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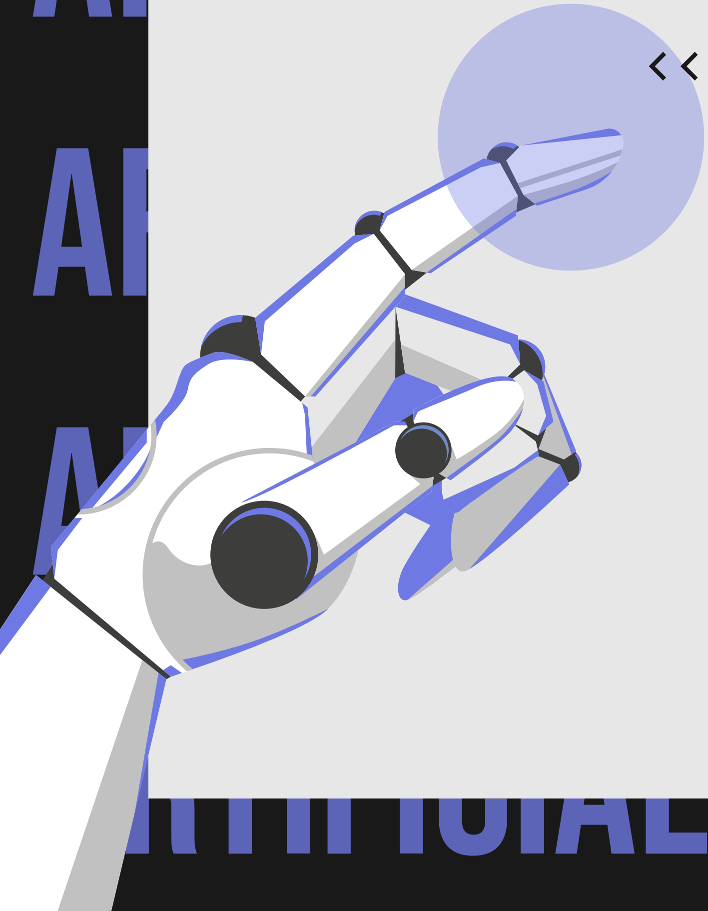

VEHICLE ROUTING PROBLEM

Making the SBRP easier than before

Team 26

INTRODUCTION

What is vehicle routing problem (VRP) ?

- VRP is a central problem in the areas of transportation, distribution and logistics.
- Transport cost typically constitutes more than half of the total logistics costs.
- Decreasing transport costs can be achieved through better utilisation of resources such as vehicles.
- VRP is to design route for vehicles so as to meet the given constraints and optimised objectives.

PROBLEM

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The VRP is a generalisation of the TSP but in our case we are focusing on a more specific one.
The School Bus Rooting Problem which is a very challenging problem considering all the different attributes starting from bus stops selection to bus route generation and strategic transportation.

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CONSTRAINT

CUSTOMER

Ensure that each customer
be assigned exactly to a single route

VEHICULES

Represents vehicle Quantity and Capacity Constraint

COST

Minimise cost by determining which customer to each vehicle serves and in what order.

TECHNOLOGY

PROBLEM

Using a standard App can lead to a major problem with platform compatibility in such the application must be developped in many versions to cover customers needs.

SOLUTION

A Web platform is the most suitable solution for our case.
As it can be very responsive with cross-platform compatibility.

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JAWADOOR

EZ USE

A costumer friendly interface, to reduce bus search time with the minimum cost.

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EZ MANAGE

No pre-requirements needed to manage and administrate platform resources.

> > > >

EZ MAINTAINE

By using a web platform We made sure that it can be easily maintained for optimal running.

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Mathematical Formulation of VRP

Let G=(V,A) be a directed graph where V= {1,...,n} and A={(i,j), 1≤i,j≤n} are the set of vertices and arcs respectively. Where: School buses are centrally located and have collect waiting students at n(here =8) pick-up points and to drive them to school. The number of students that wait at a pick-up point i is qi, (qi>0,i=1,2,...,n). The capacity of each bus is limited to Q =16 students(qi<Q). The objective function to the School Bus Problem is composing of the cost incurred by the number of buses used. Subject to operational constraints, transportation cost has to be minimized.

→ The school bus routing problem can be expressed as an integer linear programming problem.

PARAMETERS

01.

c_{ij}:

Travel cost traversing arc (i,j)

02.

K:

Number of buses

03.

Q

Capacity of the buses

04.

V

Set of all potential stops

05.

A

Set of all arcs between stops

06.

s_{li}

Binary variable that indicates whether student lcan walkto stop ior not

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DECISION VARIABLES

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x_{ijk} =Number of times that bus ktraverses arcs from i to j
y_{ik} =1 if bus k visits stop i or 0 otherwise
z_{ilk} =1 if student l is picked up by bus k at stop i 0 otherwise

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01.

PROBLEM IS:

Min Z=$\sum_{i=0}^{n}\sum_{j=0}^{n}\sum_{k=1}^{n} C_{ij}Xijk$

MEANS:

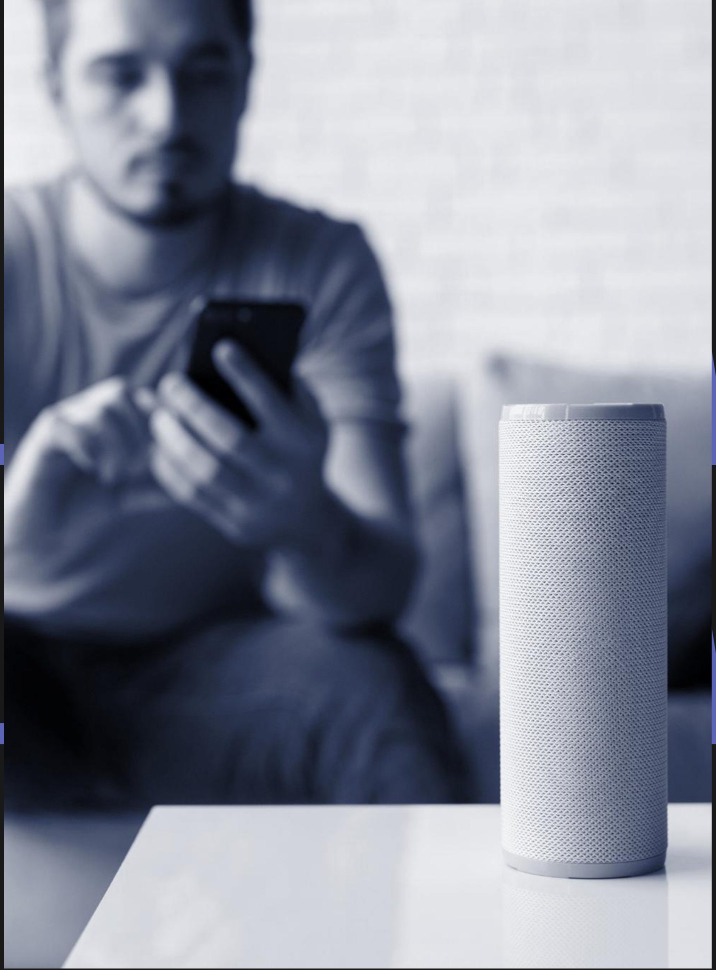
$$\sum_{k=1}^{k} y_{ok} \leq K \quad k = 1, \ldots, K$$

$$\sum_{j \in V} x_{ijk} = \sum_{j \in V} x_{ijk} = y_{ik}, \quad \forall i \in V, \; k = 1, \ldots, K$$

$$\sum_{i \in S} \sum_{j \notin S} x_{ijk} \geq y_{hk}, \quad \forall S \subseteq V \setminus \{0\}, \; h \in S, k = 1, \ldots, K$$

$$\sum_{k=1}^{K} y_{ik} \leq 1, \quad \forall i \in V \setminus \{0\}$$

$$\sum_{k=1}^{K} z_{ik} \leq s_{li}, \quad \forall l \in S, \; \forall i \in V$$



MEANS:

$$\sum_{i\in V}\sum_{l\in S} z_{ilk} \le Q \quad \forall k = 1,\dots,K$$

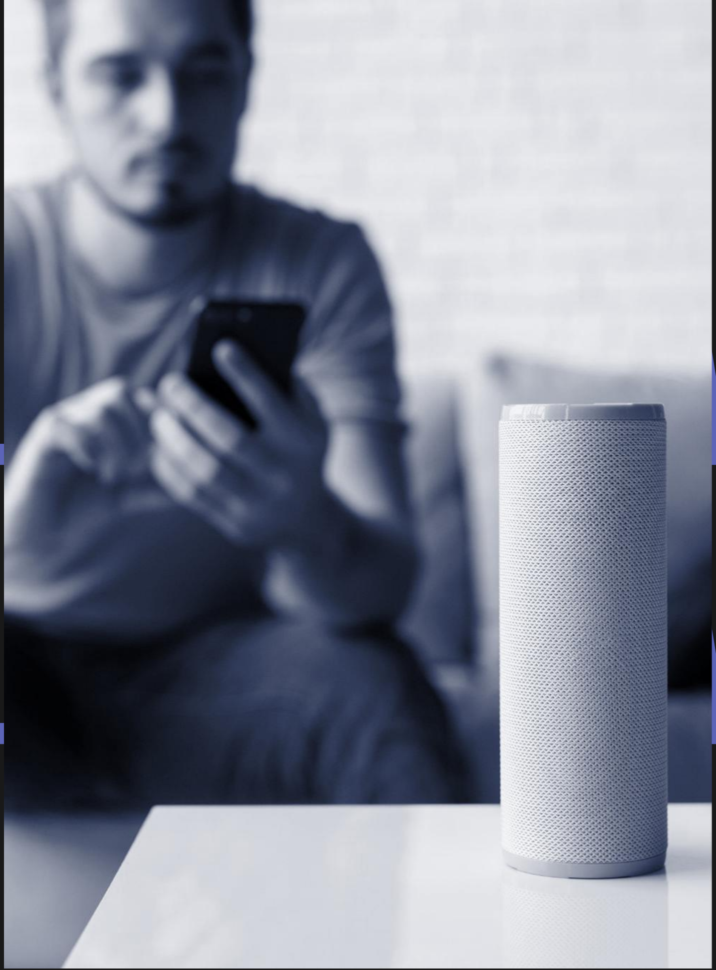
$$z_{ilk} \le y_{ik}, \quad \forall i, l, k$$

$$\sum_{i\in V}\sum_{k=1}^{K} z_{ilk} = 1, \quad \forall l \in S$$

$$x_{ijk} \in \{0, 1\}, \quad \forall i \in V,\ k = 1,\dots,K$$

$$y_{ik} \in \{0, 1\}, \quad \forall i, j \in V \setminus i \neq j$$

$$z_{ilk} \in \{0, 1\}, \quad \forall i, j \in V \setminus i \neq j.$$



SO MORE

The objective function Min Z=$\sum_{i=0}^{n}\sum_{j=0}^{n}\sum_{k=1}^{n} C_{ij}Xijk$ minimizes the transportation cost. Constraint ensures that all buses start from the depot, while constraint indicates that if stop i is visited by bus k, then one arc should be traversed by bus k entering stop i and leaving stop i.

- the sub tour breaking constraints in terms of the number of buses needed to serve set S. ensures that all are visited no more than once, except the stop corresponding to the depot.
- each student walks to a single stop he or she is allowed to walk to. Constraint guarantees that the bus capacity is never exceeded. Constraint ensures that student l is not picked up at stop i by vehicle k if vehicle k does not visit stop i.
- ensures that all students are picked up once.

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SOLUTION

- Solution by a series of probabilistic decisions where every decision extends a biased solution by adding a new solution component until a complete solution is derived
- This is done in an iterative processwhere the good solutions found by the ants of iteration shouldconduct the ants of following iterations

SOLUTION

- To solve the BRP, it is recommended to hybridize it with a local search. In this way, we propose the using a variable neighborhood to improve the solution generated after the updating.The VNS is a recent metaheuristic for solving combinatoria land global optimization problems. It is a simple yet very effective metaheuristic that has shown to be very robust on variety practical NP-hard problems
- The main idea of this new method is to use various neighborhood structures during the search. Here, several neighborhoods' structures are used instead of a simple one as itgenerally changes the case in many local search implementations. Furthermore, the systematic change of neighborhoods is applied during both a descent phase and an exploration phase, allowing getting out of local optima. In the initialization phase, a set of k_{max}(a parameter) neighborhood is reselected (N_k,k=1,...,k_{max}),a stopping condition is determined and an initial local solution is found.

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ALGORITHM 1

1

Start with any node as the beginning of a path

2

Find a node, not already on the path, which is closest to thelast added node

3

Find the biggest bus stops which have the biggest number ofpeople. Add it to the path

4

: Repeat Step 2 until all nodes belong to the path. Then, join the first and the last nodes of the path

ALGORITHM

- After the execution of the first constructive solution (nearest neighbor procedure), we try to improve the solution and to optimize the bus tours dynamically using the dynamic construction method
- A new way of building the solutions is proposed in this section. It is about the concept of Dynamic Construction. For the routes carried out using the first constructive method, we continue the solution construction dynamically

ALGORITHM

- . As a starting point it happens that is impossible to place a bus stop i without conflict after a certain time finds an advantageous place among the positions already placed.The Dynamic construction already refers to a construction where the route r_k is built using a dynamic chain of bus stops denoted by (DBS) that we can insert into all the positions, by shifting the elements already places while preserving overall constraints of the problem. For the Dynamic Construction, the logic of solution construction is reversed. With each step, randomly an ant must initially choose a route rk. Then, the best position BESTPOS into which a bus stop i of this route will be inserted is selected according to a modified transition pseudo random rule . Formally, if during the t^{th} iteration the k^{th} iteration is located in bus stop i, the next bus stop j_{is} chosen according to the probability distribution over the set of unvisited bus stops(n–DBS)

VARIABLE NEIGHBORHOOD LOCAL SEARCH

- The local search methods are a standard approach to finding so-lutions to combinatorial optimization problems. Such techniquesare built around a neighborhood structure on a set of possibleschedules. This structure can be represented by a directed graphwhose vertices correspond to the schedules, each schedule beingconnected to its neighbors by an arc of the graph

ALGORITHM 2

```
1: procedure VNS (itermax,f,kmax)
2: for i=1 to iter_max do
3: k:= 1;
3: Generate a starting solution swith nearest neighbor procedure;
4: While (k≤kmax)do
5: Generate s’∈Nk(s) at random;
6: s’’ := Local search(s’);
7: if f(s’’) < f(s) then
8: s:= s’’;
9: k:= 1;
10: else k:= k+1;
11: end if
12: end while
13: end for
14: return (s);
15: end VNS
```

IMPLEMENTATION AND INSTANCES

To evaluate the performance of the HAAC with VNS local search algorithm we consider one sets of instances. This set is composed of the fifty test problems devoted to the morning problem scope where the fleet is homogeneous. All test problems are developed by Díaz-Parra et al. (2010) and they are taken from the School Bus Routing Problem Library-SBRPLIB. The instances can be downloaded from the SBRPLIB site.(http://diazparra.net/SBRPLIB.aspx.)

PARAMETER SETTINGS

To verify the performance of the proposed metaheuristic, a series of experiments is set up. Our algorithm employs a set of parameters.

CONCLUSION

To sum up, We presented an extended study of a novel hybrid approach to rank solutions in bus routing problem in the presence of areal case. We have shown that the variable neighborhood as local search improves the performance algorithm. We have proposed and analyzed the performance of our new hybrid algorithm for solving the real bus routing problem. From the experiments carried out here we conclude that the proposed methodology is able to solve the hard bus routing problem in this case study. The results show that the solution produced by our metaheuristic is highly dependent on the choice of the local search; here we have implemented the variable neighborhood search inside the algorithm. Our approach is competitive when compared with the results of the bus network provided.

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