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Editorial for Volume 10 Number 1: Review of heuristic algorithms applied to the solution problem of land transportation of perishable products

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Abstract. The Vehicle Routing Problem (VRP) consists of minimizing the cost of transferring resources, goods or people. There are different variants of the land transport problem, among the main ones are the location of bus terminal, convoy routing, inventory routing with time windows, school bus routing, travel planning problem, among others. The problem of vehicle routes with time windows (VRPTW) is to minimize transport costs considering restrictions in the delivery time. In this work, articles from scientific journals referring to the solution of terrestrial transport problems were reviewed, specifically, the works that develop heuristic algorithms. The objective of this work is to obtain a frame of reference for the works that apply meta-heuristics to the solution of the problem of land transport of perishable products. The result of the work is a framework that shows state of the art in the solution of VRP of perishable products and outlines the future work for the investigation based on the existing gap in this subject.

Keywords. Heuristics, Meta-heuristics, perishable products, VRPTW.

1. Introduction

The problem of land transportation refers to the need for units from a point called origin to another point called destination; the selected routes determine to fulfil the requirements and to minimize the costs according to the plan. The costs arise from the distance of travel, number of vehicles and the time of delivery. The Vehicle Routing Problem (VRP) is a set of trips to a minimum total cost to deliver quantities of goods made to customers with an identical vehicle fleet, i.e. to find a set of travel minimize the total distance of the move while meeting the requirements of all customers [1]. There are three parameters of this kind of problem: 1. Resources (goods, machines, tools, people, among others), 2. Location (supply points, warehouses and stations), 3. Modes of transport (ship, aircraft,

trucks, trains, pipes, motorcycle, among others). The VRP is a generalization of the Traveling Salesman Problem (TSP) [2], and lies within the classification of the NP-Complete Problem type.

A variant of the VRP is the problem of vehicle route with time windows (VPRTW) and seeks to minimize the cost and total time for a fleet of vehicles that distributes goods from a warehouse to consumers requiring to be visited exactly within your window of time. The window of time refers to the time interval during which deliveries or visits should be done. All routes begin and end in the same deposit, and the total demand for all consumers is fulfilled by a vehicle along a particular route that should not exceed its total capacity. The typical function of the objective is to minimize the number of vehicles and the total travel time [3]. The VRPTW is an NP-complete problem [4].

There is research to transport problems of the NP-complete type that involves uncertainty. In this type of problems, talk about optimal solutions is risky, being acceptable to talk about good solutions considering the use of genetic algorithms [5]. Genetic algorithms are classified as meta-heuristics. Unlike the exact algorithms that guarantee to find the global optimum of any problem, Meta-heuristic algorithms offer solutions of good quality, but in less time. However, the drawback of the exact algorithm is that the runtime grows exponentially with the size of the problems

Within artificial intelligence, the genetic algorithms are search algorithms based on mechanisms of natural genetics and natural selection. The structure of genetic algorithms involves three types of operators: selection crossover and mutation. A genetic algorithm organizes and conducts operations that have been designed for the simulation of the processes of evolution and transformations. This type of algorithms is inspired by the theory of evolution of Darwin, in the natural evolution, where individuals who possess more skills to survive or a greater number of descendants are more suitable, passing these characteristics favourable hereditary way [7].

2. Perishable Goods Transportation Problem

Perishable products are items with a short shelf life measured in days counted from the day they are produced until it becomes unacceptable for consumption. Van Donselaar et al. [8] define how perishable items that have a useful life of less than or equal to 30 days, this to determine the threshold for the storage time. In their study, the examination of the data revealed that the shelf life of 30 days has all products requiring a conditioning atmosphere. There are key goals such as the reduction of food waste, the environmental impacts of the operations of the supply chain and minimization of costs in the management of food supply chain [9]. In the management of perishable products that are not food such as floriculture products have been found needs that require investigation, as the problems of the decision, factors of context and objectives. In terms of decision problems are the design and control of the network, in the factors of context is the uncertainty of demand, perishable products and the objectives in terms of efficiency and quality of products [10].

There are factors in agri-food products (perishable) supply chain, such as quality of products, food safety, the variability of demand, use of efficient transport, shipping time and delivery costs, the availability of products, distance that must take the product, the presence of natural phenomena, traceability, or location, among others [11].

The problem of land transport of perishable goods is to minimize the cost of transportation of products likely to decompose and that must be refrigerated to 4.4 ° C or less to stay safe or extend the time in which they remain healthy (they include meats, poultry, fish, dairy products, soft cheeses, keep refrigerated cake of cheese, most of the cakes, all cooked leftovers and any purchased refrigerated foods or with a tag). The problem of the transportation of perishable goods is a variant of the problems of the Vehicle Routing Problem with Time Windows (VRPTW) and Bin Packing Problem (BPP) [12].

Among the problems that companies have when the management and distribution of food are how to keep the quality of vegetables, find optimal routes and minimize travel time.

Song and Ko [13] show the problem of vehicle routing covering types of refrigerated and non-refrigerated to deliver multiple perishable products. Developed a non-linear mathematical model and a heuristic algorithm to obtain efficient routes of vehicles, using 500 nodes of customers, five types of food products and ten vehicles.

Naso et al. dealt with the problem of coordinating the activities of production and distribution of a network independent of perishables supply centers and propose an approach of dynamic programming that combines tools that include a detailed model of mathematical programming which specifies decision variables, technical requirements and limitations to be met at each stage of delivery, in addition, a set of quick construction heuristics using the mathematical model with the aim of identify a feasible solution for supply networks, finally, a stochastic search engine that relies on genetic algorithms to optimize the subset of variables of the problem. Genetic algorithms are optimizing, in this case, the function goal that interacts continuously with constructive heuristics while the unemployment criterion is met.

Ursani et al. presented a framework for localized optimization (LOF), choosing a genetic algorithm as a method of optimization solution of representation, concluding that on average it is capable of producing better solutions with respect to other heuristics in small VRPTW problems. Sze et al. developed a heuristic with two stages for the problem of the vehicle for multiple travel routes and programming with windows of time that empirically demonstrates efficient and effective development that easily adapts to different areas of programming and operating requirements.

Moccia et al. offer a general tool applied to problems specific to addressing widespread vehicle with

windows of time through the tabu search, where the approach is exponential, but the procedure for the evaluation has the complexity of polynomial.

Noori, & Ghannadpour apply an efficient Hybrid metaheuristics for the solution of the representation, working on three levels: a genetic algorithm as the main optimization algorithm, taboo as a method of improvement and finally the genetic algorithm that It includes local exploitation in evolutionary search, with a strategy of suppression operator, which indicates the efficiency of the inner work of the method.

Kumar & Panneerselvam emphasize the difference of genetic algorithm with the use of a swarm of particles, where in the first, individual solutions do not evolve during his life: are created, evaluated, can be selected as new parents solutions and they are destroyed. His article deals with the use of swarm optimizer particles where each has to improve his physical movement. Parents and children should follow the basic principles of swarm optimizer particles until the requirements for being selected as one of the fathers.

Vidal et al. propose an algorithmic framework that addresses three problems of the routing of vehicles such as, the periodic VRP, multi-depot and VRP periodic multi-depot with qualified vehicles and duration of the restricted route. The algorithm proposed by Nazif and Lee uses an optimized crossover operator to find an optimal set of delivery routes meeting the requirements at a minimum cost. The results show that the algorithm is competitive.

Shukla and Jharkharia propose the determination of the route that minimizes the cost of transportation and the deterioration of the product, based on the AIS system of immunization artificial, obtaining better results than other heuristics.