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Equality Donation Distribution Model using Penalty function method

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Outline

- Introduction
- Objective & Scope
- Materials
- Problem
- Algorithm & Testing
- Result & Conclusion

Introduction

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Introduction

A Multi-category Emergency Goods Distribution Model and Its Algorithm

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Logistics Routes Optimization Model under Large Scale Emergency Incident

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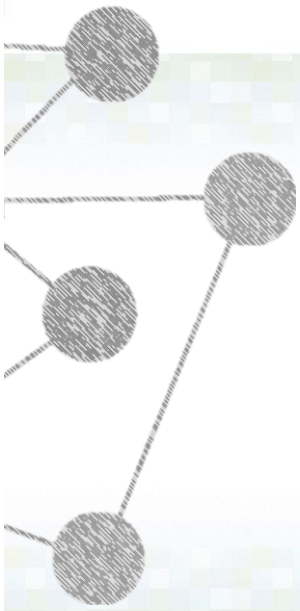
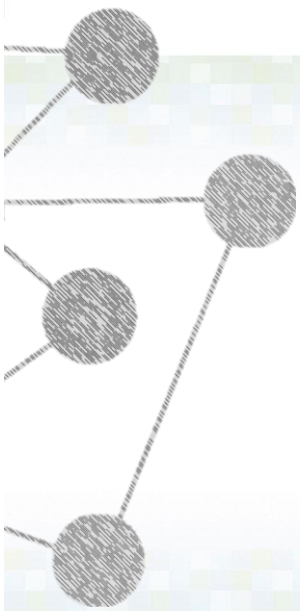


Objective

- Design an algorithm for decrease the disparity in donation distribution by using penalty function method



Scope

- Model's decision based on day-by-day distribution strategy
- Variables, Domain and Range of functions are integer

Materials

Hardware

- Dell Vostro 5480
- Toshiba Satellite L735-1042XT

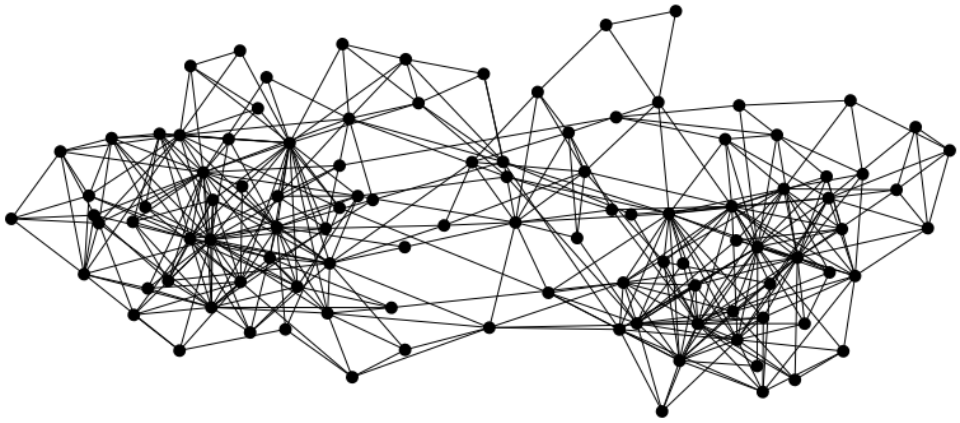
Software

- Codeblocks Version 16.01
- Microsoft Excel 2010

Environment

- Codeforces
- Polygon

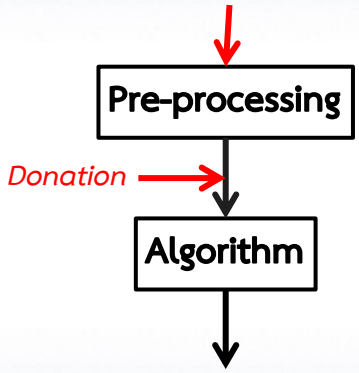
Why mathematical model?



Model: Big picture

Structure of disaster area

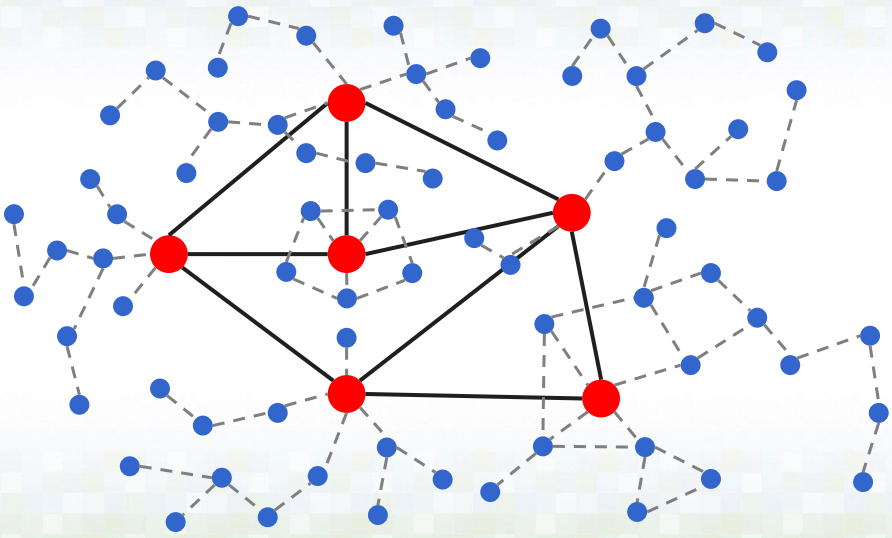
Positive integer weighted connected undirected graph



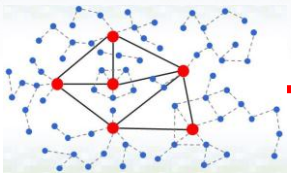
Output

Destination of donations

Model: Pre-processing



Model: Algorithm



Structure of disaster area

1. Filled demand
2. Expired date

Donation

The Algorithm

1. Initial demand
2. Increasing rate of demand
3. Penalty rate of demand
4. Time receive latest donation

Total Demand

Fulfilled Demand

Model: Objective

❑ Let $D: V \times \mathbb{N}_0 \times \mathbb{N} \rightarrow \mathbb{N}_0$ such that

$$D(u,k,t) = D(u,k,t-1) + r_u + R_u(t-k); D(u,k,0) = z_u$$

Minimize

"Difference between actual demand and fulfilled demand"

$$P(t) = \sum_{u \in V} \max(-1, (D(u,t,T_u) - X_u)^3)$$

What is the problem?

22093573	2016-11-07 14:58:50	sin_cos_tan	K -	GNU C++11	Accepted	13525 ms	300 KB
22093526	2016-11-07 14:55:51	sin_cos_tan	J -	GNU C++11	Accepted	12744 ms	300 KB
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22087790	2016-11-07 06:47:19	sin_cos_tan	B -	GNU C++11	Accepted	14913 ms	300 KB

- Time complexity is $O(N^V + V^3)$
- Error is 0 %

22272636	2016-11-16 19:24:56	sin_cos_tan	K -	GNU C++11	Accepted	31 ms	800 KB
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22272602	2016-11-16 19:23:47	sin_cos_tan	D -	GNU C++11	Accepted	31 ms	800 KB
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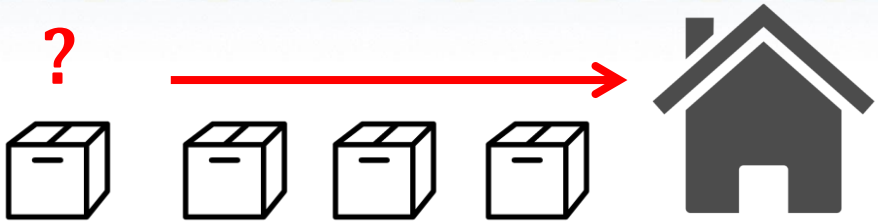
22272590	2016-11-16 19:23:30	sin_cos_tan	B -	GNU C++11	Accepted	31 ms	800 KB

- Expected time complexity is Polynomial class
- Expected Error is 10.00 %

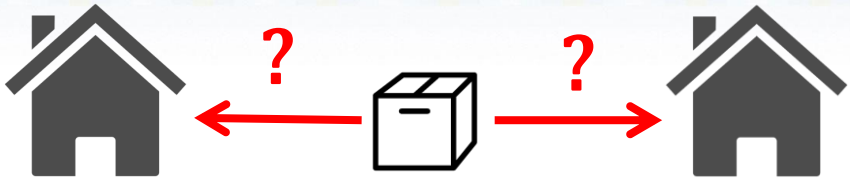
Step by Step



- Let $A: V \times N_0 \times N \times (N_0 \times N)^n \rightarrow N_0$ where $l_0 = T_u$ such that

$$A(u,t,y,\bar{I} = <(l,b)>) = \max(0, D(u, t + l_y, l_{y-1}) - \sum_{i=1}^{y-1} b_i - X_u)$$

Step by Step



❑ Let $f: V \times \mathbb{N}_0 \times \mathbb{N} \times (\mathbb{N}_0 \times \mathbb{N})^n \rightarrow \mathbb{R}$ such that

$$f(u,t,y,\bar{I} = <(l,b)>) = \frac{\min(K^3, K^3 - (K - b_y)^3)}{l_y + 1}; K = A(u,t,y,\bar{I})$$

Model: Penalty function method

Maximize

"Decreasing rate of unfulfilled demand"

$$P'(t) = \sum_{u \in V} \sum_{i=1}^{k_u} f(u,t,i,\bar{I}_u)$$

Model: Algorithm

WHILE incident occurs

Update transportation state

Receive donations

S

F

$$O(T(N^2 \log N + NV) + V^3)$$

Choose and assign feasible destination that maximize $P'(t)$

END FOR

Update transportation state

END WHILE

Testing

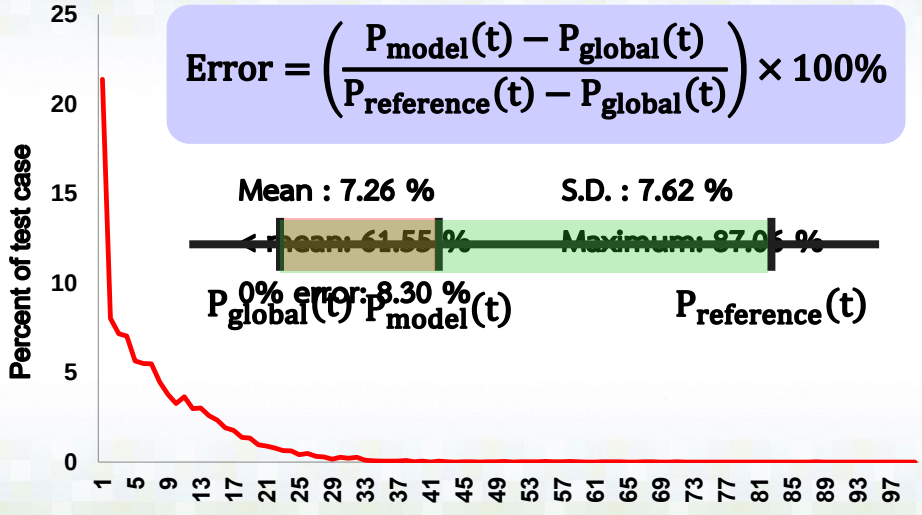
- **Library**
  - **<random> (produce random numbers)**
  - **<chrono> (deal with time)**
- Linear congruential engine (minstd_rand0) from <random>

$$P \equiv 7^5 P \pmod{2^{31} - 1}$$

Where X is calculated using <chrono>

- **There are 7,935 randomly test cases.**

Result & Conclusion



Result & Conclusion

Because algorithm's average error is 7.26 % and time complexity is $O(T(N^2 \log N + NV) + V^3)$, it is concluded that our algorithm **can distribute donations while maintain equality appropriately.**

References

Chunguang, C., Xiaoyu, S., Lijie, W., & Bo, G. (2010). 2010 International Conference on Logistics Systems and Intelligent Management. *A Multi-category Emergency Goods Distribution Model and Its Algorithm*, 1490-1494.

Chunguang, C., Dongwen, C., Xiaoyu, S., & Bo, G. (2010). 2010 International Conference on Logistics Systems and Intelligent Management. *Logistics Routes Optimization Model under Large Scale Emergency Incident*, 1471-1475.

Kleinberg, J., & Tardos, E. (2013). *Algorithm Design*: Pearson New International Edition. Boston: Pearson Education, Inc.