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LAST MILE DELIVERY

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Abstract - *We were amazed by the way in which e-commerce stores and other delivery agencies like Dunzo, Swiggy deliver products on the same day. When we researched about the process and the way in which they can make such complex decisions we decided to make such a platform that will not only be open source but can be integrated with other applications as an API. We aimed to solve the Vehicle Routing Problem along with the Travelling Sales Person coupled with route optimization. The main objective of the project is to create an algorithm that refers to a database of defined data (the parameters are constant) containing the orders placed by the inventory management and billing system which is then processed such that the orders are distributed among the available delivery vehicles such that the sum of the overall distance traveled by all the available vehicles is the minimum and the route between each pickup or delivery is optimal. We used the concept of the resource allocation, webserver, route optimization, distance matrix to provide the backend to our project. Further we will build a android application that will be used by the delivery person for better optimisation.*

***Key Words*: VEHICLE ROUTING PROBLEM, ROUTE OPITIMIZATION, ANDROID APPILICATION, API.**

1. INTRODUCTION

We as a team were intrigued with the way e-commerce stores and other delivery agencies like Dunzo, Swiggy, Grofers deliver products on the same day. When we researched about the process and the way that they can make such complex decisions we decided to make such a platform that will not only be open source but can be integrated with other applications as an API.

On reading research papers, documentations, and articles we clarified our goal and end product as a team which was to solve the Vehicle Routing Problem along with the Travelling Sales Person coupled with route optimization. We identified the technical approach that will be required for the completion of the project and identified that we will require the google maps API to provide a navigable route from pickup to drop off location.Apart from this we also needed the concept of the resource allocation, webserver to provide the backend to our project.

It is human nature to travel from one spot to another, it can be for leisure or for work, it is this travel from one spot to the other that expands traffic on the course of the development, the expanded traffic at last prompts clog. This blockage influences the street transportation framework and creates setbacks for conveyances, expansions in movement costs, natural contaminations, and so forth. The course is a course, way, or street for section or travel. There are many courses between a source or point and an objective. Frequently we stall out on a course because of helpless information on the traffic circumstance of the course and invest more energy and assets on the course which should be kept away from on the off chance that total and right data were accessible. Along these lines, underlining the requirement for earlier information on street traffic circumstances to help decision-production on which course to employ was found. The client holds the right of decision however the underlying issues are cost and appearance time at the destination. The typical peculiarity is to go between two focuses utilizing the briefest way known, inside a particular time and cost. Be that as it may, what happens when the most limited way or course turns into the longest because of an occasion or event prompting a stop on the course. The client invests more energy and costs on the course which should be more limited than different courses, accordingly making it not an ideal course at that particular time. This project investigates course and steering issues in street transportation frameworks. A review of course enhancement methods is done for both hard figuring (non intelligent) strategies and delicate processing (clever) procedures.

Android Studio is the authority incorporated improvement climate (IDE) for Android application advancement. It depends on the IntelliJ IDEA, a Java coordinated advancement climate for programming, and consolidates its code altering and engineer instruments.

To help application advancement inside the Android working framework, Android Studio utilizes a Gradle-based form framework, emulator, code formats, and Github coordination. Each venture in Android Studio has at least one modalities with source code and asset documents.

2. Literature Survey

A significant applicable class of the VRP is the pickup-delivery problem(PDP). The PDP is a direct issue with various pickup areas and delivery areas for moving products. The PDP can be characterized into three sorts: many-to-many, one-to-many-to-one, and balanced, in view of the pickup and conveyance relations.

In a many-to-numerous PDP, everything might have different pickup hubs and delivery hubs, while any hub can

demand pickup and destination of the things. Chime et al. [3] presented the MVSPDP, where some chose pickup hubs are picked to supply all delivery hubs. The goal is to observe insignificant expense delivery courses for a considerable length of time with limit and distance imperatives. Xu et al considered a multiproduct, unpaired PDP that permits different visits to every client, where beyond what one item can be conveyed in a visit, however, every item request conveyance can't be parted.

A one-to-many-to-one PDP is a place where the delivery activity is done from one warehouse to numerous clients, and the pickup activity is performed to take things from numerous clients back to the stop. The one-to-many-to-one PDP is otherwise called the VRPPD and its variations.

The VRPPD is a significant augmentation of the VRP. In the VRPPD, there are two gatherings of clients: linehaul and backhaul. Linehaul clients demand things to be conveyed from the stop, while backhaul clients demand things to be gotten to and gotten back to the terminal. The VRPPD has numerous variations arranged by utilizing the transportation conduct in light of the line haul and backhaul clients.

(I) VRPB (VRP with backhauls) determines that vehicles should serve all linehaul clients prior to serving the backhaul clients [Books: 1, 2, 3].

(ii) VRPMPD (VRP with blended pickups and conveyances) permits vehicles to serve both line haul and backhaul in any request [Books: 4].

(iii) VRPSPD (VRP with concurrent pickups and conveyances) is the issue where clients require pickup and conveyance simultaneously. Every client is permitted to be served by just a single vehicle that performs pickup and conveyance, at the same time [Books: 4].

(iv) SVRPDSP (single vehicle directing issue with conveyances and particular pickups) by [14] is one more variation of the VRPSPD. The thing that matters is that the pickup tasks can be precluded assuming they are not beneficial.

(v) VRPDDP (VRP with separable conveyances and pickups) may isolate the conveyance and pick up at a client into two tasks to such an extent that the client might be visited twice either by a similar vehicle or by two vehicles in various courses. This unwinding makes it conceivable to make achievable courses, which would be infeasible in the VRPSPD, VRPB, and VRPMPD because of the change of burdens. Note that "distinct" alludes to isolating conveyance and pickup activities at one client, which is not the same as halfway conveyance or pickup in split conveyance VRP (see [16]).

(vi) Recently, Wassan and Nagy [Books: 5] further stretched out the VRPMPD and VRPDDP to incorporate a limitation that conveyances and pickups can be blended provided that a specific measure of free space is accessible on the vehicle.

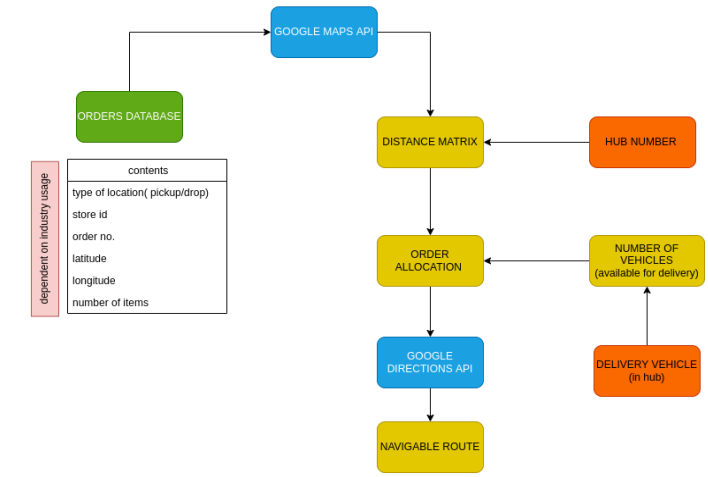
At long last, a balanced PDP comprises of pickup and conveyance demands in which every pickup area is explicitly attached to one conveyance area. This sort of issue can likewise be alluded to as the dial-a-ride issue (DARP) for shipping individuals. The parcel interest, characterized in this review, can be seen as a balanced pickup and conveyance demand.

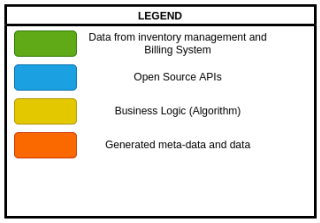
Late investigations on the balanced PDP that considered green perspectives and different limitations are. Madan Kumar and Rajendran [Books: 6] figured two numerical models for green VRPPD for a semiconductor inventory network. The principal model zeroed in on elective fuel vehicles for the essential green semiconductor inventory network that has limitations on item vehicle similarity and starts and consummation times and diverse solicitation needs for pickup and conveyance. The subsequent model was stretched out to deal with having distinctive fuel costs at various refueling stations to limit the absolute expense of refueling and steering. The proposed model considered the fuel utilization that is identified with discharges, variable vehicle speed, and street classes (i.e., metropolitan and nonurban) with various traffic guidelines. The model was settled utilizing a contextual investigation from the Netherlands. The outcomes showed critical reserve funds from adding these new factors.

PDP with parcel and time windows (PDPTTW) limitation, which is a balanced PDP that is stretched out to incorporate parcel focuses, where burdens can be shipped between transportation implies that they have various courses. Numerical models for one parcel area and subjective parcel areas have been created. The choice for every vehicle is to pick between a course that ventures out straightforwardly to the client and a course that goes through parcel habitats. This idea of parcel focuses isn't identified with pickup and conveyance of burden.

One more applicable class of VRP is the inventory routing problem (IRP). In IRP, VRP is joined with stock administration issues to such an extent that pickups and conveyance amounts from warehouse to clients are chosen dependent on a stock approach, which considers the stock holding cost.

3. SYSTEM DESIGN





3.1 Blockwise design

Discuss step-by-step internal details of each block involved in the block diagram.

3.1.1 Orders Database

The REST API which we are planning to make refers to the database containing orders placed by the inventory management and billing system. This block refers to the database that is generated by the inventory management system. The parameters of the database will be constant with some of the attributes being order id, pickup location, delivery location, etc and other parameters which will be variable and dependent on the industry application.

3.1.2 Google Maps API

This part will come under the data processing stage where we will take the data from inventory as input and then provide a navigable route by splitting it into the pickup and drop-off locations that will be known as the nodes.

3.1.3 Distance Matrix

In this data processing stage with the help of Google Maps API, we will find out the shortest internode distance. This internode distance will then be used to create a distance matrix. The distance matrix created will be then used in the algorithm to find the shortest and most feasible route.

3.1.4 Resource Allocation

Once the distance matrix has been created we enter the resource allocation phase, wherein we take in the distance matrix, relative pickup/delivery values, number of active delivery vehicles, and the location of the hub and distribute the active orders among the delivery vehicles along with the order in which the delivery vehicles will do so.

3.1.5 Google maps direction API

Here the nodes will be used to provide the navigable route from the pickup to the delivery location for each delivery vehicle.

3.2 Components/devices selection

3.2.1. Android Studio (version - 2020.3.1.25)

It is required for creating an android application used by the delivery person as an interface that interacts with the server.

3.2.2. Android Virtual Device (AVD)

It is a type of open-source virtualization software that enables us to emulate an Android Mobile Device, over which development and testing of the Android application is done.

3.2.3 OR Tools Library

OR-Tools is an open-source, fast, and portable python package that is used for solving combinatorial optimization problems.

3.2.4 Google Maps API

Google Maps API is used to fetch real-time geographical data from google's database servers. The API also acts as the base for the widely used and trusted Google Maps.

3.2.5 Visual Studio Code

Visual Studio code popularly known as VSCode is used as a coding environment for the development of the python-based Flask webserver which would be serving as the backend and would be used to hold, calculate and execute the platform's BL.

3.2.6 Firestore

For storing the vehicle details and status we are using a No-SQL Document database by Google called Firestore. Firestore is easily integrable with mobile and web-based applications and provides an interactive web-based administration console for complete software and OS independency.

3.2.7 Firebase Authentication

Firebase Authentication is used for storing the login details of the delivery vehicles and securelyproviding multi-factor

and multi-point authentication services while keeping the base application lightweight and fast.

4. METHOLOGY

4.1 Distance Matrix

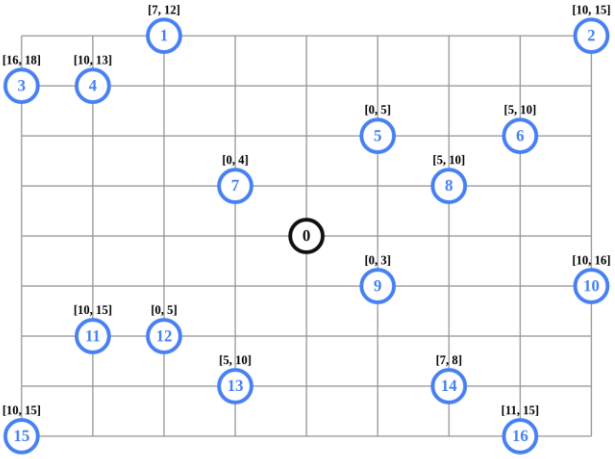
We will compute the distance matrix in this part. The distance matrix is an array of distance between the locations on meters.

In order to calculate the distance matrix we considered the co-ordinates of the locations.To calculate the distances between locations we used the Manhattan distance, i.e the distance between two points, (x1, y1) and (x2, y2) is defined to be |x1 - x2| + |y1 - y2|.

We also used the google distance matrix api to calculate the distance matrix.

If we consider there are n locations in the given problem then the matrix of n*n is created.

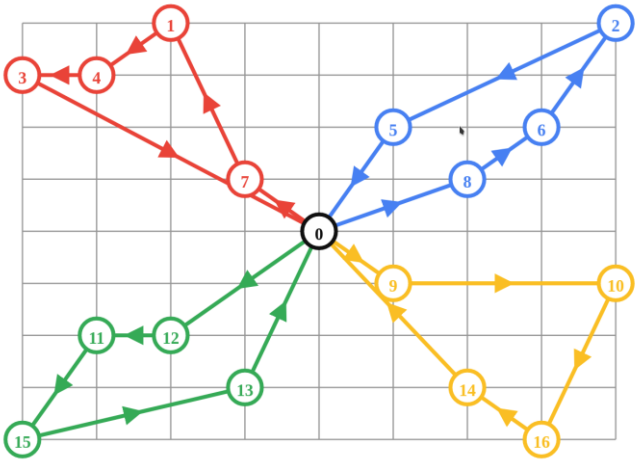
In this matrix if we consider the i and j as the traversing variable then i,j entry is the distance between the ith and jth location.



4.2 Resource Allocation

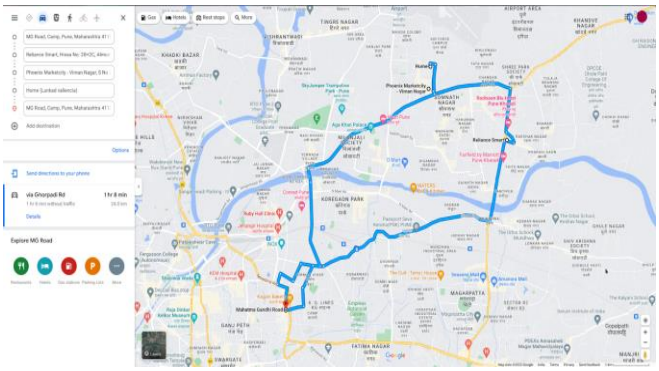
The inputs taken from the previous block are the distance matrix which is stored as an n x n matrix where n is a number of current active orders for a hub, secondly, we take the store data of the nodes as their relative pickup and delivery points with relation to the distance matrix.

The platform configurations include the number of hubs, application assigned hub number and the frequency of the algorithm execution, and the radius of the hub (so as to determine if a delivery vehicle can be categorized as available for delivery).



4.3 Navigation

Once the resources have been allocated among the available active delivery vehicles, each delivery vehicle is sent a notification and an email stating the route it has to follow in order to complete all the deliveries in the shortest and time-efficient path.



5. CONCLUSIONS

The dynamic nature of the road transport system and its associated uncertainty has caused a high level of emotional dread among road users today. Most times people embark on a road without prior knowledge of what will befall them in terms of traffic situations on the chosen route. This project exposes the real nature of road transport and different routing problems in road transportation. Various route optimization techniques both non-intelligent and intelligent are used in the project. Their general strength and weakness were presented and from the survey, the intelligent approach proffers more suitable solutions to the route optimization problems when faced with the reality of the complex and multi-criteria scenarios. This work contributes to modeling cooperation and developing methods to solve hard delivery problems in real situations. In actual practice of courier companies, some cooperative strategies are in action but without sound theory to justify performance or to explore further improvement.

6. FUTURE SCOPE

Immunizing homebound patients for COVID-19 is really difficult for the medical services local area. Strategic issues are confounded by the need to immunize however many individuals as would be prudent, as fast as could be expected. Moreover, certain gatherings of high-hazard patients are frequently homebound and incapable of venturing out to get inoculated. Simultaneously, the immunization's temperature should be painstakingly controlled to stay viable. That makes intricacies with timing and area.

During the Pandemic when the world was shut, food and medicine scarcity had risen to a new level, it was during this time that nonprofits and volunteers started operating as food banks. Our platform could have been used in collaboration with their inventory management system to facilitate faster and more efficient deliveries.

Restaurants are dependent on other services to be able to provide home deliveries. This model is successful for a single restaurant, but for food chains like McDonald's, Subway, Dominos the delivery model is a home-brewed model. Their delivery services are time-dependent. Our platform, once integrated with their order-placing service can theoretically improve their delivery services by taking into account the current ready orders and their delivery locations and creating a route based on the available delivery vehicles, preventing the delivery personnel from delivering one-order-at-a-time.

Additionally, the conceivable outcomes of carrying out the meta-heuristic calculations and further measurements for taking care of the related vehicle routing issues by considering the goals like changes of an assistance solicitation to clients, time windows, size of the vehicle (little, medium, huge). At last, the calculations ought to be tried with exceptionally huge scope benchmark cases. There is as yet far to go on the track to interface the vehicle directing issues. We trust this project might prompt new freedoms and conditions for supportable administration of coordinations businesses and will empower more specialists and make interests in picking point VRP.

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