Scheduling Worker Timetables in Flowshops with Multi-Skill Workers

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Abstract. This work is inspired by a production line for manufacturing identical products (jobs) by multi-skilled workers. The production of each job consists of a set of pre-ordered successive operations, similar to the problem of a flow shop. However, different from the standard flow shop model, each operation may be performed only by a subset of workers who have the required skills for that operation. The workers are non-identical in the sense that each may posses a different set of skills. The objective is to schedule the timetables of the workers in a manner that minimizes the makespan.

There are two known formulations in the literature that capture the extremes of the multi-skilled workers at focus. The first, flexible (a.k.a. hybrid) flow shop, deals with scenarios in which several single-skilled workers can perform the same operation. The second, reentrant flowshop, deals with scenarios in which multi-skilled workers can perform different tasks but without overlaps, i.e., each operation can be performed by exactly one specific worker.

In a previous study we focused on the reentrant flowshop extreme; we formulated the problem as an integer program (IP) and obtained deep insights on two simple heuristics that solve the problem, in some cases even to optimality. Here, we study extensions of the IP formulation to the multi-skilled flow shop problem (MSFFP). The IP formulation is inspired by modelling the problem as a multi-mode resource constrained project scheduling problem. This model also enables adaptation of heuristics for solving the MSFFP along with several lower bounds that help guaranteeing a reasonable approximation to the optimal makespan.

Keywords: Production Line · Worker Timetabling · Multi-Skilled Workers · Identical Jobs · Resource-Constrained Project Scheduling.