Tabu Search

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I. INTRODUCTION

Tabu Search is a meta-heuristic for the approximate solution of complex optimization problems. Starting from a given starting solution, modified solutions are generated in an iterative search process, whereby the search process is controlled by using the tabu search. A heuristic is understood to be a method which efficiently determines, by means of the application of methods considered useful, systematically good but not necessarily optimal solutions (in the sense of action alternatives) for given optimization problems.

Metaheuristics are general, essentially non-problem specific and thus generic principles and schemes for the development and control of heuristic procedures. In the literature, among other things, these include methods which, as part of a search process, aim at the successive identification of improved solutions and build on the principle of local search.

Local search methods search the solution space of an optimization problem in consideration of a given objective and given restrictions in an iterative process. They assume a potentially sub-optimal solution to the problem and try to improve it successively with minor changes. Such a change can also be understood as a transformation or a move, and the amount of all solutions achievable in one go can be called a neighborhood. The transformation process is repeated iteratively until a termination criterion is met.

The basic concept of Tabu Search was developed by Glover to solve (especially combinatorial) optimization problems. The principle is to control a local search method using explicitly a memory structure. The memory structure is used to restrict the search direction of the method or to control the method in an intelligent way through the solution space. In each iteration, a train is selected which leads to the greatest improvement or, if no improvement is possible, the least degradation of the objective value. Deterioration is accepted when no improvement can be realized among all neighborhood solutions. So that the process does not always return to solutions already found, so-called Tabu restrictions on the acceptance of solutions are determined. In the simplest case, solutions that have already been investigated are not investigated again in the following, i.e. a move to such a solution is made Tabu (prohibited or characterized as not executable). Whenever a particular move is made, elements of the solution it achieves are Tabu, which may cause that solution to be prohibited in later iterations.

II. SPECIFICATIONS OF TABU RESTRICTIONS

The use of Tabu restrictions affects decisions regarding the selection of the Tabu moves and the duration of their Tabu status. The definition and administration of tablets can be done in different ways.

Static procedure: In each iteration, exactly one move, namely the complement of the last move, is set for a fixed duration, ie a fixed number of iterations. The idea of the procedure is to ban the move until the likelihood of redemption of a solution by the Tabued move is low. (Saving corresponding elements of a solution corresponds to a so-called short-term memory.) If appropriate, a choice of the duration depending on the type and size of the problem instances to be solved is useful.

Dynamic procedure: In each iteration, a previously unknown number of moves is prohibited. This can be done in particular on the basis of logical problem-related considerations. For example, the reverse elimination method guarantees that all moves that would lead to a solution that has already been visited are Tabu.

In further approaches, particular attention is paid to a clever interaction between intensification and diversification of the search. Here, inter alia, a long-term memory (e.g. to study the frequency of elements of good solutions) can be used to control the search, for example, to examine so far little-considered areas of the solution space.
Reactive Tabu Search aims for an automated adaptation of Tabu restrictions. The idea is to increase the number of moves to be Tabu if more repeats occur during the search. Conversely, this number can be successively reduced if repetitions do not occur.

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