

CS145: Project 3 | Project Name

Collaborators:

Please list the names and SUNet IDs of your collaborators below:

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Project Overview

In this project we have analyzed which factors do play their part on Fare Prediction. For this purpose we are opt to apply one of the machine learning technique i.e. Linear Regression . The coming trip expenditures can be calculated by given factors such as Distance Travelled, trip duration and trip fare. in a scenario the customer pays cash, the tips may not be recorded in the dataset. Thus, we will predict the tips that were payed by cash and have left as zero in the dataset.

Analysis of Dataset

The dataset for bigquery-public-data.chicago_taxi_trips only contains 1 table - taxi_trips. The table size is 67.71 GB. There are 187,002,005 rows. The table contains information about the pickup and dropoff time and location, the fare amount, tolls, and the total cost of the trip, and the trip duration and total distance traveled as well as different taxi companies.

```
# Run this cell to authenticate yourself to BigQuery
from google.colab import auth
auth.authenticate_user()
project_id = "majestic-layout-309206"
```

```
# Initialize BiqQuery client
from google.cloud import bigquery
client = bigquery.Client(project=project_id)
```

```
%matplotlib inline
# Add imports for any visualization libraries you may need
```

```
import matplotlib.pyplot as plt

# Run this cell to create a dataset to store your model, or create in the UI

model_dataset_name = 'chicago_taxi_fare'

dataset = bigquery.Dataset(client.dataset(model_dataset_name))
dataset.location = 'US'
client.create_dataset(dataset)
```

Data Exploration

To make sure that our data is normalized for training, we assume trip distance, trip duration, trip fare and taxi company have finite value by filtering out all rows containing NULL value(s) and removing non-related columns. The following table is a sample of cleaned dataset. We will use this dataset for data exploration and prediction.

```
SELECT trip_start_timestamp,
trip_end_timestamp,
trip_seconds,
trip_miles,
fare,
tips,
trip_total,
payment_type,
company,
pickup_latitude, pickup_longitude, dropoff_latitude, dropoff_longitude
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE trip_seconds>0
AND trip_miles>0
AND fare>0
AND trip_total>0
AND payment_type IS NOT NULL
AND company IS NOT NULL
AND pickup_latitude IS NOT NULL
AND pickup_longitude IS NOT NULL
AND dropoff_latitude IS NOT NULL
AND dropoff_longitude IS NOT NULL

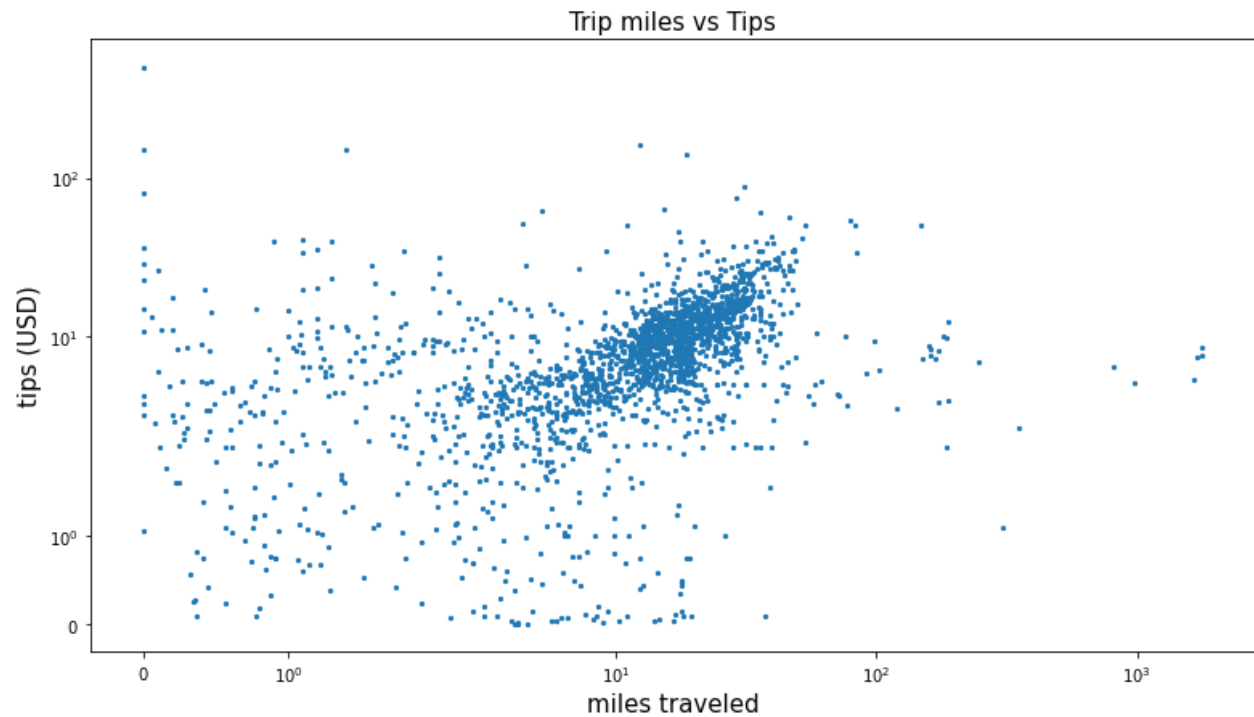
%%bigquery --project $project_id
SELECT *
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
LIMIT 10
```

	unique_key	1
0	e5a43898bc158ed36b1e106000bb346f382cf3d5	374daef85c3438787be7fa1399d4a3fc39670fa8b
1	614072e4ed5ffa07906bb2f955c276c536cf1886	ecbd0442d6b871f22f17122917c37190e9aaf0986
2	93b79cc43231b49e384fdf9562b44e0995540bad	5e48748b582fe3c16baf5ac371a27773e8aef2927
3	f3e0f3546b725eb920cb70101deec1834a158ad6	7f8be35bf085d7490245401fe27b274624245d8e7
4	07b34e999c0238794aa692238ae694310b5b9a2a	bc77aa4e4ea60e032d26d6ef6d8e73d49b985a2e7
5	1ee13c79df664083f10b5bd9706de56169d33df6	7274daf07dd4da878465e03ee2f72165d7e044bcd
6	b8903d18ddeab9e4d69ca2d9883d072e075ec182	d95b99518116b5f943d75828e78c02e668ec6add7
7	4aeed775970a30fd7da6dadd2550c6612a6ad946	a44086df314a5d983b8f1029ac487a6c6d4bc5341
8	f9f0365780ed971fdc5e0958122786027d5a2040	7cda3cbbf6cc9524c807fb5ec5e4ca397f1b736f
9	f3fdabcbf36a71ddc53d1de1967b2fb613834bc4	7b71bd5b43b70999e3c9e047b26bdb5d01cd3ed93

```
%%bigquery --project $project_id miles_tips
SELECT DISTINCT trip_miles, tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0
```

```
miles_tips_sub = miles_tips.sample(2000)
plt.figure(figsize=(13, 7))
plt.scatter(miles_tips_sub["trip_miles"], miles_tips_sub["tips"], s=5)
plt.yscale('symlog')
plt.xscale('symlog')
plt.xlabel('miles traveled', fontsize=15)
plt.ylabel('tips (USD)', fontsize=15)
plt.title('Trip miles vs Tips', fontsize=15)
```

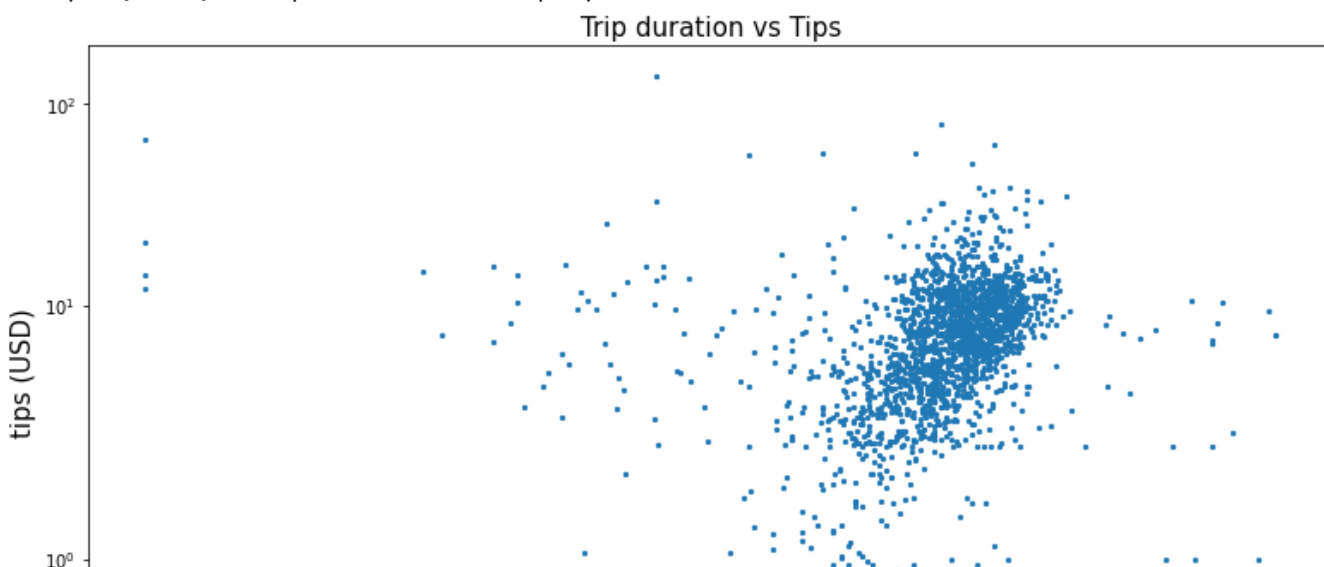
```
Text(0.5, 1.0, 'Trip miles vs Tips')
```



```
%%bigquery --project $project_id seconds_tips
SELECT DISTINCT trip_seconds, tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0
```

```
seconds_tips_sub = seconds_tips.sample(2000)
plt.figure(figsize=(13, 7))
plt.scatter(seconds_tips_sub["trip_seconds"], seconds_tips_sub["tips"], s=5)
plt.yscale('symlog')
plt.xscale('symlog')
plt.xlabel('trip duration (s)', fontsize=15)
plt.ylabel('tips (USD)', fontsize=15)
plt.title('Trip duration vs Tips', fontsize=15)
```

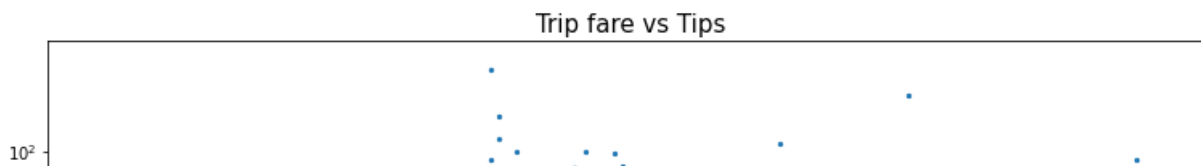
Text(0.5, 1.0, 'Trip duration vs Tips')



```
%%bigquery --project $project_id fare_tips
SELECT DISTINCT fare, tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0
```

```
fare_tips_sub = fare_tips.sample(2000)
plt.figure(figsize=(13, 7))
plt.scatter(fare_tips_sub["fare"], fare_tips_sub["tips"], s=5)
plt.yscale('symlog')
plt.xscale('symlog')
plt.xlabel('trip fare (USD)', fontsize=15)
plt.ylabel('tips (USD)', fontsize=15)
plt.title('Trip fare vs Tips', fontsize=15)
```

Text(0.5, 1.0, 'Trip fare vs Tips')



```
%%bigquery --project $project_id
SELECT company, COUNT(*) count, AVG(tips) avg_tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0 AND trip_miles>0 AND company IS NOT NULL
GROUP BY company
ORDER BY count DESC
LIMIT 10
```

	company	count	avg_tips
0	Taxi Affiliation Services	9669788	3.820970
1	Flash Cab	6214400	3.539800
2	Yellow Cab	3877946	3.198646
3	Chicago Carriage Cab Corp	3537433	3.922769
4	Dispatch Taxi Affiliation	3079220	3.378661
5	Choice Taxi Association	2882806	3.753596
6	Sun Taxi	2471739	4.103353
7	City Service	2439335	3.932554
8	Medallion Leasin	2071039	3.954155
9	Taxi Affiliation Service Yellow	1513190	3.958902

So our first question to be answered was which company will get more previliges and on what basis ?

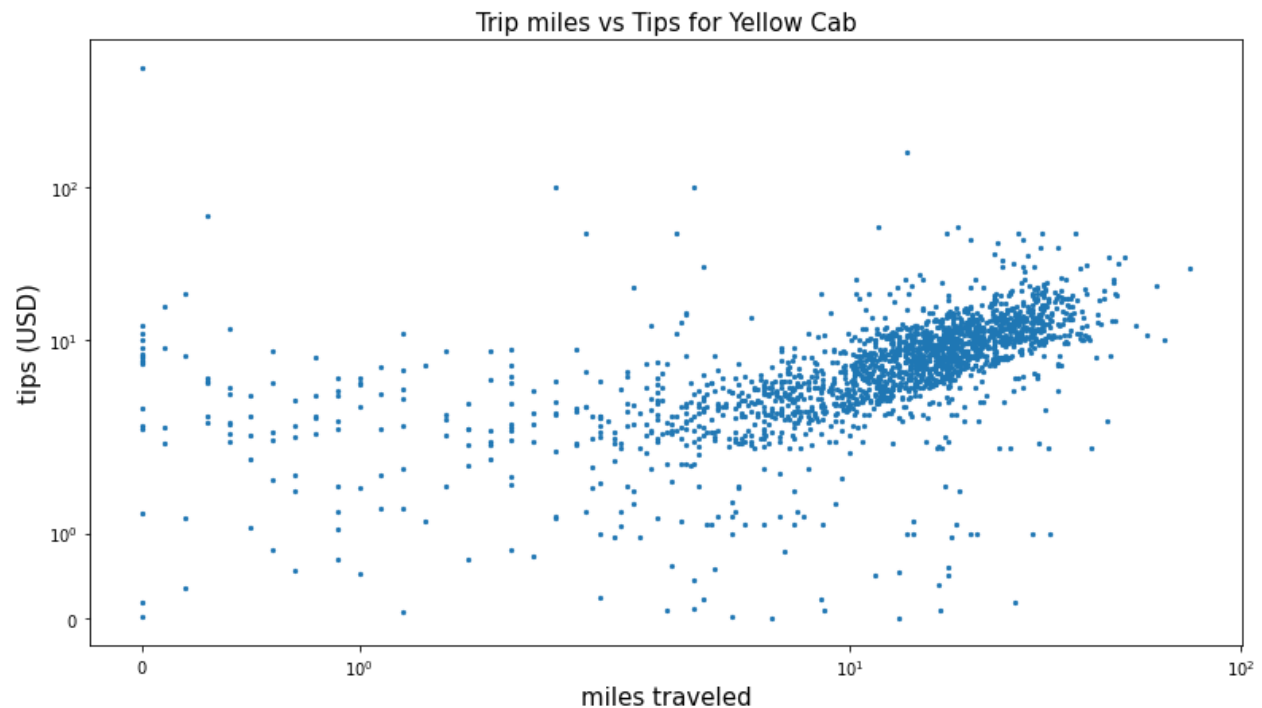
The answe to above question is that the company will receive more incentive and previliges on the terms of tips , means the more tips a company gets on average the more it will prosper in future as tips is depending on satisfaction of the rider.

```
%%bigquery --project $project_id miles_tips_yc
SELECT DISTINCT trip_miles, tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0 AND company LIKE 'Yellow Cab'
```

```
miles_tips_yc_sub = miles_tips_yc.sample(2000)
plt.figure(figsize=(13, 7))
plt.scatter(miles_tips_yc_sub["trip_miles"], miles_tips_yc_sub["tips"], s=5)
plt.xlabel('trip_miles')
```

```
plt.yscale('symlog')
plt.xscale('symlog')
plt.xlabel('miles traveled', fontsize=15)
plt.ylabel('tips (USD)', fontsize=15)
plt.title('Trip miles vs Tips for Yellow Cab', fontsize=15)
```

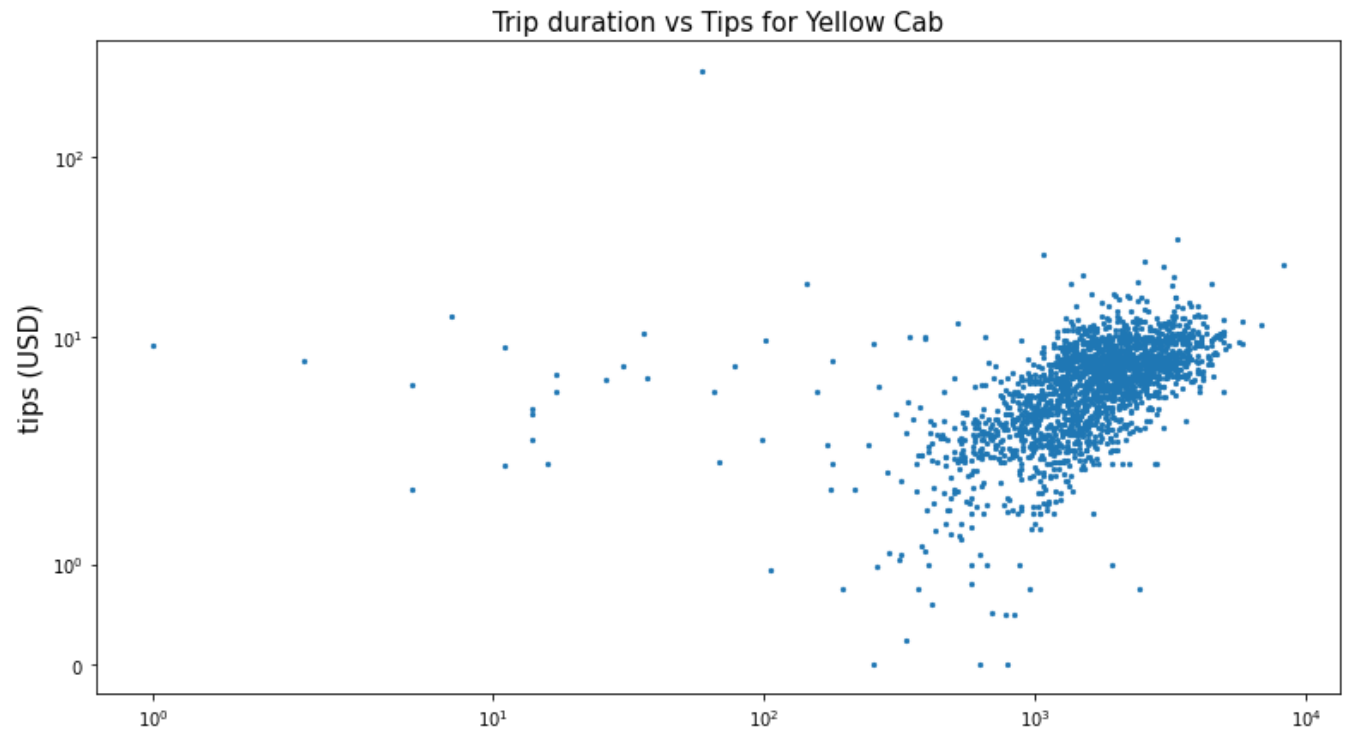
```
Text(0.5, 1.0, 'Trip miles vs Tips for Yellow Cab')
```



```
%%bigquery --project $project_id seconds_tips_yc
SELECT DISTINCT trip_seconds, tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0 AND company LIKE 'Yellow Cab'
```

```
seconds_tips_yc_sub = seconds_tips_yc.sample(2000)
plt.figure(figsize=(13, 7))
plt.scatter(seconds_tips_yc_sub["trip_seconds"], seconds_tips_yc_sub["tips"], s=5)
plt.yscale('symlog')
plt.xscale('symlog')
plt.xlabel('trip duration (s)', fontsize=15)
plt.ylabel('tips (USD)', fontsize=15)
plt.title('Trip duration vs Tips for Yellow Cab', fontsize=15)
```

Text(0.5, 1.0, 'Trip duration vs Tips for Yellow Cab')

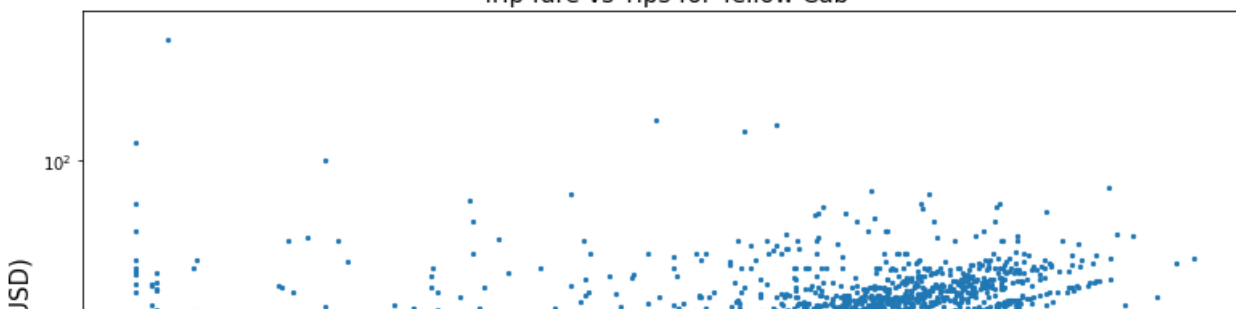


```
%%bigquery --project $project_id fare_tips_yc
SELECT DISTINCT fare, tips
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE tips>0 AND company LIKE 'Yellow Cab'
```

```
fare_tips_yc_sub = fare_tips_yc.sample(2000)
plt.figure(figsize=(13, 7))
plt.scatter(fare_tips_yc_sub["fare"], fare_tips_yc_sub["tips"], s=5)
plt.yscale('symlog')
plt.xscale('symlog')
plt.xlabel('trip fare (USD)', fontsize=15)
plt.ylabel('tips (USD)', fontsize=15)
plt.title('Trip fare vs Tips for Yellow Cab', fontsize=15)
```


Text(0.5, 1.0, 'Trip fare vs Tips for Yellow Cab')

Trip fare vs Tips for Yellow Cab



Data Prediction

*AS mentioned earlier we will use only non zero value of tips to refrain from any anomalies in training our models. We will split data Training: trip start time < 2016-01-01 Validation: trip start time between 2016-01-01 and 2017-01-01 Test: trip start time between 2017-01-01 and 2018-01-01

Note that since from the above visualization, we found the linear relation between distance, duration, fare and tips is in log-log scale; therefore, we take the log of both feature and label to make sure they also exhibit the linear relation.

```
%bigquery --project $project_id
CREATE OR REPLACE MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v1`
OPTIONS(model_type='linear_reg') AS
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_miles+1) AS feature1
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp < '2016-01-01' AND tips>0
```

```
%bigquery --project $project_id
SELECT
*
FROM
ML.TRAINING_INFO(MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v1`)
```

training_run	iteration	loss	eval_loss	learning_rate	duration_ms	
0	0	0	0.438542	0.435014	None	5764

```
%bigquery --project $project_id
# YOUR QUERY HERE
```

```

SELECT
*
FROM
ML.EVALUATE(MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v1`, (
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_miles+1) AS feature1
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp BETWEEN '2016-01-01' AND '2017-01-01' AND tips>0))

```

	mean_absolute_error	mean_squared_error	mean_squared_log_error	median_absolu
0	0.449509	0.36731	0.05036	

```

%%bigquery --project $project_id
CREATE OR REPLACE MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v2`
OPTIONS(model_type='linear_reg') AS
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_seconds+1) AS feature1
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp < '2016-01-01' AND tips>0

```

```

%%bigquery --project $project_id
SELECT
*
FROM
ML.TRAINING_INFO(MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v2`)

```

	training_run	iteration	loss	eval_loss	learning_rate	duration_ms
0	0	0	0.309395	0.301619	None	9027

```

%%bigquery --project $project_id
# YOUR QUERY HERE
SELECT
*
FROM
ML.EVALUATE(MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v2`, (
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_seconds+1) AS feature1
FROM

```

```
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp BETWEEN '2016-01-01' AND '2017-01-01' AND tips>0))
```

	mean_absolute_error	mean_squared_error	mean_squared_log_error	median_absolu
0	0.423385	0.29236	0.039235	

```
%%bigquery --project $project_id
CREATE OR REPLACE MODEL `chicago_taxi.chicago_taxi_tips_model_v3`
OPTIONS(model_type='linear_reg') AS
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_seconds+1) AS feature1,
LOG(trip_miles+1) AS feature2
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp < '2016-01-01' AND tips>0
```

```
%%bigquery --project $project_id
SELECT
*
FROM
ML.TRAINING_INFO(MODEL `chicago_taxi.chicago_taxi_tips_model_v3`)
```

	training_run	iteration	loss	eval_loss	learning_rate	duration_ms
0	0	0	0.224457	0.220545	None	24470

```
%%bigquery --project $project_id
# YOUR QUERY HERE
SELECT *
FROM
ML.EVALUATE(MODEL `chicago_taxi.chicago_taxi_tips_model_v3`, (
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_seconds+1) AS feature1,
LOG(trip_miles+1) AS feature2
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp BETWEEN '2016-01-01' AND '2017-01-01' AND tips>0))
```

```

mean_absolute_error mean_squared_error mean_squared_log_error median_absolute_error

%%bigquery --project $project_id
CREATE OR REPLACE MODEL `chicago_taxi.chicago_taxi_tips_model_v4`
OPTIONS(model_type='linear_reg') AS
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_seconds+1) AS feature1,
LOG(trip_miles+1) AS feature2,
LOG(fare+1) AS feature3
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp < '2016-01-01' AND tips>0

%%bigquery --project $project_id
SELECT
*
FROM
ML.TRAINING_INFO(MODEL `chicago_taxi.chicago_taxi_tips_model_v4`)

%%bigquery --project $project_id
# YOUR QUERY HERE
SELECT
*
FROM
ML.EVALUATE(MODEL `chicago_taxi.chicago_taxi_tips_model_v4`, (
SELECT DISTINCT
LOG(tips+1) AS label,
LOG(trip_seconds+1) AS feature1,
LOG(trip_miles+1) AS feature2,
LOG(fare+1) AS feature3
FROM
`bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE
trip_start_timestamp BETWEEN '2016-01-01' AND '2017-01-01' AND tips>0))

%%bigquery --project $project_id
# YOUR QUERY HERE
SELECT
*
FROM
  ML.PREDICT(MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v2`, (
SELECT DISTINCT
LOG(trip_seconds+1) AS feature1,
LOG(trip_miles+1) AS feature2,
LOG(fare+1) AS feature3
FROM
  `bigquery-public-data.chicago_taxi_trips.taxi_trips`
WHERE

```

```
trip_start_timestamp BETWEEN '2017-01-01' AND '2018-01-01' AND tips=0.0 AND company LIKE 'Ye
LIMIT 10))
```

	predicted_label	feature1	feature2	feature3
0	1.818325	6.968850	0.693147	2.351375
1	1.618514	5.389072	0.530628	1.832581
2	1.848649	7.208600	2.186051	3.188417
3	1.780463	6.669498	1.435085	2.583998
4	1.774884	6.625392	1.163151	2.397895
5	1.642628	5.579730	0.530628	1.871802
6	1.763482	6.535241	1.945910	2.917771
7	1.703557	6.061457	0.993252	2.169054
8	1.747455	6.408529	1.386294	2.442347
9	1.683469	5.902633	0.993252	2.110213

these are the predictions for the tips paid by cash of the trips offered by Yellow Cab. To get the actual values we have to simple that $2^{(\text{predicted_label})}$

Conclusion

-
- Only that company will receive more incentive and previliges on the terms of tips , means the more tips a company gets on average the more it will prosper in future as tips is depending on satisfaction of the rider i.eTaxi Affiliation Services
 - From the above exploration, we found that the tips of a taxi trip are correlated to traveling distance, duration and fare. We also make the predictions for the tips which are missing in the data.
-

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