Vehicle Routing Problem: Doing it the Evolutionary Way

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1 INTRODUCTION

The Vehicle Routing Problem (VRP) is a complex combinatorial optimization problem, which can be described as follows: given a fleet of vehicles with uniform capacity, a common depot, and several costumer demands, find the set of routes with overall minimum route cost which service all the demands.

Due to the nature of the problem it is not viable to use exact approaches for large instances of the VRP. The application of evolutionary computation (EC) has achieved limited success. This led researchers to rely on hybrid approaches that combine the power of EC with the use of specific heuristics (e.g., (Thangiah, 1995)) or to simplify the problem (e.g., (Zhu, 2000)).

In this paper we present two EC approaches to the generic VRP. To our knowledge this is the first attempt to apply non-specific EC methods to this variant of the VRP. Our first approach uses a standard genetic algorithm (GA), whilst in the second we resort to a coevolutionary model.

2 GA APPROACH TO THE VRP

Our model can be viewed as an extension of the traditional GA approaches to the TSP problem.

We use a fixed size chromosome. Possible values for genes are: an integer representing a customer node or a special blank symbol. This blank symbol acts as a separator between routes. Since we don't know beforehand how many vehicles will be used in the optimal solution we set this number to the number of nodes divided by two.

As genetic operators we use: the partially mapped crossover (PMX) and the swap mutation operator.

Some routes in the chromosome may cause the vehicle to exceed its capacity. When this happens, we perform the following modification: the route that exceeds the vehicle capacity is split in several ones. These changes only occur at the interpretation level and, therefore, the information codified in the chromosome is not altered.

3 COEVOLUTIONARY APPROACH

We use two subpopulations: individuals from the 1st describe the size of each route; individuals from the 2nd specify the order by which the nodes are visited. Routes that exceed vehicle capacity are split.

Since we don't know in advance the optimal number of vehicles we the size of the individuals of the first subpopulation to the number of nodes divided by two. Maximum route length is also set to this value. As genetic operators, for that subpopulation, we use two-point crossover and uniform mutation.

The size of the individuals of the second subpopulation is fixed and equal to the number of nodes. Again, we use PMX crossover and swap mutation.

4 SYNOPSIS OF THE RESULTS

The results achieved are promising, as they show that EC techniques can deal in a satisfactory way with the problem. In particular, we showed that the inclusion of a simple, and non-specific, heuristic to generic EC techniques provides significant improvement of the results. The characteristics of our approach suggest that it shows good scalability, allowing their application to more complex instances of the problem, where more specific techniques may fail.

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References

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