CS145: Project 3 | Project Name

Collaborators:

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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 = "emerald-griffin-321112"


# 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)
```

```
     Dataset(DatasetReference('emerald-griffin-321112', 'chicago_taxi_fare'))
```

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
```

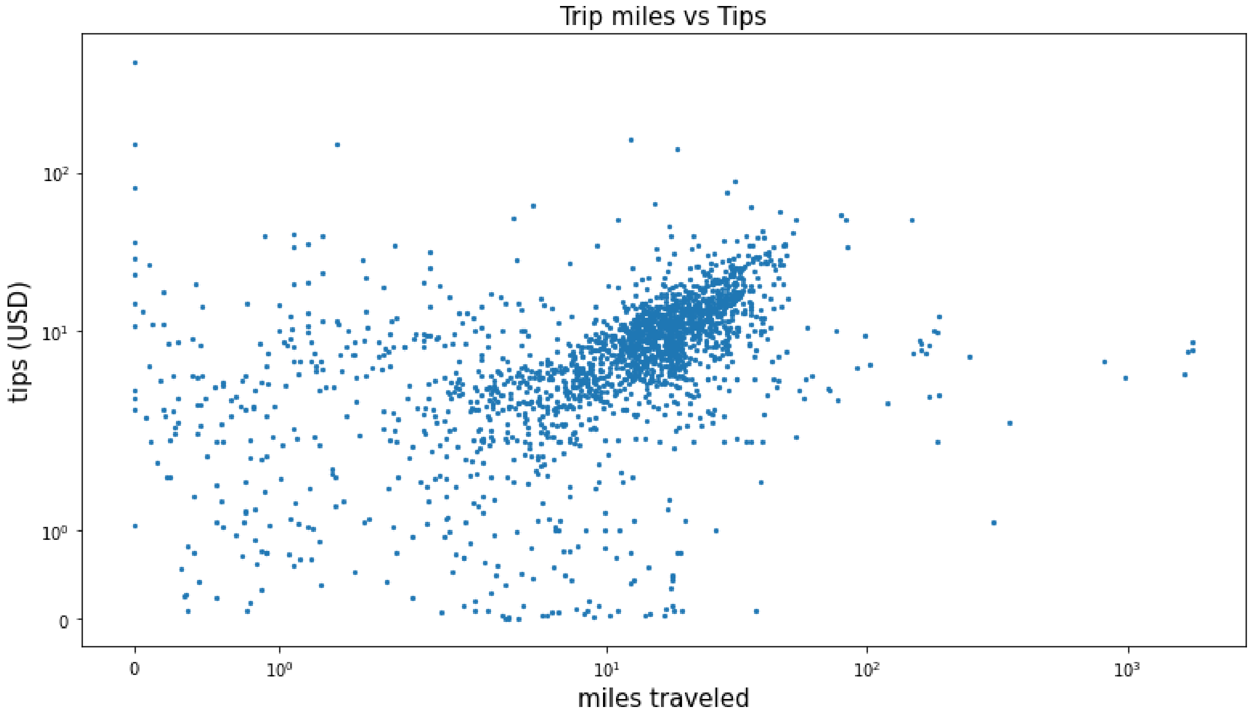
```
%%bigquery --project $project_id
SELECT *
FROM `bigquery-public-data.chicago_taxi_trips.taxi_trips`
LIMIT 10
```

	unique_key	
0	e5a43898bc158ed36b1e106000bb346f382cf3d5	374daef85c3438787be7fa1399d4a3fc396
1	614072e4ed5ffa07906bb2f955c276c536cf1886	ecbd0442d6b871f22f17122917c37190e9a
2	93b79cc43231b49e384fdf9562b44e0995540bad	5e48748b582fe3c16baf5ac371a27773e8a
3	f3e0f3546b725eb920cb70101deec1834a158ad6	7f8be35bf085d7490245401fe27b27462424
4	07b34e999c0238794aa692238ae694310b5b9a2a	bc77aa4e4ea60e032d26d6ef6d8e73d49b98
5	1ee13c79df664083f10b5bd9706de56169d33df6	7274daf07dd4da878465e03ee2f72165d7e

```
%%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)
```

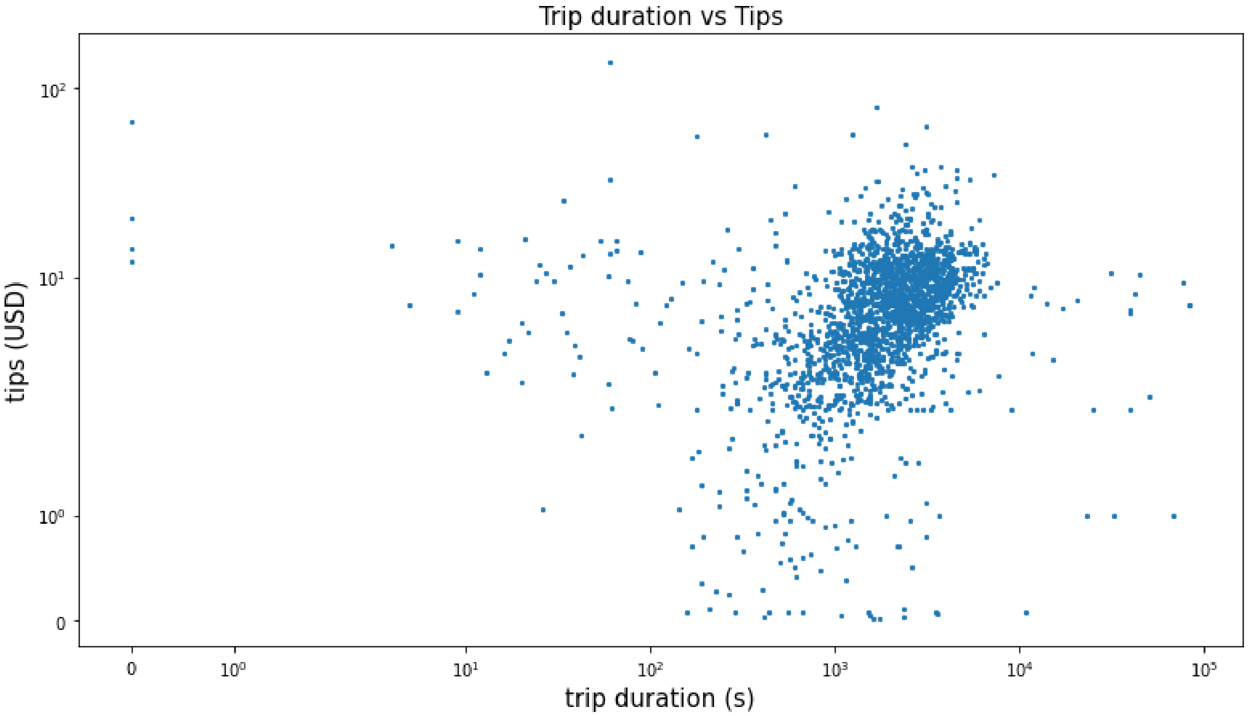
```
Text(0.5, 1.0, 'Trip miles vs Tips')
```



```
%%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)
```

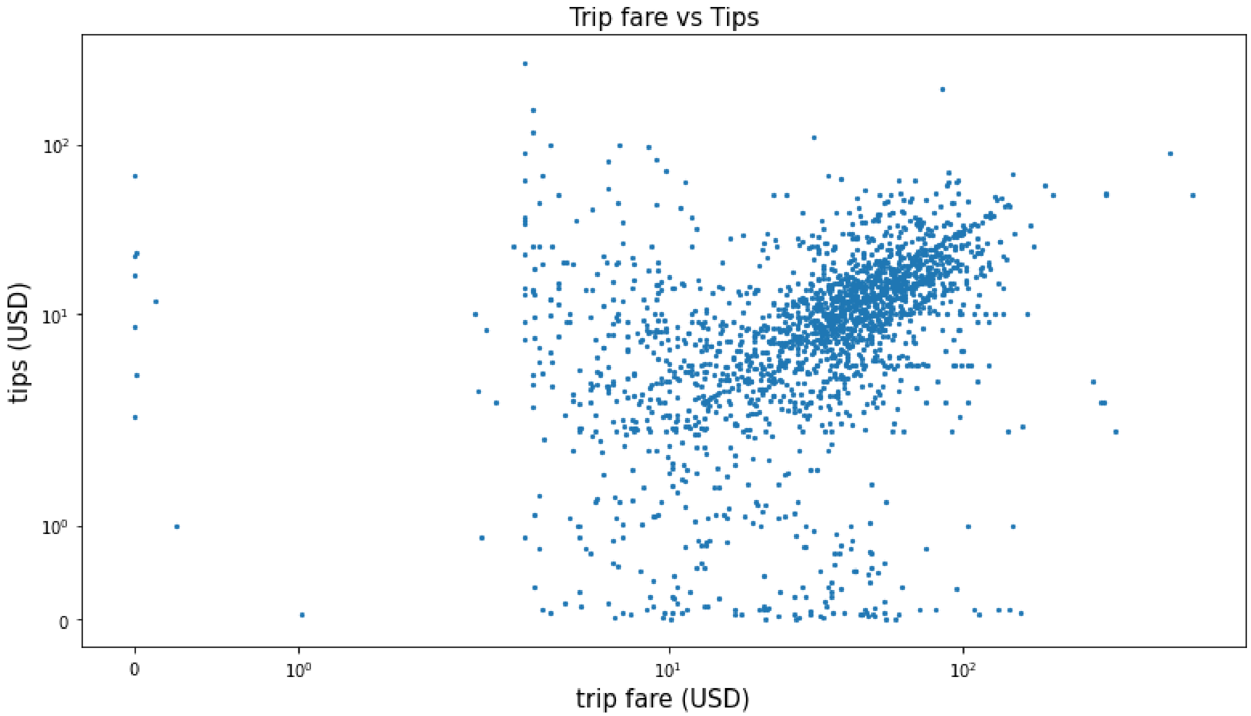
```
Text(0.5, 1.0, 'Trip duration vs Tips')
```



```
%%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

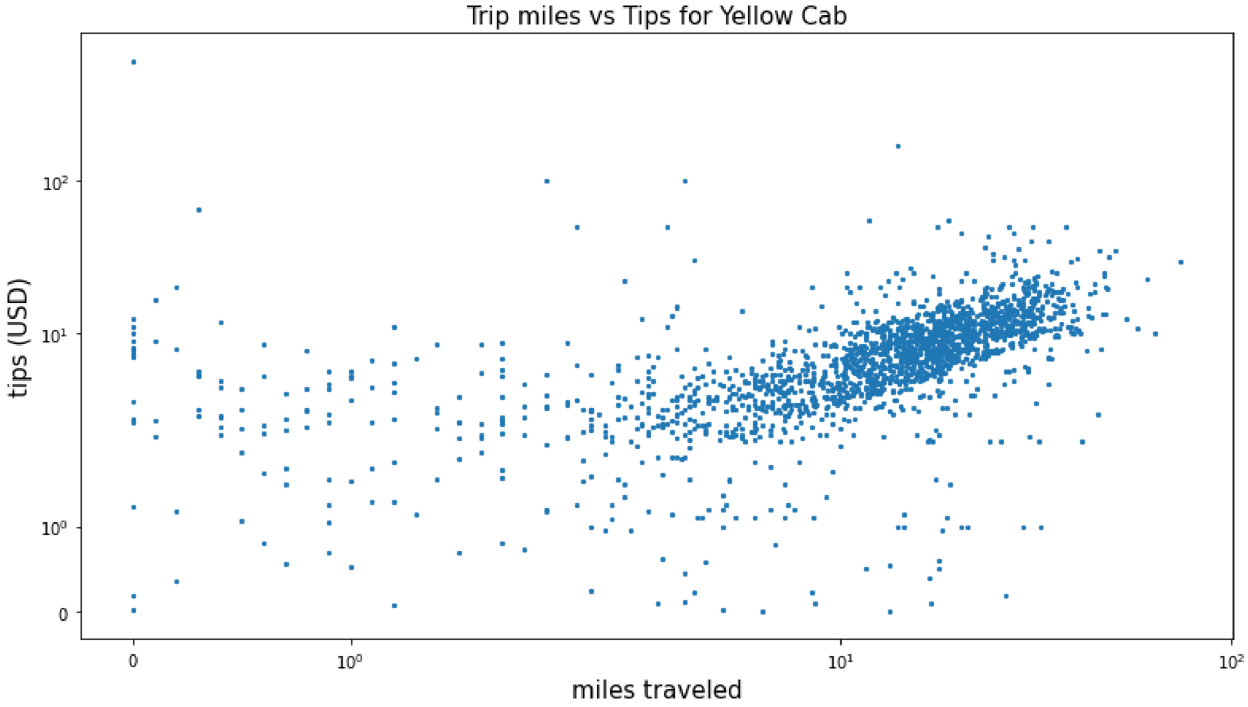
So our first question to be answered was which company will get more previliges and on what basis ?

The answere to above question is that the company will receive more incentive and previligeson 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.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)
```

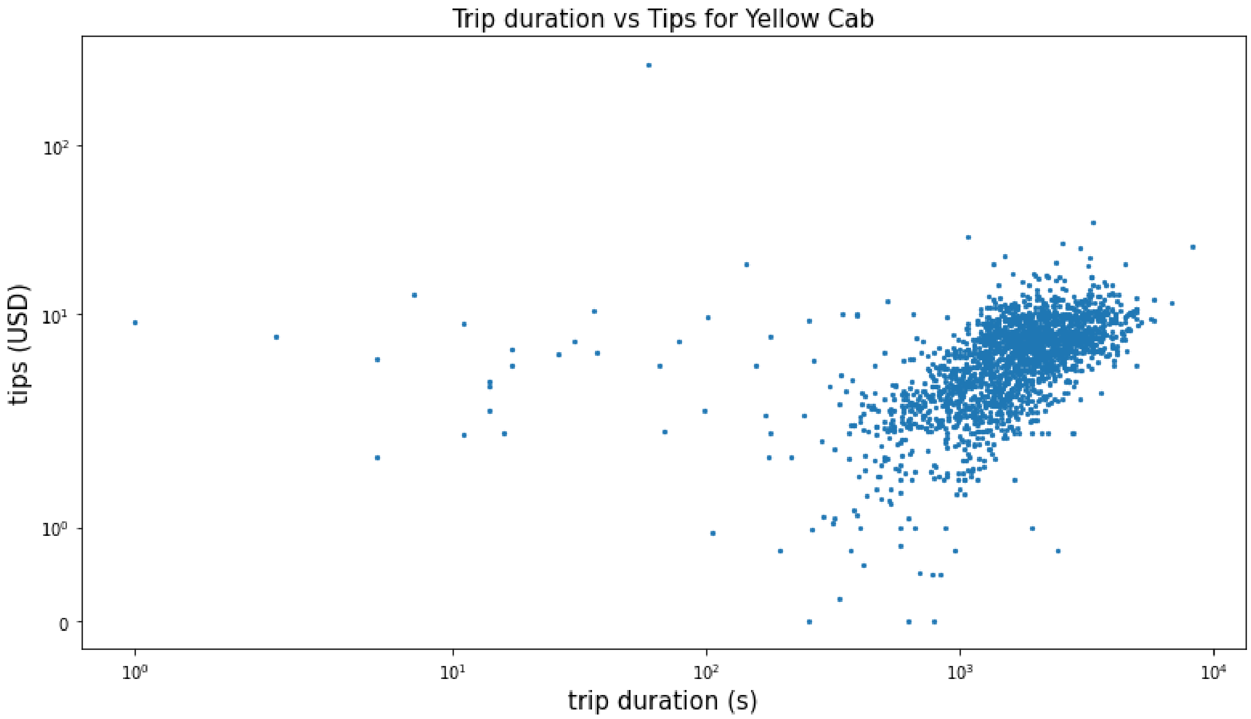
```
Text(0.5, 1.0, 'Trip miles vs Tips for Yellow Cab')
```



```
%%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)
```

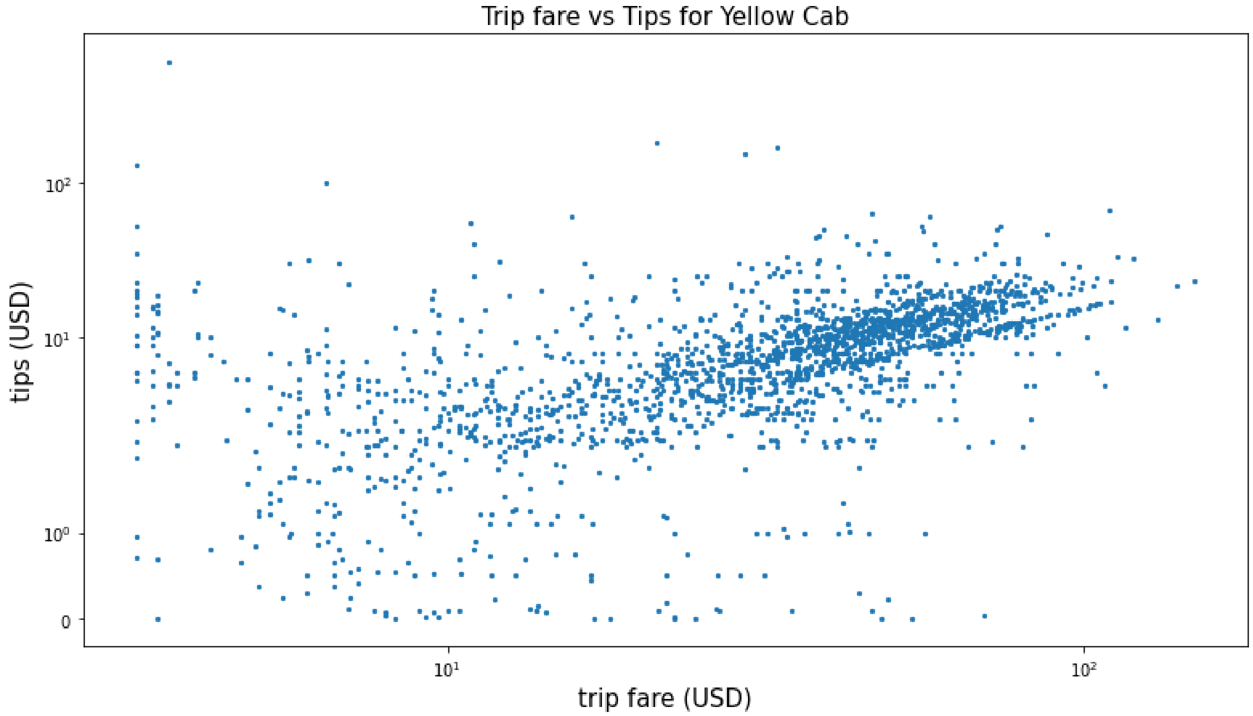
```
Text(0.5, 1.0, 'Trip duration vs Tips for Yellow Cab')
```



```
%%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')
```



Data Prediction

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*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
```

```
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_absolu
0	0.329475	0.195173	0.030569	

```
%%bigquery --project $project_id
CREATE OR REPLACE MODEL `chicago_taxi_fare.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
```

```
FROM
ML.TRAINING_INFO(MODEL `chicago_taxi_fare.chicago_taxi_tips_model_v4`)
```

	training_run	iteration	loss	eval_loss	learning_rate	duration_ms
0	0	0	0.150985	0.146353	None	17407

```
%%bigquery --project $project_id
# YOUR QUERY HERE
SELECT
*
FROM
ML.EVALUATE(MODEL `chicago_taxi_fare.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))
```

	mean_absolute_error	mean_squared_error	mean_squared_log_error	median_absolu
0	0.299485	0.273187	0.096073	

```
%%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 'Yellow Cab' AND payment_type LIKE
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 payed by cash of the trips offered by Yellow Cab.

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.
