

City X Marketplace Diagnostic Analysis

UBER Marketplace Data Analyst Recruitment Exercise

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City X Driver Positioning Analysis

- Goal: Investigate hypothesis that driver positioning is sub-optimal during rush hours.
 - City GM reports that Chelsea Court experiences :
 - Higher rush-hour surge prices
 - Higher rush-hour arrival wait times (1-2 min greater than city average)
 - Inconsistent trip growth in April
- Question: Would informing drivers of increased demand in CC alleviate the problem and encourage rider growth?

Summary of Findings (I)

- **Trip Growth.** No convincing trend in trip growth is seen over the short (~1 month) timescale of this analysis
- **Rush Hour & Chelsea Court.** Estimated arrival times for Chelsea Court (CC) in rush hour are consistent with city averages
- **High Cancellation Rates.** There is a persistent 10-15% rider cancellation rate that is fairly consistent across geography and time-of-day.
- **Rider Trip Cancellation Could Indicate Lost Growth Opportunity.** Less than 1% of riders book again within 20 minutes of cancellation. Only 10% of riders who canceled made another request in April*

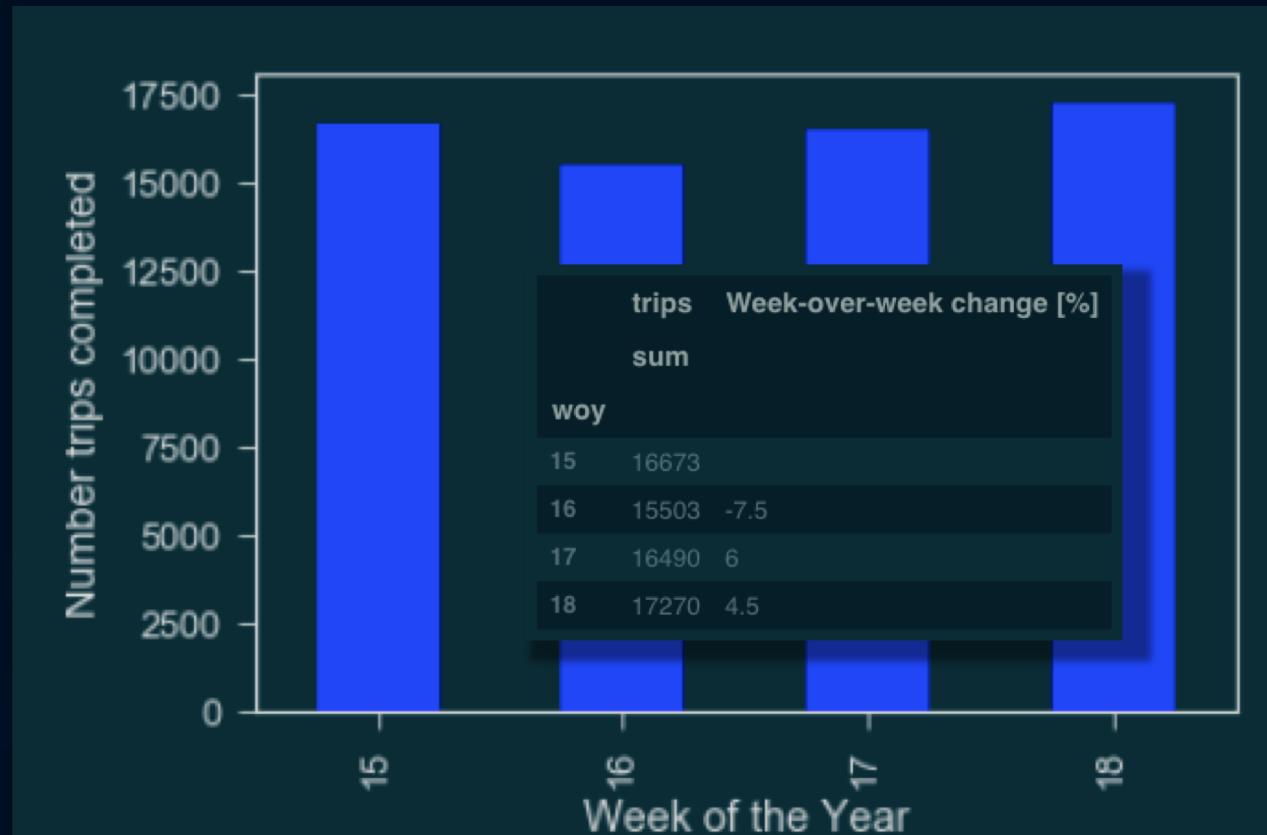
* see notes in Other Factors and Considerations at the end for caveats

Summary of Findings (II)

- **Why Riders Cancel** Riders who cancel experience higher arrival waiting times and moderately higher surge fares
- **Recommendations**
- **Other Considerations**
 - This is a simulation.

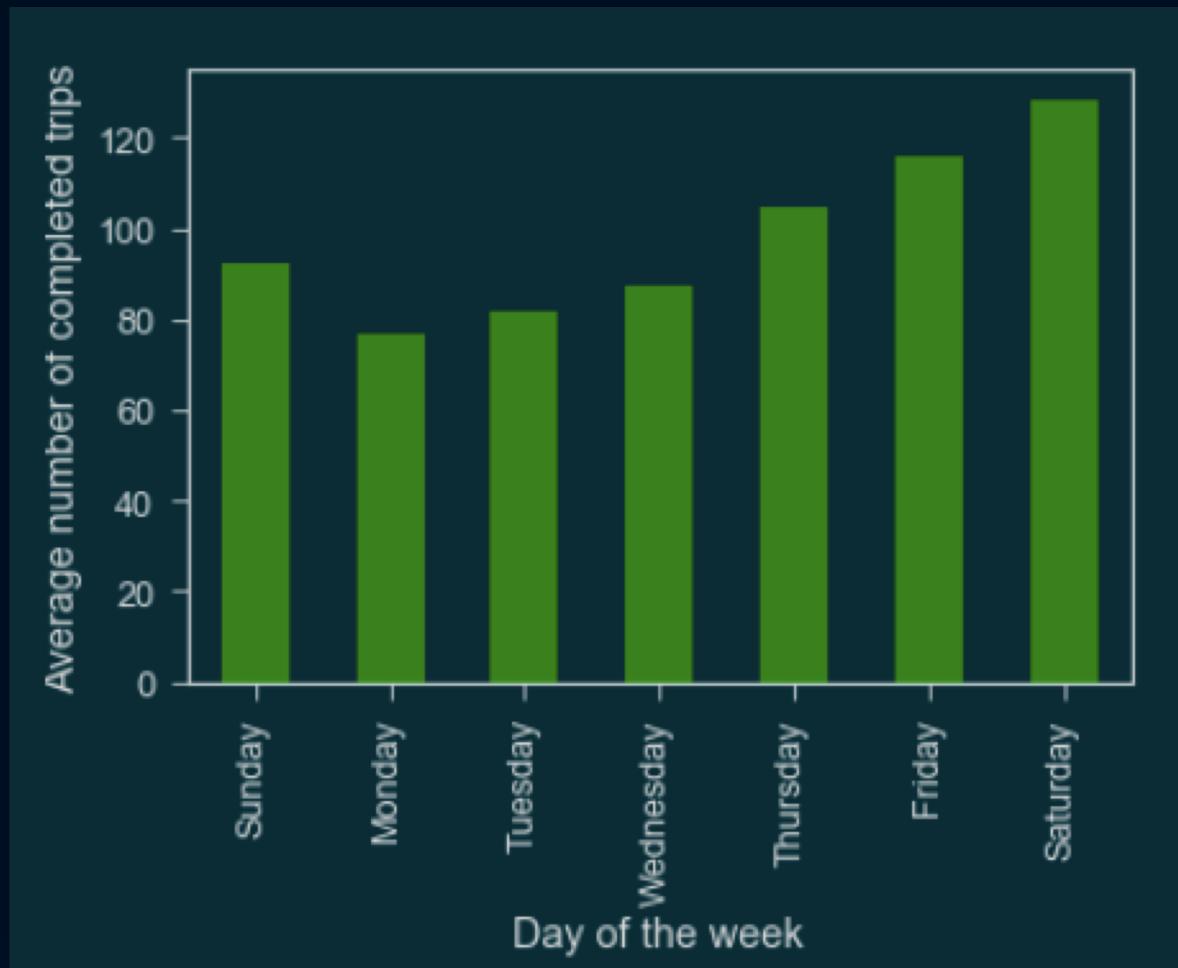
Trip Growth in April 2012

- Trips down -7.5% from week 15 to week 16, but then recover, ending up by 3% in week 18 compared to week 15
- Difficult to claim a convincing trend in trip growth based



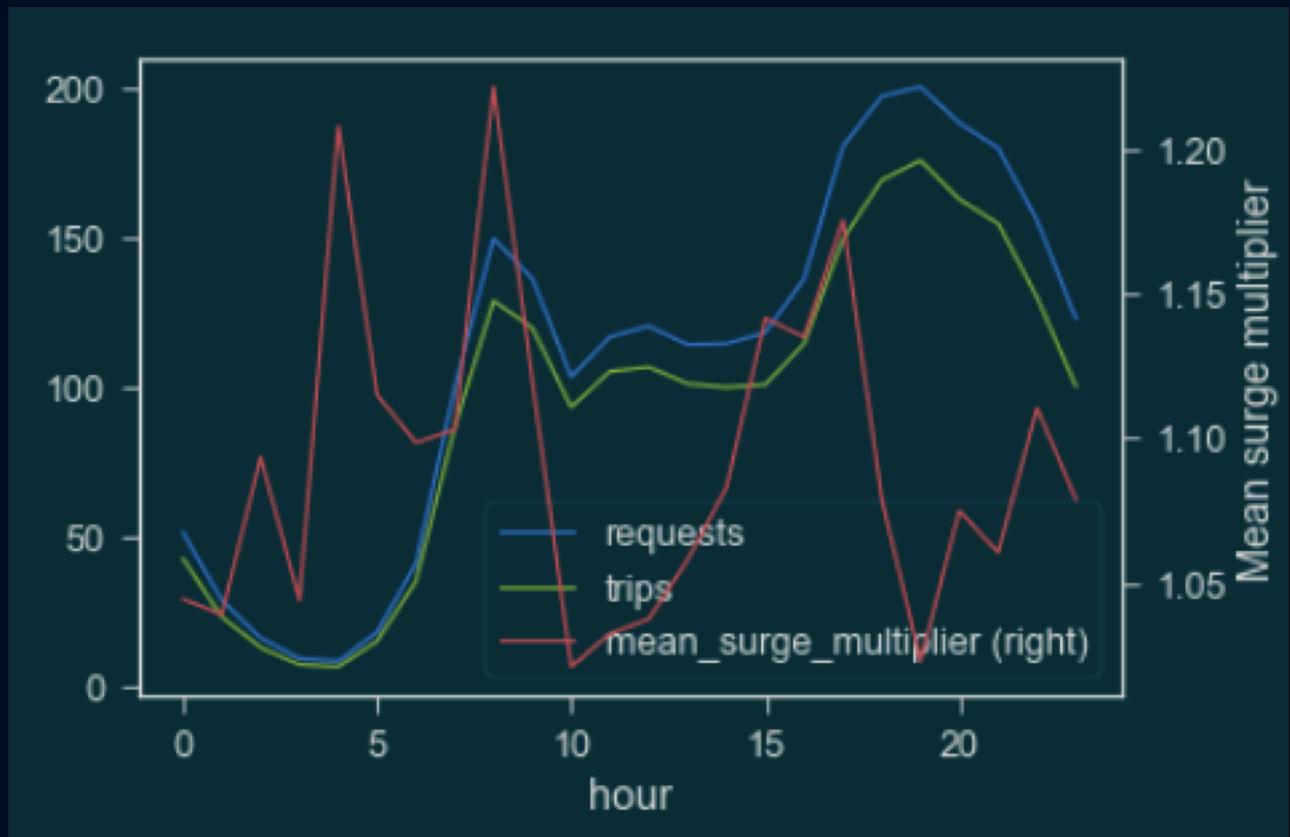
City-wide Demand vs Day of the Week

- Demand is least on Mondays and increases through the week, peaking on Saturdays



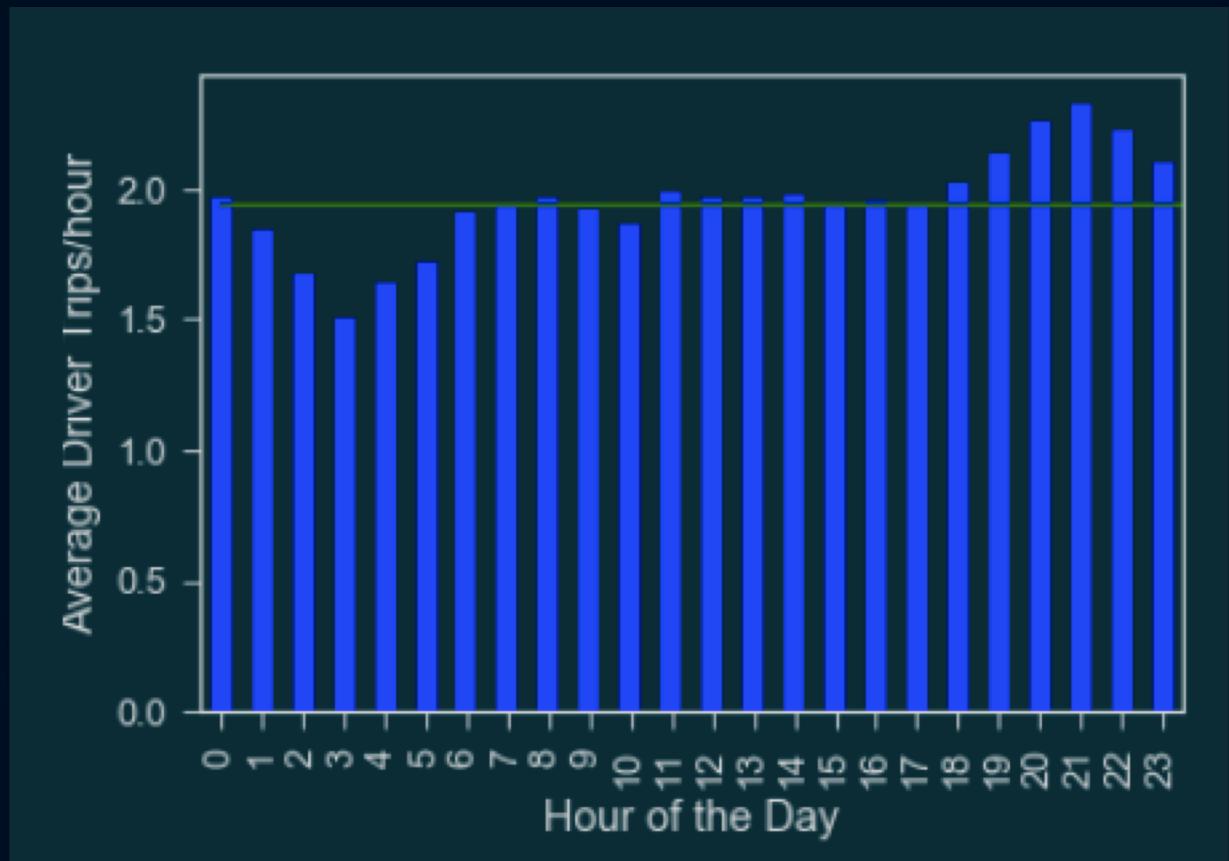
City-wide Weekday Trip Demand vs. Time of Day

- Elevated demand observed during morning rush hour (08:00-10:00) and evening rush hour (16:00-18:00)
- Greatest demand observed after evening commute, (18:00-21:00)
- Mean surge multiplier rarely moves above 1.2



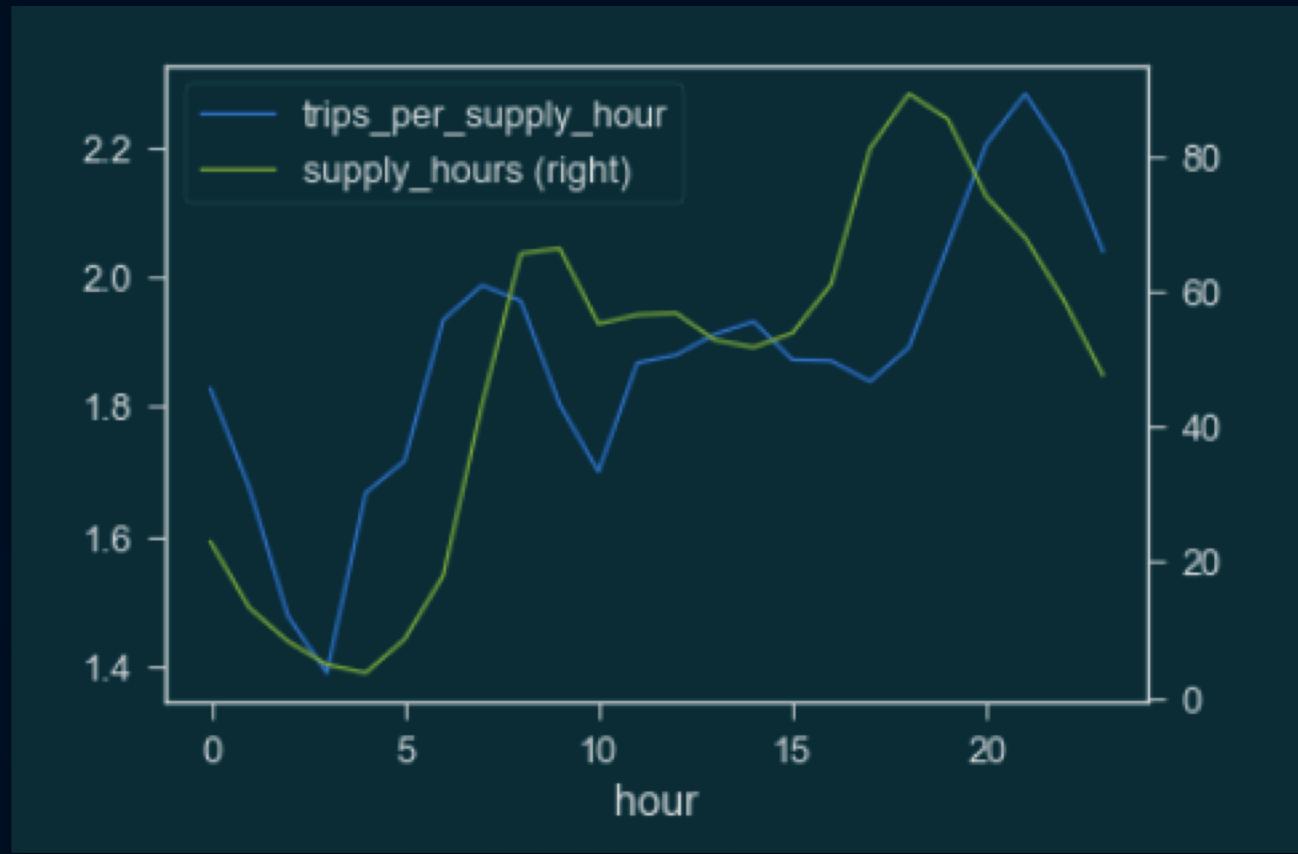
City-wide Weekday Demand vs. Supply vs Time of Day

- Overall lack of variation in the mean number of driver trips per hour indicates a good overall distribution of driver supply vs. time of day
- Slightly less supply vs. demand 19:00-23:00
- Slightly more supply vs. demand 01:00-06:00



City-wide Supply Response to Changing Demand

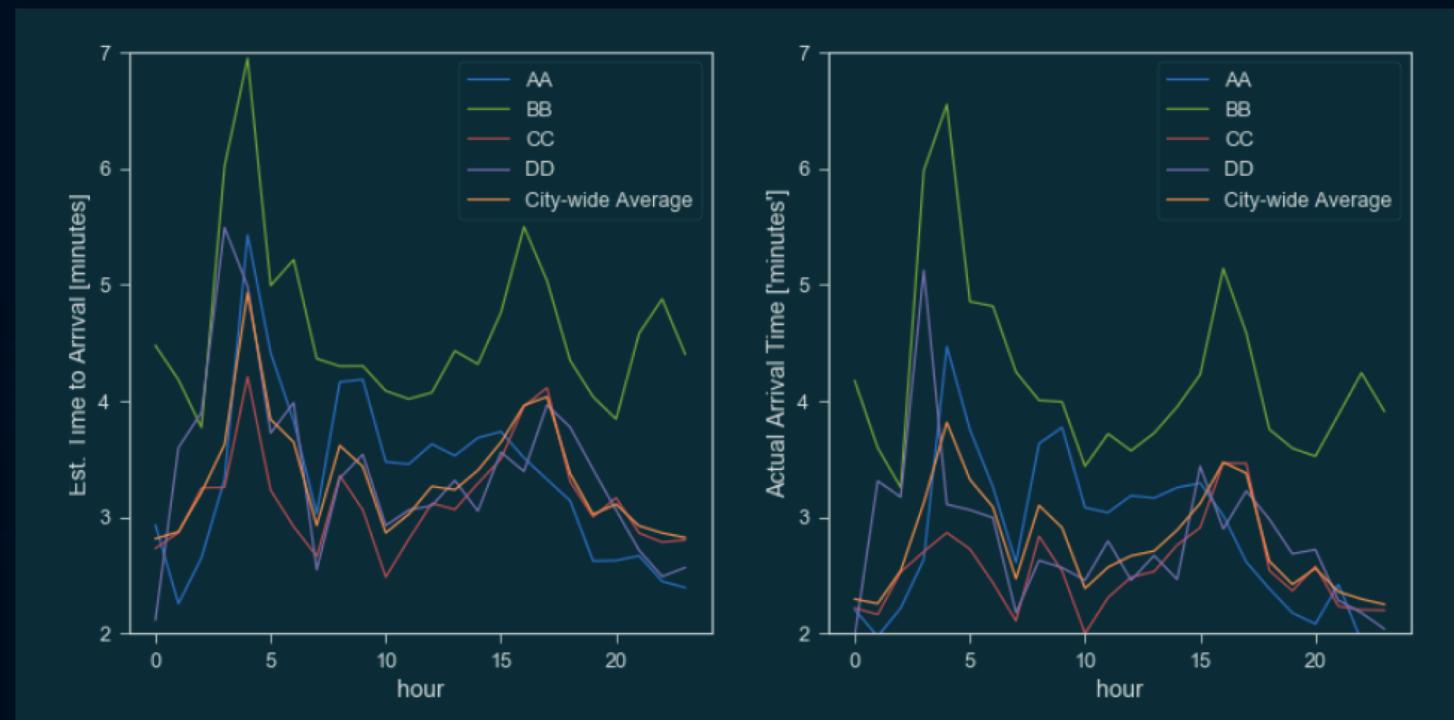
- In early morning hours demand is low and supply is adequate (although distance between supply and demand is larger)
- Demand increases ahead of lagged increases in supply during am commute
- Supply increases to match increasing demand during pm commute
- Supply falls off before demand falls off in evening



Weekday Time-to-Arrival vs. Geographic Region

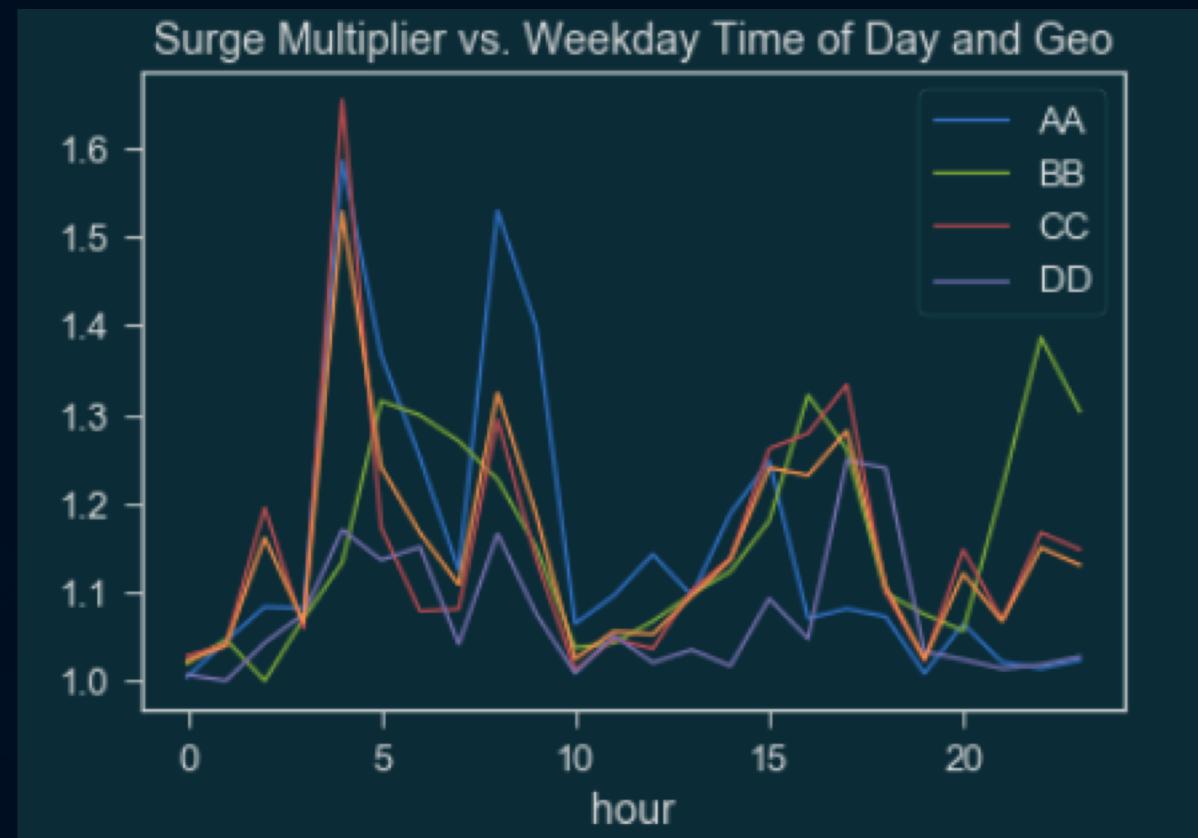
- CC sees wait times on par with or below city-wide average
- BB sees higher wait times, but has a smaller fraction of total demand

| Requests [%] | |
|---------------|------|
| Start Geo | |
| Allen Abby | 17.1 |
| Blair Bend | 7.3 |
| Chelsea Court | 67.9 |
| Daisy Drive | 7.6 |



Weekday Surge Multiplier vs. Geographic Region

- Chelsea Court sees surge multipliers on par with the city-wide average
- Allen Abby is underserved during a.m. commute (08:00-09:59)
- Blair Bend is underserved at night (22:00-23:59)

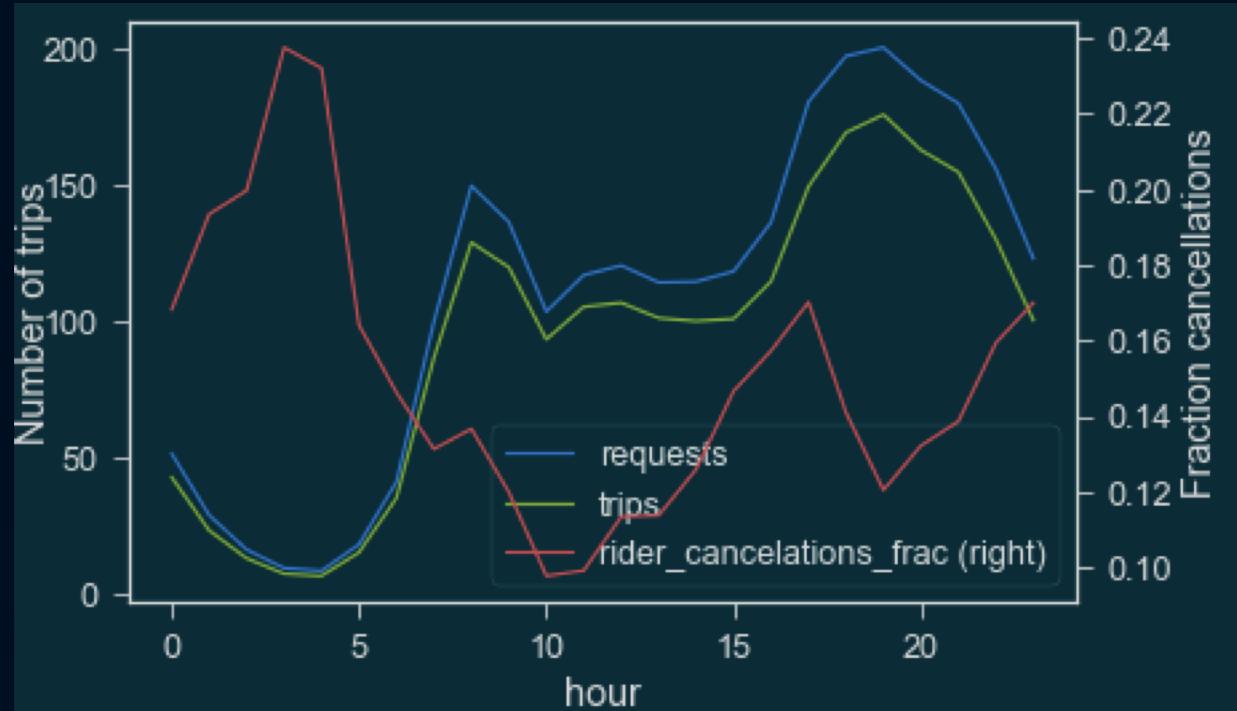


City-wide Weekday Rider Cancellation Rate

- Rider Cancelation rate is at least 10% in any given weekday hour
- Rider cancelation rate peaks at 17% during evening commute

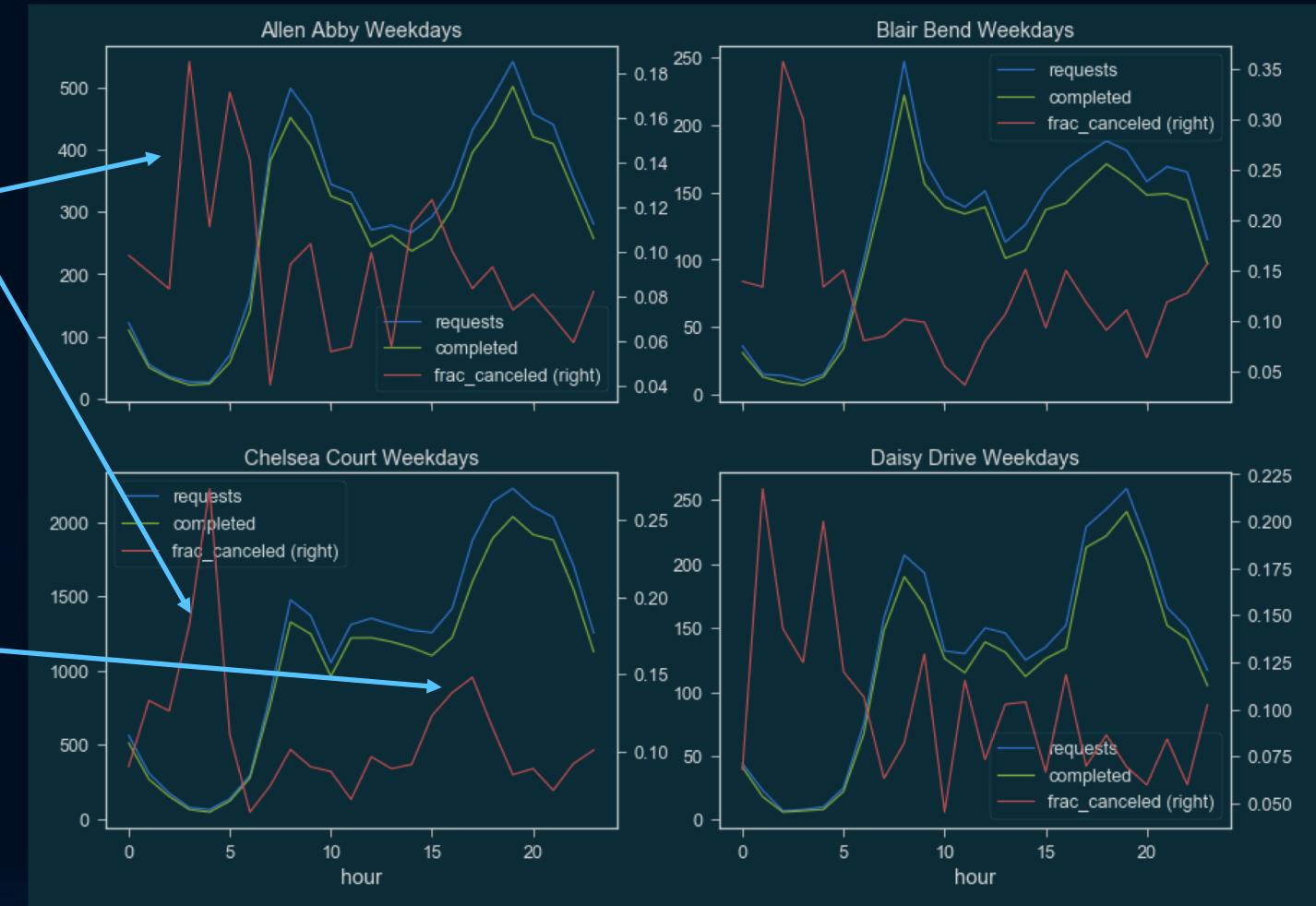
In AA, BB, CC, DD:

- Less than 1% of riders rebook within 20 minutes of cancelation
- 90% did not rebook in April



Weekday Rider Cancellation Rate vs. Time and Geo

- Wee-hour cancellation rate: supply is adequate, greater distance between drivers and riders; little growth opportunity due to small demand
- CC sees a peak 15% cancellation rate during pm commute; a little lower than city-wide average of 17% in the same hour



When Riders Cancel

| Part of Trip | Fraction of Rider Cancellations |
|---------------------------------|---------------------------------|
| Before Driver Accepts | 2.6% |
| Driver en-route to pick-up | 65.3% |
| After driver arrives at pick-up | 32.1% |

Reasons for Rider Cancellations – I

- Estimated wait times for completed rush-hour trips are very similar to those of all completed trips
- Surge multiplier for completed rush-hour trips is consistent with the average for all trips (within 5% for CC)

| start_geo | estimated_time_to_arrival | | | surge_multiplier | | | All Completed Trips | |
|---------------|---------------------------|------|--------|------------------|------|--------|---------------------|-----------------------------|
| | mean | std | median | mean | std | median | count | (total trips, uncertainty)% |
| Allen Abby | 3.14 | 1.99 | 2.77 | 1.16 | 0.36 | 1.0 | 9600 | (17.7, 0.1) |
| Blair Bend | 4.24 | 2.48 | 3.87 | 1.20 | 0.36 | 1.0 | 3899 | (7.2, 0.0) |
| Chelsea Court | 3.01 | 1.88 | 2.67 | 1.15 | 0.32 | 1.0 | 36285 | (67.0, 0.3) |
| Daisy Drive | 3.18 | 1.99 | 2.77 | 1.10 | 0.25 | 1.0 | 4354 | (8.0, 0.0) |

| start_geo | estimated_time_to_arrival | | | surge_multiplier | | | Completed Rush-hour Trips | |
|---------------|---------------------------|------|--------|------------------|------|--------|---------------------------|-----------------------------|
| | mean | std | median | mean | std | median | count | (total trips, uncertainty)% |
| Allen Abby | 3.26 | 2.15 | 2.78 | 1.20 | 0.49 | 1.0 | 1665 | (19.1, 0.2) |
| Blair Bend | 4.35 | 2.35 | 3.98 | 1.21 | 0.32 | 1.0 | 702 | (8.0, 0.1) |
| Chelsea Court | 3.21 | 1.97 | 2.85 | 1.20 | 0.38 | 1.0 | 5583 | (64.0, 0.7) |
| Daisy Drive | 3.35 | 2.13 | 2.93 | 1.19 | 0.32 | 1.0 | 773 | (8.9, 0.1) |

Reasons for Rider Cancellations – II

- Estimated wait times for canceled rush-hour trips are >2 minutes longer than those that are completed
- Surge multiplier is about 10% higher for canceled vs. completed rush-hour trips

| start_geo | estimated_time_to_arrival | | | surge_multiplier | | | Canceled Rush-hour Trips | |
|---------------|---------------------------|------|--------|------------------|------|--------|--------------------------|-----------------------------|
| | mean | std | median | mean | std | median | count | (total trips, uncertainty)% |
| Allen Abby | 5.60 | 3.34 | 5.75 | 1.32 | 0.49 | 1.0 | 144 | (14.0, 0.4) |
| Blair Bend | 5.77 | 3.80 | 4.92 | 1.28 | 0.41 | 1.0 | 77 | (7.5, 0.2) |
| Chelsea Court | 5.46 | 3.25 | 4.98 | 1.33 | 0.50 | 1.0 | 740 | (72.2, 2.3) |
| Daisy Drive | 5.00 | 3.35 | 4.60 | 1.16 | 0.29 | 1.0 | 64 | (6.2, 0.2) |

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Reasons for Rider Cancellations – III

- It's not just during rush hour. Canceled trips always have longer wait times, regardless of time of day

| | estimated_time_to_arrival | | | surge_multiplier | | | Canceled Rush-hour Trips | |
|---------------|---------------------------|------|--------|------------------|------|--------|--------------------------|-----------------------------|
| | mean | std | median | mean | std | median | count | (total trips, uncertainty)% |
| start_geo | | | | | | | | |
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| | estimated_time_to_arrival | | | surge_multiplier | | | All Canceled Trips | |
|---------------|---------------------------|------|--------|------------------|------|--------|--------------------|-----------------------------|
| | mean | std | median | mean | std | median | count | (total trips, uncertainty)% |
| start_geo | | | | | | | | |
| Allen Abby | 4.63 | 3.19 | 4.07 | 1.21 | 0.39 | 1.0 | 878 | (15.2, 0.2) |
| Blair Bend | 5.78 | 3.80 | 5.03 | 1.29 | 0.45 | 1.0 | 464 | (8.0, 0.1) |
| Chelsea Court | 4.39 | 2.90 | 3.95 | 1.22 | 0.39 | 1.0 | 4025 | (69.7, 0.9) |
| Daisy Drive | 4.40 | 2.99 | 3.80 | 1.12 | 0.29 | 1.0 | 410 | (7.1, 0.1) |

Reasons for Rider Cancellations

- Looking at all canceled vs completed trips, surge multiplier is only slightly higher for those canceled, but wait time is always at least a minute longer for canceled trips

| start_geo | estimated_time_to_arrival | | | surge_multiplier | | | All Completed Trips | |
|---------------|---------------------------|------|--------|------------------|------|--------|---------------------|-----------------------------|
| | mean | std | median | mean | std | median | count | (total trips, uncertainty)% |
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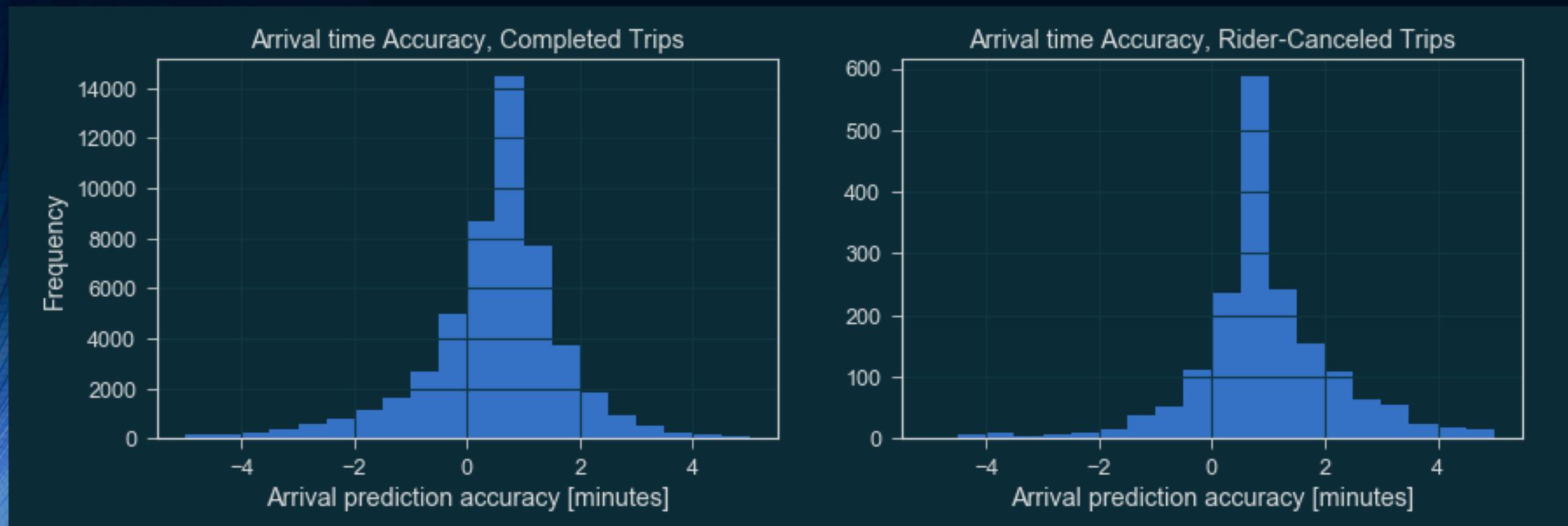
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Hypothesis

- Longer wait time estimates is the primary reason why riders cancel
- The effect of increased surge multiplier on cancelation rate is subdominant

Time-to-Arrival Estimate Accuracy

- Estimate accuracy is about the same for completed vs. canceled trips
- Both estimates are nearly one minute longer than actual



A/B Test Proposal

- Three test groups and one control group:
 - Test group B₁ has estimated time to arrival artificially reduced by 1 minute
 - Test group B₂ has estimated time to arrival artificially reduced by 2 minutes
 - Test group B₃ has surge-factor = 1.0 at all times.
 - Control group A has no adjustments to arrival estimates or surge factors
- Test group population sizes:
 - We need to be sensitive to changes in a rider decision that occurs 10% of the time. To get 5% sensitivity to the effects of the tested changes would require
$$1/\sqrt{0.1 \cdot N} = 0.05 \rightarrow N = 1250$$
 trip requests for each test group

Recommended Next Steps

Assuming the A/B test confirms the hypothesis that higher estimated wait times are to blame for high rider cancelation rates:

- Improve the accuracy of the estimated arrival time. On average it is about 1 minute too long.
- Increase driver engagement efforts. Supply is already nearly-optimally distributed across the geos and time of day. More driver supply overall is needed.
 - Most of the drivers only completing one or two trips in the timeframe of the dataset. Engagement efforts should focus on existing low-participation drivers rather than recruiting new drivers.
 - Increase rider engagement efforts, targeting existing riders. Most riders only make one request in the April time frame.

Other Factors and Considerations – I

- This is almost certainly a simulated data set
 - That there are almost exactly 60,000 trip requests is just one clue
 - There is an unrealistically high population of drivers participating in the April timeframe: ~20,000. If I had more time I would look in more detail at this population and look for patterns in their sign-up dates and lifetime driver stats.
- The simulation of rider behavior seems a bit simplistic
 - Most riders only make one or two requests in the April timeframe. (This may explain why 90% of riders never rebook after canceling)
 - I would expect more than 1% of riders to rebook within 20 minutes of canceling a request. As a rider, I've personally done this plenty of times because I make a mistake in the destination or discover that I'm not yet ready to leave.
 - If I had more time, I would see if I could tease out the population of riders that use Uber for commuting, and look at the impact of surge fare and wait times on them as a group, if such a population is present in this simulation.

Other Factors and Considerations – II

- There is one driver_id with an unrealistically large number of lifetime trips contributing in this data set. It would be physically impossible for a single person to have accumulated the lifetime stats of this driver. Whether intentional or not, there must be multiple drivers being conflated into a single rider_id. See the analysis notebook for more detail.
- There is a similar rider_id with unrealistic lifetime stats.