Equality Donation Distribution Model using Penalty function method

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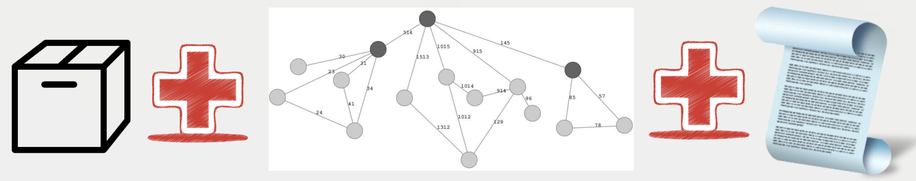
Abstract

When an emergency incident happens, it is literally difficult to maintain fair distribution of donations. To improve efficiency of distribution, an optimization model for equality donation distribution is established. The model's objective is to find an optimal strategy to distribute donations. Constraints of the model include demand of victims, quality and quantity of donations in multi-category, and structure of the disaster area. Transportation route for each pair of nodes is the shortest path. Penalty function method was applied to transform the model into a simpler problem, and then greedy algorithm was applied. Algorithm's time complexity is $O\left(T\left(\beta\varepsilon + (C+N)\left(\log(C+N) + |V|\left(\epsilon + \alpha + \frac{1}{C+N}\right)\right)\right)\right)$ where C, N, $|V|$ and T are number of vehicle, number of donations, number of victims, and time interval of the incident, respectively. The experiment result shows that the algorithm can distribute donations while maintain equality.

Objectives

1. To establish an optimization model represent equality donation distribution problem
2. To develop an efficient algorithm for distribute donation equally

Overview



Conclusion and Further Development

According to the result from 8,168 test cases, mean, median, and mode of error from optimal solution and model solution is 9.06%, 5.40%, and 0.00%, respectively. Error from optimal solution and model solution resembles exponential distribution. Thus, the algorithm can distribute donations while maintain equality.

For further development, there are 2 important things to develop,

- Adjust function $\mathbf{f}$ to decrease error, on the other word, develop function $\mathbf{h}: \mathbb{R}_0^+ \to \mathbb{R} - \{0\}$ such that

$$f_u(t, y, \bar{I}) = \frac{K^2 - \max^2(0, K - b_y)}{h(l_y)}$$

where $K = A_u(t, y, \bar{I})$

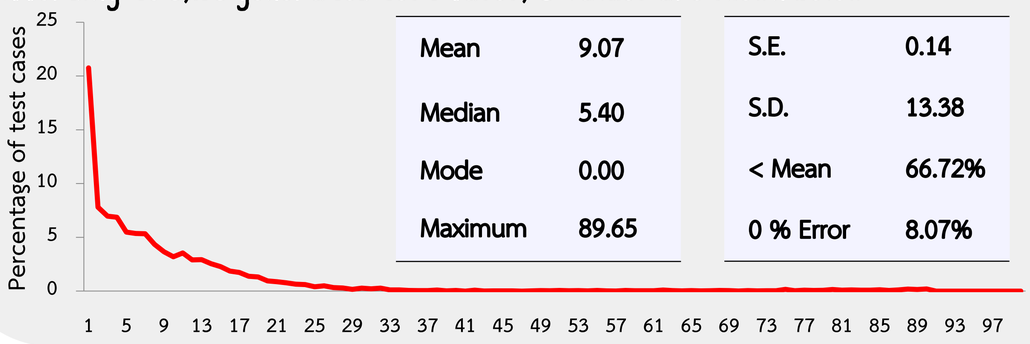
- Test algorithm with test cases consist of dynamic graph and non-polynomial penalty demand function

Result

Error of algorithm is calculated by percentage error of objective function (δ)

$$\delta = \left(\frac{P_{model}(t) - P_{global}(t)}{P_{reference}(t) - P_{global}(t)}\right) \times 100\%$$

According to 8,168 generated test cases, δ values are shown below



Mean	9.07	S.E.	0.14
Median	5.40	S.D.	13.38
Mode	0.00	< Mean	66.72%
Maximum	89.65	0 % Error	8.07%

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