DIAPO1

Good morning,

My name is christian perez and I am a PhD student at the Universitat Politécnica de Valencia.

First of all, I would like to thank the organizing committee for giving me the opportunity to present our paper at this conference.

DIAPO2

The speech will have the structure shown here:

First we will introduce the problem and its specification, we will teach the techniques that are already used by the company and the one developed by us showing all the improvements made to the basic grasp algorithm.

We will end with a full evaluation of the proposed algorithms and their conclusions and future work.

DIAPO3

The company with which it collaborates has a logistics network strategically distributed throughout the national territory.

Currently has about two thousand orders every week, eleven possible containers to offer to its customer for the transport of any type of product and fourteen warehouses with highly automated installations.

Each of the orders can have different articles with their quantity and a list of warehouses where these articles can be loaded.

DIAPO4

The company follows a circular economy based on efficient management of resources.

For this purpose, an internal process is created in the company. The containers that arrive at the logistics center can be reused, repaired, or recycled, avoiding the waste of excess material, and reintegrating it back into the raw-material loop.

DIAPO5

The external process, in which we are going to work, seeks to optimize customer orders generating the minimum cost. Taking into account characteristics such as transportation cost, delivery time or customer specifications.

For all this, we have a dataset of warehouses, orders and prices of the different containers.

**DIAPO 6**

The data set that the company provides us is made up of a set of orders, a set of warehouses and a price list. This contains orders that are ordered for the same week and is made of:

a delivery date indicates the day on which the order has to be loaded. Decreasing the stock in the assigned warehouse.

The article list contains the id of each item and the quantity of this article.

and the list of warehouses is made up of a triple:

ava identifies if that platform is valid for that trip, pr indicates the cost of transporting that order to that warehouse and dl is the delay of the order.

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on the other hand, the dataset contains a list of warehouse matrices that indicate the stock available at the beginning of each week. Where the column indicates the day of the week and the rows the id of the article.

The data in this matrix may be negative because the company can manufacture its own containers to make up for the lack of stock.

and finally the price list that indicates the unit price of each item identified by its id

**DIAPO8**

the objective function is a mono objective that combines two variables to be minimized. The transportation cost is obtained from the assigned warehouse and the stock cost is obtained from the sum of the costs of restocking each item with negative stock in the assigned warehouse.

these two variables are weighted by an alpha value between zero and one with decimal values

DIAPO9

the company has implemented a greedy algorithm organized in several layers to meet the needs of the problem.

Control of the distance from the warehouse to the customer and other convenient factors

The zone of influence or geograhical area is a higher priority in the assignment. This is done because it significantly reduces the cost of transportation.

Restrict the warehouses loading by the type of articles contained in the order and the quantity of articles is not constant throughout the year because most of the products loaded in the containers are food.

DIAPO10

The metaheuristic developed is based on the structure of the GRASP algorithm adapted to the exposed problem.

The algorithm input is based on the data set made up of the orders, the stock matrices, the price list and a variable that we will use to indicate the size of the candidate list LCR.

First we order the LCR list with metaheuristics that allow us to facilitate the assignment of the warehouses, we will talk about this order later.

then we iterate the LCR list until it is empty, doing a local search to obtain the store with the minimum fitness.

Finally we save the order warehouse tuple in a list to return the solution later.

DIAPO11

The local search obtains the warehouse with the lowest cost for an order, for this we obtain the list of articles and possible warehouses .

Between lines five and thirteen we calculate de transport and stock cost.

we obtain the cost of transportation of each of the possible warehouses obtaining the variable pr of the warehouse

then we review each of the items in the order and calculate the negative stock units that remain in the warehouse multiplying it by the price of manufacturing the missing items.

By weighting these two values with an alpha variable we are able to balance the algorithm so that it obtains the warehouse with the minimum cost

**DIAPO12**

now we are going to enter the ordering of the LCR list for an improvement of the allocation of warehouses.

DIAPO 13

we have generated six ordering models that we believe could positively affect the allocation

Each of these models has different characteristics combined with others that allow us to fine-tune the algorithm.

The first four models are based on the number of possible warehouses, where the first is the basic metahuristics and the second to the fourth are combined with other types of characteristics to improve it.

DIAPO 14

within the ordering of the lcr list we realized that in each iteration the ordering generated is the same. To solve this problem we created a random shuffling method.

As can be seen in the image, the ordering model for the example is the first in which they are ordered by number of available warehouses. groups are generated with the same quantity and a random quantity of orders is shuffled to obtain a different list.

DIAPO 15

The last of the improvements implemented is based on the dynamic modification of the alpha variable.

This is done because during the execution of the tests, a polarization of the objective function is observed when there are a large number of assignments with zero stock cost, erroneously choosing warehouses with less stock.

DIAPO 16

to fix this problem we create an alpha factor.

This alpha factor is calculated as the subtraction of one minus alpha divided by the number of orders that remain to be assigned.

When an assigned order has no stock cost, the factor is added to the alpha variable, otherwise that amount is subtracted so that the stock cost has more weight in the objective function.

**DIAPO17**

In the evaluation of the algorithm and the improvements made to adapt the GRASP to the problem, three case studies are used:

the first is a test case that contemplates all the casuistry of the problem, this case will be used to tune the algorithm parameters.

The other cases are real cases in which orders for the first and second week of July of two thousand and twenty will be assigned.

These case studies have around two thousand order. Each order can contain between one and fourteen possible warehouses and between one and eleven items for the whole week.

DIAPO18

The dispersion of the negative stock and the different costs will be evaluated. Dispersion is measured as the total number of items with negative stock among all warehouses.

This graph shows the dispersion of each of the models implemented in the LCR ordering.

Being model two the one that generates less dispersion due to a smaller quantity of items in stock

DIAPO19

To verify that model two is the best, we obtain a comparison of the costs between the different models.

and as can be seen, the cost of transport remains more or less stable in all models, but model two generates a lower cost of stock.

Therefore, model 2 that orders the list according to the number of available warehouses and the number of items the order needs

DIAPO20

now we go on to evaluate each of the improvements implemented.

The improvements implemented are the LCR ordering with model 2 that we have already seen is the best of all, the shuffle of the LCR ordered list and the alpha scheduler to avoid the polarization of the fitness function. Each of the improvements is implemented on the previous one, the first being the basic GRASP algorithm.

As we can see, each of the improvements obtains lower costs than the previous one. Being the set of all the improvements the best solution

**DIAPO21**

Finally, the algorithm will be evaluated with all the improvements with respect to the algorithm that is implemented in the company. Both algorithms have been evaluated with the same two case studies from the first and second week of July.

the dispersion of the negative stock is reduced in both cases by the GRAPS algorithm. The second case being the one that generates the greatest best.

DIAPO22

When comparing the different costs, there is a clear difference between the greedy algorithm stock cost and the grasp. It is also observed that the transport cost is higher in the grasp algorithm in both cases, this is because the objective function sometimes allows the transport cost to be increased as long as there is a greater improvement in the cost of stock. This can be seen in the total cost where the grasp algorithm generates a better result.

**DIAPO 23**

To conclude, it is determined that logistics companies need to optimize their strategies by implementing algorithms that combine problems to improve their economy.

On the other hand, the implemented GRASP algorithm improves the average negative stock by up to eighty-two percent, obtaining a solution in less than a minute and a half.

Future work is focused on the creation of a data pool from solutions of the grasp algorithm and the creation of a genetic algorithm that evaluates the solutions looking for better solutions.

DIAPO24

Finally, I want to thank my director for helping me and supporting me in this project.

and to all of you for paying your attention.

Thank you.











