In [10]:
```
#Imported libraries and packages
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import datetime as dt
import seaborn as sns
```

In [3]:
```
# Load dataset into dataframe
df = pd.read_csv('2017_Yellow_Taxi_Trip_Data.csv')
print("done")
```

done

In [4]:
```
df.head(10)
```

Out[4]:

	Unnamed: 0	VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_distance
0	24870114	2	03/25/2017 8:55:43 AM	03/25/2017 9:09:47 AM	6	3.34
1	35634249	1	04/11/2017 2:53:28 PM	04/11/2017 3:19:58 PM	1	1.80
2	106203690	1	12/15/2017 7:26:56 AM	12/15/2017 7:34:08 AM	1	1.00
3	38942136	2	05/07/2017 1:17:59 PM	05/07/2017 1:48:14 PM	1	3.70
4	30841670	2	04/15/2017 11:32:20 PM	04/15/2017 11:49:03 PM	1	4.37
5	23345809	2	03/25/2017 8:34:11 PM	03/25/2017 8:42:11 PM	6	2.30
6	37660487	2	05/03/2017 7:04:09 PM	05/03/2017 8:03:47 PM	1	12.83
7	69059411	2	08/15/2017 5:41:06 PM	08/15/2017 6:03:05 PM	1	2.98
8	8433159	2	02/04/2017 4:17:07 PM	02/04/2017 4:29:14 PM	1	1.20
9	95294817	1	11/10/2017 3:20:29 PM	11/10/2017 3:40:55 PM	1	1.60

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 22699 entries, 0 to 22698
Data columns (total 18 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Unnamed: 0             22699 non-null  int64  
 1   VendorID               22699 non-null  int64  
 2   tpep_pickup_datetime   22699 non-null  object 
 3   tpep_dropoff_datetime  22699 non-null  object 
 4   passenger_count        22699 non-null  int64  
 5   trip_distance          22699 non-null  float64
 6   RatecodeID             22699 non-null  int64  
 7   store_and_fwd_flag     22699 non-null  object 
 8   PULocationID           22699 non-null  int64  
 9   DOLocationID           22699 non-null  int64  
 10  payment_type           22699 non-null  int64  
 11  fare_amount            22699 non-null  float64
 12  extra                  22699 non-null  float64
 13  mta_tax                22699 non-null  float64
 14  tip_amount             22699 non-null  float64
 15  tolls_amount           22699 non-null  float64
 16  improvement_surcharge  22699 non-null  float64
 17  total_amount           22699 non-null  float64
dtypes: float64(8), int64(7), object(3)
memory usage: 3.1+ MB
```

In [6]:
```
df.describe()
```

Out[6]:

	Unnamed: 0	VendorID	passenger_count	trip_distance	RatecodeID	PULocationID	DOLc
count	2.269900e+04	22699.000000	22699.000000	22699.000000	22699.000000	22699.000000	2269
mean	5.675849e+07	1.556236	1.642319	2.913313	1.043394	162.412353	16
std	3.274493e+07	0.496838	1.285231	3.653171	0.708391	66.633373	7
min	1.212700e+04	1.000000	0.000000	0.000000	1.000000	1.000000	
25%	2.852056e+07	1.000000	1.000000	0.990000	1.000000	114.000000	11
50%	5.673150e+07	2.000000	1.000000	1.610000	1.000000	162.000000	16
75%	8.537452e+07	2.000000	2.000000	3.060000	1.000000	233.000000	23
max	1.134863e+08	2.000000	6.000000	33.960000	99.000000	265.000000	26

In [4]:
```
# Sort the data by trip distance from maximum to minimum value

df_sort = df.sort_values(by=['trip_distance'],ascending=False)
df_sort.head(10)
```

Out[4]:

	Unnamed: 0	VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_dist
9280	51810714	2	06/18/2017 11:33:25 PM	06/19/2017 12:12:38 AM	2	3
13861	40523668	2	05/19/2017 8:20:21 AM	05/19/2017 9:20:30 AM	1	3
6064	49894023	2	06/13/2017 12:30:22 PM	06/13/2017 1:37:51 PM	1	3
10291	76319330	2	09/11/2017 11:41:04 AM	09/11/2017 12:18:58 PM	1	3
29	94052446	2	11/06/2017 8:30:50 PM	11/07/2017 12:00:00 AM	1	3
18130	90375786	1	10/26/2017 2:45:01 PM	10/26/2017 4:12:49 PM	1	3
5792	68023798	2	08/11/2017 2:14:01 PM	08/11/2017 3:17:31 PM	1	3
15350	77309977	2	09/14/2017 1:44:44 PM	09/14/2017 2:34:29 PM	1	2
10302	43431843	1	05/15/2017 8:11:34 AM	05/15/2017 9:03:16 AM	1	2
2592	51094874	2	06/16/2017 6:51:20 PM	06/16/2017 7:41:42 PM	1	2

In [5]:
```
# Sort the data by total amount and print the top 20 values
total_amount_sorted = df.sort_values(
    ['total_amount'], ascending=False)['total_amount']
total_amount_sorted.head(20)
```

Out[5]:
```
8476     1200.29
20312     450.30
13861     258.21
12511     233.74
15474     211.80
6064      179.06
16379     157.06
3582      152.30
11269     151.82
9280      150.30
1928      137.80
10291     131.80
6708      126.00
11608     123.30
908       121.56
7281      120.96
18130     119.31
13621     115.94
13359     111.95
29        111.38
Name: total_amount, dtype: float64
```

In [6]:
```
# Sort the data by total amount and print the bottom 20 values
total_amount_sorted.tail(20)
```

Out[6]:
```
14283      0.31
19067      0.30
10506      0.00
5722       0.00
4402       0.00
22566      0.00
1646      -3.30
18565     -3.80
314       -3.80
5758      -3.80
5448      -4.30
4423      -4.30
10281     -4.30
8204      -4.80
20317     -4.80
11204     -5.30
14714     -5.30
17602     -5.80
20698     -5.80
12944   -120.30
Name: total_amount, dtype: float64
```

In [10]:
```
# How many of each payment type are represented in the data?
df['payment_type'].value_counts()
```

Out[10]:
```
1    15265
2     7267
3      121
4       46
Name: payment_type, dtype: int64
```

In [11]:
```
# What is the average tip for trips paid for with credit card?
avg_cc_tip = df[df['payment_type']==1]['tip_amount'].mean()
print('Avg. cc tip:', avg_cc_tip)

# What is the average tip for trips paid for with cash?
avg_cash_tip = df[df['payment_type']==2]['tip_amount'].mean()
print('Avg. cash tip:', avg_cash_tip)
```

```
Avg. cc tip: 2.7298001965280054
Avg. cash tip: 0.0
```

In [12]:
```
# How many times is each vendor ID represented in the data?
df['VendorID'].value_counts()
```

Out[12]:
```
2    12626
1    10073
Name: VendorID, dtype: int64
```

In [13]:
```
# What is the mean total amount for each vendor?
df.groupby(['VendorID']).mean(numeric_only=True)[['total_amount']]
```

Out[13]:

	total_amount
VendorID	
1	16.298119
2	16.320382

In [14]:
```
# Filter the data for credit card payments only
credit_card = df[df['payment_type']==1]

# Filter the credit-card-only data for passenger count only
credit_card['passenger_count'].value_counts()
```

Out[14]:
```
1    10977
2     2168
5      775
3      600
6      451
4      267
0       27
Name: passenger_count, dtype: int64
```

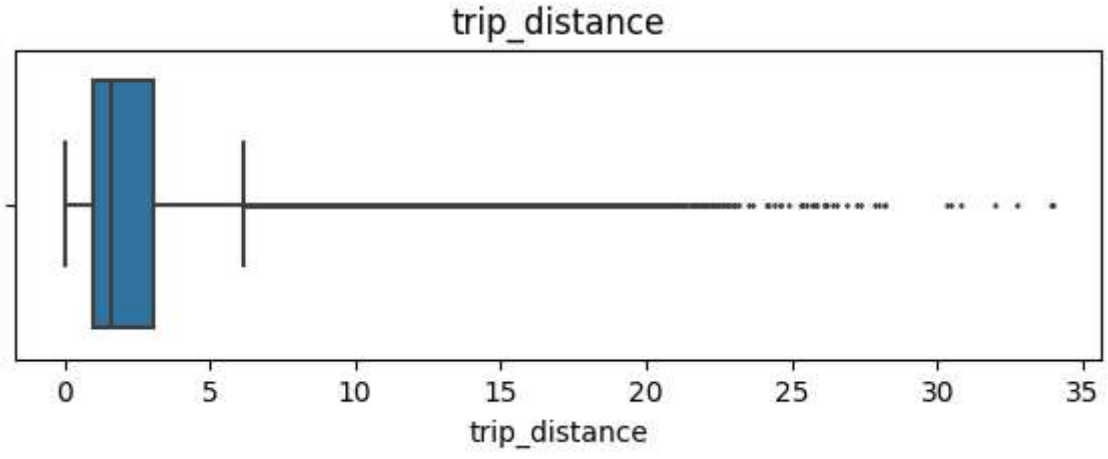
In [15]:
```
# Calculate the average tip amount for each passenger count (credit card payments only
credit_card.groupby(['passenger_count']).mean(numeric_only=True)[['tip_amount']]
```

Out[15]:

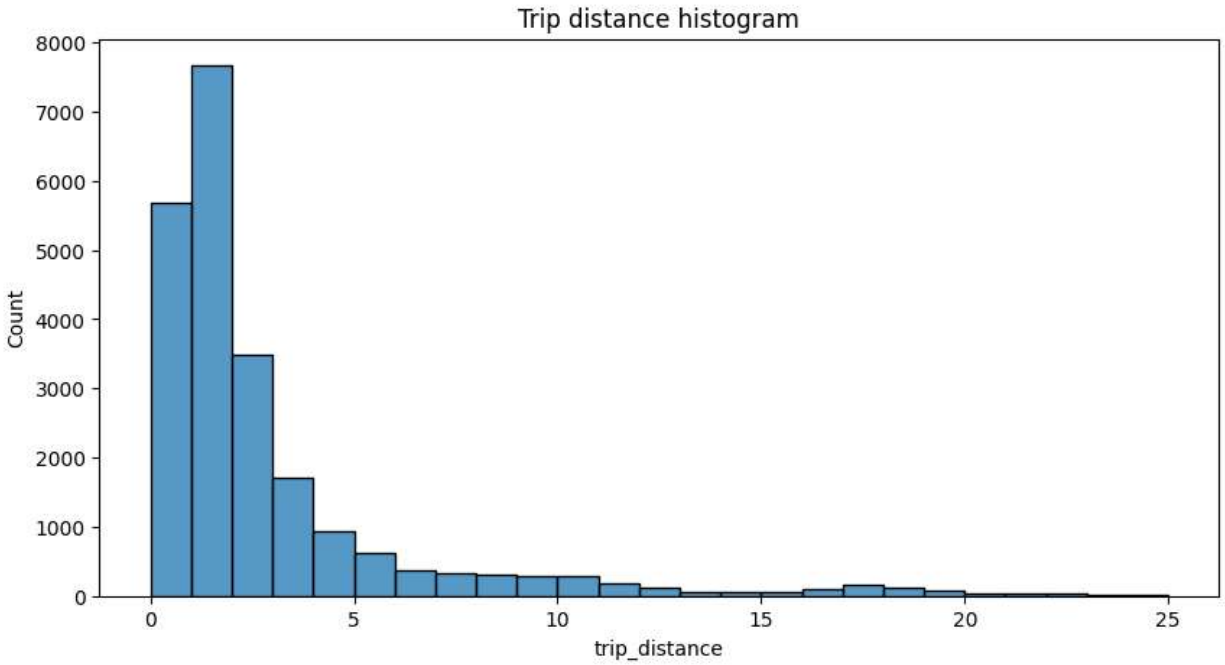
passenger_count	tip_amount
0	2.610370
1	2.714681
2	2.829949
3	2.726800
4	2.607753
5	2.762645
6	2.643326

In [8]:
```
# Convert data columns to datetime
df['tpep_pickup_datetime']=pd.to_datetime(df['tpep_pickup_datetime'])
df['tpep_dropoff_datetime']=pd.to_datetime(df['tpep_dropoff_datetime'])
```

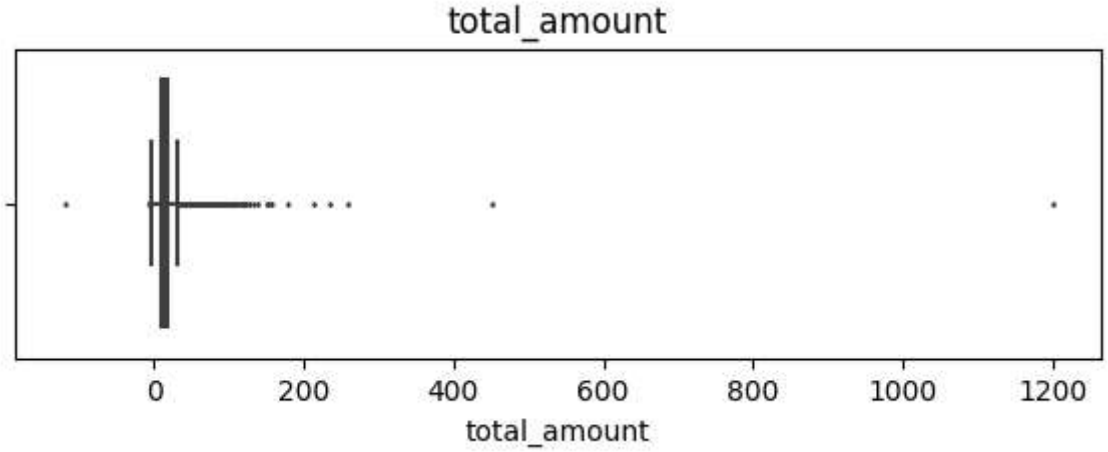
In [11]:
```
# Create box plot of trip_distance
plt.figure(figsize=(7,2))
plt.title('trip_distance')
sns.boxplot(data=None, x=df['trip_distance'], fliersize=1);
```



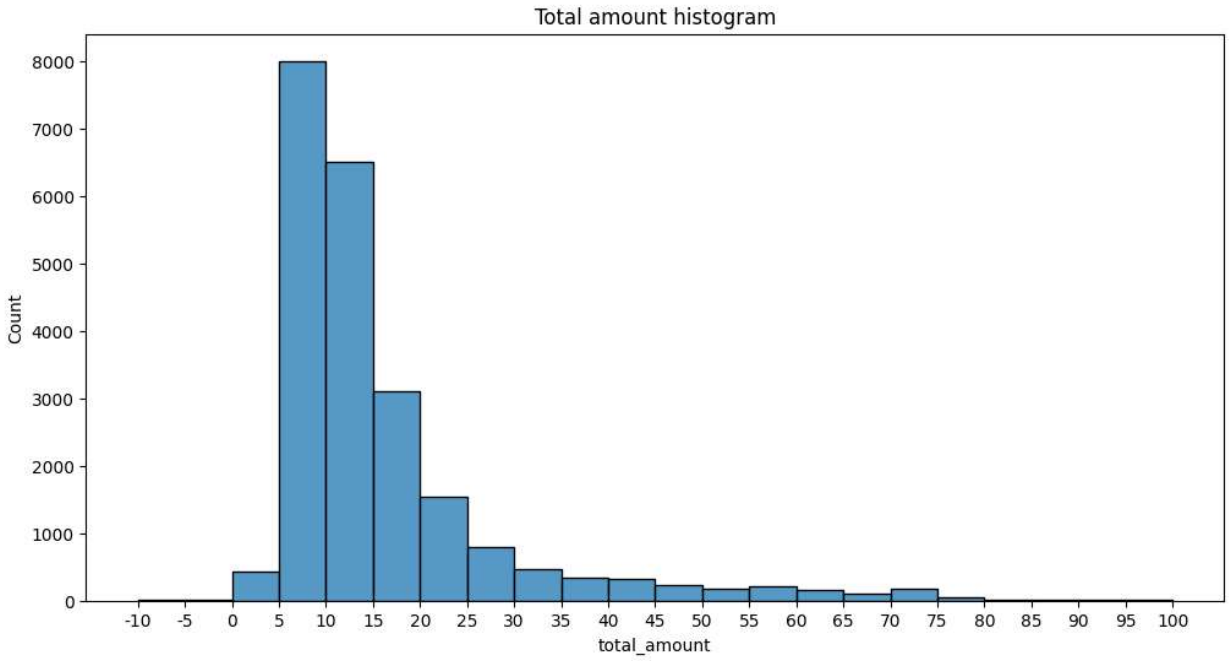
In [12]:
```
# Create histogram of trip_distance
plt.figure(figsize=(10,5))
sns.histplot(df['trip_distance'], bins=range(0,26,1))
plt.title('Trip distance histogram');
```



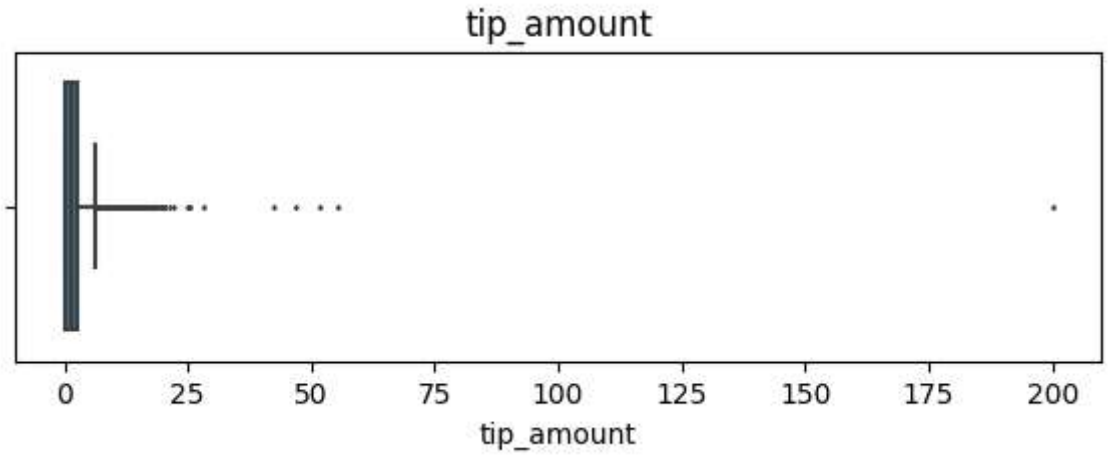
In [13]:
```
# Create box plot of total_amount
plt.figure(figsize=(7,2))
plt.title('total_amount')
sns.boxplot(x=df['total_amount'], fliersize=1);
```



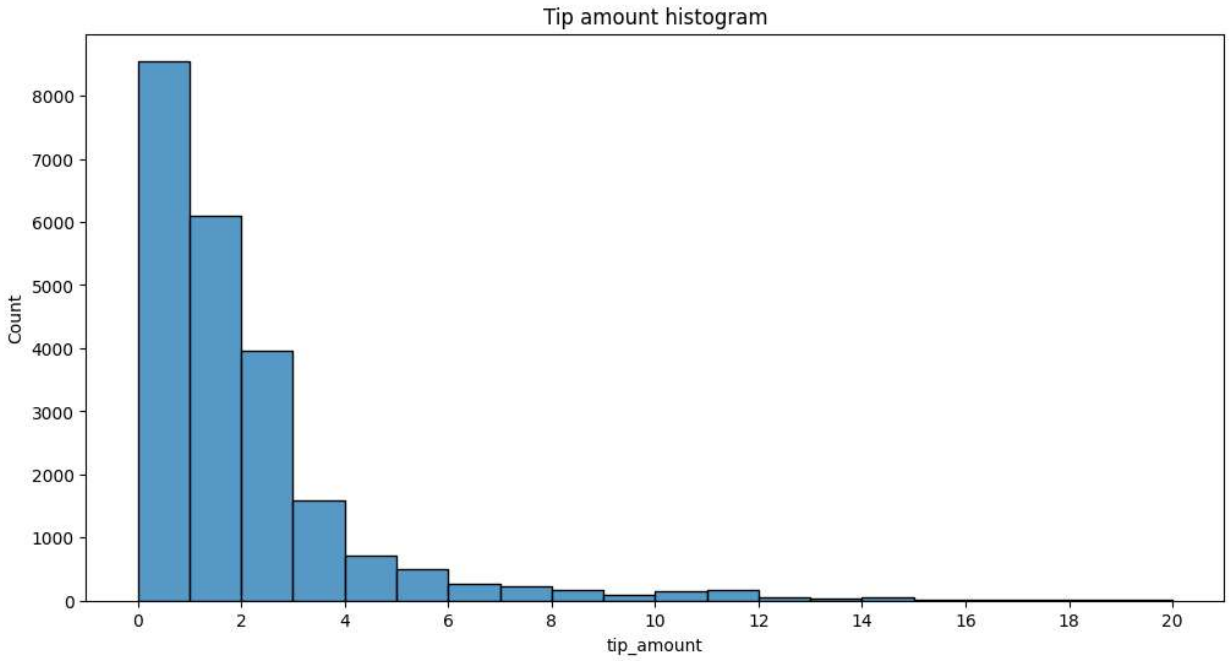
In [14]:
```
# Create histogram of total_amount
plt.figure(figsize=(12,6))
ax = sns.histplot(df['total_amount'], bins=range(-10,101,5))
ax.set_xticks(range(-10,101,5))
ax.set_xticklabels(range(-10,101,5))
plt.title('Total amount histogram');
```



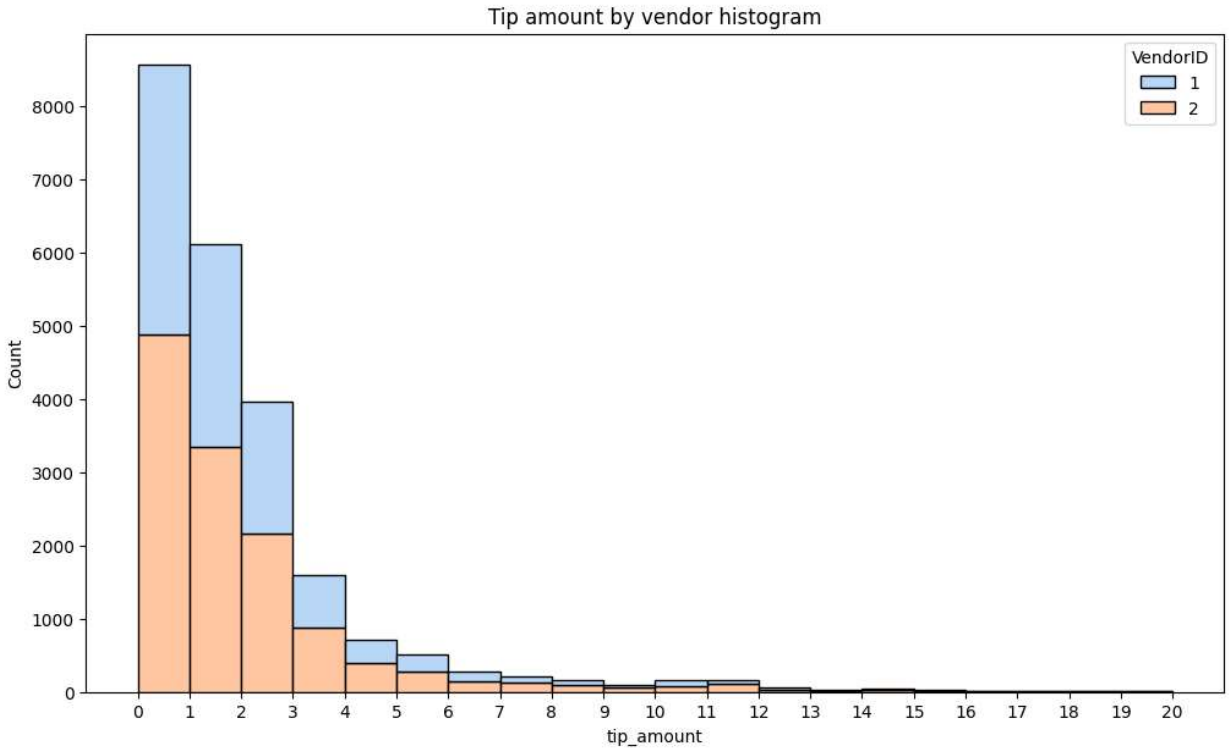
In [15]:
```
# Create box plot of tip_amount
plt.figure(figsize=(7,2))
plt.title('tip_amount')
sns.boxplot(x=df['tip_amount'], fliersize=1);
```



In [16]:
```
# Create histogram of tip_amount
plt.figure(figsize=(12,6))
ax = sns.histplot(df['tip_amount'], bins=range(0,21,1))
ax.set_xticks(range(0,21,2))
ax.set_xticklabels(range(0,21,2))
plt.title('Tip amount histogram');
```

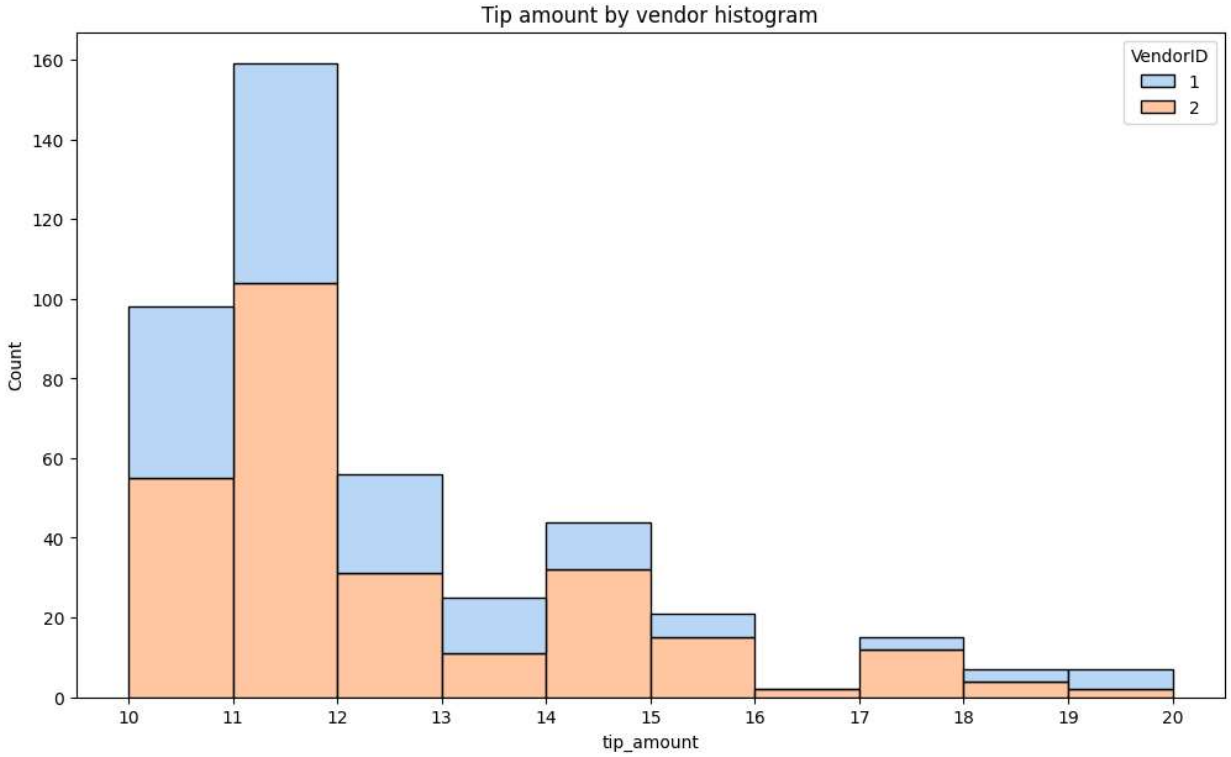


In [17]:
```
# Create histogram of tip_amount by vendor
plt.figure(figsize=(12,7))
ax = sns.histplot(data=df, x='tip_amount', bins=range(0,21,1),
                  hue='VendorID',
                  multiple='stack',
                  palette='pastel')
ax.set_xticks(range(0,21,1))
ax.set_xticklabels(range(0,21,1))
plt.title('Tip amount by vendor histogram');
```



In [18]:
```
# Create histogram of tip_amount by vendor for tips > $10
tips_over_ten = df[df['tip_amount'] > 10]
plt.figure(figsize=(12,7))
ax = sns.histplot(data=tips_over_ten, x='tip_amount', bins=range(10,21,1),
```

```
                  hue='VendorID',
                  multiple='stack',
                  palette='pastel')
ax.set_xticks(range(10,21,1))
ax.set_xticklabels(range(10,21,1))
plt.title('Tip amount by vendor histogram');
```



In [19]:
```
df['passenger_count'].value_counts()
```

Out[19]:
```
1    16117
2     3305
5     1143
3      953
6      693
4      455
0       33
Name: passenger_count, dtype: int64
```

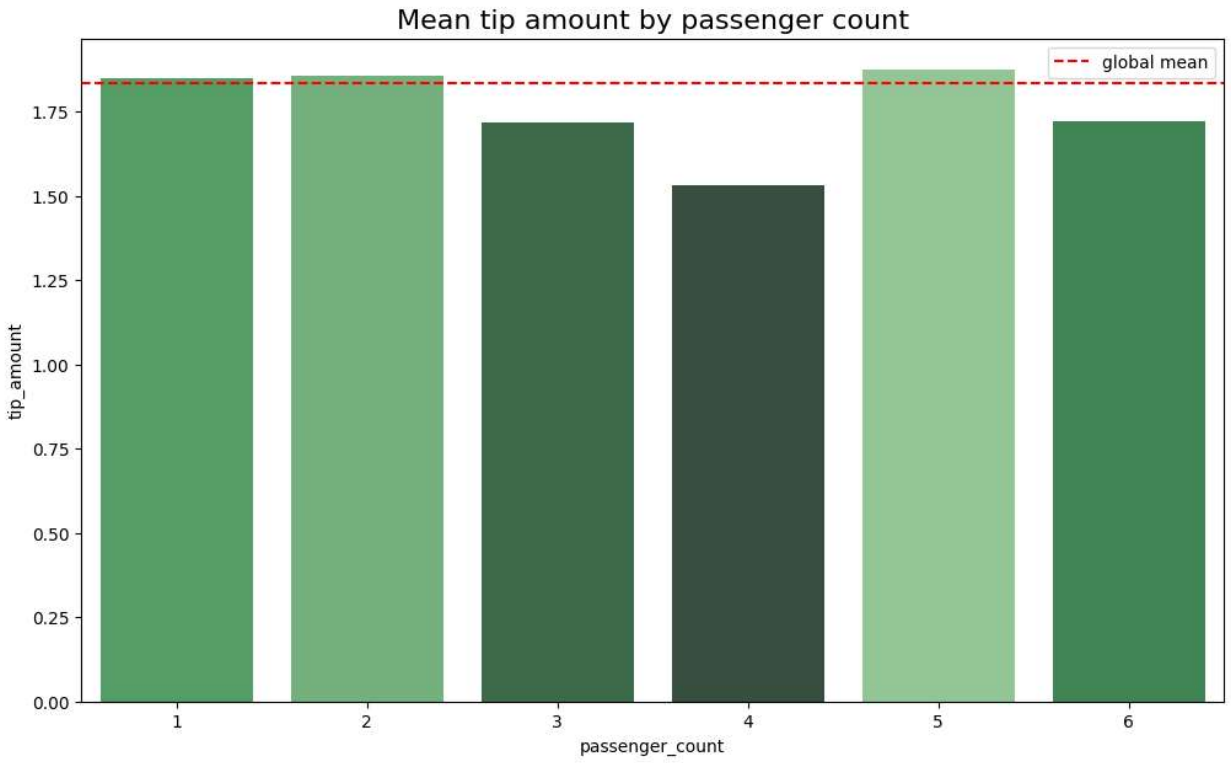
In [20]:
```
# Calculate mean tips by passenger_count
mean_tips_by_passenger_count = df.groupby(['passenger_count']).mean()[['tip_amount']]
mean_tips_by_passenger_count
```

```
C:\Users\bussy\AppData\Local\Temp\ipykernel_31048\1943984880.py:2: FutureWarning: The
default value of numeric_only in DataFrameGroupBy.mean is deprecated. In a future ver
sion, numeric_only will default to False. Either specify numeric_only or select only
columns which should be valid for the function.
  mean_tips_by_passenger_count = df.groupby(['passenger_count']).mean()[['tip_amoun
t']]
```

Out[20]:

passenger_count	tip_amount
0	2.135758
1	1.848920
2	1.856378
3	1.716768
4	1.530264
5	1.873185
6	1.720260

In [21]:
```
# Create bar plot for mean tips by passenger count
data = mean_tips_by_passenger_count.tail(-1)
pal = sns.color_palette("Greens_d", len(data))
rank = data['tip_amount'].argsort().argsort()
plt.figure(figsize=(12,7))
ax = sns.barplot(x=data.index,
            y=data['tip_amount'],
            palette=np.array(pal[::-1])[rank])
ax.axhline(df['tip_amount'].mean(), ls='--', color='red', label='global mean')
ax.legend()
plt.title('Mean tip amount by passenger count', fontsize=16);
```



In [22]:
```
# Create a month column
df['month'] = df['tpep_pickup_datetime'].dt.month_name()
# Create a day column
df['day'] = df['tpep_pickup_datetime'].dt.day_name()
```

In [23]:
```
# Get total number of rides for each month
monthly_rides = df['month'].value_counts()
monthly_rides
```

Out[23]:
```
March        2049
October      2027
April        2019
May          2013
January      1997
June         1964
December     1863
November     1843
February     1769
September    1734
August       1724
July         1697
Name: month, dtype: int64
```

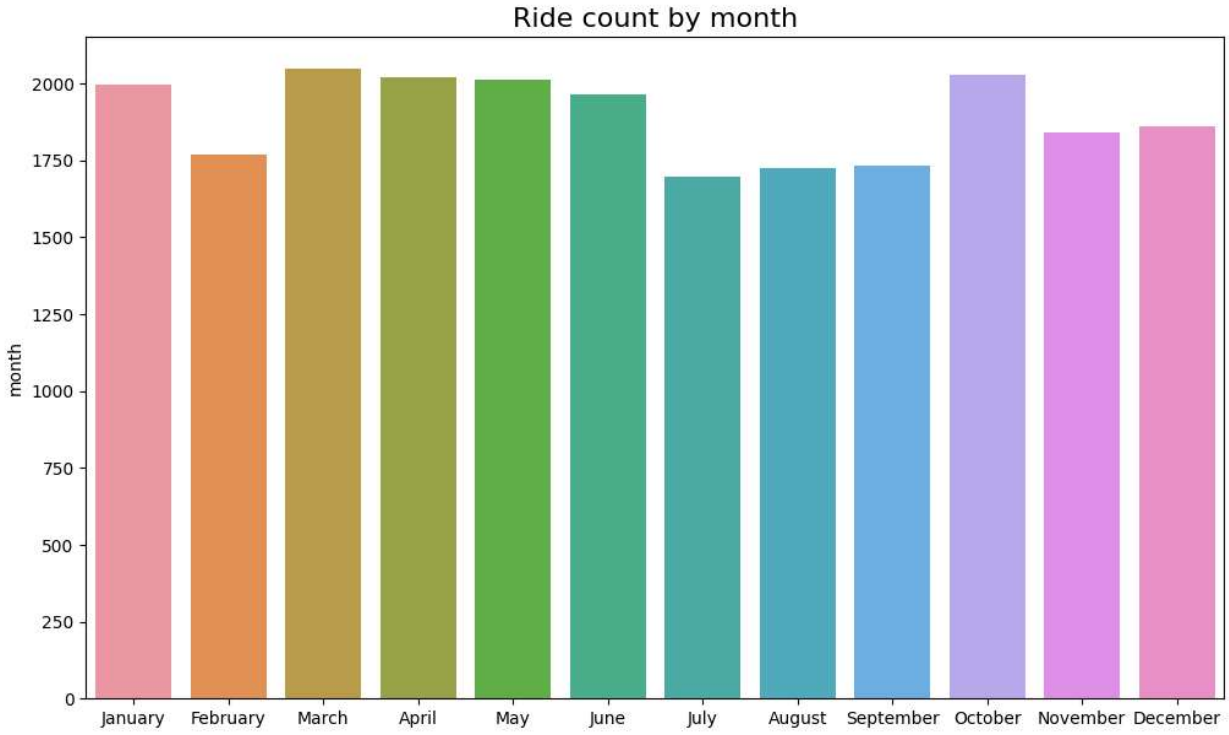
In [24]:
```
# Reorder the monthly ride list so months go in order
month_order = ['January', 'February', 'March', 'April', 'May', 'June', 'July',
         'August', 'September', 'October', 'November', 'December']

monthly_rides = monthly_rides.reindex(index=month_order)
monthly_rides
```

Out[24]:
```
January      1997
February     1769
March        2049
April        2019
May          2013
June         1964
July         1697
August       1724
September    1734
October      2027
November     1843
December     1863
Name: month, dtype: int64
```

In [25]:
```
# Show the index
monthly_rides.index
```

Out[25]:
```
Index(['January', 'February', 'March', 'April', 'May', 'June', 'July',
       'August', 'September', 'October', 'November', 'December'],
      dtype='object')
```

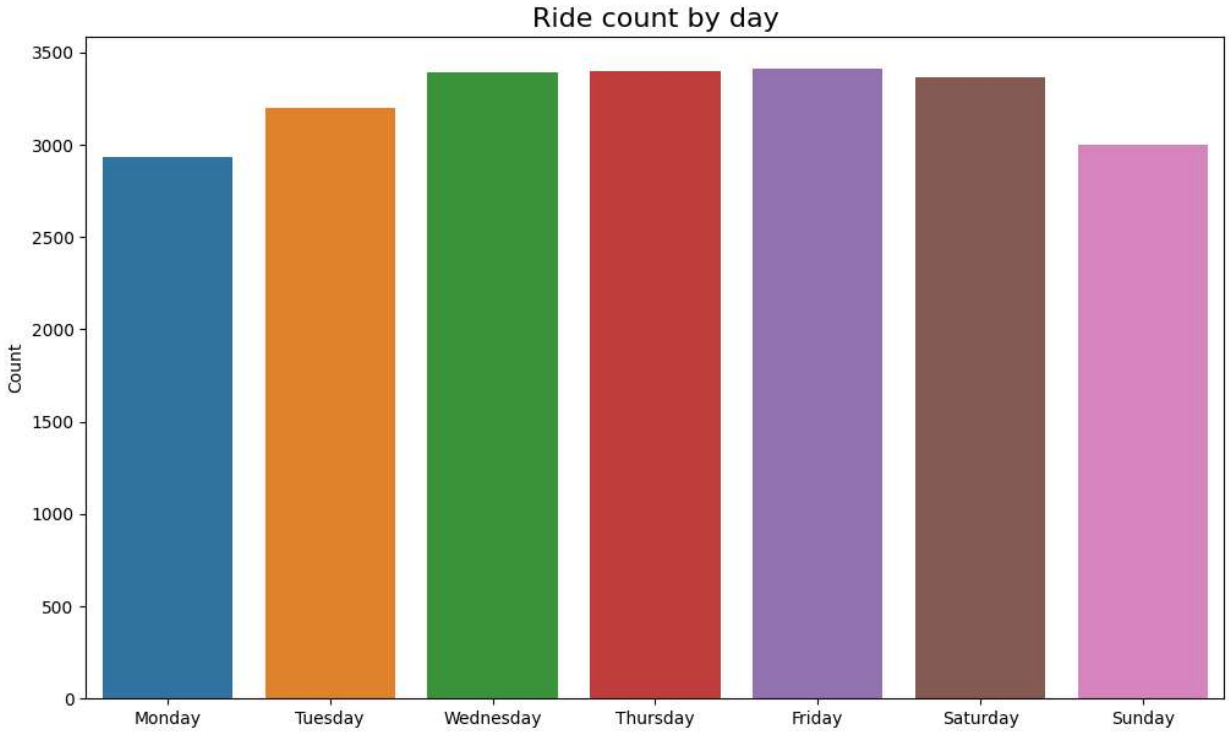
In [26]:
```
# Create a bar plot of total rides per month
plt.figure(figsize=(12,7))
ax = sns.barplot(x=monthly_rides.index, y=monthly_rides)
ax.set_xticklabels(month_order)
plt.title('Ride count by month', fontsize=16);
```



In [27]:
```
# Repeat the above process, this time for rides by day
daily_rides = df['day'].value_counts()
day_order = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunc
daily_rides = daily_rides.reindex(index=day_order)
daily_rides
```

Out[27]:
```
Monday       2931
Tuesday      3198
Wednesday    3390
Thursday     3402
Friday       3413
Saturday     3367
Sunday       2998
Name: day, dtype: int64
```

In [28]:
```
# Create bar plot for ride count by day
plt.figure(figsize=(12,7))
ax = sns.barplot(x=daily_rides.index, y=daily_rides)
ax.set_xticklabels(day_order)
ax.set_ylabel('Count')
plt.title('Ride count by day', fontsize=16);
```



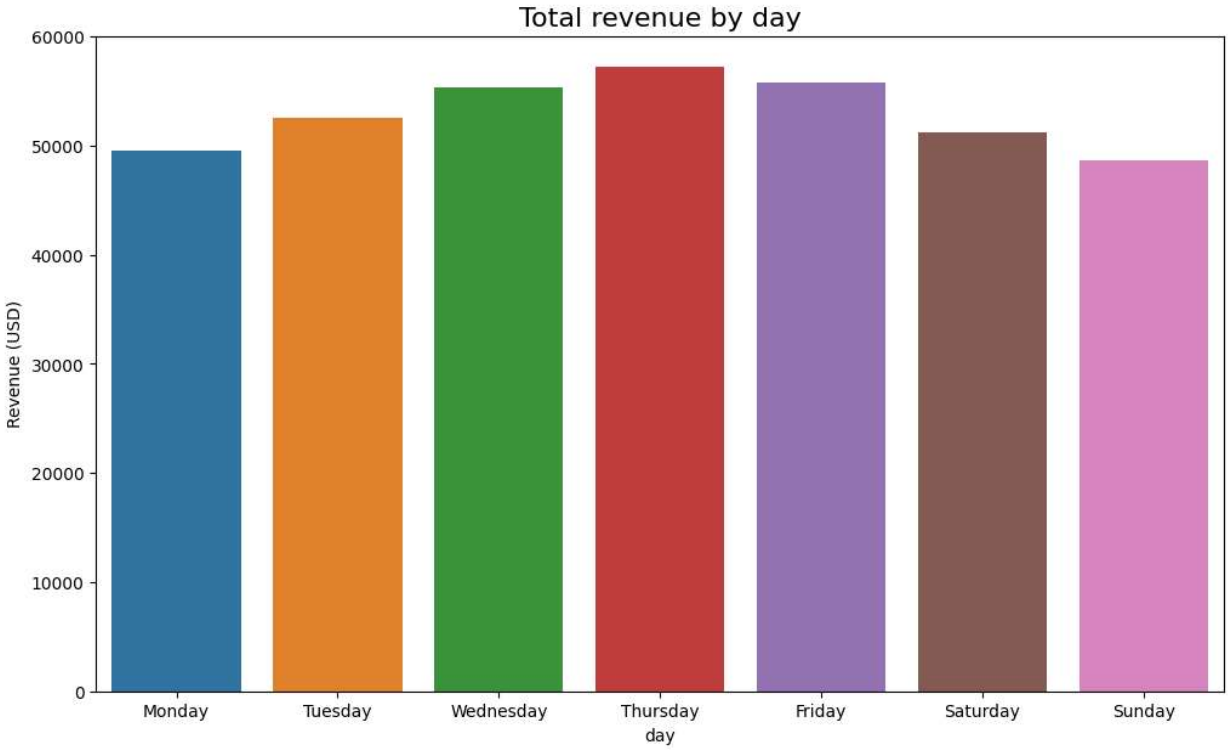
In [29]:
```
# Repeat the process, this time for total revenue by day
day_order = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunc
total_amount_day = df.groupby('day').sum()[['total_amount']]
total_amount_day = total_amount_day.reindex(index=day_order)
total_amount_day
```

```
C:\Users\bussy\AppData\Local\Temp\ipykernel_31048\4104135426.py:3: FutureWarning: The
default value of numeric_only in DataFrameGroupBy.sum is deprecated. In a future vers
ion, numeric_only will default to False. Either specify numeric_only or select only c
olumns which should be valid for the function.
  total_amount_day = df.groupby('day').sum()[['total_amount']]
```

Out[29]:

day	total_amount
Monday	49574.37
Tuesday	52527.14
Wednesday	55310.47
Thursday	57181.91
Friday	55818.74
Saturday	51195.40
Sunday	48624.06

In [30]:
```
# Create bar plot of total revenue by day
plt.figure(figsize=(12,7))
ax = sns.barplot(x=total_amount_day.index, y=total_amount_day['total_amount'])
ax.set_xticklabels(day_order)
ax.set_ylabel('Revenue (USD)')
plt.title('Total revenue by day', fontsize=16);
```



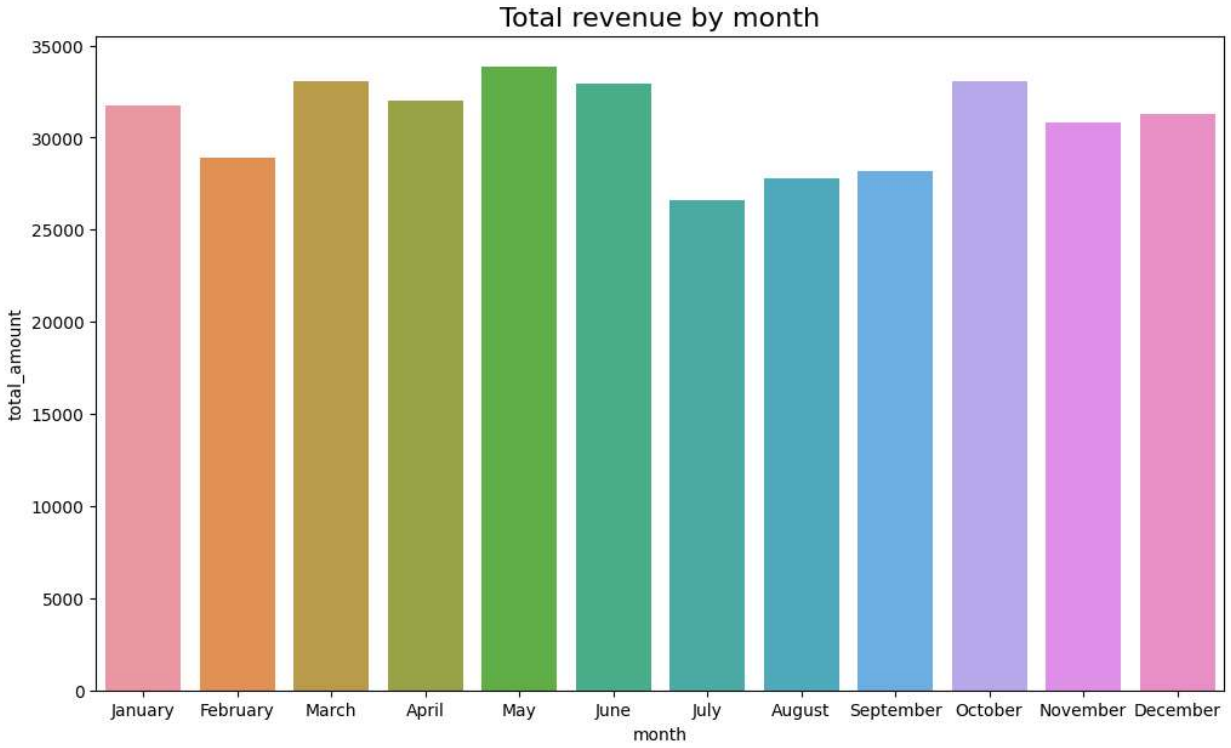
In [31]:
```
# Repeat the process, this time for total revenue by month
total_amount_month = df.groupby('month').sum()[['total_amount']]
total_amount_month = total_amount_month.reindex(index=month_order)
total_amount_month
```

```
C:\Users\bussy\AppData\Local\Temp\ipykernel_31048\749544936.py:2: FutureWarning: The
default value of numeric_only in DataFrameGroupBy.sum is deprecated. In a future vers
ion, numeric_only will default to False. Either specify numeric_only or select only c
olumns which should be valid for the function.
  total_amount_month = df.groupby('month').sum()[['total_amount']]
```

Out[31]:

month	total_amount
January	31735.25
February	28937.89
March	33085.89
April	32012.54
May	33828.58
June	32920.52
July	26617.64
August	27759.56
September	28206.38
October	33065.83
November	30800.44
December	31261.57

In [32]:
```
# Create a bar plot of total revenue by month
plt.figure(figsize=(12,7))
ax = sns.barplot(x=total_amount_month.index, y=total_amount_month['total_amount'])
plt.title('Total revenue by month', fontsize=16);
```

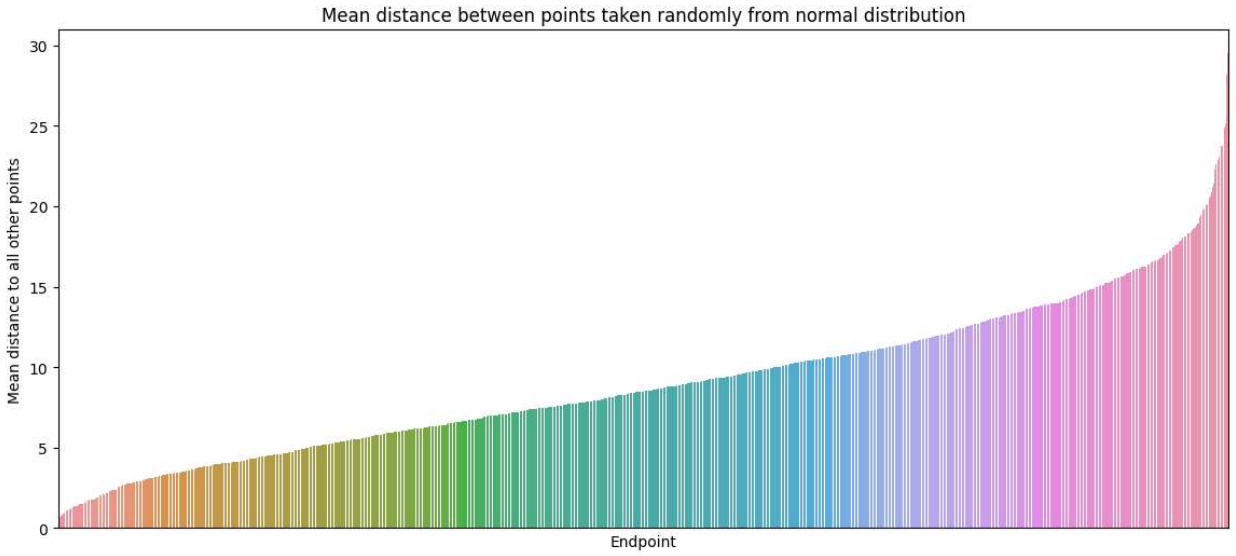


In [33]:
```
# Get number of unique drop-off location IDs
df['DOLocationID'].nunique()
```

Out[33]:
```
216
```

In [34]:
```
# 1. Generate random points on a 2D plane from a normal distribution
test = np.round(np.random.normal(10, 5, (3000, 2)), 1)
midway = int(len(test)/2)  # Calculate midpoint of the array of coordinates
start = test[:midway]      # Isolate first half of array ("pick-up locations")
end = test[midway:]        # Isolate second half of array ("drop-off locations")

# 2. Calculate Euclidean distances between points in first half and second half of arr
distances = (start - end)**2
distances = distances.sum(axis=-1)
distances = np.sqrt(distances)

# 3. Group the coordinates by "drop-off location", compute mean distance
test_df = pd.DataFrame({'start': [tuple(x) for x in start.tolist()],
                        'end': [tuple(x) for x in end.tolist()],
                        'distance': distances})
data = test_df[['end', 'distance']].groupby('end').mean()
data = data.sort_values(by='distance')

# 4. Plot the mean distance between each endpoint ("drop-off location") and all points
plt.figure(figsize=(14,6))
ax = sns.barplot(x=data.index,
                 y=data['distance'],
                 order=data.index)
ax.set_xticklabels([])
```

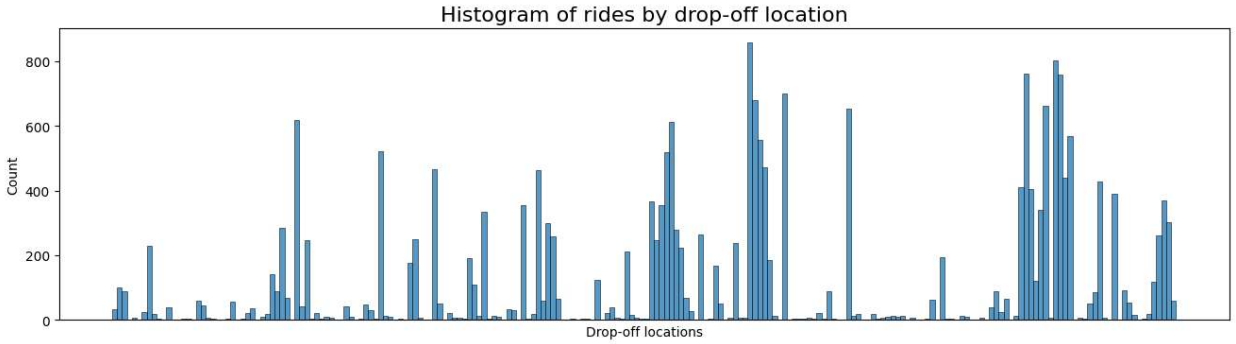
```
ax.set_xticks([])
ax.set_xlabel('Endpoint')
ax.set_ylabel('Mean distance to all other points')
ax.set_title('Mean distance between points taken randomly from normal distribution');
```



In [35]:
```
# Check if all drop-off locations are consecutively numbered
df['DOLocationID'].max() - len(set(df['DOLocationID']))
```

Out[35]: 49

In [36]:
```
plt.figure(figsize=(16,4))
# DOLocationID column is numeric, so sort in ascending order
sorted_dropoffs = df['DOLocationID'].sort_values()
# Convert to string
sorted_dropoffs = sorted_dropoffs.astype('str')
# Plot
sns.histplot(sorted_dropoffs, bins=range(0, df['DOLocationID'].max()+1, 1))
plt.xticks([])
plt.xlabel('Drop-off locations')
plt.title('Histogram of rides by drop-off location', fontsize=16);
```



In [37]:
```
df['trip_duration'] = (df['tpep_dropoff_datetime']-df['tpep_pickup_datetime'])
```

In [38]:
```
df.head(10)
```

Out[38]:

	Unnamed: 0	VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_distance
0	24870114	2	2017-03-25 08:55:43	2017-03-25 09:09:47	6	3.34
1	35634249	1	2017-04-11 14:53:28	2017-04-11 15:19:58	1	1.80
2	106203690	1	2017-12-15 07:26:56	2017-12-15 07:34:08	1	1.00
3	38942136	2	2017-05-07 13:17:59	2017-05-07 13:48:14	1	3.70
4	30841670	2	2017-04-15 23:32:20	2017-04-15 23:49:03	1	4.37
5	23345809	2	2017-03-25 20:34:11	2017-03-25 20:42:11	6	2.30
6	37660487	2	2017-05-03 19:04:09	2017-05-03 20:03:47	1	12.83
7	69059411	2	2017-08-15 17:41:06	2017-08-15 18:03:05	1	2.98
8	8433159	2	2017-02-04 16:17:07	2017-02-04 16:29:14	1	1.20
9	95294817	1	2017-11-10 15:20:29	2017-11-10 15:40:55	1	1.60

10 rows × 21 columns