On the large neighborhood search methods

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1 Introduction

In this paper, we provide a framework of metaheuristic designed to solve the vehicle routing problem with time windows (VRP-TW). We integrate a new mechanism to deal with the Adaptive Large Neighborhood Search (ALNS) algorithm applied to the problem. The main challenge is to highlight intensification over diversification within the heuristic search process. In this context, we integrate the process of the choice function into the ALNS algorithm. Therefore, several destroy/repair methods is combined to explore multiple neighborhoods within the same search and defined implicitly the large neighborhood. In order to study the quality of the resulting solution, a comparison between the classical ALNS and the new Modified ALNS (MALNS) is subject to the experiment part of this paper.

2 Modified Adaptive Large Neighborhood Search (MALNS)

2.1 Adaptive Large Neighborhood Search (ALNS)

We will now describe the ALNS that we have used in the present paper [2]. We believe that ALNS can be applied to a large class of difficult optimization problems.

In order to design an ALNS algorithm for a given optimization problem we need to :

— Choose a number of fast construction operators which are able to construct a full solution.
— Select a number of destruction operators. It might be sufficiently important to choose the destruction operators that are expected to work well with the construction operator, but it is unnecessary.

2.2 The Choice Function

The Choice Function is an elegant heuristic selection method which scores heuristics based on three different measures, which emphasises the intensification parameter of the original Choice Function [1]. At each iteration of a search, a heuristic is selected based on a weighted combination of these three measures. The first measure (f_1) reflects the previous performance of a given low-level heuristic. The second measure (f_2) rewards heuristics which are successful when applied consecutively. Values of f_2 are calculated for each heuristic h_j when applied immediately following h_k. The third measure (f_3) is the time $(\tau(h_j))$ since each heuristic was last selected by the Choice Function. This gives all heuristics at least a small chance of selection. This is the general formula :

$$F_t(h_j) = \phi_t f_1(h_j) + \phi_t f_2(h_k, h_j) + \delta_t f_3(h_j)$$

where t is the current iteration. At each step, if the quality of the solution improves, ϕ is rewarded heavily while δ is hardly punished. If the solution quality deteriorates after a low-level heuristic is applied, ϕ is reduced linearly and δ is increased in order to diversify the heuristic search process. This scheme intends to make the intensification component the dominating factor in the calculation of F.

2.3 The Modified Adaptive Large Neighborhood Search (MALNS)

The Modified Adaptive Large Neighborhood Search (MALNS) algorithm studied here, conserves the whole process of the classical ALNS. The only difference that the Modified Adaptive Large Neighborhood Search uses the choice function for each iteration of the destruction and the construction phase in order to select a method for generating the neighborhood (nodes to be removed or to be inserted). During the search process, the MALNS maintains a score $F_t(h_j)$ which measures the best performance of an heuristic h_j in the past iterations.

3 Computational results

The Modified Adaptive Large Neighborhood Search examined was tested on a set of small instances based on the reference of Solomon benchmark (1987)[3].

Table : Comparison between ALNS and the Modified ALNS in terms of objective function

Instance	Best known results	MALNS	ALNS
c103	826.3	854.9	884.1
c104	822.9	846.1	872.3
c105	827.3	839.9	873.6
r105	1355.3	1385.5	1429.5
r106	1234.6	1260.6	1305.1
r107	1064.6	1103.4	1130
rc205	1154	1187	1213.7
rc206	1051.1	1081.3	1112.5
rc208	777.3	823.3	841.6

Experimental results show that our suggested approach is quite effective, as it provides solutions that are competitive with the results obtained by using ALNS alone.

Références

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