Continuous improvement to the distribution of perishable goods for a food bank on the basis of its physical space (Bin packing)

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Abstract

The present work shows how you can make the distribution of perishable foods, based on the classic model of vehicle routing problem known as VRP to try to make continuous improvement with regard to the supply and/or distribution of food products from the basic basket using the algorithm of the nearest neighbor. The distribution of perishable foods of a particular company as is Diconsa has different restrictions and/or variants on the basis of the VRP. As far as logistics of the distribution, the distribution and delivery, since the transport and its capacity, up to the routes and the amount of vehicles that are required for compliance are of vital importance in the companies and the aim is to show that the algorithm of the nearest neighbor with the Matlab software can be used to solve problems in the distribution companies and finally the expected results are shown.

Key Words: Distribution of perishable foods, Matlab, PVR, algorithm of the nearest neighbor.

1. Introduction

Today the logistics is of vital importance for the provisioning process and/or distribution of products and/or services, by what the establishment of routes for vehicles in the most optimal manner has generated a great investigative interest. Has three subsystems that are: logistics of attorney: that has to do with the activities that companies must undertake to procure the inputs for producing, internal logistics: you have to see how they are produced to the inside of the company products and distribution logistics: arrive with the products to the customers [3]. The problems of routing of vehicles commonly known as PVR, trying to solve problems such as the one that is living in the real world as the distribution of products, the VRP comes from a family of problems that has customers with demands, and a fleet that departing from cellar(s) along the distributing/collecting products, Which aims at finding the optimal path for each vehicle in the tank and /or warehouse, complying with the demand and restrictions of the customers, the capacity of having a fleet of vehicles homogeneous and minimizing the total cost. In the management of operations one of the important areas of study is logistics, which is often defined as the set of features that allow companies to get their products to the customers [1].

The problem of PVR is one of the most common in the optimization of logistics operations and is one of the most studied today, for certain companies that distribute their products; it raises the search for the optimal solution with different restrictions such as: Number of vehicles, its capacity, duty stations customers and customer demand, among others, and one formulation of this type may include a large number of variables and various parameters [5].Investigations have suggested a large number of models that cover the problem of the VRP in order to improve the logistics performance. Do mention that the first problem was the VRP type of TSP (traveling salesman problem) introduced by flood in 1956.Some of the first considerations of the generalized TSP can be assumed as a VRP and can be seen as a CVRP (Capacited PVR), a routing problem vehicles where the capacity of the fleet becomes a restriction for the formulation.
One of the functions of the CVRP is to minimize the total cost to distribute and/or take to all consumers, this type of problem of CVRP, shows consumers they have an deterministic demand, in the identifications all vehicles are equal and out of a distribution center. The CVRP found an exact quantity of paths with minimum cost defined as the sum of the costs of the arcs belonging to the paths that will be under way in question to the distribution, In such a way that each tour will visit the distribution center, that each center of consumption is visited exactly by a vehicle and the sum of the demands of the Center for the consumption i to another center of consumption j is equal to the cost of going from the center of consumption j to the center i [5]. The routing problem vehicles naturally arises as the central problem in the fields of transportation, distribution and logistics

and distribution of the food bank of the perishable products of a fleet of vehicles based on its physical space (bin packing), it is essential knowing their restrictions to distribute these products. Such is the case of the company Diconsa, a company that is majority state, which belongs to the Social Development Sector and that has the purpose of helping to overcome the food poverty, through the supply of commodities and complementary to rural locations of high and very high marginalization.

It mentioned a list of products that are called (basket), which are: corn, table salt, beans, oats, rice pasta to soup, standard sugar, wheat flour, corn flour, chocolate powder, edible vegetable oil, Biscuits Marias and topiary, Tuna, laundry soap, sardine, soap, milk powder, toilet paper, canned Chiles, detergent powder, soluble coffee and toothpaste [10]. There are several basic baskets, since various institutions, both public and private, can generate and generate their own baskets and, depending on the purpose of the same can be classified as: a) real baskets. Compiled from surveys on what people consumed daily and serves for the changes in the purchasing power of wages and b) recommended baskets. Developed to indicate what to consume in order to achieve a certain social welfare. The basic food basket, understood as a subset of the products included in the calculation of the National Consumer Price Index, is a set of 82 products, which are determined on the basis of the National Survey of Household Income and Expenditure (ENIGH), by the Institute National of Geographic e Informatic (INEGI) [9].

Today, many institutions have problems to optimize and it is necessary the use of computational tools to solve these problems, which are able to adapt to different scenarios and get good results without consume high volumes of resources. This distribution will take you to have transport problems and to find a distribution in such a way as to cover the demand of all customers within a certain number of routes [8]. However, there are times that the allocation of the routes does not always lead to find the kittens already costs in the majority of cases the problems are addressed without taking into account the optimization of the space within each vehicle based on the accommodate the objects and/or articles that are transported, which is accomplished by using the cvrp method [8]. Unos de los problemas de optimización es la distribución de objetos en contenedores comúnmente conocido BPP, que por sus siglas en ingles se denomina Bin Packing problem y la asignación de carga será representada como un BPP [4]. Bin packing or BPP (bin packing problem), is to pack n items indivisible, pesos w_i concrete, in the shortest possible number of boxes of finite capacity c.

In this issue of packaging there are numerous variants, it is understood is that it wants to minimize the ability of a specific number of boxes, can be seen at two or three dimensions, etc. On the other hand mention that the BPP has numerous applications in the present because it allows you to make, among other situations, the loading of trucks with weight limitations, storage situations, and the design of pages of newspapers, among others [7]. MATLAB was developed in 1984 by Jack Little and Cleve grind those who founded the company The Mathworks, inc. In Natick, Massachusetts [2]. MATLAB is a powerful system of very high level designed for technical computation in same environment very easy to use calculations, displays and programming. Some of the most common uses of computing technical are: Mathematical calculations, algorithm development, modeling and simulation, data acquisition, data analysis, obtaining graphics, development of graphical user interfaces, graphical programming with Simulink and interface with spreadsheets.
Matlab is the acronym stands for Matrix Laboratory and was originally developed to perform operations with matrices. As well it can also be seen as a powerful programming language called language-m and an editor are associated with Matlab. To the program files generated with this language they are known as files-m. This programming language-m more powerful than languages such as FORTRAN, C, C, C#, Basic, or Visual Basic, to mention some [2].

2. Mathematical Modeling of the VRP

The mathematical model most commonly used to represent this problem was proposed by Miller-Tuckin Zemlin:

$$(CVRP) \min \sum_{i \in V} \sum_{i \in V} cijxij \qquad (1)$$

$$s.t. \sum_{i \in V} xij = 1 \qquad j \in V\backslash\{0\} \qquad (2)$$

$$\sum_{j \in V} xij = 1 \qquad i \in V\backslash\{0\} \qquad (3)$$

$$\sum_{i \in V} xi0 = K \qquad (4)$$

$$\sum_{i \in V} x0j = K \qquad (5)$$

$$uj - ui + C(1 - xij) \geq dj \quad i,j \in V\backslash\{0\}, i \neq j \qquad (6)$$

$$di \leq ui \leq C \qquad i \in V\backslash\{0\} \qquad (7)$$

$$xij \in \{0,1\} \qquad i \in V\backslash\{0\} \qquad (8)$$

The routing problem vehicles is composed of two major types of very complex decisions which is the allocation of customers to vehicles and establish the proper sequence of visit to the clients who must perform a seller or vehicle (traveling salesman problem or TSP).
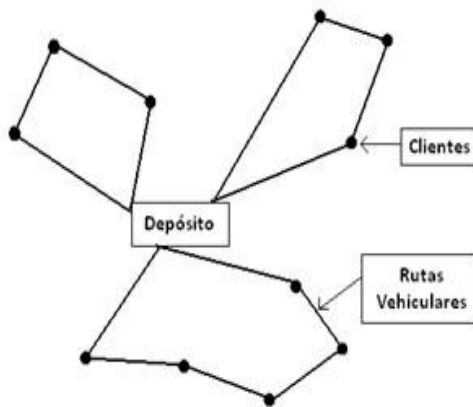

Figure 1. Simple solution of a VRP.

Some variants of the VRP are: [6].

- CVRP, Routing problem Vehicles with Capacity
- MDVRP, Routing problem Vehicles with Multiple Deposits
- VRP periodic (PVRP)
- SDVRP, Routing problem delivery vehicles Divided
- SVRP, Routing problem Vehicles Stochastic
- VRPPD, Routing problem Vehicles with pick ups and deliveries
- VRPB, Routing problem Vehicles with Backhaul
- VRPTW, Routing problem Vehicles with time windows

Due to the type of problem is CVRP selection for the distribution of a food bank to distribute food products from the basic basket in delegations margins Guerrero state.

3.   Methodology

The algorithm of the nearest neighbor was first introduced by J. G. Skellam, which used half of the instances observed to determine if the data are grouped together. The bulk of the work done for this algorithm was made by P. J. Clark and F. C. Evnas in 1954 and was in computer science, one of the first algorithms used to determine a solution to the problem of the traveller. As a general rule, if the last steps in the path are comparable in length to that of the first steps, the route is reasonable; if these are much higher, then it is likely that there are much better roads.

4.   Algorithm of the nearest neighbor

```
NumberOfRoutes=n
TotalDistance=TotalDistance
img = imread ('mapa.jpg.png'); %<==File name of your map
min_x = 0; max_x = 100; min_y = 0; max_y = 100;
x=Problem (:,2); y=Problem (:,3); figure x_min = min_x;
x_max = max_x; y_min = min_y; y_max = max_y;
imagesc ([x_min x_max ], [y_min y_max], img);
%Colouring Line
for tyt=1: n
hold on
   shortestPath=Routes{1,tyt};
colour=mod(tyt,6);
xd=[x(shortestPath)];
yd=[y(shortestPath)];     for
i=2:length(shortestPath)-1
        text(xd(i),yd(i),['Comedor   A.    ',num2str(shortestPath(i))]);
end
   text(xd (1), yd(1),[' Banco De Alimentos ']);        if
colour==1                          plot        (xd,yd,'-
cs','LineWidth',2,'MarkerEdgeColor','k',...
          'MarkerFaceColor','g',...
          'MarkerSize',10)
       Plot(x(1),y(1),'MarkerEdgeColor','k',...
          'MarkerFaceColor','k',...
'MarkerSize',10)
hold  on           elseif  colour==3         plot(xd,yd,'-
ys','LineWidth',2,'MarkerEdgeColor','k',...
          'MarkerFaceColor','y',...
'MarkerSize',10)
plot(xd(1),yd(1),'MarkerEdgeColor','k',...
          'MarkerFaceColor','k',...
'MarkerSize',10)     hold on      elseif colour==4
plot(xd, yd,'-ks','LineWidth',2,'MarkerEdgeColor','k',...
          'MarkerFaceColor','w',...
'MarkerSize',10)
plot(xd(1),yd(1),'MarkerEdgeColor','k',...
          'MarkerFaceColor','k',...
'MarkerSize',10)    hold on     elseif colour==5    plot (xd,
yd,'-bs','LineWidth', 2,'MarkerEdgeColor','k',...
          'MarkerFaceColor','b',...
'MarkerSize',10)
plot(xd(1),yd(1),'MarkerEdgeColor','k',...
```

```
            'MarkerFaceColor','k',...
'MarkerSize',10)     hold on     elseif colour==0
plot(xd,yd,'-ms','LineWidth',2,'MarkerEdgeColor','k',...
            'MarkerFaceColor','m',...
'MarkerSize',10)
plot(xd(1),yd(1),'MarkerEdgeColor','k',...
            'MarkerFaceColor','k',...
'MarkerSize',10)     hold on
    end end
```
Title (['Total Distance = ', num2str (TotalDistance),' | Number of Routes = ', num2str (NumberOfRoutes)]);

Table 1. Displays the instances of (x, y)

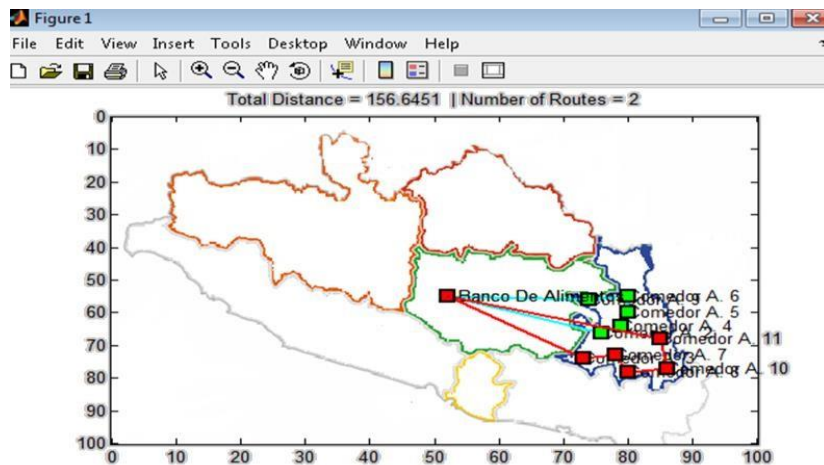| Instances			
Number of output	x	y	Demand
1	52	55	0
2	76	66	10
3	73	74	15
4	79	64	10
5	80	60	20
6	80	55	30
7	78	73	10
8	80	78	20
9	74	56	30
10	86	77	20
11	85	68	25

5. Design of Experiments

Figure 2. Map of the distribution of the food bank in Matlab

The map represents the distribution of a food bank, which it used two routes to distribute foodstuffs to the delegations most marginalized of the state of Guerrero.

Table 2. Results of execution of the instance of the food bank

Route 1_VRP	9	6	5	4	2
Route 2_VRP	3	7	8	10	11

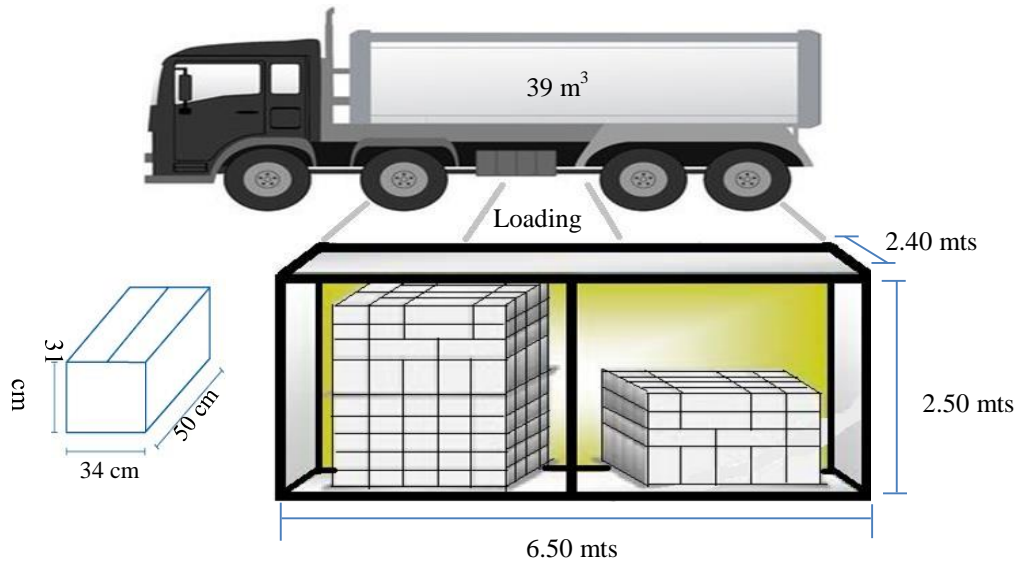| Vehicles	2				
Capacity	12 Tons				
Number of routes	2				
Total Distance	156.6451				

Figure 3. Closed Container-maximum capacity of 12 tons.

Program of the C ++ of Ant Colony to determine the total time for distribution to a food bank

```
include <stdio.h> #include
<math.h>
#include <stdlib.h>
#include <assert.h>
#include <time.h>
#include "common/rand.h"
//#define NUM_ANTS            1002
#define NUM_ANTS            11
#define NUM_CITIES          11
//#define NUM_CITIES          1002
//#define EDGE_SIZE           100
#define NUM_ITERATIONS      (NUM_CITIES * 100)
#define BASE_PHEROMONE      (double)(1.0 / (double)NUM_CITIES)
const double alpha = 1.0; const double beta  = 1.0; const double rho   = 0.9;
const double qval  = 60;

typedef struct {
   int node;
    float x;
    float y; }
CITY_T;
typedef struct {
    int current_city;
    int next_city;
```

```
//      unsigned char tabu[NUM_CITIES];
      unsigned   int   tabu[NUM_CITIES];
    int tour_index;
//      unsigned char tour[NUM_CITIES];
      unsigned int tour[NUM_CITIES];

    double tour_length;
} ANT_T;
CITY_T cities[NUM_CITIES];
ANT_T  ants[NUM_ANTS];

double pheromone[NUM_CITIES][NUM_CITIES];
double precomputed_distance[NUM_CITIES][NUM_CITIES];

int   best_index; double
best_tour = 100000.0; //double
best_tour = 300000.0; void
cargar (void)
{
FILE *fp;//apuntador de archivo register
int i;
int MAX=NUM_CITIES;
int x,y,z;
//se abre el archivo a280.tsp con permisos de escritura if((fp=fopen("a280.tsp",
"r"))==NULL){
            printf("No  se  puede  abrir  el  archivo.\n");
    return;
            }
```

Table 3a 11

Table 3b

delegations   11 delegations 60% of ants   60% of ants

Beta=1 Beta=1

Rho=0.9   Rho=0.95

Número of runs	Iteration	Results
1	44	183.607
2	154	182.736
3	88	179.017
4	66	183.607
5	594	179.017
6	33	179.88
7	1089	186.044
8	418	179.017
9	22	179.017

delegations   11 delegations

Table   3c
Table
3d
    11

Número of runs	Iteration	Results
1	220	179.88
2	187	179.017
3	55	179.017
4	33	180.493
5	110	176.827
6	66	183.607
7	66	179.017
8	55	179.017
9	88	182.736

10	297	179.017

60%of ants
60% of

10	33	189.756

ants

Beta=5 Beta=5

Rho=0.9   Rho=0.95 Table 4a   Table 4b

11

Número of runs	Iteration	Results
1	11	179.017
2	44	179.017
3	33	179.017
4	44	179.017
5	44	179.017
6	55	179.017
7	110	179.017
8	33	179.017
9	44	179.017
10	33	179.017

Número of runs	Iteration	Results
1	33	179.017
2	33	179.017
3	55	179.017
4	11	179.017
5	44	179.017
6	88	179.017
7	22	179.017
8	22	179.017
9	44	179.017
10	33	179.017

delegations   11 delegations

80% of ants   80% of ants

Beta=1 Beta=1

Rho=0.9   Rho=0.95

Número of runs	Iteration	Results
1	66	188.234
2	33	176.827
3	396	179.017
4	176	179.017
5	55	179.017
6	44	179.88
7	66	185.629
8	33	186.695
9	121	179.017
10	22	183.607

Table   4c
     Table
4d
   11

Número of runs	Iteration	Results
1	66	179.017
2	396	183.607
3	33	179.017
4	319	179.888
5	22	179.888
6	132	176.827
7	33	185.45
8	44	179.017
9	99	179.017
10	88	176.827

delegations 11 delegations

80% of ants   80% of ants

Beta=5   Beta=5

Rho=0.9   Rho=0.95 Table 5a   Table 5b

Number of runs	Iteration	Results
1	33	179.017
2	88	179.017
3	88	179.017
4	33	179.017
5	22	179.017
6	55	179.017
7	33	179.017
8	22	179.017
9	44	179.017
10	55	179.017

11

Number of runs	Iteration	Results
1	22	179.017
2	33	179.017
3	11	179.017
4	22	179.017
5	77	179.017
6	11	179.017
7	22	179.017
8	99	179.017
9	11	179.88
10	44	179.017

delegations   11 delegations

100% of ants   100% of ants

Beta=1 Beta=1

Rho=0.9   Rho=0.95

Number of runs	Iteración	Results
1	55	179.017
2	22	187.691
3	55	180.547
4	132	179.888
5	132	179.017
6	165	188.478
7	341	179.888
8	55	180.493
9	209	179.017
10	396	183.762

Number of runs	Iteration	Results
1	66	182.736
2	176	179.888
3	22	185.45
4	143	188.478
5	22	184.52
6	88	176.827
7	33	179.017
8	66	179.017
9	77	179.017
10	33	179.888

Table 5c
11 delegations

100% of ants

Beta=5

Rho=0.9

Number of runs	Iteration	Results
1	33	179.017
2	22	179.017
3	55	179.017
4	22	179.017
5	22	179.017
6	33	179.017
7	220	179.017
8	44	179.017
9	275	176.827
10	11	179.017

Table 5d
11 delegations

100% of ants

Beta=5

Rho=0.95

Number	Iteration	Results
1	33	179.017
2	88	179.017
3	33	179.017
4	187	179.88
5	11	179.017
6	33	179.017
7	66	179.017
8	66	179.017
9	44	179.017
10	44	179.017

Table 6 Summary of experiments

(instances of 11 delegations)

% of ants	Beta	Rho	Iteration	Results
60%	1	0.9	88	179.017
60%	1	0.95	110	176.827
60%	5	0.9	11	179.017
60%	5	0.95	33	179.017
80%	1	0.9	33	176.827
80%	1	0.95	132	176.827
80%	5	0.9	33	179.017
80%	5	0.95	22	179.017
100%	1	0.9	55	179.017
100%	1	0.95	88	176.827

100%	5	0.9	275	176.827
100%	5	0.95	33	179.017

The first column shows the percentage of ants, the values that were used were:

60% Ant = 6.6

80% Ant =8.8

100 Ant=11

The second column shows the values of the variable beta, which are 1 and 5. Third column shows the values of the variable rho, which are 0.9 and 0.95. The fourth column shows that iteration is found the optimum result of the tour. The last column shows the result of the optimal tour.

Remarked The results show the best of all the experiments. On the basis of these results it was found that the best values for beta, rho and the percentage of ants:

Beta = 5

Rho = 0.9

Percentage of ants =100%

Time of the distribution of the 2 paths is 176,827 with a total distance of 156.6451 with a maximum load of 12 tons.

6. Conclusions and future reserch

In the present work was carried out a problem that is within the field of study of the logistics that the PVR with a mathematical formulation of the nearest neighbor in the software using Matlab, which made it possible to reach the optimal solution for the distribution of a food bank and to determine the time of distribution program was used for the C to determine the total time and distance was obtained with the Matlab software.

Significantly was demonstrated the results with the use of a mathematical model as it is the nearest neighbor that can be used to reduce the solution of many VRP variants with regard to the Bin packing.
The problem of routing of vehicles is presented in a food bank of Diconsa distributor which is located in the state of Guerrero that distributes its products in the basket to the delegations of the mountain which have a social status quite marginalized.

During this work only consider to distribute the products of the basic basket of a food bank considering 2 delegations of the state of Guerrero, however were not considered the time windows, nor much less the costs that will be generated during the distribution of such products. For future work is to continue with the implementation of the PVR and with its various restrictions.

7. Acknowledgments

8.   References

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