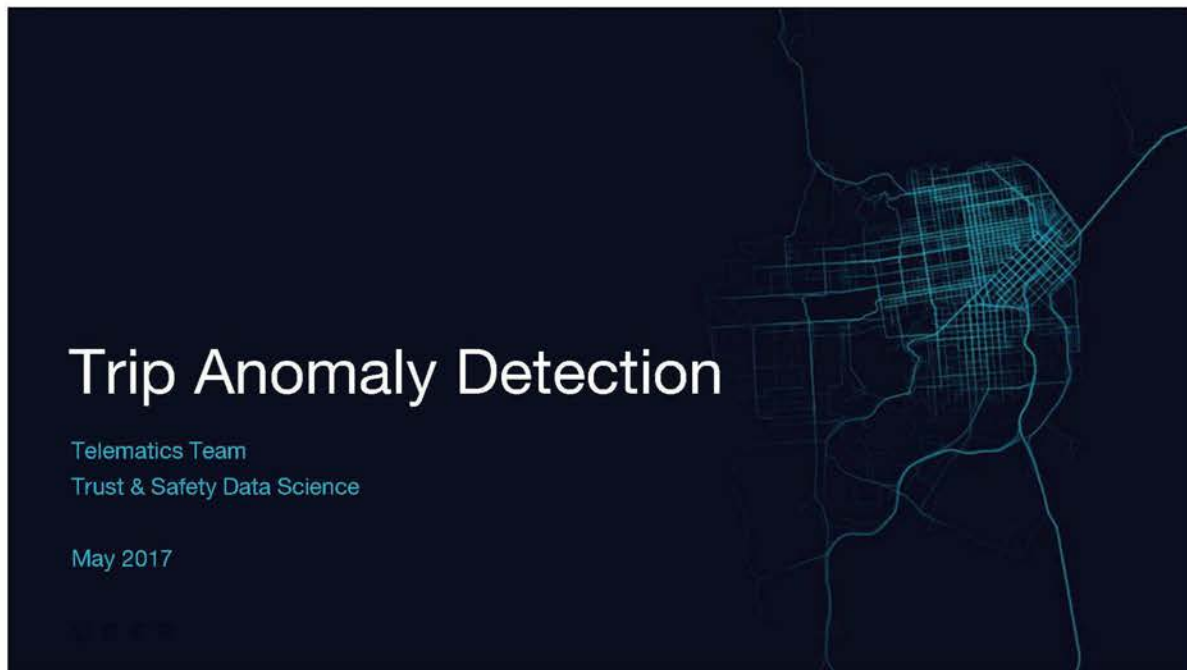


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Collaborators	jsevert@uber.com; ambar@uber.com; nirveek@uber.com; frank@uber.com; akankshu@uber.com; dmitriy@uber.com; nick.silver@uber.com; dpurdy@uber.com; uber.com	SEMANTIC
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Trial Exhibit No.

P-00801



TO CHANGE THE BACKGROUND PHOTO:

- Go to 'View > Master'
- Right-click on the image and select 'Replace image...'
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PHOTOS SHOULD BE AT LEAST 1700 x 866px FOR OPTIMAL RESOLUTION

WHEN THE PRESENTATION TITLE EXTENDS TO TWO OR MORE LINES:

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Motivation



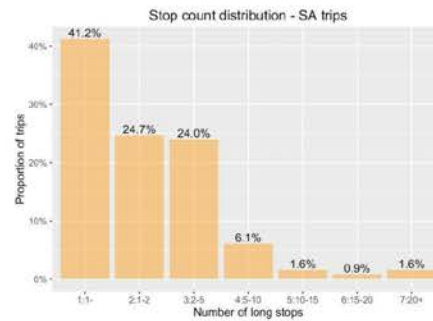
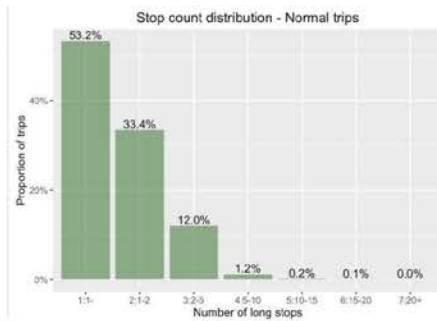
- No problem in driver profile
 - Active with Uber for over 6 months
 - Two level 1 tickets
 - Pass BGC
 - Life-time rating: 4.78
- Risky signals on trip
 - Mid-night trip
 - At least 6 bars within 1 minute walking distance
 - **Stopped for over an hour near the destination**



Summary

- Goal:
 - Develop a real-time rule that detects trip anomaly such as
 - On-trip: going in wrong direction, making unnecessary detour, long stops.
 - After-trip: unnecessary contact, long distance between destination and drop-off location, stay close to rider for anomalous long time.
 - Detect the anomalies as early as possible on the trip.
- Status:
 - Multiple well-performed models have been developed
 - Product design jam sessions started
- Rule Performance:
 - Sexual assaults: recall 11.1% / trigger rate 0.5% / lift 22X
 - Rapes: recall 20.3% / trigger rate 0.5% / lift 40X

SA Trips Have More Long Stops

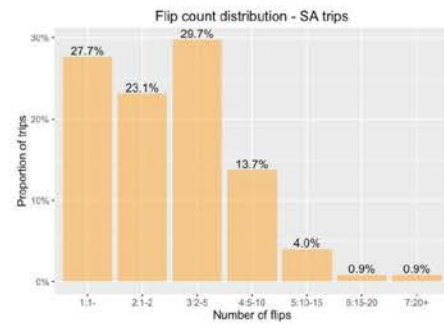
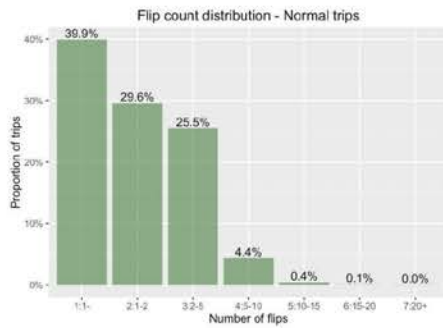


Avg. Number of Long Stops - Normal Trips	Avg. Number of Long Stops - SA Trips	P-value (T-test)	Relative Difference
0.73	1.99	<0.001	173%

Notes: Normal Trips refer to all UberX in the first week of Nov 2016 in LA; SA trips refer to all US UberX SA trips from Oct 1st 2016 to Dec 31st 2016 that have data stored in the ETA table

Stop: the progress made to destination at any checkpoint is less than 10m compared to the previous checkpoint.

SA Trips Have More Flips



Avg. Number of Flips - Normal Trips	Avg. Number of Flips - SA Trips	P-value (T-test)	Relative Difference
1.29	2.75	<0.001	113%

Notes: Normal Trips refer to all UberX in the first week of Nov 2016 in LA; SA trips refer to all US UberX SA trips from Oct 1st 2016 to Dec 31st 2016 that have data stored in the ETA table

Trip Anomaly Model

Check UberX trips at every checkpoint (about every 1 minute):

- Real-time features for trip anomaly detection:
 - Number of slow movements in previous 3/5/10 checkpoints
 - Number of moving to wrong directions in previous 3/5/10 checkpoints
 - Relative progress made to destination compare to the previous checkpoint
 - Difference between real-time ETA and original ETA
- Predict sexual assaults using rules with trip anomaly score, trip time, gender, spatial features



Model Performance - With Gender

Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Driver-rider different gender,
- Trip Anomaly model score is above threshold p^* .

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.5%	11.1% (64/575)	22.2X
1%	16.5% (95/575)	16.5X
Non-Consensual Intercourse Only		
0.5%	20.3% (13/64)	40.6X
1%	23.4% (15/64)	23.4X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% (72/647) SA trips lost data in ETA table
 - LB on recall is 9.9% (with 0.5% trigger rate)
- Recall on Rape tickets is calculated from all UberX rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% (30/94) Rape trips lost data in ETA table
 - LB on recall is 13.8% (with 0.5% trigger rate)

Model Performance - Without Gender

Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Trip happens on Friday, Saturday or Sunday,
- Trip Anomaly model score is above threshold p^* .

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.5%	9.6% (55/575)	19.2X
1%	14.3% (82/575)	14.3X
Non-Consensual Intercourse Only		
0.5%	10.9% (7/64)	21.8X
1%	14.1% (9/64)	14.1X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 8.5% (with 0.5% trigger rate)
- Recall on Rape tickets is calculated from all UberX rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 7.4% (with 0.5% trigger rate)

Case Review

Triggered

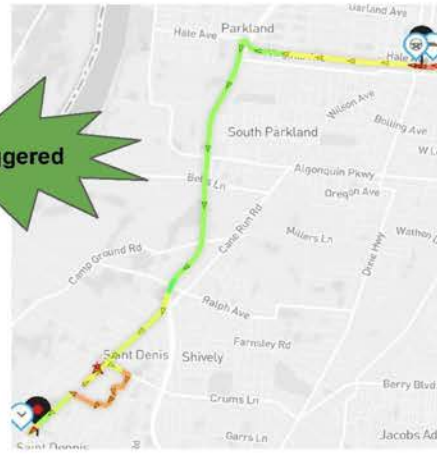
- Ticket
 - Driver continued to harass passenger in front seat
 - Made sexual advances both physically and verbally
 - Ignored the correct route
 - Took longer route to destination
- Trip
 - Midnight trip
 - Male driver, female passengers
 - Multiple passengers
 - Went on wrong directions multiple times
 - Made long stops multiple times
- Anomaly detection
 - Model detected anomalous low speed and wrong direction at very early stage of the trip
 - If intervention was sent out right after trip began, we may prevent the situation getting worse



Case 1: triggered

- Ticket
 - Passenger offered sexual favors to driver multiple times
 - Touched driver's private areas
- Trip
 - 9PM trip
 - Male driver male passenger
 - A slight unexpected U-turn on the trip

Not Triggered



- Anomaly detection
 - Model did **NOT** detect any anomaly for this trip

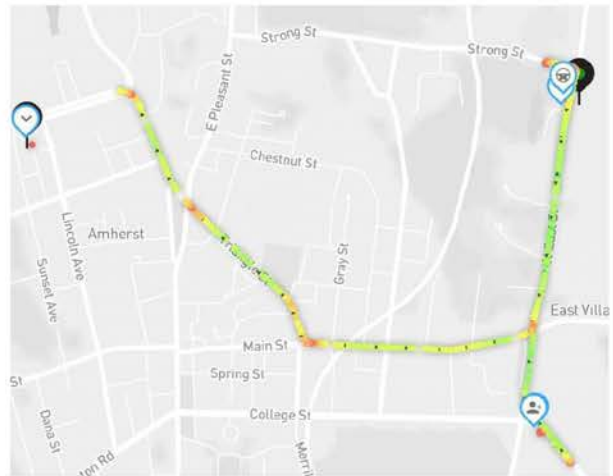
Case 4: not triggered

Next Steps

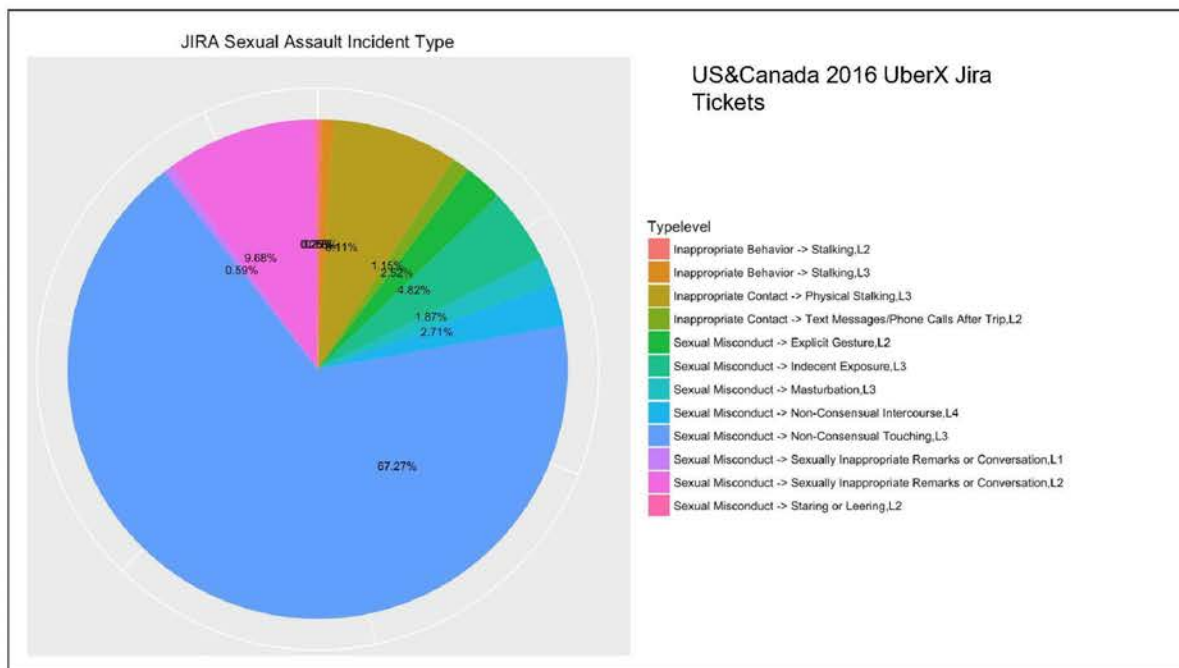
- Proper use cases
- Better intervention

Questions?

- Ticket
 - Driver touched passenger's leg multiple times
- Trip
 - Midnight trip
 - Male driver female passenger
 - Normal route was taken
 - Dropoff location is a few blocks from destination
- Anomaly detection
 - Model did **NOT** detect any anomaly for this trip



Case 3: not triggered



US&Canada 2016 UberX Jira tickets distribution

Next Steps

- Aggregate the trip anomaly features to account level
 - Check if drivers with SA tickets are more likely to have flips/long stops
 - Potential features for Gwyneth
- Support real-time interventions
 - Prevent opportunistic bad behaviors
 - Offer help and support in real-time

Naive Model Performance (1) - Without Gender

Naive Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Trip happens on Friday, Saturday or Sunday,
- Slow movement in last 3 minutes.

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.5%	7.1% (41/575)	14.2X
Non-Consensual Intercourse Only		
0.5%	20.3% (13/64)	40.6X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 6.3%
- Recall on Rape tickets is calculated from all UberX Rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 13.8%

Naive Model Performance (2) - Without Gender

Naive Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Trip happens on Friday, Saturday or Sunday,
- Current ETA + time elapsed exceeds 1.8 times initial ETA; and current ETA + time elapsed exceeds initial ETA + 15 minutes

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.54%	8.5% (49/575)	15.7X
Non-Consensual Intercourse Only		
0.54%	9.4% (6/64)	17.4X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 7.6%
- Recall on Rape tickets is calculated from all UberX Rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 6.4%

Appendix

After-trip Rule Performance

Prediction Rule: Predict trip will end in sexual assault if:

- Haversine distance between drop-off and destination is longer than x^* km

	Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults			
$x^*=13$ km (8.08 miles)	0.5%	6.3%	12.6X
$x^*=7$ km (4.35 miles)	1%	11.3%	11.4X
$x^*=3$ km (1.86 miles)	2%	16.9%	8.5X
Non-Consensual Intercourse Only (62% of Rape tickets do not have destination lat/long data)			
$x^*=13$ km (8.08 miles)	0.5%	3.1%	
$x^*=7$ km (4.35 miles)	1%	6.3%	
$x^*=3$ km (1.86 miles)	2%	12.5%	

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 5.6% (with 0.5% trigger rate)
- Recall on Rape tickets is calculated from all UberX rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 2.1% (with 0.5% trigger rate)

Model Performance - With Gender

Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Driver-rider different gender,
- Trip Anomaly model score is above threshold p^* .

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.07%	1.7% (10/575)	24.3X
0.5%	11.1% (64/575)	22.2X
1%	16.5% (95/575)	16.5X
Non-Consensual Intercourse Only		
0.07%	3.1% (2/64)	44.3X
0.5%	20.3% (13/64)	40.6X
1%	23.4% (15/64)	23.4X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% (72/647) SA trips lost data in ETA table
 - LB on recall is 9.9% (with 0.5% trigger rate)
- Recall on Rape tickets is calculated from all UberX rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% (30/94) Rape trips lost data in ETA table
 - LB on recall is 13.8% (with 0.5% trigger rate)

Naive Model Performance (1) - Without Gender

Naive Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Trip happens on Friday, Saturday or Sunday,
- Slow movement in last 10 minutes.

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.07%	2.1% (12/575)	30X
Non-Consensual Intercourse Only		
0.07%	9.4% (6/64)	134X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 1.9%
- Recall on Rape tickets is calculated from all UberX Rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 6.4%

Naive Model Performance (1) - With Gender

Naive Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Driver-rider different gender,
- Slow movement in last 10 minutes.

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.07%	2.1% (12/575)	30X
Non-Consensual Intercourse Only		
0.07%	9.4% (6/64)	134X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 1.9%
- Recall on Rape tickets is calculated from all UberX Rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 6.4%

Naive Model Performance (2) - With Gender

Naive Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Driver-rider different gender,
- Slow movement in last 3 minutes.

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.5%	7.1% (41/575)	14.2X
Non-Consensual Intercourse Only		
0.5%	20.3% (13/64)	40.6X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 6.3%
- Recall on Rape tickets is calculated from all UberX Rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 13.8%

Naive Model Performance (3) - With Gender

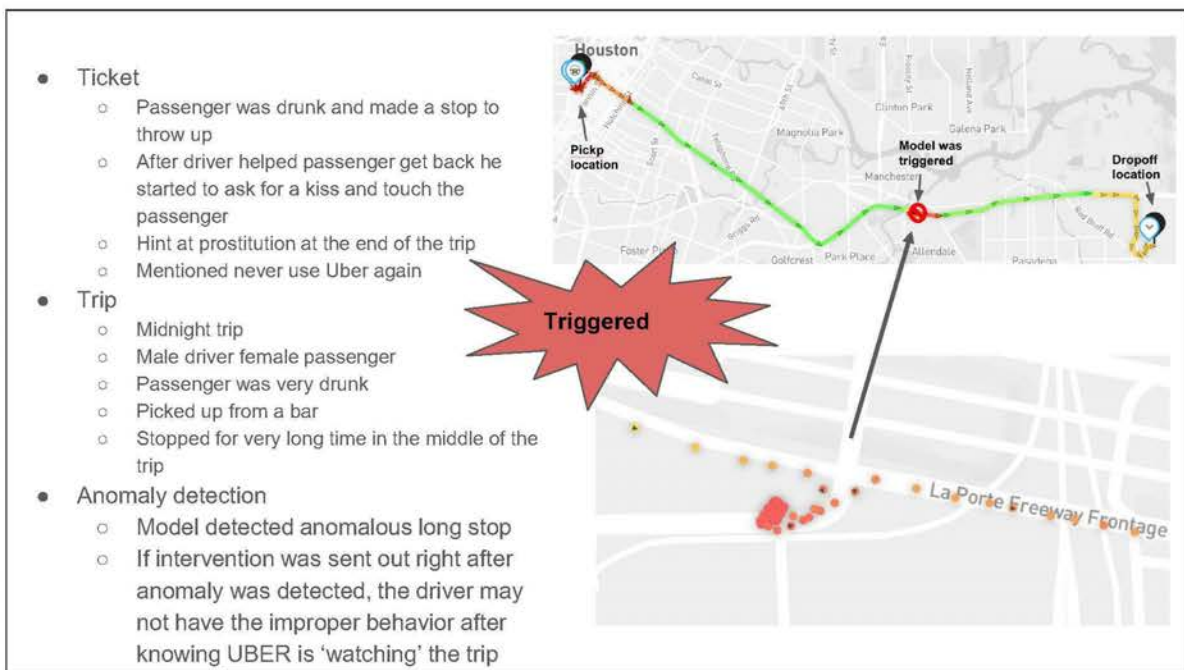
Naive Prediction Rule: Predict trip will end in sexual assault if:

- Trip time between 7pm-5am,
- Driver-rider different gender,
- Current ETA + time elapsed exceeds 1.8 times initial ETA; and current ETA + time elapsed exceeds initial ETA + 15 minutes

Trigger Rate	Recall	Lift in Ticket Rate
All UberX US Sexual Assaults		
0.55%	9.7% (56/575)	17.6X
Non-Consensual Intercourse Only		
0.55%	18.8% (12/64)	34.2X

Notes:

- Trigger rate is calculated from all UberX trips in the first week of Nov in LA
- Recall on SA tickets is calculated from all UberX SA trips from Oct 1st to Dec 31st 2016 that have data stored in the ETA table
 - 11% SA trips lost data in ETA table
 - LB on recall is 8.7%
- Recall on Rape tickets is calculated from all UberX Rape ticket trips from Aug 1st to Dec 31st 2016 that have data stored in the ETA table
 - 32% Rape trips lost data in ETA table
 - LB on recall is 12.8%

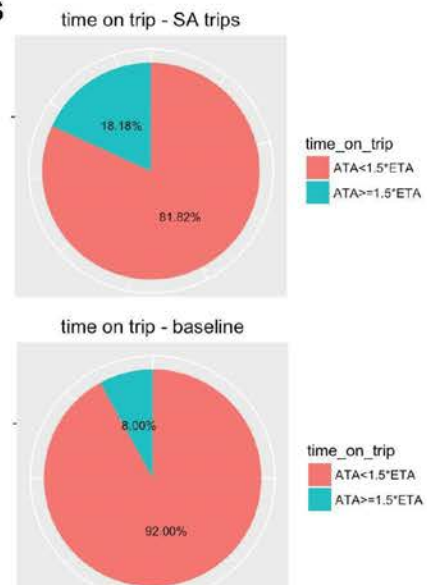


Case 2: triggered

Characteristics of Sexual Assault Trips

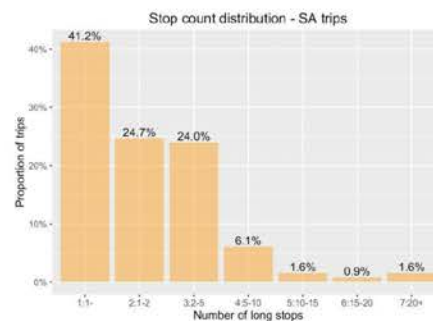
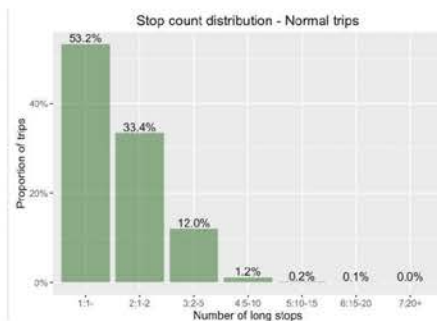
- $\frac{1}{5}$ of the sexual assault trips take 50% longer than initial ETA
- $\frac{1}{3}$ out of those anomalous sexual assault trips are caught by the model

**Distribution over SA trips is based on all US&Canada UberX SA trips from 2016/10/01 - 2017-01-01;
Distribution for the baseline is based on all UberX trips that are longer than 5 miles in Chicago from 2016-10-01 - 2016-10-07*



Focus on sexual assault trips and check the ticket distributions

SA Trips Have More Long Stops (refreshed data with 2017 Dec)



Avg. Number of Long Stops - Normal Trips	Avg. Number of Long Stops - SA Trips	P-value (T-test)	Relative Difference
0.73	1.99	<0.001	173%

Notes: Normal Trips refer to all UberX in the first week of Nov 2016 in LA; SA trips refer to all US UberX SA trips from Dec 1st 2017 to Dec 31st 2017 that have data stored in the ETA table

Stop: the progress made to destination at any checkpoint is less than 10m compared to the previous checkpoint.