Preface

This book aims to give the reader some of the most recent research dealing with the development of metaheuristics.

The document gathers 28 chapters. These chapters could be divided into two main sets. The first one, Chaps. 1–10, is dedicated specifically to present some new optimization and modeling techniques based on metaheuristics. The goal of the second set, Chaps. 11–28, is to develop some advanced metaheuristic approaches to solve real-life applications issue such as scheduling, vehicle routing problem, multimedia sensor network, supplier selection, bin packing, objects tracking, radio frequency identification.

All the results proposed in the present document were accepted and presented during the conferences MIC'15, the eleventh edition of the Metaheuristics International Conference, which was held from June 7 to 10, 2015, in Agadir, Morocco, and META'14, the fourth edition of the International Conference on Metaheuristics and Nature Inspired Computing, which was held from October 27 to 31, 2014 in Marrakech, Morocco.

The first chapter, entitled "Hidden Markov Model Classifier for the Adaptive Particle Swarm Optimization," by Oussama Aoun, Malek Sarhani, and Abdellatif El Afia, presents an integration of hidden Markov Model (HMM) particle swarm optimization (HMM) in APSO (adaptive particle swarm optimization) to have a stochastic state classification at each iteration. To tackle the problem of the dynamic environment during iterations, an additional online learning for HMM parameters is integrated into the algorithm using online expectation-maximization algorithm. The authors performed evaluations on ten benchmark functions to test the HMM integration inside APSO.

The second chapter, by Oumayma Bahri, Nahla Ben Amor, and El-Ghazali Talbi, is dedicated to deal with the possibilistic framework for multi-objective optimization under uncertainty. This chapter addresses the multi-objective problems with fuzzy data, in particular, with triangular-valued objective functions. To solve

such problems, the authors have proposed an extension of two multi-objective evolutionary algorithms SPEA2 and NSGA-II, by integrating a new triangular Pareto dominance.

The third chapter, "Combining Neighborhoods into Local Search Strategies," by Renaud De Landtsheer, Yoann Guyot, Gustavo Ospina, and Christophe Ponsard, develops a declarative framework for defining local search procedures. It proceeds by combining neighborhoods by means of so-called combinators that specify when neighborhoods should be explored and introduce other aspects of the search procedures such as stop criteria, solution management, and various metaheuristics. The approach proposed by the authors introduces these higher-level concepts natively in local search frameworks in contrast with the current practice which still often relies on their adhoc implementation in imperative language.

The fourth chapter, "All-Terrain Tabu Search Approaches for Production Management Problems," by Nicolas Zufferey, Jean Respen, and Simon Thevenin, is dedicated to the presentation of tabu search approaches with enhanced exploration and exploitation mechanisms. For this purpose, some specific ingredients are discussed: different neighborhood structures (i.e., different types of moves), guided restarts based on a distance function, and deconstruction/reconstruction techniques.

The fifth chapter, "A Re-characterization of Hyper-heuristics," by Jerry Swan, Patrick De Causmaecker, Simon Martin, and Ender Özcan, tackles with hyper-heuristic optimization methodology. Hyper-heuristic search has traditionally been divided into two layers: a lower problem-domain layer (where domain-specific heuristics are applied) and an upper hyper-heuristic layer (where heuristics are selected or generated). The interface between the two layers is commonly termed the "domain barrier". The authors show how it is possible to make use of domain knowledge without loss of generality and describe generalized hyper-heuristics which can incorporate arbitrary domain knowledge.

The sixth chapter, "POSL: A Parallel-Oriented Metaheuristic-Based Solver Language," by Alejandro Reyes Amaro, Eric Monfroy, and Florian Richoux, proposes a parallel-oriented solver language (POSL, pronounced "puzzle"), a new framework to build interconnected metaheuristic-based solvers working in parallel. The novelty of this approach lies in looking at solver as a set of components with specific goals, written in a parallel-oriented language based on operators. A major feature in POSL is the possibility to share not only information, but also behaviors, allowing solver modifications during runtime. POSL's main advantage is to allow solver designers to quickly test different heuristics and parallel communication strategies to solve combinatorial optimization problems, which are usually time-consuming and very complex technically, requiring a lot of engineering.

The seventh chapter, "An Extended Neighborhood Vision for Hill-Climbing Move Strategy Design," by Sara Tari, Matthieu Basseur, and Adrien Goëffon, aims at determining pivoting rules that allow hill-climbing to reach good local optima. The authors propose to use additional information provided by an extended neighborhood for an accurate selection of neighbors and introduce the maximum expansion pivoting rule which consists in selecting a solution which maximizes the improvement possibilities at the next step.

The eighth chapter, "Theory Driven Design of Efficient Genetic Algorithms for a Classical Graph Problem," by Dogan Corus and Per Kristian Lehre, presents a principled way of designing a genetic algorithm which can guarantee a rigorously proven upper bound on its optimization time. The shortest path problem is selected to demonstrate how level-based analysis, a general-purpose analytical tool, can be used as a design guide. We show that level-based analysis can also ease the experimental burden of finding appropriate parameter settings.

The ninth chapter, "On the Impact of Representation and Algorithm Selection for Optimisation in Process Design: Motivating a Metaheuristic Framework," by Eric S. Fraga, Abdellah Salhi, and El-Ghazali Talbi, aims at demonstrating that the method choice does matter. For a set of problems, all in the same domain of heat exchanger network synthesis, different combinations of method and representation work best for individual problems. This motivates the development of an overarching method which could identify the best combination and solve the problem most effectively. The authors propose a Multiple Heuristics, Multiple Representation (MHMR) paradigm which mirrors the Multiple Algorithm, Multiple Formulation (MAMF) model for the exact solution. Exploring this paradigm, say through the design and implementation of prototype software frameworks will be the focus for future work in our respective research groups.

The tenth chapter, "Manufacturing Cell Formation Problem Using Hybrid Cuckoo Search Algorithm," by Bouchra Karoum, Bouazza Elbenani, Noussaima El Khattabi, and Abdelhakim A. El Imrani, presents an adapted optimization algorithm entitled the cuckoo search algorithm for solving this kind of problems. The proposed method is tested on different benchmark problems; the obtained results are then compared to others available in the literature.

Chapter 11, "Hybridization of Branch-and-Bound Algorithm with Metaheuristics for Designing Reliable Wireless Multimedia Sensor Network," by Omer Ozkan, Murat Ermis, and Ilker Bekmezci, contributes to deploy sensor nodes to maximize the WMSN reliability under a given budget constraint by considering terrain and device specifications. The reliable WMSN design with deployment, connectivity, and coverage has NP-hard complexity, therefore a new hybridization of an exact algorithm with metaheuristics is proposed. A branch-and-bound approach is embedded into hybrid simulated annealing (HSA) and hybrid genetic algorithm (HGA) to orient the cameras exactly. Since the complexity of the network reliability problem is NP-complete, a Monte Carlo simulation is used to estimate the network reliability.

Chapter 12, "A Hybrid MCDM Approach for Supplier Selection with a Case Study," by Hanane Asselaou, Brahim Ouhbi, and Bouchra Frikh, considers the supplier selection problem where one of the strategic decisions that have a significant impact on the performance of the supply chain. In this chapter, the supplier selection problem of a well-known refining company in Africa is investigated, and an integrated DEMATEL-ANP-TOPSIS methodology is used to select the best supplier providing the most customer satisfaction for the criteria determined.

Chapter 13, "A Multi-objective Optimization via Simulation Framework for Restructuring Traffic Networks," subject to increases in population by Enrique Gabriel Baquela, and Ana Carolina Olivera, studies a nonlinear and stochastic problem

which is the traffic network design problem. The origin-destiny traffic assignment problem is a particular case of this problem. The authors propose the use of a multi-objective particle swamp optimization together with traffic simulations in order to generate restructuring alternatives that optimize both, traffic flow and cost associated to this restructure.

Chapter 14, by S. Chaimatanan and D. Delahaye and M. Mongeau, deals with hybrid metaheuristic for air traffic management with uncertainty, the 4D trajectory optimization of each aircraft so as to minimize the probability of potential conflicts between trajectories. A hybrid-metaheuristic optimization algorithm has been developed to solve this large-scale mixed-variable optimization problem. The algorithm is implemented and tested with real air traffic data, taking into account uncertainty over the French airspace for which a conflict-free and robust 4D trajectory plan is produced.

Chapter 15, by Michaela Zehetner and Walter J. Gutjahr, considers the sampling-based genetic algorithms for the bi-objective stochastic covering tour problem. The authors presented different approaches for solving an extended version of the covering tour problem (CTP), namely, the bi-objective stochastic.

Chapter 16, "A Metaheuristic Framework for Dynamic Network Flow Problems," by M. Hajjem, H. Bouziri, and E.G. Talbi, considers the definition of a metaheuristic framework for the NP-hard flow over time problems. A specific case study of dynamic flow problem is treated, precisely the evacuation problem from a building. Therefore, the authors have supposed that the dynamic maximum flow model with flow-dependent transit time could handle the dynamic property and the crowdedness on nodes and arcs. The genetic algorithm as a population-based evolutionary method to treat this NP-hard problem is proposed.

In Chap. 17, "A Greedy Randomized Adaptive Search for the Surveillance Patrol Vehicle Routing Problem," by Simona Mancini, a new rich vehicle routing problem is introduced, the surveillance patrol vehicle routing problem (SPVRP). This problem came out from a real need of a surveillance company to create fairer routing plans for its security patrols. The problem consists into routing a set of patrols in order to visit a set of checkpoints. Each checkpoint requires one or more visits, each one of which is to be performed within a fixed time window. Minimum time spacing between two consecutive visits should be observed. The goal is to minimize cost while minimizing, at the same time, time windows and minimum spacing constraint violations. To address this problem, a greedy randomized adaptive search algorithm is used to provide good solutions, and a further GRASP algorithm is used to generate pools of good solutions.

Chapter 18, "Strip Algorithms as an Efficient Way to Initialize Population-Based Metaheuristics," by Birsen İrem Selamoğlu, Abdellah Salhi, and Muhammad Sulaiman, presents the strip algorithm (SA) which is a constructive heuristic. This method has been tried on the Euclidean travelling salesman problem (TSP) and other planar network problems with some success. The authors set out to investigate new variants such as the 2-part strip algorithm (2-PSA), the spiral strip algorithm (SSA) and the adaptive strip algorithm (ASA).

Chapter 19, "Matheuristics for the Temporal Bin Packing Problem," by Fabio Furini and Xueying Shen, develops an extension of the bin packing problem, where items consume the bin capacity during a time window only. The problem asks for finding the minimum number of bins to pack all the items respecting the bin capacity at any instant of time. Both a polynomial-size formulation and an extensive formulation are studied. Various heuristic algorithms are developed and compared, including greedy heuristics and a column generation-based heuristic.

Chapter 20, "A Fast Reoptimization Approach for the Dynamic Technician Routing and Scheduling Problem," by V. Pillac, C. Guéret, and A.L. Medaglia, the technician routing and scheduling problem (TRSP) consists in routing staff to serve requests for service, taking into account time windows, skills, tools, and spare parts. The authors tackle the dynamic TRSP (D-TRSP) with new requests appear over time. They propose a fast reoptimization approach based on a parallel adaptive large neighborhood search (RpALNS) able to achieve state-of-the-art results on the dynamic vehicle routing problem with time windows. In addition, the authors solve a set of randomly generated D-TRSP instances and discuss the potential gains with respect to a heuristic modeling a human dispatcher solution.

Chapter 21, "Optimized Air Routes Connections for Real Hub Schedule Using SMPSO Algorithm," by H. Rahil, B. Abou El Majd, and M. Bouchoum, presents study dealing with the choice to open new routes for air carriers, airports and regional governments have some tools to promote desirable connections to be offered toward specific destinations. With a given flight program, the air carrier decision to open new routes faces several constraints and affects the flight schedules in a remarkable way. This chapter is the first to introduce the problem of connectivity in the network of an airline whose main activity is based on air hub structure, optimizing the insertion of new airline routes while ensuring the best fill rate seats and avoiding significant delays during correspondence. Quality of service index (QSI) will be considered as a dual parameter for the profit of a newly opened market. The experimental tests are based on real instance of Royal Air Maroc flights schedule on the hub of Casablanca.

Chapter 22, "Solving the P/Prec,pj;Ci j/Cmax Using an Evolutionary Algorithm," by Dalila Tayachi, tackles the problem of scheduling a set of related tasks on a set of identical processors, taking into account the communication delays with the objective of minimizing the maximal completion time. As the problem is well known as NP-hard, a particle swarm optimization (PSO) is proposed to solve it. The proposed approach HEA-LS is a hybrid algorithm involving particle swarm optimization (PSO) and local search algorithm (LSA). Experiments conducted on several benchmarks known in the literature prove the effectiveness of the proposed approach and show that it compares very well to the state-of-the-art methods.

Chapter 23, "A User Experiment on Interactive Reoptimization Using Iterated Local Search," by David Meignan, presents an experimental study conducted with subjects on an interactive reoptimization method applied to a shift scheduling problem. The studied task is the adjustment, by a user, of candidate solutions provided by an optimization system in order to introduce a missing constraint. Two proce-

dures are compared on this task. The first one is a manual adjustment of solutions assisted by software that dynamically computes the cost of the current solution. The second procedure is based on reoptimization. For this procedure, the user defines some desired changes on a solution, and then a reoptimization method is applied to integrate the changes and re-optimize the rest of the solution.

Chapter 24, "Surrogate-Assisted Multi-objective Evolutionary Algorithm for Fuzzy Job Shop Problems," by Juan José Palacios, Jorge Puente, and Camino R. Vela, Inés González-Rodríguez and El-Ghazali Talbi, considers a job shop scheduling problem with uncertain processing times modeled as triangular fuzzy numbers and propose a multi-objective surrogate-assisted evolutionary algorithm to optimize not only the schedules' fuzzy makespan but also the robustness of schedules with respect to different perturbations in the durations. The surrogate model is defined to avoid evaluating the robustness measure for some individuals and estimate it instead based on the robustness values of neighboring individuals, where neighbor proximity is evaluated based on the similarity of fuzzy makespan values.

In Chap. 25, "Toward a Novel Reidentification Method Using Metaheuristics," by Tarik Ljouad, Aouatif Amine, and Ayoub Al-Hamadi, and Mohammed Rziza, tracking multiple moving objects in a video sequence can be formulated as a profile matching problem. The authors introduce a novel modified cuckoo search (MCS) based reidentification algorithm. A complex descriptor representing each moving person is built from different low-level visual features such as the color and the texture components. The authors make use of a database that involves all previously detected descriptors, forming therefore a discrete search space where the sought solution is a descriptor and its quality is represented by its similarity to the query profile.

Chapter 26, "Facing the Feature Selection Problem with a Binary PSO-GSA Approach," by Malek Sarhani, Abdellatif El Afia, and Rdouan Faizi, considers feature selection. The latter has become the focus of much research in many areas where we can face the problem of big data or complex relationship among features. Metaheuristics have gained much attention in solving many practical problems, including feature selection. The contribution of the authors is to propose a binary hybrid metaheuristic to minimize a fitness function representing a trade-off between the classification error of selecting the feature subset and the corresponding number of features. This algorithm combines particle swarm optimization (PSO) and gravitational search algorithm (GSA).

Chapter 27, "An Optimal Deployment of Readers for RFID Network Planning Using NSGA-II," by Abdelkader Raghib, Badr Abou El Majd, and Brahim Aghezzaf, considers radio frequency identification (RFID). RFID process depends on radio frequency waves to transfer data between a reader and an electronic tag attached to an item, in order to identify objects or persons, which allows an automated traceability. In order to optimize the deployment of RFID reader problem, the authors propose a new approach based on multi-level strategy using as main objectives the coverage, the number of deployed readers and the interference. Non-dominated sorting genetic algorithm II (NSGA-II) is adopted in order to minimize the total quantity of readers required to identify all tags in a given area.

Chapter 28, "An Enhanced Bat Echolocation Approach for Security Audit Trails Analysis Using Manhattan Distance," by Guendouzi Wassila and Boukra Abdelmadjid, deals with the security audit trail analysis problem. This problem is classified as an NP-hard combinatorial optimization problem. The authors propose to use the bat echolocation approach to solve such a problem. The proposed approach, named an enhanced binary bat algorithm (EBBA), is an improvement of bat algorithm (BA). The fitness function is defined as the global attack risks.

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December 2016

http://www.springer.com/978-3-319-58252-8

Recent Developments in Metaheuristics
Amodeo, L.; Talbi, E.-G.; Yalaoui, F. (Eds.)
2018, XXIII, 496 p. 190 illus., 75 illus. in color.,
Hardcover
ISBN: 978-3-319-58252-8