Minimizing Resource Cost in Project Scheduling Problem with Accumulative Resources

Aleksandr Yu. Pirogov[1] and Anna A. Romanova[2,3]⋆

[1] Institut Mines-Télécom Atlantique, 4, Rue Alfred Kastler, 44300, Nantes, France,
aleksandr.pirogov@imt-atlantique.fr
[2] Omsk Law Academy, 12, Korolenko st., 644010, Omsk, Russia;
[3] Dostoevsky Omsk State University, 55a, Mira avenue, 644077, Omsk, Russia.
anna.a.r@bk.ru

We consider a project with a set of jobs $J = \{1, \ldots, n\}$. Precedence constraints are given by a directed acyclic graph $G = (J, E)$, where vertices correspond to jobs and an arc (i, j) belongs to E if and only if job i is a direct predecessor of job j. All jobs have to be completed before the due date T of the project. To be processed, the jobs require accumulative resources that are purchased. Let K denote the set of resources. While being processed, job $j \in J$ requires q_{kj} units of resource $k \in K$ during every period of its non-preemptable duration p_j. The purchase cost of a resource depends on used amount of it per time period. If the amount of the resource $k \in K$ is less than V_k^{norm}, then the cost of resource k per unit equals c_k^{norm}. When this level is exceeded, the new price c_k^{over} is set. Both cases $c_k^{over} > c_k^{norm}$ and $c_k^{over} < c_k^{norm}$ are considered. The goal is to find a feasible schedule and a planning of purchasing and using of resources so that the total resource cost is minimized. This problem with renewable resources is known as Resource Availability Cost Problem (see for ex. [1], [2]).

For unlimited storage, when each resource can be stored in any amount, both considered cases can be solved in polynomial time. However limited storage is more interesting from the practical point of view. In this case, the surplus of a resource k, that is, the resource amount which may be spent later should not exceed the value V_k^{cont}, $k \in K$, in each period of time.

In this paper, we prove NP-hardness and propose integer linear programming models for the considered cases of the problem with limited storage. Dynamic programming algorithms and some heuristics are also developed.

References

1. Möhring, R.H.: Minimizing costs of resource requirements in project networks subject to a fixed completion time. Oper. Res. **32**, 89-120 (1984)
2. Rodrigues, S.B., Yamashita, D.S.: An exact algorithm for minimizing resource availability costs in project scheduling. Eur. Jour. Oper. Res. **206(3)**, 562-568 (2010)

⋆ This research is supported by the RFBR grant 17-07-00868.