0. Overview

This project analyzes New York City yellow taxi trips in 2016 using the publicly available dataset from Google BigQuery: bigquery-public-data.new_york_taxi_trips.tlc_yellow_trips_2016 (https://bigquery.cloud.google.com/dataset/bigquery-public-data:new_york).

The objective is to uncover patterns in ride behavior, evaluate driver earnings, and explore the impact of various factors—such as trip length, time of day, and weather—on taxi activity and tipping behavior.

We aim to answer the following five questions:

1. How does the number of taxi rides vary over time of day?
2. What types of trips are common?
    - Create your own definition of short, medium, and long trip
    - Show what percentage of rides fall into each category.
3. Are short or long trips better for drivers?
    - Compare how much money drivers earn from each type of trip.
4. Can the weather explain changes in taxi activity?
    - Try to find a connection between weather and the number of taxi rides.
5. How can drivers earn more tips?
    - Based on your analysis, what advice would you give a driver to help them increase their tips?

1. Data Loading

```
# Load data from bigquery
from google.cloud import bigquery
from google.colab import auth
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
import numpy as np

# Authenticate and initialize BigQuery client
auth.authenticate_user()
project_id = "pure-ivy-465314-k4"
client = bigquery.Client(project=project_id)


# Query taxi data (sample for January 2016)
query = """
SELECT
  pickup_datetime,
  dropoff_datetime,
  passenger_count,
  trip_distance,
  fare_amount,
  tip_amount,
  total_amount,
  payment_type,
  pickup_location_id,
  dropoff_location_id
FROM `bigquery-public-data.new_york_taxi_trips.tlc_yellow_trips_2016`
WHERE pickup_datetime BETWEEN '2016-01-01' AND '2016-01-31'
  AND trip_distance > 0
  AND fare_amount > 0
LIMIT 100000
"""
df = client.query(query).to_dataframe()
df.head
```

```
pandas.core.generic.NDFrame.head
def head(n: int=5) -> Self

/usr/local/lib/python3.11/dist-packages/pandas/core/generic.py
Return the first `n` rows.

This function returns
on position. It is useful for quickly testing if your object
has the right type of data in it.
```

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2. Data Cleaning & Preprocessing

```
# Convert datetime fields
df['pickup_datetime'] = pd.to_datetime(df['pickup_datetime'])
df['dropoff_datetime'] = pd.to_datetime(df['dropoff_datetime'])

# Add derived features
df['hour'] = df['pickup_datetime'].dt.hour
df['weekday'] = df['pickup_datetime'].dt.day_name()
df['trip_duration'] = (df['dropoff_datetime'] - df['pickup_datetime']).dt.total_seconds() / 60

# Define trip categories
def categorize_trip(dist):
    if dist <= 2:
        return 'Short'
    elif dist <= 6:
        return 'Medium'
    else:
        return 'Long'
df['trip_type'] = df['trip_distance'].apply(categorize_trip)
```

```
df.head
```

```
pandas.core.generic.NDFrame.head
def head(n: int=5) -> Self
```

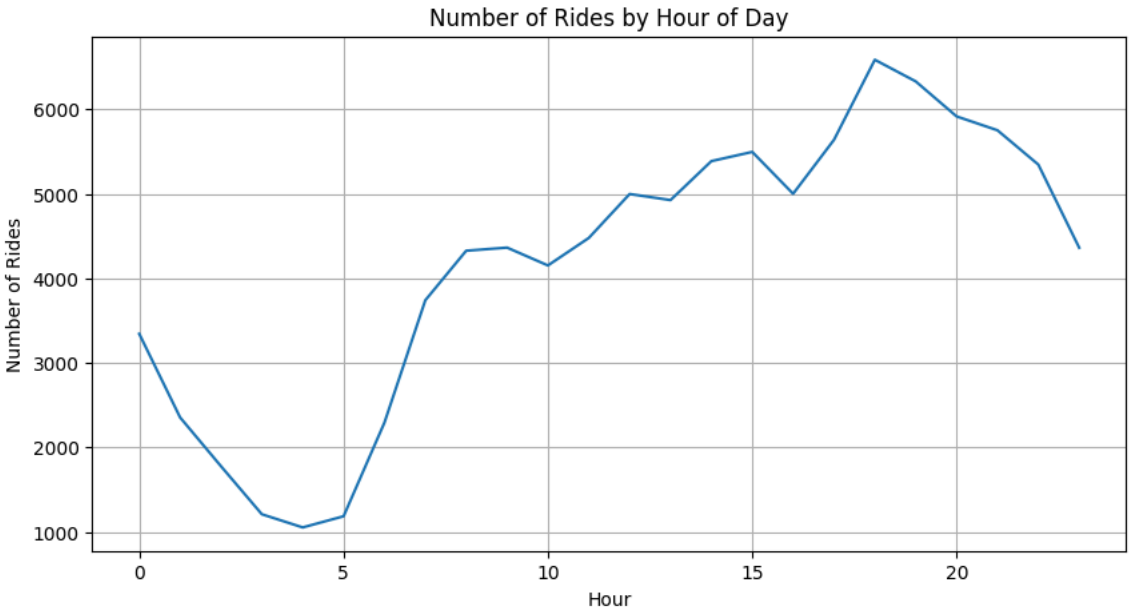
```
/usr/local/lib/python3.11/dist-packages/pandas/core/generic.py
Return the first `n` rows.

This function returns the first `n` rows for the object based
on position. It is useful for quickly testing if your object
has the right type of data in it.
```

3. Exploratory Data Analysis & Questions

Q1: How does the number of taxi rides vary over time of day?

In this section, we explore how taxi ride volume fluctuates throughout the day. By aggregating the number of trips by hour (0–23), we aim to identify peak and off-peak periods of demand.

```
rides_by_hour = df.groupby('hour').size()
plt.figure(figsize=(10,5))
sns.lineplot(x=rides_by_hour.index, y=rides_by_hour.values)
plt.title('Number of Rides by Hour of Day')
plt.xlabel('Hour')
plt.ylabel('Number of Rides')
plt.grid(True)
plt.show()
```

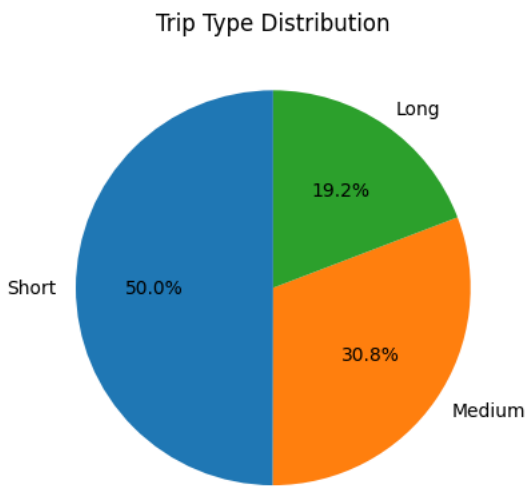


Q2: What types of trips are common?

Based on the cleaned and processed data, trips are categorized by trip_distance into three types:

- Short trips: distance ≤ 2 miles
- Medium trips: distance between 2 and 6 miles
- Long trips: distance > 6 miles

```
trip_type_counts = df['trip_type'].value_counts(normalize=True)
trip_type_counts.plot(kind='pie', autopct='%1.1f%%', startangle=90)
plt.title('Trip Type Distribution')
plt.ylabel('')
plt.show()
```



Q3: Are short or long trips better for drivers?

```
earnings_by_trip = df.groupby('trip_type')[['fare_amount', 'tip_amount', 'total_amount']].mean()
print(earnings_by_trip)
```

```
           fare_amount tip_amount total_amount
trip_type
Long         45.196745   6.480078    56.317933
Medium       13.196752    1.80894    16.199449
Short          8.40453    1.07964    10.614625
```

Q4: Can the weather explain changes in taxi activity?

In this section, We merged the taxi trip data with weather data to analyze how weather factors relate to taxi activity.

```
# Load daily taxi ride counts for 2016
query_rides_per_day = """
SELECT
  DATE(pickup_datetime) AS date,
  COUNT(*) AS num_rides
FROM `bigquery-public-data.new_york_taxi_trips.tlc_yellow_trips_2016`
WHERE pickup_datetime BETWEEN '2016-01-01' AND '2016-12-31'
GROUP BY date
ORDER BY date
"""
rides_df = client.query(query_rides_per_day).to_dataframe()
rides_df.head()
```

	date	num_rides
0	2016-01-01	345036
1	2016-01-02	312830
2	2016-01-03	302878
3	2016-01-04	316008
4	2016-01-05	343128

后续步骤： 使用 rides_df 生成代码 查看推荐的图表 New interactive sheet

```
# Load daily weather data (precipitation and max temperature) for 2016 from a specific weather station
query_weather = """
SELECT
  DATE(date) AS date,
  element,
  value
FROM `bigquery-public-data.ghcn_d.ghcnd_2016`
WHERE id = 'USW00094728'
  AND element IN ('PRCP', 'TMAX')
"""
weather_raw_df = client.query(query_weather).to_dataframe()
weather_raw_df.head()
```

	date	element	value
0	2016-03-03	TMAX	22.0
1	2016-03-17	PRCP	0.0
2	2016-03-19	TMAX	78.0
3	2016-10-19	TMAX	294.0
4	2016-10-22	TMAX	139.0

后续步骤： 使用 weather_raw_df 生成代码 查看推荐的图表 New interactive sheet

```
# Pivot weather data from long to wide format
weather_df = weather_raw_df.pivot(index='date', columns='element', values='value').reset_index()

# Unit conversion:
# PRCP (precipitation) is originally in tenths of millimeters -> convert to millimeters
# TMAX (max temperature) is originally in tenths of degrees Celsius -> convert to degrees Celsius
weather_df['PRCP'] = weather_df['PRCP'] / 10
weather_df['TMAX'] = weather_df['TMAX'] / 10
weather_df.head()
```

element	date	PRCP	TMAX
0	2016-01-01	0.0	5.6
1	2016-01-02	0.0	4.4
2	2016-01-03	0.0	7.2
3	2016-01-04	0.0	2.2
4	2016-01-05	0.0	-1.6

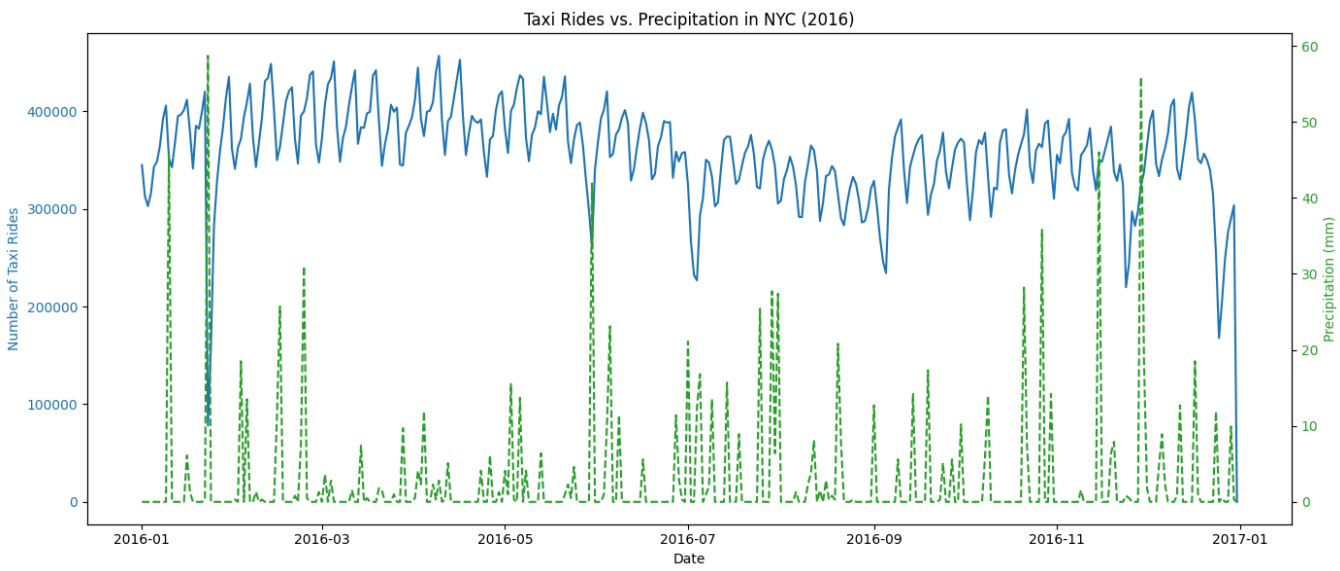
后续步骤： 使用 weather_df 生成代码 查看推荐的图表 New interactive sheet

```
# Merge taxi rides and weather data on the date column (inner join to keep only matching dates)
combined_df = pd.merge(rides_df, weather_df, on='date', how='inner')
combined_df.head()
```

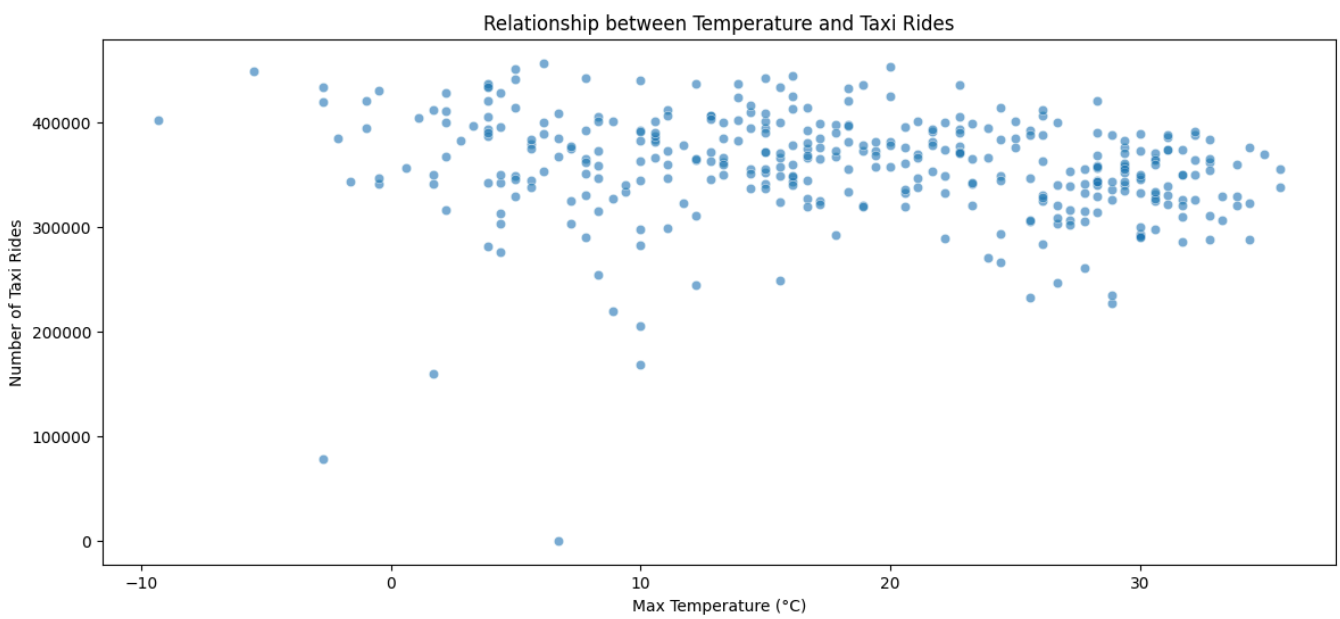
	date	num_rides	PRCP	TMAX
0	2016-01-01	345036	0.0	5.6
1	2016-01-02	312830	0.0	4.4
2	2016-01-03	302878	0.0	7.2
3	2016-01-04	316008	0.0	2.2
4	2016-01-05	343128	0.0	-1.6

后续步骤： 使用 combined_df 生成代码 查看推荐的图表 New interactive sheet

```
# Plot number of taxi rides and precipitation over time with dual y-axes
fig, ax1 = plt.subplots(figsize=(14, 6))

# Plot taxi rides on left y-axis
ax1.set_xlabel("Date")
ax1.set_ylabel("Number of Taxi Rides", color="tab:blue")
ax1.plot(combined_df['date'], combined_df['num_rides'], color="tab:blue", label="Taxi Rides")
ax1.tick_params(axis='y', labelcolor="tab:blue")

# Create a second y-axis sharing the same x-axis for precipitation
ax2 = ax1.twinx()
ax2.set_ylabel("Precipitation (mm)", color="tab:green")
ax2.plot(combined_df['date'], combined_df['PRCP'], color="tab:green", linestyle="--", label="Precipitation")
ax2.tick_params(axis='y', labelcolor="tab:green")

# Set plot title and adjust layout
plt.title("Taxi Rides vs. Precipitation in NYC (2016)")
fig.tight_layout()
plt.show()
```




```
# Scatter plot to visualize relationship between max temperature and number of taxi rides
plt.figure(figsize=(14, 6))
sns.scatterplot(data=combined_df, x='TMAX', y='num_rides', alpha=0.6)
plt.title("Relationship between Temperature and Taxi Rides")
plt.xlabel("Max Temperature (°C)")
plt.ylabel("Number of Taxi Rides")
plt.show()
```



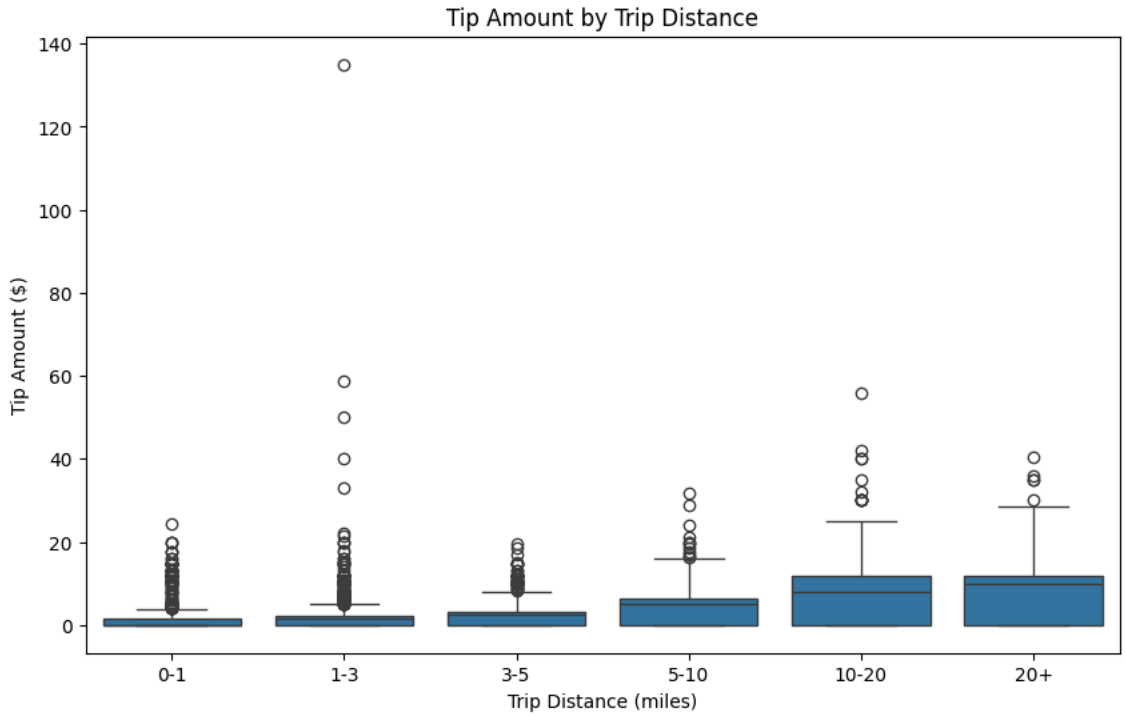
Q5: How can drivers earn more tips?

In this section, we investigate the key factors that may influence the amount of tips received by taxi drivers. We focus on five variables:

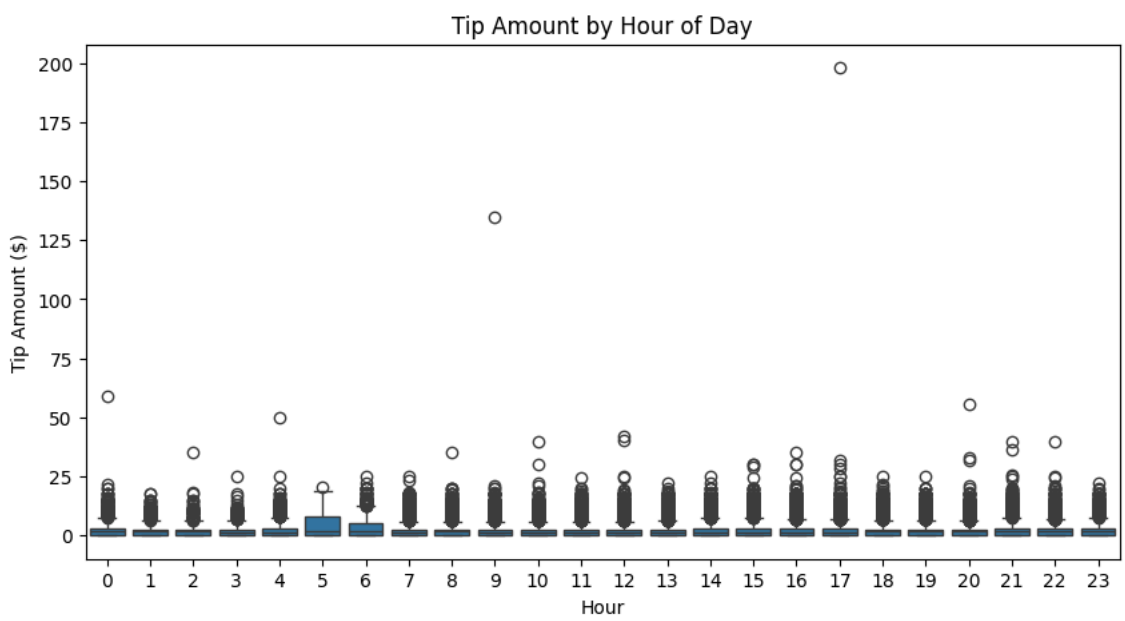
- Trip distance
- Hour of the day
- Trip duration
- Day of the week

Our goal is to identify patterns that help drivers understand when and how they can maximize their tips.

```
# Tip vs Trip Distance
df['distance_bin'] = pd.cut(df['trip_distance'], bins=[0, 1, 3, 5, 10, 20, 50], labels=['0–1','1–3','3–5','5–10','10–20','20

plt.figure(figsize=(10,6))
sns.boxplot(x='distance_bin', y='tip_amount', data=df)
plt.title("Tip Amount by Trip Distance")
plt.xlabel("Trip Distance (miles)")
plt.ylabel("Tip Amount ($)")
plt.show()
```

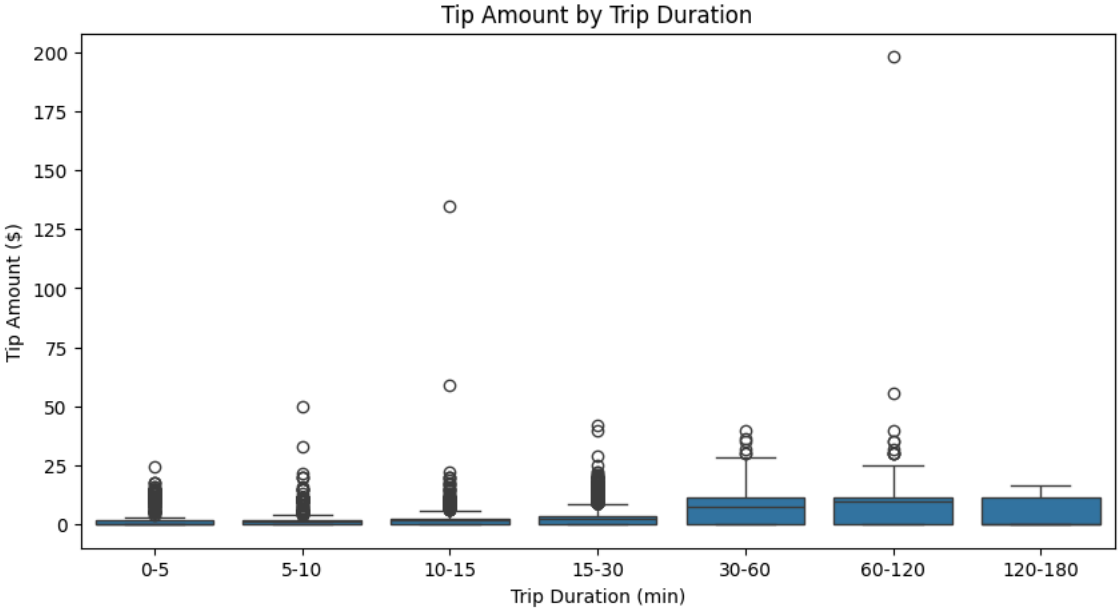



```
# Tip vs Hour of Day
df['hour'] = df['pickup_datetime'].dt.hour

plt.figure(figsize=(10,5))
sns.boxplot(x='hour', y='tip_amount', data=df)
plt.title("Tip Amount by Hour of Day")
plt.xlabel("Hour")
plt.ylabel("Tip Amount ($)")
plt.show()
```

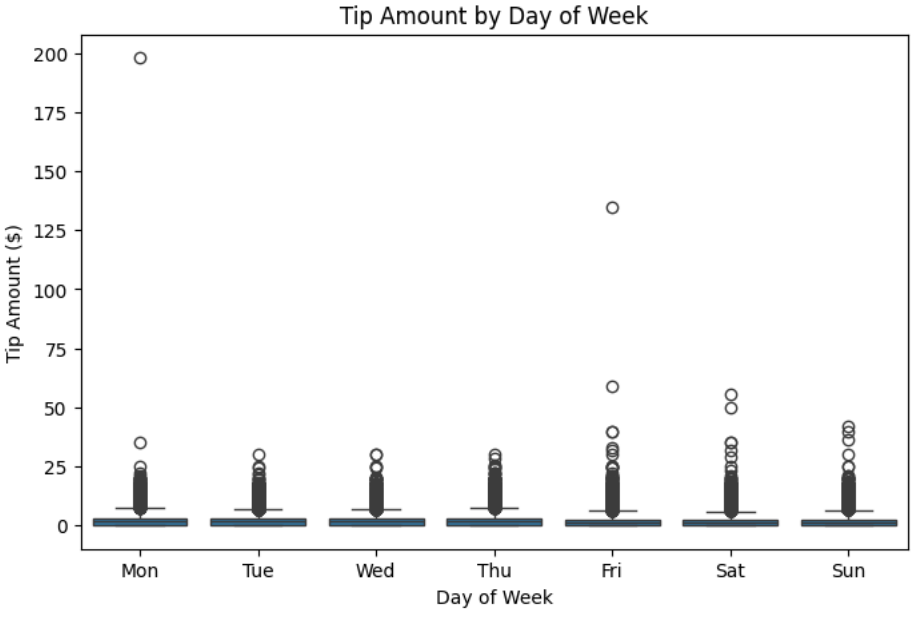



```
# Tip vs Trip Duration
df['trip_duration_min'] = (df['dropoff_datetime'] - df['pickup_datetime']).dt.total_seconds() / 60
df = df[df['trip_duration_min'] < 180]  # remove extreme values

# Binning
df['duration_bin'] = pd.cut(df['trip_duration_min'], bins=[0,5,10,15,30,60,120,180], labels=['0-5','5-10','10-15','15-30','3

plt.figure(figsize=(10,5))
sns.boxplot(x='duration_bin', y='tip_amount', data=df)
plt.title("Tip Amount by Trip Duration")
plt.xlabel("Trip Duration (min)")
plt.ylabel("Tip Amount ($)")
plt.show()
```

```
/tmp/ipython-input-60-208284368.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-
  df['duration_bin'] = pd.cut(df['trip_duration_min'], bins=[0,5,10,15,30,60,120,180], labels=['0-5','5-10','10-15','15-
```




```
# Tip vs Day of Week
df['day_of_week'] = df['pickup_datetime'].dt.dayofweek  # 0=Monday, 6=Sunday
weekday_map = {0:'Mon',1:'Tue',2:'Wed',3:'Thu',4:'Fri',5:'Sat',6:'Sun'}
df['day_str'] = df['day_of_week'].map(weekday_map)

plt.figure(figsize=(8,5))
sns.boxplot(x='day_str', y='tip_amount', data=df, order=['Mon','Tue','Wed','Thu','Fri','Sat','Sun'])
plt.title("Tip Amount by Day of Week")
plt.xlabel("Day of Week")
plt.ylabel("Tip Amount ($)")
plt.show()
```



4. Summary

Q1: How does the number of taxi rides vary over time of day?

Ride volume is lowest in the early morning hours (around 4–6 AM), then increases sharply during the morning commute (7–9 AM). Activity remains steady throughout the afternoon and peaks in the evening, with the highest number of rides occurring between 6 PM and 8 PM. After 9 PM, the number of rides gradually decreases.

This pattern suggests that demand is highest during evening hours, likely due to people commuting home, attending events, or going out for