Abstract

The term "bottleneck" has been widely used in scheduling research. However, there is little uniformity among the various ways in which the term has been defined. In this context, this thesis examines the concept of bottleneck with a view to developing a unified framework. We analyse, among others, the well known Shifting Bottleneck (SB) heuristic, which is one of the most successful approximation methods for the Job Shop problem. It has been shown that there is limited theoretical justification in choosing L_{max} as the bottleneck predictor in SB heuristic. We propose a bottleneck definition that parallels the concept of Average Shadow Price and show that under certain situations the comparison is an exact one. Valid bottleneck values have been computed for a number of instances of the Job Shop problem. Implications of the Law of Diminishing Returns for the concept of Average Shadow Price have been established. The bottleneck concept has been extended to certain application areas other than scheduling.

Through our analysis of the SB heuristic, we have identified an improvement of the current representation of the One Machine Scheduling (OMS) problem. By introducing a bottleneck predictor which can be computed in polynomial time, we have constructed a variant of the SB heuristic that reports schedule quality comparable to the original SB heuristic with significant savings in computational time.

In the final chapters of the thesis, we analyse the effectiveness of the Resource-based Approach for scheduling Job Shops. While a similar approach of Goldratt for the repetitive manufacturing scenario has been widely acclaimed, we show that a Resource-based Approach will fail to optimally schedule most instances of the n job 2 machine Flow Shop problem. An analysis of the failure of the bottleneck-focussed approach resulted in the identification of a new neighbourhood structure for the Job Shop problem. It has been shown that an algorithm exploiting this neighbourhood structure can optimally solve the n job 2 machine Flow Shop problem.