Chapter 7: Optimized Fleet Size with 3, 6, 15, and 50 person aTaxis

Preliminary study of a sample data set

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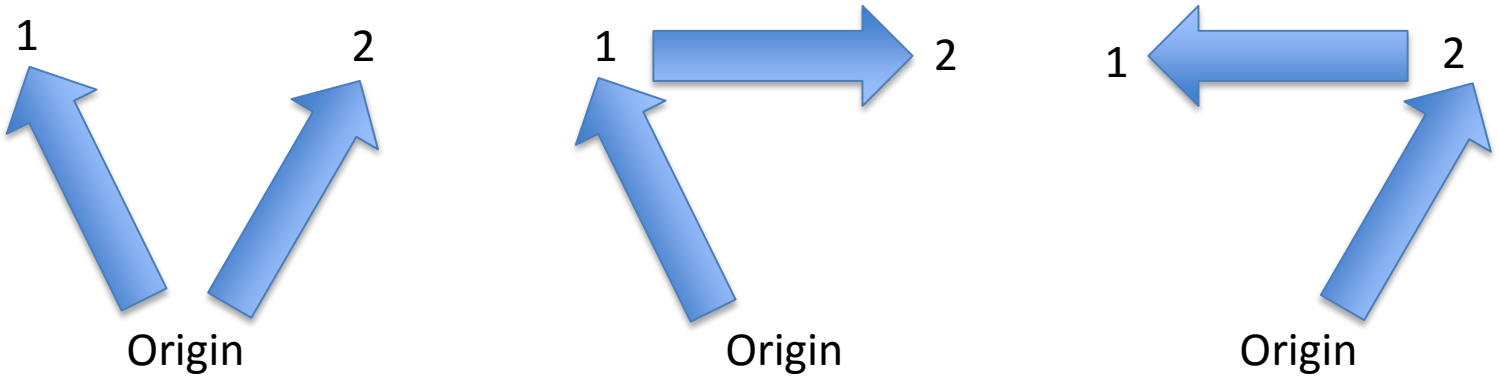
Cost for each vehicle

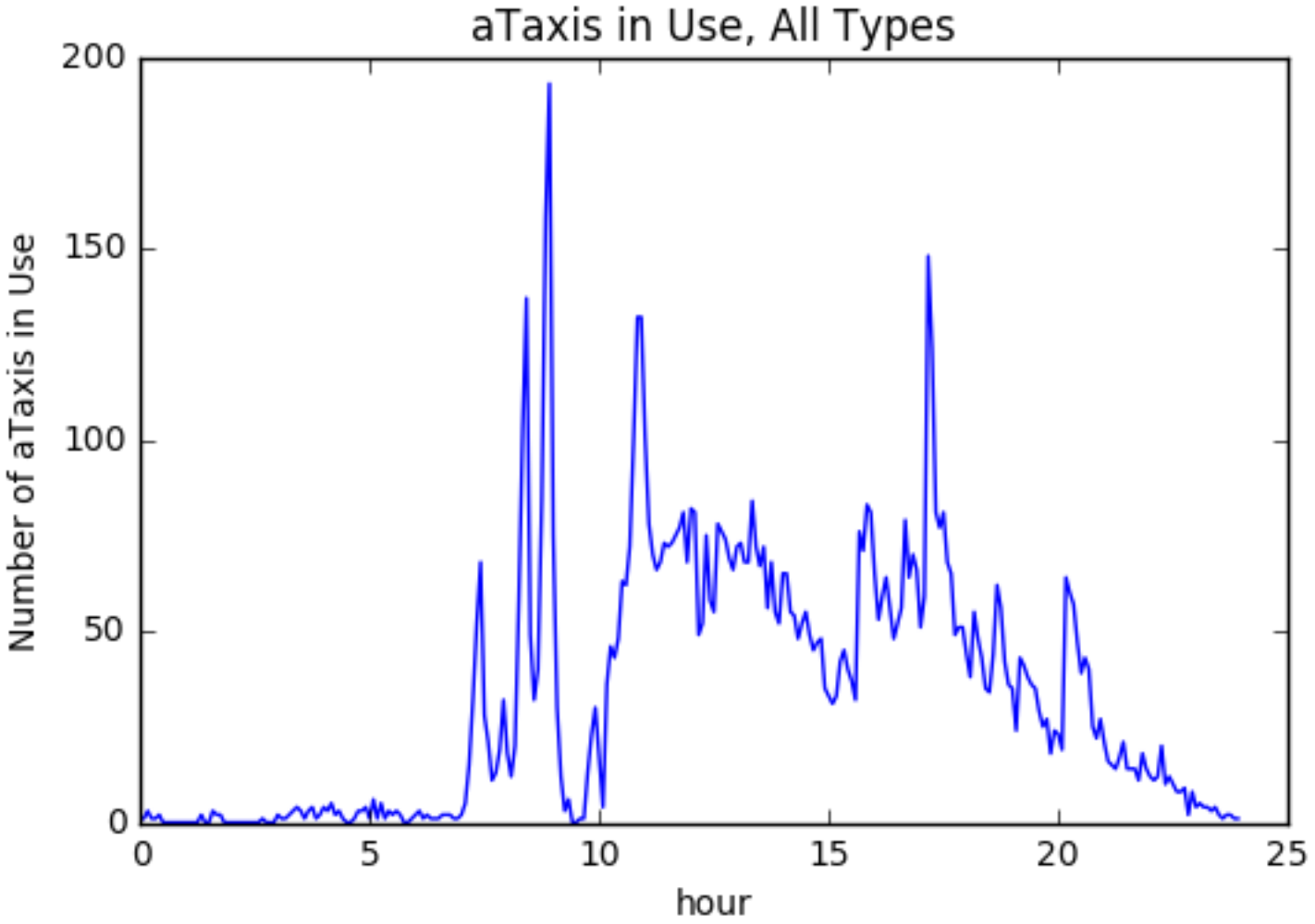
# passengers	3	6	15	50
Operating				
MPG	43.54	23.41	7.69	3.26
Lifespan (miles)	231,000	231,000	250,000	250,000
Variable Cost (per mile)	0.119	0.164	0.231	2.495
Capital				
Purchase price	30,000	60,000	100,000	175,000
Environmental				
Environmental cost (per CO2 ton)	40	40	40	40
CO2 emissions (grams per gal)	8,887	8,887	10,180	10,180
Total Costs				
Purchase price over lifetime	0.130	0.260	0.400	0.700
Environmental	0.008	0.015	0.053	0.125
Operating	0.119	0.164	0.231	2.495
Total (per Vehicle Mile Traveled)	**0.257**	**0.439**	**0.684**	**3.320**

- Issues: yet to find reliable data on maintenance costs
- Currently, cost of 50-person aTaxis is too high: it's always cheaper to send 4 of the 15-person vehicles instead of a single 50-person vehicle.

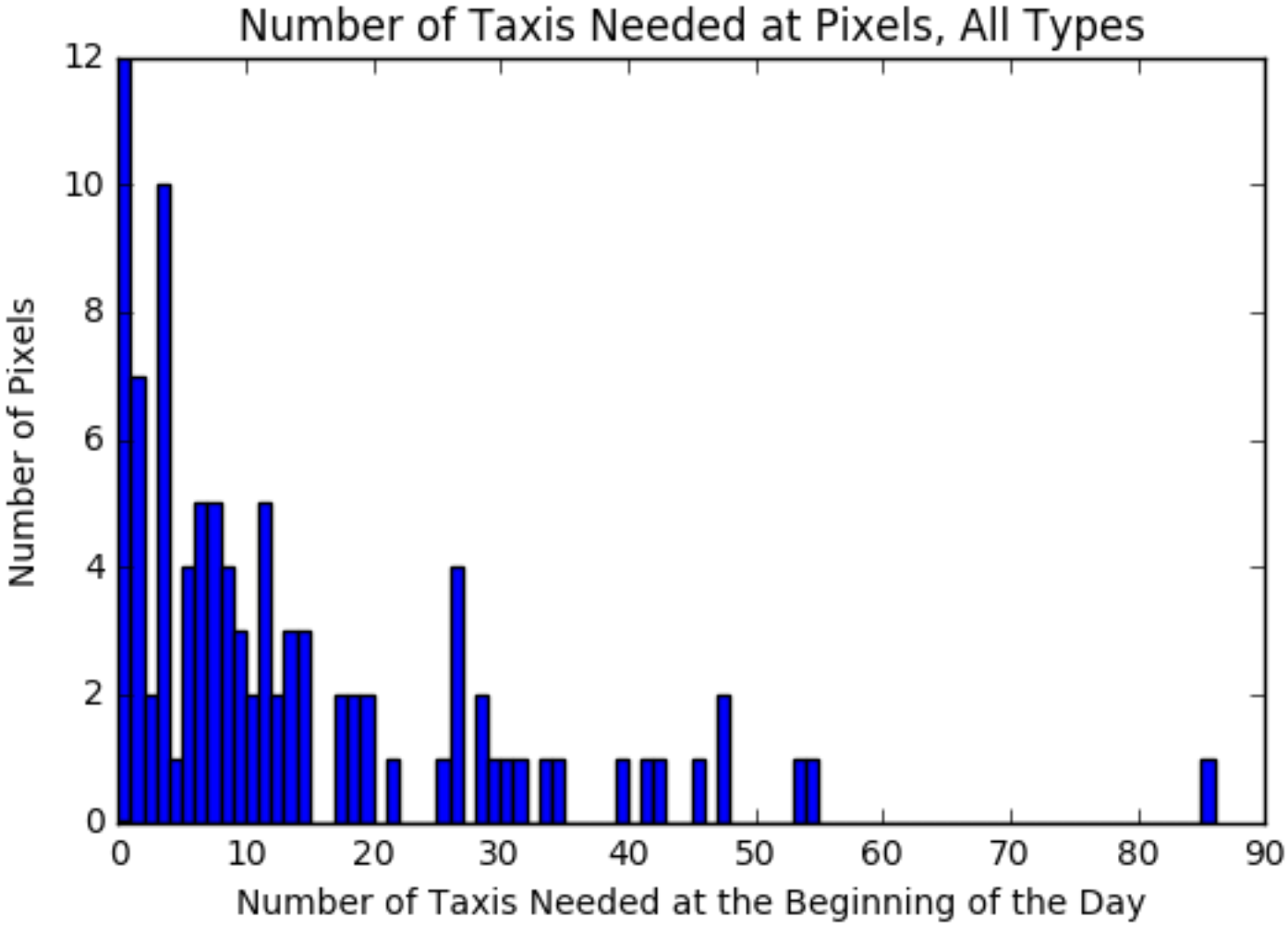
Methodology

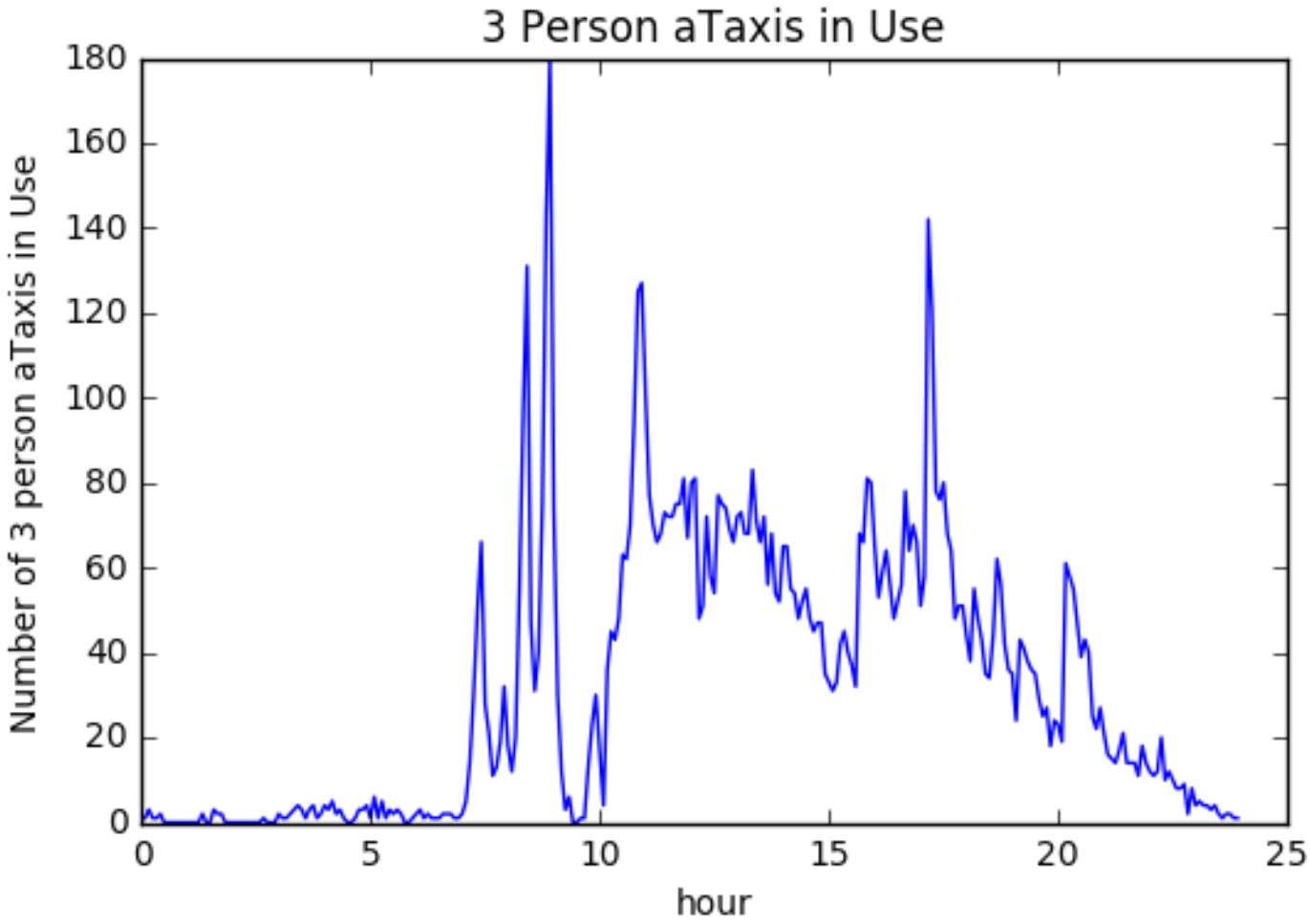
- Vehicles can accommodate 3, 6, 15 or 50 passengers
- A vehicle will have at most 3 destinations
- GOAL: Minimize total cost
- How? Consider all possible combinations of routes and vehicle types such that total trip cost is minimized
  - For example: 11 people are on the trip, is it better to get a 15-person taxi or two six-person taxis?
  - Or: 3 people on the trip, two are stopping at Destination 1, one is stopping at Destination 2; do we send a single 3-person taxi to stop at both places, or do we send two taxis, one to each destination?



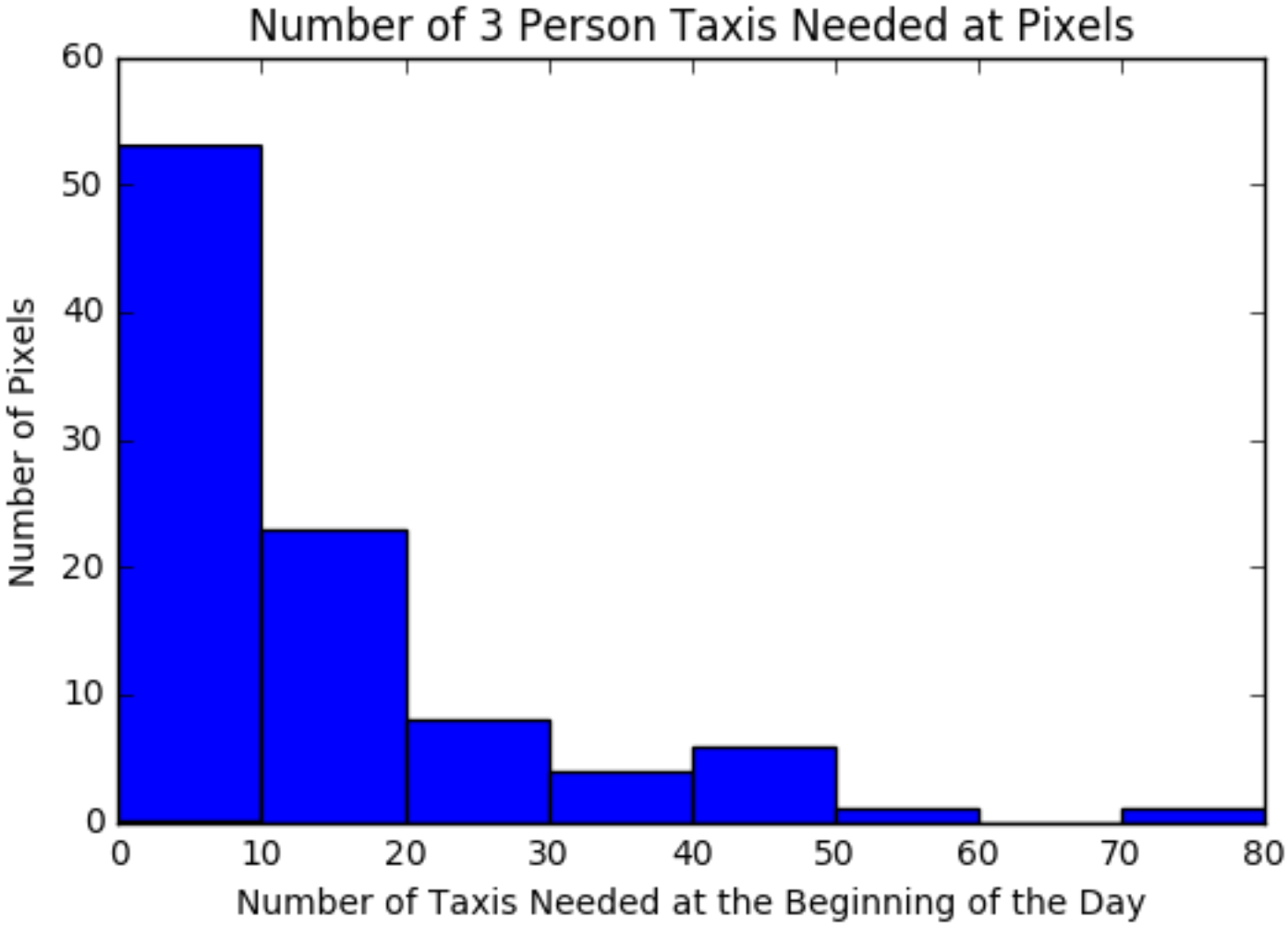


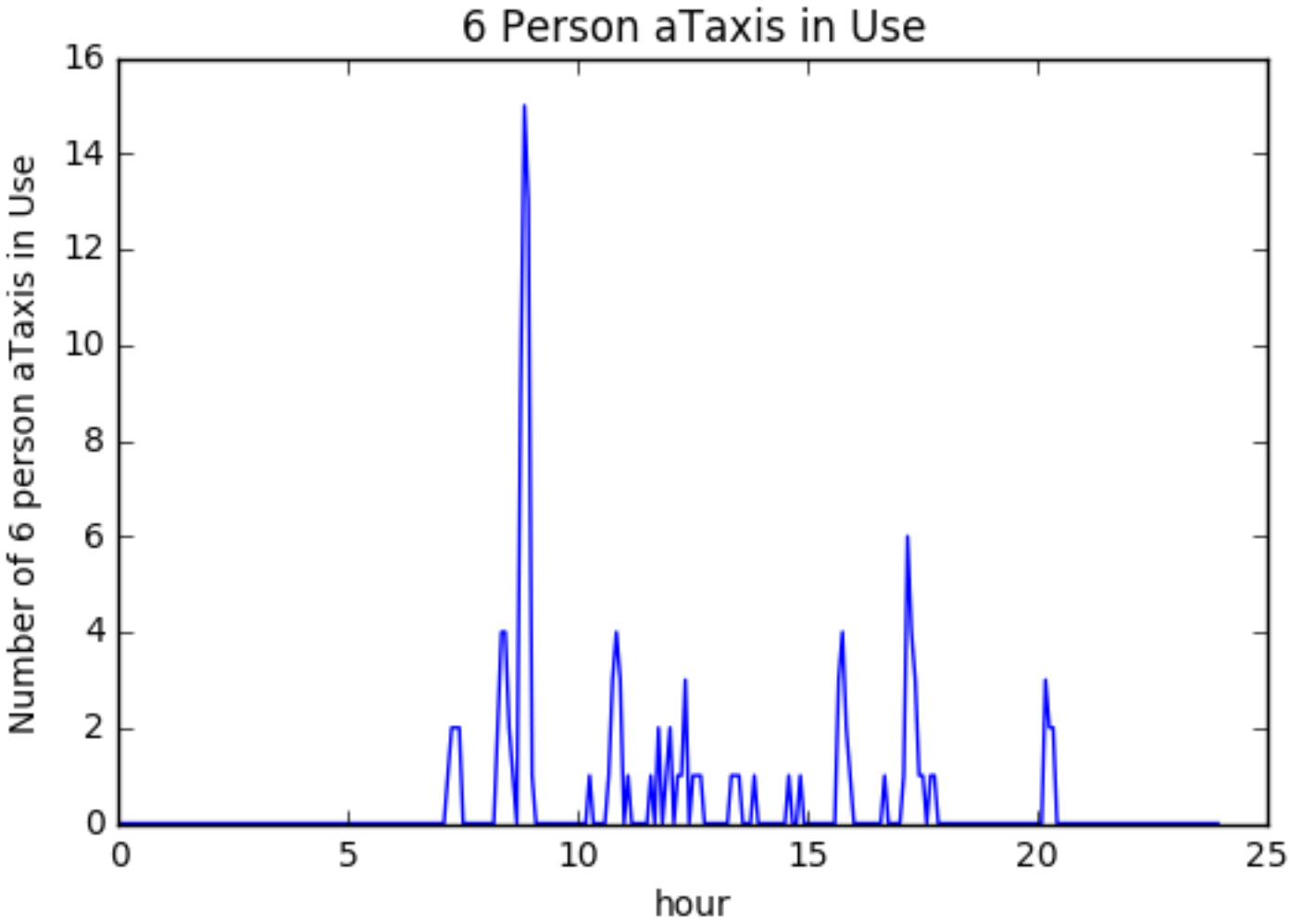
- For this particular data set, peak hours occur at approximately 8:40am, 12:00pm, and 6:00pm.
- The maximum number of taxis in use at any moment is 193
- AVO = 1.394 passengers/trip


Number of Taxis Needed at Pixels, All Types
Number of Pixels
Number of Taxis Needed at the Beginning of the Day
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90

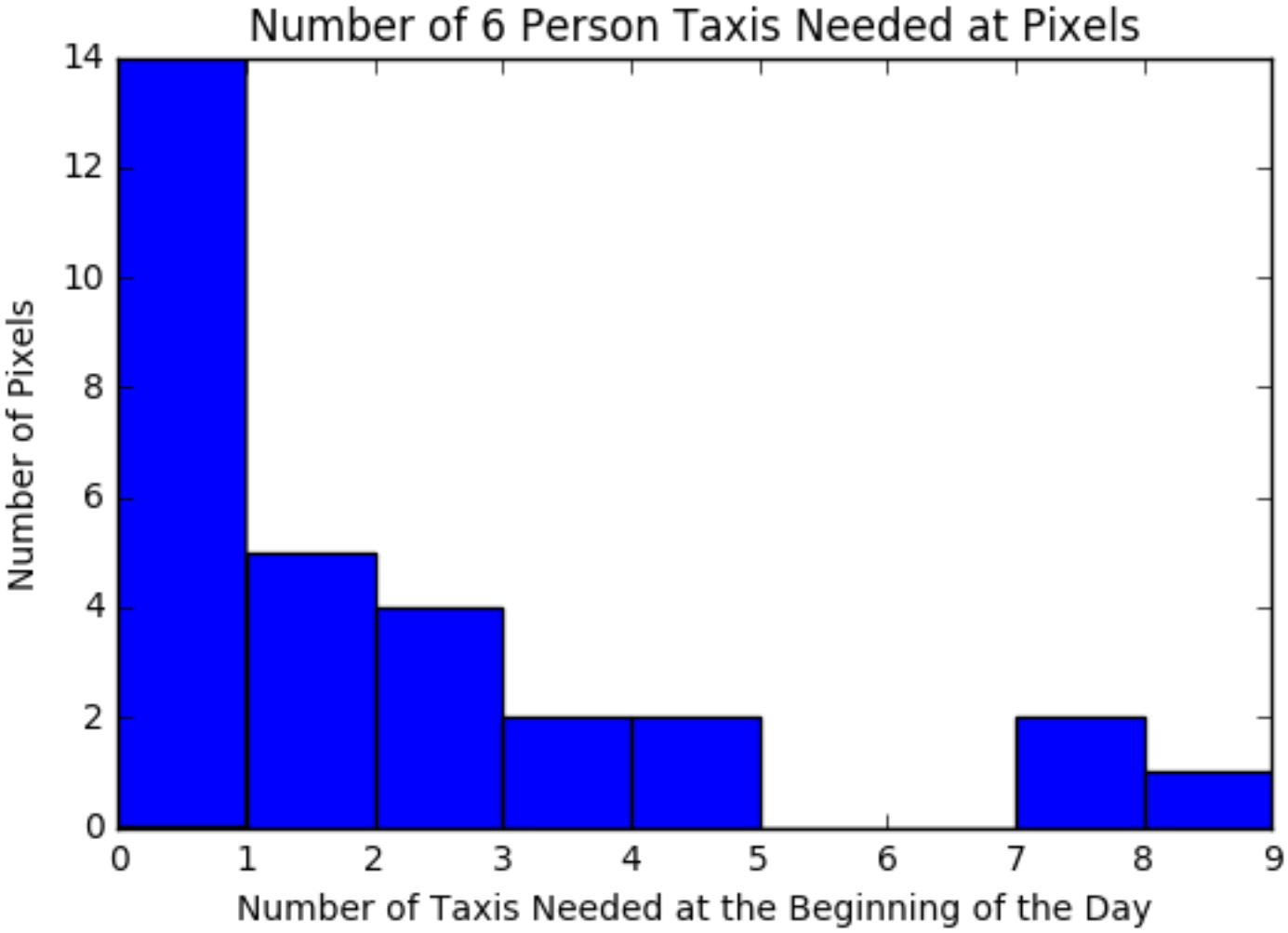


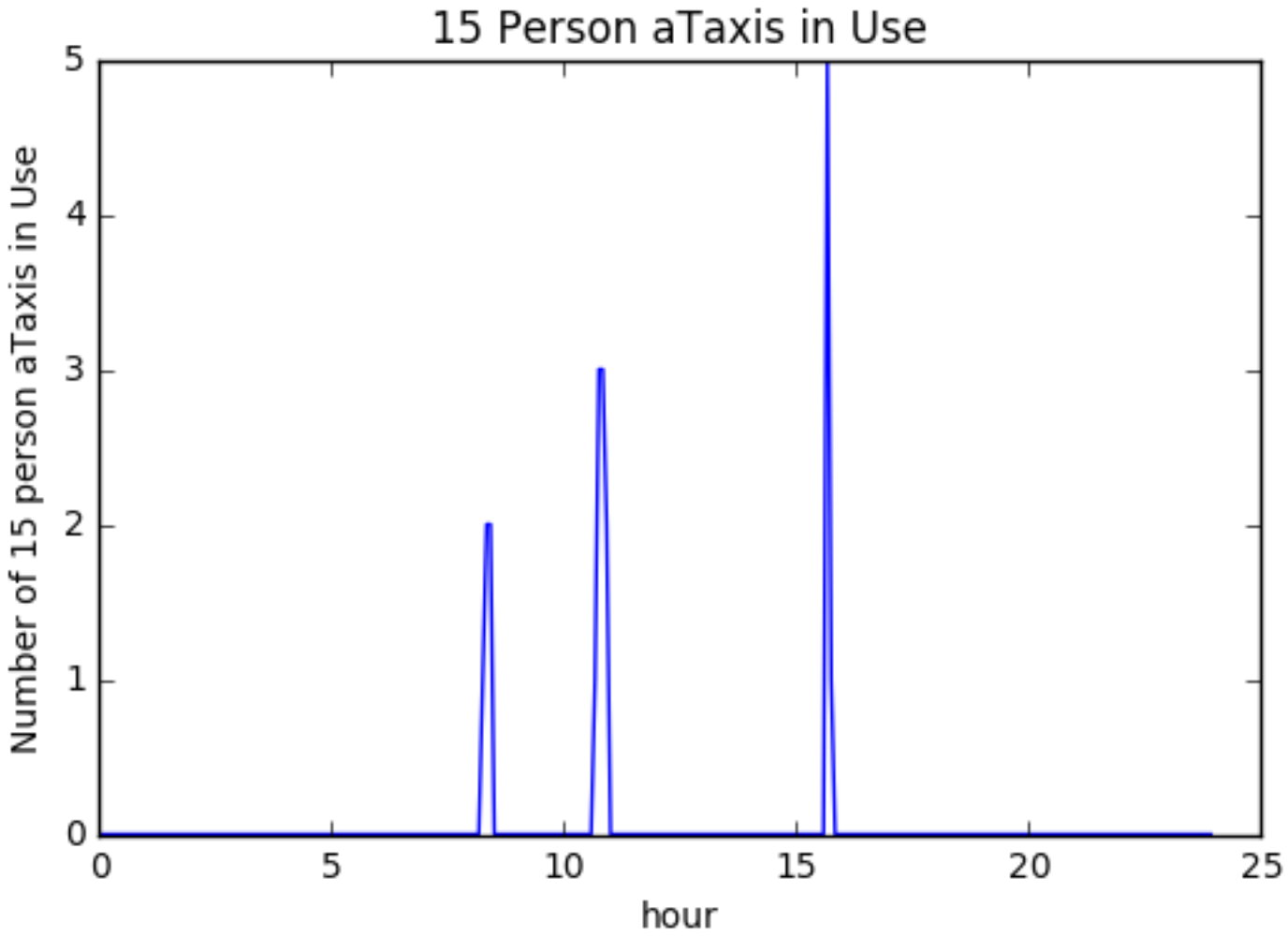
- By displaying only 3-person aTaxis, the shape of the distribution of taxi trips does not change significantly
- This makes sense, since the majority of trips are 3-person aTaxi trips
- At around 8:00am there are 180 3-person aTaxis in transit


Number of 3 Person Taxis Needed at Pixels
Number of Pixels
0
10
20
30
40
50
60
0
10
20
30
40
50
60
70
80
Number of Taxis Needed at the Beginning of the Day

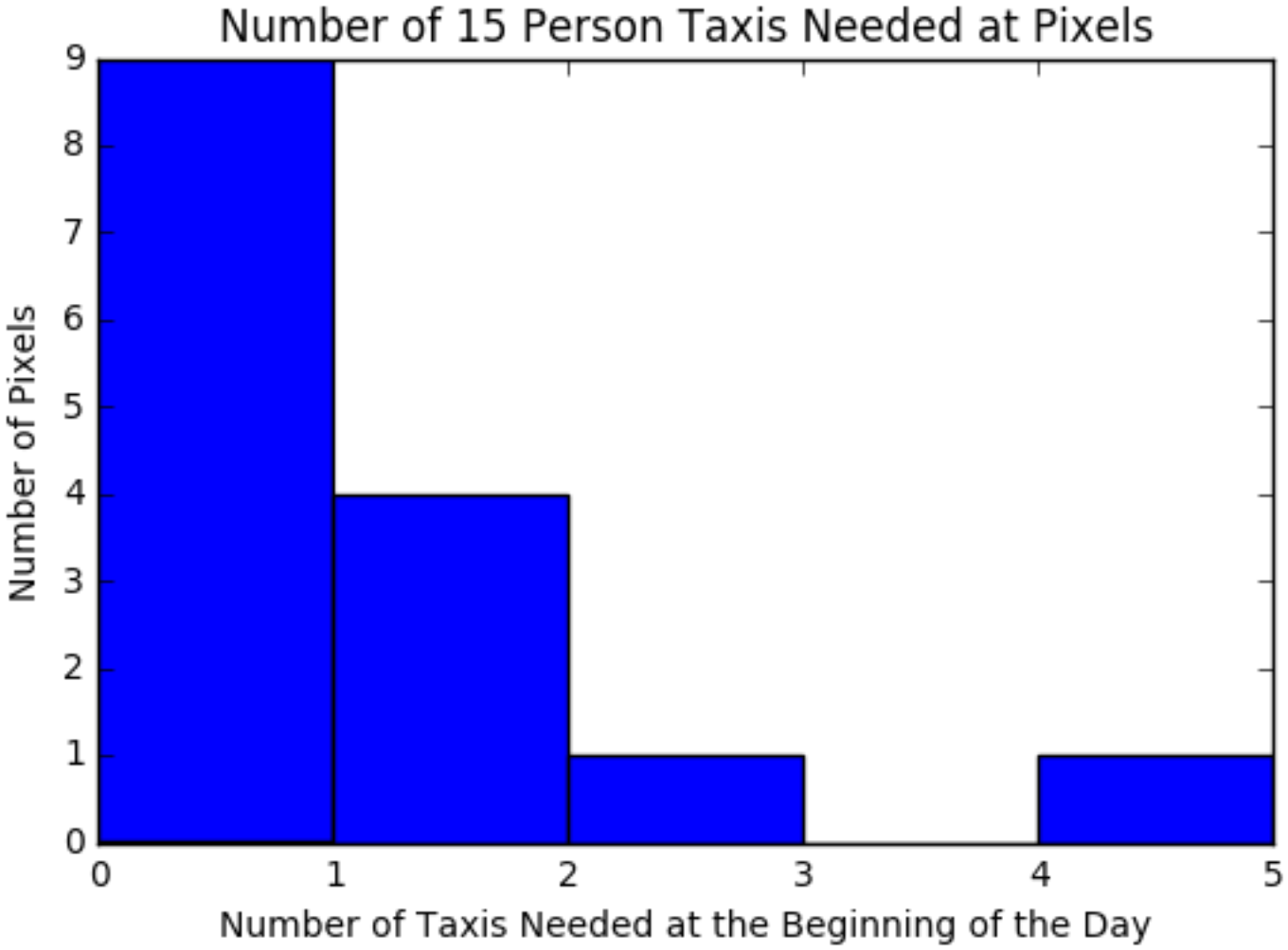


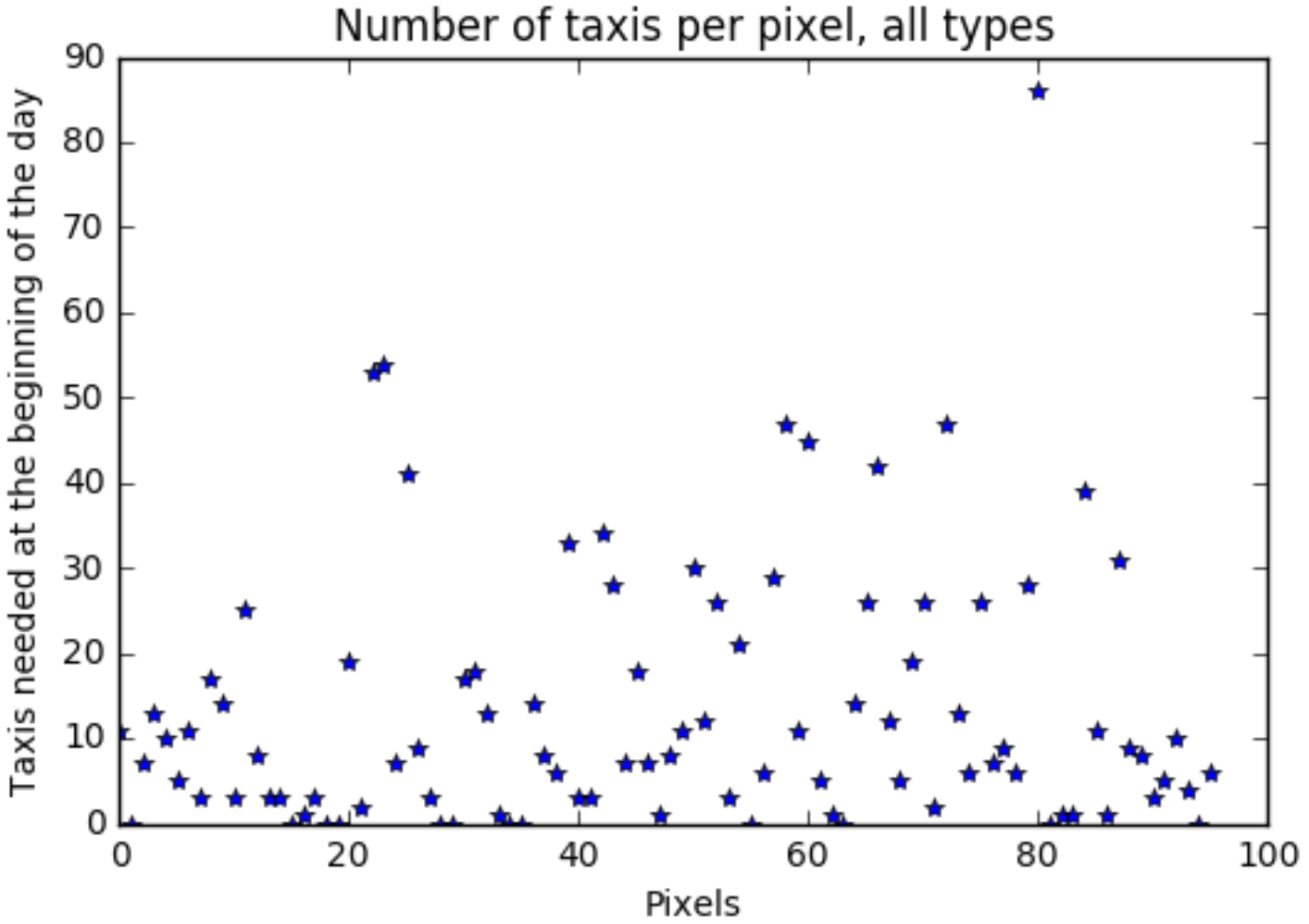
- By displaying only 6-person aTaxis, the distribution of vehicles in use changes significantly.
- The peak at 8:00am is by far the most significant of the day, possibly explained by the more sporadic trip originations that occur as the day progresses
- There are at most 15 of these vehicles in transit throughout the day


Number of 6 Person Taxis Needed at Pixels
Number of Pixels
0
2
4
6
8
10
12
14
0
1
2
3
4
5
6
7
8
9
Number of Taxis Needed at the Beginning of the Day

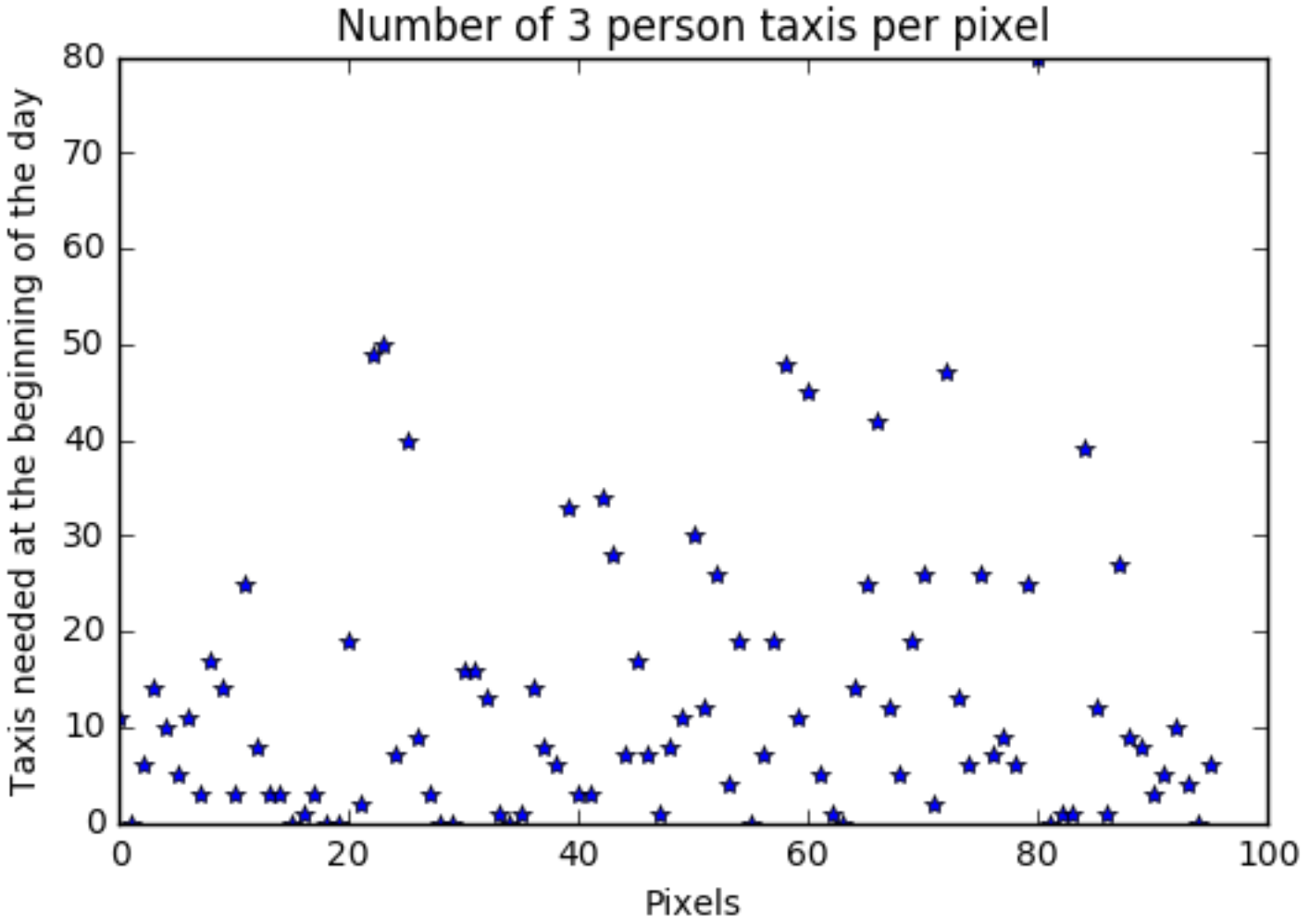


- There are at most five 15-person aTaxis in transit at any point of the day for this data set, and it happens at 5:40pm
- One possible explanation is that these are workers that perform a large commute to come back home at the end of the day, but they had different places to go to at the beginning of the working day (so they don't demand a 15-person aTaxi in the morning rush hour

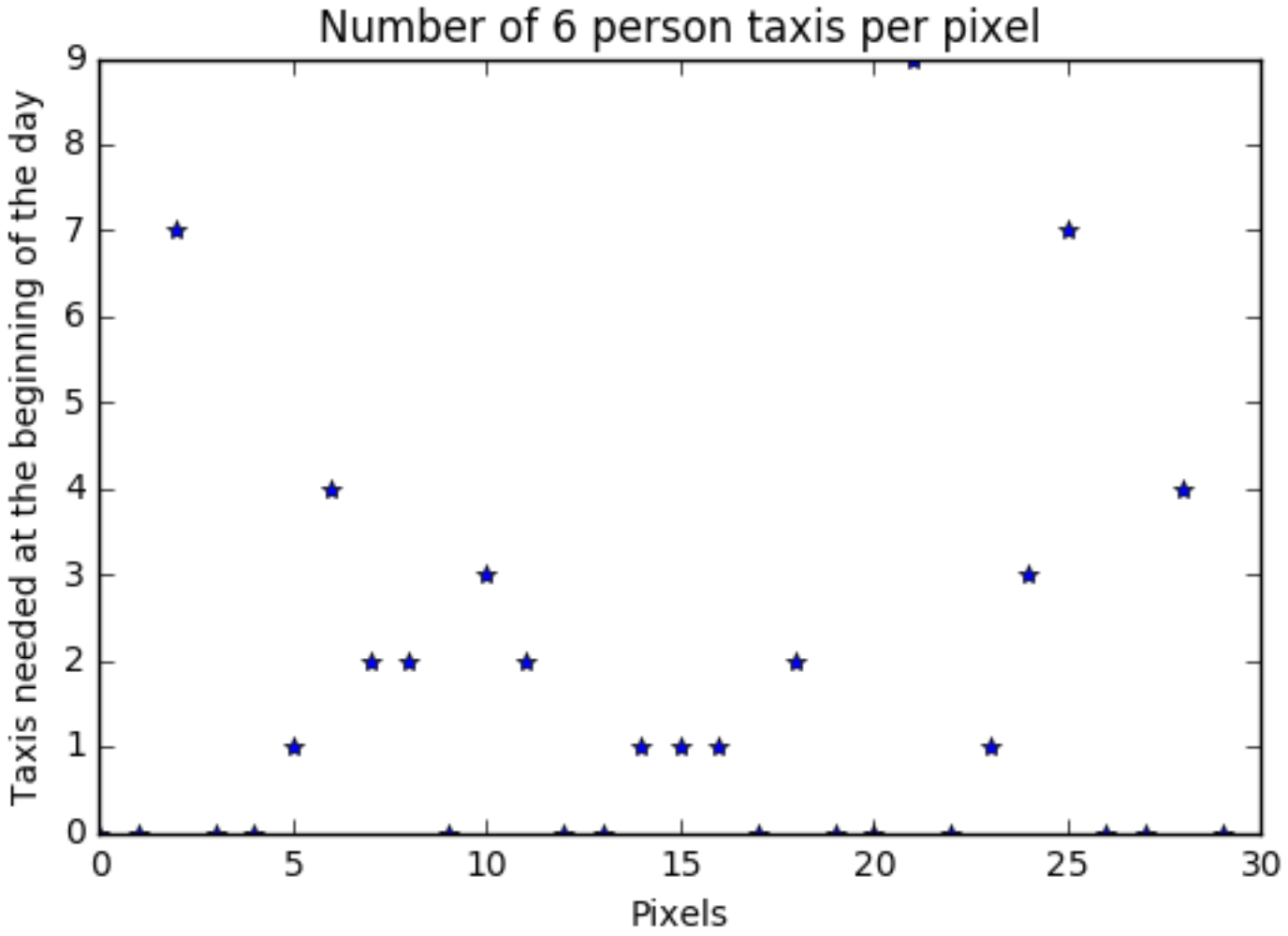

Number of 15 Person Taxis Needed at Pixels
Number of Pixels
0
1
2
3
4
5
6
7
8
9
0
1
2
3
4
5
Number of Taxis Needed at the Beginning of the Day



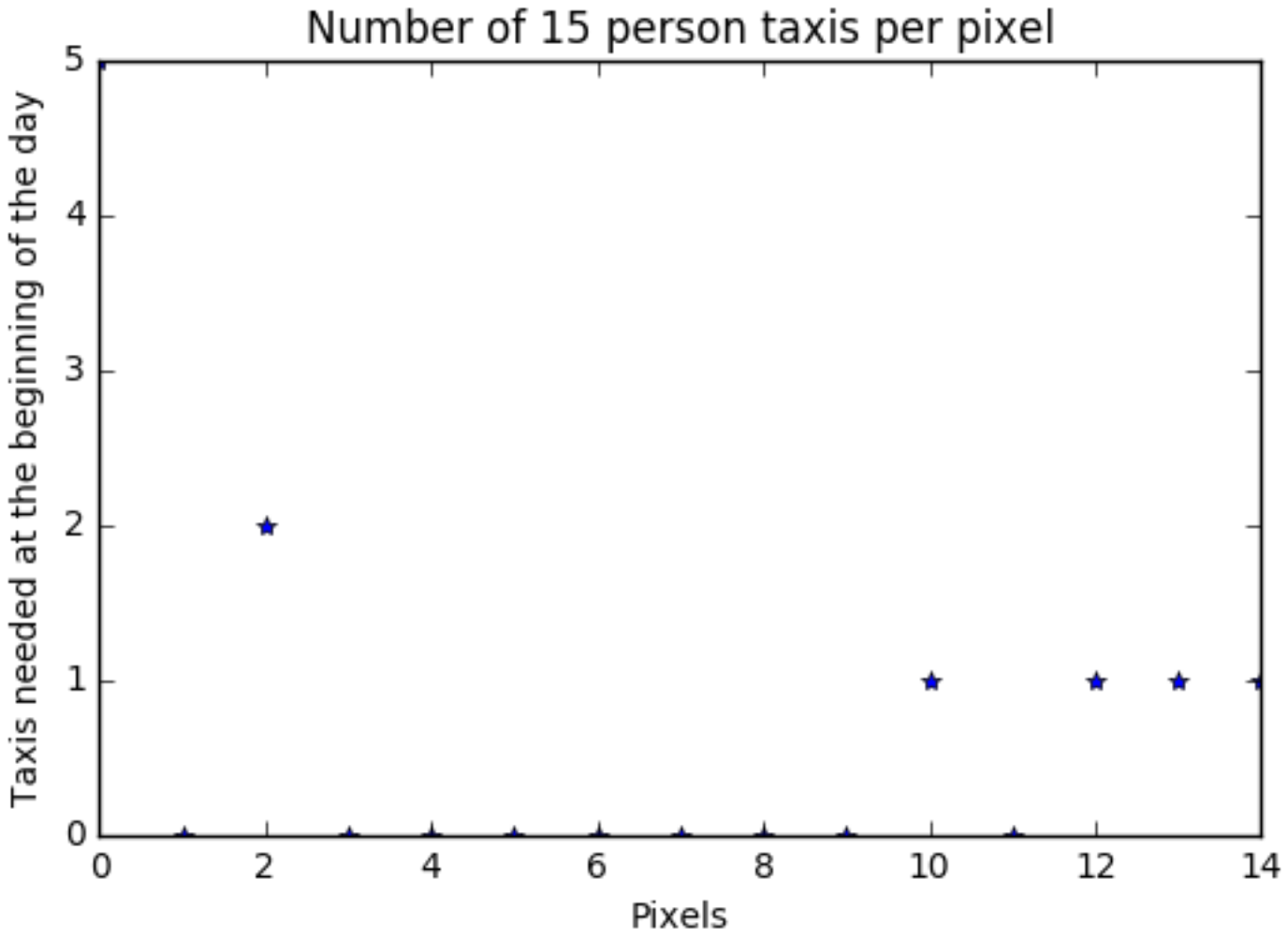
- There are 92 pixels in this data set, each labeled 1 through 92.
- This is a representation of the taxi demand at the beginning of the day for each of these pixels
- Demand in this region is generally evenly distributed, except for 1 – 3 outliers



- This is the demand for only 3-person aTaxis in the beginning of the day
- Once again, this distribution does not change from the demand for aTaxis in general, because the vast majority of trips are being serviced by 3-person vehicles.



- The demand for 6-person vehicles in the beginning of the day is quite different
- Fewer pixels require these vehicles in the beginning of the day, and demand is not evenly distributed among these pixels



- This is t he demand for 15-person aTaxis in the beginning of the day
- 5 of these vehicles are required in a total of 4 pixels in this particular data set