Model of Vehicle Routing Planning for Picking up of Junk

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ABSTRACT
In this paper, we are going to propose a model of vehicle routing planning for picking up of junk. Some techniques are going to be used in order to determinate which one is the best for the solution. The paper is organized in as follows:

Keywords
Traveling Salesman Problem or TSP, TSP Variations, Vehicle Routing Problem or VRP, VRP Variations, Genetic Algorithms, Artificial Immune Networks.

1. INTRODUCTION
This paper is about Vehicle Route Planning for picking up of junk. There are many problems similar to that, for example Traveling Salesman Problem (TSP) is an NP-hard Problem, which has many different real life applications and the Vehicle Routing Problem (VRP) is another problem so similar to the TSP. The TSP is a problem that has been studied for many years in subjects such as mathematics and computer science, because it is so easy to describe but so difficult to resolve. There are many solutions for some of those problems, and the TSP has several variations. Those variations depend of some restrictions of time, spatial and no spatial. The formulation of the research problem is so closely related with the TSP.

Techniques like Genetic Algorithms (GA) are robust and probabilistic search algorithms based on the mechanics of natural selection and survival of the fittest that is used to solve optimization and many real life problems, although the Artificial Immune Networks are appropriated for some chores like clustering and classification. Another technique is a mixture of Fuzzy C-means and Lin-Kernighan Algorithm, where the first one is a clustering algorithm and the second is for path planning.

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2. THEORETICAL FRAME
In this part of the paper, we are going to gather the main theory about the most important problems in transportation. Also, there is some theory about the techniques that are going to be used in on the solution of this problem. Vehicle Routing Problem and Traveling Salesman Problem are the most popular problems in this subject, that's way, is very important to know about them. In another hand, techniques as Genetic Algorithms and Artificial Immune Networks are going to be explained and used along the paper.

2.1 Traveling Salesman Problem (TSP)
TSP is a NP-hard problem because the computational effort for finding a solution has an exponential grown. In graph theory the TSP is defined so: "A complete undirected graph G=(V,E) has a non negative integer cost C(u,v) associated with each edge (u,v) ? E. Each node must be visited exactly once, starting and ending of tour must be at same city and total cost of travel must be minimum". This problem has been presented from several modifications that are related problems in the following formulations of TSP [1][2].

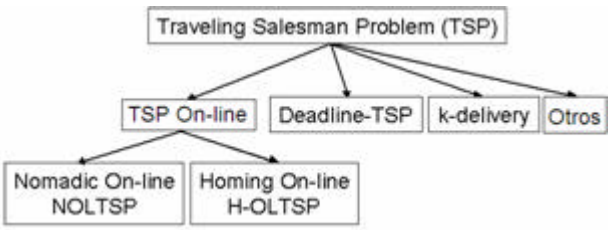

Fig. 1 TSP Variations

Those variations were found in the literature about the TSP, and were gathered in this conceptual map. The first of those is the TSP On-line[3], it is a problem defined in two versions, the Nomadic On-line Travelling Salesman Problem (NOLTSP) and Homing On-line Travelling Salesman Problem - (H-OLTSP), the first one is defined like the time of finishing required for attending every request and the second is the time minimization of finishing

required for serving every request and return to the origin. Deadline-TSP[9] in another hand implies a finite number of points must be visited, but it can be done only in an interval time. Given n identical objects, placed at arbitrary initial locations, consider the problem of transporting them efficiently to n target locations with a vehicle that can carry at most k pegs at a time; this problem is referred to as k-delivery TSP.

2.2 Vehicle Routing Problem

It is a problem so similar to the TSP; the principal objective is to attend a group of customers who need a service through a rout whit a minimum cost that has an origin and a finish point. Generally the group of customers is placed in a geographical space. The VRP can be defined depending of some things like objectives and restrictions, where the delivery can be from one or more than one store, or the customers has to be attend in a time window. The following formulations are some of the variations for this problem:

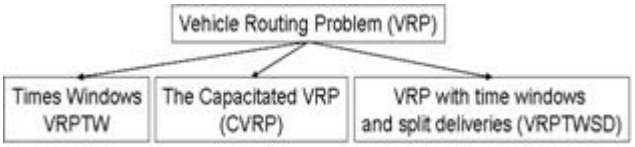

Fig. 2 VRP Variations

The variations have been studied because each one of them is a big problem and they have different constraints. The *VRP with time windows* VRPTW [10] consist in that there are many customers who have to be attended only in a time interval. Another constraint is about the capacity of the vehicles, it is worked in the *Capacitated VRP* CVRP [5], in another hand, there is another variation that includes *times windows and split deliveries* VRPTWSD, the problem is that a delivery can not be satisfied in only one time, it has to be done in several deliveries.

2.3 Genetic Algorithm

It is a search technique used in computing to find true or approximate solutions to optimization and search problems. Genetic Algorithms or GA are categorized as global search heuristics [12]. Those are a particular class or evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover or recombination. GA´s are implemented as a computer simulation in which a population of abstract representations (chromosomes or the genothype) of candidate solutions (individuals, creatures or phenotypes) to an optimization problem evolves toward better solutions. The solutions are represented in binary strings of 0s and 1s, but other encodings are also possible. The evolution begins from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness) and modified (mutated or recombined) to form a new population. The new population is then used in the next iteration of the algorithm.

2.4 Fuzzy C-Means

The fuzzy c-means (FCM) algorithm [6] is one of the most widely used methods in fuzzy clustering. It is based on the concept of fuzzy c-partition, introduced by Ruspini. The goal of traditional clustering is to assign each data point to one and only one cluster. In contrast, fuzzy clustering assigns different degrees of membership to each point. The membership of a point is thus shared among various clusters. This creates the concept of fuzzy boundaries which differs from the traditional concept of well-defined boundaries.

Usually, membership functions are defined based on a distance function, such that membership degrees express proximities of entities to cluster centers. This algorithm attempts to minimize a cost-function and a local minimizer is attained, instead of a global. In this case the following cost-function is minimized, with respect to U, a fuzzy K-partition of the data set, and to C, a set of K prototypes (cluster centers)[6]:

$$J_q(U,C) = \sum_{j=1}^{m}\sum_{i=1}^{K}(u_{ij})^q d^2(X_j, C_i);\ K \leq N$$

where q is any real number greater than 1, Xj is the jth n-dimensional feature vector, Ci is the centroid of the ith cluster, u_{ij} is the degree of membership of Xj in the ith cluster, $d^2(X_j, C_i)$ is any inner product metric (distance between xj and Ci) M is the number of data points, K is the number of clusters. The parameter q is the weighting exponent for uij and controls the "fuzziness" of the resulting clusters.

2.5 Artificial Immune Network

An artificial immune system (AIS) is a type of optimization algorithm inspired by the principles and processes of the vertebrate immune system [8]. Typically, the algorithms exploit the immune system´s characteristics of learning and memory to solve a problem. They are coupled to artificial intelligence and closely related to genetic algorithms.

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