AV Demand Simulation

Autonomous Vehicles and Behavioral Modeling

June 27, 2018

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Background

- UC Berkeley: Civil/Environmental Engineering (Transportation Systems), 2018

President (2017-2018)

- Research Assistant at the Institute of Transportation Studies

Project Background

- Modeling the demand of various automated vehicles
- Trying to nudge travelers into shared mobility
    - Environmental, time, socioeconomic benefits
- Pricing vs. Lane Allocation

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Heaven

- All electric
- Shared Fleet (subscription or pay as you go)
- Shared Rides
- Technology will solve many current transportation problems

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Hell

- Maybe electric and efficient
- Not shared
- Behavioral change → Huge increases in VMT (as much as 70% potentially)
- Curb access stressed
- Streets are safe but not desirable

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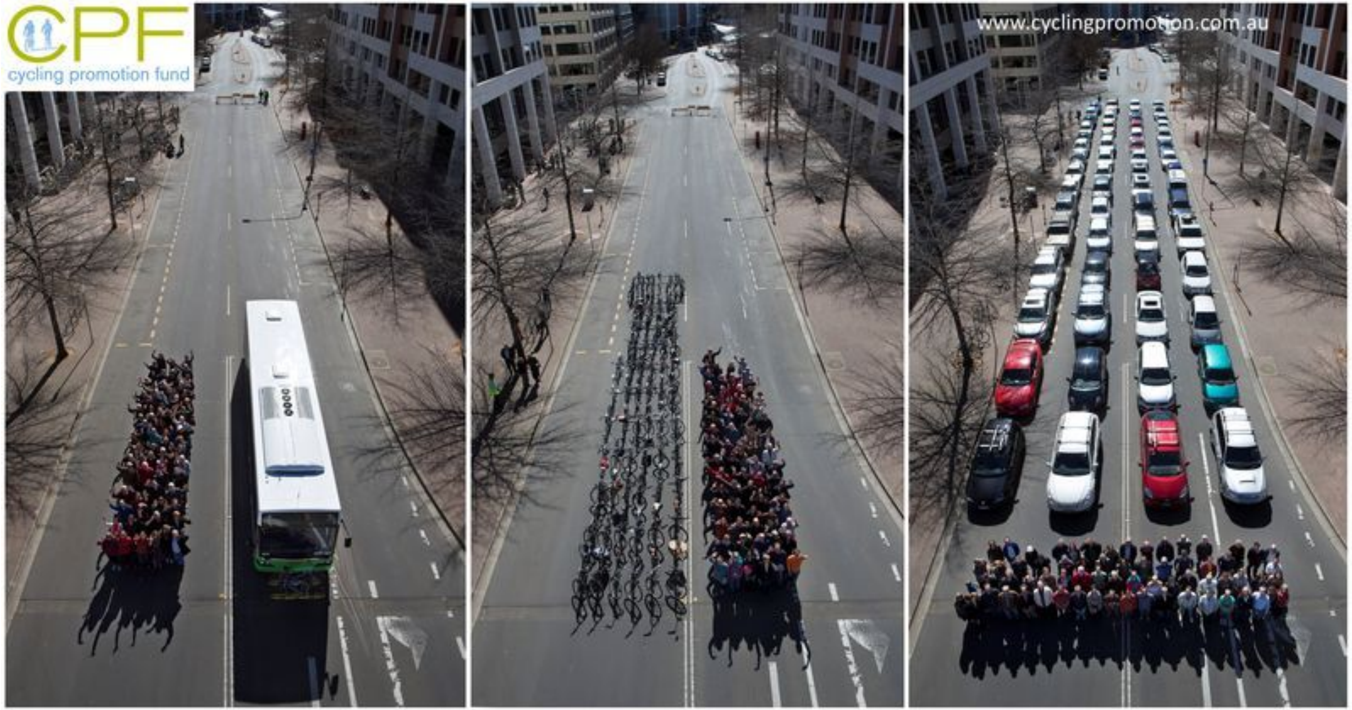
Will AVs really solve this?



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Set Up

- 10 mile freeway stretch, 5 lanes
- 3 modes of transportation:
  - Private AV (Personal Auto)
  - Shared AV (Uber/Lyft)
  - Shared Ride AV (Uber Pool/Lyft Line)
- 3 cases to study:
  - Base (all mixed flow, no pricing)
  - Pricing
  - Lane allocation

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Simulation

- Simulate the demand for each mode of transportation using a Logit Model
- Simulate travel time using Bureau of Public Roads (BPR) formula
- All other inputs are derived from previous studies/estimated by us

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Logit Model

- Calculate the utility of each mode using a variety of inputs

$$V_{SAV} = ASC_{SAV} + \beta_{cost} \times Cost_{SAV} + \beta_{TT} \times TT_{SAV}$$

- Use Logit Equation to predict probability

probability of mode i

utility of mode i

$$\Pr(i) = \frac{\exp(V_i)}{\sum_{j=1}^{J} \exp(V_j)}$$

sum of J modes (j=1,2,3...J)

utility of mode j

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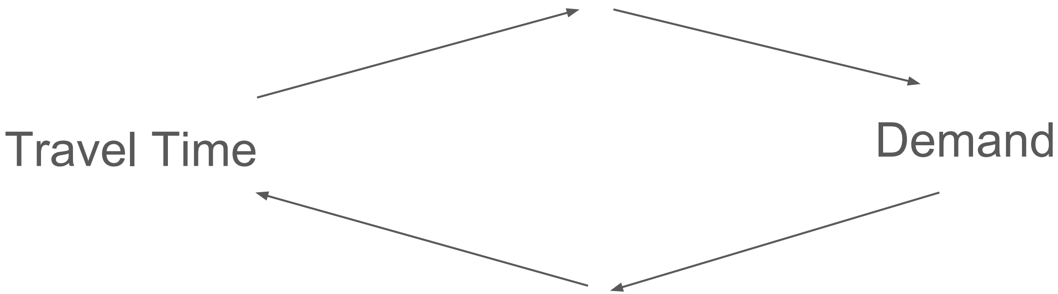
BPR Formula for travel time

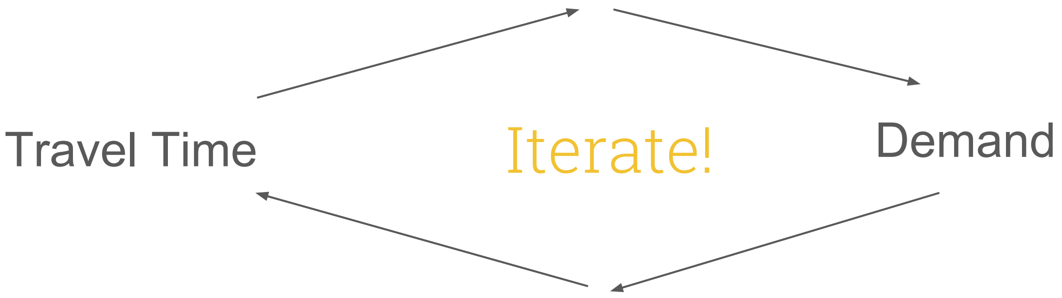
- Use ratio of demand/capacity to calculate the travel time

$$TT = FF \times (1 + \alpha c^{\beta})$$

Dependency



Iterate



Iteration Process

1. Ignoring travel time, calculate initial demand estimates

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Iteration Process

1. Ignoring travel time, calculate initial demand estimates
2. Then calculate travel times

Iteration Process

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2. Then calculate travel times
3. Calculate new demands

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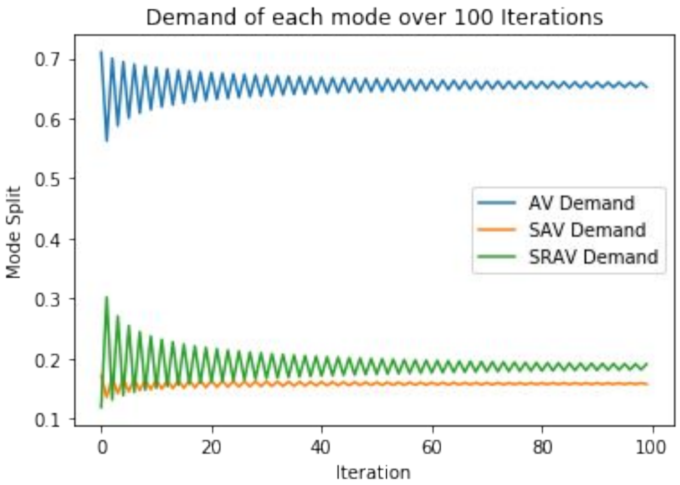

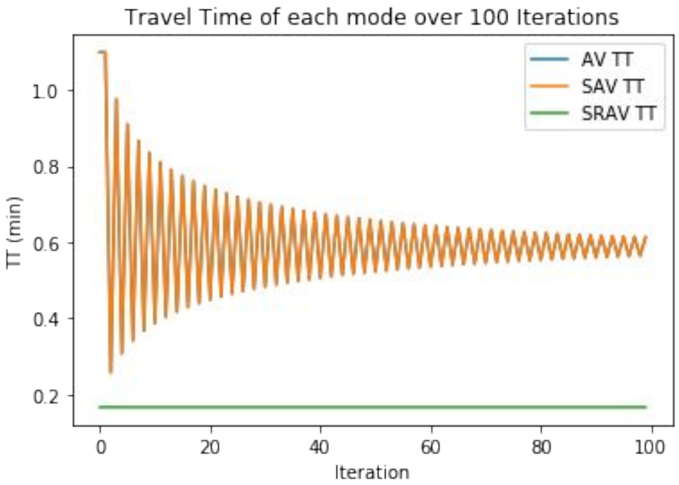

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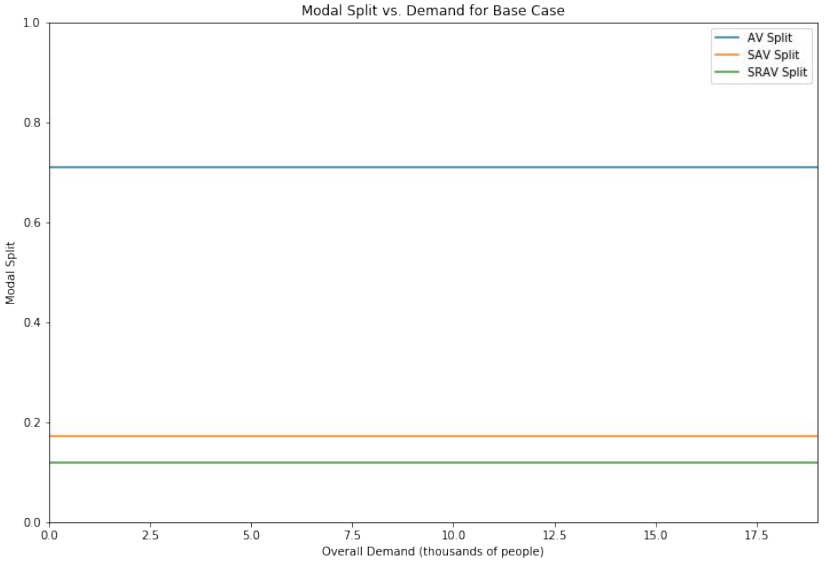
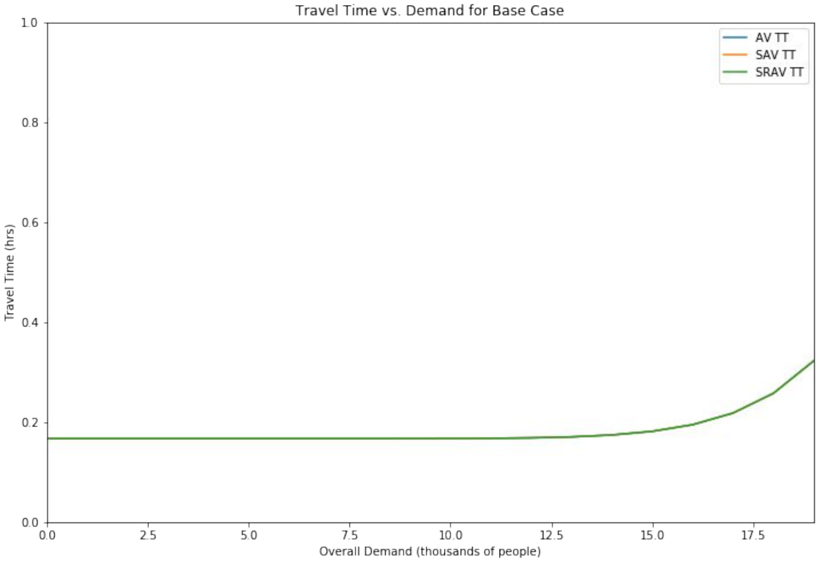
Results: Base Case





Mode shares are constant, demand is irrelevant

Uniform travel time, starts to increase as system is stressed

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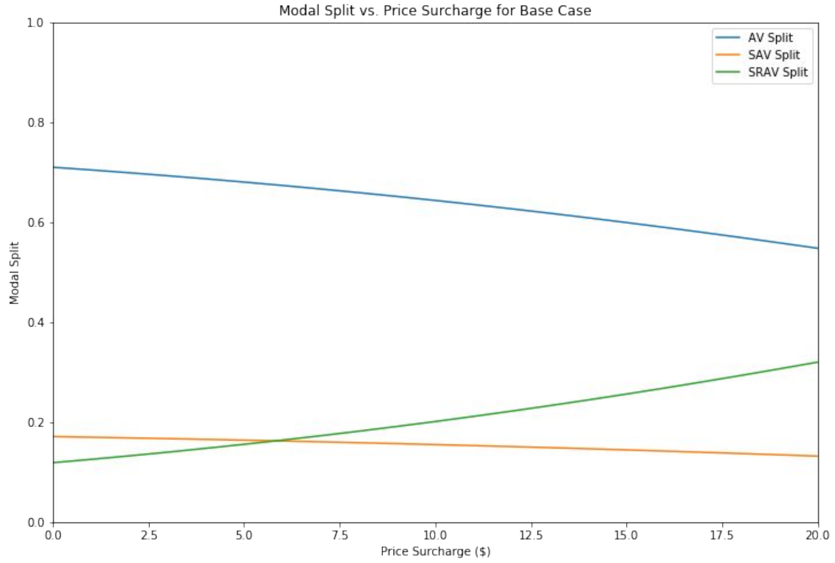
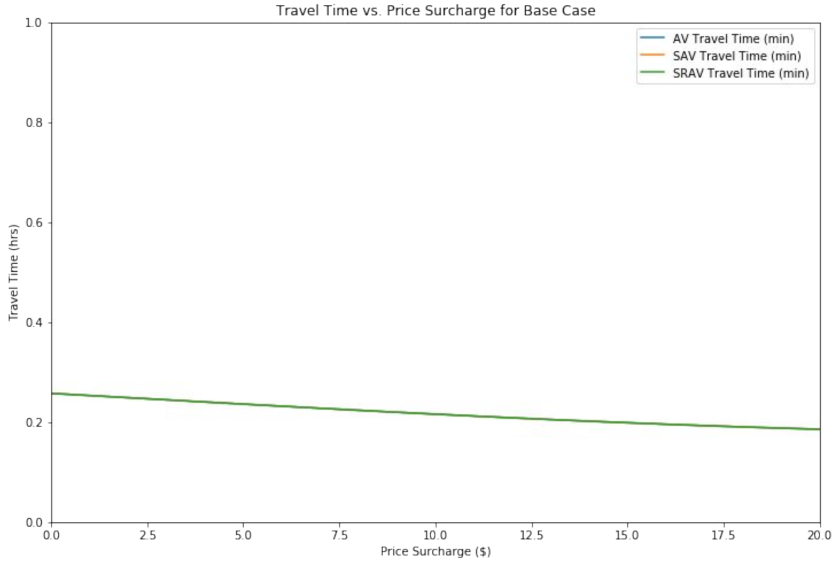
Results: Price Surcharge





Shared increases with price surcharge, others decrease

Overall travel time savings for all modes

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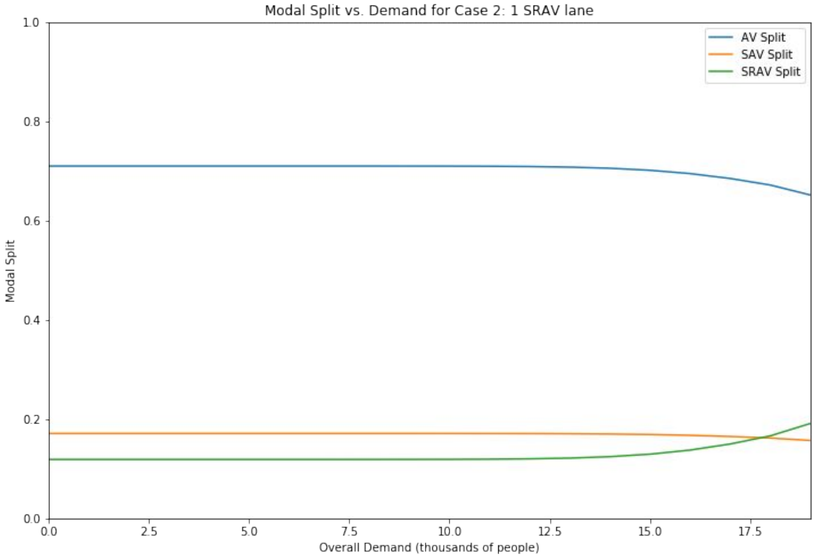
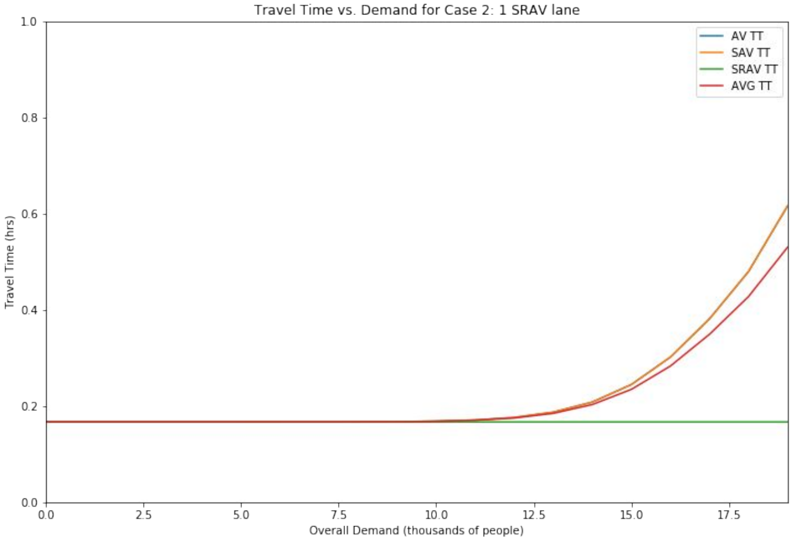
Results: Lane Allocation





Low Demand: no difference from base
High Demand: mode shift to shared

As demand increases, low occupancy travel time increases

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Limitations & Areas for Improvement

- Any number of lane allocation and pricing schemes could be modeled
- Greater accuracy in input parameters is needed
- Induced demand
- Want to model even higher stress points for longer travel times

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Conclusions

71% (AV), 17% (SAV), 12% (AV) → 65% (AV), 16% (SAV) and 19% (SRAV)

Equivalence point between high occupancy lane and pricing appears to be a $9/person fee, for the given conditions

Pricing will work at low demand, lane works when system approaches capacity

Lane allocation will penalize low occupancy with travel delays, surcharge produces travel time savings for all

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