UberNewDataset

September 21, 2024

[2]:
```python
import pandas as pd
df = pd.read_csv(r"C:\Users\Admin\OneDrive\Desktop\Unified Mentor␣
↪Projects\uber_new_dataset.csv")
```

[3]:
```python
df
```

[3]:
```
             key  fare_amount          pickup_datetime  pickup_longitude  \
0        15:22.0          8.5  2009-01-01 01:15:22 UTC        -73.981918
1        59:17.0         13.0  2009-01-01 01:59:17 UTC        -73.983759
2        05:03.0         10.6  2009-01-01 02:05:03 UTC        -73.956635
3        09:13.0         12.2  2009-01-01 02:09:13 UTC        -73.984605
4        13:41.0         11.0  2009-01-01 02:13:41 UTC        -73.980127
…            …          …                      …               …
199995   57:53.0         18.5  2015-06-30 22:57:53 UTC        -73.971703
199996   16:42.0         25.5  2015-06-30 23:16:42 UTC        -74.001099
199997   31:06.0         20.0  2015-06-30 23:31:06 UTC        -73.999962
199998   33:33.0          8.5  2015-06-30 23:33:33 UTC        -73.980988
199999   40:39.0         27.0  2015-06-30 23:40:39 UTC        -73.984795

        pickup_latitude  dropoff_longitude  dropoff_latitude  passenger_count
0             40.779456         -73.957685         40.771043                2
1             40.721389         -73.994833         40.687179                2
2             40.771254         -73.991528         40.749778                2
3             40.728020         -73.955746         40.776830                1
4             40.737425         -74.009544         40.726025                4
…                   …                …                 …               …
199995        40.782207         -73.943680         40.827991                2
199996        40.730961         -73.957123         40.806908                2
199997        40.733135         -73.962448         40.773041                4
199998        40.762020         -73.960083         40.770531                1
199999        40.751411         -73.927765         40.706287                1

[200000 rows x 8 columns]
```

[4]:
```python
df.isnull().sum()  # Check for missing values
df.duplicated().sum()  # Check for duplicates
```

[4]: 0

[5]:
```
df.drop(columns=['key'], inplace=True)
```

[ ]:
```

```

1 Feature Engineering

[7]:
```
# Extract date features
df['pickup_datetime'] = pd.to_datetime(df['pickup_datetime'])
df['hour'] = df['pickup_datetime'].dt.hour
df['day_of_week'] = df['pickup_datetime'].dt.day_name()
df['month'] = df['pickup_datetime'].dt.month
```

[8]:
```
df.columns
```

[8]:
```
Index(['fare_amount', 'pickup_datetime', 'pickup_longitude', 'pickup_latitude',
       'dropoff_longitude', 'dropoff_latitude', 'passenger_count', 'hour',
       'day_of_week', 'month'],
      dtype='object')
```

[9]:
```
df
```

[9]:
```
        fare_amount           pickup_datetime  pickup_longitude  \
0               8.5 2009-01-01 01:15:22+00:00        -73.981918
1              13.0 2009-01-01 01:59:17+00:00        -73.983759
2              10.6 2009-01-01 02:05:03+00:00        -73.956635
3              12.2 2009-01-01 02:09:13+00:00        -73.984605
4              11.0 2009-01-01 02:13:41+00:00        -73.980127
…                 …                         …                 …
199995         18.5 2015-06-30 22:57:53+00:00        -73.971703
199996         25.5 2015-06-30 23:16:42+00:00        -74.001099
199997         20.0 2015-06-30 23:31:06+00:00        -73.999962
199998          8.5 2015-06-30 23:33:33+00:00        -73.980988
199999         27.0 2015-06-30 23:40:39+00:00        -73.984795

        pickup_latitude  dropoff_longitude  dropoff_latitude  passenger_count  \
0             40.779456         -73.957685         40.771043                2
1             40.721389         -73.994833         40.687179                2
2             40.771254         -73.991528         40.749778                2
3             40.728020         -73.955746         40.776830                1
4             40.737425         -74.009544         40.726025                4
…                     …                  …                 …                …
199995        40.782207         -73.943680         40.827991                2
199996        40.730961         -73.957123         40.806908                2
199997        40.733135         -73.962448         40.773041                4
199998        40.762020         -73.960083         40.770531                1
199999        40.751411         -73.927765         40.706287                1
```

```
        hour day_of_week  month
0          1    Thursday      1
1          1    Thursday      1
2          2    Thursday      1
3          2    Thursday      1
4          2    Thursday      1
…       …         …     …
199995    22     Tuesday      6
199996    23     Tuesday      6
199997    23     Tuesday      6
199998    23     Tuesday      6
199999    23     Tuesday      6

[200000 rows x 10 columns]
```

[10]:
```python
import numpy as np

def haversine(lat1, lon1, lat2, lon2):
    R = 6371  # Earth radius in kilometers
    dlat = np.radians(lat2 - lat1)
    dlon = np.radians(lon2 - lon1)
    a = np.sin(dlat/2) * np.sin(dlat/2) + np.cos(np.radians(lat1)) * np.cos(np.
↪radians(lat2)) * np.sin(dlon/2) * np.sin(dlon/2)
    c = 2 * np.arctan2(np.sqrt(a), np.sqrt(1-a))
    return R * c

df['distance'] = haversine(df['pickup_latitude'], df['pickup_longitude'],␣
↪df['dropoff_latitude'], df['dropoff_longitude'])
```

[ ]:
```python

```

[11]:
```python
# Calculating fare per kilometer, using the distance generated
# Calculate fare per km
df['fare_per_km'] = df['fare_amount'] / df['distance']
```

[12]:
```python
# Handle any Possible infinite or nan values
# Replace infinite values or NaN values in fare_per_km
df['fare_per_km'].replace([np.inf, -np.inf], np.nan, inplace=True)
df['fare_per_km'].fillna(0, inplace=True)
```

[13]:
```python
df
```

[13]:
```
        fare_amount           pickup_datetime  pickup_longitude  \
0               8.5 2009-01-01 01:15:22+00:00        -73.981918
1              13.0 2009-01-01 01:59:17+00:00        -73.983759
2              10.6 2009-01-01 02:05:03+00:00        -73.956635
3              12.2 2009-01-01 02:09:13+00:00        -73.984605
```

```
4               11.0 2009-01-01 02:13:41+00:00        -73.980127
…              …                        …                 …
199995          18.5 2015-06-30 22:57:53+00:00        -73.971703
199996          25.5 2015-06-30 23:16:42+00:00        -74.001099
199997          20.0 2015-06-30 23:31:06+00:00        -73.999962
199998           8.5 2015-06-30 23:33:33+00:00        -73.980988
199999          27.0 2015-06-30 23:40:39+00:00        -73.984795

        pickup_latitude  dropoff_longitude  dropoff_latitude  passenger_count  \
0             40.779456         -73.957685         40.771043                2
1             40.721389         -73.994833         40.687179                2
2             40.771254         -73.991528         40.749778                2
3             40.728020         -73.955746         40.776830                1
4             40.737425         -74.009544         40.726025                4
…                   …                 …                 …               …
199995        40.782207         -73.943680         40.827991                2
199996        40.730961         -73.957123         40.806908                2
199997        40.733135         -73.962448         40.773041                4
199998        40.762020         -73.960083         40.770531                1
199999        40.751411         -73.927765         40.706287                1

        hour day_of_week  month  distance  fare_per_km
0          1    Thursday      1  2.244765     3.786588
1          1    Thursday      1  3.916842     3.319001
2          2    Thursday      1  3.786736     2.799244
3          2    Thursday      1  5.946957     2.051469
4          2    Thursday      1  2.784022     3.951118
…       …          …    …        …            …
199995    22     Tuesday      6  5.610774     3.297228
199996    23     Tuesday      6  9.221233     2.765357
199997    23     Tuesday      6  5.447442     3.671448
199998    23     Tuesday      6  1.998738     4.252683
199999    23     Tuesday      6  6.947619     3.886224

[200000 rows x 12 columns]
```

[14]:

```python
# Check for NaN values in the relevant columns
print(df[['fare_per_km', 'distance', 'passenger_count']].isnull().sum())
```

```
fare_per_km        0
distance           1
passenger_count    0
dtype: int64
```

[15]:

```python
# Drop rows where distance is NaN
df.dropna(subset=['distance'], inplace=True)
```

[16]:
```python
from sklearn.ensemble import IsolationForest

# Use relevant columns for anomaly detection
X = df[['fare_per_km', 'distance', 'passenger_count']]

# Fit the Isolation Forest model
iso_forest = IsolationForest(contamination=0.01)  # Adjust contamination level␣
 ↪as needed
#df['anomaly'] = iso_forest.fit_predict(X)

# Ensure the input to predict also has column names (like the training data)
df['anomaly'] = iso_forest.fit_predict(df[['fare_per_km', 'distance',␣
 ↪'passenger_count']])

# Filter for anomalous trips
fraudulent_trips = df[df['anomaly'] == -1]
print(fraudulent_trips)
```

```
C:\Users\Admin\anaconda3\Lib\site-packages\sklearn\base.py:439: UserWarning: X
does not have valid feature names, but IsolationForest was fitted with feature
names
  warnings.warn(
```

```
        fare_amount           pickup_datetime  pickup_longitude  \
22             6.50 2009-01-01 12:49:05+00:00        -74.689571
84             2.50 2009-01-02 12:26:51+00:00        -73.994285
108           45.00 2009-01-02 20:44:41+00:00        -73.776740
131           14.60 2009-01-03 00:51:01+00:00        -73.922683
158           35.70 2009-01-03 12:30:00+00:00        -73.979965
…             …                        …             …
199465         3.00 2015-06-23 12:21:16+00:00        -73.985115
199601         2.50 2015-06-25 11:49:53+00:00        -73.954498
199688         4.00 2015-06-26 13:27:42+00:00          0.000000
199886        12.00 2015-06-29 09:04:46+00:00        -73.980919
199939        75.54 2015-06-30 02:01:49+00:00        -73.703262

        pickup_latitude  dropoff_longitude  dropoff_latitude  passenger_count  \
22            45.031653         -74.689603         45.031598                1
84            40.754210         -73.993981         40.754157                1
108           40.645381         -73.989201         40.773589                3
131           40.813401         -73.923197         40.813703                2
158           40.754408         -73.980038         40.753787                1
…                   …                 …                …              …
199465        40.755615         -73.984917         40.755547                2
199601        40.765678           0.000000          0.000000                1
199688         0.000000         -73.992157         40.742779                1
199886        40.755779         -73.980888         40.755787                1
199939        40.653118         -73.703285         40.653126                1
```

```
        hour day_of_week  month     distance   fare_per_km  anomaly
22        12    Thursday      1     0.006613    982.981982       -1
84        12      Friday      1     0.026276     95.143944       -1
108       20      Friday      1    22.889600      1.965958       -1
131        0    Saturday      1     0.054761    266.611253       -1
158       12    Saturday      1     0.069325    514.963625       -1
…        …          …    …           …           …        …
199465    12     Tuesday      6     0.018370    163.313220       -1
199601    11    Thursday      6  8663.886212      0.000289       -1
199688    13      Friday      6  8666.534629      0.000462       -1
199886     9      Monday      6     0.002706   4434.120138       -1
199939     2     Tuesday      6     0.002109  35815.135109       -1

[2000 rows x 13 columns]
```

[17]:

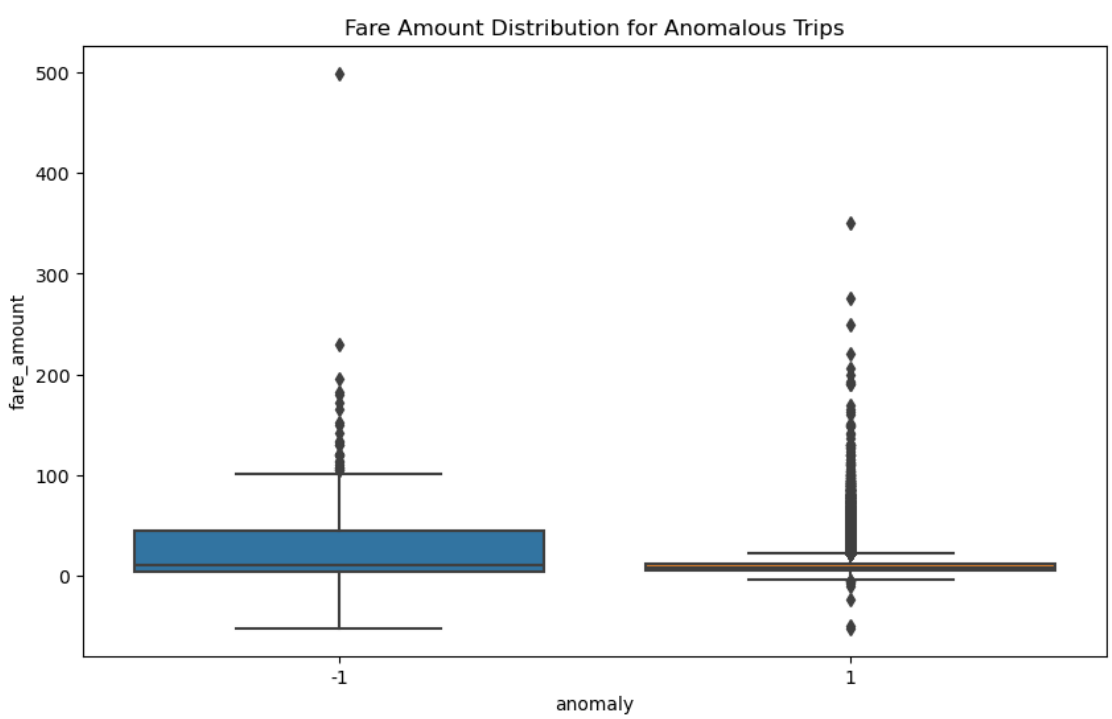
```python
# Filter for anomalous trips (fraudulent ones)
fraudulent_trips = df[df['anomaly'] == -1]

# Summary statistics for fraudulent trips
print(fraudulent_trips.describe())

# Example: Analyze if certain pickup locations are prone to fraud
print(fraudulent_trips[['pickup_longitude', 'pickup_latitude']].head())
```

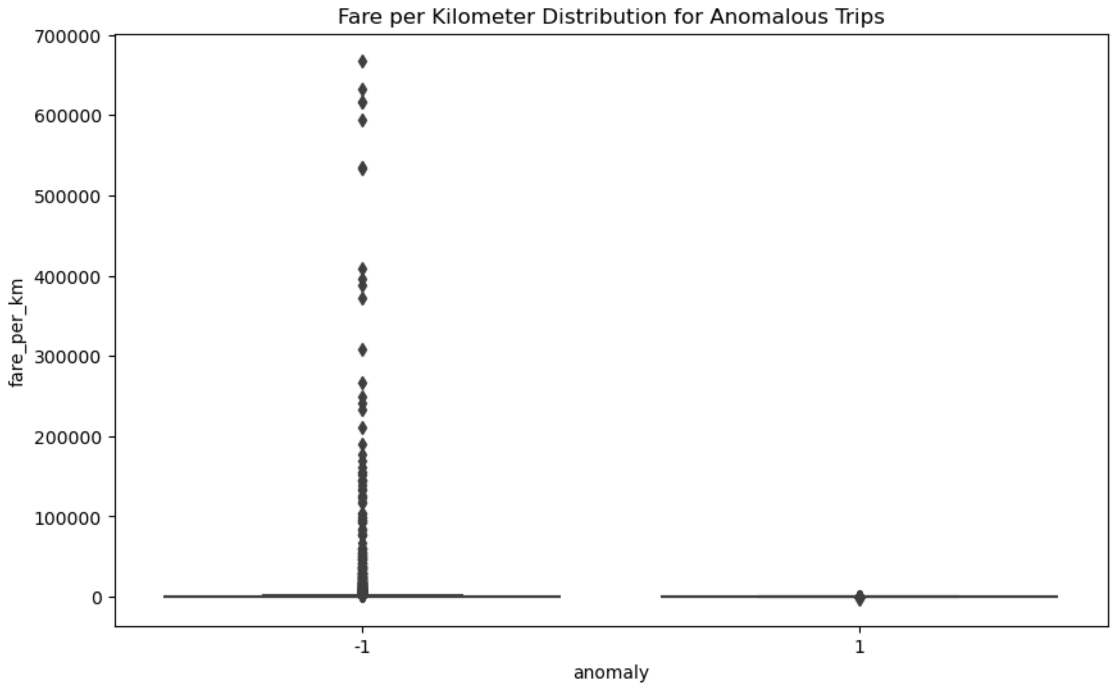
```
       fare_amount  pickup_longitude  pickup_latitude  dropoff_longitude  \
count  2000.000000       2000.000000      2000.000000        2000.000000
mean     22.830620        -68.105118        38.089571         -67.971371
std      27.045825         52.458600        48.120136          82.929075
min     -52.000000      -1340.648410       -73.962430       -3356.666300
25%       4.500000        -73.989580        40.694843         -73.989583
50%      11.000000        -73.970980        40.745866         -73.971679
75%      44.500000        -73.859379        40.764079         -73.893847
max     499.000000         57.418457      1644.421482        1153.572603

       dropoff_latitude  passenger_count        hour        month  \
count       2000.000000       2000.00000  2000.00000  2000.000000
mean          37.046067          2.55000    12.97050     6.378500
std           32.113436          4.97593     6.55035     3.444876
min         -881.985513          0.00000     0.00000     1.000000
25%           40.707673          1.00000     8.00000     3.000000
50%           40.747088          1.00000    14.00000     6.000000
75%           40.764586          4.00000    18.00000     9.000000
max          872.697628        208.00000    23.00000    12.000000

          distance   fare_per_km  anomaly
count  2000.000000   2000.000000   2000.0
mean   1761.261416   7829.245394     -1.0
```

```
std      3407.449339   44916.933187       0.0
min         0.000084      -2.448748      -1.0
25%         0.011244       2.115839      -1.0
50%         0.121240      94.213894      -1.0
75%        22.799522     645.247438      -1.0
max     16409.239135  667985.030660      -1.0
     pickup_longitude  pickup_latitude
22         -74.689571        45.031653
84         -73.994285        40.754210
108        -73.776740        40.645381
131        -73.922683        40.813401
158        -73.979965        40.754408
```

[18]:

```python
import seaborn as sns
import matplotlib.pyplot as plt

# Visualize fare amounts for flagged trips
plt.figure(figsize=(10,6))
sns.boxplot(x='anomaly', y='fare_amount', data=df)
plt.title("Fare Amount Distribution for Anomalous Trips")
plt.show()

# Visualize fare per kilometer for flagged trips
plt.figure(figsize=(10,6))
sns.boxplot(x='anomaly', y='fare_per_km', data=df)
plt.title("Fare per Kilometer Distribution for Anomalous Trips")
plt.show()
```





[19]:
```
# Count anomalies and normal points
anomaly_counts = df['anomaly'].value_counts()
total_rows = df.shape[0]

print(f"Total rows in dataset: {total_rows}")
print(f"Anomalies flagged: {anomaly_counts[-1]} ({(anomaly_counts[-1]/
    ↪total_rows)*100:.2f}%)")
print(f"Normal points: {anomaly_counts[1]} ({(anomaly_counts[1]/total_rows)*100:
    ↪.2f}%)")
```

```
Total rows in dataset: 199999
Anomalies flagged: 2000 (1.00%)
Normal points: 197999 (99.00%)
```

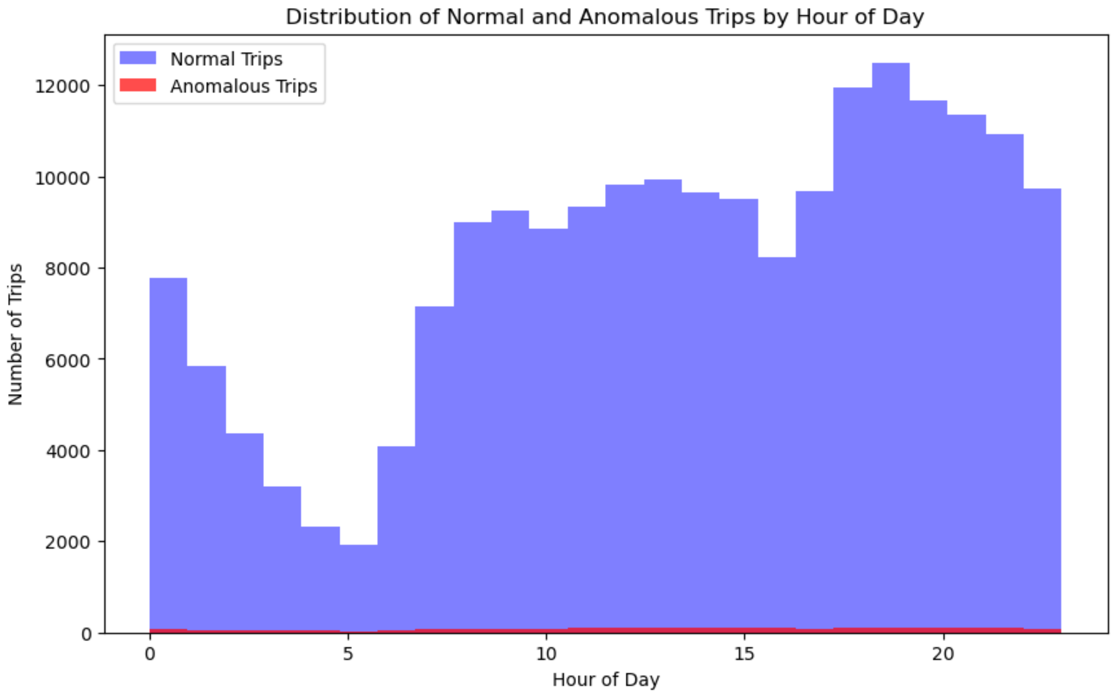
[20]:
```
# Display the top anomalous trips based on fare per km
fraudulent_trips = df[df['anomaly'] == -1].sort_values(by='fare_per_km',␣
    ↪ascending=False)
print(fraudulent_trips[['fare_amount', 'distance', 'passenger_count',␣
    ↪'pickup_datetime', 'pickup_longitude', 'pickup_latitude',␣
    ↪'dropoff_longitude', 'dropoff_latitude']].head())
```

```
        fare_amount  distance  passenger_count            pickup_datetime  \
154139        113.0  0.000169                2 2013-12-06 02:17:00+00:00
```

```
69311         499.0  0.000790                  1 2011-04-10 04:10:00+00:00
158156         52.0  0.000084                  1 2014-01-25 03:31:46+00:00
176380         52.0  0.000084                  1 2014-08-31 20:02:06+00:00
12489          50.0  0.000084                  1 2009-05-28 19:40:00+00:00

        pickup_longitude  pickup_latitude  dropoff_longitude  dropoff_latitude
154139        -74.468770        40.476630         -74.468772         40.476630
69311         -73.968377        40.764602         -73.968368         40.764600
158156        -74.030855        40.740735         -74.030856         40.740735
176380        -73.789883        40.647023         -73.789882         40.647023
12489         -73.977602        40.782908         -73.977603         40.782908
```

[21]:

```python
# Time of day analysis:  To check if anomalies are concentrated during certain␣
↪hours, such as late-night hours when fraud might be more likely.
# Create a new column for the hour of the day (from pickup_datetime)
#df['pickup_hour'] = df['pickup_datetime'].dt.hour

# Compare normal trips and anomalous trips based on the hour of the day
normal_hours = df[df['anomaly'] == 1]['hour']
anomalous_hours = df[df['anomaly'] == -1]['hour']

# Plot the distributions of normal and anomalous trips by hour
plt.figure(figsize=(10, 6))
plt.hist(normal_hours, bins=24, alpha=0.5, label='Normal Trips', color='blue')
plt.hist(anomalous_hours, bins=24, alpha=0.7, label='Anomalous Trips',␣
↪color='red')
plt.title('Distribution of Normal and Anomalous Trips by Hour of Day')
plt.xlabel('Hour of Day')
plt.ylabel('Number of Trips')
plt.legend()
plt.show()


anomalous_hours
```



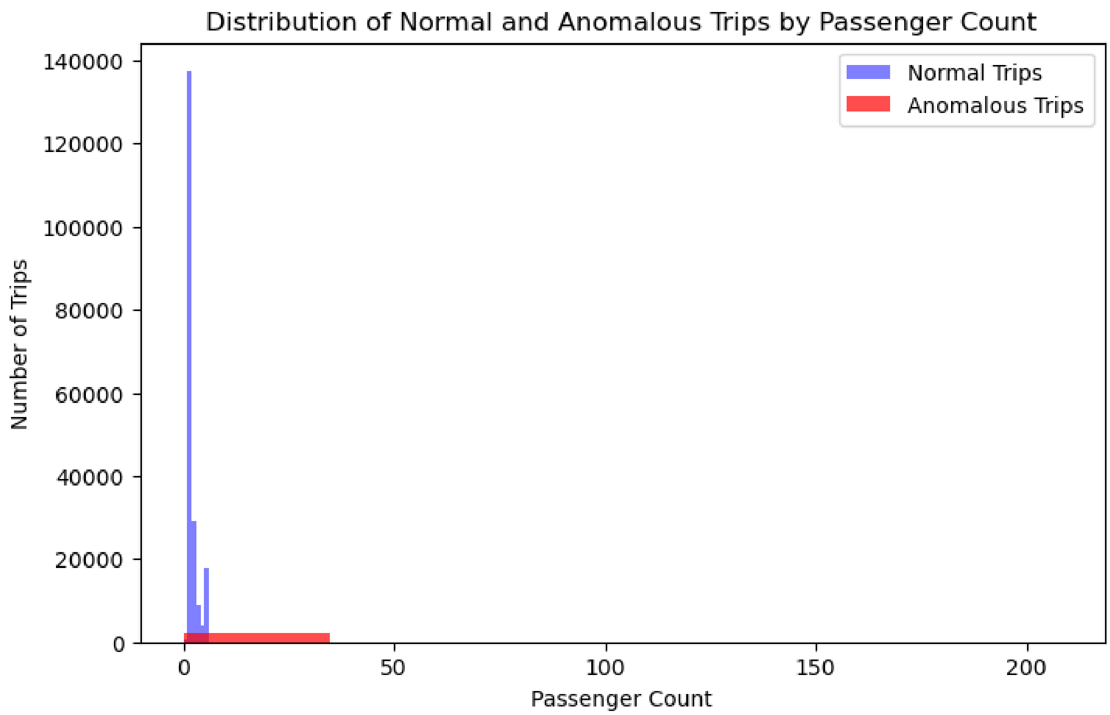
[21]:

```
22        12
84        12
108       20
131        0
158       12
          ..
199465    12
199601    11
199688    13
199886     9
199939     2
Name: hour, Length: 2000, dtype: int32
```

[22]:

```python
# Compare normal trips and anomalous trips based on passenger count
normal_passengers = df[df['anomaly'] == 1]['passenger_count']
anomalous_passengers = df[df['anomaly'] == -1]['passenger_count']

# Plot the distributions of normal and anomalous trips by passenger count
plt.figure(figsize=(8, 5))
plt.hist(normal_passengers, bins=6, alpha=0.5, label='Normal Trips',␣
 ↪color='blue')
plt.hist(anomalous_passengers, bins=6, alpha=0.7, label='Anomalous Trips',␣
 ↪color='red')
plt.title('Distribution of Normal and Anomalous Trips by Passenger Count')
```

```
plt.xlabel('Passenger Count')
plt.ylabel('Number of Trips')
plt.legend()
plt.show()
```

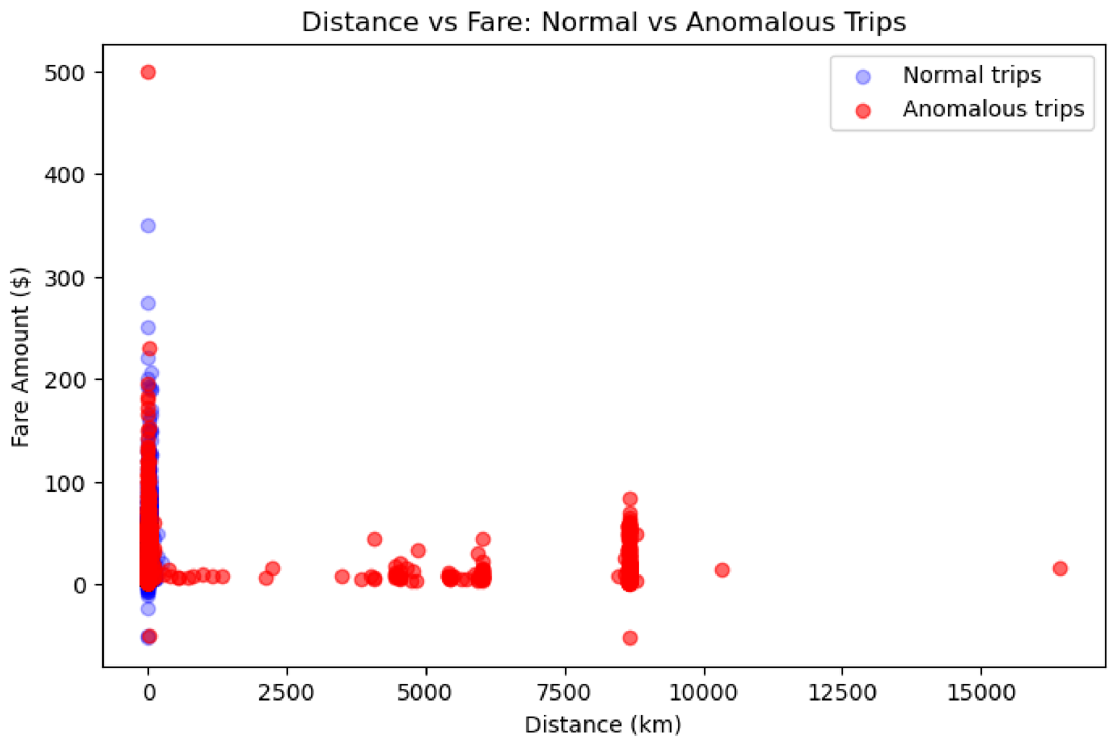


[ ]:

```
[ ]:
```

[24]:

```
plt.figure(figsize=(8, 5))
plt.scatter(df[df['anomaly'] == 1]['distance'], df[df['anomaly'] ==␣
 ↪1]['fare_amount'], alpha=0.3, color='blue', label='Normal trips')
plt.scatter(df[df['anomaly'] == -1]['distance'], df[df['anomaly'] ==␣
 ↪-1]['fare_amount'], alpha=0.6, color='red', label='Anomalous trips')
plt.title('Distance vs Fare: Normal vs Anomalous Trips')
plt.xlabel('Distance (km)')
plt.ylabel('Fare Amount ($)')
plt.legend()
plt.show()
```



[25]:
```python
# Check the distribution of anomalies
print(df['anomaly'].value_counts())
```

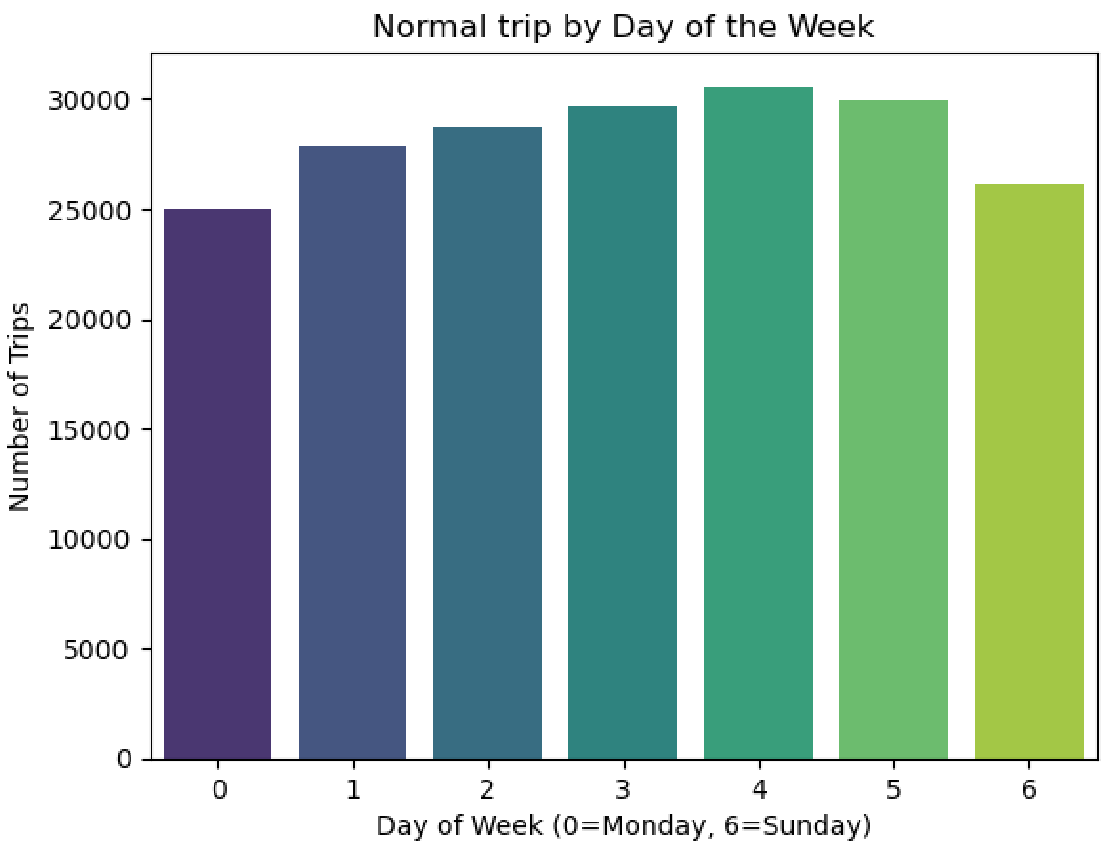
```
anomaly
 1    197999
-1      2000
Name: count, dtype: int64
```

[26]:
```python
import seaborn as sns


# Ensure 'pickup_datetime' is in datetime format
df['pickup_datetime'] = pd.to_datetime(df['pickup_datetime'])

# Extract 'day_of_week' and 'month' columns
df['day_of_week'] = df['pickup_datetime'].dt.dayofweek  # Monday=0, Sunday=6
df['month'] = df['pickup_datetime'].dt.month

# Convert day_of_week and month to categorical
df['day_of_week'] = df['day_of_week'].astype('category')
df['month'] = df['month'].astype('category')

# Plot normal trips by day of the week (Counts on y-axis)
```

```python
sns.countplot(x='day_of_week', data=df[df['anomaly'] ==1], palette="viridis")
plt.title('Normal trip by Day of the Week')
plt.xlabel('Day of Week (0=Monday, 6=Sunday)')
plt.ylabel('Number of Trips')  # This is the y-axis (default)
plt.show()

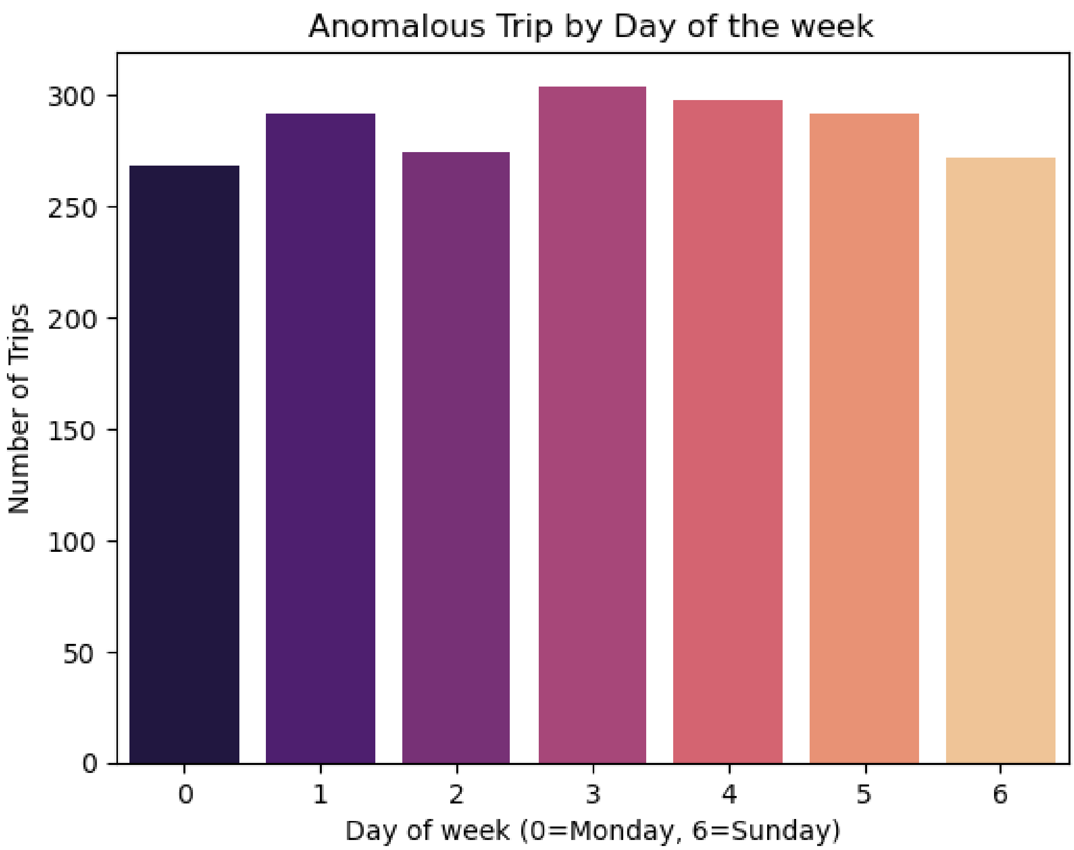
# Plot anomalous trips by day of the week (Counts on y-axis)
sns.countplot(x='day_of_week', data=df[df['anomaly'] == -1], palette="magma")
plt.title('Anomalous Trip by Day of the week')
plt.xlabel('Day of week (0=Monday, 6=Sunday)')
plt.ylabel('Number of Trips')  # This is the y-axis (default)
plt.show()
```

```
C:\Users\Admin\anaconda3\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be changed
to True in a future version of pandas. Pass observed=False to retain current
behavior or observed=True to adopt the future default and silence this warning.
  grouped_vals = vals.groupby(grouper)
```



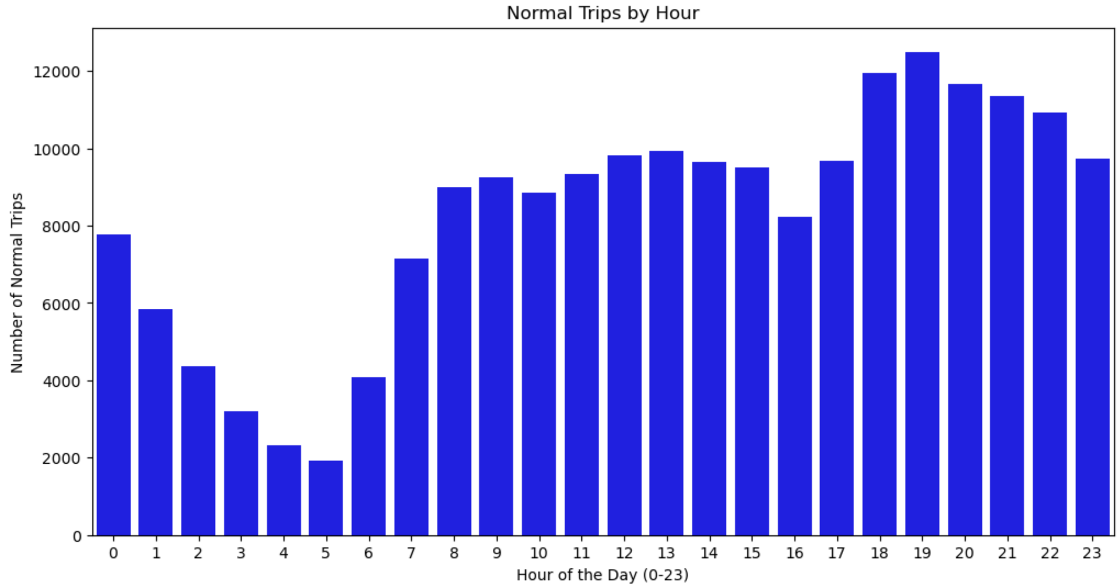

```
C:\Users\Admin\anaconda3\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be changed
```

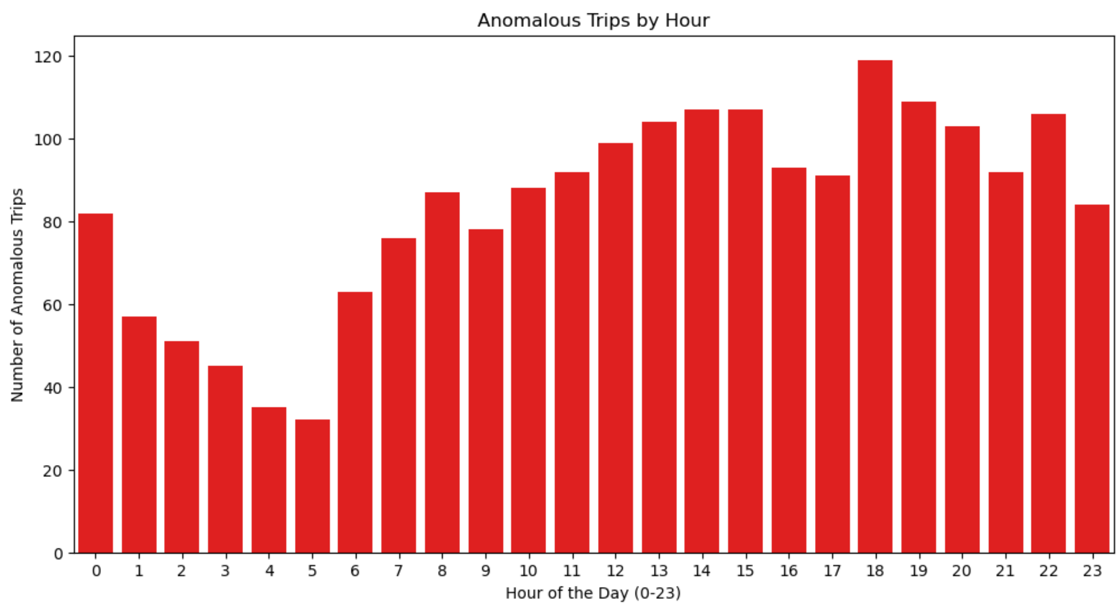
```
to True in a future version of pandas. Pass observed=False to retain current
behavior or observed=True to adopt the future default and silence this warning.
  grouped_vals = vals.groupby(grouper)
```



[27]:
```
# Plot normal trips by hour
plt.figure(figsize=(12, 6))
sns.countplot(x='hour', data=df[df['anomaly'] == 1], color='blue')
plt.title('Normal Trips by Hour')
plt.xlabel('Hour of the Day (0-23)')
plt.ylabel('Number of Normal Trips')
plt.show()

# Plot anomalous trips by hour
plt.figure(figsize=(12, 6))
sns.countplot(x='hour', data=df[df['anomaly'] == -1], color='red')
plt.title('Anomalous Trips by Hour')
plt.xlabel('Hour of the Day (0-23)')
plt.ylabel('Number of Anomalous Trips')
plt.show()
```





[ ]:

```

```

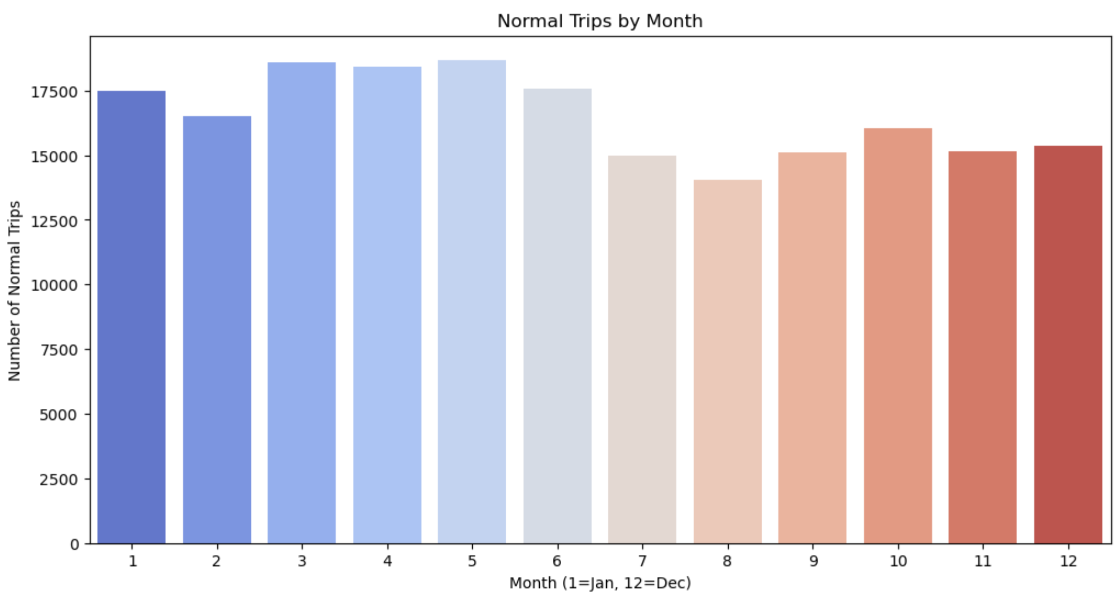
[28]:

```
# Analyze seasonal trends
# Plot normal trips by month
plt.figure(figsize=(12, 6))
sns.countplot(x='month', data=df[df['anomaly'] == 1], palette="coolwarm")
plt.title('Normal Trips by Month')
```

```
plt.xlabel('Month (1=Jan, 12=Dec)')
plt.ylabel('Number of Normal Trips')
plt.show()

# Plot anomalous trips by month
plt.figure(figsize=(12, 6))
sns.countplot(x='month', data=df[df['anomaly'] == -1], palette="viridis")
plt.title('Anomalous Trips by Month')
plt.xlabel('Month (1=Jan, 12=Dec)')
plt.ylabel('Number of Anomalous Trips')
plt.show()
```

```
C:\Users\Admin\anaconda3\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be changed
to True in a future version of pandas. Pass observed=False to retain current
behavior or observed=True to adopt the future default and silence this warning.
  grouped_vals = vals.groupby(grouper)
```




```
C:\Users\Admin\anaconda3\Lib\site-packages\seaborn\categorical.py:641:
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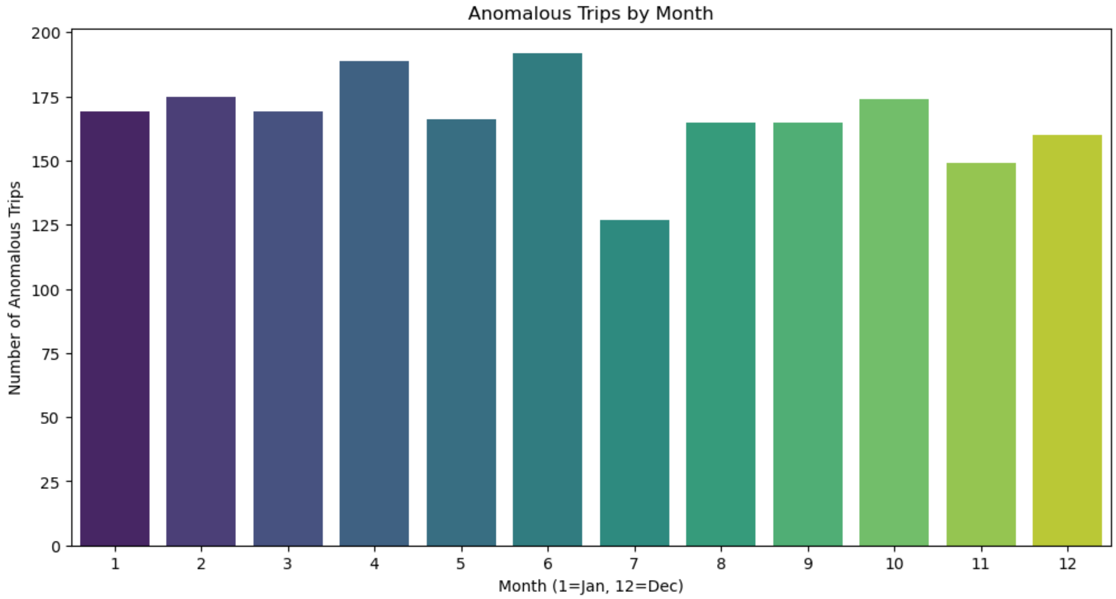

[ ]:

[29]:
```python
# Categorize hours into time of day: Night (0-5), Morning (5-12), Afternoon␣
↪(12-17), Evening (17-21), Night (21-24)
df['time_of_day'] = pd.cut(df['hour'],
                            bins=[0, 5, 12, 17, 21, 24],
                            labels=['Late Night', 'Morning', 'Afternoon',␣
↪'Evening', 'Night'],
                            include_lowest=False,
                            ordered=False)

# Plot normal trips by time of day
plt.figure(figsize=(12, 6))
sns.countplot(x='time_of_day', data=df[df['anomaly'] == 1], palette="magma")
plt.title('Normal Trips by Time of Day')
plt.xlabel('Time of Day')
plt.ylabel('Number of Normal Trips')
plt.show()

# Plot anomalous trips by time of day
plt.figure(figsize=(12, 6))
sns.countplot(x='time_of_day', data=df[df['anomaly'] == -1], palette="viridis")
plt.title('Anomalous Trips by Time of Day')
plt.xlabel('Time of Day')
plt.ylabel('Number of Anomalous Trips')
plt.show()
```

```
C:\Users\Admin\anaconda3\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be changed
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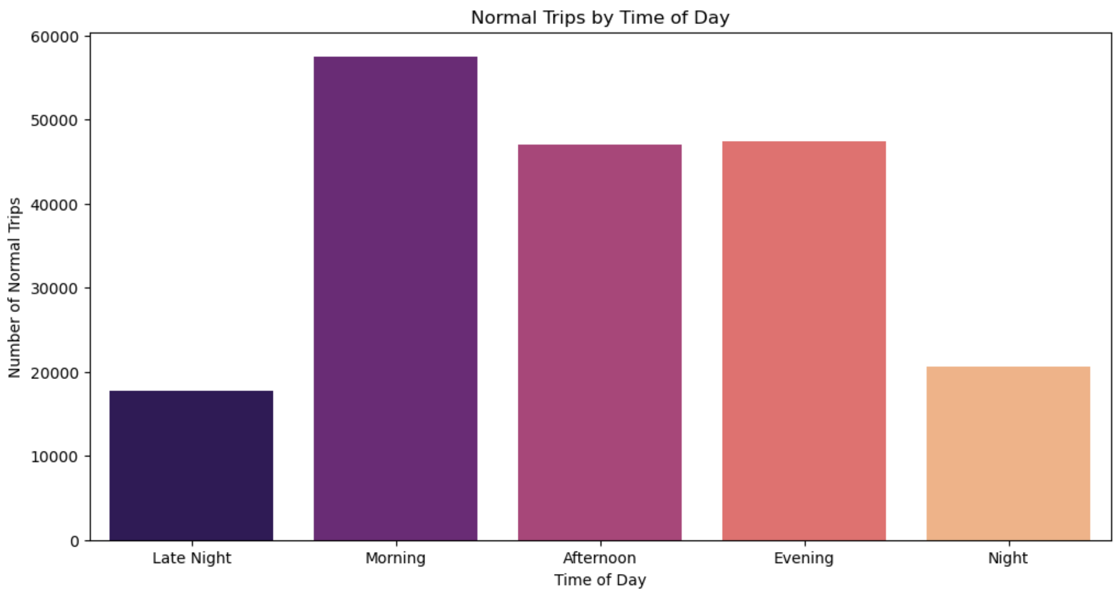


```
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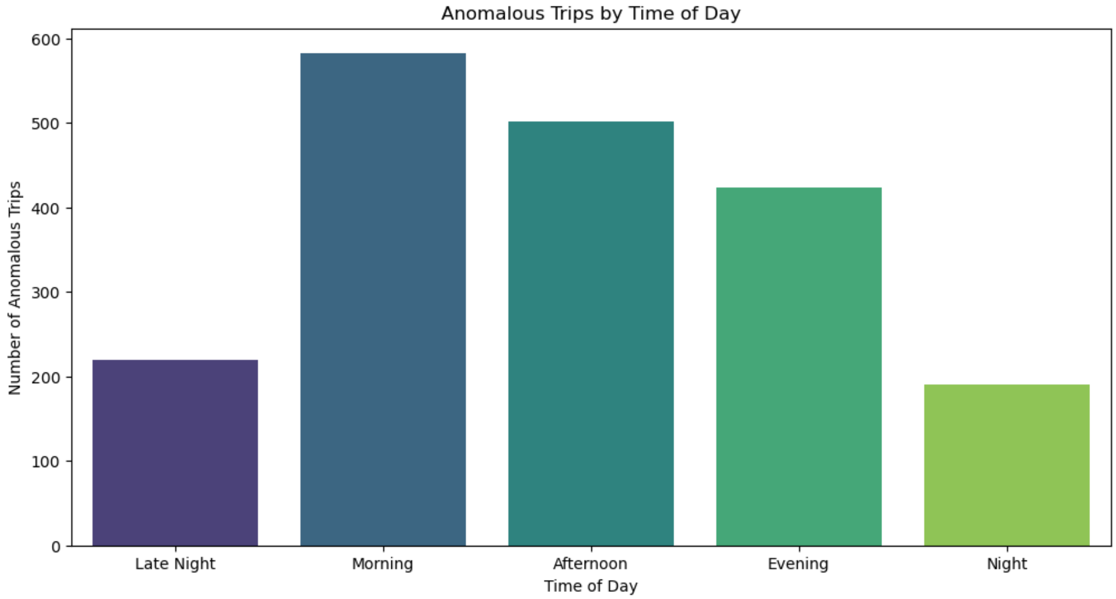


[ ]:

```

```

[30]:

```
# Log the number of normal and anomalous trips
print(f"Number of normal trips: {len(df[df['anomaly'] == 1])}")
print(f"Number of anomalous trips: {len(df[df['anomaly'] == -1])}")

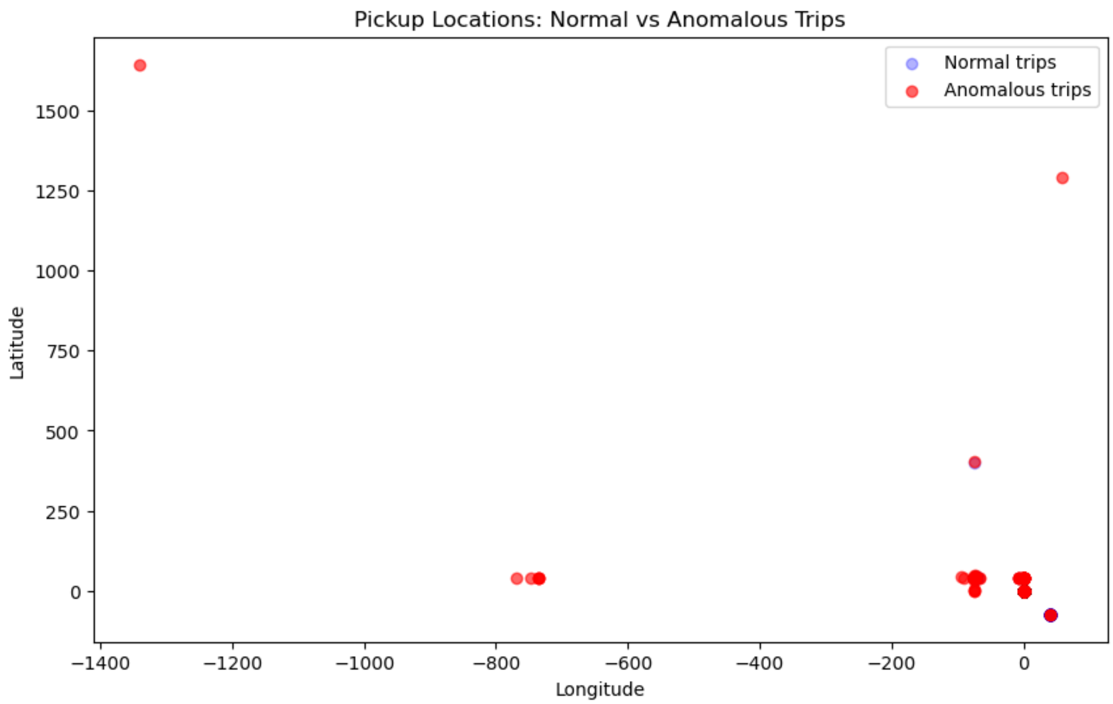
# Pickup locations plot with logging
plt.figure(figsize=(10, 6))
print("Plotting pickup locations for normal and anomalous trips...")
plt.scatter(df[df['anomaly'] == 1]['pickup_longitude'],
            df[df['anomaly'] == 1]['pickup_latitude'],
            color='blue', alpha=0.3, label='Normal trips')
plt.scatter(df[df['anomaly'] == -1]['pickup_longitude'],
            df[df['anomaly'] == -1]['pickup_latitude'],
            color='red', alpha=0.6, label='Anomalous trips')
plt.title('Pickup Locations: Normal vs Anomalous Trips')
plt.xlabel('Longitude')
plt.ylabel('Latitude')
plt.legend()
plt.show()

# Dropoff locations plot with logging
plt.figure(figsize=(10, 6))
print("Plotting dropoff locations for normal and anomalous trips...")
plt.scatter(df[df['anomaly'] == 1]['dropoff_longitude'],
            df[df['anomaly'] == 1]['dropoff_latitude'],
            color='blue', alpha=0.3, label='Normal trips')
```

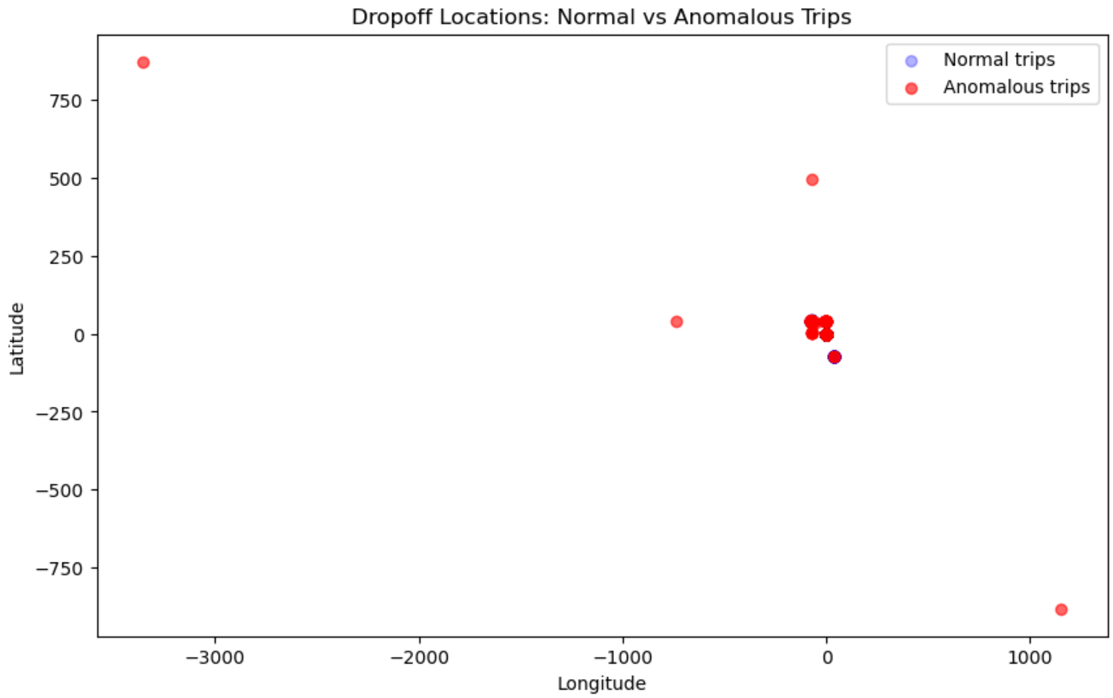
```
plt.scatter(df[df['anomaly'] == -1]['dropoff_longitude'],
            df[df['anomaly'] == -1]['dropoff_latitude'],
            color='red', alpha=0.6, label='Anomalous trips')
plt.title('Dropoff Locations: Normal vs Anomalous Trips')
plt.xlabel('Longitude')
plt.ylabel('Latitude')
plt.legend()
plt.show()

print("Geographical analysis completed.")
```

```
Number of normal trips: 197999
Number of anomalous trips: 2000
Plotting pickup locations for normal and anomalous trips…
```




```
Plotting dropoff locations for normal and anomalous trips…
```




```
Geographical analysis completed.
```

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[ ]:
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[ ]:
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[ ]:
```