborhood Descent for software quality optimization*** Javier Yuste, Eduardo G. Pardo and Abraham Duarte	

Tuesday, July 12th ***10:05 – 11:05***

Session B1	Scheduling Problems Chair: Thomas Stützle	Apollo Room

10:05 – 10:25 ***Scheduling Jobs in Flexible Flow Shops with s-batching Machines Using Metaheuristics***
Jens Rocholl and Lars Moench

10:25 – 10:45 ***Simulated annealing for a complex industrial scheduling problem***
Quentin Perrachon, Alexandru-Liviu Olteanu and Marc Sevaux

10:45 – 11:05 ***Local search for integrated predictive maintenance and scheduling in flow-shop***
Andrea Ecoretti, Sara Ceschia and Andrea Schaerf

Session B2	Analysis & Methodology Chair: Günther Raidl	Arethusa Room

10:05 – 10:25 ***Meta-analysis of metaheuristics***
Kenneth Sörensen, Renata Turkes and Lars-Magnus Hvattum

10:25 – 10:45 ***Analytical Methods to Separately Evaluate Convergence and Diversity for Multi-Objective Optimization***
Takato Kinoshita, Naoki Masuyama, Yusuke Nojima and Hisao Ishibuchi

10:45 – 11:05 ***How a Different Ant Behavior Affects on the Performances of the Whole Colony***
Carolina Crespi, Georgia Fargetta, Mario Pavone and Rocco A. Scollo

Session B3	Learning & Data Mining Chair: Luciana Pessoa	Dionysius Room

10:05 – 10:25 ***A Learning Metaheuristic Algorithm for a Scheduling Application***
Nazgol Niroumandrad, Nadia Lahrichi and Andrea Lodi

10:25 – 10:45 ***Unsupervised Machine Learning for the Quadratic Assignment Problem***
Thé-Van Luong and Éric D Taillard

10:45 – 11:05 ***MineReduce-based Metaheuristic for the Minimum Latency Problem***
Marcelo R. H. Maia, Ítalo Santana, Isabel Rosseti, Uéverton S. Souza and Alexandre Plastino

Tuesday, July 12th *11:30 – 12:50*

Session B4 — Routing & Transportation Problems — Apollo Room
Chair: Lionel Amodeo

11:30 – 11:50 ***REQreate: instance generation tool for on-demand transportation problems***
Michell Queiroz, Flavien Lucas and Kenneth Sörensen

11:50 – 12:10 ***On-Demand Bus Routing Problem with Dynamic Stochastic Requests and Prepositioning***
Ying Lian, Flavien Lucas and Kenneth Sörensen

12:10 – 12:30 ***Tabu search with multiple decision levels for solving Heterogeneous Fleet Pollution Routing Problem***
Bryan F. Salcedo-Moncada, Daniel Morillo-Torres and Gustavo Gatica

12:30 – 12:50 ***A demand-responsive feeder service with a maximum headway at mandatory stops***
Bryan David Galarza Montenegro, Kenneth Sörensen and Pieter Vansteenwegen

Session B5 — Agriculture Applications — Arethusa Room
Chair: Martínez-Gavara Anna

11:30 – 11:50 ***The Quantitative Features Analysis of the Nonlinear Model of Crop Production by Hybrid Soft Computing Paradigm***
Muhammad Sulaiman, Muhammad Umar, Kamsing Nonlaopon and Fahad Sameer Alshammari

11:50 – 12:10 ***Addressing Sustainability in Precision Agriculture via Multi-Objective Factored Evolutionary Algorithms***
Amy Peerlinck and John Sheppard

12:10 – 12:30 ***Decision support for agri-food supply chains in the e-commerce era: The inbound inventory routing problem with perishable products***
Daniel Cuellar-Usaquén, David Álvarez-Martínez, Camilo Gomez and Marlin Ulmer

12:30 – 12:50 ***Genetic algorithms for sowing schedule strategies in pest management***
Alfaima L. Solano-Blanco, Camilo Gomez, Martha Blanco, Felipe Montes, Felipe Borrero-Echeverry, Paola Zuluaga, Hugo Fernando Rivera-Trujillo and Diego F. Rincon

Session B6 — Location Problems — Chair: Stefan Voss — Dionysius Room

11:30 – 11:50 ***The p-next center problem with capacity and coverage radius constraints: model and heuristics***
Mariana Londe, Luciana Pessoa and Carlos Eduardo Andrade

11:50 – 12:10 ***A SOPR algorithm for the Multi-objective k-Balanced Center Location Problem***
Ana D. López-Sánchez, Jesús Sánchez-Oro, Anna Martínez-Gavara, Abraham Duarte and Alfredo G. Hernández-Díaz

12:10 – 12:30 ***An Efficient Fixed Set Search for the Covering Location with Interconnected Facilities Problem***
Isaac Lozano-Osorio, Jesús Sánchez-Oro, Anna Martínez-Gavara, Ana Dolores López-Sánchez and Abraham Duarte

12:30 – 12:50 ***Fixed Set Search applied to the Territory Design Problem***
Tobias Cors, Tobias Vlcek, Stefan Voss and Raka Jovanovic

Tuesday, July 12th — *17:30 – 18:30*

Session B7 — Tabu Search — Chair: Vincenzo Cutello — Apollo Room

17:30 – 17:50 ***Tabu Search for Diversity problems***
Anna Martínez-Gavara, Fred Glover and Rafael Marti

17:50 – 18:10 ***A Tabu Search Matheuristic for the Generalized Quadratic Assignment Problem***
Peter Greistorfer, Rostislav Staněk and Vittorio Maniezzo

18:10 – 18:30 ***Tabu Search Exploiting Local Optimality in Binary Optimization with Alternating Ascent Algorithm***
Said Hanafi, Yang Wang, Fred Glover, Wei Yang and Rick Hennig

Session B8 — Multi-Objective Optimization — Arethusa Room
Chair: Taha Arbaoui

17:30 – 17:50 ***Bi-objective RCPSP with time-dependent resource costs***
Javier Alcaraz, Laura Anton-Sanchez and Francisco Saldanha-da-Gama

17:50 – 18:10 ***An Evolutionary Algorithm for the Multi-Objective Travelling Salesman Problem***
Luis Henrique Pauleti Mendes, Fabio Luiz Usberti and Mário César San Felice

Wednesday, July 13th — *10:05 – 11:05*

Session C1 — Neural Networks & Applications — Apollo Room
Chair: Amir Nakib

10:05 – 10:25 ***On optimizing the structure of neural networks through a compact codification of their architecture***
Marcos Lupión Lorente, Nicolás Calvo Cruz, Ben Paechter and Pilar Martínez Ortigosa

10:25 – 10:45 ***Neural Architecture Search Using Differential Evolution in MAML Framework for Few-Shot Classification Problems***
Ayla Gülcü and Zeki Kuş

10:45 – 11:05 ***Neural Architecture Search Using Metaheuristics for Automated Cell Segmentation***
Zeki Kus, Musa Aydin, Berna Kiraz and Burhanettin Can

Session C2	Emergency Services Chair: Eva Vallada	Arethusa Room

10:05 – 10:25 ***Quasi-persistency Heuristic for Medical Emergency Drone Network Design***
Miguel Lejeune and Francois Margot

10:25 – 10:45 ***A Multi-objective BRKGA for the Siting of Emergency Vehicles***
Francesca Da Ros, Luca Di Gaspero, David La Barbera, Vincenzo Della Mea, Kevin Roitero, Laura Deroma, Sabrina Licata and Francesca Valent

10:45 – 11:05 ***Heuristic algorithms based on the isochrone analysis for dynamic relocation of medical emergency vehicles***
Yulia Karpova, Fulgencia Villa, Eva Vallada and Miguel Ángel Vecina

Session C3	Algorithm Configuration Chair: Charlotte Beauthier	Dionysius Room

10:05 – 10:25 ***Hyper-parameter optimization using continuation algorithms***
Jairo Rojas-Delgado, Jorge Alejandro Jiménez, Rafael Bello and Jose Antonio Lozano

10:25 – 10:45 ***Automatic Configuration of Metaheuristics for Solving the Quadratic Three-dimensional Assignment Problem using irace***
Imène Ait Abderrahim and Thomas Stützle

10:45 – 11:05 ***Selecting the Parameters of an Evolutionary Algorithm for the Generation of Phenotypically Accurate Fractal Patterns***
Habiba Akter, Rupert Young, John Woodward, Philip Birch and Chris Chatwin

Wednesday, July 13th ***11:30 – 12:50***

Session C4	Routing Problems Chair: Andrea D'Ariano	Apollo Room

11:30 – 11:50	***New Neighborhood Strategies for the Multi-Objective Vehicle Routing Problem with Time Windows*** Clément Legrand, Diego Cattaruzza, Laetitia Jourdan and Marie-Eleonore Kessaci
11:50 – 12:10	***Metaheuristic algorithms for UAV trajectory optimization in mobile networks*** Valentina Cacchiani, Sara Ceschia, Silvia Mignardi and Chiara Buratti
12:10 – 12:30	***Solving the probabilistic drone routing problem for searching targets in case of disasters*** Amadeu Coco, Christophe Duhamel and Andréa Santos
12:30 – 12:50	***Effective train routing selection for real-time traffic management: improved model and ACO parallel computing*** Bianca Pascariu, Marcella Samà, Paola Pellegrini, Andrea D'Ariano, Joaquin Rodriguez and Dario Pacciarelli

Session C5	Scheduling Problems Chair: Sara Ceschia	Arethusa Room

11:30 – 11:50	***A Multi-Population BRKGA for Energy-Efficient Job Shop Scheduling with Speed Adjustable Machines*** Seyed Mahdi Homayouni, Dalila B.M.M. Fontes and Fernando A.C.C. Fontes
11:50 – 12:10	***A Mixed-Integer Programming Formulation and Heuristics for an Integrated Production Planning and Scheduling Problem*** Diego Mello Silva and Geraldo Robson Mateus
12:10 – 12:30	***An investigation of Hyper-Heuristic Approaches for Teeth Scheduling*** Felix Winter and Nysret Musliu
12:30 – 12:50	***A beam search algorithm for minimizing crane times in premarshalling problems*** Ramon Alvarez-Valdes, Consuelo Parreño and Francisco Parreño

Session C6	Methodology & Analysis Chair: Charlotte Beauthier	Dionysius Room

11:30 – 11:50	***Evaluating the effects of Chaos in Variable Neighbourhood Search*** Sergio Consoli and José Andrés Moreno Pérez
11:50 – 12:10	***Investigating fractal decomposition based Algorithm on low-dimensional continuous optimization problems*** Arcadi Llanza Carmona, Nadiya Shvai and Amir Nakib
12:10 – 12:30	***A Comparative Analysis of Different Multilevel Approaches for Community Detection*** Guido Bordonaro, Vincenzo Cutello, Mario Pavone and Rocco A. Scollo
12:30 – 12:50	***Use of a Genetic Algorithm to Evolve the Parameters of Iterated Function Systems to Create Adapted Phenotypic Fractal Structures Observed in Nature*** Habiba Akter, Rupert Young, Phil Birch and Chris Chatwin

Thursday, July 14th — *10:05 – 11:05*

Session D1	Miscellaneous Problems Chair: Christophe Duhammed	Apollo Room

10:05 – 10:25	***Construct, Merge, Solve and Adapt Applied to the Maximum Disjoint Dominating Sets Problem*** Roberto Maria Rosati, Salim Bouamama and Christian Blum
10:25 – 10:45	***Optimizing Multi-Variable Time Series Forecasting using Metaheuristics*** Francesco Zito, Vincenzo Cutello and Mario Pavone
10:45 – 11:05	***A fast metaheuristic for finding the minimum dominating set in graphs*** Alejandra Casado Ceballos, Sergio Bermudo Navarrete, Ana Dolores López-Sánchez and Jesús Sánchez-Oro

Thursday, July 14th ***11:30 – 12:50***

Session D2	Assignment Problems Chair: Mauricio Resende	Apollo Room

11:30 – 11:50 ***Modeling and Solving the K-track Assignment Problem***
Jakob Preininger, Nysret Musliu and Felix Winter

11:50 – 12:10 ***Instance Space Analysis for the Generalized Assignment Problem***
Tobias Geibiner, Lucas Kletzander and Nysret Musliu

12:10 – 12:30 ***Iterated Local Search with Genetic Algorithms for the photo slideshow problem***
Labeat Arbneshi and Kadri Sylejmani

Session D3	Miscellaneous Problems Chair: Vittorio Maniezzo	Arethusa Room

11:30 – 11:50 ***Self-adaptive publish/subscribe network design***
Vittorio Maniezzo, Marco Boschetti and Pietro Manzoni

11:50 – 12:10 ***An agent-based model of follow-the-leader search using multiple leaders***
Martha Garzón, Lindsay Álvarez-Pomar and Sergio Rojas-Galeano

12:10 – 12:30 ***Hybrid PSO/GA+solver approaches for a bilevel optimization model to optimize electricity dynamic tariffs***
Maria João Alves, Carlos Henggeler Antunes and Maria Inês Soares

The MIC 2022 List of Abstracts

A BRKGA with Implicit Path-Relinking for the Vehicle Routing Problem with Occasional Drivers and Time Windows

Paola Festa[1], Francesca Guerriero[2], Mauricio G. C. Resende[3,4] and Edoardo Scalzo[2]

[1]Department of Mathematics and Applications, University of Napoli Federico II;
[2]Department of Mechanical, Energy and Management Engineering, University of Calabria;
[3]University of Washington;
[4]Amazon.com

This paper describes a biased random-key genetic algorithm (BRKGA) with implicit path-relinking for the Vehicle Routing Problem with Occasional Drivers (VRPOD). After a review of the relevant literature, the paper describes a proposed decoder and how BRKGA parameters are set. Experimental results show the efficacy of the proposed approach.

Application of CMSA to the Electric Vehicle Routing Problem with Time Windows, Simultaneous Pickup and Deliveries, and Partial Vehicle Charging

Mehmet Anil Akbay[1], Can Berk Kalayci[2] and Christian Blum[1]

[1]CSIC-IIIA; [2]Pamukkale University

As a consequence of the growing importance of environmental issues, partially due to a negative impact of transportation activities, the use of environmentally-friendly vehicles in logistics has become one of the prominent concepts in recent years. In this line, this paper addresses a variant of the vehicle routing problem, the electric vehicle routing problem with time windows and simultaneous pickup and deliveries, which are two essential real-life constraints. Moreover, we consider partial recharging of electric vehicles at charging stations. A recent self-adaptive variant of the matheuristic ``Construct, Merge, Solve & Adapt'' (CMSA) is applied to solve the tackled problem. CMSA combines heuristic elements, such as the probabilistic generation of solutions, with an exact solver that is iteratively applied to sub-instances of the original problem instances. Two constructive heuristics, a Clark & Wright Savings algorithm and a sequential insertion heuristic, are probabilistically applied to generate solutions which are then subsequently merged to form a sub-instance. The numerical results show that CMSA outperforms CPLEX in the context of small problem instances. Moreover, it is shown that CMSA outperforms the heuristic algorithms when large problem instances are concerned.

A Matheuristic for Multi-Depot Multi-Trip Vehicle Routing Problems

Tiziana Calamoneri[1], Federico Corò[2] and Simona Mancini[3]

[1]*Università di Roma La Sapienza;*
[2]*Missouri University of Science and Technology, Rolla;*
[3]*University of Klagenfurt*

Starting from a real-life application, in this short paper, we propose the original Multi-Depot Multi-Trip Vehicle Routing Problem with Total Completion Times minimization (MDMT-VRP-TCT). For it, we propose a mathematical formulation as a MILP, design a matheuristic framework to quickly solve it, and experimentally test its performance. Regardless of the application, our solution works in any case in which a multi-depot multi-trip vehicle routing problem must be solved.

A Scatter Search approach for the Parallel Row Ordering Problem

Raul Martín-Santamaría, Jose Manuel Colmenar and Abraham Duarte

Universidad Rey Juan Carlos

In this work, we present a new approach for the Parallel Row Ordering Problem (PROP), based on the Scatter Search metaheuristic. The PROP focuses on minimizing the total weighted sum of all distances between each pair of facility centers in a linear layout. The proposed method is able to obtain all known optimal values in a fraction of the time required by the previous exact methods for the set of smaller instances, and it outperforms the current state of the art metaheuristic for the set of larger instances, spending a comparable computing time.

Comparing QUBO Models of the Magic Square Problem for Quantum Annealing

Philippe Codognet

JFLI - CNRS / Sorbonne University / University of Tokyo

QUBO (Quadratic Unconstrained Binary Optimization) has become the modeling language for quantum annealing and quantum-inspired annealing solvers. We present different modeling in QUBO of the Magic Square problem, which can be modeled by linear equations and a permutation/all-different constraint over integer variables. Different ways of encoding integers by Booleans in QUBO amounts to models that have very different performance. Experiments performed on the Fixstars Amplify Annealer Engine, a quantum-inspired annealing solver, show that using Boolean domain-wall encoding for integers performs much better than using the classical one-hot encoding of integers.

Variable Neighborhood Descent for software quality optimization

Javier Yuste, Eduardo G. Pardo and Abraham Duarte

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In the Software Development Life-Cycle, the maintenance phase is often the most costly stage, where most efforts are devoted to understanding the system. To facilitate this task, the code is usually organized in a modular structure, where components from different modules are loosely connected and components in the same module are closely related. The Software Module Clustering Problem (SMCP) is an optimization problem which objective is to find the most modular organization of software systems. In this problem, software projects are frequently modeled as graphs, where vertices represent components of the system and edges represent dependencies among components. Then, the objective of the SMCP, which is proved to be NP-hard, is to group the vertices in modules such that the modularity of the graph is maximized. In this work, we present an algorithm based on Variable Neighborhood Descent for the SMCP. To evaluate the quality of the solutions, we study a novel quality metric, the Function of Complexity Balance, which was recently proposed as an alternative to traditional objective functions for the SMCP. Our proposal has been favorably evaluated over a dataset of 34 real software projects, outperforming the previous state-of-the-art method, a Hybrid Genetic Algorithm, in terms of both quality and computing time. Moreover, the results are statistically significant, according to the Wilcoxon's signed rank test.

Scheduling Jobs in Flexible Flow Shops with s-batching Machines Using Metaheuristics

Jens Rocholl and Lars Moench

University of Hagen

A scheduling problem for a two-stage flexible flow shop with s-batching machines is considered. A batch is a group of jobs that are processed at the same time on a single machine. A maximum batch size is given. The jobs belong to incompatible families. Only jobs of the same family can be batched together. A setup time occurs between different batches. The processing time of a batch is the sum of the processing times of the jobs forming the batch, i.e., the jobs are processed in a serial manner. Batch availability is assumed. Each job has a weight, a due date, and a release date. The performance measure is the total weighted tardiness (TWT). An iterative decomposition approach (IDA) is proposed that uses a grouping genetic algorithm (GGA) or an iterated local search (ILS) scheme to solve the single-stage subproblems. Results of computational experiments based on randomly generated problem instances demonstrate that the IDA hybridized with ILS is able to determine high-quality solutions.

Simulated annealing for a complex industrial scheduling problem

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Small and mid-sized industrial companies often deal with niche production processes that add complex constraints to the scheduling task such as resource availability and multiple or even partial resource requirements. Many of these companies do not have a decision-making process that optimises their scheduling operations, often involving simple spreadsheets, or even manually drawing on a board. In this work, we propose a solution to this problem in the form of a Flexible Job Shop Scheduling tool that integrates the previously mentioned constraints as well as multiple objective functions. This solution is based on the needs of multiple companies that deal with production processes requiring all of these elements. Our goal is to propose a more generic model that can be adapted to multiple industrial clients' needs.

Local search for integrated predictive maintenance and scheduling in flow-shop

Andrea Ecoretti, Sara Ceschia and Andrea Schaerf

University of Udine

We address the Permutation Flow-Shop Scheduling Problem with Predictive Maintenance (PFSP-PM) presented by Varnier and Zerhouni, that consists in finding the integrated schedule for production and maintenance tasks such that the total production time and the advance of maintenance services are minimized. Predictive maintenance services are scheduled based on a prognostics system that is able to provide the remaining useful life of a machine. To solve the PFSP-PM, we propose a local search method with neighborhoods specifically tailored for maintenance interventions. Computational experiments performed on generated benchmarks demonstrate the effectiveness and scalability of our method with respect to an exact technique based on the mathematical model.

Meta-analysis of metaheuristics

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Even though metaheuristics have been studied for several decades, most of the knowledge in the field remains anecdotal and poorly generalizable. Papers that demonstrate that one method outperforms another for a specific problem abound, while studies that analyze the effect of a certain metaheuristic feature independent of a specific implementation of a specific framework on a specific problem are few and far between. As a result, the design of heuristics to solve optimization problems remains a craft that one learns by doing (usually in a process that has been referred to as "iterated hacking"), rather than a structured method backed by scientific results.

In a recent publication, we show that meta-analysis, a tool often used in medical research to investigate the effect of a treatment on an illness, can be used to discover generalizable knowledge in the

field of metaheuristics. In this talk, we discuss what is, to the best of our knowledge, the first meta-analysis analysis performed in the metaheuristics literature. More specifically, we investigate the effect of adaptiveness in the well-known metaheuristic Adaptive Large Neighborhood Search. By combining the research results of more than 20 independent implementations of ALNS, we provide a nuanced answer to the question: "Does the adaptive layer of ALNS improve its performance (and to which extent)?"

Analytical Methods to Separately Evaluate Convergence and Diversity for Multi-Objective Optimization

Takato Kinoshita[1], Naoki Masuyama[1], Yusuke Nojima[1] and Hisao Ishibuchi[2]

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This paper proposes two analytical methods which completely separate the search performance of multi-objective evolutionary algorithms (MOEAs) into convergence and diversity for quantitatively comparing MOEAs. Specifically, Convergence-Diversity Pair (C-D Pair) is proposed to statistically compare the convergence and diversity of two MOEAs. C-D Pair provides analytical information on the overall experimental results. In addition, Convergence-Diversity Diagram (C-D Diagram) is also proposed to visualize a pair of convergence and diversity of a solution set as a single point in a two-dimensional space. C-D Diagram enables a detailed and intuitive comparison of the search performance trends of multiple MOEAs. Moreover, this paper introduces two diversity indicators. These indicators are designed to evaluate only the diversity of the population in an MOEA by completely eliminating the effect of the convergence. Computational experiments demonstrate the analytical capability and validity of the proposed analytical methods by using various test problems.

How a Different Ant Behavior Affects on the Performances of the Whole Colony

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This paper presents an experimental analysis of how different behavior performed by a group of ants affects the optimization efficiency of the entire colony. Two different interaction ways of the ants with each other and with the environment, that is a weighted network, have been considered: (i) Low Performing Ants (LPA), which destroy nodes and links of the network making it then dynamic; and (ii) High Performing Ants (HPA), which, instead, repair the destroyed nodes or links encountered on their way. The purpose of both ant types is simply to find the exit of the network, starting from a given entrance, whilst, due to the uncertainty and dynamism of the network, the main goal of the entire colony is maximize the number of ants that reach the exit, and minimize the path cost and the resolution time. From the analysis of the experimental outcomes, it is clear that the presence of the LPAs is advantageous for the entire colony in improving its performances, and then in carrying out a better and more careful optimization of the environment.

A Learning Metaheuristic Algorithm for a Scheduling Application

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Polytechnique Montreal

Tabu Search is among one of the metaheuristic algorithms that are widely recognized as efficient approaches to solve many combinatorial problems. Studies to improve the performance of metaheuristics have increasingly relied on the use of various methods, either combining different metaheuristics or originating outside of the metaheuristic field.

This paper presents a learning algorithm to improve the performance of tabu search by reducing its search space and the evaluation effort.

We study its performance using classification methods in an attempt to select moves through the search space more intelligently. The experimental results demonstrate the benefit of using a learning mechanism under deterministic environment and with uncertainty conditions.

Unsupervised Machine Learning for the Quadratic Assignment Problem

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An unsupervised machine learning method based on association rule is studied for the Quadratic Assignment Problem. Parallel itemsets and local search algorithms are proposed. The extraction of frequent itemsets in the context of local search is shown to produce good results for a few problem instances. Negative results of the proposed learning mechanism are reported for other instances. This result contrasts with other hard optimization problems for which efficient learning processes are known in the context of local search.

MineReduce-based Metaheuristic for the Minimum Latency Problem

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The minimum latency problem is a variant of the well-known travelling salesperson problem where the objective is to minimize the sum of arrival times at vertices. Recently, a proposal that incorporates a data mining process into a state-of-the-art metaheuristic by injecting patterns from high-quality solutions has consistently led to improved results in terms of solution quality and running time for this problem. This paper extends that proposal by leveraging data mining to contract portions of the problem frequently found in high-quality solutions. Our proposal aims at mitigating the burden of searching for improving

solutions by periodically solving a reduced version of the original problem. Computational experiments conducted on a well-diversified set of instances demonstrate that our proposal improved solution quality without increasing computational time, introducing 11 new best solutions to the literature.

REQreate: instance generation tool for on-demand transportation problems

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We present REQreate, a tool created with the aim to generate instances for on-demand transportation problems. Currently, some examples are the Dial-a-Ride Problem (DARP), On-demand Bus Routing Problem (ODBRP), and School Bus Routing Problem (SBRP). Such problems consist of optimizing the routes of vehicles according to demand of passengers for transportation under space and time restrictions (requests). In previous literature, researchers frequently chose to test their algorithms with instances from artificial networks or perform real-life case studies on a specific city or region. Furthermore, locations of requests for on-demand transportation problems were mostly randomly chosen according to an uniform distribution across the network. We designed REQreate to overcome these non-realistic and overfitting shortcomings, so we retrieve real-world street networks from OpenStreetMaps (OSM). To the best of our knowledge, this is the first tool to make use of real-life networks to generate instances for an extensive catalogue of existing and upcoming on-demand transportation problems. Additionally, we present a simple method that can be embedded in the instance generation process to produce distinct urban mobility patterns. We perform an analysis with real life datasets reported by rideshare companies and compare them with properties of synthetic instances generated with REQreate.

On-Demand Bus Routing Problem with Dynamic Stochastic Requests and Prepositioning

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The On-Demand Bus Routing Problem (ODBRP) is defined as a large-scale dial-a-ride problem with bus station assignment. Specifically, each passenger can have alternative stations to board and alight; then, station pairs with the smallest total User Ride Time (URT) are chosen for overall efficiency. In dynamic ODBRP (DODBRP), buses are only dispatched to the stations with received requests. However, our present study considers prepositioning: buses are sent to stations where new requests are likely to appear if the expected number of served requests has increased consequently. A heuristic algorithm with variable neighborhood search (VNS) is proposed to solve this dynamic and stochastic ODBRP, with multiple scenarios representing different realizations of stochastic requests.

Experimental artificial data show the superiority of prepositioning compared to DODBRP. On average, 24.27% - 38.80% more passengers can be served with the use of prepositioning with a simultaneous reduction from 2.06\% to 5.93\% of the average URT. In addition, different parameters are

investigated to show robustness, such as instance sizes, station distributions, ratios of dynamic requests, probabilities of stochastic requests, time windows, and levels of estimation accuracy of stochastic requests.

Tabu search with multiple decision levels for solving Heterogeneous Fleet Pollution Routing Problem

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Organizations, in order to gain a competitive advantage, must improve their logistics performance along with the planning and distribution of their goods. Thus, they face significant challenges in managing their orders to be delivered on time. However, transportation is responsible for 79% of the CO_2 emissions of the total polluting gases in the atmosphere. Therefore, there is a growing interest to investigate methods to optimize logistics and to consider environmental aspects. However, the literature only considers realistic system characteristics such as: different vehicles and speeds, time windows and route inclination. For this reason, the focus is on the solution of an extension with a heterogeneous fleet and discrete speeds of the Vehicle Routing Pollution Problem (PRP), whose objective is the reduction of greenhouse gases (GHG). Based on the MEET model, the main polluting gases with the greatest impact on health are measured: carbon dioxide (CO_2), nitrogen dioxide (NO_X) and carbon monoxide (CO). For its solution, a Tabu Search metaheuristic is proposed with different decision levels: node sequence, assigned speeds and vehicles used, from different neighborhood structures. Finally, the balance between exploration and exploitation is achieved by incorporating favorable attributes to the created solutions. The proposed metaheuristic achieves efficient results both in total logistic cost and in emissions released to the environment.

A demand-responsive feeder service with a maximum headway at mandatory stops

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Public transportation out of suburban or rural areas is crucial. Feeder transportation services offer a solution by transporting passengers to areas where more options for public transport are available. On one hand, fully flexible demand-responsive feeder services efficiently tailor their service to the needs of the passengers. On the other hand, traditional feeder services provide predictability and easier cost control. In this paper, a semi-flexible demand-responsive feeder service is considered, which combines positive characteristics of both traditional services as well as fully flexible services. This feeder service has two types of bus stops: mandatory bus stops and optional bus stops. Mandatory bus stops are guaranteed to be visited by a bus within a certain time interval. Optional stops are only visited when there is demand for transportation nearby. The performance of this feeder service is optimized with the use of a heuristic that

combines elements of different metaheuristic frameworks. Experimental results on small benchmark instances indicate that the heuristic performs on average 12.42% better than LocalSolver, a commercial optimization solver, with an average runtime of 2.1s. Larger instances can also be solved, typically within two minutes.

The Quantitative Features Analysis of the Nonlinear Model of Crop Production by Hybrid Soft Computing Paradigm

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In this study, we provide a discretized system of a continuous dynamical model for enhancing crop production in the presence of insecticides and insects. Crops are assumed to grow logistically but are limited by an insect population that entirely depends on agriculture. To protect crops from insects, farmers use insecticides, and their overmuch use is harmful to human health. We assumed that external efforts are proportional to the gap between actual production and carrying capacity to increase the field's development potential. We use the Levenberg–Marquardt algorithm (LMA) based on artificial neural networks (NNs) to investigate the approximate solutions for different insecticide spraying rates. "NDSolve" tool in Mathematica generated a data collection for supervised LMA. The NN-LMA approximation's value is achieved by the training, validation, and testing of reference data sets. Regression, error histograms, and complexity analysis help to validate the technique's robustness and accuracy.

Addressing Sustainability in Precision Agriculture via Multi-Objective Factored Evolutionary Algorithms

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Montana State University

Precision agriculture is a research area that uses technology from engineering and computer science to improve all aspects of agriculture, including but not limited to crop health, irrigation, and fertilizer application. In agriculture, questions of sustainability often arise: How do we minimize environmental impact while simultaneously helping farmers maximize their net return?

In this paper, we present a method to optimize crop yield production in winter wheat, with the goal of seeking to increase farmers' production. However, only focusing on optimizing production can lead to poor sustainability if an unnecessary amount of fertilizer is applied or farming equipment is put under undo stress. We therefore seek to address these impacts on sustainability by including objectives that directly address these concerns. Our method utilizes a new approach to solve multi-objective optimization that uses overlapping subpopulations, known as a Multi-Objective Factored Evolutionary Algorithm. Our results indicate that including overlapping subpopulations in the multi-objective optimization context is beneficial for exploration of the objective space. Our results also indicate that including these sustainability-driven objectives does not significantly impact net return or yield.

Decision support for agri-food supply chains in the e-commerce era: The inbound inventory routing problem with perishable products

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We consider an integrated planning problem that combines purchasing, inventory, and inbound transportation decisions in an agri-food supply chain where several suppliers (farmers) offer a subset of products with different selling prices and available quantities. We provide a mixed-integer programming formulation of the problem and a matheuristic decomposition that divides the problem into two stages. First, the purchasing and inventory problem is solved. Second, the capacitated vehicle routing problem is solved using a split CVRP procedure. Computational experiments on a set of generated test instances show that the matheuristic can solve instances of large size within reasonably short computational times, providing better solutions than its MIP counterpart. In future work, it is proposed to develop heuristic approaches to validate the performance of the presented matheuristic and to try other routing cost approximations.

Genetic algorithms for sowing schedule strategies in pest management

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The tomato leafminer (Tuta absoluta) is a pest insect that causes important economic losses in tomato crops at a global scale. In Colombia, T. absoluta pest management requires the application of large amounts of insecticides in greenhouse crops. This piece of research is part of a project that aims to help build integrated pest management strategies at a regional scale in the medium term through the collective control of sowing schedules. We built a simulation-optimization scheme to identify strategies that reduce the overall T. absoluta population in the region. The simulation model is a metapopulation network model of T. absoluta which includes the geographical distribution of greenhouses, the growth and migration dynamics of T. absoluta and the phenological state of the crops. We propose an optimization strategy based on genetic algorithms as a first approach to generate sowing schedules that minimize the overall population of T. absoluta according to the metapopulation model. The solutions are analyzed seeking for patterns that can be translated into rules of thumb for farmers. With the implementation of the method, we achieve a reduction of more than 20% of T. absoluta average population in the region. The analyses and recommendations from this study serve as evidence for the generation of guidelines in integrated pest management plans in similar crops and landscapes.

The p-next center problem with capacity and coverage radius constraints: model and heuristics

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This paper introduces a novel problem of facility location, called the p-next center problem with capacity and coverage radius constraints. We formulate a mixed-integer programming model for this problem and compare the results found by CPLEX with three Biased Random-Key Genetic Algorithms variants. We also propose several instances for this problem, based on existing ones for the p-next center problem. Additionally, we analyze the effect of the radius and demand on instance difficulty. We also observe the performance gains with a relaxed capacity and demand constraint, i.e., permitting demand to be unmet by the model. Results point out that the BRKGA variants had significantly better performance than CPLEX and similar performances among themselves. Of those, \BRKGANLS was shown to have slightly better results than the other variants.

A SOPR algorithm for the Multi-objective k-Balanced Center Location Problem

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A hybrid Strategic Oscillation (SO) with Path Relinking (PR) algorithm is presented to provide a set of high quality non-dominated solutions for the Multi-objective k-Balanced Center Location problem. The considered location problem seeks to locate k out of m facilities in order to serve n demand points, minimizing the maximum distance between any demand point and its closest facility while balancing the workload among the facilities. Our algorithm combines Strategic Oscillation, designed with the purpose of crossing back and forth between the feasible and infeasible solution spaces, with Path Relinking, applied here with the purpose of exploring trajectories connecting pairs of infeasible solutions to fix the feasibility and so to obtain a large quantity of high quality non-dominated solutions. An extensive computational experimentation is carried out to compare the performance of our proposal, including the best method found in the state of the art as well as traditional multi-objective evolutionary algorithms.

An Efficient Fixed Set Search for the Covering Location with Interconnected Facilities Problem

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Ana Dolores López-Sánche[z3] and Abraham Duarte[1]

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This paper studies the Coverage Location Problem with Interconnected Facilities (CPIF). It belongs to the family of Facility Location Problems, but being more realistic to nowadays situations as surveillance, or natural disaster control. This problem aims at locating a set of interconnected facilities to minimize the number of demand points that are not covered by the selected facilities. Two facilities are considered as interconnected if the distance between them is smaller than or equal to a predefined distance, while a facility covers a demand point if the distance to it is smaller than a certain threshold. The wide variety of real-world applications that fit into this model makes them attractive for designing an algorithm able to solve the problem efficiently. To this end, a metaheuristic algorithm based on the Fixed Set Search framework is implemented. The proposed algorithm will be able to provide high-quality solutions in short computational times, being competitive with the state of the art.

Fixed Set Search applied to the Territory Design Problem

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In this paper we apply the novel fixed set search (FSS) metaheuristic in combination with mixed integer programming to solve the Territory Design Problem (TDP). In this matheuristic approach we select the territory centers with a greedy randomised adaptive search procedure (GRASP) while optimising the subproblem of the territory-center allocation with CPLEX. The FSS adds a learning procedure to GRASP and helps us to narrow down the most common territory centers in the solution population in order to fix them. This improves the speed of the optimisation and helps us to find high-quality solutions on all instances of our computational study at least once after five runs.

Tabu Search for Diversity problems

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The diversity or dispersion problem consists in the selection of a specific number of elements from a given set, in such a way that the distance or dissimilarity among the selected elements is maximized. This problem comprises a variety of combinatorial optimization models that have received a lot of attention in

the last 30 years. In particular, many exact methods and metaheuristics have been proposed to solve them. According to some recent studies, tabu search (TS) is the most successful methodology to target these problems. In this talk, we focus on TS, and review its different applications to the two most widely used diversity models: MaxSum and MaxMin. Our study considers the early papers on diversity models, in which seminal ideas on constructive and destructive neighborhoods expanded the notion of improvement methods. In line with research on other combinatorial optimization problems, we show the contribution of the adaptive memory in these implementations, which makes significant differences as compared with other memory-less designs. The evolution of the TS proposals over time illustrates how the methodology has become more competitive by implementing simple and efficient strategies. We include a computational comparison with other state-of-the-art metaheuristics that confirms the superiority of TS. We refer the interested reader to the invited paper submitted to the book "Discrete diversity and dispersion optimization" that will be published by Springer in 2023.

A Tabu Search Metaheuristic for the Generalized Quadratic Assignment Problem

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This work treats the so-called Generalized Quadratic Assignment Problem. Solution methods are based on heuristic and partially optimal solution ideas. Base constructive results stem from a heuristic branch-and-bound approach, then we use a combination of Tabu Search and Linear Programming for the improving phase. Hence, the overall approach constitutes a type of mat- and metaheuristic algorithm. Computational results on a number of data sets, instances from literature as well as own ones, show that former results could be improved and give rise to the assumption that the existing framework is worth to be examined in greater detail.

Tabu Search Exploiting Local Optimality in Binary Optimization with Alternating Ascent Algorithm

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A variety of strategies have been proposed for overcoming local optimality in metaheuristic search. This paper examines characteristics of moves that can be exploited to make good decisions about steps that lead away from a local optimum and then lead toward a new local optimum. We introduce strategies to identify and take advantage of useful features of solution history with an adaptive memory metaheuristic, to provide rules for selecting moves that offer promise for discovering improved local optima. Our approach uses a new type of adaptive memory based on a construction called exponential extrapolation. The memory operates by means of threshold inequalities that ensure selected moves will

not lead to a specified number of most recently encountered local optima. Associated thresholds are embodied in choice rule strategies that further exploit the exponential extrapolation concept. The Alternating Ascent (AA) Algorithm incorporates new strategies to exploit local optimality within the context of bi-nary combinatorial optimization. Together these produce a threshold based AA algorithm that opens a variety of research possibilities for exploration. The considerations treated in the body of this study will be illustrated in an implementation to solve the quadratic unconstrained binary optimization (QUBO) problem. We show that AA algorithm reaches easily all the best knowns solutions of the 60 instances of OR-Library up to 2500 variables.

Bi-objective RCPSP with time-dependent resource costs

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This work provides new insights on bi-criteria resource-constrained project scheduling problems. We define a realistic problem where the objectives to combine are the makespan and the total cost for resource usage. Time-dependent costs are assumed for the resources, i.e., they depend on when a resource is used. An optimization model is presented and it is followed by the development of an algorithm aiming at finding the set of Pareto solutions. The intractability of the optimization models underlying the problem also justifies the development of a metaheuristic for approximating the same front. We design a bi-objective evolutionary algorithm that includes problem-specific knowledge and is based on the Non-dominated Sorting Genetic Algorithm (NSGA-II). The results of extensive computational experiments performed using instances built from those available in the literature are reported. The results demonstrate the efficiency of the metaheuristic proposed.

An Evolutionary Algorithm for the Multi-Objective Travelling Salesman Problem

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This paper presents an evolutionary algorithm for the Multi-Objective Travelling Salesman Problem, based on the Biased Random-Key Genetic Algorithms (BRKGAs) and on the Elitist Non-dominated Sorting Genetic Algorithm (NSGA-II). Computational experiments compared our evolutionary algorithm with state-of-the-art algorithms from the literature. The results show that our methodology consistently outperformed the other approaches with respect to the hypervolumes from the obtained non-dominated fronts.

On optimizing the structure of neural networks through a c ompact codification of their architecture

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Neural networks stand out in Artificial Intelligence for their capacity of being applied to multiple challenging tasks such as image classification. However, designing a neural network to address a particular problem is also a demanding task that requires expertise and time-consuming trial-and-error stages. The design of methods to automate the designing of neural networks define a research field that generally relies on different optimization algorithms, such as population meta-heuristics. This work studies utilizing TLBO, which had not been used before for this purpose up to the authors' knowledge. It is widespread and does not have specific parameters. Besides, it would be compatible with deep neural network design, i.e., architectures with many layers, due to its conception as a large-scale optimizer. A new encoding scheme has been proposed to make this continuous optimizer compatible with neural network design. This method, which is of general application, i.e., not linked to TLBO, can represent different network architectures with a plain vector of real values. A compatible objective function that links the optimizer and the representation of solutions has also been developed. The performance of this framework has been studied by addressing the design of an image classification neural network based on the CIFAR-10 dataset. The achieved result outperforms the initial solutions designed by humans after letting them evolve.

Neural Architecture Search Using Differential Evolution in MAML Framework for Few-Shot Classification Problems

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Model-Agnostic Meta-Learning (MAML) algorithm is an optimization based meta-learning algorithm which aims to find a good initial state of the neural network that can then be adapted to any novel task using a few optimization steps. In this study, we take MAML with a simple four-block convolution architecture as our baseline, and try to improve its few-shot classification performance by using an architecture generated automatically through the neural architecture search process. We use differential evolution algorithm as the search strategy for searching over cells within a predefined search space. We have performed our experiments using two well-known few-shot classification datasets, miniImageNet and FC100 dataset. For each of those datasets, the performance of the original MAML is compared to the performance of our MAML-NAS model under both 1-shot 5-way and 5-shot 5-way settings. The results reveal that MAML-NAS results in better or at least comparable accuracy values for both of the datasets in all settings. More importantly, this performance is achieved by much simpler architectures, that is architectures requiring less floating-point operations

Neural Architecture Search Using Metaheuristics for Automated Cell Segmentation

Zeki Kus, Musa Aydin, Berna Kiraz and Burhanettin Can

Fatih Sultan Mehmet Vakif University

Deep neural networks give successful results for segmentation of medical images. The need for optimizing many hyper-parameters presents itself as a significant limitation hampering the effectiveness of deep neural network based segmentation task. Manual selection of these hyper-parameters is not feasible as the search space increases. At the same time, these generated networks are problem-specific. Recently, studies that perform segmentation of medical images using Neural Architecture Search (NAS) have been proposed. However, these studies significantly limit the possible network structures and search space. In this study, we proposed a structure called UNAS-Net that brings together the advantages of successful NAS studies and is more flexible in terms of the networks that can be created. The UNAS-Net structure has been optimized using metaheuristics including Differential Evolution (DE) and Local Search (LS), and the generated networks have been tested on Optofil and Cell Nuclei cell data sets. When the results are examined, it is seen that the networks produced by the heuristic methods improve the performance of the U-Net structure in terms of both segmentation performance and computational complexity. As a result, the proposed structure can be used when the automatic generation of neural networks that provide fast inference as well as successful segmentation performance is desired.

Quasi-persistency Heuristic for Medical Emergency Drone Network Design

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We propose a queueing optimization model to design a drone network responding to out-of-hospital cardiac arrests (OHCA). The network is modeled as a collection of M/G/1 queues and the model takes the form of an integer nonlinear model with fractional and bilinear terms and minimizes the average response time. We derive a mixed-integer linear programming (MILP) reformulation and devise a persistency-based heuristic to solve very large instances. We use real cardiac arrest data for Virginia Beach to ascertain the computational efficiency and scalability of our approach and to derive practical insights about the benefits of drones on the response time and probability of survival of OHCA patients.

A Multi-objective BRKGA for the Siting of Emergency Vehicles

Francesca Da Ros[1], Luca Di Gaspero[1], David La Barbera[1], Vincenzo Della Mea[1], Kevin Roitero[1], Laura Deroma[2], Sabrina Licata[2] and Francesca Valent[3]

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We propose the development and application of a multi-objective biased random-key genetic algorithm in order to identify sets of optimal ambulance locations in a rural-mountainous area. The algorithm involves a discrete event simulator to estimate the objective functions, thus we want to minimize the response time while maximizing the area served within the standard time. It is applied to the case of the mountainous area of the Italian region of Friuli Venezia Giulia. Preliminary results are encouraging, as the best case for each objective shows that the average response time decreases of 28,9%, the 90th percentile for the response time decreases of 43,0%, the number of municipalities served within the standard time increases of 8 units during the day and of 26 units during the night.

Heuristic algorithms based on the isochrone analysis for dynamic relocation of medical emergency vehicles

Yulia Karpova, Fulgencia Villa, Eva Vallada and Miguel Ángel Vecina

Universitat Politècnica de València

Among the wide range of medical services, prehospital health care is one of the most relevant, as it usually involves an emergency situation. The qualified medical team is dispatched to the scene of the incident as soon as possible. One of the most influential factors in response time depends on where the ambulances are stationed, however, when a medical vehicle is attending an emergency, it becomes unavailable for other calls. Increasing the ambulance fleet is costly nor does it guarantee efficiency. An alternative solution is the relocation of available ambulances to increase the population covered by them. Obtaining the optimal solution in real time is not feasible for this problem. With this in mind, this work addresses the problem of dynamic relocation of ambulances through the design and development of heuristic tools. The isochron overlap analysis defines possible scenarios that may occur when ambulances become unavailable for emergencies and determines the appropriate conditions to carry out the relocation of ambulances. Computational experiments are run using a benchmark of instances based on the characteristics of a real Emergency Medical Service. Based on the results of the study, we can conclude that the designed relocation algorithms perform better than if there was no relocation strategy.

Hyper-parameter optimization using continuation algorithms

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Hyper-parameter optimization is a common task in many application areas and a challenging optimization problem. In this paper, we introduce an approach to search for hyper-parameters based on continuation algorithms that can be coupled with existing hyper-parameter optimization methods. Our continuation approach can be seen as a heuristic to obtain lower fidelity surrogates of the fitness function. In our experiments, we conduct hyper-parameter optimization of neural networks trained using a benchmark set of forecasting regression problems, where generalization from unseen data is required. Our results show a small but statistically significant improvement in accuracy without negatively affecting the execution time.

Automatic Configuration of Metaheuristics for Solving the Quadratic Three-dimensional Assignment Problem using irace

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Metaheuristic algorithms are traditionally designed following a manual and iterative algorithm development process. The performance of these algorithms is, however, strongly dependent on their correct tuning, including their configuration and parametrization. This is labour-intensive, error-prone, difficult to reproduce and explores only a limited number of design alternatives. To overcome manual tuning, the automatic configuration of algorithms is a technique that has shown its efficiency in finding performance-optimizing settings of parameters. This paper contributes to overcoming the challenge of automatically configured metaheuristics using the iterated racing for automatic algorithm configuration " irace" applied to the quadratic three-dimensional assignment problem. In particular, we use particle swarm optimization (PSO), a tabu search (TS), an iterated local search (ILS) and two hybrid algorithms PSO-TS and PSO-ILS. Of these algorithms, the tabu search algorithm and the PSO-ILS worked the best. The results show that the algorithm automatic configuration enables identifying an ideal tuning of the parameters and reaching better results when compared to a manual configuration, in similar execution time.

Selecting the Parameters of an Evolutionary Algorithm for the Generation of Phenotypically Accurate Fractal Patterns

Habiba Akter[1], Rupert Young[1], John Woodward[2], Philip Birch[1] and Chris Chatwin[1]

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This paper describes the selection of parameters of an Evolutionary Algorithm (EA) suitable for optimising the genotype of a fractal model of phenotypically realistic structures. To achieve the proposed goal an EA is implemented as a metaheuristic search tool to find the coefficients of the transformation matrices of an Iterated Function System (IFS) which then generates regular fractal patterns. Fractal patterns occur throughout nature, a striking example being the fern patterns modelled by Barnsley. Thus the algorithm is evaluated using the IFS for the fern fractal using the EA-evolved parameters.

New Neighborhood Strategies for the Multi-Objective Vehicle Routing Problem with Time Windows

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Local search (LS) algorithms are efficient metaheuristics to solve vehicle routing problems (VRP). They are often used either individually or integrated into evolutionary algorithms. For example, the Multi-Objective Evolutionary Algorithm based on Decomposition (MOEA/D) can be enhanced with a local search replacing the mutation step based on a single move operator traditionally. LS are based on an efficient exploration of the neighborhoods of solutions. Many methods have been developed over the years to improve the efficiency of LS. In particular, the exploration strategy of the neighborhood and the pruning of irrelevant neighborhoods are important concepts that are frequently considered when designing a LS. In this paper, we focus on the multi-objective vehicle routing problem with time windows (MO-VRPTW) where the total traveling cost and the total waiting time have to be minimized. We propose two neighborhood strategies to improve an existing LS, efficient on the single-objective VRPTW. First, we propose a new method to explore the neighborhood of a solution. Second, we propose a new method for pruning the solution neighborhood that takes into account the second criterion of our MO-VRPTW namely the waiting time between customers. Experiments on Solomon's instances show that using LS with our neighborhood strategies in the MOEA/D gives better performance. Moreover, we can achieve some best-known solutions considering the traveling cost minimization only.

Metaheuristic algorithms for UAV trajectory optimization in mobile networks

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We consider a mobile network in which traditional static terrestrial base stations are not capable of completely serving the existing user demand, due to the huge number of connected devices. In this setting, an equipped Unmanned Aerial Vehicle (UAV) can be employed to provide network connection where needed in a flexible way, thereby acting as an unmanned aerial base station. The goal is to determine the best UAV trajectory in order to serve as many users as possible. The UAV can move at different speeds and can serve users within its communication range, although the data rate depends on the respective UAV to user positions. In addition, each user has a demand (e.g., the number of bits the user wants to download/upload from/to the network) and a time window during which requires the service. We propose a Biased Random-Key Genetic Algorithm (BRKGA) and a Simulated Annealing Algorithm (SAA), and compare them on realistic instances with more than 500 users in different settings.

Solving the probabilistic drone routing problem for searching targets in case of disasters

Amadeu Coco, Christophe Duhamel and Andréa Santos

Normandie Université, UNIHAVRE, UNIROUEN, INSA Rouen, LITIS, Le Havre, France

Several major industrial disasters happen each year around the world. They usually involve limited accessibility, poor ground conditions and toxic wastes. This reduces the efficiency of human interventions and flying drones may be a viable alternative: they move faster, they do not depend on ground conditions, and a single observation can scan larger areas at once. Several challenges have to be addressed such as defining and optimizing the drone's routes, setting the relay points for recharging equipment, among others. We consider several additional features to existing works. First, a node can be visited several times. In addition, the nodes are prioritized according to a given heatmap and there is a probability of identifying each target. Thus, the Probabilistic Drone Routing Problem (PDRP) consists in finding a route, i.e a sequence of trips, for each drone such that the sum of the expected number of identified targets on all routes is maximized. Constraints on energy consumption, collision avoidance and drone-base assignment are taken into account. We propose a greedy constructive heuristic and an Adaptive Large Neighborhood Search for the PDRP. The methods are tested on a set of grid instances in order to analyse the efficiency of both methods.

Effective train routing selection for real-time traffic management: improved model and ACO parallel computing

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The real-time Railway Traffic Management Problem (rtRTMP) is the problem of detecting and solving time-overlapping conflicting requests done by multiple trains on the same track resources. This problem consists in retiming, reordering and rerouting trains in such a way that the propagation of disturbances in the railway network is minimized. The rtRTMP is an NP-complete problem and finding good strategies to simplify its solution process is paramount to obtain good quality results in a short computation time. Solving the Train Routing Selection Problem (TRSP) aims to reduce the size of rtRTMP instances by limiting the number of routing variables: during a pre-processing the most promising routing alternatives among the available ones are selected for each train. These alternatives are the only ones to be then used in the rtRTMP solution. A first version of the TRSP has been recently proposed in the literature. This paper presents an improved TRSP model where rolling stock re-utilization timing constraints and estimation of train delay propagation are taken into account. Additionally, a parallel Ant Colony Optimization (ACO) algorithm is proposed. We analyze the impact of the TRSP model and algorithm on the rtRTMP through a thorough computational campaign performed on a French case study with timetable disturbances and infrastructure disruptions. The model presented leads to a better correlation between TRSP and rtRTMP solutions, and the proposed ACO algorithm outperforms the former state-of-the-art.

A Multi-Population BRKGA for Energy-Efficient Job Shop Scheduling with Speed Adjustable Machines

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Energy-efficient scheduling has become a new trend in industry and academia, mainly due to extreme weather conditions, stricter environmental regulations, and volatile energy prices. This work addresses the energy-efficient Job shop Scheduling Problem with speed adjustable machines. Thus, in addition to determining the sequence of the operations for each machine, one also needs to decide on the processing speed of each operation.

We propose a multi-population biased random key genetic algorithm that finds effective solutions to the problem efficiently and outperforms the state-of-the-art solution approaches.

A Mixed-Integer Programming Formulation and Heuristics for an Integrated Production Planning and Scheduling Problem

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Federal Institute of Minas Gerais

This paper proposed a new mixed-integer programming formulation for an integrated multiproduct, multiperiod, and multistage capacitated lot sizing with hybrid flow shop problem (CLSP-HFS) and a combined relax-and-fix with fix-and-optimize heuristics to solve it that uses decomposition of variables by product, period and stage. Relax-and-fix heuristic takes an initial feasible solution, and fix-and-optimize heuristic tries to improve it. In order to evaluate the performance of the combined strategy, some experiments were done considering seven datasets as a benchmark, each one composed of ten randomly generated instances with 5, 10, 15, 20, 25, 30, and 40 products processed in parallel machines during three stages along a planning horizon of eight periods. Experimental results suggest that period-based strategies achieve near-zero percentage deviation to optimum, while product-based strategies offer a trade-off between solution quality and time.

An investigation of Hyper-Heuristic Approaches for Teeth Scheduling

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TU Wien

Modern day production sites for teeth manufacturing often utilize a high-level of automation and sophisticated machinery.

Finding efficient machine schedules in such a production environment is a challenging task, as complex constraints need to be fulfilled and multiple cost objectives should be minimized. This paper investigates a hyper-heuristic solution approach for the artificial teeth scheduling problem which originates from real-life production sites of the teeth manufacturing industry. We propose a collection of innovative low-level heuristic strategies which can be utilized by state-of-the-art selection-based hyper-heuristic strategies to efficiently solve practical problem instances. Furthermore, the paper introduces eight novel large-scale scheduling scenarios from the industry, which are included in the experimental evaluation of the proposed techniques.

An extensive set of experiments with well-known hyper-heuristics on benchmark instances shows that our methods improve state-of-the-art results for the large majority of the instances.

A beam search algorithm for minimizing crane times in premarshalling problems

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The premarshalling problem consists of sorting the containers placed in a bay of the container yard so that they can be retrieved in the order in which they will be required. We study the premarshalling problem with crane time minimization objective and develop a beam search algorithm, with some new elements adapted to the characteristics of the problem, to solve it. We propose various evaluation criteria, depending on the type of container movement, for its local evaluation; a new heuristic algorithm including local search for its global evaluation; and several new dominance rules. The computational study shows the contribution of each new element. The performance of the complete algorithm is tested on well-known benchmarks. The beam search algorithm matches all known optimal solutions, improves on the known suboptimal solutions, and obtains solutions for the largest instances, for which no solution had previously been found.

Evaluating the effects of Chaos in Variable Neighbourhood Search

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Metaheuristics are problem-solving methods which try to find near-optimal solutions to very hard optimization problems within an acceptable computational timeframe, where classical approaches usually fail, or cannot even been applied. Random mechanisms are an integral part of metaheuristics, given randomness has a role in dealing with algorithmic issues such as parameters tuning, adaptation, and combination of existing optimization techniques. In this paper, it is explored whether deterministic chaos can be suitably used instead of random processes within Variable Neighbourhood Search (VNS), a popular metaheuristic for combinatorial optimization. As a use case, in particular, the paper focuses at this purpose on labelling graph problems, where VNS has been already used with success. These problems are formulated on an undirected labelled graph and consist on selecting the subset of labels such that the subgraph generated by these labels has, respectively, an optimal spanning tree or forest. The effects of using chaotic sequences in the VNS metaheuristic are investigated during several numerical tests. Different one-dimensional chaotic maps are applied to VNS in order to compare the performance of each map in finding the best solutions for this class of graph problems.

Investigating fractal decomposition based Algorithm on low-dimensional continuous optimization problems

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This paper analyzes the performance of the Fractal Decomposition Algorithm (FDA) metaheuristic applied to low-dimensional continuous optimization problems. This algorithm was originally developed specifically to deal efficiently with high-dimensional continuous optimization problems by building a fractal-based search tree with a branching factor linearly proportional to the number of dimensions. Here, we aim to answer the question of whether FDA could be equally effective for low-dimensional problems. For this purpose, we evaluate the performance of FDA on the Black Box Optimization Benchmark (BBOB) for dimensions 2, 3, 5, 10, 20, and 40. The experimental results show that overall the FDA in its current form does not perform well enough. Among different function groups, FDA shows its best performance on Misc. moderate and Weak structure functions.

A Comparative Analysis of Different Multilevel Approaches for Community Detection

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Community Detection is one of the most investigated problems as it finds application in many real-life areas. However, detecting communities and analysing community structure are very computationally expensive tasks, especially on large networks. In light of this, to better manage large networks, two new Multi-Level models are proposed in order to reduced and simplify the original graph via aggregation of groups of nodes. Both models have been applied on two variants of an immune-inspired algorithm, the first one based on a fully random-search process, and the second based on a hybrid approach. From the experimental analysis it clearly appears that the two proposed models help the random-search and the hybrid immune-inspired algorithms to significantly improve their performances from both computational and quality of found solutions point of view. In particular, the hybrid variant appears to be very competitive and efficient.

Use of a Genetic Algorithm to Evolve the Parameters of Iterated Function Systems to Create Adapted Phenotypic Fractal Structures Observed in Nature

Habiba Akter, Rupert Young, Phil Birch and Chris Chatwin

University of Sussex

In this work we investigate the generation of fractal pattern structures representing the phenotype of a biological organism, using the Barnsley fern as an example. We employ a Genetic Algorithm to generate and evolve the parameters of this Iterated Function System of the fern. Then we select the resulting best fractal structures, each representing a generated phenotype, using a box-counting

dimension as a fitness metric. In this way, realistic fern structures are evolved over a few tens of generations.

Construct, Merge, Solve and Adapt Applied to the Maximum Disjoint Dominating Sets Problem

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We propose a "construct, merge, solve and adapt" (CMSA) approach for the maximum disjoint dominating sets problem (MDDSP), which is a complex variant of the classical minimum dominating set problem in undirected graphs. The problem requires to find as many vertex-disjoint dominating sets of a given graph as possible. CMSA is a recent metaheuristic approach based on the idea of problem instance reduction. At each iteration of the algorithm, sub-instances of the original problem instance are solved by an exact solver. These sub-instances are obtained by merging the solution components of probabilistically generated solutions. CMSA is the first metaheuristic proposed for solving the MDDSP. The obtained results show that CMSA outperforms all existing greedy heuristics.

Optimizing Multi-Variable Time Series Forecasting using Metaheuristics

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Multi-variable time series forecasting is one of several applications of machine learning. Creating an artificial environment capable of replicating real-world behavior is useful for understanding the intrinsic relationship between variables. However, selecting a predictor that ensures good performance for variables of different natures is not always a simple process. An algorithmic approach based on metaheuristics could be a good alternative to find the best predictive model for variables. Each predictor is optimized for forecasting a particular variable in a multi-agent artificial environment to improve the overall performance. The resulting environment is compared with other solutions that use only the same type of predictor for each variable. Finally, we can assert that using a multi-agent environment can improve the performance, accuracy, and generalization of our model.

A fast metaheuristic for finding the minimum dominating set in graphs

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Finding minimum dominating sets in graphs is a problem that has been widely studied in the literature. However, due to the increase in the size and complexity of networks, new algorithms with the ability to provide high quality solutions in short computing times are desirable. This work presents a Greedy Randomized Adaptive Search Procedure for dealing with the Minimum Dominating Set Problem in large networks. The algorithm is conformed by an efficient constructive procedure to generate promising initial solutions and a local search designed to find a local optimum with respect to those initial solutions. The experimental results show the competitiveness of the proposed algorithm when comparing it with the state-of-the-art methods.

Modeling and Solving the K-track Assignment Problem

Jakob Preininger, Nysret Musliu and Felix Winter

TU Wien

In the industrial production of cleaning supplies, larger production quantities are stored in storage boilers and from there they are filled into household-sized bottles. An interesting problem arises in the planning of this process in which production orders have to be assigned to these storage boilers at predetermined times.

It turns out that this problem corresponds to a variant of the problem known in the literature as the k-track assignment problem or operational fixed job scheduling problem (OFJSP), which is a classical NP-hard optimization problem. In this paper we investigate and compare different modelling approaches including a direct ILP model, a network flow based reformulation as well as a simulated annealing approach. We evaluate these methods on a large set of instances for this problem and on benchmark instances for a related problem. We show that the simulated annealing approach provides very good solutions and outperforms other known solution approaches for larger instances. Our methods have been applied in real-life scenarios, where they have been able to obtain optimal solutions in a short time.

Instance Space Analysis for the Generalized Assignment Problem

Tobias Geibiner, Lucas Kletzander and Nysret Musliu

TU Wien

In this work we consider the well-studied Generalized Assignment Problem and investigate the performance of several metaheuristic methods. To obtain insights on strengths and weaknesses of these solution approaches we perform Instance Space Analysis on the existing instance types and propose a set of features describing the hardness of an instance.

This is of interest since the existing benchmark set is dated and rather limited and the known instance generators might not be fully representative. Our analysis for metaheuristic methods reveals that this is indeed the case and finds several gaps, which we fill with newly generated instances thus adding diversity and providing a new benchmark instance set. Further we analyze the impact of problem features on the performance of used methods and identify the most important ones.

Iterated Local Search with Genetic Algorithms for the photo slideshow problem

Labeat Arbneshi and Kadri Sylejmani

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In this extended abstract, we present a two-stage approach for solving the photo slideshow problem as defined in the qualification round of the Google Hash Code 2019. In the first stage, we apply a Genetic Algorithm to produce a good-quality initial solution, whereas, in the second stage, we apply an Iterated Local Search metaheuristic to further optimize the solution. The presented computational study in four challenging test instances show that our approach produces comparable results to the ones achieved in the competition, where, for two of the instances, new benchmark results are obtained.

Self-adaptive publish/subscribe network design

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The pub/sub pattern is gaining momentum in IoT architectures, thanks to its robustness and since it offers many-to-many communication. An efficient network management is needed when only scarse and unreliable resources are available as network infrastructure. Moreover, any form of centralized control should be avoided so as not to limit the application potential. This {\it short paper} presents preliminary results of a research line casting pub/sub communication as a dynamic network design problem and supporting optimized adaptive routing via a fully distributed lagrangian matheuristic applied to an extension of the integer multicomodity flow problem.

An agent-based model of follow-the-leader search using multiple leaders

Martha Garzón, Lindsay Álvarez -Pomar and Sergio Rojas-Galeano

Universidad Distrital Francisco José de Caldas

In this paper we study a swarm optimisation algorithm for real-valued bound-constraint cost functions whose search strategy operates on the basis of follow-the-leader intensification and random walk diversification. We studied the single-leader and multi-leader modes of operation. The simplicity of the search rules allows for a straightforward implementation of the algorithm as an agent-based model. In addition, various techniques were devised to prevent premature convergence to local minima and stagnation. We evaluate the efficacy/efficiency of the algorithm with empirical experiments on a testbed of well-known unconstrained real-valued cost functions using the NetLogo simulation environment. Our results indicate that the multi-leader configuration, with a small number of followers, proved to be advantageous both in accelerating convergence to the optimum on all testbed problems and in improving success rates compared to its single-leader version.

Hybrid PSO/GA+solver approaches for a bilevel optimization model to optimize electricity dynamic tariffs

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Electricity retail markets are subject to competition and retailers generally work with thin commercialization margins. Thus, to increase their market share, these companies should offer attractive tariff options to consumers, including time-of-use pricing schemes, to maximize profits by exploiting the differences between buying energy in wholesale markets and selling it to consumers. In turn, consumers aim to minimize the electricity bill by making the most of time-differentiated prices. For this purpose, consumers may be assisted by an automated energy management system performing on their behalf the integrated optimization of appliance operation, charging/discharging of electric vehicle and stationary batteries, on-site generation, and exchanges with the grid. The retailer's problem considering the consumer's demand response can be formulated as a bilevel mixed-integer nonlinear programming model. The retailer is the leader acting first by setting the prices, and the consumer is the follower reacting to those prices. Two hybrid PSO+solver and GA+solver algorithms have been developed to cope with the complexity of this model. The PSO and the GA deal with the upper-level search determining the prices. The exact solver computes the solution to the lower-level problem for each price instantiation, which becomes a mixed-integer linear program to determine the corresponding optimal demand schedule. Results are presented for realistic data, comparing the two hybrid approaches. The GA+solver approach achieved slightly better results than the PSO+solver approach.


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