Point Queue Model Validation using NGSIM Data

CE 291F/ME 236 Project
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OUTLINE

• Background
• Point Queue Model
• Data
• Simulation
• Results & Discussion
BACKGROUND

- Arterials vs Freeways
- Different challenges
- Varying constraints
**Point Queue Model**

- Transit and Exit queues
- Transit link lengths
- Stop Lights as Shock waves
- Split Ratios
- Discharge rates
**Point Queue Model**

- Transit and Exit queues
- Transit link lengths
- Stop Lights as Shock waves
- Split Ratios
- Discharge rates

Link Length equivalent to Number of bins
POINT QUEUE MODEL

- Transit and Exit queues
- Transit link lengths
- Stop Lights as Shock waves
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- Discharge rates
Point Queue Model

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POINT QUEUE MODEL

- Transit and Exit queues
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- Discharge rates
DATA

• NGSIM background
• Study Area – Lankershim Boulevard (LA)
DATA

• Origin-Destination distribution
  ➢ 11 origins, 10 destinations

<table>
<thead>
<tr>
<th>Origin</th>
<th>201</th>
<th>203</th>
<th>204</th>
<th>205</th>
<th>206</th>
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<th>209</th>
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<td>305</td>
<td>6</td>
<td>29</td>
<td>60</td>
<td>1,211</td>
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</tbody>
</table>

• Vehicle Trajectory Data
  ➢ Data from images every 0.1 sec
  ➢ Each data point gives:
    - veh id, time, local/global x & y, veh length & width, veh type, speed, acceleration, lane, origin & destination, intersection/section, direction, movement, preceding & following veh, spacing, headway
IMPLEMENTING THE MODEL

- Object-Oriented Simulation in MATLAB
- Link capacity, crossing time, split ratios, signal timing & vehicle entries from NGSIM
**Simulation Algorithm**

1. **Initialize Network - Set up links**
2. **For Each Link**
   - Add cars based on boundary flows
   - Determine Number of cars to release
     \[
     f^{\text{out}}_l(k) = s_l(k) \cdot \min \left\{ q_l(k), c_l, \min_{\substack{z \in \mathcal{L} \cap \partial_s \setminus \{l\} \ : \ b_{l,z} > 0}} \left\{ \frac{x_z - v_z(k) - q_z(k)}{b_{l,z}} \right\} \right\}
     \]
   - Move cars along transit queue, and from exit to downstream links (or out of sim)
3. **Advance to next time step**
Validated Point-Queue Model with NGSIM based on the following metrics –

- Exit Flows (to verify network was set up properly)
- Vehicle transit times
- Number of vehicles in a link (approximation of queue lengths)
# Results & Discussion

- **Exit Flows**

<table>
<thead>
<tr>
<th>Exit Links</th>
<th>Actual Sum</th>
<th>Vehicle Sum</th>
<th>Error</th>
<th>% corresp</th>
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<tr>
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<td>211</td>
<td>60</td>
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<td>1.000</td>
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</table>

| Simulation With Signal Data | 1211 | 1211 | 0.916 |
RESULTS & DISCUSSION

• Transit Times and Link Occupancy

Best correspondence

<table>
<thead>
<tr>
<th># of Vehicles</th>
<th>Real</th>
<th>Simulation</th>
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<tr>
<td>μ (mean)</td>
<td>59 sec</td>
<td>65 sec</td>
</tr>
<tr>
<td>σ (s. d.)</td>
<td>1.98</td>
<td>1.78</td>
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</table>
RESULTS & DISCUSSION

- Transit Times and Link Occupancy

Worst correspondence

<table>
<thead>
<tr>
<th></th>
<th>Real</th>
<th>Simulation</th>
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<tbody>
<tr>
<td># of Vehicles</td>
<td>41</td>
<td>38</td>
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<tr>
<td>( \mu ) (mean)</td>
<td>42 sec</td>
<td>98 sec</td>
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<tr>
<td>( \sigma ) (s. d.)</td>
<td>1.89</td>
<td>4.59</td>
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RESULTS & DISCUSSION

• Transit Times and Link Occupancy

Leakage on 102 right

<table>
<thead>
<tr>
<th></th>
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<th>Simulation</th>
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<tbody>
<tr>
<td># of Vehicles</td>
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<td>119</td>
</tr>
<tr>
<td>μ (mean)</td>
<td>84 sec</td>
<td>74 sec</td>
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<tr>
<td>σ (s. d.)</td>
<td>2.29</td>
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RESULTS & DISCUSSION

- Transit Times and Link Occupancy

Leakage + No right on red

<table>
<thead>
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<th></th>
<th>Real</th>
<th>Simulation</th>
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<tbody>
<tr>
<td># of Vehicles</td>
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<td>57</td>
</tr>
<tr>
<td>$\mu$ (mean)</td>
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<td>43 sec</td>
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<tr>
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<td>8.79</td>
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Conclusions

• Point Queue Model works well with
  ➢ Straight Traffic Flows
  ➢ Complete Signal Regulated Movement

• Limitations
  ➢ Right turns on red
  ➢ Permissive left turns

• Higher peak values in link occupancies possibly due to the limitations

• Model implementation sensitive to
  ➢ Transit and Queue lengths
  ➢ Split Ratios
ACKNOWLEDGEMENTS

➢ Professor Alexandre M. Bayen
  • For the idea, the class and his cheerful teaching

➢ Leah Anderson
  • For guiding us and answering all our stupid questions

➢ Maxime, Michaella and Ziheng
  • For sharing the fun (and not so fun) times with NGSIM

➢ All our classmates (especially the back bencher French Team)
  • For a laugh riot that the semester was.

Remember the Lewinsky Pool? ➔