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Solving Production Planning Problems Using the Tabu Search Metaheuristic

Throughout the last decades the production planning problem has generated considerable amount of research. Being an NP-hard optimization problem, the target is outlined as finding heuristic solutions, rather than optimal ones. This thesis describes the current state of the art and analyzes diverse models designed for solving the production planning problem. For the present purposes, the problem is tackled following an adapted Discrete Lot Sizing and Scheduling model, and a specifically tailored algorithm based on the Tabu Search metaheuristic is proposed.

Discrete Lot-Sizing and Scheduling Problem
Metaheuristic
Production Planning
Optimization Techniques
Tabu Search

Introduction

The project models a real life production planning problem from the industry of Automotive Supply Chain and proposes a metaheuristic solution based on the Tabu Search method.

A theoretical overview of the Tabu search method, describing the key elements and the characteristic advanced strategies associated with this searching technique, is provided. A detailed description of the construction of the initial solution algorithm is offered together with the neighborhood operators involved in the search. In addition to the short-term memory based strategies, diversification and intensification mechanisms are employed to enhance the efficiency of the proposed solution method. Experimental testing is conducted to determine the most suitable values of the parameters for the Tabu Search. Finally, the paper draws a parallel by comparing the performance of the Tabu Search method and two other well-known optimization techniques.

Production Planning

The economic success of modern companies is more and more decided by their ability to react quickly and effectively to changing selling conditions. They have to use their production capacities and resources in an optimal way to be a successful player on the global market. The key for this success is effective production planning. Production planning represents the beating heart of the manufacturing process. It entails the acquisition and allocation of limited resources to production activities so as to satisfy customer demand over a specified time horizon. As such, planning and control problems are inherently optimization problems, where the objective is to develop a plan that meets demand at minimum cost or that fills the demand that maximizes profit. Therefore, the main purpose is to efficiently organize the resources, minimize production costs and maximize efficiency. The underlying optimization problem will vary due to differences in the manufacturing and market context.

Optimization Technique - Tabu Search Metaheuristic

Hard optimization problems abound in the real world in all known domains. Exact methods are the answer for small instances of such problems, however medium and highly complex instances are tackled using metaheuristic algorithms.

As the problem size increases, the search space's size is consequently growing exponentially. Being an NP hard problem, an exhaustive exploration of the search space cannot be performed. Therefore, one option would be to adopt a method able to select and explore only parts of the search space.

By means of memory lists, Tabu search is based on the interplay between intensification and diversification of the search in different regions of the search space. Intensification concerns the throughout exploitation of an interesting region, whilst diversification mainly aims to explore new regions of the search space. It follows the trajectory of a single solution, which is modified step by step until termination criteria are satisfied.

All in all, the underlying concepts of Tabu search, namely the dynamic neighborhood operators and the usage of Tabu lists, give the algorithm flexibility and allow the exploration of the most interesting regions of the search space. Following the trajectory of the solution, a TS based algorithm is self-adaptive and can automatically adjust the search towards intensification or diversification. The memory lists allow the algorithm to proceed from a local optimum aiming at better solutions. Moreover, Tabu Search relies on a reduced number of parameters which must be adjusted and fine tuned. Therefore Tabu Search method represents a promising candidate for solving complex problems like production planning.