

Special Issue: “Optimization Algorithms: Theory and Applications”

Frank Werner 

Faculty of Mathematics, Otto-von-Guericke University, 39016 Magdeburg, Germany; frank.werner@ovgu.de;
Tel.: +49-391-675-2025

1. Introduction

This Special Issue of the journal *Mathematics* was dedicated to compiling new results in the area of optimization algorithms, and both theoretical works and practical applications have been searched. In comparison with my recent guest-edited Special Issues on Discrete Optimization in mathematics (with 19 papers published between 2018 and 2019) and AIMS Mathematics (22 papers published between 2023 and 2024), as well as a recent Special Issue jointly edited with Alexander Lazarev and Bertrand Lin on Discrete Optimization and Scheduling in mathematics (11 published papers between 2022 and 2024), I have broadened the scope of the current Special Issue.

In the Call for Papers, a wide range of subjects were mentioned, e.g., linear, non-linear, integer and mixed-integer programming; combinatorial optimization; stochastic optimization; robust optimization; multi-criteria optimization problems; optimization on graphs and networks; scheduling; control-theoretic problems, advanced heuristics and metaheuristics; and machine learning, to name a few. Papers on applications, e.g., in logistics, manufacturing, transportation or healthcare, were also welcome. Such optimization problems are of great relevance and practical importance.

For this Special Issue, 32 submissions were received. After a careful refereeing process, 10 papers with authors from 9 countries were selected for this Special Issue, which represented a broad spectrum of research fields in the optimization area. This corresponds to an acceptance rate of 31.25%. The papers in this Special Issue address topics such as unconstrained optimization, scheduling, graph theory, and multi-criteria optimization. As a rule, all submissions were reviewed by two or more experts from the corresponding research field. Subsequently, the published papers were surveyed in order of their publication dates for this Special Issue.

The first accepted paper, by Chen et al., presents an arithmetic optimization algorithm that is based on a population control strategy. In particular, the population is classified, and the number of individuals is adaptively controlled, which leads to a more effective search in the space. The developed algorithm is tested on six nonlinear systems of equations, 10 numerical integrations, and an engineering problem. The presented algorithm outperforms existing ones.

The second paper in this Special Issue, by Feng et al., deals with a high-dimensional semi-parametric regression model. The authors consider a partially linear model with a restricted profile and use the least squares method to estimate the parameters. By using an augmented Lagrangian function under linear constraints, the problem is transformed into an unconstrained optimization problem. Some numerical simulations are used to underline the effectiveness of the developed algorithm for solving high-dimensional models that are partially linear.

In contribution 3, Zang et al. deal with the distributed blocking flow shop scheduling problem by minimizing the makespan. After presenting a mixed integer linear program-



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ming model, an iterated greedy-algorithm-blending multi-factory collaboration mechanism is derived. For the computational experiments, 270 instances with up to 7 factories, 10 machines, and 500 jobs are used. The developed approach gives better results than the five algorithms used for the comparison.

Then, Lai et al. deal with nonlinear unconstrained optimization and present a modification of the q -BFGS algorithm (q -calculus Broydon–Fletcher–Goldfarb–Shanno method), which is a quasi-Newton approach. For building a q -Hessian, the approach uses only first-order q -derivatives. The presented modification preserves the convergence properties of the q -BFGS method without the convexity assumption of the objective function. Detailed numerical results are given that show that the algorithm can often escape from local optima and can move towards a global minimum.

In the next paper, Lemus-Romani et al. investigate the application of metaheuristic techniques to the retaining wall problem. The two objective functions are cost and CO₂ emissions. In particular, a new discretization technique based on reinforcement learning and transfer function is presented. Finally, extensive experiments are performed to compare the implemented techniques, and they show that the suggested approach is promising.

The sixth published paper, by Cobos et al., deals with many-objective optimization and proposes a new mathematical object, augmenting coiving arrays, which allows for better sampling of the intersections of the different objectives by taking the least number of weight vectors based on an a priori-defined interaction level. Their proposed method gives better results compared with the traditional weight vector definition and the NSGA-III approach.

In the next paper, Wang et al. present a new hybrid descent conjugate gradient method based on the strongly convergent property of the Dai–Yuan approach and the Hestenes–Stiefel method. Independent of any line search technique, the new approach has a sufficient descent property. Numerical results are presented for 61 problems with 9 large-scale dimensions and 46 ill-conditioned matrix problems. It turns out that the new approach is more effective, robust, and reliable than the other methods considered.

Contribution 8, by Magklaras et al., investigates the fitness of the ordinary least squares approach for tuning the parameters of overlay models. They propose the application of ridge regression, a widely known machine learning approach. The derived method is applied to perturbed data from a 300 mm wafer fab and results in reduced residuals in comparison with the ordinary least squares algorithm.

Then, Arcos-Argudo et al. deal with a graph-theoretic problem. In particular, they investigate some properties of minimal strong digraphs with the goal of bounding the length of a longest cycle. They present several new results. Among others, they derive a bound for the coefficients of the characteristic polynomial of such digraphs and prove that the computation of a longest cycle is an NP-hard problem.

In contribution 10, the last accepted paper, Udvardy et al. investigate the enhancement of the Storage Location Assignment Problem by using evolutionary algorithms. In particular, they develop a Bacterial Memetic Algorithm and compare it with a traditional genetic algorithm. Although the new algorithm does not yield the expected results, one of the novelties of this paper is the specification of the concept of adaptive parameterization and rules.

It is my pleasure to thank all authors for submitting their recent works, all reviewers for their timely and insightful reports, and the staff of the Editorial Office for their support in preparing this Special Issue. I hope that the readers of this Special Issue will find stimulating ideas that initiate new research works in this interesting research field of great practical importance.

Conflicts of Interest: The author declares no conflicts of interest.

List of Contributions

1. Chen, M.; Zhou, Y.; Luo, Q. An Improved Arithmetic Optimization Algorithm for Numerical Optimization Problems. *Mathematics* **2022**, *10*, 2152.
2. Feng, A.; Chang, X.; Shang, Y.; Fan, J. Application of the ADMM Algorithm for a High-Dimensional Partially Linear Model. *Mathematics* **2022**, *10*, 4767.
3. Zhang, C.; Han, Y.; Wang, Y.; Li, J.; Gao, K. A Distributed Flow Shop Algorithm with Setup Times Using Multi-Factory Collaboration Iterated Greedy Algorithm. *Mathematics* **2023**, *11*, 581.
4. Lai, K.K.; Mishra, S.K.; Sharma, R.; Sharma, M.; Ram, B. A Modified q-BFGS Algorithm for Unconstrained Optimization. *Mathematics* **2023**, *11*, 1420.
5. Lemus-Romani, J.; Ossandon, D.; Sepulveda, R.; Carrasco-Astudillo, N.; Yepes, V.; Garcia, J. Optimizing Retaining Walls through Reinforcement Learning Approaches and Metaheuristic Techniques. *Mathematics* **2022**, *11*, 2104.
6. Cobos, C.; Ordonez, C.; Torres-Jimenez, J.; Ordonez, H.; Mendoza, M.: Weight Vector Definition for MOEA/D-Based Algorithms Using Augmented Covering Arrays for Many-Objective Optimization. *Mathematics* **2024**, *12*, 1680.
7. Wang, S.; Wang, X.; Tian, Y.; Pang, L. A New Hybrid Descent Algorithm for Large-Scale Non-convex Optimization and Application to Some Image Restoration Problems. *Mathematics* **2024**, *12*, 3088.
8. Magklaras, A.; Gogos, C.; Alefragis, P.; Birbas, A. Enhancing Parameters Tuning of Overlay Models with Ridge Regression: Addressing Multicollinearity in High-Dimensional Data. *Mathematics* **2024**, *12*, 3179.
9. Arcos-Argudo, M.; Lacalle, J.; Pozo-Coronado, L.M. Cyclic Structure, Vertex Degree and Number of Linear Vertices in Minimal Strong Digraphs. *Mathematics* **2024**, *12*, 3657.
10. Udvardy, K.; Görbe, P.; Bodis, T.; Botzheim, J. Conceptual Framework for Adaptive Bacterial Memetic Algorithm Parameterization in Storage Location Assignment Problem. *Mathematics* **2024**, *12*, 3688.

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