Minimize overtime in a parallel machine environment

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(joint work with T. Kis)

We address a resource levelling problem in a parallel machine environment. Given a set of m parallel machines, one renewable resource, and a set of n tasks each dedicated to exactly one of the parallel machines. Each task has a processing time, an earliest start time, a deadline, and a resource requirement. The resource has a finite capacity, but it can be used above this capacity which is the overtime usage of the resource. A schedule with minimum cumulative overtime resource usage is sought.

There are a number of algorithms for the resource levelling problems in project scheduling (see e.g. [2, 3]), but those only work for small instances. However in machine scheduling, resources are generally considered as constraints ([1]).

We propose an exact Branch-and-Bound algorithm to solve this problem. In order to calculate the lower bound in each node of the search tree we have applied Lagrangian relaxation for the preemptive relaxation of the problem, while the upper bound is determined heuristically. This relaxation allows the decomposition of the problem to smaller independent problems which can be solved parallelly. We have tested the parallel implementation of the algorithm on generated test instances and the results show that within reasonable time the optimality gap can be reduced to less then 4% in average.

References:

[1] H. Kellerer, V. A. Strusevich (2004), ,,Scheduling problems for parallel dedicated machines under multiple resource constraints", Discrete Applied Mathematics, 133: pp. 45-68.

[2] K. Neumann and J. Zimmermann (1999), ,,Resource levelling for projects with schedule dependent time windows", European J. Operational Research, 117: pp. 591-605.

[3] K. Neumann and J. Zimmermann (2000), ,,Procedures for resource levelling and net present value problems in project scheduling with general temporal and resource constraints", European J. Operational Research, 127: pp. 425-443.