Algorithmic Approaches to Flexible Job Shop Scheduling

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Abstract

The flexible job shop is a generalization of the classical job shop and the parallel machine environment, which allows each operation to be performed by one machine out of a finite subset of valid machines. Accordingly, a more realistic modeling of a wide range of real manufacturing systems is provided. The aim of the flexible job shop scheduling problem (FJSP) is to assign operations to machines (routing problem) and to arrange the operations on the machines (sequencing problem) minimizing the maximal completion time (makespan) of all operations.

In this thesis different mixed integer program formulations of the FJSP are presented and comprehensively analyzed in order to achieve optimal solutions for small size problems. Due to the high computational complexity it is quite difficult to achieve optimal solutions for medium and actual sized problems with traditional optimization approaches. Consequently, approximation algorithms for the FJSP are studied from two different points of view: On the one hand, approaches aiming for performance guarantees of approximation algorithms for the FJSP are considered. For the case of identical machines, i.e. an operation has identical processing times on each machine out of the subset of valid machines, worst case bounds for the makespan of the approximative solution are provided. On the other hand, motivated by the task of optimizing the manufacturing process of a medium-sized enterprise, an efficient heuristic for the FJSP is developed and computational results are evaluated.