Real-time queue length estimation: Implementation and limitations

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The Queue Length Problem

Existing models in literature:
- Input-output to signal link
- LWR shockwave theory based on arrival information

However, these models do not take into account cases when queue becomes so long that it spills past the detectors.
LWR Shockwave Theory

Figure 1. Break points A, B, C and traffic shockwaves at an intersection (Liu et al., 2009)
Queue Length Estimation

\[ \nu_1 = \frac{0 - q_a^n}{k_j - k_a^n} \]
\[ \nu_2 = \frac{q_m - 0}{k_m - k_j} \]
\[ \nu_3 = \frac{q_m - q_a^n}{k_m - k_a^n} \]

\[ \begin{cases} 
L_{\text{max}}^n = L_d + \left( T_C - T_B \right) \left( \frac{1}{\nu_2} + \frac{1}{\nu_3} \right) \\
T_{\text{max}}^n = T_B + \left( L_{\text{max}}^n - L_d \right) / \nu_2 
\end{cases} \]

Figure 3. Greenshield’s fundamental diagram (Liu et al., 2009)
NGSIM Data

Link 2
Lane 3
Queues
Detector Occupancy & Time Gap: Theoretical

Figure 2. (a) Detector occupancy profile and (b) time gap between consecutive vehicles (Liu et al., 2009)
Detector Occupancy & Time Gap: Actual
Dynamic Time Warping Algorithm

Dynamic time warping is an algorithm that detects similarity between two time-series signals. It computes the optimal match between two signals based on similarities in patterns.
Time Gap with Break Point C

from DTW algorithm
Signal Timing
Signal Timing

Queue 5

Queue 9
Theoretical vs. Actual
Limitations of the model

Errors in detector occupancy time, time gap and speed estimation.

Liu et al. explicitly mention that the proposed model works properly when break point C is correctly identified – are there better ways to do this than using the dynamic time warping algorithm?

Cases of oversaturation and downstream queue spillover.