# Vehicle Management, AVO, and Fleet Size of 5-passenger aTaxis

ORF 467

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# Overview

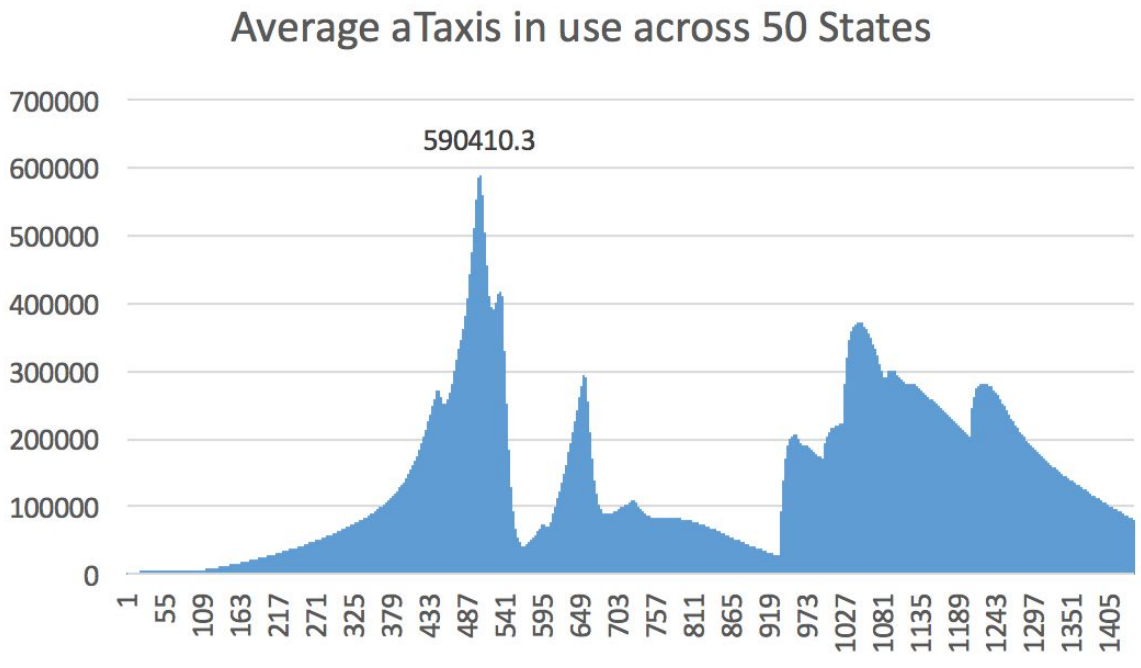
- We looked at **five-passenger** aTaxis using nationwide trips between two and two hundred miles
- Using Bill Van Cleve and Tianay Zeigler's trip files, we analyzed supply and demand in each state and nationwide which allowed us to:
  - Look at fleet-size requirements and Average Vehicle Occupancy (AVO) nationwide
  - Compare repositioning strategies to reduce fleet size and maximize number of trips per aTaxis per day

# ATaxis in Motion

- Our goal was to find the necessary fleet size to satisfy the nationwide demand for trips between two and two-hundred miles
- To analyze the trip files generated by Bill Van Cleave and Tianay Zeigler, we wrote an aTaxiCounter.m file. The code initializes a function called ‘countThoseTaxis()’ that counts the number of taxis arriving at and departing from each pixel
- At any given minute if a taxi is leaving a pixel, it is added to the count of aTaxis in motion. If it is arriving at a pixel it is taken out of the count. This gives us the total number of taxis in motion nationwide at any given time.

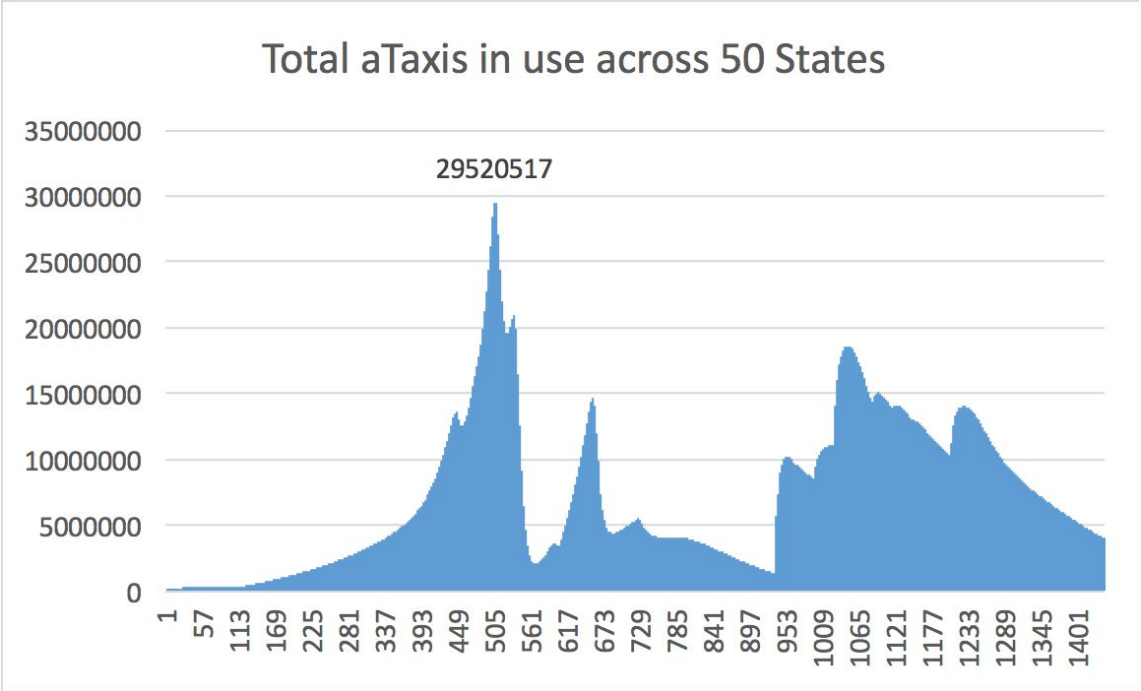
# Average aTaxis in Motion Nationwide

- We can see the peak throughout the day is 590,410 at the 504th minute (a little before 8:30am)
- There are peaks around 11:00am, 5:30pm, and 8:15pm



# Aggregate National aTaxi Motion

- The peak, at around 8:30am, is 29,520,517 aTaxis across the 50 states
- Same peaks as average motion data
- This represents the minimum fleet size needed (with no repositioning)



# Fleet Size and AVO

- Using this data, for five-passenger taxis with trips between two and two-hundred miles our results show:

| | |
|---|---|
| Minimum Fleet Size Requirement | 29,520,517 |
| Average Vehicle Occupancy | 1.63 |

- Looking at the AVO for this trip criteria, it is slightly higher than the current national average and lower than the 1.72 AVO for infinite aTaxi capacity.

# Potential Repositioning Strategies

- System-wide, one time repositioning
- Hourly repositioning
- Individual repositioning throughout the day
- Demand-centric real-time close radius pickup

➔ In each strategy we would like to compare approaches by looking for data on what percentage of the fleet is moving and repositioning at any given time, the required fleet size, number of average trips per aTaxi per day, and utilization during peak morning commute

# System-wide Repositioning

- ATaxis are repositioned at one time of day and this repositioning seeks to fill expected expected demand at another time during the day
- Repositioning is done at the hour of lowest expected demand (on a national scale this is around midnight) to satisfy demand at the morning peak (around 8:00am)
- Modeled as a network flow problem: in each pixel we subtract the number of aTaxis in each pixel at the repositioning hour from the expected hour we want to satisfy demand
    - If positive, this gives us the number of aTaxis that need to be repositioned to this pixel
    - If negative, this is the number of excess aTaxis at a given pixel
    - If zero, our expected demand for that pixel is satisfied and no repositioning is necessary
- This gives us supply and demand nodes and each arc has an associated cost (1.2 times the Cartesian distance)

# Hourly Repositioning

- Similar to the prior strategy but repositions at every hour of the day
- The goal of this strategy is to deal with imbalance throughout the day instead of it cummulating at the end of the day as in the system-wide one time repostioning strategy
- At each hour, we calculate the expected demand imbalance for each pixel (as in the system-wide repositioning)
- This gives us a higher percentage of aTaxis in motion at any given time, a higher number of trips per aTaxi per day, and a smaller fleet size

# Individual Repositioning

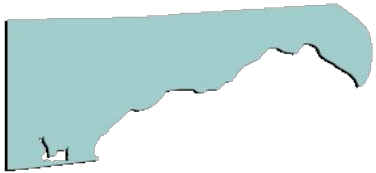
- This strategy repositions throughout the day
- Unoccupied aTaxis reposition themselves if their drop off location has low expected demand
- Each pixel is assigned a value: the number of expected arrivals - the expected number of aTaxis already there - the distance between the pixels
    - This shows us how many aTaxis are needed/are excess in each pixel and takes into consideration distance so aTaxis are not being repositioned to far distances
- This strategy gives us a much lower expected fleet size than the system-wide repositioning, given that aTaxis are reused many times during the day

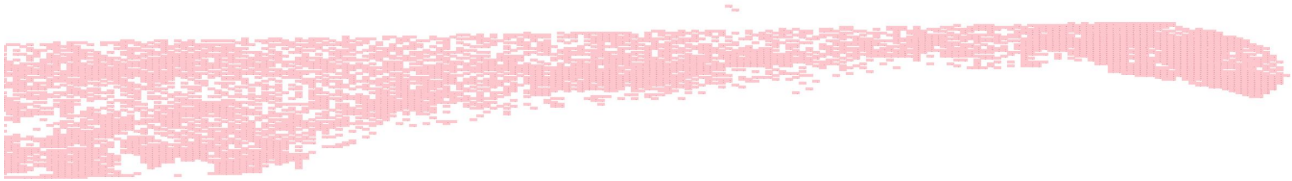
# Demand-centric close radius pickup

- Rather than generating a new aTaxi when demand is not being serviced, this strategy searches for available taxis within a close radius (say, within 30 closets pixels)
- This is demand-centric in that it looks at individual demand instead of looking at the system as a whole
- This will reduce the fleet size but increase passenger wait time

# ATaxi Supply and Demand

- Our algorithm developed a snapshot of the total demand for each pixel in each state
- This allowed us to establish a maximum fleet size with no repositioning
- For example, a summary of the total aTaxi demand for the state of Delaware:

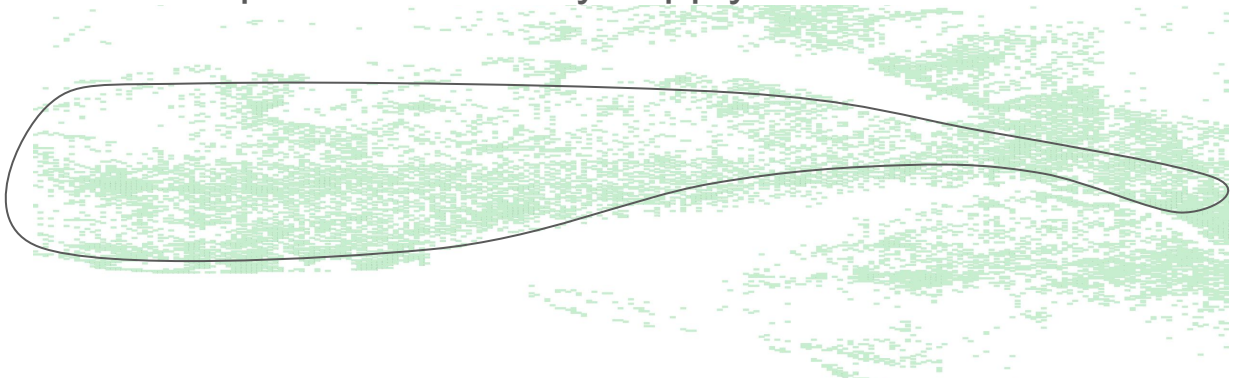




- Every colored pixel in the above array represents a pixel that requires a certain number of aTaxis at the beginning of the day. For Delaware, the maximum fleet size is 279,405.

# ATaxi Supply

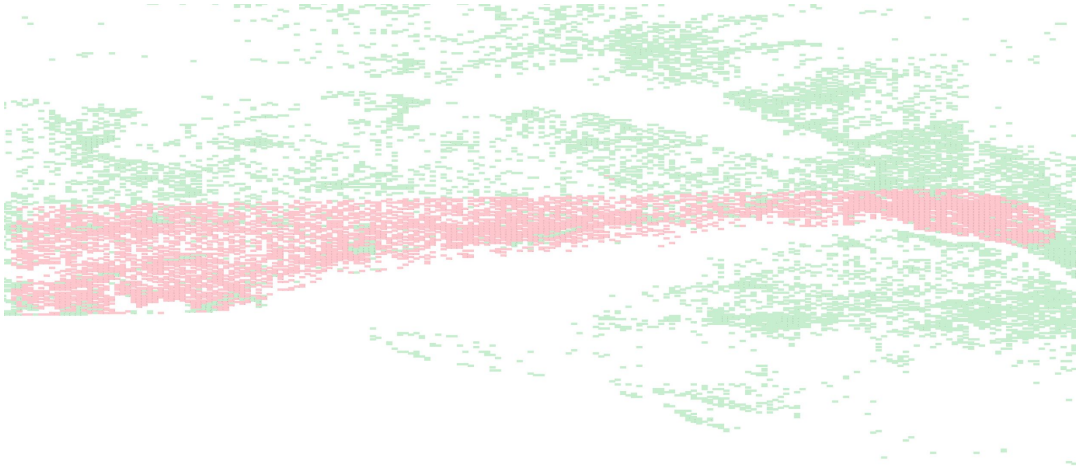
- Our algorithm also developed a picture of aTaxi supply for the end of the day, which was useful for our initial attempt at vehicle management which consisted of a one-time overnight system-repositioning
- Below is an example of end-of-day supply for the state of Delaware:



- Here we can see that the supply at the end of the day is scattered across a greater area than our demand covered because our aTaxi trips were not restricted to the boundaries of Delaware.

# Supply and Demand Difference

- The green pixels show the supply and the red pixels show the demand for the state of Delaware.
- Our initial vehicle management strategy (one-time system-wide repositioning) requires that aTaxis at the green pixels be repositioned to the red:



# State-by-State Repositioning

- We decided that this strategy did not fit our needs mainly because of the inability to deal with more than one state at a time.
- This is problematic for nationwide repositioning strategies due to the fact that there is clearly interstate aTaxi movement.
- We would have to enable the trip files and the code to capture the dynamics of interstate motion in an array that is populated across a 24-hour period but over all 50 states. This would allow us to more realistically consider a mass overnight repositioning strategy.