MCM Thesis

ABC

November 10, 2024

Abstract

This is the abstract.

Contents

1 Introduction

This is an introduction [3] [1] [2]

2 Assumptions

Our assumptions are:

- **item 1**
- **item 2**
- **item 3**

3 Our Model

Col1	Col2	Col2	Col3
1	6	87837	787
2	7	78	5415
3	545	778	7507
4	545	18744	7560
5	88	788	6344

Table 1: Table to test captions and labels.

From Table 1 the result is clear.

4 Sensitivity Analysis

To test the robusness of our solution, we used statistical data (See appendix) to generate random sequences of $W_{d,t}$. By gradually increasing the standard diviation of generated sequence, we evaluate how our solution perform under realistic fluctuations of trash generation. The results are showed in Fig. 1

The generation is achieved by letting:

$$W_{d,t} \sim \mathcal{N}(m_d, \sigma_d^2) \tag{1}$$

Where m_d, σ_d^2 are determined using statistical tonnage data.

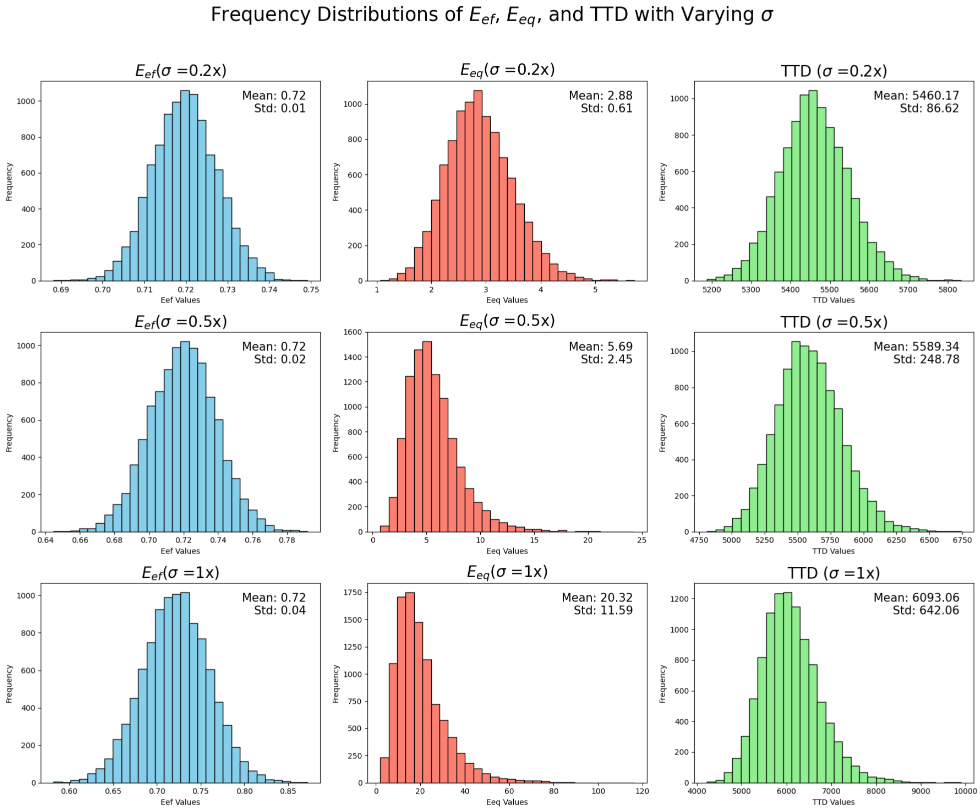

Figure 1: Sensitivity analysis of the TTD model. We generated 10,000 sets of $W_{d,t}$ and tested how our solution perform. Where $\sigma = 0.2x$ denotes $\sigma = 0.2 \times \sigma_s$, where σ is the standard diviation parameter of the random sequence generation, and σ_s is the statistical value from real world data. From the result we can see that the mean of E_{ef} and TTD are not sensitive to the flutuations of trash generation(where E_{ef} retained it's mean and TTD has an 10 % increase). While the mean of E_{eq} increased drastically when the trasit twords real world data happens. This indicates that in real world sanarios, we are not likely to achieve the desired equity of service.

5 Conclusion

From Fig. 2 the result is clear.

6 Future Work

$$E = mc^2 \tag{2}$$

Eq. (2)

To account for how long trash stayed at the residency uncollected, we introduce the number TTD (which stands for total trash delay). Assume we have a schedule for trash collection and we know how much trash is generated each day, then for

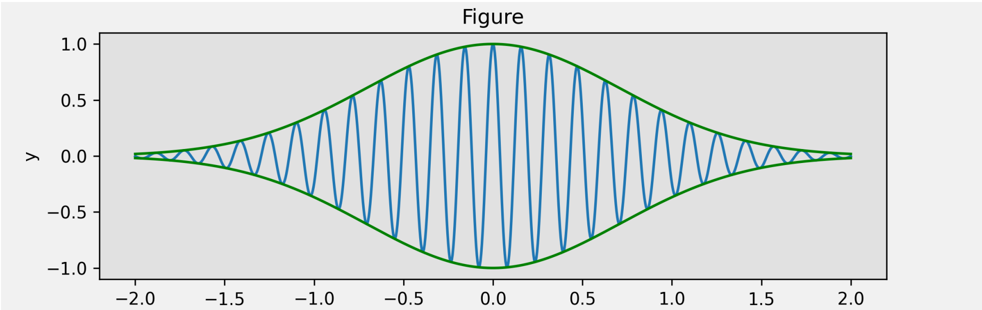

Figure 2: Visualization of the function

each district and time t, we can calculate the amount of uncollected trash at time t, denoted by a function $T(t)$. Given this function, it is natural to quantify the severity of trash delation by the integral:

$$TTD = \int_{t_1}^{t_2} T(t)dt \tag{3}$$

Where t_1, t_2 are the start and end times. If all trash are collected immediately once they are generated, then $T(t) = 0$ for all t and $TTD = 0$. While if we collect all trash at once at time t_2 gives a positive TTD (since if we do not collect any trash in the time interval $[t_1, t_2]$, then $T(t)$ is increasing). Both schedules of trash collection

Since in our problem the time divided into 7 days, the total TTD for a district is calculated by:

$$\sum_{d=1}^{7} T_d \tag{4}$$

7 Appendix

Listing 1: Python example

```python
import numpy as np

def incmatrix(genl1,genl2):
    m = len(genl1)
    n = len(genl2)
    M = None #to become the incidence matrix
    VT = np.zeros((n*m,1), int)  #dummy variable

    #compute the bitwise xor matrix
    M1 = bitxormatrix(genl1)
    M2 = np.triu(bitxormatrix(genl2),1)

    for i in range(m-1):
        for j in range(i+1, m):
            [r,c] = np.where(M2 == M1[i,j])
            for k in range(len(r)):
                VT[(i)*n + r[k]] = 1;
                VT[(i)*n + c[k]] = 1;
                VT[(j)*n + r[k]] = 1;
                VT[(j)*n + c[k]] = 1;

                if M is None:
                    M = np.copy(VT)
                else:
                    M = np.concatenate((M, VT), 1)

                VT = np.zeros((n*m,1), int)

    return M
```

References

[1] Lawrence Barringer and Claire M Ciafré. “Worldwide feeding host plants of spotted lanternfly, with significant additions from North America”. In: *Environmental Entomology* 49.5 (2020), pp. 999–1011.

[2] Steven B Horton. “MCM Director’s Overview of the Mathematical Contest in Modeling: What Advisors Need to Know.” In: *2021 Joint Mathematics Meetings (JMM)*. AMS. 2021.

[3] Julie M Urban and Heather Leach. “Biology and management of the spotted lanternfly, Lycorma delicatula (Hemiptera: Fulgoridae), in the United States”. In: *Annual Review of Entomology* 68.1 (2023), pp. 151–167.