

points, which serve a finite number of demand points. Each supply point is located on a road connecting two exits to main streets leading directly to the demand points. The requirements are expressed as inequality systems, which must be satisfied by the membership function values to ensure required quality properties of the connections. Existence of solutions of such inequality systems as well as optimization problems with constraints expressed by such systems is studied. Effective solution methods will be proposed.

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3 - On scale normalization in pairwise comparisons

Jiri Mazurek

Perhaps the most known scale for pairwise comparisons is Saaty's fundamental scale from 1 to 9 (with reciprocals), but other scales (S), for example with 3, 5, or 10 items, are also possible. Usually, S denotes the degree of importance (preference) between two objects i and j . However, it is demonstrated that the scale itself is also important, though some well known pairwise comparisons frameworks, such as the analytic hierarchy process (AHP), are scale invariant. If, for example, S , then its meaning for the scale and the scale is different. In the former case, the preference means medium preference of the object i to the object j , while in the latter case the preference is almost negligible. Therefore, the need of scale normalization arises. The aim of the article is to discuss some suitable transformations of a general scale for pairwise comparisons to interval along with their properties.

4 - Coordination of fuzzy processes working in regular stages

Martin Gavalec, Daniela Ponce, Karel Zimmermann

Mathematical models are proposed, which are based on combinations of different t -norms to satisfy requirements of processes working in regular stages, and on algebraic models of their interactive work. The coordination of the processes is often required in production, transport, economic and social processes, like job-shop scheduling, as well as in some problems of the fuzzy set theory. These lead to systems of $(\max, +)$ -linear and $(\min, +)$ -linear equations or inequalities. Other similar systems use linear operations (\max, T) with a fuzzy t -norm T . The activities in the model may be related to transporting passengers, delivering goods, machine processing of products and others. Each activity is characterized by computing an optimality interval. Finding the solution can be an NP-hard problem. Specific cases in which the problem is polynomially solvable are described.

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solving effects. In experimental analysis, two hybrid meta heuristics including cuckoo search hybrid with variable neighborhood searches and particle swarm optimization algorithms embedded with the proposed variable neighborhood searches are implemented to obtain their solving effects in different sizes of problems. The numerical results show that the embedded particle swarm optimization algorithm can obtain better objective values.

2 - Definition of a new flow graph to model the constraints of a VRPPD in the RCPSPR

Marina Vinot, Philippe Lacomme

The RCPSPR (RCPSP with Routing) is an extension of the RCPSP (Resource-Constrained Project Scheduling Problem) where resources must be transported from one activity to another using a vehicle. This problem deals with two interrelated problems, a scheduling problem (RCPSP) and a routing problem (Vehicle Routing Problem with Pickup and Delivery - VRPPD), and belongs to the family of integrated problems. The RCPSPR is solved by Lacomme et al. in 2017 using a resource flow, inspired by Artigues et al. in 2003. The definition of a resource flow permits to identify the transportation operations, and to obtain a solution of the RCPSPR with an evaluation function. In the resource flow proposed by Lacomme et al. in 2017, modelled by a graph flow, the unit-capacity vehicles are not allowed to transport an amount of resource exceeding the demand of the destination activity. A new graph flow is proposed in this paper, in order to extend the routing problem, by allowing the vehicles to transport an amount of resource exceeding the demand of the destination activity with multiple-capacity vehicles. The extra resources transported can either be delivered and stored on the activity or kept in the vehicle to be delivered in another activity. This new model is evaluated with numerical experimentations, based on a mixed integer linear programming solved with CPLEX. The new solutions of the RCPSPR prove that the makespan can be significantly reduced, by avoiding costly transportation operations.

3 - Paint shop scheduling in the automotive supply industry

Felix Winter, Emir Demirović, Nysret Musliu, Christoph Mrkvicka

We formulate and present a production scheduling problem that appears in paint shops of the automotive supply industry. The goal is to find an optimized schedule for the painting of a large number of different synthetic material pieces that will later be used as assembly parts during car manufacturing. During the process of painting, the demanded pieces will be placed on special made carrier devices which automatically move through the paint shop on a system of conveyer belts and pass by multiple cabins that will then apply layers of paint onto the pieces. Finding a good painting schedule therefore includes the determination of an efficient distribution of the demanded pieces onto the carrier devices and deciding on an optimized production sequence. Thereby, the main optimization objective is to minimize the setup costs that are caused by color and carrier changes that appear within the painting sequence. We formulate the problem mathematically and also propose heuristic solution strategies. Furthermore, we provide a collection of instances and evaluate the results produced with the proposed solution methods. Affiliation: Christian Doppler Laboratory for Artificial Intelligence and Optimization for Planning and Scheduling, TU Wien Acknowledgements: The financial support by the Austrian Federal Ministry for Digital and Economic Affairs and the National Foundation for Research, Technology and Development is gratefully acknowledged.

4 - An integrated mixed method approach for decision making in a multi-facility supply chain: a real life case from the UK steel industry

Lina Simeonova, Niaz Wassan, Said Salhi

This research presents an integrated unified approach to Supply Chain Management applied to the case of the largest steel stockholder in the UK. The purpose is to identify the most efficient and effective Supply Chain Route to satisfying customers' orders. In a multi-facility setting, making informed decisions about which facility to supply the raw materials from, where to process the order and where to deliver the order from, is paramount for minimising inefficiencies, multiple material handling and the overall cost of production. We utilise some Lean tools

■ MD-13

Monday, 14:30-16:00 - SOUTH BUILDING UV S201

Supply Chain Scheduling

Stream: Supply Chain Management II

Chair: *Lina Simeonova*

1 - Cuckoo search for integrating machine scheduling and vehicle routing

Ting-Jhao Jian, Bailu Fang, Gen-han Wu

In this study, we focus on solving the integrating problem of parallel machine scheduling and vehicle routing with the objective of minimizing the total weighted tardiness time. We coordinate the production sequence in identical parallel machines and delivery routes in identical vehicles simultaneously after accepting the customers' order requests. Both of the cuckoo search and particle swarm optimization algorithm are developed to find the optimal solution. In order to intensify the capability of cuckoo search, cuckoo search and particle swarm optimization algorithm into variable neighborhood search and compare their