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INFORMS BEST PUBLICATION IN NATURAL RESOURCES 2023

Two Successful Applications of Resource-Constrained Project Scheduling: Ship Waterway Traversals at Maritime Ports and Strategic Underground Mining

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Lunedì, 20 Novembre 2023

18:00 -19:00

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Abstract: We present two recent optimization-based approaches to real world planning problems in the fields of maritime logistics and underground mining. In both cases we report significant improvements with respect to existing methods that we achieve through the application of resource-constrained project scheduling models. In our first problem, we consider short-term scheduling of ship traversals of waterways that connect the seacoast with the actual port area in accordance with arrival and departure times. Side constraints arising from the port's geographical situation, traffic and the influence of the tides make this problem challenging when minimizing the total ships' turnaround times. We show that this problem can be expressed as a multi-mode resource-constrained project scheduling problem. Using integer programming, we improve previous results for real-world instances allowing us to obtain optimal schedules within a few seconds. In the second problem, we consider a class of problems in strategic underground mine planning that can be modeled as a variant of the resource-constrained project scheduling problem with optional activities and generalized precedence constraints; the objective maximizes net present value. We provide a computational review of mathematical programming and constraint programming, describe and implement novel problem-size reductions, and develop linear programming- and constraint programming-based hybrid techniques to significantly expand the number of computationally tractable problem instances. We analyze the efficacy of the methods applied to instances both from the literature and derived from real-world mines. These practical, large-scale planning problems cannot even be processed using standard optimization approaches. However, our reduction and hybrid strategies allow us to solve them to within less than 5% of optimality in ten minutes and to within less than 3.5% of optimality within a day.

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