FYP-II Chapter 1

Group # 5

Routing Optimization System

**INTRODUCTION:**

Route optimization is the process of finding the best (shortest and cheapest) route for your vehicles in a such way that we can optimize and find optimal solution. A route optimization tool can find the most efficient routes to travel based on the constraints and goals of a business. This includes taking into account the number of stops required, their locations, and the time windows for deliveries.

But, it is not that simple. If you have a business, you may know that route planning includes deciding on the best way to get customers to your business. You might have had difficulty following the proper route. There should be challenges to face if you are not likely to take them more seriously.

We are used to requesting multiple pick-ups and drop-off requests for our packages, because we want them to be delivered to any location. Also, handling multiple clients may increase your workload. Managing all these tasks one-handed can lead to serious bugs and problems. A carpenter cannot do the job of an electrician. People who are skilled at performing tasks quickly are able to do so effectively and with less time spent on the task. Likewise, vehicles are also made for specific functions. Reefers are designed to carry cold items, trucks are made for carrying heavy items, and so on. Therefore, it is important to choose the right vehicle for the job. It is important to find a driver who is communicative and able to complete the process easily.

The service time includes the travel time and a fixed stop time per customer. There is no one answer to this question since it depends on the individual's needs. You may also want to consider following through with your plan. It is difficult to determine which route and at what time a driver delivers the products. If an average time doesn't seem to be working, there might be a time crisis looming.

Accounting is essential for ensuring that all financial matters are taken care of properly. It can be difficult to gather all of the details necessary for a report. Accounting is important for keeping track of the costs associated with your business. If you neglect this part of your business, it could bring your company down. You may have assets with their own limitations. The volume, weight, and load meter are a part of the limitations of these devices. It is easy to manage the limitations of a single vehicle when doing so. However, when the number changes, the task becomes very tiring and difficult.

We often change the delivery destination at the last minute. This can be a serious problem for your logistics company. Since finding an optimized route at the last minute can be quite difficult. Moreover, there is a high chance of customer dissatisfaction if you fail to deliver your goods on time.

So, how one can overcome all these problems? Definitely all the above problems will manage with the help of a routing optimization system.

**OPTIMIZATION**

Maximizing or minimizing some function relative to some set, often representing a range of choices available in a certain situation. The function allows comparison of the different choices for determining which might be the “best”.

Some Common goals of Optimization are minimal cost, maximal profit, minimal error, optimal design and optimal management.

Usually optimization is of two types:

* Mathematical Optimization.
* Heuristic Optimization

**MATHEMATICAL OPTIMIZATION:**

Mathematical optimization is the process of finding the best possible solution to a problem by adjusting variables in a way that makes the problem as efficient as possible. Some variation of optimization is required for all deep learning models to function, whether using supervised or unsupervised learning.

There are many optimization techniques to choose from, but all require a starting point and a goal. In order to optimize something, you need to define an objective function that will tell you what you want to achieve.

This function can produce a specific result or a probability threshold.

Inputs can be either discrete or continuous.

Limits on the size of variables are important in order to keep the data in the model accurate. Equality constraints are usually noted with an hn (x), and inequality constraints are noted with a gn (x).

Unlimited optimization problems are those that do not impose any constraints on the variables.

**HEURISTIC OPTIMIZATION:**

Heuristic design is a computational procedure that tries to find an optimal solution by iteratively improving a candidate solution according to a given measure of quality. Heuristics make little or no assumptions about the problem, being optimized and can search large areas of candidate solutions to find the optimal or near-optimal solutions at a reasonable computational cost with no guarantee of feasibility or optimality, or even in many cases the state, as in near optimality is a particularly viable solution. Heuristics implement some form of search optimization, such as evolutionary programming, evolution strategy, genetic algorithms, genetic programming, and differential evolution.

**DIFFERENCE BETWEEN HEURISTIC AND OPTIMIZATION:**

Basically every supply chain planning and scheduling problem is at its core an optimization problem. The company's solution involves determining the best way to synchronize the supply and demand across the supply chain network in order to boost customer satisfaction and bottom-line results. One common way businesses try to solve their supply chain planning and scheduling problems is by using heuristics. Simply put, a heuristic is a problem solution that uses a practical process (often referred to as a "rule of thumb" or "best practice") to produce a workable solution good enough to quickly solve a specific problem and immediate goals - but not necessarily an optimal solution.

In contrast, an optimization model uses an intelligent, automated process to create an optimal solution to a specific problem, given decision variables such as production, inventory, and shipment volumes, as well as constraints and key performance indicators (KPIs). Supply chain optimization solutions aim to improve the performance of your procurement, production, inventory, and distribution operations so that you can achieve the best possible delivery performance and overall profitability.

**ROUTE OPTIMIZATION SYSTEM**

If you run a logistics company, then you know that your destination may not always be where you plan to take your products. Even if it is not a pickup point, the delivery point can be multiple. How can you find the shortest route that covers all of your points? How can you know about the road conditions remotely? To optimize a route, you will need a route optimization system. Delivery route optimization software can help you find the shortest distance between two or more locations. A truck routing software can also analyze current dicey situations and business limitations, like the available vehicles and drivers, traffic conditions, etc. This will help you get your goods to their destination in a timely manner. The best route optimization software generally follows three primary strategies: optimizing routes based on available data, optimizing routes based on user preferences, and optimizing routes to minimize travel time.

The three types of routing are:

**Static**, which is based on requirements such as quarterly or monthly plans.

**Dynamic**, which is based on daily developments.

**Real-time dynamic routing** – Developing routes based on current road and traffic conditions in real-time to help drivers on the ground.

**Benefits of a Route Optimization System**

The global best route optimization software market is projected to grow by 24.7% over the next four years. This is equal to $5.32 billion! This market has a high dominance in certain regions.

But why do people go after the best path improvement tool? Does the best route optimization software have any benefits for travelers? Yes, I am excited about the new product. Route optimization software can also have benefits, such as saving you time. This section provides information about all of the different types of yoga. Invest less, but get a bigger return (higher return on investment)

* Reduce human error.
* Provides you with a clear insight into your overall work operations
* Save fuel costs and manage budgets efficiently
* Reduced travel time for each journey
* Can help staff complete their working hours.
* Save on redelivery costs and stockpiled first-try shipments
* Manage multiple pickups and drop off points at the same time
* Get instant alerts on route differences and incidents without incident
* Replace your operator's route optimization system to save labor costs
* Smaller distances mean low carbon emissions and pollution
* Helps deliver efficient last-mile deliveries to enhance customer satisfaction

**How to Optimize Route Planning**

Use software to plan your logistics routes and improve your delivery services. Access a centralized dashboard that shows dispatch and other details of the orders in real-time. Use a logistics route optimization software to manage resources, assign tasks, and allocate orders from a single dashboard. Use a vehicle/Package route optimization platform to improve fleet performance by gathering data analytics and other reports. Field agents can easily navigate and deliver orders on time with effective vehicle route optimization. The location intelligence feature of the logistics route planning software can help you avoid congestion and optimize movement times. There are alternate routes you can take to optimize your vehicle route. Understand the factors that influence the ETA, including the time it takes to make the signals. Use logistics route optimization software to uncover hidden data points that can help improve supply chain and cost efficiency.

**USE CASES:**

**OTL LOGISTIC**

OTL is a logistics company in Malaysia. The bank has over 250 branches in different parts of the world and operates over 300 vehicles. The company had difficulty managing its fleet efficiently due to an outdated fleet management system. The company had trouble repeating routes, and was unsure of where the vehicles were. After using a route optimization system, the company was able to improve its service and tracking. Moreover, they benefited hugely. Let's take a look at the various solutions.

Solution:

Optimize the route

15% savings in fuel costs

Reduced number of trucks as there are few enough trucks to reach multiple destinations.

**CRATE AND BARREL:**

Crate & Barrel is a well-known American-based home decor and furniture company founded in 1962. Currently, the store has over 160 stores and 7,000 associates. It also has over 80 delivery trucks. The main distribution centers of this company are in New Jersey, San Francisco, and Chicago. The coverage of the insurance policy is 300,000 per year. However, the company faced a major delivery problem. Their fleet management system was the reason for this. The problems they faced are listed below. The company sought a route optimization solution to help improve vehicle and driver utilization, inefficient vehicle tracking, failure to track data properly, and poor customer experience. The solutions they got were incredibly mesmerizing.

Solutions:

Enhanced vehicle tracking

Real-time insight into delivery statistics

Delivery time reduced by half

Real-time delivery tracking

Improved customer satisfaction

**THE FOODERY:**

The Foodery is a home delivery service based in Boston. This is a home delivery service. They deliver nourishing food to people. Moreover, their target audience consists of mainly working individuals who do not get the time to prepare food. Foodery was using a manual fleet management system. This created a lot of challenges for them. Let’s check them out.

Challenges:

Finding experienced drivers who were well-versed with the routes

Delivering food on time

Solutions:

Optimized routes

Up to 28% of delivery cost savings

Reduction of delivery time by half

On-time delivery

**Problem Statement**

The delivery industry is growing massively as the new newly "online" trend has started due to the Covid. Most of the businesses have now shifted to "online" platforms. This increased the demand for the packages to be delivered. Therefore, finding an optimized route for delivering the packages has become more critical and harder than ever for delivery businesses. But today almost every business uses route optimization software from small cottage industries and stores to large B2B enterprises of all industries.

In delivery system, when done manually, finding the best route is near to impossible. Even if we have few vehicles with 10 stops each there can be million routes. While planning a route is very hard having hundreds of different routes without having the right tools. Also, the biggest challenge with last mile delivery includes Delivery efficiency, margins, customer demands, delivery agility, costs, end customer interactions, missed deliveries etc. Companies also risk inflating their operational costs, often in the form of too many vehicles in their fleet and/or wasted fuel and wages due to longer than necessary routes. Delivery businesses face these types of problems every day. Effective route planning would save fuel, time, cost, employee expense, transport expense, maintenance expense. So, if we use proper route optimization mechanism we can overcome and save all above things which will help businesses to generate more revenue and let them make profitable.

An effective route optimization solution will help delivery businesses minimize wages, driving time, and fuel consumption by finding the most efficient route for the entire fleet in a matter of minutes. Thus, we will formulate an algorithm that would optimize the route for a delivery company, hence minimizing the operational costs incurred by the company and the time taken to deliver a certain number of parcels.

Now a day many companies like Food panda, UberEATS, Groceries, bottled beverages, CSA farm and others are using software that helps them in planning their route for deliveries. These companies having an optimized route can create a valuable effect on cost and time taken by a package to be delivered or collected, thus minimizing the operational cost for the delivery companies.

As we are targeting optimization in route planning. Our main target is minimizing travelling time. To minimize travelling time by using optimization of all the routes and riders we will design algorithm in such a way that when we try to plan a route our optimization system selects best rider from all available riders of particular area and assign deliveries to them.

# Motivation and Challenges

It is observed by the people who order food online that the time taken by the delivery company often exceeds the expected time. The main causes behind this are often longer or incorrect routes, or sometimes due to the inexperience riders. These significant delays often bother people a lot.

The major challenging part here is the data collection. To carry out experiments on our formulated algorithm, we need some real-time data. Getting this real-time data is very difficult as no company will be willing to provide its data due to security reasons.

Our ultimate goal is to minimize the delivery time by minimizing the operational costs incurred in terms of travel time and fuel costs due to longer or ineffective routes or even due to an inexperience ride.

# Project Objectives

* To collect data related to VRP i.e. Vehicle Routing Problem, that would contain the information regarding delivery and depot locations, the rider/delivery vehicle capacity and other customer related data.
* To apply different clustering techniques to divide the customers or the delivery locations according their delivery needs or their locations or the like features.
* To minimize time by formulating an algorithm that would suggest the best possible route given the locations for delivery and the capacity of the delivery entity (i.e. the delivery van or the delivery boy).
* To develop a web API that would implement the designed algorithm so that the route data can be fetched when needed.
* To develop a demonstration app with maps implemented, that would visually display the routes suggested by the algorithm.

# Structure of the Report

The rest of this report is laid out as follows. The literature review of related work is presented in Chapter 2. The system's basic model is presented in Chapter 3, along with the model's functional and non-functional requirements. On the other side, Chapter 4 discusses the system's detailed design, which can assist developers in implementing the system. The porotype and the development of the system are discussed in Chapters 5 and 6. This report comes to a close with Chapter 7.

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