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A Collaborative Service Decision-Making Method for the Delivery Management of PSS

by

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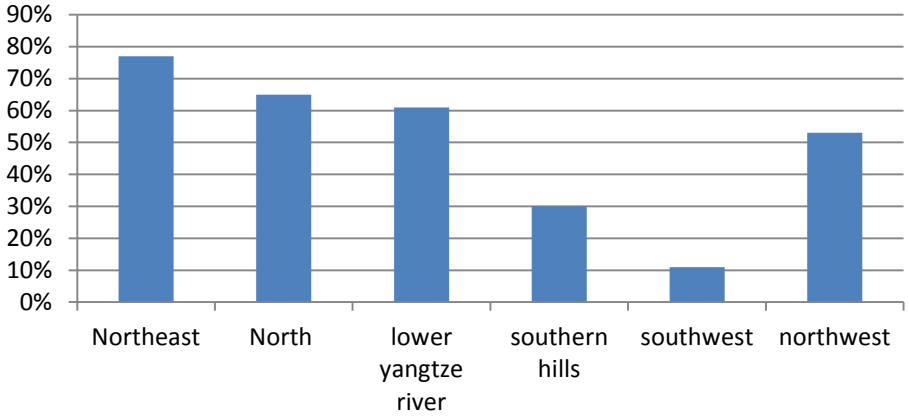
01

Introduction

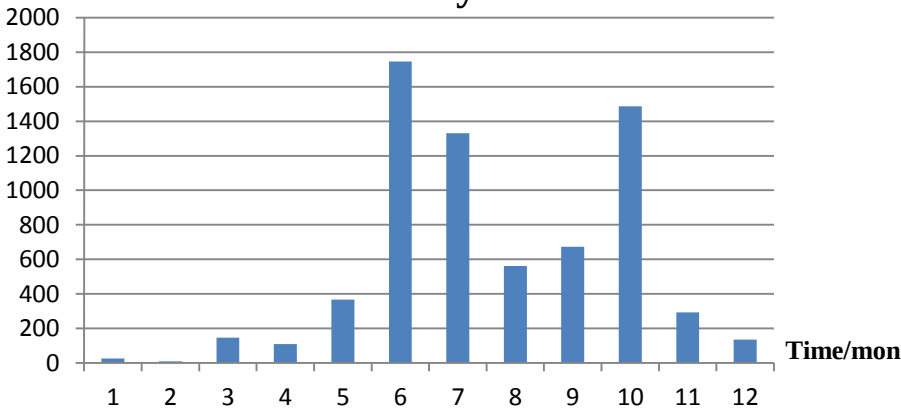
- Research significance
- Literature review

Research significance

The integrated ratio of mechanically farming in China



The distribution map for the number of machinery faults



- There is a high amount of agricultural equipment in China.
- Service is becoming more and more important for enterprise.

- High number of machinery fault didn't get timely maintenance.
- Fault of agricultural machinery caused heavy losses.

Research significance

Enterprises must take measures to improve the level of service delivery!

Literature Review

Background

- PSS
- FTSP
- CVRP

Research Gap

Background

PSS

- From a pure product perspective towards an integrated product–service orientation is termed as PSS（ S. Vandermerwe et al,1988).
- **Service delivery** has drawn the most attention (Wang X et al,2013).
- For **machinery and equipment industry**, services become increasingly important (Meier H et al,2013).

Background

FTSP(Field Technician Scheduling Problem)

Assign a set of jobs, at different locations with time windows, to a group of field technicians with different job skills.

- Aircraft Maintenance Planning(Weigel, D et al,2010)
- Electric Utility Dispatching(Weintraub et al,2011)
- Medical Field (Fenlian Luo et al,2011)
- Natural Disaster(Fiedrich et al,2000)

Background

CVRP (Collaborative Vehicle Routing Problem)

☐ **Motivating Factors**

- Complexity of Delivery Management
- Sharp Competition of Market

☐ **Status**

- Yet not received wide attention.
- Main in Logistics

Research Gap

Method

Collaboration in service delivery

Considering multi-constraint including technicians' skills

02

Problem statement

Service Providers

several service stations of the same manufacturer

Customers

customers those who required service

Constraints

Resources

technicians,
service vehicles

Time windows

penalty cost

Skill match

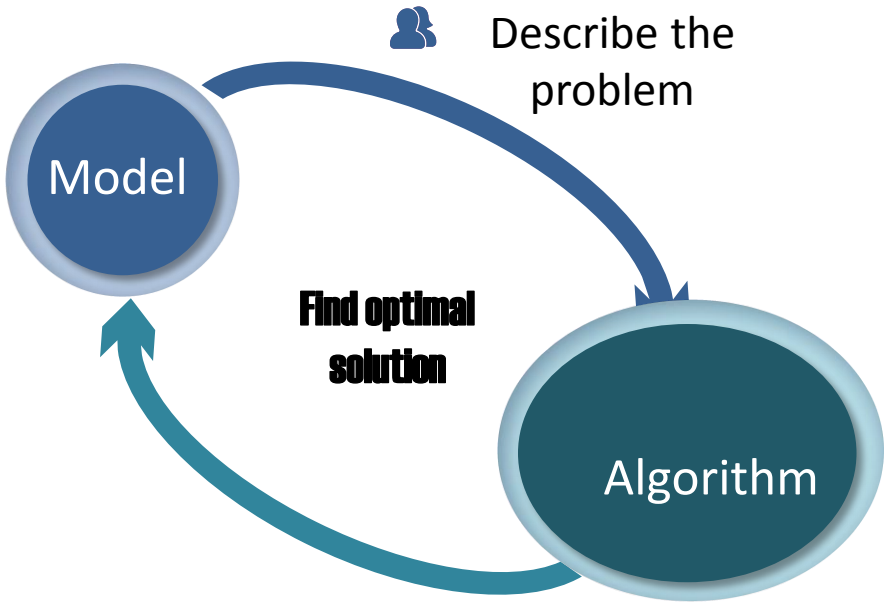
skill (p) ≥ skill (r)

Collaborative Option

collaborate by jointly
using service resources
among service stations

03

Method


Describe the problem
Model
Find optimal solution
Algorithm
Solve the model

Model

Considering the existence of lots of uncertain factors

Assumptions

- There are good relations and cooperation among the service stations.
- Service stations are in proper geographical location and cover certain service area.
- Service time for each customer is gotten from the statistical analysis of historical data.

Model

- the problem this paper study can be stated mathematically as follows:

$$\text{Min } Z = \omega \sum_{m \in M} \sum_{k \in k_m} \sum_{j \in M \cup C} \sum_{i \in M \cup C} d_{ij} x_{ij}^{mk} \quad (1)$$

objective function

s.t.

$$K_p \cap K_q = \varnothing \quad p, q \in M \quad (2)$$

$$C_1^1 \cup C_1^2 \cup \cdots \cup C_1^{k_1} \cup C_2^1 \cup C_2^2 \cup \cdots \cup C_m^1 \cup C_m^2 \cup \cdots \cup C_m^{k_m} = C \quad (3)$$

$$\sum_{k \in K} x_{mi}^k = 1 \quad m \in M, i \in C \quad (4)$$

$$\sum_{j \in M \cup C} x_{ij}^{mk} = \sum_{j \in M \cup C} x_{ji}^{mk} = x_{mi}^k \quad m \in M, k \in K, i \in C \quad (5)$$

$$\sum_{j \in c} x_{ij}^{mk} \le 1 \quad i = m \in M, k \in K \quad (6)$$

$$S_m^i \le R_m^k \quad (7)$$

skill match

$$\sum_{i \in M \cup C} \sum_{j \in M \cup C} d_{ij} x_{ij}^{mk} \le D \quad , m \in M, k \in K \quad (8)$$

$$(t_m^i + p_m^i + t_{ij}) x_{ij}^{mk} \le b_j \quad m \in M, i, j \in C \quad (9)$$

$$y_{ipq} = \begin{cases} 1 \\ 0 \end{cases} \quad i \in C, p, q \in M \quad (10)$$

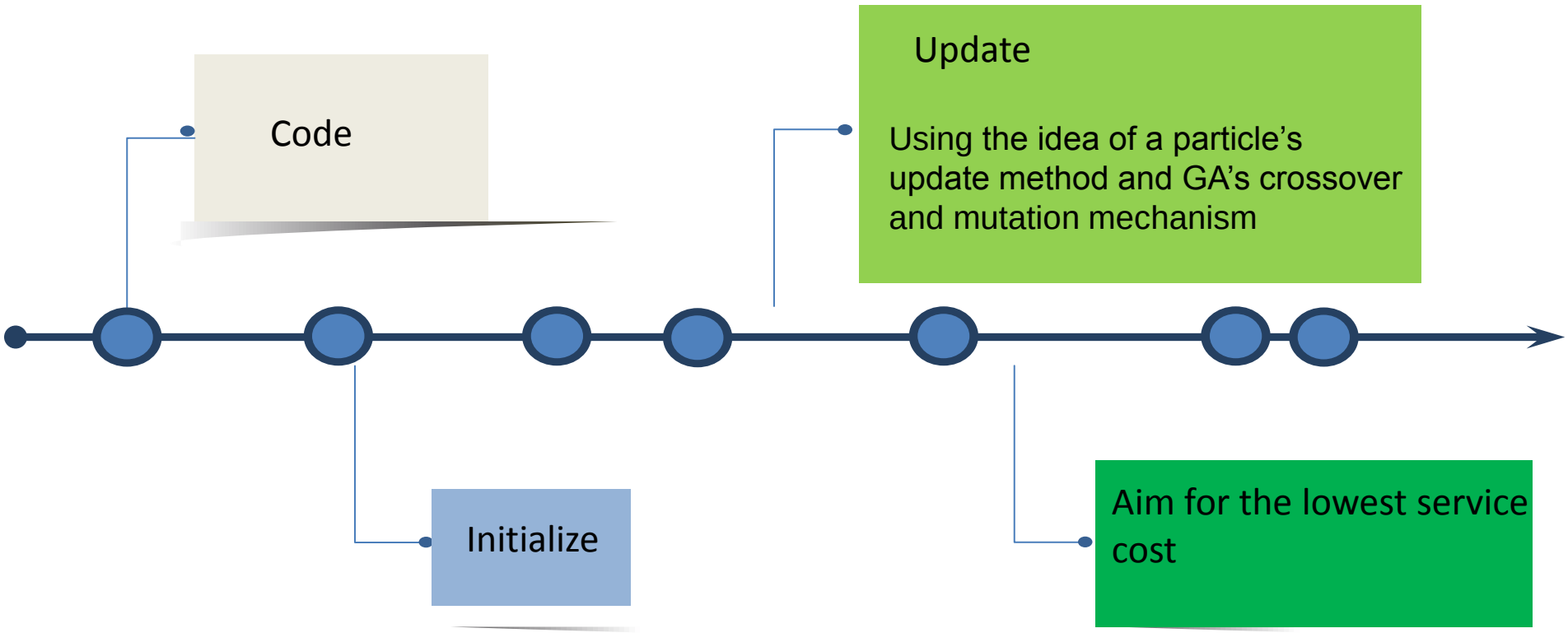
collaborative service options

Algorithm

PSO (Particle Swarm Optimization)

GA (Genetic Algorithm)

PSO-GA


Code
Update
Using the idea of a particle's update method and GA's crossover and mutation mechanism
Initialize
Aim for the lowest service cost

04

Case Study

A Experiment data

B Experiment setup

C Results

D Discussion

Experiment Data and Setup

Experimental Environment：
Matrix Laboratory.

Service station： A(26,25), B(69,74)
Customers: 20
Technicians: 6
Skill matrix:[5 4 4 4 5 3]

Number of Particles: 50
Iteration Times: 80

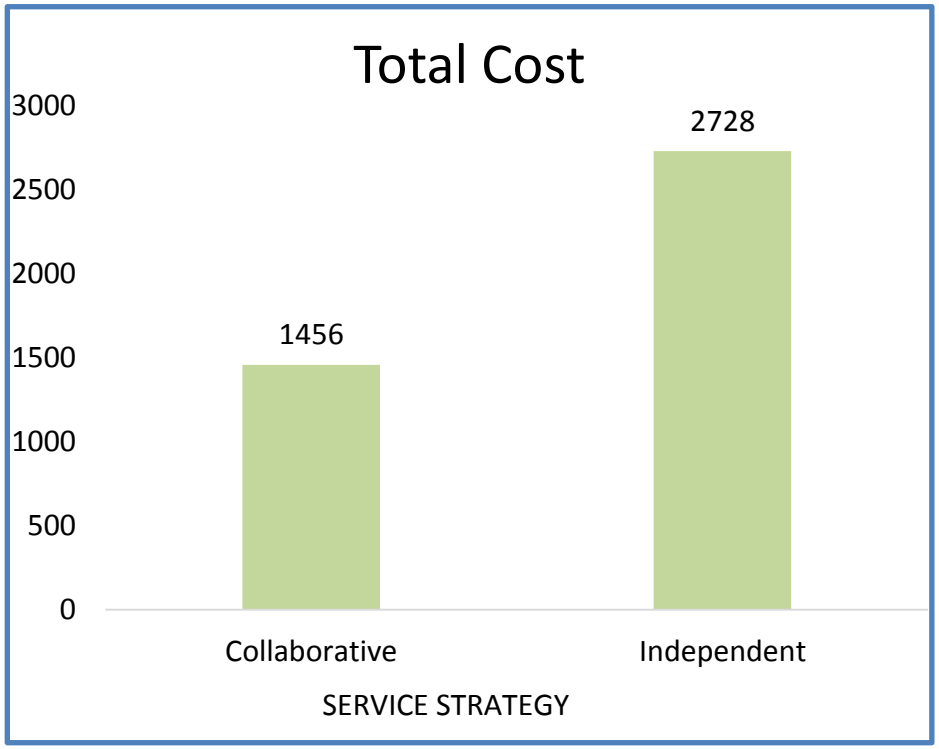
Customer	Demand point location	Process time(h)	Time window	Required level	Responsible Station
1	(25，67)	0.8	(0.3，3.9)	5	A
2	(14，18)	0.4	(1.5，4.3)	1	A
3	(31，8)	0.3	(1.4，3.1)	2	A
4	(9，3)	0.2	(0.1，2.3)	3	A
5	(27，13)	0.2	(1.4，3.9)	4	A
6	(69，10)	0.3	(0.4，4.1)	2	A
7	(89，10)	0.7	(1.6，2.2)	3	A
8	(20，71)	0.3	(1.5，3.7)	1	A
9	(71，22)	0.7	(2.7，4.5)	3	A
10	(43，30)	0.7	(0.9，3.6)	4	A
11	(83，67)	0.1	(1.8，2.2)	2	B
12	(81，31)	0.3	(0.8，3.0)	3	B
13	(81，84)	0.4	(4.1，4.4)	3	B
14	(86，70)	0.3	(1.4，4.4)	2	B
15	(60，93)	0.3	(1.9，4.4)	2	B
16	(94，20)	0.7	(2.7，3.9)	4	B
17	(97，75)	0.2	(2.4，3.8)	5	B
18	(47，85)	0.2	(3.0，3.7)	2	B
19	(98，28)	0.5	(0.7，3.7)	3	B
20	(89，77)	0.2	(0.2，0.9)	3	B

Experiment Results and Discussions

Strategy	Routes	Technician Number	Service station	Cost
Collaborative	A-3-4-10-2-A	T3	A	1456
	B-7-6-16-13-B	T4	B	
	A-1-8-5-A	T1	A	
	B-11-15-B	T6	B	
	B-20-14-9-19-12-B B-18-17-B	T2 T5	A B	
Independent	A-7-5-6-9-A	T2	A	1370
	A-1-8-10-A	T1	A	
	A-4-3-2-A	T3	A	
	B-19-17-13-B	T5	B	1358
	B-14-11-18-B	T6	B	
	B-20-15-12-16-B	T4	B	

2728

Experiment Results and Discussions



Reduced by

46.7%

05

Conclusions

- Method
- Service Mode

Conclusions

NO.1

The collaborative mode is more beneficial for service delivery in PSS.

NO.2

The model is strong and effective for the problem.

NO.3

Hybrid PSO-GA is appropriate for this problem.

Future Research

THANKS