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Editorial: new branches, old roots

**Jacek Blazewicz · Edmund K. Burke ·
Valery S. Gordon · Mikhail Y. Kovalyov ·
Yakov M. Shafransky · Vitaly A. Strusevich**

This special issue of the *Journal of Scheduling* is dedicated to the memory of Vyacheslav S. Tanaev (1940–2002), the initiator and the leader of scheduling research in the Soviet Union and the countries of Eastern Europe. His main fields of interest and contribution include the minimization of functions on permutations of partially ordered elements, conditions for the existence of non-preemptive optimal schedules, mixed graph and multigraph scheduling models, models with recursive functions, symmetric function minimization, scheduling with transfer operators, the parametric decomposition of optimization problems, and many more.

The main topic of this special issue is the development of ideas, mathematical analyses, and solution approaches which were developed in the early days of scheduling research and which are still theoretically and practically relevant today.

There were 18 submissions to this special issue, and 10 of them were accepted for publication. The following two papers directly refer to Tanaev's works.

Gordon, Kovalyov, Levin, Shafransky, Sotskov, Strusevich, and Tuzikov discuss the most important results obtained by Tanaev and trace how his research has influenced others. The bibliography contains the original sources of many results which are insufficiently presented in the Western literature.

Levner and Kats focus on the key contributions by Tanaev to machine scheduling with transportation considerations. In particular, they address cyclic models that arise in robotics. The authors stress Tanaev's pioneering role in this area and give a historical account that features the techniques that he introduced in the 1960s. They discuss how these techniques have contributed to modern research, and they list a number of open questions that were posed in Tanaev's early work.

J. Blazewicz
Institute of Computing Science, Poznan University of Technology, Poznan, Poland
e-mail: jblazewicz@cs.put.poznan.pl

E.K. Burke
School of Computer Science, University of Nottingham, Nottingham, UK
e-mail: ekb@cs.nott.ac.uk

M.Y. Kovalyov (✉) · Y.M. Shafransky
United Institute of Informatics Problems, National Academy of Sciences of Belarus, Minsk, Belarus
e-mail: kovalyov_my@newman.bas-net.by

Y.M. Shafransky
e-mail: shafr@newman.bas-net.by

V.A. Strusevich
School of Computing and Mathematical Sciences, University of Greenwich, London, UK
e-mail: V.Strusevich@gre.ac.uk

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The other papers can be classified as successors of Tanaev's contributions to scheduling theory and its applications.

In the 1970s, computational complexity was recognized as an essential characteristic of a combinatorial problem, and Tanaev's monographs, brochures, and his articles on symmetric function minimization are a rich source of information on this topic.

Kononov, Sevastyanov, and Sviridenko extend our knowledge of computational complexity of shop scheduling problems by providing a complete computational complexity classification for a class of such problems with respect to the values of four parameters: the type of the model (job shop, open shop, or mixed shop), the maximum processing time of operations, the maximum number of operations per job, and the upper bound on the makespan. They establish that this class of problems possesses a basis system consisting of ten problems, which represents the borderline between the polynomially solvable and NP-complete problems of this class.

Tanaev supported studies of models that combine scheduling with other real life activities such as due date determination, transportation, and shop configuration.

Gordon, Strusevich, and Dolgui review scheduling models that combine due date assignment with precedence constraints, variable job processing times, or machine rate modifying activities. The due dates are decision variables in these models which affect the objective function value. The job processing times are variable because they depend on the values of the additional resources, job positions on the machines, or the time spent in the system. The rate modifying activity is a service which increases the machine productivity, but during this service the machine is idle. Computational complexity and algorithmic results for the considered combined models are reported.

Ng and Lu address a model that integrates production and outbound delivery. For both preemptive and non-preemptive versions of the problem on-line algorithms are designed and their competitive ratios are analyzed.

Aubry, Espinose, Jacomino, and Rossi present a method for determining a configuration of a shop with multi-purpose parallel machines that allows a robust performance under demand uncertainties.

With the growth of computer technologies, Tanaev recognized the important role of scheduling models in computer task dispatching and information transfer.

Bodlaender, Schuurman, and Woeginger investigate a class of scheduling problems that arise in the optimization of SQL queries for parallel machines. The aim is to distribute jobs over parallel identical machines to minimize the makespan under the following conditions. The jobs are interconnected and should communicate during their processing, which takes some additional time. If two jobs are interconnected and are allocated to the same machine, their communication time equals zero. The communication time is added to the processing times of both jobs if the jobs are interconnected and are assigned to different machines. The communication times are individual for each pair of interconnected jobs. The problem is evidently NP-hard. The authors demonstrate the existence of a polynomial-time approximation scheme for the case where the operator graph (the graph of the job interconnections) is a tree or where this graph has a treewidth bounded by some constant. For general operator graphs, the existence of a polynomial-time approximation algorithm with a worst-case performance guarantee better than 4/3 implies that P = NP.

Dereniowski and Kubiak study the problem of message routing on a slotted ring network to minimize the makespan and the diagonal makespan. The authors present computational complexity proofs, approximation algorithms, and polynomial-time algorithms for special cases.

Kononov, Hong, Kononova, and Lin consider the following two-machine flow shop permutation problem with multimedia applications. There is a buffer of a bounded size between the two machines. A job may be processed on machine 2 only if its processing has been completed on machine 1 and as a result it is loaded into the buffer. The size of a job that should be loaded into the buffer equals its processing time on machine 1. A job leaves the buffer after it has been completed on machine 2. The total size of the jobs in the buffer cannot exceed the buffer size. The aim is to minimize the makespan. Two models are considered in the paper. In the PP model, all preemptions are prohibited (the processing of a job on machine 1 may start only if the current free buffer size is not less than the size of the job). In the AP model, preemptions on machine 1 are allowed (in this case, the buffer may contain the processed parts of jobs). The strong NP-hardness of the AP-problem is established, and some polynomially solvable subproblems are detected. New lower bounds for both problems are proposed.

Quite recently, logistics has become the main application area for scheduling. The roots of the corresponding models lie in the works of the pioneers of scheduling research.

Boysen, Jaehn, and Pesch consider the transshipment yard scheduling problem which arises in such situations as Megahubs of hub-and-spoke railway systems. Huge gantry cranes transship containers between different freight trains in order to group containers that have the same destination. As the set of trains to be consolidated at the same time (in a bundle) exceeds the number of tracks in the yard, containers have to be exchanged between trains assigned to different bundles. Containers must be temporarily stored in a storage area and picked up again when the receiving train enters the yard (split move). Revisits occur if a train has to enter the yard twice. This happens when not all the containers that are intended for this train were available during the first visit. The paper contains complexity proofs for different problem settings, a branch and bound procedure, and several heuristics to minimize split moves and revisits.

All the papers of this special issue have been strictly refereed in accordance with the normal high standards of the *Journal of Scheduling*. We would like to thank the referees for their objective criticism and useful suggestions and comments. The refereeing process of the paper by Gordon, Kovalyov, Levin, Shafransky, Sotskov, Strusevich, and Tuzikov was handled by Jacek Blazewicz alone.

We are very sad to report that, during the preparation of this special issue, our esteemed friend and colleague, Valery Gordon, passed away. Valery made an outstanding contribution to scheduling theory, and he will be greatly missed by all of us.