Preface

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The second “Data science meets optimization (DSO)” workshop was held in Macao, China, on August 11, 2019, at the 28th International Joint Conference on Artificial Intelligence (IJCAI 2019).

This workshop continued the first DSO workshop at the Federated Artificial Intelligence Meeting 2018 in Stockholm. The DSO workshop is closely related to the DSO working group of The Association of European Operational Research Societies (EURO). This working group, coordinated by Patrick De Causmaecker, was created in 2016 with members from both operations research (OR) and Artificial intelligence (AI) communities. The aim of the DSO workshop series is to organize an open discussion and exchange of ideas by researchers from AI and OR in order to identify how techniques from these two fields can benefit each other. The presentations from the DSO workshop at IJCAI 2019 covered the following topic areas: machine learning for solving optimization problems; algorithm tuning, selection, and portfolios; methods from AI meeting optimization; and optimization techniques for machine learning.

We invited presenters at the DSO workshop 2019 to submit full papers to this special issue of the journal *Annals of Mathematics and Artificial Intelligence*. This process led to the selection of six papers.

In *Instance Space Analysis for a Personnel Scheduling Problem*, the authors study a rotating workforce scheduling problem. They evaluate various algorithms on test instances generated based on a method called Instance Space Analysis (ISA). The ISA method first uses machine learning to classify the hardness of problem instances, then identifies gaps in the instance space, and finally adds additional, diverse samples to the test suite. In this way, the strengths and weaknesses of algorithms can be analyzed in a more unbiased way.

The authors of *Black-box Combinatorial Optimization using Models with Integer-valued Minima* tackle a challenge in solving optimization problems, whose objectives can only be evaluated with costly or noise measurements. Although black-box optimization algorithms are

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suitable for handling this situation, their applications are mainly on continuous optimization problems. The authors propose a black-box algorithm called IDONE, which can be used to solve combinatorial problems with integer constraints. The IDONE algorithm is tested on a noise perturbed Travelling Salesman Problem and compared with several other search algorithms and a Bayesian optimization algorithm.

In *Classifier-Based Constraint Acquisition*, the authors consider constraint acquisition methods to automate the modeling process for optimization problems. In the proposed two-stage approach, ClassAcq, to constraint acquisition, the authors train a classifier to discriminate between solution and non-solutions and then derive a constraint model from the classifier. The authors take a specific classifier, i.e., Bernoulli Naive Bayes classifier, to illustrate the potential of the ClassAcq approach in solving several constraint satisfaction problems such as Latin squares, Sudoku, Golomb rulers, and Random 3-SAT. The approach is shown to be fast and scalable and can learn redundant constraints.

Data Driven Design for Online Industrial Auctions also addresses the challenge of automating the modeling process. The authors study a real-world auction optimization problem with an objective to maximize the expected auction performance. Since there is very little expert knowledge available on the relations between auction parameters and performance, the authors apply classification methods on historical auction data to learn such relations. The learned classifier is then transformed into constraints to be integrated into an integer linear programming (ILP) model for the action optimization problem, which is solved by an off-the-shelf optimization solver. The optimized auction designs are validated by auction experts.

In *Optimal Algorithm Portfolios for Computationally Hard Real-Time Problems*, the authors consider a real-time system setting where the best possible solution to an NP-hard problem must be obtained within a short and fixed amount of time. The authors model this problem as a K-Algorithms Cover Problem that selects the optimal K out of n anytime algorithms. They prove the complexity of this problem and show that it is approximable. The empirical results compare different parallel portfolios on the instances that are similar to those from the drone navigation problem and demonstrate the effectiveness of the approach in coping with hard combinatorial optimization problems under a very short timeout.

Finally, the authors of *Data-driven Algorithm Selection and Tuning in Optimization and Signal Processing* address an empirical algorithm selection and tuning approach. Problem instances are used to train a neural network that can assist in tuning parameters and algorithm selection. The authors illustrate their method in selecting greedy algorithms for solving the compressed sensing problem and the best step size in the stochastic gradient descent algorithm. Moreover, they prove that there exist learning algorithms for these problems of interest, which, with high probability, select the algorithm or parameter that achieves the optimal average performance for a given distribution of functions.

We would like to thank the reviewers for their excellent work: this special issue would not have been possible without their efforts.

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