Bringing the Appalcart to the Tropical Setting

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Outline

Goals

Make the most efficient model for the train system with standard departure times, and apply this system to the AppalCart routes.

Assumptions

- Travel times of the trains are constant
- Trains should wait for each other
- Trains leave as soon as possible

Basic Operations

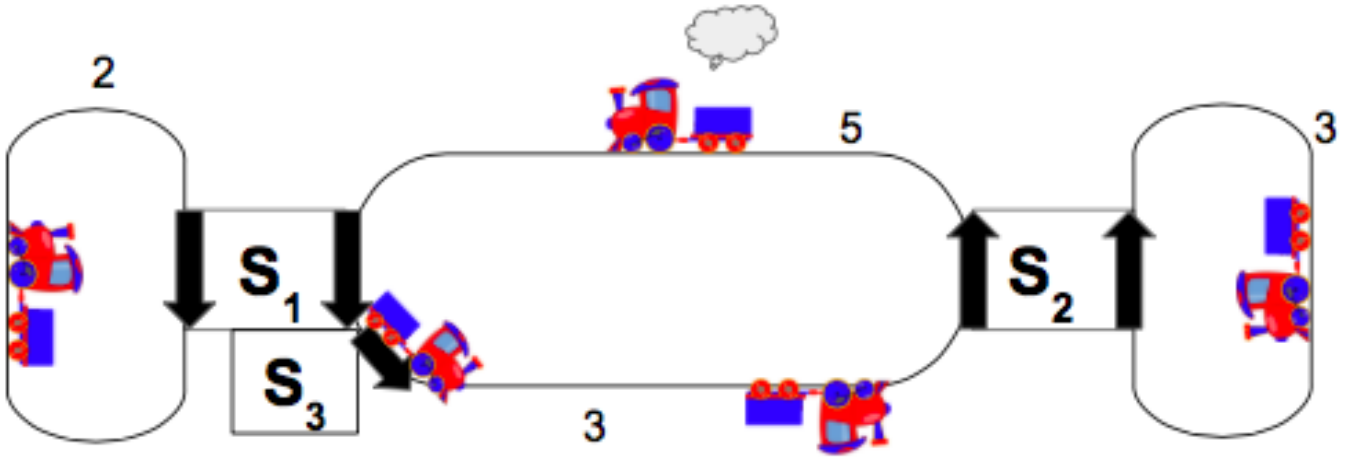
Operations

- $A \bigoplus B = \text{Max}(A, B)$
- $2 \bigoplus 5 = \text{Max}(2, 5) = 5$
- $A \bigotimes B = A + B$
- $2 \bigotimes 5 = 2 + 5 = 7$

Identities

- $\epsilon = -\infty$
- $e = 0$
- ϵ: direct path between stations does not exist
- e: travel time between stations is 0

Train Diagram



$$A = \begin{bmatrix} 2 & 5 & \epsilon \\ \epsilon & 3 & 3 \\ e & \epsilon & \epsilon \end{bmatrix}$$

A_{ij} = the time from station j to i

Why Max-Plus?

- $\otimes$: gives the arrival times of trains
- $\oplus$: makes all the trains wait on one another

Relating to Train Diagram

- Outer cycles
- Need for passengers

Eigenvalue

- $|Y|_w$ = circuit weight or total travel time
- $|Y|_l$ = circuit length or the number of paths
- $\mu = \dfrac{|Y|_w}{|Y|_l}$
- $\lambda = \text{Max}(\mu_1, \mu_2, ...)$
- In the train diagram $\lambda = 3$

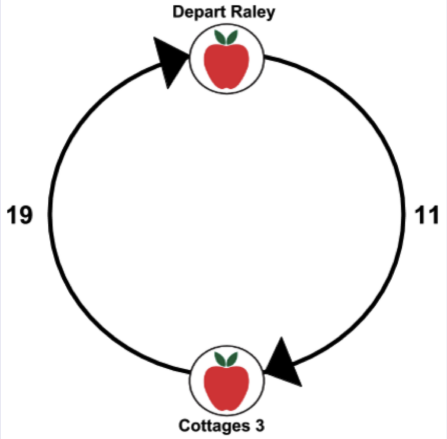
Eigenvector

- Gives departure times for trains
- $A_\lambda = \begin{bmatrix} -1 & 2 & \epsilon \\ \epsilon & 0 & 0 \\ 3 & \epsilon & \epsilon \end{bmatrix}$
- To find eigenvector use $\bigoplus_{k \geq 0} A_\lambda^k$
- $\begin{bmatrix} 2 \\ 0 \\ -1 \end{bmatrix}$
- Train 3 leaves first, a minute later Train 2 leaves, two minutes after that Train 1 leaves

Teal Route

Computations

- $A = \begin{bmatrix} \epsilon & 19 \\ 11 & \epsilon \end{bmatrix}$



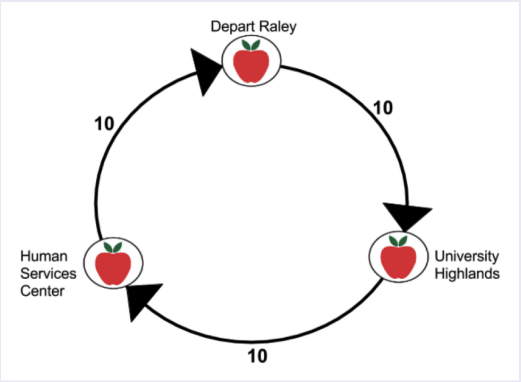
Results

- Teal Route is optomized for two buses
- Route could be made more efficient with 3 buses

POP 105 Route

Computations

- $A = \begin{bmatrix} \epsilon & \epsilon & 10 \\ 10 & \epsilon & \epsilon \\ \epsilon & 10 & \epsilon \end{bmatrix}$



Results

- Optomized for Friday and Saturday Schedule
- Could be more efficient Monday thru Thursday

Future Work

- We started to look at how the Teal route and Pop 105 route interacted. However, we didn't get any interesting results this way
- In the future, we might want to look at more of the Appalcart routes. We would attempt to combine multiple routes and to see what changes when buses are added to the system.

Thank You

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