Hop On Dining

Team Monkey

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1 Introduction

Our goal is to create an APP that can show the map of the campus, provide total number of people in the dining halls in real-time, and tell users what the menus are and how long the expected wait time in line is.

2 Principle Equations

2.1 Total Number of People in the Dining Hall

- $P(t)$ stands for the number of people in the dining hall with respect to time.
- $I(t)$ stands for the number of people coming into the dining hall with respect to time.
- $O(t)$ stands for the number of people leaving the dining hall with respect to time.
- $P^{'}(t)$ stands for the rate of change of the number of people in the dining hall with respect to time.
- $I^{'}(t)$ and $O^{'}(t)$ follow similarly.
- $\alpha(t)$ stands for expected staying time of one person in the dining hall.

$$P(t) = I(t) - O(t)$$

$$P^{'}(t) = I^{'}(t) - O^{'}(t) \approx \frac{I(t) - I(t-5)}{5} - \frac{P(t)}{\alpha}$$

2.2 Expected Waiting Time with Respect to Current Time

- $Q(t)$ stands for the number of people currently waiting in line with respect to time.
- $W(t)$ stands for the estimated waiting time with respect to time.
- $Q^{'}(t)$ stands for the rate of change of the number of people waiting in line with respect to time.
- Notice that the waiting time per person at a specific section is relatively consistent. Thus, by passing data through the statistical analysis, we can obtain the proportionality of the number of people between each section, which is concluded by ϵ, a fraction s.t. $W(t) = \epsilon \cdot Q(t)$.

$$Q^{'}(t) = I^{'}(t) - \frac{1}{W(t)/(Q(t) \cdot 2)}$$

$$W(t) = \epsilon \cdot Q(t)$$

$$\implies Q^{'}(t) = I^{'}(t) - \frac{2}{\epsilon}$$

3 Data Interpretation and Stats Analysis Description

3.1 Input Data

- *Pop* is an 4×1 array representing how frequent people go to each section. All components of this array is non-negative fractions and they sum up to 1.
- *Wait* is an 4×1 array representing the time one person spends taking the food they need in each section.
- *WhetherToGo* is an 4×1 array that takes binary inputs, where the first entry is always 1.

3.2 Output Data

- ϵ is a fraction as described in Section 2.2.
- this fraction will give us all the information about the formula of $Q(t)$.

3.3 Analytic Process

The data processing of this program is divided by student-response-based stats analysis and computation of ODE system. The former one will give results of α and *epsilon*. The second part will plug in them to ODEs formed in Section 2.1 and Section 2.2, gives expression for the values we are interested in. The only two variables obtained from Stats analysis will be α and ϵ. Notice that the α can just be simply calculated by taking mean value of the inputs, so we just omit this process and give an reasonable estimation for breakfast, lunch, and dinner, respectively.

4 Conclusion

Mission accomplished!

Utilizing reasonable scientific approaches and powerful math tools such as student feedback-based statistical analysis and continuously evolving ordinary differential equation systems, our Hop On Dining APP is able to 1) display a Google map showing the two dining halls' locations; 2) the total number of people in each dining hall in real time; 3) estimated overall waiting time in each dining hall; 4) estimated waiting time in each section of the dining halls.

5 Discussion

Currently we are not getting the real-time updated $I(t)$ from the dining halls. In the future, we will try to contact Hopkins Dining to get the instantaneous count of J-Card swipes. We assigned three α values for the breakfast, lunch, and dinner; but we will improve the accuracy of estimation by doing survey-based statistical analysis to calculate the 3 α values for three meals a day. Moreover, we will improve the quintessence of ϵ by collecting more data.