

Computer Science Department  
Cihan University-Erbil



# Routing Optimization in Computer Networks

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# Route optimization

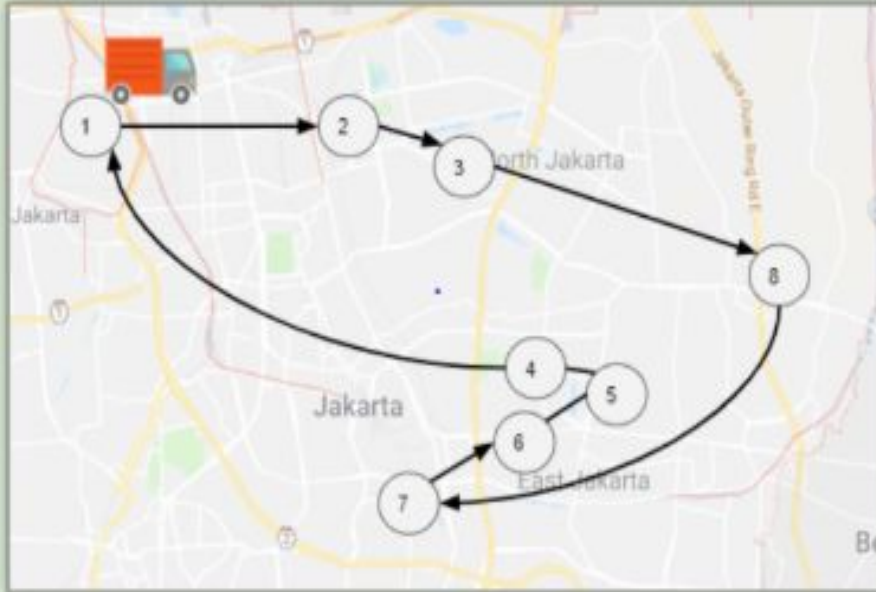
Routing optimization Algorithms basically designs for the best routes to reduce travel cost, energy consumption and time.



# Vehicle routing problem (VRP)

The applications of VRP are very common in real life. It can be described by the scenario that follows:

Let consider a depot having a fleet of vehicles with limited capacities and a set of customers. The problem is to determine optimal routings for each vehicle to visit every customer exactly once in order to fulfill the demand. The most common goal for optimization is to minimize the overall distance travelled by the vehicles.



## Vehicle Route Optimization (VRO)

VRO helps reduce the cost of lastmile services by optimizing route and resources allocation. Resulting savings can be significant as over half the costs associated with a typical logistics company is borne in the execution of firstmile or lastmile.

### Benefits can come in form of

- Time savings
- Distance and fuel savings
- Customer satisfaction from shorter delivery times

## The following conditions must be satisfied:

- The total demand of any vehicle route must not exceed the capacity of the vehicle.
- Any given customer is served by one, and only one vehicle.
- The least number of vehicles is used and the shortest distance is covered.
- Customer delivery should be done efficiently and economically.



# Applications

Companies like Amazon and Alibaba are investing hundreds of millions of dollars in order to make their delivery processes that much faster and more efficient to ensure the next day or even same-day delivery.



# Artificial Intelligence (AI) in Logistics

Artificial Intelligence can be used to improve logistics experience by increasing reliability, reducing the cost of transportation, faster processing, and deciding optimal routes for last-mile operations. Algorithms like: traveling salesman, swarm optimization and ant colony optimization are used for routing optimization.

# How AI can help Logistics...

Reduce inventory risk with demand prediction



2

3

Reduce cargo charges by peak hour prediction.



Route optimization  
Vehicle cargo matching  
Find best route with VRP

Predict product mix in region  
Ensure next day or same day delivery!



4

Accurate receipt forecast.  
Keep customer happy.



5



1



Reduce production and inventory risk with accurate JIT manufacturing and demand prediction

8



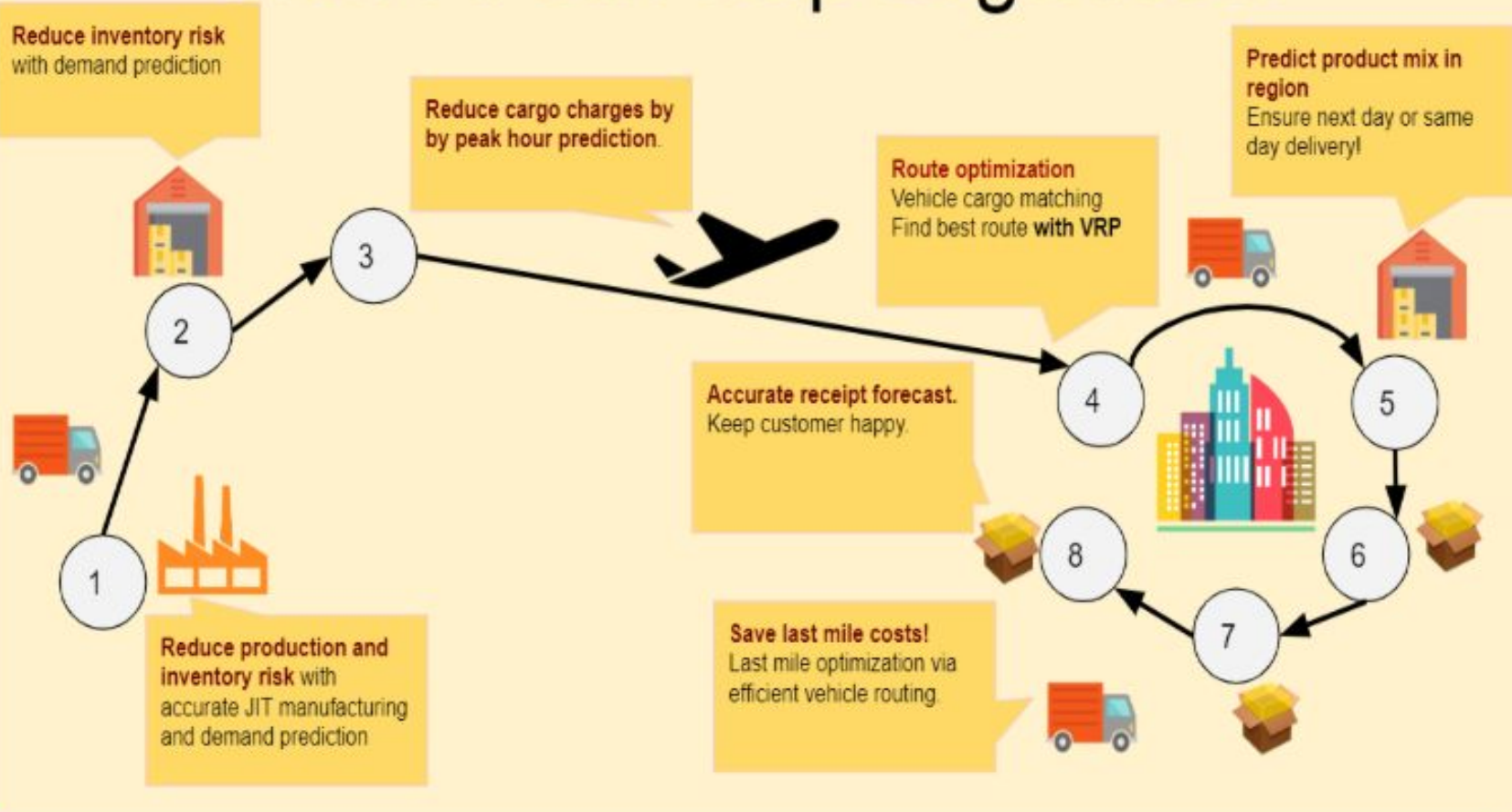
Save last mile costs!  
Last mile optimization via efficient vehicle routing.



7



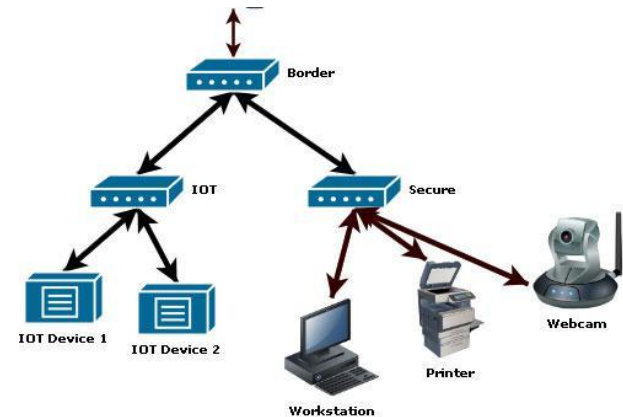
6

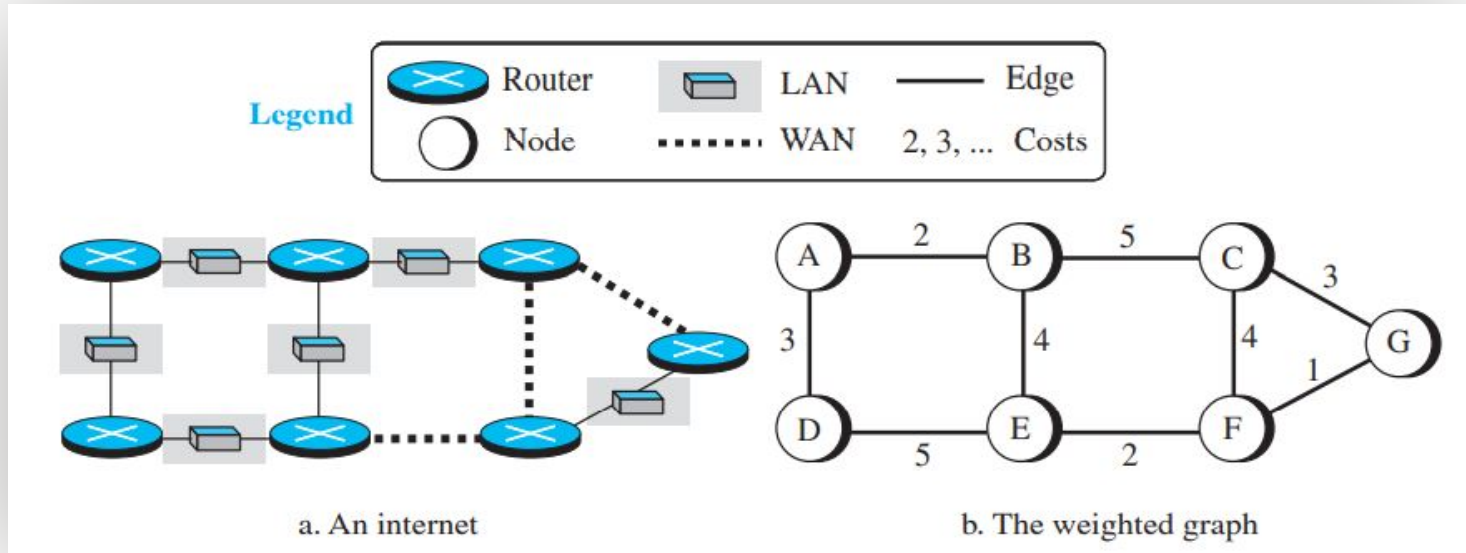




# Computer Networks Algorithms

Dijkstra's Algorithm is used to find the shortest path between nodes in a graph. The algorithm maintains a set of unvisited nodes and calculates a tentative distance from a given node to another.





**Fig. 1: Computer network and graphical representation**

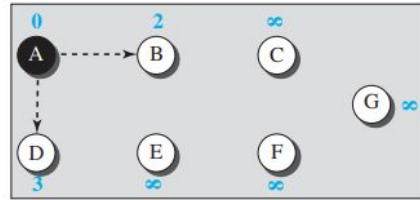
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1  Dijkstra's Algorithm ( )
2  {
3      // Initialization
4      Tree = {root}           // Tree is made only of the root

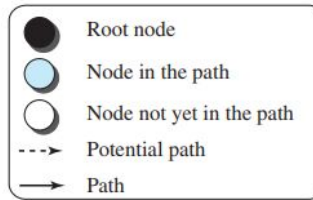
5      for (y = 1 to N)       // N is the number of nodes
6      {
7          if (y is the root)
8              D[y] = 0       // D[y] is shortest distance from root to node y
9          else if (y is a neighbor)
10             D[y] = c[root][y] // c[x][y] is cost between nodes x and y in LSDB
11         else
12             D[y] = ∞
13     }
14     // Calculation
15     repeat
16     {
17         find a node w, with D[w] minimum among all nodes not in the Tree
18         Tree = Tree ∪ {w}     // Add w to tree
19         // Update distances for all neighbors of w
20         for (every node x, which is a neighbor of w and not in the Tree)
21         {
22             D[x] = min {D[x], (D[w] + c[w][x])}
23         }
24     } until (all nodes included in the Tree)
25 } // End of Dijkstra

```

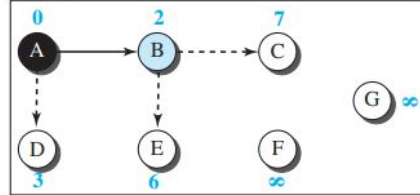
Initialization



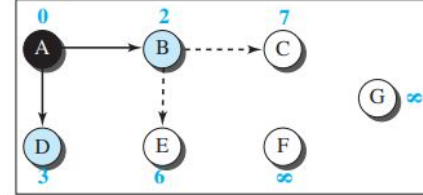
Legend



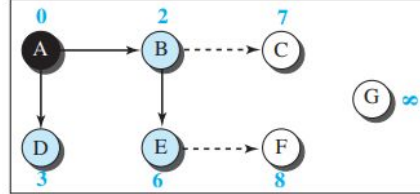
Iteration 1



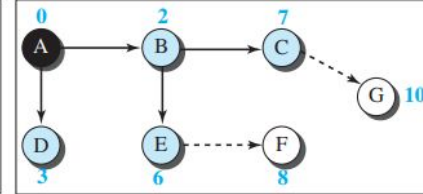
Iteration 2



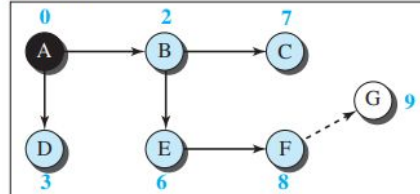
Iteration 3



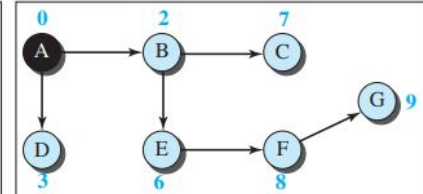
Iteration 4



Iteration 5



Iteration 6



# Mutli-stop route planners



OptimoRoute



Route4Me

 onfleet



Flightmap

OptimoRoute my.optimoroute.com

Apps Al on IoT 2019: 1st... Android Basics: Use... Cisco 1841 Integrat... cna summer traini... Bologna Process @... Article Submission Sci-Hub: removing... Course: Computati...

OptimoRoute™ Trial - 30 days left Purchase Administration Support Logout

Plan and Optimize Live Analytics

Scheduled 0 Unscheduled 0 Total 0 Routes 0

Unschedule Switch Reverse Copy Driver

### Getting Started

## Welcome to OptimoRoute!

In just a few steps, we will set you up to plan routes.

Please enter your depot address:

Example: 951 20th St, Denver, CO 80202

Next >

Hide Drivers

Type here to search

12:40 AM 3/10/2021

## Getting Started

My business does: (choose one)

- |   |  |
|---|--|
| <input type="radio"/> Food Delivery                         | <input type="radio"/> Pest Control           |
| <input type="radio"/> Retail & Distribution                 | <input type="radio"/> Laundry & Dry Cleaning |
| <input checked="" type="radio"/> Installation & Maintenance | <input type="radio"/> Waste Collection       |
| <input type="radio"/> Healthcare                            | <input type="radio"/> Cleaning Services      |

or:

- |                                      |                                     |
|--------------------------------------|-------------------------------------|
| <input type="radio"/> Other Delivery | <input type="radio"/> Other Service |
|--------------------------------------|-------------------------------------|

< Back

Next >

## Getting Started

To optimize your routes, we need to know more about your drivers

Number of drivers:

Drivers work time:  —

Schedule a break for this driver

Break duration (minutes):

Break must happen between:  —

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Next >



## Add order

### Basic Info

Order ID:  Date\*:

### Load parameters

Order type\*:

### Skills

Location\*:

### Vehicle features

Duration:  min Priority\*:

### Details

[+ Add Time Window](#)

### Order tracking

Notes:

Skills:

Vehicle features:

Manual scheduling

Save

Cancel

Scheduled 19 Unscheduled 0 Total 19 Routes 1

Unschedule Switch Reverse Copy

Driver

Driver 001 3h 59m Orders: 19 75km



Select date: 10/03/2021 Import Orders Plan Routes Share Routes



Plan and Optimize Live Analytics

Scheduled 0 Unscheduled 0 Total 0 Routes 0

Unschedule Switch Reverse Copy

Driver Driver 001



Select date: 10/03/2021 Import Orders Plan Routes Share Routes

Orders	Routes	Timeline								
<input type="button" value="Add order"/> <input type="button" value="Edit orders"/> <input type="button" value="Delete orders"/> <input type="button" value="Unschedule orders"/> <input type="button" value="Copy orders"/> <span>Filter orders...</span>										
<input type="checkbox"/>	Order ID	Priority	Location	Address	Duration	Time windows	Skills	Vehicle features	Scheduled driver	Stop number
<input type="checkbox"/>	ORD004	Medium	مصرف چوکی	-	4 min	-	-	-	Driver 001 - Vehicle 001	1
<input type="checkbox"/>	ORD013	Medium	کۆنگای ده برمانی دازین	شعاعی یزینگان	7 min	-	-	-	Driver 001 - Vehicle 001	2
<input checked="" type="checkbox"/>	ORD011	Medium	پیشکۆمۆن	-	9 min	-	-	-	Driver 001 - Vehicle 001	3
<input type="checkbox"/>	ORD005	Medium	Koshki Derin Resturant	-	7 min	-	-	-	Driver 001 - Vehicle 001	4
<input type="checkbox"/>	ORD001	Medium	مطعم البندی	Hawler-Koya road	9 min	-	-	-	Driver 001 - Vehicle 001	5
<input type="checkbox"/>	ORD016	Medium	قوتابخانهی کارۆخی کۆرۆن	Molla Afandy	7 min	-	-	-	Driver 001 - Vehicle 001	6
<input type="checkbox"/>	ORD014	Medium	دانسایی شارمۆانی	شعاعی کارۆی گهلاڵی، هەرێزین	3 min	-	-	-	Driver 001 - Vehicle 001	7

Thank  
you

A square graphic with a blue bokeh background. The words "Thank you" are written in a blue cursive font. The word "Thank" is on the top line and "you" is on the bottom line. The text is centered and has decorative flourishes extending from the left and right sides.