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Smart Logistics using Apache Spark Environment

Abstract

Logistics plays a primary role in the world economy and business. It ranges from as big as exporting to faraway continents to as small as door delivery planning for a department store within a city. The routes are often decided and optimized keeping just time or distance in mind. We have planned to consider other factors like vehicle capacity, priority or urgency of delivery, carbon emissions, vehicle conditions, rest for drivers, flight weight, and others so that the system built could be of great use to the world today. The algorithms to be used are primarily Heuristics because the VRP (Vehicle Routing Problem) is an NP-Hard problem that needs a lot of optimization. The distribution of data to different clusters for faster algorithm execution locally is also considered as the SPARK environment is proposed to be the platform of implementation of the work.

KEYWORDS: Logistics, routing, fleet management, optimization, maps, graph, traffic

Introduction

Transport plays a major role in all businesses. It involves a lot of costs and contributes to more than 50% of the total cost to be spent. Minimization of the money involved for the logistics and routing is primary on the list of possible optimizations. Increasing customer satisfaction by taking into account priority, urgency, and freshness of goods delivered is also a must to enforce customer retention in business. Then, the carbon emissions of vehicles are a great contributor to environmental pollution. The container size and package of goods also add to cost. Drivers who constantly drive need rest to recharge themselves. These times are often forgotten in calculating the time for delivery. So, taking into consideration these factors and also exploring more factors becomes an important objective of our work.

The main focus of vehicle routing is determining optimal routes for a fleet of vehicles given constraints like distance, traffic and weather conditions, the urgency of the delivery, etc. It

helps fleet managers to plan routes that can maximize the deliveries and the efficiency of the delivery and also minimizes the delivery costs. Route optimization helps in managing resource limitations and also it helps in saving fuel on multiple routes and multiple vehicles. It helps in reducing last-mile costs. Route optimization reduces last-mile costs like idling and maintenance costs. It helps in reducing fuel consumption by providing more efficient and optimal routes that can reduce the number of kilometers driven. Route optimization enables on-time deliveries and a better customer experience. Customer expectations are more demanding every year. Customers expect faster delivery without making mistakes and preferably at an agreed-upon time. Route optimization technique helps in improving delivery performance and in increasing punctuality which helps to increase customer satisfaction. It helps delivery businesses to adjust their routes instantly and meet anticipated requests from customers.

Literature Survey

The various papers which worked on this domain include:

Innovation mode and Optimization Strategy of B2C E-Commerce Logistics Distribution under Big Data published by Yingyan Zhao, Yihong Zhou and Wu Deng 3 in 2020, uses COHADOOP (ECLHADOOP) big data mining methods. The development of logistics enterprises reduces the cost of B2C e-commerce logistics distribution, improves efficiency and service quality of logistics enterprises, and enhances competitiveness, which further promotes economic development.

Mortaza Zolfpour-Arokhlo, Ali Selamat, Siti Zaiton Mohd Hashim used RPA using MAS algorithm in the paper Route planning model of multi-agent system for supply chain management published in 2013. They used some real-time data. This algorithm shows optimized results by reviewing agent applications. Novelty - using MAS in RPS to solve, results in suitable answers to complex transportation network problems.

Route learning: a machine learning based approach to infer constrained customers in delivery routes published by Andre Snoeck ́ a, Daniel Merchan ́ a, Matthias Winkenbacha in 2020, uses Metropolis-Hastings-within-Gibbs sampling algorithm. It treats the entire VRP as a probabilistic model, including travel times, service times and drop sizes. machine learning should be applied beyond routing, for example in delivery network design and warehousing.

Freight Time and Cost Optimization in Complex Logistics Networks published by Egemen Sert, Leila Hedayatifar , Rachel A. Rigg, Amir Akhavan, Olha Buchel, Dominic Elias Saadi, Aabir Abubaker Kar, Alfredo J. Morales and Yaneer Bar-Yam in 2020, considered some of the factors like freight cost from production facilities to customers, storage cost for storing goods in warehouses and cost for opening new warehouses. The optimizations used can provide considerable cost savings and improved service quality and customer satisfaction.

The best few papers are summarised as follows:

SNo	Paper Title	Authors	Algorithms used	Advantages	Disadvantages
1	Route Optimization in logistics distribution based on Particle Swarm Optimization (2019)	Appiah Martinson Yeboah, Xiong Qiang	Particle Swarm Optimization(PSO)	PSO has stronger function extreme value optimization ability so it provides the value which is close to actual optimal function value. When population size increased, results were faster and better.	Certain parameters were not considered like loading and unloading time, real-time constraints.
2	Automotive Route Optimization for a Logistics Service Provider : Pre-study for Route Planning and Optimization Software Investment (2017)	ALDIN AVDIC & ZHENGYANG XIANG	VRP, SVRP (Stochastic), RPS (Algorithm), Centralised and Decentralised vehicle routing	Factors considered are elaborate and detailed.	Some supply chain issues are recorded that might affect the investment decision. Capacity issue affects the availability of inventory spaces.
3	Optimization of Transportation Routing Problem for Fresh Food by Improved Ant Colony Algorithm Based on Tabu Search (2019)	Jing Chen 1,2,3, Pengfei Gui 3, Tao Ding 3, Sanggyun Na 3, and Yingtang Zhou 1	Improved Ant Colony Algorithm (IACA), Tabu search (TS)	VRP problem solving uses the minimum total distribution cost. It helps cold chain logistics to deliver fresh goods which is a unique point.	Due to experimental limitations, extensive and comprehensive comparative experiments will need to be applied to the LCFD-VRP model to get better overall optimization results.

4	International Truck Routing Optimization Using Deep Reinforcement Learning (2020)	Taufik Nur Adi, Yelita Anggiane Iskandar and Hyerim Bae	DQN (Deep Q Network - combination of RL and a convolutional neural network), SA, Tabu search	DQN can quickly adapt to the environment. Compared to SA and TS, DQN is faster.	DQN does not show better results across all datasets. Another issue is the development of a stable DQN that requires less training data and training time.

Hardware and Software Requirements

I. Hardware Requirements

- 14 GB RAM
- Compute resources for running the algorithm
- Cloud services for data storage

II. Software Requirements

- Graph visualization and analysis tools like Gephi, NetworkX, GraphX
- Databricks for SPARK