AN EVALUATION OF EXACT AND SUBOPTIMAL PROCEDURES FOR CONSTRUCTING STABLE PROJECT SCHEDULES

Stijn Van de Vonder, Erik Demeulemeester and Willy Herroelen
Department of Applied Economics,
K.U.Leuven, Belgium
<firstname>.<last name>@econ.kuleuven.be

Abstract Solution robust project scheduling is a growing research field aiming at constructing proactive baseline schedules that anticipate multiple disruptions during project executions. When activity durations are assumed to be stochastic, including time buffers (gaps) in the baseline schedule to absorb disruptions is a proven method to improve the stability of the baseline schedule. The objective of this paper is to introduce and compare exact and heuristic algorithms for allocating buffers into a schedule.

Keywords: Project scheduling, uncertainty, stability, buffers

Introduction

In this paper, we construct stable baseline schedules for projects with stochastic activity durations. Maximizing stability in this context means minimizing the expected weighted deviation between the preschedule and the realized schedule during project execution (Leus, 2003). Recent research (Van de Vonder et al., 2004) showed that this objective function is an interesting alternative for the traditional $min\ C_{max}$ for realistic project settings. We refer to Leus and Herroelen, 2005 for NP-hardness proofs of different stable scheduling problems

The literature concerning stable buffer allocation is almost void. We propose multiple heuristic algorithms. The simple RFDFF heuristic proposed in Van de Vonder et al., 2004 is used as a benchmark method. An exact partial enumeration procedure for smaller projects is also introduced. We provide an extensive computational analysis of all considered algorithms.

1. Algorithms

A qualitative buffer allocation procedure to include safety in a project schedule should mainly consider two important project characteristics. First, the size of the buffer protecting an activity i should be positively correlated with the marginal cost w_i of delaying that activity. Second, also the amount of variability in the durations of all activities that precede activity i in the schedule is relevant information to decide upon the size of the required buffer in front of i.

Our benchmark heuristic RFDFF is only concerned with the relative proportions of all w_i's. The newly proposed single-pass algorithms will also include available information on the activity duration variances.

We also propose a steepest descent and a tabu search algorithm to solve the introduced problem. Last, an exact procedure for allocating time buffers into a schedule is presented. The procedure is based on a partial enumeration of all possible solutions. The search tree is pruned by some dominance rules.

2. Experimental set-up and results

All algorithms have been coded in C++. Extensive simulation on a large set of project networks is used to evaluate the objective function. The impact of the activity durations variance structure on the results is also discussed in detail.

We analyze the computational efficiency of the exact procedure and the effectiveness of the dominance rules.

References

Leus, R. (2003). *The generation of stable project plans.* PhD thesis, Department of applied economics, Katholieke Universiteit Leuven, Belgium.

Leus, R. and Herroelen, W. (2005). The complexity of machine scheduling for stability with a single disrupted job. *Operations Research Letters*, 33:151–156.

Van de Vonder, S., Demeulemeester, E., Herroelen, W., and Leus, R. (2004). The trade-off between stability and makespan in resource-constrained project scheduling. Technical Report 0423, Department of Applied economics, Katholieke Universiteit Leuven, Belgium.