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Editorial

Special Issue "Scheduling: Algorithms and Applications"

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1. Introduction

This special issue of *Algorithms* is dedicated to recent developments of scheduling algorithms and new applications. After the Special Issue on Algorithms for Scheduling Problems, which had 12 papers (see [1]), and the Special Issue on Exact and Heuristic Scheduling Algorithms, which had 9 papers (see [2]), both of which are also available as printed books, this is the third issue in the field of Scheduling in the journal *Algorithms* since 2018 and underlines the increasing interest of researchers in this subject.

For this issue, high-quality papers were solicited to address both theoretical and practical issues in the wide area of Scheduling. Some topics mentioned in the Call for Papers for this issue were enumerative and approximate scheduling algorithms; meta- and matheuristics; scheduling algorithms for problems in logistics, transport, timetabling, healthcare, and energy management; and scheduling under uncertainty, to name a few.

After a careful refereeing process, 12 papers were selected for this issue. As a rule, all submissions have been reviewed by two or three experts in the corresponding area. The authors of the accepted papers come from 13 countries: Belarus, United Arab Emirates, Colombia, China, Korea, Japan, Indonesia, Czech Republic, Greece, Croatia, Denmark, Morocco, and India. First, the review and then the published papers in increasing order of their publication dates for this special issue are briefly surveyed.

2. Special Issue

The survey paper [3] deals with the design, balancing, and scheduling of assembly and production lines under inaccurate data. This paper discusses 149 references from the recent literature on this interesting research field, in particular 30 surveys and books on assembly and production lines published after 1986, as well as about 100 papers since 1998 for assembly lines and about 30 papers since 2014 dealing with disassembly lines. After first briefly giving deterministic formulations and variants of generalizations of the simple assembly line balancing problem, stochastic, fuzzy, and uncertain formulations of such problems are reviewed. Finally, some unsolved research issues are discussed, and various new settings in this research area are suggested.

The first accepted paper [4] deals with the energy management of a power system with multiple energy sources. The goal is the minimization of the power consumption from all sources, which is needed to satisfy the power demand of the system. The authors present a mathematical model and derive a heuristic approach. Both approaches are tested and analyzed on a ground robot with multiple energy sources.

The second paper [5] studies a multi-criteria permutation flow-shop scheduling problem, where both the processing times and the setup times are of stochastic nature. The authors consider four optimization criteria, namely two quantitative and two qualitative criteria. For this problem, they suggest a hybridized simheuristic approach that combines a GRASP procedure, a Monte Carlo simulation, a Pareto archived evolution strategy, and an analytic hierarchy process. Detailed computational results are presented to test the effects of the processing times and the sequence-dependent setup times.

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In the paper [6], the authors deal with the scheduling of a financial data supply chain in order to evaluate the performance of the efficiency of the banking sector. In particular, the objective is the minimization of different cost types subject to such constraints as the availability of the resources, the customer service level, and the dependency relations of the tasks. This paper develops an iterative dynamic scheduling algorithm to handle the data batching process, which turned out to be effective. In addition, a sensitivity analysis is presented when the parameters of the problems are varied.

The paper [7] considers hybrid mixed-flow workshop scheduling with the goal of minimizing the maximum completion time. Using the Spark platform, they develop a hybrid particle swarm algorithm, which is parallelized. The presented parallel algorithm is particularly effective in the case of large batches and avoids falling into a local optimum.

In the paper [8], a problem from the construction industry in Korea is investigated. In particular, a staff scheduling strategy is suggested, which also considers the irregular absence of employees and a new labor policy by applying linear programming. They derive a deterministic staff schedule and then, via a sensitivity analysis and simulation dealing with the stochastic characteristics of absence, various proactive cases are presented.

The paper [9] investigates a User-PC computing system and presents a static assignment algorithm of uniform jobs to workers in such a system. For finding a lower bound on the makespan, the authors use simultaneous linear equations. Moreover, the paper considers the extension of the algorithm to the case of multiple job types. Computational experiments are made for 651 uniform jobs in 3 applications to run on 6 workers in the testbed system. In the future, they also planned to use this algorithm for a multi-criteria shop scheduling problem.

The paper [10] considers an assignment problem and some modifications which can be converted to routing, distribution, or scheduling problems. For some of the resulting variants, the authors focus on the direct use of mixed-integer programming models within the GAMS environment. Finally, benchmark instances of the permutation flow-shop problem and the travelling salesman problem are applied to present the limits of the applicability of the software. In particular, they show that permutation flow-shop problems with 20 jobs and 10 machines, as well as travelling salesman problems with 100 cities, can be solved within a few minutes using GAMS.

In the paper [11], single machine scheduling problems with time-dependent capacity and the objective to minimize the total aggregated tardiness are considered. The authors formulate linear programming and constraint programming models. In addition, three local search schemes are presented, which are applied in a hybrid approach that takes advantage of the constraint programming part. Detailed computational results confirm that for 48 of the considered instances, new best values have been found by the suggested approach.

The paper [12] deals with a problem related to the design of roundabouts with the goal of reducing the uncertainty in decision making during the final design stage. In particular, they analyze and compare the performance estimations of the roundabout using an analytical and a regression model to give recommendations for possible changes in the geometric parameters of a roundabout. In the experiments, the authors generated 60 single-lane roundabouts with 4 legs, which have different sizes and leg alignments. It turned out that the regression model estimated a higher functionality.

The next paper [13] considers a robotic-arm-based food processing system with multiple conveyors, namely an infeed conveyor and two tray lane conveyors. The core problem consists of fixing which item on an infeed conveyor belt is selected by which robotic arm at which position, and on which tray this item will be located. For this problem, the scheduling part must be solved almost in real time. The authors suggest to decompose the problem into sub-problems formulated as a goal program, where the robotic arms are scheduled only for a single tray. Then, the authors test their approach under a simulation environment.

The last accepted paper [14] considers the flow-shop scheduling problem by minimizing the makespan. For this problem, a hybrid metaheuristic algorithm is presented which combines a genetic algorithm with a so-called spotted hyena optimization algorithm. The algorithm has been tested and compared with other state-of-the-art algorithms on instances of the OR library. It turned out that the new algorithm generates optimal or near-optimal solutions and also outperforms existing algorithms, which is confirmed by the application of several statistical analyses.

Finally, as the editor, it is my pleasure to thank the editorial staff of the journal *Algorithms* for their pleasant cooperation, not only during the preparation of this volume, but also for the previous Special Issues which I handled as editor for the journal. I would also like to thank all referees for their thorough and timely reports on the submitted works, and also the authors for submitting many interesting works from a broad spectrum in the Scheduling field.

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References

1. Werner, F.; Burtseva, L.; Sotskov, Y. (Eds.) Special Issue on Algorithms for Scheduling Problems. *Algorithms* **2018**, *11*, 87. [CrossRef]
2. Werner, F.; Burtseva, L.; Sotskov, Y. (Eds.) Special Issue on Exact and Heuristic Scheduling Algorithms. *Algorithms* **2020**, *13*, 9. [CrossRef]
3. Sotskov, Y. Assembly and Production Line Designing, Balancing and Scheduling with Inaccurate Data: A Survey and Perspectives. *Algorithms* **2022**, *16*, 100. [CrossRef]
4. Salah, O.; Shamayleh, A.; Mukhopadhyay, S. Energy Management of a Multi-Source Power System. *Algorithms* **2021**, *14*, 206. [CrossRef]
5. Gonzalez-Neira, E.M.; Montoya-Torres, J.R.; Jimenez, J.-F. A Multicriteria Simheuristic Approach for Solving a Stochastic Permutation Flow Shop Scheduling Problem. *Algorithms* **2021**, *14*, 210. [CrossRef]
6. Sadawi, A.A.; Shamayleh, A.; Ndiaye, M. Efficient Dynamic Cost Scheduling Algorithm for Financial Data Supply Chain. *Algorithms* **2021**, *14*, 211. [CrossRef]
7. Zheng, T.; Wang, J.; Cai, Y. Parallel Hybrid Particle Swarm Algorithm for Workshop Scheduling Based on Spark. *Algorithms* **2021**, *14*, 262. [CrossRef]
8. Park, C.H.; Ko, Y.D. A Practical Staff Scheduling Strategy Considering Various Types of Employment in the Construction Industry. *Algorithms* **2022**, *15*, 321. [CrossRef]
9. Zhou, X.; Funabiki, N.; Htet, H.; Kamoyedji, A.; Anggraini, I.T.; Huo, Y.; Syaifudin, Y.W. A Static Assignment Algorithm of Uniform Jobs to Workers in a User-PC Computing System Using Simultaneous Linear Equations. *Algorithms* **2022**, *15*, 369. [CrossRef]
10. Seda, M. The Assignment Problem and its Relation to Logistics Problems. *Algorithms* **2022**, *15*, 377. [CrossRef]
11. Valouxis, C.; Gogos, C.; Dimitsas, A.; Potikas, P.; Vittas, A. A Hybrid Exact-Local Search Approach for One–Machine Scheduling with Time-Dependent Capacity. *Algorithms* **2022**, *15*, 450. [CrossRef]
12. Ivancev, A.C.; Ahac, M.; Ahac, S.; Dragcevic, V. Comparison of Single-Lane Roundabout Entry Degree of Saturation Estimations from Analytical and Regression Models. *Algorithms* **2023**, *16*, 164. [CrossRef]
13. Nielsen, K.G.; Sung, I.; El Yafrani, M.; Kilic, D.K.; Nielsen, P. A Scheduling Solution for Robotic Arm-Based Batching Systems with Multiple Conveyor Belts. *Algorithms* **2023**, *16*, 172. [CrossRef]
14. Mzili, T.; Mzili, I.; Riffi, M.E.; Dhiman, G. Hybrid Genetic and Spotted Hyena Optimizer for Flow Shop Scheduling Problem. *Algorithms* **2023**, *16*, 265. [CrossRef]