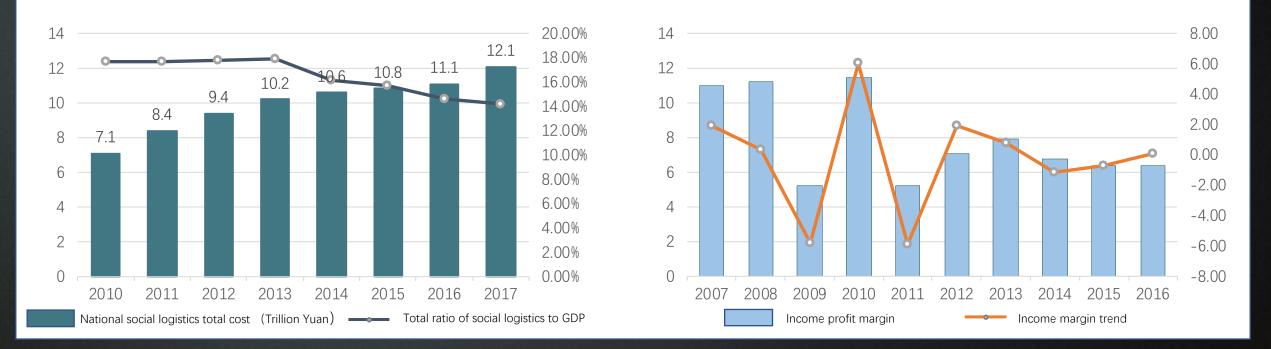
Logistics Tracking and Synchronization Solution of CommaTech

Dr. Leon Kong 10 July 2019





Background



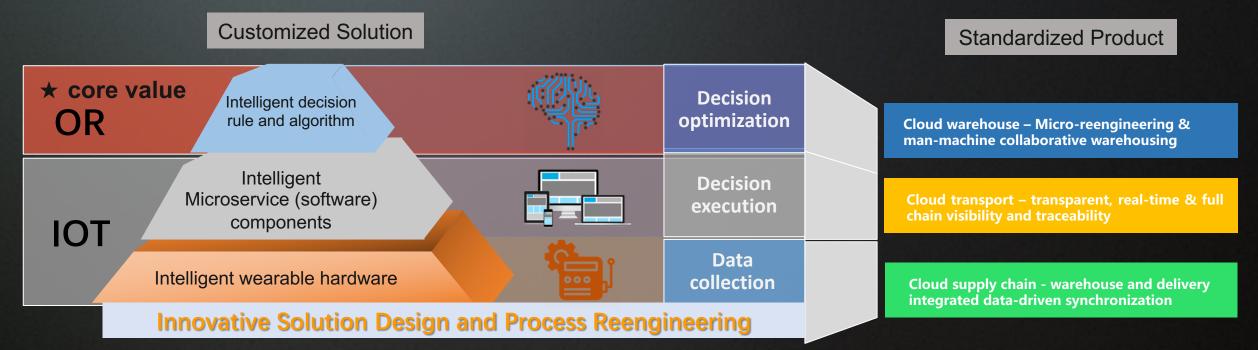
- The China logistics market is huge. The total social logistics cost in 2017 was 12.1 trillion, with a compound growth rate of 7%.
- The maturity of the logistics industry needs to be improved, and the total logistics cost accounts for 14% of GDP, which is far from the countries of Europe, America and Japan (on average 8%-10%).
- The overall profit margin of the logistics industry is around 5%, and the cost reduction is urgently needed.

Business Model

"Over the past three years, we have contacted and served more than 100 logistics supply chain companies, and almost all 2B companies need an integrated one-stop solution."

The core value of enterprise empowerment lies in the third layer (realizing cost reduction and efficiency increase), and with the abundant scenes and data, the decision is more precise and effective.

However, the current status is the lack of data or inaccurate, incomplete, and untimely data collection.

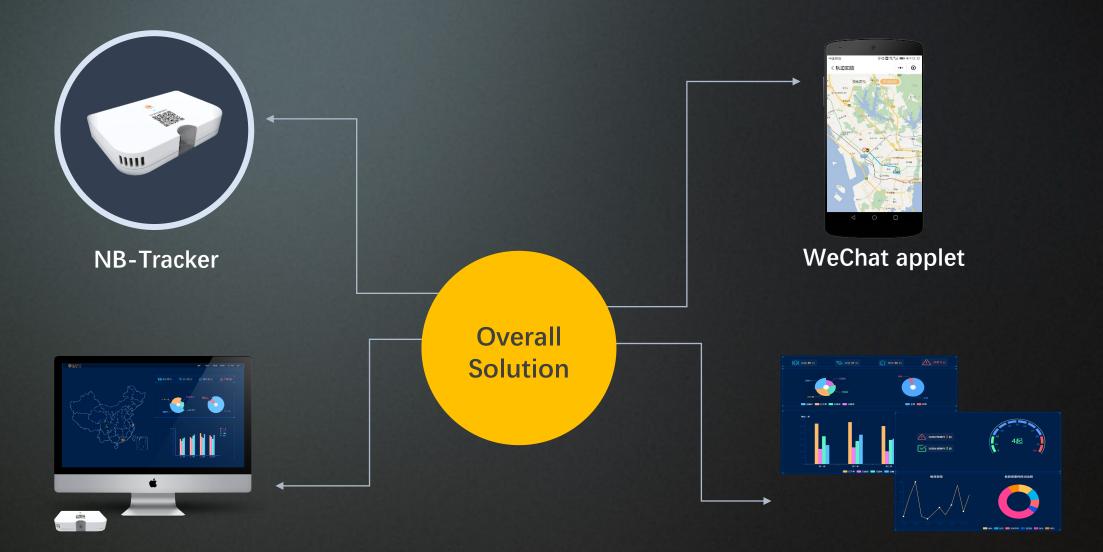


CommaTech core competitiveness: Algorithm-driven software and hardware integrated and innovative solution.





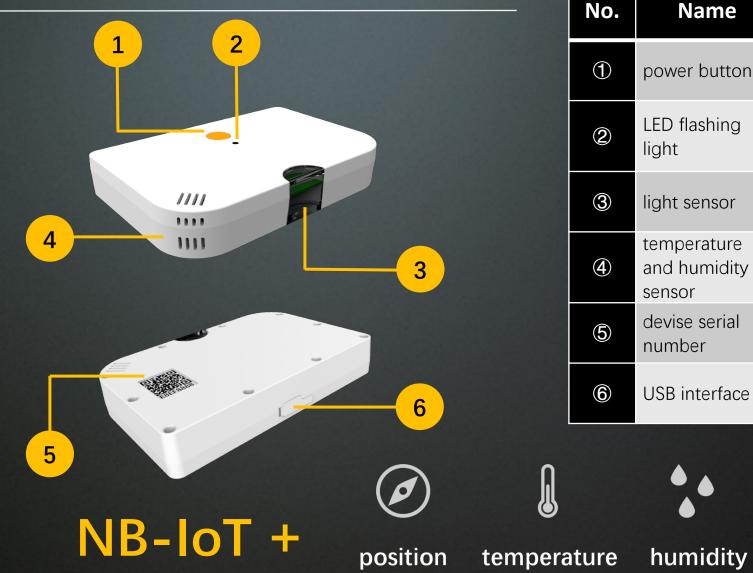
A Unified Platform Solution is Needed for Full-truckload Transport, Less-than-truckload Transport & City Logistics



logistics cloud platform

data analysis and abnormal warning

CommaTracker Pro



| No. | Name | Description |
|-----|---------------------------------------|---|
| 1 | power button | view battery status |
| 2 | LED flashing light | green, yellow, and red indicate that the device has sufficient, medium, and low battery levels. |
| 3 | light sensor | collect light data |
| 4 | temperature and humidity sensor | collect temperature and humidity data |
| 5 | devise serial number | device unique code |
| 6 | USB interface | for device charging and upgrading |

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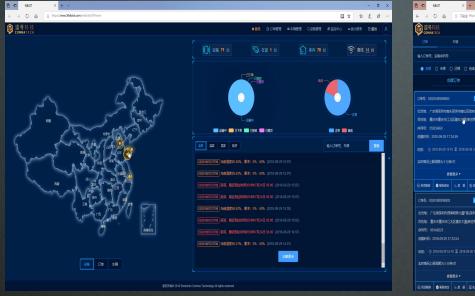


tilt

light

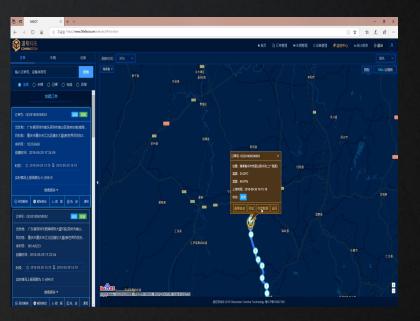
shock

Smart Logistics cloud platform



- big data visualization
- understand the location distribution and usage of all devices
- master different types of abnormal alarm conditions (e.g., temperature, humidity, light, position, etc.)
- get real-time KPI information

- create orders, customize data upload content (including latest arrival time, temperature and humidity range, etc.)
- define users who receive abnormal alerts for each order across logistics chain



- query on the real-time location of orders, vehicles and equipment, and support trajectory playback
- display multi-dimensional data (including temperature and humidity, light, etc.) of orders and vehicles in transit

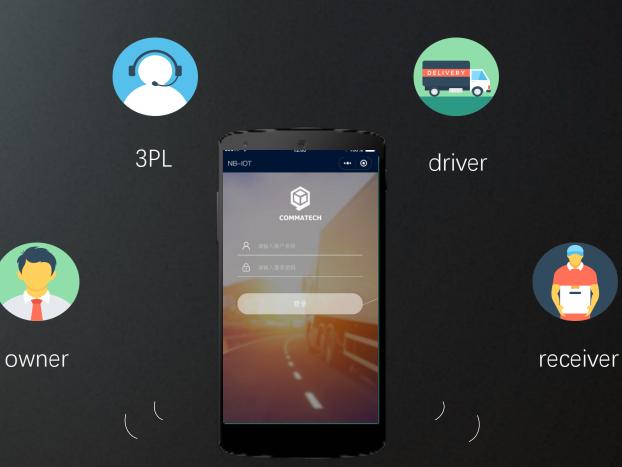
WeChat for Multi-Players in logistics ecosystem

Advantages:

- ✓ Free installation can be used inside WeChat, go away when you run out
- Free registration
 share the order data to others for a one-time
 view by sharing

✓ Mobile office

real-time data update, abnormal warning information is known at the first time



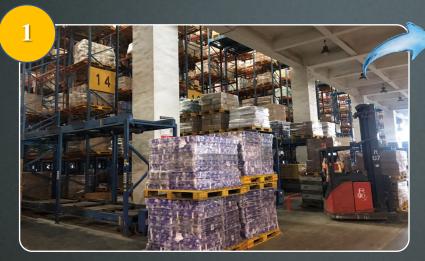


Case of Urban Distribution for Intelligent Planning of CR Vanguard





- More than 10 RDC, 3000+ stores nationwide, covering 29 provinces in China, 242 cities, 2000+ cars per day;
- Logistics costs account for a high proportion of total operating expenses, with annual logistics costs of 1.5 billion;
- The inventory of urban stores is small, the frequency of replenishment is high, the demand for single stores cannot fill the vehicles, and carpooling is required;
- Shops in urban areas are densely distributed and delivery routes need to be properly designed.



High-rise shelf



Sorting



Stocking lane



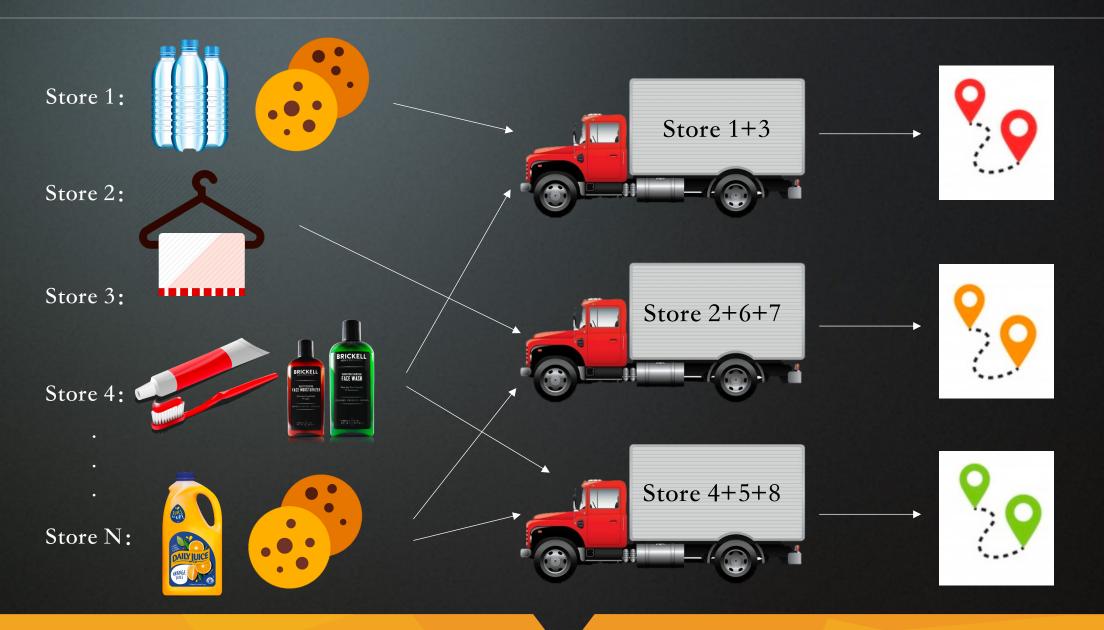
Loading dock



Loading/closing



The Core Question: how to carpool the goods in multiple stores and design the driving route for each car?

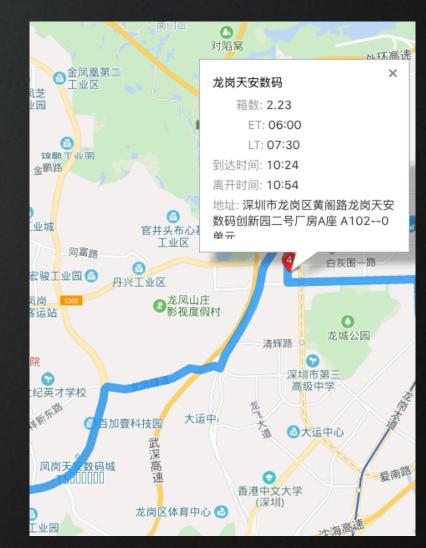


Current Situation I: Based on experience, the stores are combined into a number of fixed routes, and will **11** not be adjusted according to demand.

| ┓明细数(イ▼ | 配送点 | • Î |
|---------|--|------------|
| 5 6 | 宝源路分店,文汇分店,天骄世家便利店,骏丰园分店,滨海大厦便利店 | |
| 7 7 | 东海国际便利店,华强电子便利店,盛唐大厦店,侨香村便利店,皇城广场分店,卓越便利店,经贸中心分店 | |
| 7 11 | 东海国际便利店,华强电子便利店,盛唐大厦店,侨香村便利店,卓越便利店,皇城广场分店,经贸中心分店 | |
| 6 7 | 汉京大厦便利店,美年广场店,中心路便利店,数码大厦分店,招商广场分店,南海便利店 | |
| 6 6 | 汉京大厦便利店,美年广场店,中心路便利店,数码大厦分店,招商广场分店,南海便利店 | |
| | 汉京大厦便利店,中心路便利店,美年广场店,数码大厦分店,招商广场分店,南海便利店 | |
| | 汉京大厦便利店,中心路便利店,美年广场店,数码大厦分店,招商广场分店,南海便利店 | |
| | 华强电子便利店,东海国际便利店,盛唐大厦店,侨香村便利店,皇城广场分店,卓越便利店,经贸中心分店 | |
| | 华强电子便利店,东海国际便利店,盛唐大厦店,侨香村便利店,卓越便利店,皇城广场分店,经贸中心分店 | |
| | 锦绣分店,Ole深圳海上世界店,山海逸居分店,Ole深圳壹方城店,蔚蓝海岸分店 | |
| | 莲塘聚宝便利店,海山分店,壹海城三分店,君逸华府便利店,海轩广场便利店 | |
| | 六约二分店,万象汇分店,六约三分店,六约一分店,万象分店 | |
| | 六约二分店,万象汇分店,六约三分店,六约一分店,万象分店 | |
| | 六约二分店,万象汇分店,六约三分店,六约一分店,万象分店 | |
| | 龙岗天安数码,嘉宏湾花园便利店,东方沁园店,摩尔城便利店,益田假日天地二分店 | |
| | 龙岗天安数码,嘉宏湾花园便利店,摩尔城便利店,东方沁园店,益田假日天地二分店,天健城分店 | |
| | 前海便利店,三诺大厦便利店,浪琴半岛便利店,前海湾物流园便利店,汇景豪苑便利店 | |
| | 前海便利店,三诺大厦便利店,浪琴半岛便利店,前海湾物流园便利店,汇景豪苑便利店 | |
| | 前海便利店,三诺大厦便利店,浪琴半岛便利店,前海湾物流园便利店,汇景豪苑便利店 | |
| | 前海公馆分店,海运分店,新时代二分店,兰溪谷分店,桃花园分店 | |
| | 万科麓城分店,南方科技大学分店,清湖地铁2便利店,水木丹华分店,深圳龙胜地铁二店 | |
| | 粤商中心一分店,赛龙豪轩分店,龙华九方分店,卓越城分店,莱蒙春天分店,南方明珠 | |
| | 粤商中心一分店,赛龙豪轩分店,龙华九方分店,卓越城分店,莱蒙春天分店,南方明珠 | |
| 6 6 | 粤商中心一分店,赛龙豪轩分店,龙华九方分店,卓越城分店,莱蒙春天分店,南方明珠 | |

Current Situation II: Unable to take into account the time window of receipt, which may affect the operation of the store and receive complaints from the store everyday

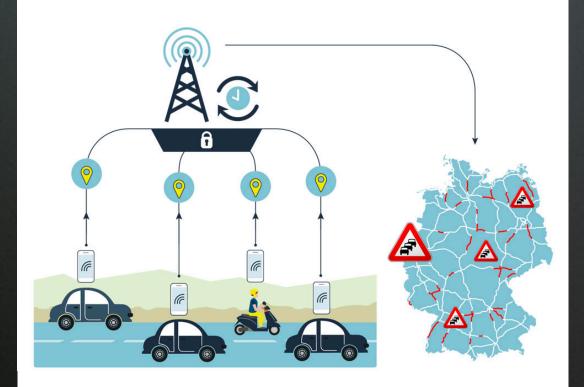
| 门店名称 | 当前车型报价(按车计算) | 货量(箱) | 到达时间 | 最早收货时间 | 最迟收货时间 |
|--|-------------------------------------|-------------------------------------|---|----------------------------------|----------------------------------|
| 云里智能园分店 | 249.26 | 29.93 | 15:36 | 06:00 | 07:30 |
| 壹海城二分店 | 299.24 | 11.46 | 09:21 | 06:00 | 07:30 |
| 创建大厦店 | 294.06 | 27.47 | 09:19 | 06:00 | 07:30 |
| 南方科技大学分店 | 304.93 | 11.45 | 09:04 | 06:00 | 07:30 |
| 优越时代分店 | 273.05 | 58.68 | 08:46 | 06:00 | 07:30 |
| 万象分店 | 297.22 | 41.62 | 08:45 | 06:00 | 07:30 |
| 太阳花 | 276.9 | 21.49 | 08:44 | 06:00 | 07:30 |
| 深圳龙胜地铁二店 | 272.04 | 11.03 | 08:42 | 06:00 | 07:30 |
| 连城新天地便利店 | 287.47 | 49.51 | 08:40 | 06:00 | 07:30 |
| 财富广场便利店 | 308.93 | 11.67 | 08:39 | 06:00 | 07:30 |
| 科学园分店 | 315.9 | 73.6 | 15:54 | 08:00 | 15:00 |
| 摩尔城便利店 | 296.84 | 19.8 | 08:04 | 06:00 | 07:30 |
| 红树绿洲分店 | 297.86 | 204.95 | 15:33 | 08:00 | 15:00 |
| 新时代二分店 | 338.84 | 19.42 | 07:33 | 06:00 | 07:30 |
| | | 化目(林) | 전문문학 | | |
| 门店名称 | 当前车型报价(按车计算) | | 到达时间 | 最早收货时间 | 最迟收货时间 |
| 万象汇分店 | 225.95 | | 11:02 | 06:00 | 07:30 |
| 清湖地铁2便利店 | 246.67 | 12.32 | | 06:00 | 07:30 |
| 深圳北地铁二店 | 315.36 | 21.56 | | 06:00 | 07:30 |
| 滨海大厦便利店 | 335.46 | 13.62 | | 06:00 | 07:30 |
| 万象分店 | 297.22 | | 10:11 | 06:00 | 07:30 |
| 壹海城二分店 | 299.24 | 20.94 | 10:04 | 06:00 | 07:30 |
| | | | | | |
| 嘉宏湾花园便利店 | 320.42 | 29.39 | | 06:00 | 07:30 |
| 深圳龙胜地铁二店 | 272.04 | 23.39 | 09:28 | 06:00 | 07:30 |
| 深圳龙胜地铁二店 金地便利店 | 272.04 305.83 | 23.39 0.79 | 09:28 09:22 | 06:00 06:00 | 07:30 07:30 |
| 深圳龙胜地铁二店 金地便利店 蛇口人才公寓分店 | 272.04 305.83 330.2 | 23. 39 0. 79 15. 34 | 09:28 09:22 08:53 | 06:00 06:00 06:00 | 07:30 07:30 07:30 |
| 深圳龙胜地铁二店 金地便利店 蛇口人才公寓分店 宝源路分店 | 272.04 305.83 330.2 345.29 | 23. 39 0. 79 15. 34 21. 11 | 09:28 09:22 08:53 08:50 | 06:00 06:00 06:00 06:00 | 07:30 07:30 07:30 07:30 |
| 深圳龙胜地铁二店 金地便利店 蛇口人才公寓分店 | 272.04 305.83 330.2 | 23. 39 0. 79 15. 34 | 09:28 09:22 08:53 08:50 08:38 | 06:00 06:00 06:00 | 07:30 07:30 07:30 |

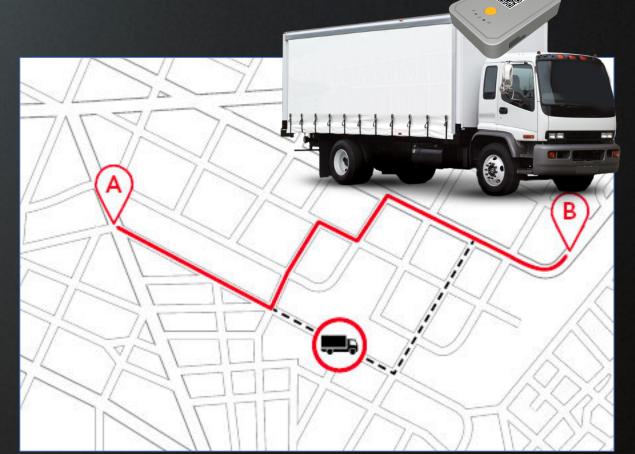


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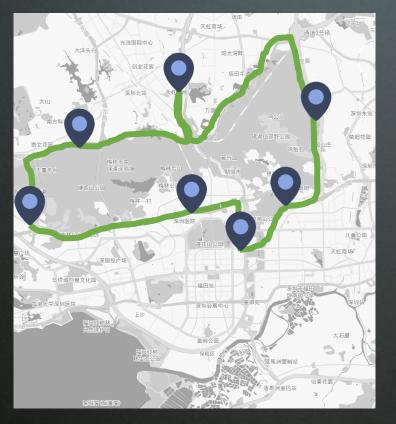
Challenge 1: How to improve the accuracy of the basic data?

- The initial data comes from an open platform such as Baidu / Gao De (Chinese Google Map).
- Track vehicles by intelligent hardware and continuously correct road network data.

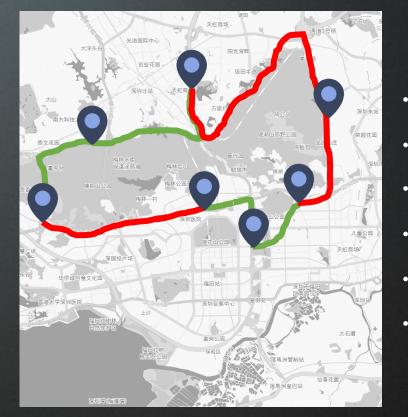




Leisure time road condition



Peak road condition



- Usually not blocked, blocked at peak
- The journey is not blocked, the return is blocked.
- Workday is not blocked, weekend blocking
- Dynamic road conditions have certain regularity
- Time series analysis based on historical data
- Predict future road conditions

Go through the congested roads during the noncongestion time period, arrange the trip reasonably

Challenge 3: How to improve the speed and quality of the solution?

| <u>File Edit View N</u> avigate <u>C</u> oo | | | es [vanguard@localhost] - PyCharm w <u>H</u> elp | _ | | | | | | | | | | | |
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| Vanguard | | 37 A0IS V | /a | | | | | | | | | | | | |
| ▶ 🖿 .idea ▶ 🖿 Algorithm | | 46 A0KI # | 🚽 🧮 Database) 🌱 vanguard@loo | calhost | | ables 🕅 routes 🔪 | | | | | | | | 🕨 🗮 🏶 🕸 🖬 🔲 | |
| E Common | | 10 A021 | 0 Project ▼ ⊕ + - + | 👸 Sir | nulator.py 🛛 👸 ExcelOperator.py 👋 👸 Analyze.py 👋 👔 | Para.py 🛛 👸 Test.py 👋 👸 Tabi | .py 🛛 👸 1 | | | × 📰 routes [vanguard@loca | alhost] 🛛 🏢 | | | | |
| 🕨 🖿 DBO | | 14 A036 # | | | | | | | | | | | | | |
| Model | | 26 A0C7 | data | | | | | | | | | | | | |
| 📸 5.29标超到货.xlsx 🞒 0528-0530实际配送箱 | | 13 A034 1 | End examples Vanguard | | 📆 route_id • 🛛 👯 result_id • 🐖 pa | ired_id 🔹 🎹 origin | | | 💷 destination | | • 🆩 tag 🔹 | 💷 distance 🛛 💷 | duration 🛛 🔠 toll 🔹 | III toll_distance • III e | |
| 2018.8.21 Vanguard. | | 31 A0HD 8 | vanguard vanguard | | 1534415674172293120 1534415674151 1-2 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.72299, | "lng": 114.545926} | 常规路线 | 55085 | 3894 ¥25.00 | 40066 201 | |
| 🚽 2018.8.23 Vanguard | | 27 A0GN V | Algorithm | | 1534415674347037696 1534415674333 1-3 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 23.093939 | , "lng": 114.421979] | 常规路线 | 35919 | 3654 ¥0.00 | 0 201 | |
| 🛃 By门店的承运商报价.xl | | 25 A0A6 | E Common | | 1534415674472877312 1534415674458 1-6 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.603421 | , "lng": 114.480584) | 常规路线 | 81880 | 4750 ¥40.00 | 64613 20: | |
| 🛃 dump.sql | | 15 A047 | DBO | | 1534415674688593920 1534415674672 1-4 | | | | | , "lng": 114.076526] | | 92751 | 5592 ¥45.00 | 78333 20 | |
| 🚰 Filtering_fee.py 🐔 Simulator.py | | 24 A0A3 | Model | | 1534415675632108544 1534415675611 1-5 | | | | | , "lng": 114.10065} | | 100417 | 6393 ¥50.00 | 80889 20 | |
| 44 华润30门店.xlsx | 11 | 40 A0JY V | → 5.29标超到货.xlsx | | 1534415680573399296 1534415680560 1-7 | | | | {"lat": 22.6443, | | 常规路线 | 97754 | 6391 ¥45.00 | 78333 20 | |
| 🚽 实际运费.xlsx | | 18 A094 | a | | | | | | | | | 92538 | 6146 ¥40.00 | 72994 20 | |
| 📫 实际运量.xlsx | | 44 A0KE V | 2018.8.21 Vanguard. | | 1534415680798617344 1534415680783 1-10 | | | | | , "lng": 114.149465] | | | | | |
| ♣ 收货时间警.xlsx | | 39 A0JW V | By门店的承运商报价.xl | | 1534415681006580480 1534415680991 1-9 | | | | | , "lng": 114.237986) | | 98259 | 6409 ¥45.00 | 79189 26 | |
| ♣ 门店基础信息.xlsx ■ venv | | 42 A0KB V | dump.sql | | 1534415681190582528 1534415681175 1-8 | | | | | , "lng": 113.987163) | | 106217 | 6474 ¥45.00 | 78333 26 | |
| Zhuhai | | | Filtering_fee.py | | 1534415681365548544 1534415681350 1-11 | | 1, "lng" | : 114.728518} | {"lat": 22.563542 | , "lng": 114.055615] | 常规路线 | 101763 | 6315 ¥45.00 | 78333 20 | |
| | | 23 A0A1 # | 9 💑 Simulator.py | | 1534415681581710848 1534415681567 1-12 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.553893 | , "lng": 114.155655) | 常规路线 | 94975 | 6549 ¥40.00 | 72994 20 | |
| 🕌 8F520110 | | 11 A023 | 7 👘 ~\$5.29标超到货.xlsx | | 1534415681848948992 1534415681833 1-17 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 23.089945 | , "lng": 114.452728] | 常规路线 | 34007 | 3153 ¥0.00 | 0 20 | |
| # 11063A40 # ~\$sort_by_date_time_OE | | | 示 | | 1534415682066334208 1534415682001 1-14 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.546905 | , "lng": 113.951229) | 常规路线 | 111336 | 6871 ¥45.00 | 78333 20 | |
| External Libraries | | 45 A0KH 8 | S头际运量.xisx S收货时间窗.xisx | | 14 | 1534415682291090176 1534415682276 1-15 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.522461 | , "lng": 114.054419) | 常规路线 | 106386 | 6747 ¥45.00 | 78333 20 |
| | | 279 A0JF # | ☆ → ~ \$门店基础信息_xlsx | | 1534415682524719616 1534415682509 1-13 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.548583 | , "lng": 113.940319] | 常规路线 | 112164 | 6939 ¥45.00 | 78333 20 | |
| | | 19 A096 1 | ₩ 「 小 小 小 小 小 小 小 小 小 小 小 小 小 | | 1534415682758091008 1534415682742 1-18 | {"lat": 22.98976 | 1, "lng" | 114.728518} | {"lat": 22.608143 | , "lng": 114.308863) | 常规路线 | 88665 | 4888 ¥50.00 | 79014 20 | |
| | | 12 A025 | ☆ 「 」 実际运费.xlsx | 17 | 1534415682983354368 1534415682968 1-19 | {"lat": 22.98976 | 1. "lng" | 114.728518 | {"lat": 22.52908. | "lng": 114.031765} | 常规路线 | 109428 | 6801 ¥45.00 | 78333 20 | |
| | | 22 A401 # | が 「 家际运量.xlsx | | 1534415683283675648 1534415683225 1-22 | | | | | , "lng": 114.395882] | | 40721 | 3929 ¥0.00 | 0 20 | |
| | | 29 A0GZ # | 示 | | 1534415683491910656 1534415683476 1-20 | | | | | , "lng": 114.021742) | | 104919 | 6397 ¥45.00 | 78333 20 | |
| | | 35 A0IQ 8 | 示 IDE基础信息.xisx L ▶ ■ venv | | 1534415683858938112 1534415683843 1-24 | | | | | , "lng": 114.021742) | | 87022 | 5644 ¥45.00 | 73118 20 | |
| | | 33 A0IP V | ► ► Thuhai | | | | | | | | | | 5044 +45.00 6047 ¥45.00 | 73118 20 | |
| | | 8 A0D0 # | 8.10 Vanguard.zip | | 1534415684050597632 1534415684035 1-21 | | | | | "lng": 114.064759} | | 94898 | | | |
| | | 57 A07V # | a 🚮 8F520110 | | 1534415684375655168 1534415684361 1-23 | | | | | , "lng": 114.01729} | 常规路线 | 105207 | 6423 ¥45.00 | 78333 20 | |
| | | 89 A00Z | 10 👃 🏭 11063A40 | | 1534415684717738496 1534415684652 1-25 | | | | | , "lng": 114.060463) | | | 5961 ¥45.00 | 78333 20 | |
| | | 80 Y12Q | t time_OE time_OE time_OE | | 1534415684992891904 1534415684935 1-26 | | | | | "lng": 114.151632} | | 90925 | 6140 ¥40.00 | 72994 20 | |
| | | 73 AZT6 🔮 | External Libraries Scratches and Consoles | | 1534415685310088960 1534415685295 1-28 | | | | | , "lng": 114.069463] | | 104998 | 6676 ¥45.00 | 78333 20 | |
| 500 rows retrieved starting f | rom 1 in 283 ms (e | execution: 56 ms, fetchi | nç | | 1534415685642936064 1534415685627 1-29 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.592859 | , "lng": 113.972314) | 常规路线 | 105204 | 6425 ¥45.00 | 78333 20 | |
| | | | | | 1534415686009811712 1534415685943 1-27 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.507211 | , "lng": 113.887252] | 常规路线 | | 7839 ¥45.00 | 10 2.6 | |
| | | | | | 1534415686335290368 1534415686320 1-30 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.549905 | , "lng": 114.051523] | 常规路线 | 103417 | 6421 ¥45.00 | 48*) 2.8 | |
| | | | | 29 | 1534415686651987456 1534415686636 1-32 | {"lat": 22.98976 | 1, "lng" | : 114.728518} | {"lat": 22.690231 | , "lng": 114.345124) | 常规路线 | 64441 | 4197 ¥25.00 | 47782 20 | |
| | | | | 30 | 1534415686897009408 1534415686881 1-33 | | | | | , "lng": 114.273937] | | 68111 | 4504 ¥25.00 | 54160 20 | |
| | | | | | 1534415687179896064 1534415687165 1-31 | | | | | , "lng": 113.950809] | | 110419 | 6700 ¥45.00 | 78333 20 | |
| | | | | | 1534415687513800960 1534415687498 1-34 | | | | | "lng": 114.261761} | | 69253 | | | |
| | | | | | 155441508751500500 1554415087498 1-34 | (tat . 22.989/0 | r, eng | 114.7205185 | (tat : 22.75720, | ung . 114.201/01 | 113 200 441 234 | 09233 | 1013 120 9 | Þ 🌙 🤊 🍨 🖽 🐁 🕇 🕯 | |
| | | | Connected (12 minutes ago) | | | | | | | | | | | | |

- Building an electronic road network: taking a certain city as an example, the data volume is about 25GB, and the working mode of "online update, offline operation" is realized.
- Based on the characteristics of the algorithm, the database is consolidated and optimized to speed up the database query.

Challenge 3: How to improve the speed and quality of the solution?

Current allocation

1 3 2 ... 2

Using a mathematical language, describe:

- Various optimization goals
- "around the road"
- "corner"
- "Generally not splitting the order"
- "Not worthwhile"

One of the most advanced algorithmic architectures in the world of VRP : VNS + TS

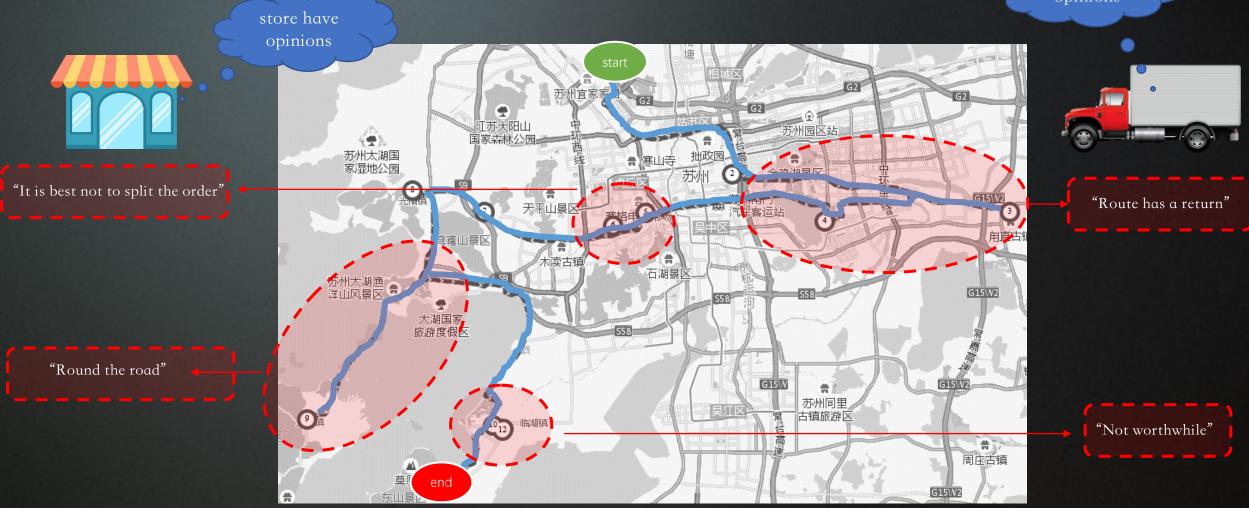
- VNS (Variable Neighborhood Search) : Responsible for controlling search depth
- TS (Tabu Search) : Control search accuracy
- Introduce "matching set", "elite solution strategy", "perturbation strategy", etc. to improve search quality
- Self-learning adjustments to algorithms and operators based on actual customer data

| | - |
|--|---|
| 1 st neighborhood | |
| 04 | |
| X 3 2 2 | |
| | |
| | |
| | |
| □ □ □ ↓ 2 nd neighborhood | |
| $ = 2 \qquad 1 \qquad x \qquad 2 \qquad 2^{2^{n}} \text{ neighborhood} $ | |
| : X X 2 2 | |
| | |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | |
| | |
| | |
| 1 X X 2 k th neighborhood | |
| | |
| $\begin{array}{c c} & \mathbf{x} & \mathbf{x} & \mathbf{z} & \dots & \mathbf{z} \\ \hline & & \mathbf{x} & \mathbf{x} & \mathbf{z} & \dots & \mathbf{z} \\ \hline & & \mathbf{y} & \mathbf{y} & \mathbf{y} & \mathbf{y} \end{array}$ | |
| | |
| 0+0+ | |
| 1 3 X 2 | |
| $ \bigcirc \downarrow \bigcirc \downarrow \cdots \bigcirc \downarrow $ $ 1 X X 2 $ | |
| | |
| 1 | |
| | |
| | |
| world of VRP : VNS + TS | |
| world of VNP : $VNS + 15$ | |
| | |

| 1 $A \leftarrow$ Choose a random allocation 2 $S' \leftarrow Construct(A)$ 3 IF S' is feasible 4 $S^* \leftarrow S'$ 5 END IF 6 $k \leftarrow 1$ 7 REPEAT 8 $A' \leftarrow Shake(A,k)$ 9 $S' \leftarrow Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF 27 UNTIL $k > k_{max}$ | Alg | orithm 1: Overall Framework |
|---|--------|---|
| 3 IF S' is feasible 4 $S^* \leftarrow S'$ 5 END IF 6 $k \leftarrow 1$ 7 REPEAT 8 $A' \leftarrow Shake(A,k)$ 9 $S' \leftarrow Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 1 | $A \leftarrow$ Choose a random allocation |
| 4 $S^* \leftarrow S'$ 5 END IF 6 $k \leftarrow 1$ 7 REPEAT 8 $A' \leftarrow Shake(A,k)$ 9 $S' \leftarrow Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count \leftarrow StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 2 | $S' \leftarrow Construct(A)$ |
| 5 END IF 6 $k \in 1$ 7 REPEAT 8 $A' \in Shake(A, k)$ 9 $S' \in Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \in TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \in S'$ 14 $A \in A'$ 15 $k \in 1$ 16 $count \in 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 3 | IF S' is feasible |
| 6 $k \leftarrow 1$ 7 REPEAT 8 $A' \leftarrow Shake(A,k)$ 9 $S' \leftarrow Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 4 | $S^* \leftarrow S'$ |
| 7 REPEAT 8 $A' \leftarrow Shake(A, k)$ 9 $S' \leftarrow Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 5 | END IF |
| 8 $A' \leftarrow Shake(A, k)$ 9 $S' \leftarrow Construct(A')$ 10 IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 ELSE 18 $count \leftarrow count + 1$ 19 END IF 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 6 | $k \leftarrow 1$ |
| 9 $S' \leftarrow Construct(A')$ 10 $IF obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12 $IF obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17 $ELSE$ 18 $count \leftarrow count + 1$ 19 $END IF$ 20 $ELSE$ 21 $count \leftarrow count + 1$ 22 $IF count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 $END IF$ 26 $END IF$ | 7 | REPEAT |
| 10IF $obj(S') > \lambda * obj(S^*)$ 11 $S' \leftarrow TabuSearch(S')$ 12IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 8 | $A' \leftarrow Shake(A,k)$ |
| 11 $S' \leftarrow TabuSearch(S')$ 12IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 9 | $S' \leftarrow Construct(A')$ |
| 12IF $obj(S') > obj(S^*)$ 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 10 | IF $obj(S') > \lambda * obj(S^*)$ |
| 13 $S^* \leftarrow S'$ 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 11 | $S' \leftarrow TabuSearch(S')$ |
| 14 $A \leftarrow A'$ 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 12 | IF $obj(S') > obj(S^*)$ |
| 15 $k \leftarrow 1$ 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 13 | $S^* \leftarrow S'$ |
| 16 $count \leftarrow 1$ 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 14 | $A \leftarrow A'$ |
| 17ELSE18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 15 | $k \leftarrow 1$ |
| 18 $count \leftarrow count + 1$ 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 16 | $count \leftarrow 1$ |
| 19END IF20ELSE21 $count \leftarrow count + 1$ 22IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25END IF26END IF | 17 | ELSE |
| 20 ELSE 21 $count \leftarrow count + 1$ 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 18 | $count \leftarrow count + 1$ |
| 21 $count \leftarrow count + 1$ 22 $IF \ count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 $END IF$ 26 $END IF$ | 19 | END IF |
| 22 IF $count = StepSize(k)$ 23 $k \leftarrow k + 1$ 24 $count \leftarrow 0$ 25 END IF 26 END IF | 20 | ELSE |
| $\begin{array}{ccc} 23 & k \leftarrow k + 1 \\ 24 & count \leftarrow 0 \\ 25 & END IF \\ 26 & END IF \end{array}$ | 21 | $count \leftarrow count + 1$ |
| $24 \qquad count \leftarrow 0$ $25 \qquad END IF$ $26 \qquad END IF$ | 22 | IF $count = StepSize(k)$ |
| 25 END IF 26 END IF | 23 | $k \leftarrow k + 1$ |
| 26 END IF | 24 | $count \leftarrow 0$ |
| | 25 | END IF |
| 27 UNTIL $k > k_{max}$ | 26 | |
| mua | 27 | UNTIL $k > k_{max}$ |

Challenge 4: How to balance multi-stakeholder interests?

driver has opinions





The algorithm needs to consider the complex game between the owner and the driver, the driver and the driver, and take care of the interests of all parties.

Challenge 5: Full consideration of various constraints in reality

• 1. Multiple types of vehicles, as well as limited travel policies (electric vehicles)

(by volume, by weight, number of boards)



Vehicle pricing

Minimum cost...

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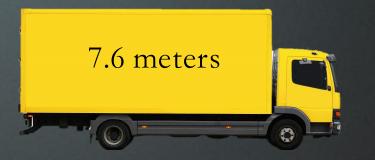
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2. Multiple quotation methods :

Parcel-share valuation

Loading/Unloading fee



3. driver :

•

- Balance of income between drivers
- Work intensity balance, fatigue assessment

- 4. Multiple central warehouses
 - Dry goods
 - Fresh, vegetable and fruit warehouse
 - Frozen warehouse
 - Partial sharing between vehicles



Challenge 6: Support for manual intervention

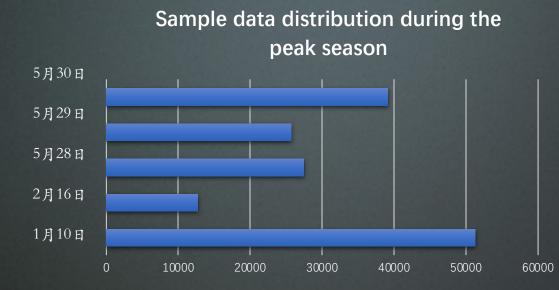


For the "with comments" route, you can click X, after a round of evaluation, real-time recalculation, iterative improvement

Challenge 6: Support for manual intervention



Comparative Results :





• The total cost is reduced by 25-30%, the driver's total driving mileage is reduced by about 30%, and the average driver's revenue per kilometer is increased by about 5%.

| 日期 | | 人工 | | | 算法 | | 对比 | | | |
|-------|-----------------|---------|--------|-----------------|---------|--------|--------|---------|-------|--|
| | 总 费 用(元) | 总里程(KM) | 费用/公里 | 总 费 用(元) | 总里程(KM) | 费用/公里 | 总费用(元) | 总里程(KM) | 费用/公里 | |
| 1月10日 | 51283 | 4984 | 10. 29 | 42139 | 3853 | 10. 94 | -18% | -23% | 6. 3% | |
| 2月16日 | 12726 | 1585 | 8. 03 | 9729 | 1147 | 8.48 | -24% | -28% | 5.6% | |
| 5月28日 | 27438 | 3079 | 8. 91 | 17828 | 1878 | 9.49 | -35% | -39% | 6.5% | |
| 5月29日 | 25704 | 2605 | 9.87 | 18859 | 1877 | 10.05 | -27% | -28% | 1.8% | |
| 5月30日 | 39132 | 3930 | 9.96 | 28785 | 2784 | 10. 34 | -26% | -29% | 3.8% | |
| 均值 | 31256. 6 | 3236. 6 | 9. 41 | 23468 | 2307.8 | 9.86 | -25% | -29% | 4. 8% | |

Manually planning store timeouts



THANKS

THANKS FOR YOUR ATTENTION



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