Point Queue Model Validation using NGSIM Data

CE 291F/ME 236 Project

Avi Hecht
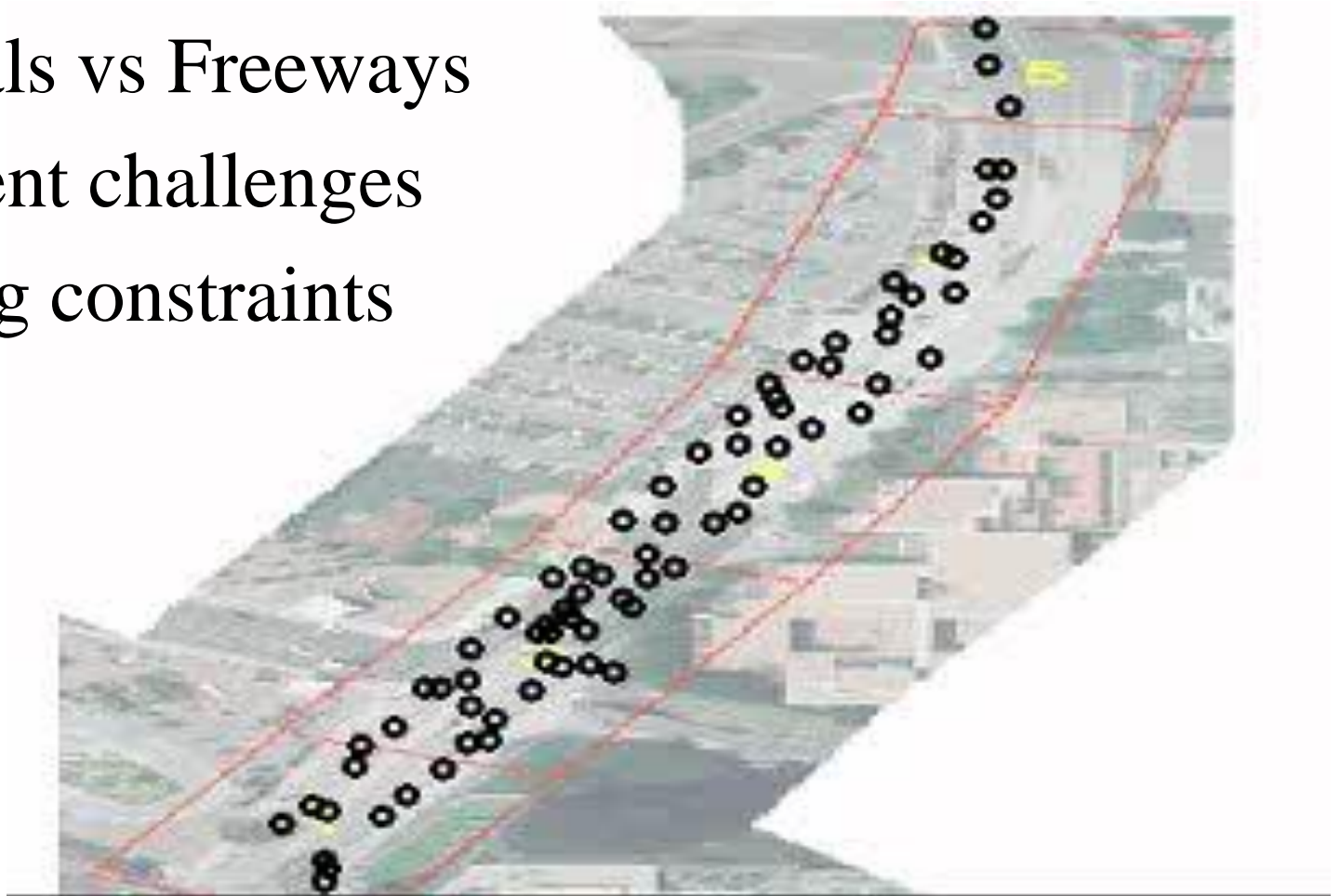
Vishwanath Bulusu

OUTLINE

- Background

- Point Queue Model

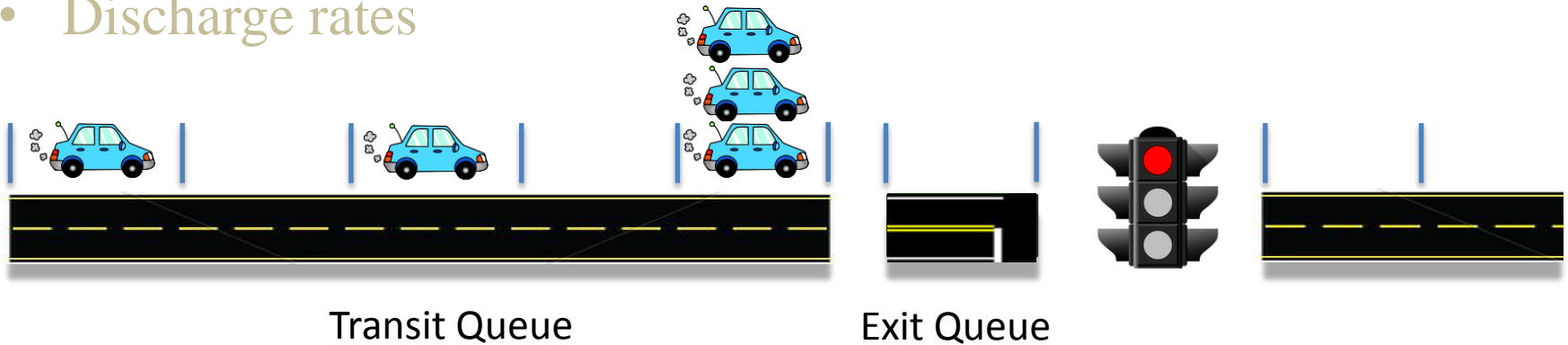- Data

- Simulation

- Results & Discussion

BACKGROUND

- Arterials vs Freeways
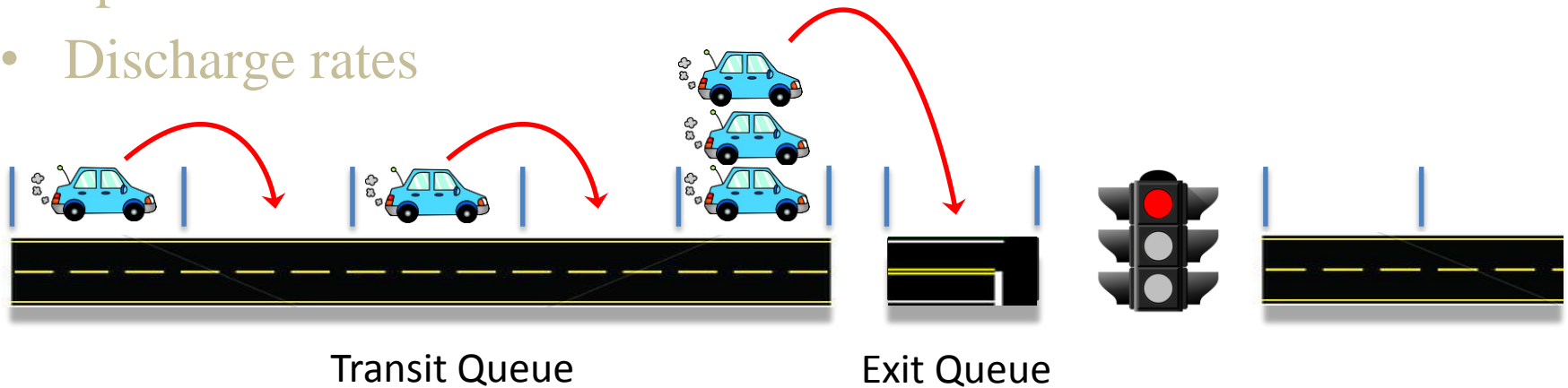- Different challenges
- Varying constraints

POINT QUEUE MODEL

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

Transit Queue   Exit Queue

POINT QUEUE MODEL

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Transit Queue

Exit Queue

Link Length equivalent to Number of bins

Point Queue Model

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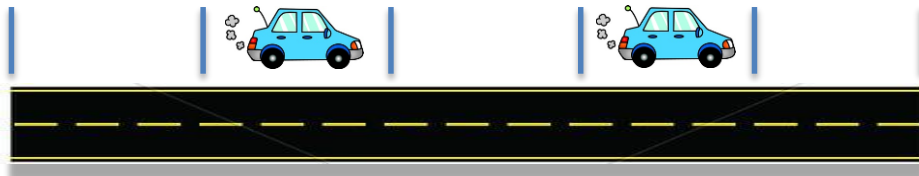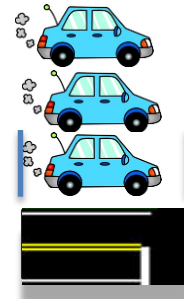- Split Ratios
- Discharge rates

Transit Queue

Exit Queue

POINT QUEUE MODEL

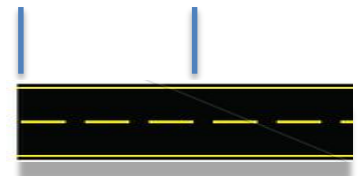- Transit and Exit queues
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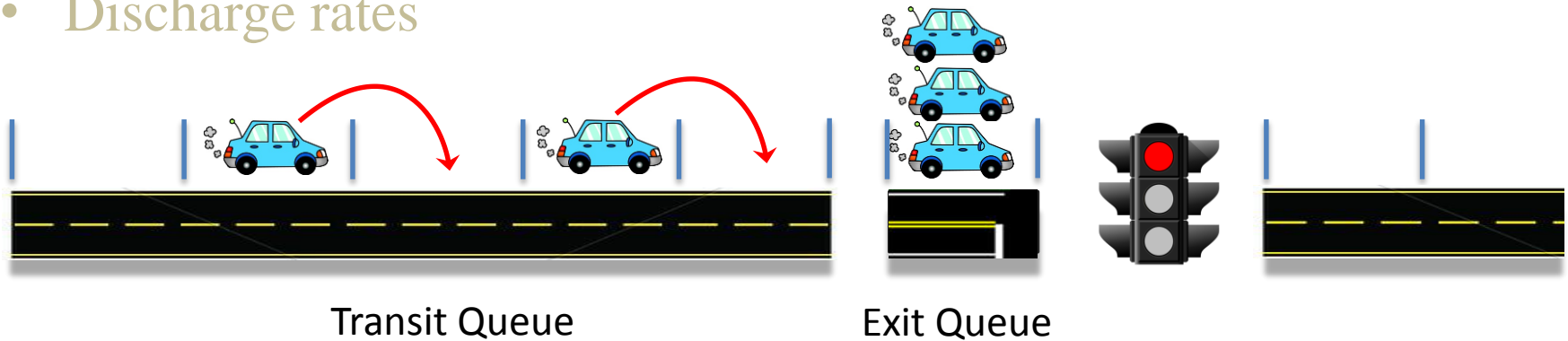- Split Ratios
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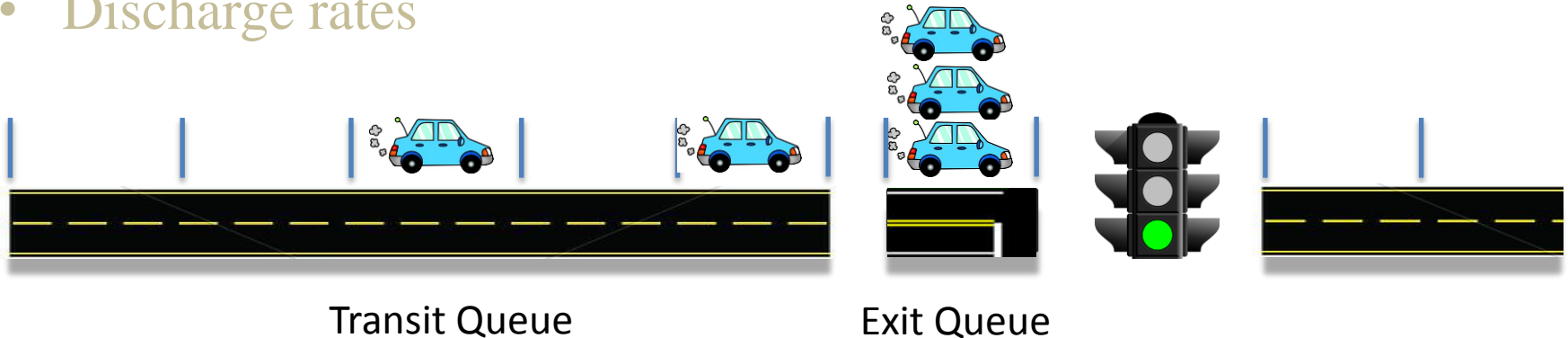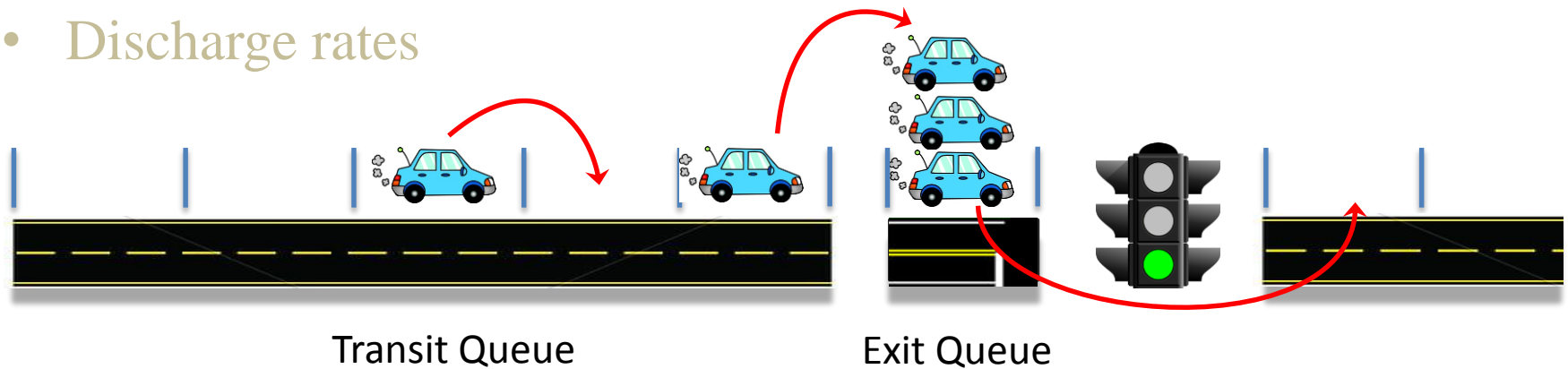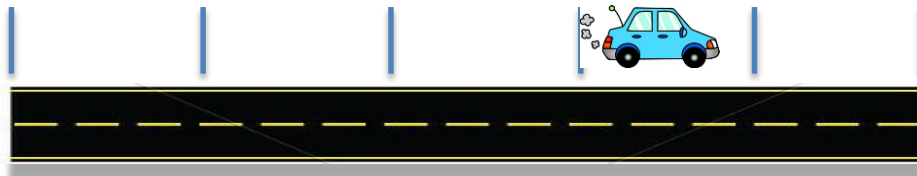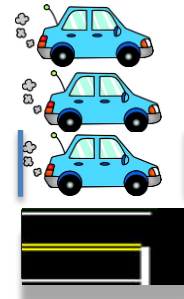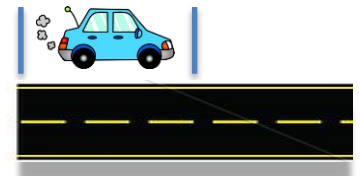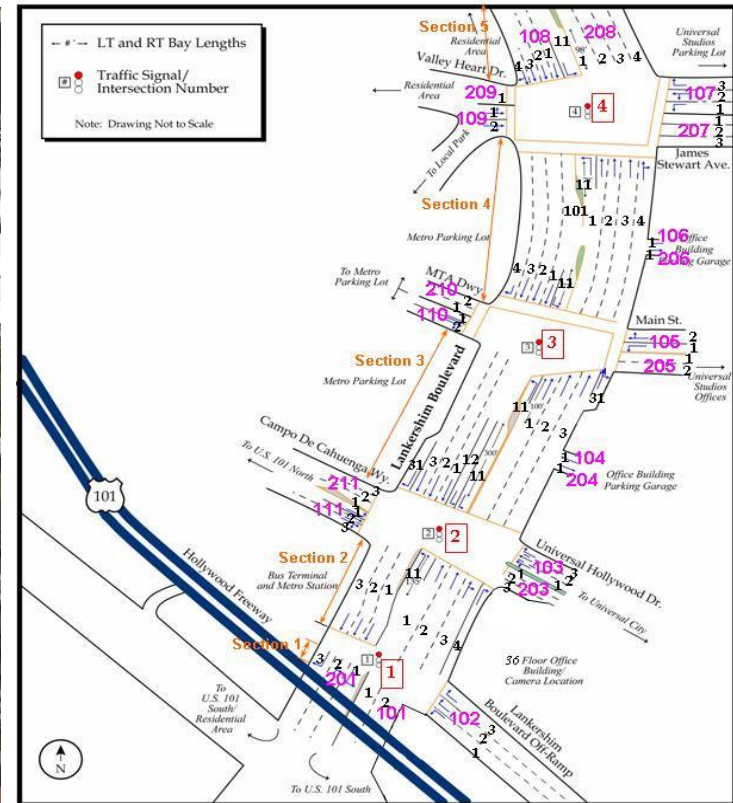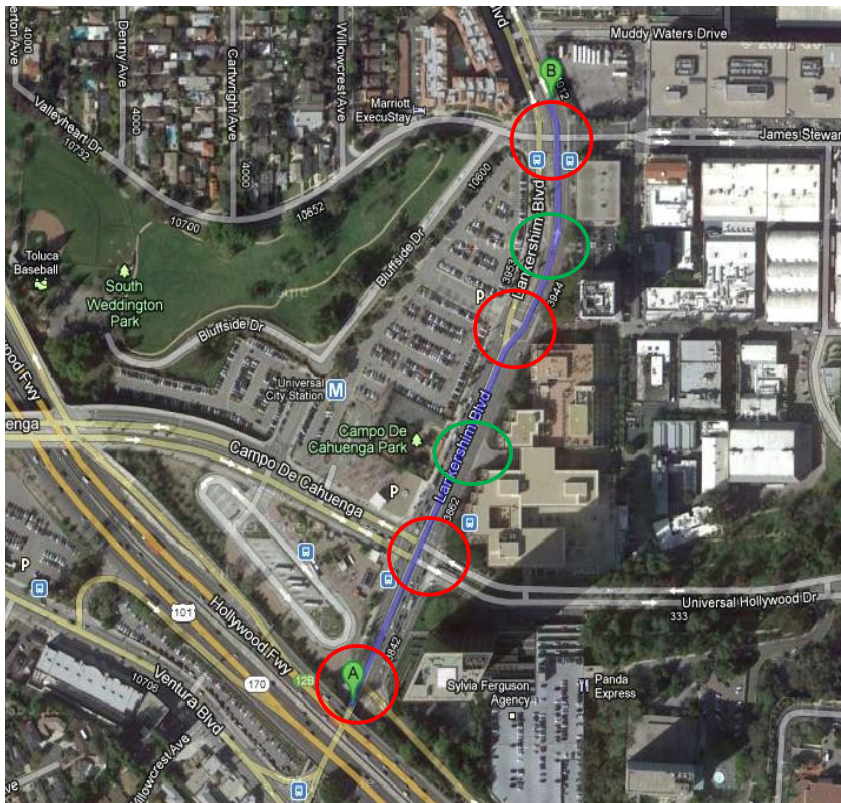
Transit Queue   Exit Queue   Downstream

DATA

- NGSIM background
- Study Area – Lankershim Boulevard (LA)

DATA

- ## Origin-Destination distribution
  - ➢ 11 origins, 10 destinations

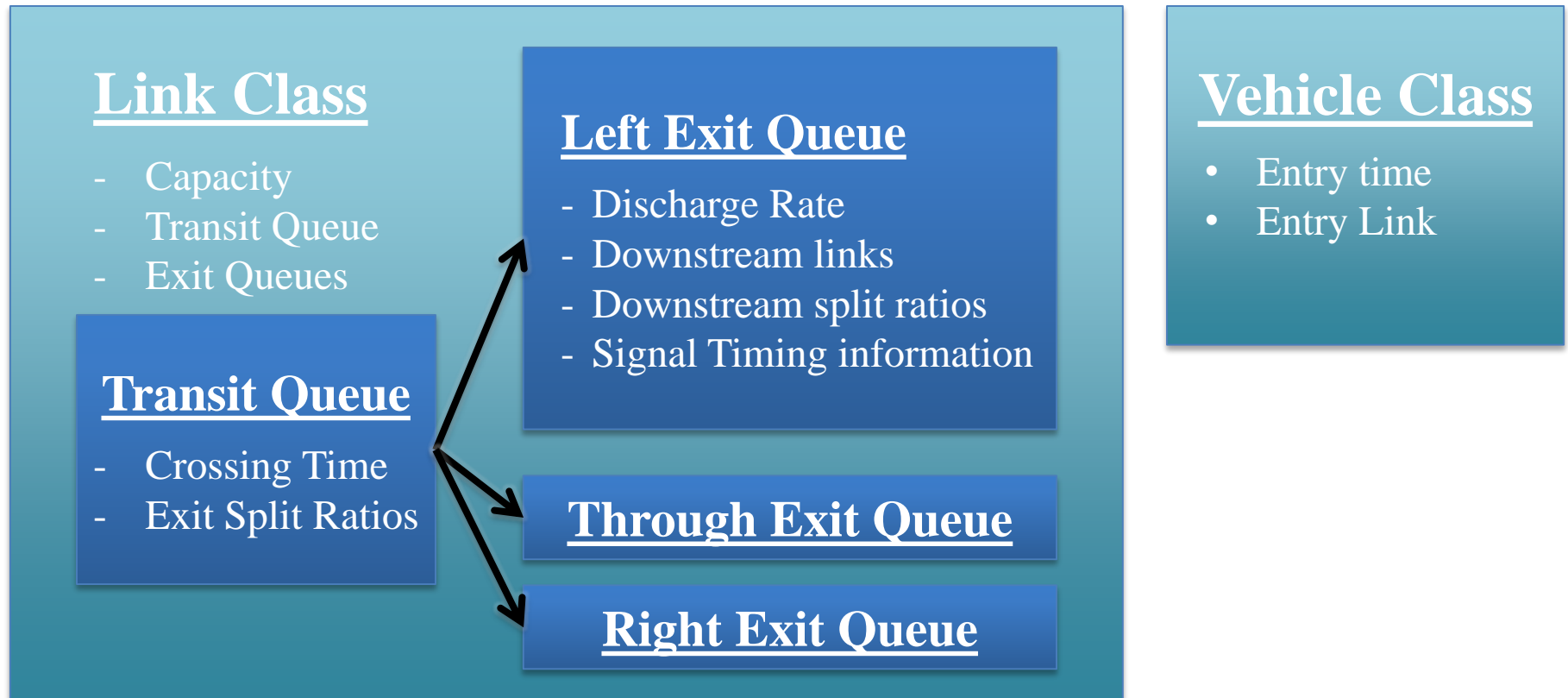| Origin	Destination										Sum
	201	203	204	205	206	207	208	209	210	211	
101	0	54	5	5	1	3	70	2	5	14	159
102	19	41	4	5	0	24	157	2	1	1	254
103	7	0	2	0	0	0	41	0	1	13	64
104	0	1	0	1	0	1	1	0	1	1	6
105	4	2	1	0	1	0	5	0	0	1	14
106	0	1	0	0	0	0	2	0	0	1	4
107	2	1	1	0	0	0	6	1	0	0	11
108	365	150	12	11	3	21	0	1	21	25	609
109	4	0	0	0	0	0	2	0	0	4	10
110	2	1	0	0	0	0	5	0	0	0	8
111	4	35	4	3	0	10	16	0	0	0	72
Sum	407	286	29	25	5	59	305	6	29	60	1,211

- ## 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
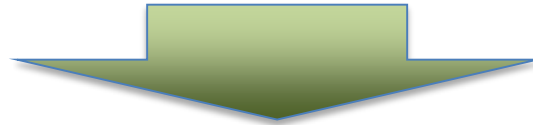
IMPLEMENTING THE MODEL

- Object-Oriented Simulation in MATLAB

- Link capacity, crossing time, split ratios, signal timing & vehicle entries from NGSIM

Link Class

- Capacity
- Transit Queue
- Exit Queues

Transit Queue

- Crossing Time
- Exit Split Ratios

Left Exit Queue

- Discharge Rate
- Downstream links
- Downstream split ratios
- Signal Timing information

Through Exit Queue

Right Exit Queue

Vehicle Class

- Entry time
- Entry Link

SIMULATION ALGORITHM

Initialize Network- Set up links

For Each Link

Add cars based on boundary flows

Determine Number of cars to release

$$f_l^{\text{out}}(k) = s_l(k) \cdot \min\left\{ q_l(k), c_l, \min_{\substack{z \in \mathcal{L}: \\ b_{l,z} > 0}} \left\{ \frac{x_z - v_z(k) - q_z(k)}{b_{l,z}} \right\} \right\}$$

Move cars along transit queue, and from exit to downstream links (or out of sim)

Advance to next time step

RESULTS & DISCUSSION

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)
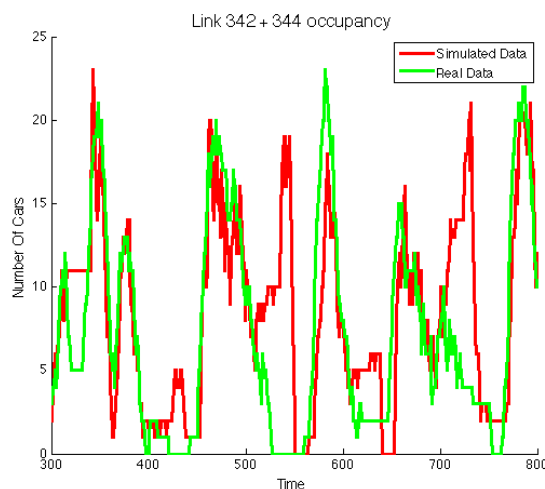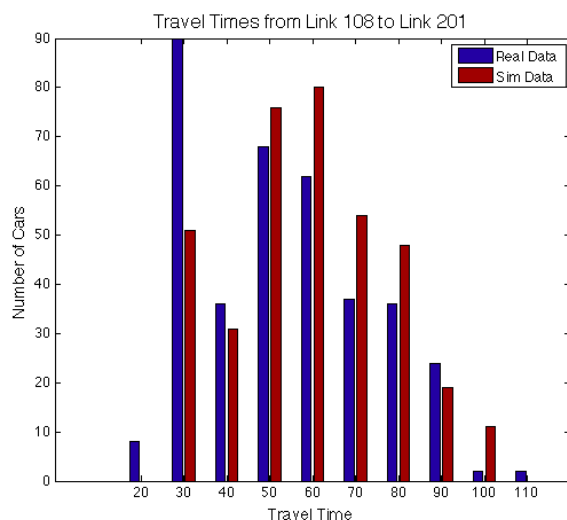
RESULTS & DISCUSSION

- Exit Flows

Exit Links	Actual Sum	Simulation		
		With Signal Data		
		Vehicle Sum	Error	% corresp
201	407	405	2	0.995
203	286	289	-3	0.990
204	29	26	3	0.897
205	25	25	0	1.000
206	5	6	-1	0.800
207	59	55	4	0.932
208	305	311	-6	0.980
209	6	8	-2	0.667
210	29	26	3	0.897
211	60	60	0	1.000
	1211	**1211**		**0.916**

RESULTS & DISCUSSION

- Transit Times and Link Occupancy

  Best correspondence

108 to 201

	Real	Simulation
# of Vehicles	365	370
μ (mean)	59 sec	65 sec
σ (s. d.)	1.98	1.78
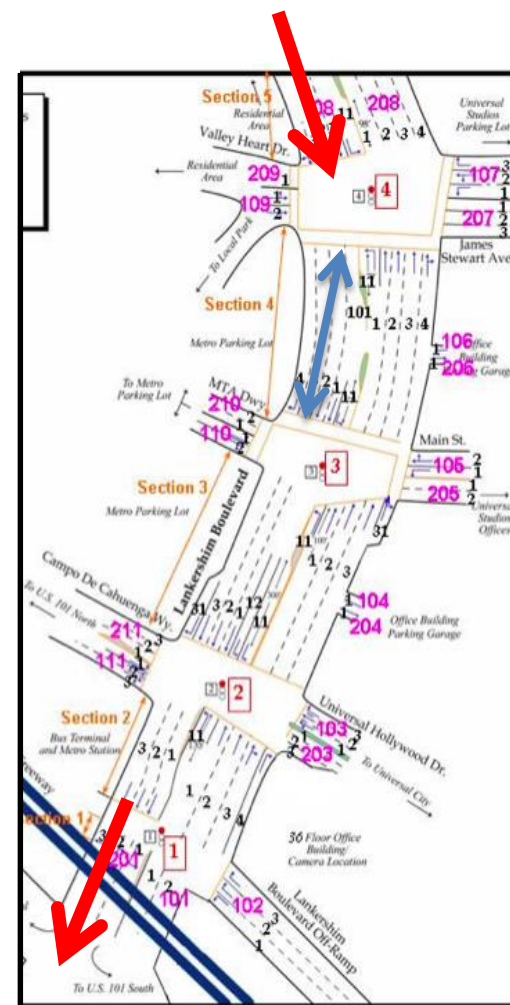
RESULTS & DISCUSSION

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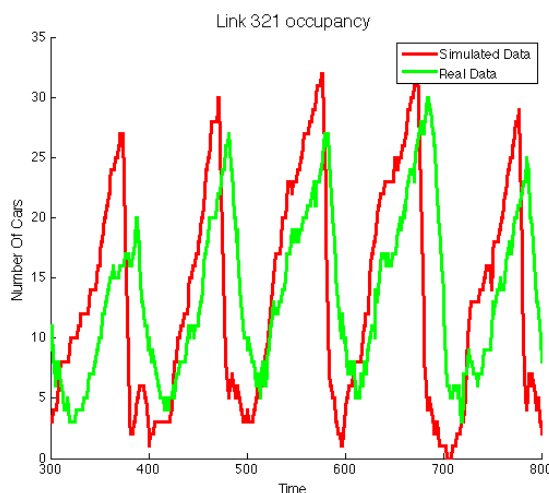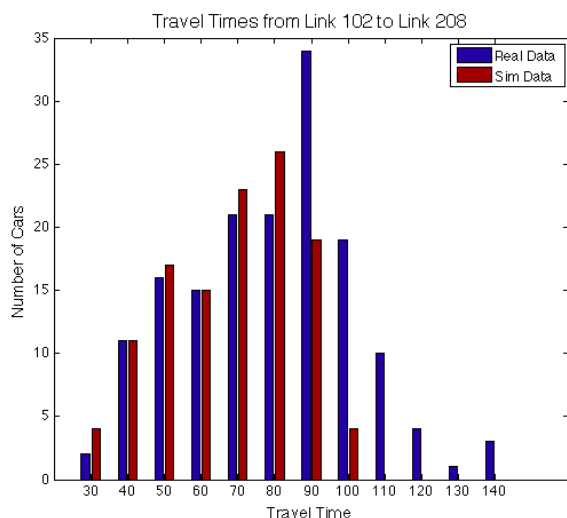
  Worst correspondence

Travel Times from Link 103 to Link 208

Link 331 + 333 occupancy
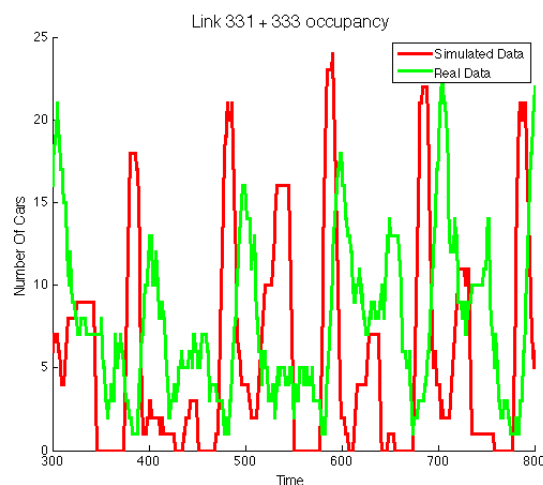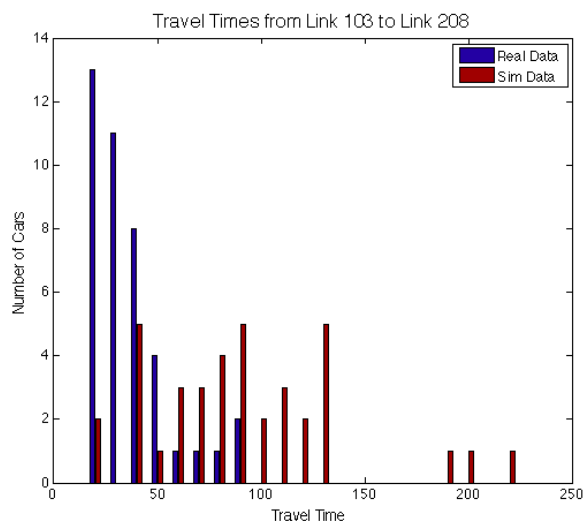
103 to 208

	Real	Simulation
# of Vehicles	41	38
μ (mean)	42 sec	98 sec
σ (s. d.)	1.89	4.59
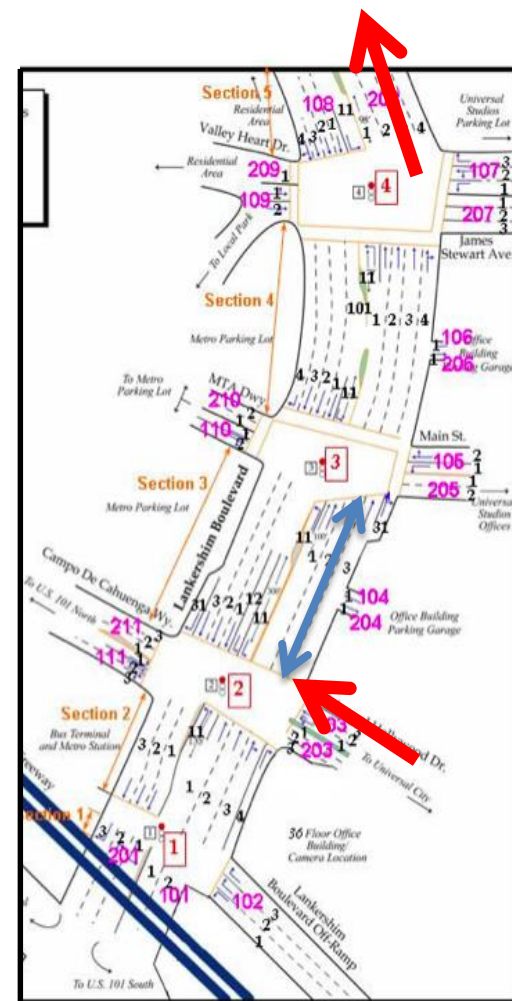
RESULTS & DISCUSSION

- Transit Times and Link Occupancy

  Leakage on 102 right

Travel Times from Link 102 to Link 208

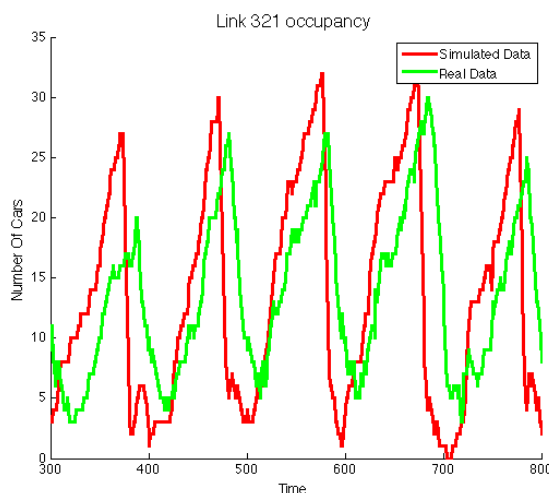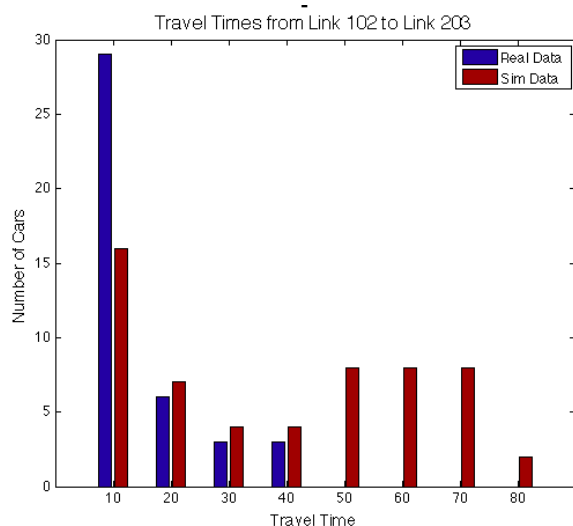
Link 321 occupancy

102 to 208

	Real	Simulation
# of Vehicles	157	119
μ (mean)	84 sec	74 sec
σ (s. d.)	2.29	1.78
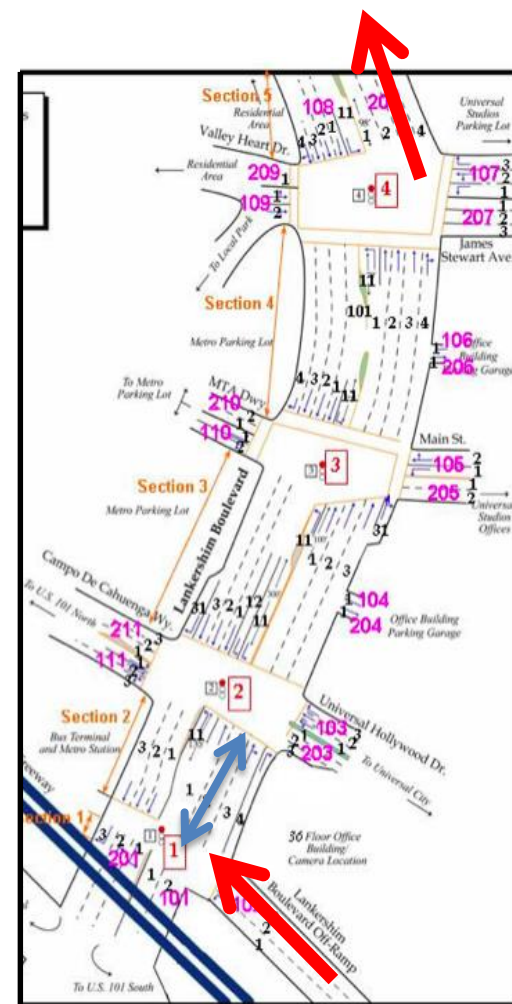
RESULTS & DISCUSSION

- Transit Times and Link Occupancy

  Leakage + No right on red

102 to 203

	Real	Simulation
# of Vehicles	41	57
μ (mean)	20 sec	43 sec
σ (s. d.)	8.79	2.38
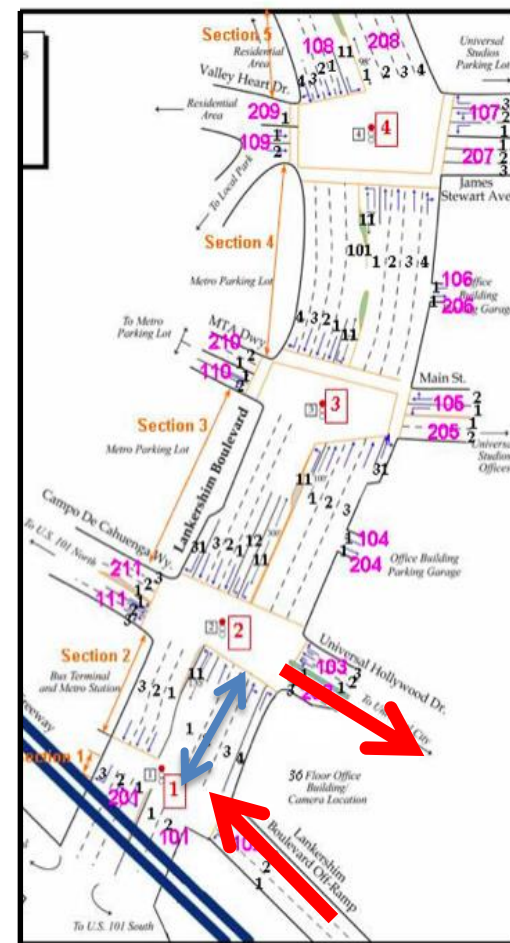
CONCLUSIONS

- 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 ? →