Background & Motivation

Benefits of AVs (vs. HVs [human-driven vehicles]):

- Safety
  - Fewer crashes
  - Less severe crashes
- Mobility
  - Easier travel
  - Mobility for non-drivers
  - Vehicle-sharing & ride-sharing can lower costs
- Sustainability
  - Possibly lower emissions
  - Possibly lower congestion & greater travel time reliability

Car-Sharing (SAVs)

- SAVs allow users to obtain AV benefits without all the costs & responsibilities of AV ownership.
- Car-sharing is now common in many US & world cities.
- SAVs reduce the access hurdles of traditional (human-operated) shared vehicles (shared HVs).

Case Study Site & Key Assumptions

Traffic Analysis Zones (n = 2102 zones)

Population (n = 2.3 M travelers)

Realistic Home locations (n = 0.9 M homes)

Model Choice

The utility function for using a HV is:

\[ U_{HV} = -0.2 \times Distance - 17.67 \times IVTT \]

The utility function for using a bus is:

\[ U_{Bus} = -2 + 0.84 \times IVTT_{Bus} - 35.34 \times (IVTT_{Bus} - IVTT_{HV}) \]

The utility function for using an AV is:

\[ U_{AV} = \text{Fixed Cost} - \text{Fare} \times Distance - 0.84 \times IVTT - 35.34 \times (IVTT_{AV} - IVTT_{HV}) \]

\[ IVTT_{AV} = \text{Mode-specific utility (fVTT = AV travel time (based on HV trips); IVT}_{AV} = \text{1.5 AV travel time; SAV trips' cost} = \text{$1 per ride + $0.20, $0.50, $0.75, $1 per mile.} \]

SAV Mode Splits:

- $0.20 per mile → 36.6% of trips
- $0.50 per mile → 12.1% of trips
- $0.75 per mile → 8.0% of trips
- $1 per mile → 6.4% of trips

Served Requests include:

- on-time service (waiting = 0 ~ 5 minutes)
- late service (waiting = 5 ~ 10 minutes).

Mode Choice Results

- 4 SAV fare scenarios = $0.20, $0.50, $0.75 & $1 per mile plus $1 per trip
- Choice between HV, Bus & SAV
  - for travelers with HVs
- Choice between Bus & SAV
  - for travelers without HVs

Final Thoughts & Emissions Estimates

Who is selecting SAVs?

- Low-per-mile rates → longer-distance trips
- High rates → shorter-distance trips
- Transit use falls in this setting.

How do SAVs serve requests?

- Long-distance travelers → low HV replacement rate
- Short-distance requests → high HV replacement rate
- Dense request → high HV replacement rate

Final thoughts:

- SAVs serve more short trips in $0.50/mi scenario, vs. $0.20/mi scenario, & trip request density/demand is higher, vs. $0.75+ scenario.
- Essentially, SAV systems are more efficient for denser, shorter-distance trip request settings.

Sustainability

Benefits of AVs (vs. HVs [human-driven vehicles]):

- Safety
  - Increased safety
  - No pedestrian deaths
  - No fatalities

- Mobility
  - Easier travel
  - Mobility for non-drivers
  - Vehicle-sharing & ride-sharing can lower costs
  - Possibly lower congestion & greater travel time reliability

- Sustainability
  - Possibly lower emissions
  - Possibly lower congestion & greater travel time reliability

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