安全 准确 快速 便捷

EXPRESS
顺丰速运

SF cost optimization

- By Group Unicorn

CONTENTS

Introduction

- Problem description & Data

Problem description & Data

Problem description:

- Intra-city pickup process
- 2021 customer areas(potential local hubs) & 1 gateway hub(SFA)
- Work out a proper local hub plan, which minimizes the total cost and satisfies customer demands.

Data:

- Customer demand
- Distance matrix

Parameter:

- Vehicle cost and capacity
- Fix cost of local hub(￥20)

Resource	Type A Van	Type B Van	Type C Van
Cost (Yuan)	max(70, 70+ 4.5 * (dist - 5))	max(30, 30 + 4* (dist - 5))	6*dist
Capacity (Piece)	800	200	40

demand.xlsx

customer_code	demand
SF0001	6
SF0002	111
SF0003	37
.....	.....

dist_matrix.txt

node_1	node_2	dist
SF1681	SF1681	0
SF1681	SF0871	14.354
SF1681	SFA	24.406
.....	.....	.....

Clustering

- Reason for clustering
- Clustering model
- Clustering algorithm - PAM
- Clustering result

Clustering reason & model

Reasons for clustering

2021 customer nodes：

- if we directly do the optimization : NP problem
- It takes long time to solve the algorithm

Clustering model

- 20 clusters with approximately 100 customer nodes in each cluster (80-120 customer nodes are appropriate for the algorithm to solve according to the research)

Clustering algorithm

PAM clustering

- PAM stands for “partition around medoids”
- **Clustering rule：**
  - partitional (breaking the dataset up into groups)
  - attempt to minimize the distance between points labeled to be in a cluster and a point designated as the center of that cluster

Clustering methods:

★ PAM clustering

K-means clustering

Hierarchical clustering

We choose PAM clustering algorithm because we only have relative distance between nodes

1st：transferred the distance matrix into a symmetric matrix

2nd: entered the symmetric matrix and got 20 clusters using PAM clustering algorithm

Clustering result

- We got 20 clusters with 60-200 customer nodes in it
- Each cluster has customer nodes with smallest possible distance in it - rare extreme case

clusters	number_nodes
1	231
2	103
3	90
4	85
5	66
6	134
7	58
8	79
9	78
10	104
11	76
12	120
13	48
14	93
15	103
16	160
17	132
18	68
19	109
20	84

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Optimization

- Input data
- Constraints
- Cost Decompositon

Used Tool

Python-Gurobi

Input Data & Decision Variables

1. **N**
List of nodes

2. **D_{ij}**
Distance between node i and hub j

3. **g_j**
Distance between hub j and gateway hub SFA

4. **d_i**
Customer demand of node i

A. **X_{ij}**
$X_{ij} = 1$
{if node i is assigned to node j}

B. **y_j**
$y_j = 1$
{if node j is a local hub}

C. **C_i**
Number of Type C Vancs needed for Node i

D. **A_j**
Number of Type A Vans needed of Hub j

Constraints

Node i will only be assigned to node j if j is a local hub.

Each node is only assigned to one local hub.

$$x_{ij} <= y_j \text{ for all } i,j \in N$$

$$\sum x_{ij} = 1 \text{ for each node } i \in N$$

Number of vehicles can fulfill the demand

$$40C_i >= di \text{ for each node } i \in N$$

$$800A_j >= \sum x_{ij} \cdot d_i \text{ for each hub } j \in N$$

Cost Decomposition

Fixed Cost

Unit cost: 20

$F \cdot \sum y_j,\ F = 20$

Cost of Type C Vans

Unit cost: 6*dist

$\sum x_{ij} \cdot 6D_{ij} \cdot C_i$

Cost of Type A Vans

Unit cost: max{70, 70+4.5*(dist-5)}

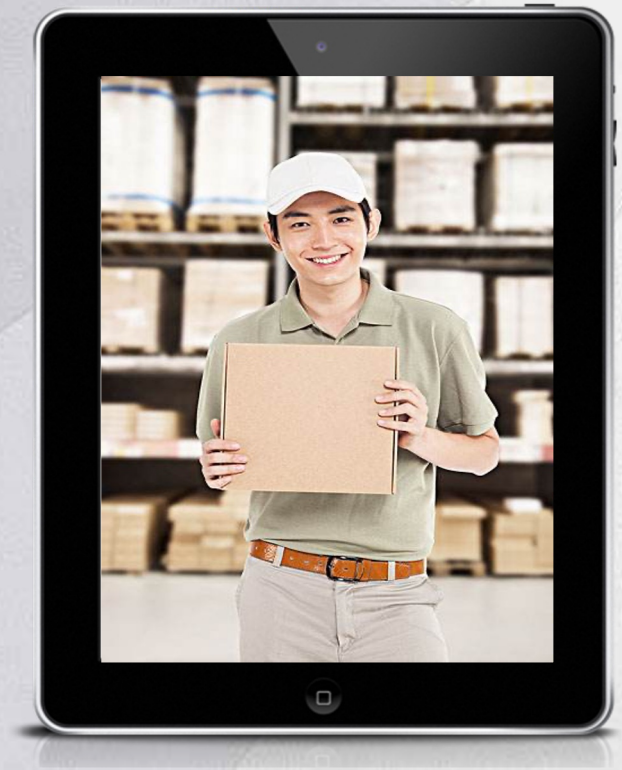
$\sum y_j \cdot max(70,\ 70+4.5(g_j-5)) \cdot Aj$

$g'_j = max(5,\ g_j)$

$\sum y_j \cdot (70+4.5(g'_j-5)) \cdot A_j$

Objective Function: minimize $20F \cdot \sum yj + \sum xij \cdot 6Dij \cdot Ci + \sum yj \cdot (70+4.5(g'j-5)) \cdot Aj$

Optimization Result



Average Nodes: 101.05

Average Hubs: 7.6

Average Costs: 2557.19

Clusters	Costs	Nodes	Hubs	Clusters	Costs	Nodes	Hubs
1	4685.20	231	14	11	3138.14	76	6
2	2624.67	103	9	12	3134.21	120	11
3	2523.90	90	9	13	1397.52	48	3
4	2654.19	85	7	14	1801.72	93	8
5	2155.87	66	6	15	2006.98	103	8
6	3326.61	134	8	16	3738.28	160	11
7	1727.54	58	5	17	3181.74	132	9
8	1654.53	79	7	18	1715.64	68	5
9	2453.38	78	7	19	2907.47	109	7
10	2341.12	104	7	20	1975.09	84	5

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Cost comparison

- Cost without local hubs
- Cost with local hubs

Cost comparision

With out clustering:

1. Direct transportation from customer areas to SFA
2. No fix cost
3. Only type C van is used

method	fixed cost	Transportation cost - Type A	Transportation cost - Type C	total cost
direct	0	0	676308.98	676308.98
cluster	3040	26852.38	21251.42	51143.8
2-node-path	3040	26852.38	19222.3	49114.68



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Further discussion

- Visulization
- The variables
- About the ‘key’

Further discussion

More things to consider...
&
Something to improve...

01

Visualization

How to show our research result in a more professional way ?

e.g. Try to use ArcGIS?

02

The variables

Besides weight & distance...

More things to consider?

03

About the 'key'

A conclusion for MORE and FURTHER use...

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Thank you!

Worked by: Group Unicorn