Route First Cluster Second-Based Formulations for a Variety of Routing Problems[1]

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In this talk, we observe that the partitioning of a giant tour for a multiple travelling salesman problem (mTSP) can be seen as a polynomially solvable 0-1 knapsack problem. Variations on this initial model permit to partition a giant tour for several types of routing problems. These include, among others, the mTSP with bounds on the number of cities to be visited (mTSP$_{[K,L]}$), the VRP, the heterogeneous VRP, the mTSP with time windows and the multidepot mTSP (MmTSP).

The routing first-cluster second approach has already been considered by Beasley [1], Golden et al [2] and more recently by Imran et al [3] using dynamic programming or network based methods. The latter consist in constructing a cost network then computing a shortest path to optimally partition the giant tour. Though the optimal partitioning can be performed in a polynomial time, generalising this method can be problematic even for small changes as fixing the number of vehicles to an integer m.

Partitioning an optimal giant tour will not always produce an optimal solution as there is a lack of correlation between the quality of the giant tour and the solution of its corresponding optimal partitioning.

In order to tackle this, we put forward a hybridisation of the variable neighbourhood search heuristic, introduced by Mladenović and Hansen [4], with our models. This approach consists in partitioning an initial giant tour then perturbing it and splitting again a number of times. Reiterating this process in association with a reoptimizer such as 2-opt or an exact method permits to improve the initial solution.

For empirical testing, we assess the performance of our split-based VNS heuristic using two variants namely the mTSP and the mTSP$_{[K,L]}$. Our hybrid approach performs well when compared to other approaches in litterature.

Computing times needed to solve the various models are presented. The CPU time needed to split a giant tour depends on the problem nature. In a VRP situation, a giant tour can be partitioned for instances of up to 261 cities and 6 vehicles. A cost network approach is however preferred for larger instances if m is free using Djikstra's algorithm or dynamic programming. On another hand, partitioning a giant tour for other variants such as the MmTSP can be performed quickly even for large instances. As an illustration only, the partitioning of a MmTSP 4460-nodes giant tour is performed within 2 seconds.

Keywords - routing problems, route first–cluster second, integer programming, VNS.

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