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PREFACE

Preface to the special issue of JOGO on the occasion of the 40th anniversary of the Group for Research in Decision Analysis (GERAD).

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Machine learning and optimization research communities have been increasingly gathering efforts to face hard global optimization problems. For example, optimization is largely used for setting the parameters of machine learning models, or to create more compact data representations without much loss of information. In turn, machine learning is widely used for data-driven optimization yielding methods better tailored for the final practical applications. This special issue of JOGO is devoted to the publication of innovative global optimization algorithms revolving around the combination of optimization and machine learning techniques.

Moreover, this special issue is published on the occasion of the 40th anniversary of the Group for Research in Decision Analysis (GERAD) research center, funded in 1979. GERAD is a well established laboratory that regroups researchers in operational research and optimization from various universities in Montréal, Canada. Currently, it hosts 110 members and more than 400 graduate students.

The referee process led to the acceptance of nine articles whose contributions are in accordance with the special issue proposed topic. The first article *Learning chordal extensions* by D. Liu, A. Lodi and M. Tanneau proposes the use of machine learning, more specifically an on-policy imitation learning algorithm, to compute chordal extensions of graphs which play an important role in sparse numerical optimization. The second article *The conditional p-dispersion problem* by M. Cherkesly and C. Contardo introduces the conditional p-dispersion problem and proposes efficient global optimization solution methods for it based on data clustering. The third article *Learning discontinuous piecewise affine fitting functions using mixed integer programming over lattice* by R. Shen, B. Tang, L. Liberti, C. D'Ambrosio and S. Canu. addresses the problem of fitting a piecewise-affine, possibly discontinuous, function to data belonging to a lattice. Two unsupervised and non-parametric models, modeled as MILPs, are presented, and results reported for 2D-image segmentation and denoising. The fourth article *Advances in verification of ReLU neural networks* by A. Rössig and M. Petkovic deals with MIP-based techniques to verify trained neural networks with ReLU activation. This topic has received a lot of attention recently, motivated especially by the detection of adversarial

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examples and the embedding of trained neural networks within optimization models. The fifth article *Resolving sets and integer programs for recommender systems* by A. Hertz, T. Kuflik and N. Tuval proposes to use resolving sets, which are efficiently computed via integer programming, to make recommendations to users based on their ratings about a number of items, for which a set of attributes is known. The sixth article *An outer-inner linearization method for non-convex and nondifferentiable composite regularization problems* by M. Pham, X. Lin, A. Ruszczyński and Y. Du proposes a new outer-inner linearization method for non-convex learning problems involving non-convex structural penalties and non-convex loss that can be expressed as a composite optimization model. The seventh article, *Surrogate Optimization of Deep Neural Networks for Groundwater Predictions*, by J. Müller, J. Park, R. Sahu, C. Varadharajan, B. Arora, B. Faybishenko, and D. Agarwal, introduces model-based derivative-free techniques for the hyperparameter optimization of deep neural networks, which are applied to the tuning of several types of networks for the prediction of groundwater levels. This is a good illustration of the application of optimization to tackle a machine learning problem. The eighth article, *Optimal Decision Trees for Categorical Data via Integer Programming* by O. Günlük, J. Kalagnanam, M. Menickelly, and K. Scheinberg, is another illustration of the use of (discrete) optimization for machine learning problems: it formulates a mixed-integer programming model to design optimal decision trees for classifying categorical data. Finally, in the ninth and last article, *Using symbolic calculations to determine largest small polygons*, C. Audet, P. Hansen, and D. Svrtan pursue their long tradition of using global optimization and mathematical techniques to find the exact polynomials that give the maximal area of the hexagon and octagon of unit diameter.

Finally, we would like to thank the Editor-in-Chief Sergiy Butenko for accepting our special issue proposal. We are also very grateful to the contributing authors and the anonymous reviewers who ensured the high standards of this special issue.