6.336 Project Abstract

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Motivation

Drivers in the United States can waste up to 82 hours in traffic annually. In addition to incurring an annual cost of 124 billion dollars, road congestion also causes environmental damage. With increasing levels of population and environmental concerns, traffic congestion is becoming an urgent issue that city planners and policy makers have to consider, and tools that help analyze urban transportation are becoming increasingly relevant. In this project, we simulated and studied traffic behavior in Cambridge during peak hours, when people are commuting between work and home in the region shown in Figure 1.

Figure 1: Region of interest in Cambridge.

Problem Formulation

Network

Input: Flow of cars from origins, flow of cars into destinations $\equiv \boldsymbol{f_{s,i}}$

Output: Congestion as a ratio of travel time to free flow travel time

Nodes: Geographical decision points
Signals: Time from origin to node i, $\equiv \boldsymbol{T_i}$
Parameters: Free-flow-travel-time to node i, $\equiv \boldsymbol{T_{0,i}}$

Components: Roads
Signals: Flow of cars $\frac{cars}{time}$, $\equiv \boldsymbol{f_a}$
Parameters: Capacity of road, $\equiv \boldsymbol{K_a}$,
Proportionality constant $\equiv \boldsymbol{\beta_a}$

Equations

Let A_i be the set of all components connected at node i. The conservation of traffic flow gives us

$$\sum_{a \in A_i} f_a = -f_{s,i} \; for \; all \; i. \quad (1)$$

Let j,k be nodes that component a is connected to. If we treat the cost of travel as the time required, the Bureau of Public Roads (BPR)[2] gives us the formulation represented by Equation 2:

$$T_j - T_k = (T_{0,j} - T_{0,k})(1 + \beta_a (\frac{f_a}{K_a})^4) \; for \; all \; a. \quad (2)$$

Results

We have investigated congestion, measured in terms of $\frac{T_i}{T_{0,i}}$, during hours when people are commuting between work and home in Cambridge. We have created a plot of the times during which the time taken for travel exceeds twice the free flow time, an indicator of heavy congestion, as can be seen in Figure 2. Additionally, we have tested the road network with a constant input, equal to the average flow traffic over an entire day, and tested whether or not the current infrastructure can support the expected traffic. We found that the current roads actually cannot support the average amount of traffic; therefore, we conclude that congestion is an infrastructure problem that could be solved with larger capacity roads.

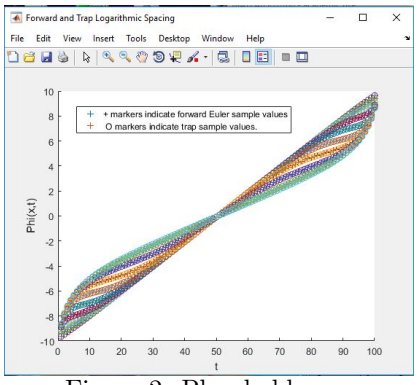

Figure 2: Placeholder for final plot.

References

[1] "A Circuit Simulation technique for Congested Network Traffic Assignment", Cho,H.J. & Huang,H. AIP Conference Proceedings, 963, 993(2007)

[2] "The Determination of Urban Traffic Movements with electrical analogues" James McCarthy Small

[3] Hurricane Evacuation Model. Anisha Nakagawa, MIT Media Lab, Changing Places Group.