Silence of the Jams

The Effects of Self-Driving Cars on Traffic Patterns in the Puget Sound Region

*Jesse Jenks, *Matthew Moreno, Jordan Fonseca

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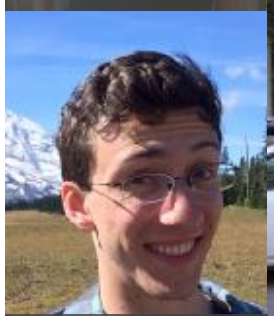
Jesse Jenks ‘18



Jordan Fonseca ‘18

Matthew Moreno ‘17

Uber self-driving car test drive in San Francisco, Oct. 2016, photo by Diablanco

Seattle Traffic at the I-5 and Yesler Way, by Oran Viriyincy

Motivation

- In 2015, Seattle was ranked 7th in the nation for the worst traffic conditions for auto commuters
- 63 hours a year to traffic delays, which are estimated to cost each commuter $1491 per year.
- 62,136,000 gallons of fuel are wasted each year in Seattle due to traffic delays
- net cost of traffic to the city is estimated at more than $3 billion annually [Schrank et al., 2015].

Micro Model: Design

The micro model is a discrete cellular automata model based on work from Nagel and Schrekenberg. Their model used four rules:

- Acceleration If a car can accelerate up to the speed limit without hitting the car in front of it, it will.
- Slowing down If a car will hit the car in front of in in the next time step, it will slow down.
- Randomization Every car has some random probability of slowing down. (Bad driving)
- Motion: Each car moves forward.

Micro Model: Design

Our model modifies Nagel and Schrekenberg's original model.

- Acceleration Self-driving cars can accelerate to be closer to the car in front of it.
- Randomization Self-driving cars have a lower probability of slowing down.

Micro Model: Results

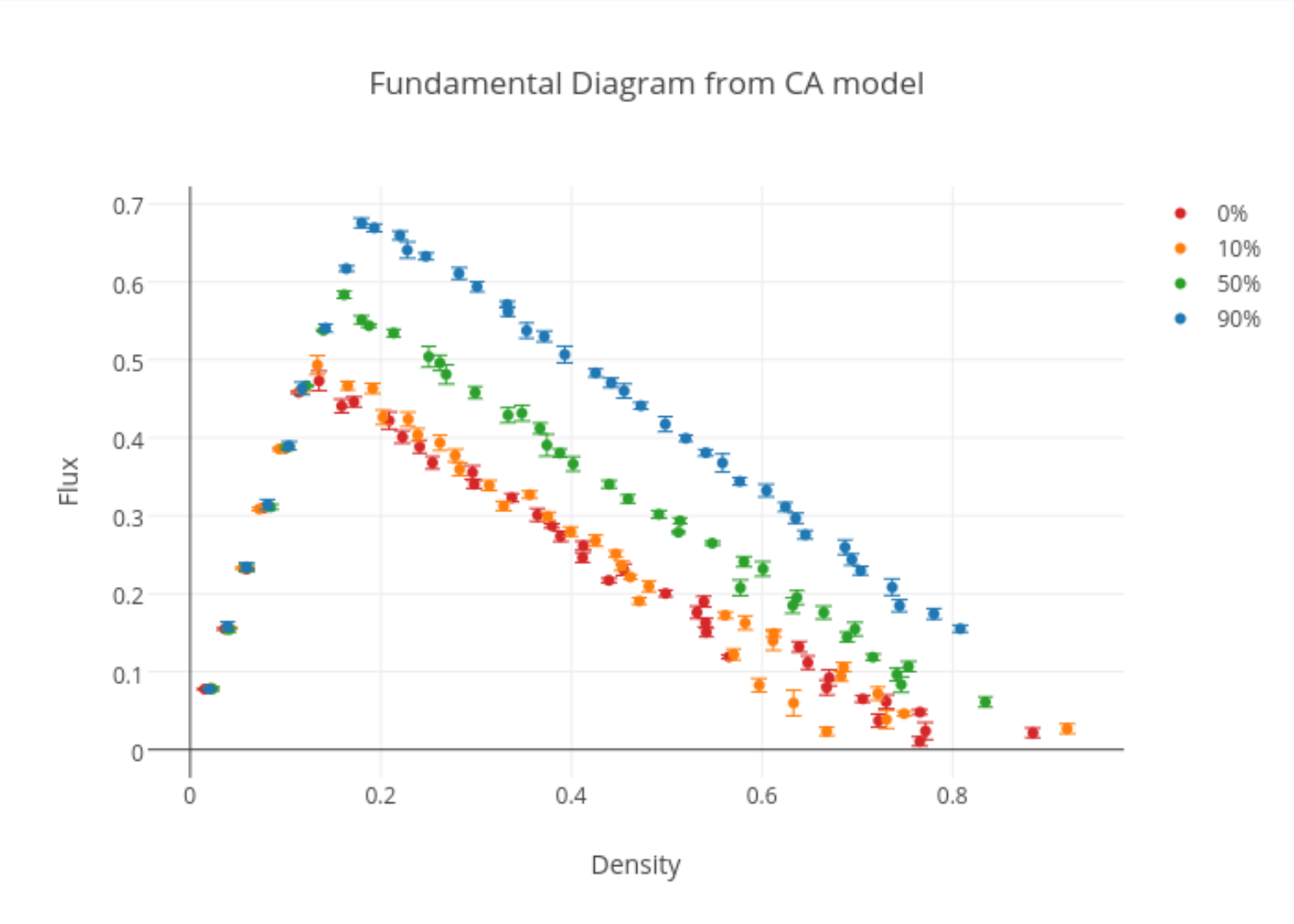


Figure 1: Traffic density versus traffic flux for varied proportions of autonomous vehicles in traffic predicted by the cellular automata model.

Micro Model: Results

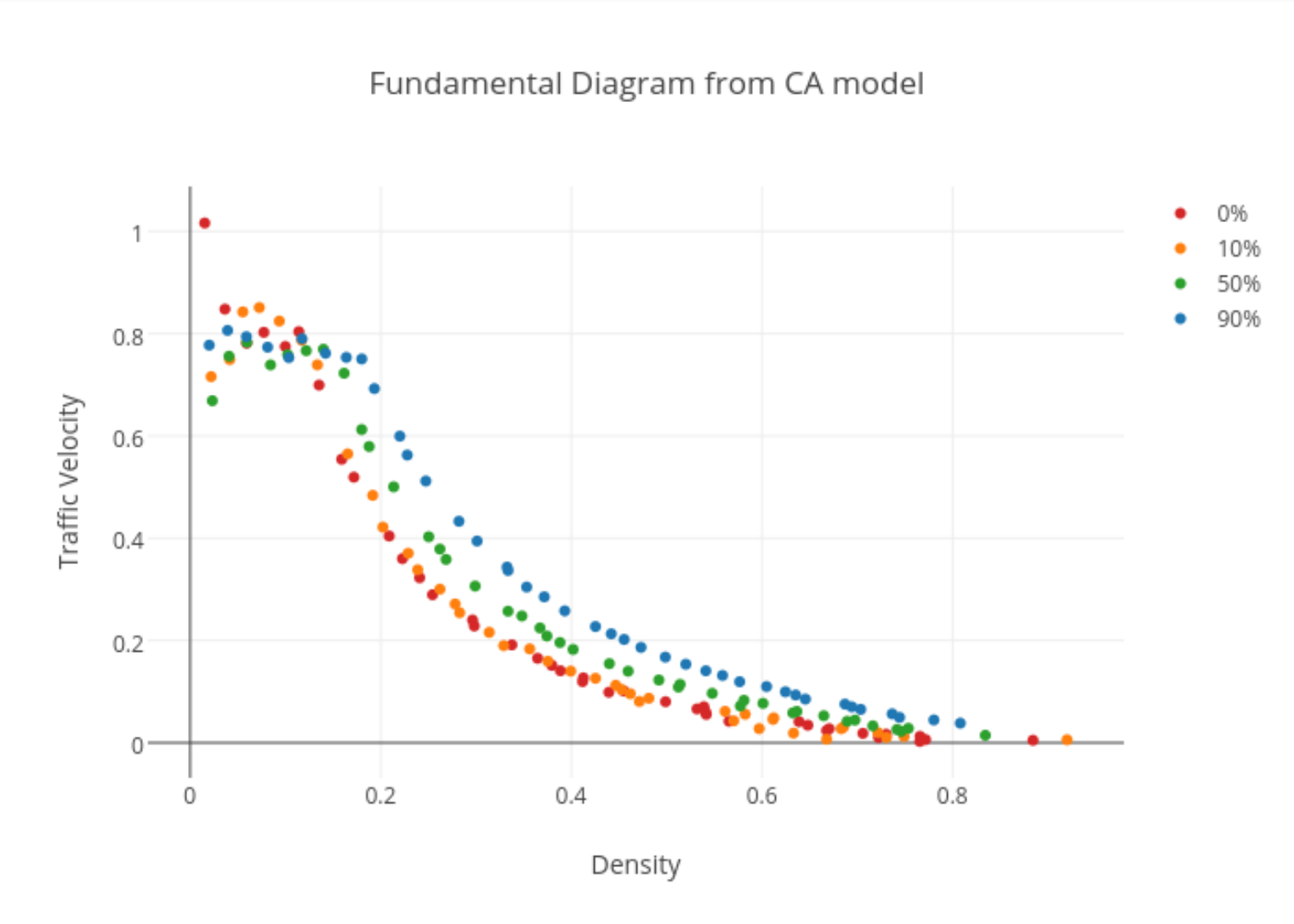


Figure 2: The relationship between traffic density and traffic speed for varied proportions of autonomous vehicles in traffic predicted by the cellular automata model.

Macro Model: Design

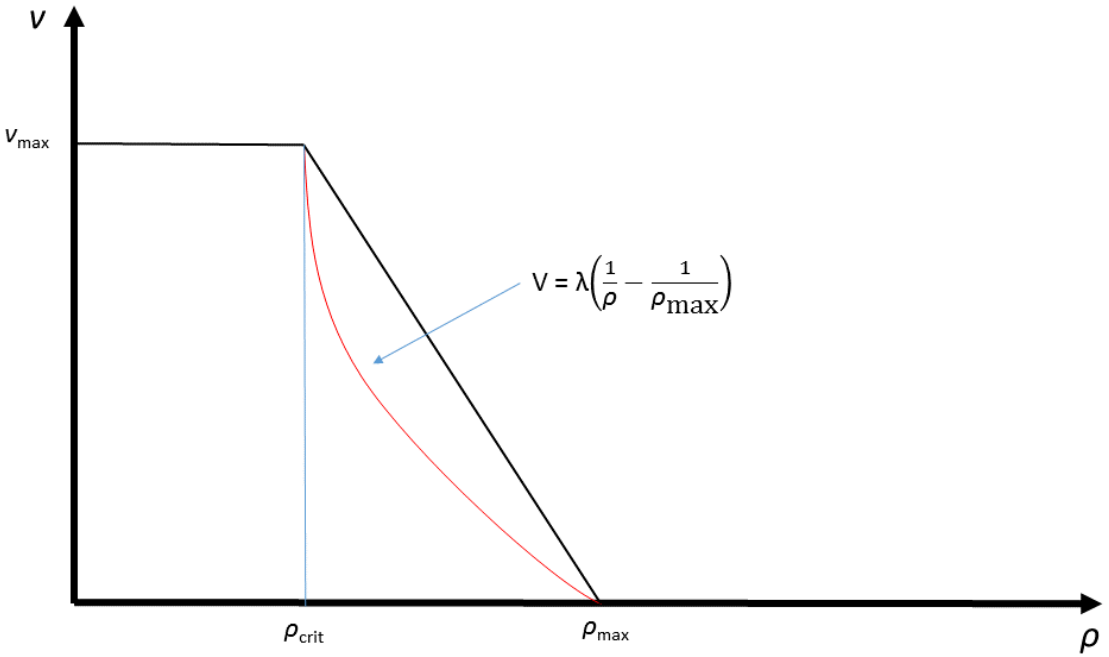


Figure 3: Original (in red, from [Dym, 2004]) and simplified flux curves illustrating speed-density relationship.

Macro Model: Design

We model each direction of travel on each highway as a separate one-dimensional chain of highway segments.

$$\frac{dN_i}{dt} = v_i \times \rho_{i-1} - v_{i+1} \times \rho_i + \Delta C_i - \Delta C_{i+1}$$

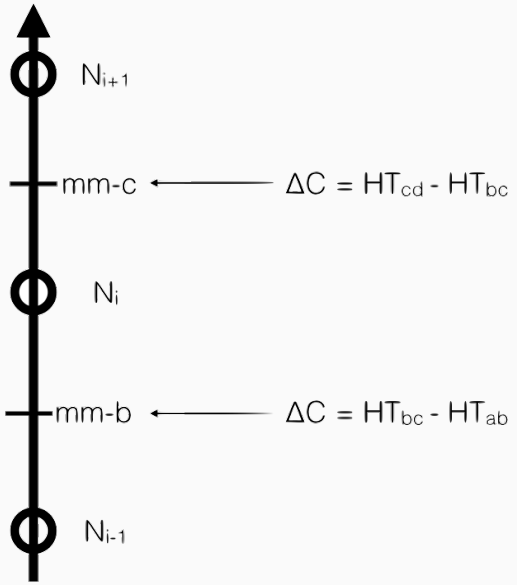


Figure 4: Schematic of *i*th road segment as a circular node.

Policy Recommendations

- self-driving cars $\rightarrow$ less traffic delay
- at best, will only reduce — not eliminate — major traffic delays
- for roads three lanes and wider, designate a lane for the exclusive use of self-driving cars when self-driving cars account for 5% or more of vehicles on the road
- the potential of autonomous vehicles to increase total traffic volume [Org et al., 2014] must be seriously and actively considered by policy makers

Acknowledgements

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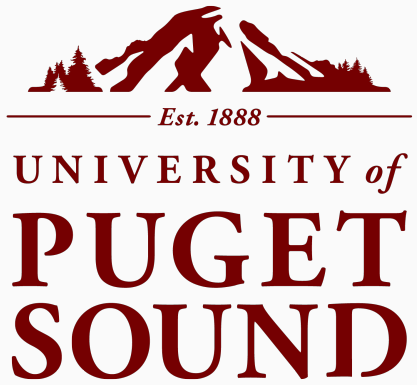

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