Stochastic Fundamental Diagram


The relative benefits of VII as function of market penetration of VII in different cases (x-axis: market penetration of non-assisted vehicles; y-axis: ratio of increased capacity to the original capacity)

Comparison of the three models based on 2006 Honda Civic engine

Performance of the three models (left: MAPE of power, right: MAPE of torque)

VII-Enabled Intersection Collision Warning

Traffic Flow Modeling at the Picoscopic Level


Trajectory Reconstruction for Travel Time Estimation

Minimize: Total cost = congest cost + sensor cost

\[ t(d) = s_C \left( \frac{L}{d} + 1 \right) + N_Y N_P p c_v L D_P \left( \frac{q_D^2}{2(q_D - q_A)} \right) (NMSE) \]

NMSE as a function of sensor spacing based on PSD model \( S(\chi, \tau, c) \). Total cost \( t(d) \) as a function of sensor spacing.

### Determining Traffic Flow Characteristics by Definition

1. **Total Distance**

\[
t(A_x) = \sum_{i=n_{lo}}^{n_{hi}} t^{(i)}(A_x) = \sum_{i=n_{lo}}^{n_{hi}} \left\{ \min(t_{x=x_{hi}}(n_i), t_{hi}) - \max(t_{x=x_{lo}}(n_i), t_{lo}) \right\}
\]

2. **Total Time**

\[
d(A_x) = \sum_{i=n_{lo}}^{n_{hi}} d^{(i)}(A_x) = \sum_{i=n_{lo}}^{n_{hi}} t^{(i)}(A_x) \frac{x_{hi} - x_{lo}}{t_{x=x_{hi}}(n_i) - t_{x=x_{lo}}(n_i)}
\]

3. **Region Area**

\[
|A_x| = |A_n| = (x_{hi} - x_{lo})(t_{hi} - t_{lo})
\]

**Flow**

\[
q(A_x) = \frac{d(A_x)}{|A_x|}
\]

**SMS**

\[
\bar{u}_s(A_x) = \frac{d(A_x)}{t(A_x)}
\]

**Density**

\[
k(A_x) = \frac{t(A_x)}{|A_x|}
\]

# Link Flow Optimization and Markovian Breakdown Prediction

## Link Flow Optimization

<table>
<thead>
<tr>
<th>Maximize</th>
<th>$\theta = q(t)(1 - P_b)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject to</td>
<td>$0 \leq q(t) \leq q_{\text{max}}$</td>
</tr>
</tbody>
</table>

### Blocking Probability

$P_b = \frac{n}{n_c} \left(1 - \frac{v_n}{v_f}\right)$

## Exponential Model of the Blocking Probability

![Exponential Model of the Blocking Probability Graph]

## Traffic State vs. Blocking Probability

![Traffic State vs. Blocking Probability Graph]

## Input Flow, Throughput, and Penalty

- **Input Flow**
- **Throughput**
- **Penalty**

## Flow in Vehicles/Hour/Lane

![Flow in Vehicles/Hour/Lane Graph]

Regional Traveler Information Center (RTIC)

1. Website: http://www.masstraveler.com/