1. Introduction

The Technician Routing and Scheduling Problem (TRSP) is an extension of the vehicle routing problem with time windows (Kallehauge et al. 2005) which aims to find the best set of routes (sequence of visits) performed by a set of vehicles (technicians) to serve a set of geographically distributed tasks.

In this work, we tackle a problem already presented in Mathlouthi et, al., (2016) encountered by a company providing maintenance and repair of electronic transaction equipments. Technicians have different skills level which allow them to perform a different tasks. The routes of each technician should not exceed a maximum traveled distance, it starts from 9H00 AM and finishes at 5H00 PM, if there is no overtime. Each technician should take three breaks during the day. He starts and finishes his route from his home base position with an initial inventory of spare parts. Along the route, a pre-assigned depot can be used (one per day) to replenish the inventory of spare parts and also get, if needed, a special parts. Each task has a service time and multiple possible time windows to be served, it has also a gain which stands for its priority. Given that not all tasks can be served, the objective is to maximize the total gain, minus the total traveled distances and total overtime over all routes.

Despite its complexities and its challenges, it has received a limited attention from the research community. Exact methods are able to address the small-size application such as a branch-and-price algorithm (Cortés et al., 2014; Mathlouthi et al., 2017). For the most large-size applications, the meta-heuristic approaches has been mostly used such as a GRASP (Xu and Chiu., 2001), a Tabu Search with an adaptive memory (Tang et al., 2007), an Adaptive Large Neighborhood Search method (Cordeau et al., 2010), a Parallel Adaptive Large Neighborhood Search (Pillac et al., 2012), a Particle Swarm method (Günther and Nissen., 2012) and a Large Neighborhood Search meta-heuristic (Meneghetti and De Zan., 2016).

To solve the TRSP problem we propose a General Variable Neighborhood Search algorithm (GVNS) that has proven successful in a variety of real world application like the home health care (Frifita et al., 2017) and many others.

2. Proposed approach

The GVNS algorithm (Hansen et al. (2008) is a variant of the Variable Neighborhood Search algorithm (Mladenovic and Hansen 1997) that use a shaking step flowed by several local search.

Our algorithm starts with an initial solution from a constrictive heuristic. The provided construction heuristic is sequential and consists of designing one by one the routes of the technicians. The best feasible insertion, taking into account skills and time windows, for the tasks and depot is considered. Then, the GVNS execute alternately a shaking procedure to escape from local optima and a Pipe Variable Neighborhood Descent algorithm (PVND) within the local search procedure to improve the solution with neighborhood change step until fulfilling a predefined stopping criterion. In our methods, six effective local search operators **(**Insertion-with-new, Intra-route, Inter-route, Swap-intra, Swap-inter, and Swap-with-new) with different movements have been considered for both shaking and PVND steps. The route candidate to receive the neighborhood move is randomly selected. As a stopping criterion, we choose the maximum CPU time (t_{max}).

3. Computational results:

To test the performance of our GVNS, we use benchmarks introduced in Methlouthi et, al., (2016). These data sets are constructed from a real-world application. Each group has 10 varieties of instances according to the size of time windows; wide (W) and narrow (N). In Methlouthi et, al., (2016), they consider 3 technicians to serve 50 tasks for a planning horizon of 1 days.

The proposed algorithms described here have been coded in Java with Eclipse 1.8, on laptop HP Intel Core i3, 4GB RAM. To check the efficiency of the proposed algorithms a comparison with the tabu search solutions from literature are reported.

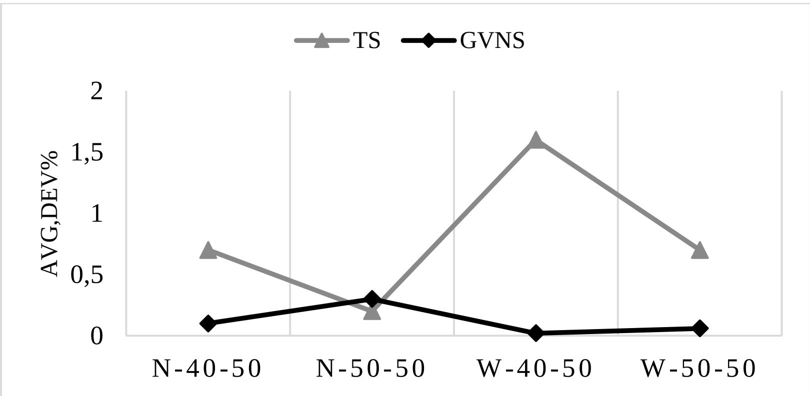

Fig.1 Average of Dev% for the 40 instances

The *Fig.1* shows that the GVNS outperforms the TS algorithm. It gives a higher-quality solutions in reduced computation time. OIt should be noted that GVNS found the best solution for the most instances however, for category M-50-50, the TS is the best followed by the GVNS.

4. Conclusion

In this paper, we solve a technician routing and scheduling problem (TRSP) with a general variable neighborhood search algorithm (GVNS). To test the approach, we use benchmarks from the literature. Experiments show that our approach is able to solve all the instances, in a reasonable amount of time. Future works, we will add a multi-objective to our variant.

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