Business Problem

As a marketing agency, our primary objective is to maximize the return on investment (ROI) for our clients' advertising campaigns. We have conducted two ad campaigns, one on Facebook and the other on AdWords, and we need to determine which platform yields better results in terms of clicks, conversions, and overall cost-effectiveness. By identifying the most effective platform, we can allocate our resources more efficiently and optimize our advertising strategies to deliver better outcomes for our clients.

Research Question

Which ad platform is more effective in terms of conversions, clicks, and overall cost-effectiveness?

Importing Libraries

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as st
import numpy as np
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score, mean_squared_error
from statsmodels.tsa.seasonal import seasonal_decompose
from statsmodels.tsa.stattools import coint
import warnings
warnings.filterwarnings('ignore')
```

Data Description The dataset comprises a collection of data comparing the performance of two separate ad campaigns conducted throughout the year 2019. Specifically, the data covers a Facebook Ad campaign and an AdWords Ad campaign. For each day of the year 2019, there is a corresponding row in the dataset, resulting in a total of 365 lines of campaign data to analyze. The dataset includes various performance metrics for each ad campaign, providing insights into their effectiveness and efficiency over time.

Key features included in the dataset are as follows:

```
Date: The date corresponding to each row of campaign data, ranging
from January 1st, 2019, to December 31st, 2019.

Ad Views: The number of times the ad was viewed.

Ad Clicks: The number of clicks received on the ad.
```

Ad Conversions: The number of conversions resulting from the ad.

Cost per Ad: The cost associated with running the Facebook ad campaign.

Click-Through Rate (CTR): The ratio of clicks to views, indicating the effectiveness of the ad in generating clicks.

Conversion Rate: The ratio of conversions to clicks, reflecting the effectiveness of the ad in driving desired actions.

Cost per Click (CPC): The average cost incurred per click on the ad.

```
#Loadinig the Dataset
df=pd.read_csv("C:/Users/dahak/Downloads/AB
testing/marketing_campaign.csv")
df
```

```
           Date Facebook Ad Campaign  Facebook Ad Views  Facebook Ad
Clicks  \
0      1/1/2019             FB_Jan19               2116
18
1      1/2/2019             FB_Jan19               3106
36
2      1/3/2019             FB_Jan19               3105
26
3      1/4/2019             FB_Jan19               1107
27
4      1/5/2019             FB_Jan19               1317
15
..          ...                  ...                ...
...
360  12/27/2019             FB_Dec19               3240
51
361  12/28/2019             FB_Dec19               1510
69
362  12/29/2019             FB_Dec19               2918
44
363  12/30/2019             FB_Dec19               2212
37
364  12/31/2019             FB_Dec19               1470
60

     Facebook Ad Conversions Cost per Facebook Ad  \
0                          8                 $126
1                         12                 $104
2                          8                 $102
3                          9                  $71
4                          7                  $78
..                       ...                  ...
```

```
360                          13                   $63
361                          18                   $97
362                          13                   $49
363                           8                  $102
364                          17                   $99

    Facebook Click-Through Rate (Clicks / View)  \
0                                           0.83%
1                                           1.15%
2                                           0.84%
3                                           2.45%
4                                           1.10%
..                                            ...
360                                         1.57%
361                                         4.55%
362                                         1.50%
363                                         1.68%
364                                         4.06%

    Facebook Conversion Rate (Conversions / Clicks)  \
0                                            42.73%
1                                            34.04%
2                                            31.45%
3                                            34.76%
4                                            47.59%
..                                              ...
360                                          25.89%
361                                          25.82%
362                                          29.11%
363                                          22.70%
364                                          28.38%

    Facebook Cost per Click (Ad Cost / Clicks) AdWords Ad Campaign  \
0                                        $7.14            AW_Jan19
1                                        $2.91            AW_Jan19
2                                        $3.89            AW_Jan19
3                                        $2.62            AW_Jan19
4                                        $5.38            AW_Jan19
..                                         ...                 ...
360                                      $1.24            AW_Dec19
361                                      $1.42            AW_Dec19
362                                      $1.11            AW_Dec19
363                                      $2.75            AW_Dec19
364                                      $1.65            AW_Dec19

     AdWords Ad Views  AdWords Ad Clicks  AdWords Ad Conversions  \
0                4984                  59                       5
1                4022                  71                       6
2                3863                  44                       4
3                3911                  49                       5
```

```
4                4070                  55                          7
..                ...                 ...                        ...
360              5332                  72                          9
361              3887                  49                          6
362              5327                  62                          6
363              4020                  71                          6
364              4592                  47                          6

    Cost per AdWords Ad AdWords Click-Through Rate (Clicks / View)  \
0                  $194                                        1.18%
1                   $75                                        1.77%
2                  $141                                        1.13%
3                  $141                                        1.26%
4                  $133                                        1.36%
..                  ...                                         ...
360                 $76                                        1.35%
361                $121                                        1.27%
362                $128                                        1.16%
363                $119                                        1.76%
364                 $86                                        1.01%

    AdWords Conversion Rate (Conversions / Click)  \
0                                          8.40%
1                                          7.80%
2                                          9.59%
3                                         11.08%
4                                         12.22%
..                                           ...
360                                       11.92%
361                                       13.10%
362                                        9.85%
363                                        7.83%
364                                       13.60%

    AdWords Cost per Click (Ad Cost / Clicks)
0                                       $3.30
1                                       $1.05
2                                       $3.23
3                                       $2.86
4                                       $2.40
..                                        ...
360                                     $1.06
361                                     $2.46
362                                     $2.08
363                                     $1.68
364                                     $1.85

[365 rows x 17 columns]
```

```
# Data overview
df.head()
```

```
       Date Facebook Ad Campaign  Facebook Ad Views  Facebook Ad
Clicks  \
0  1/1/2019             FB_Jan19               2116
18
1  1/2/2019             FB_Jan19               3106
36
2  1/3/2019             FB_Jan19               3105
26
3  1/4/2019             FB_Jan19               1107
27
4  1/5/2019             FB_Jan19               1317
15

   Facebook Ad Conversions Cost per Facebook Ad  \
0                        8                 $126
1                       12                 $104
2                        8                 $102
3                        9                  $71
4                        7                  $78

  Facebook Click-Through Rate (Clicks / View)  \
0                                       0.83%
1                                       1.15%
2                                       0.84%
3                                       2.45%
4                                       1.10%

  Facebook Conversion Rate (Conversions / Clicks)  \
0                                          42.73%
1                                          34.04%
2                                          31.45%
3                                          34.76%
4                                          47.59%

  Facebook Cost per Click (Ad Cost / Clicks) AdWords Ad Campaign  \
0                                     $7.14            AW_Jan19
1                                     $2.91            AW_Jan19
2                                     $3.89            AW_Jan19
3                                     $2.62            AW_Jan19
4                                     $5.38            AW_Jan19

   AdWords Ad Views  AdWords Ad Clicks  AdWords Ad Conversions  \
0              4984                59                       5
1              4022                71                       6
2              3863                44                       4
3              3911                49                       5
4              4070                55                       7
```

```
  Cost per AdWords Ad AdWords Click-Through Rate (Clicks / View)  \
0                $194                                          1.18%
1                 $75                                          1.77%
2                $141                                          1.13%
3                $141                                          1.26%
4                $133                                          1.36%

  AdWords Conversion Rate (Conversions / Click)  \
0                                         8.40%
1                                         7.80%
2                                         9.59%
3                                        11.08%
4                                        12.22%

  AdWords Cost per Click (Ad Cost / Clicks)
0                                     $3.30
1                                     $1.05
2                                     $3.23
3                                     $2.86
4                                     $2.40
```

```
#rows and column count of the dataset
df.shape
```

```
(365, 17)
```

```
df.dtypes
```

```
Date                                            object
Facebook Ad Campaign                            object
Facebook Ad Views                                int64
Facebook Ad Clicks                               int64
Facebook Ad Conversions                          int64
Cost per Facebook Ad                            object
Facebook Click-Through Rate (Clicks / View)     object
Facebook Conversion Rate (Conversions / Clicks) object
Facebook Cost per Click (Ad Cost / Clicks)      object
AdWords Ad Campaign                             object
AdWords Ad Views                                 int64
AdWords Ad Clicks                                int64
AdWords Ad Conversions                           int64
Cost per AdWords Ad                             object
AdWords Click-Through Rate (Clicks / View)      object
AdWords Conversion Rate (Conversions / Click)   object
AdWords Cost per Click (Ad Cost / Clicks)       object
dtype: object
```

```
df['Date']=pd.to_datetime(df['Date'])
df.dtypes
```

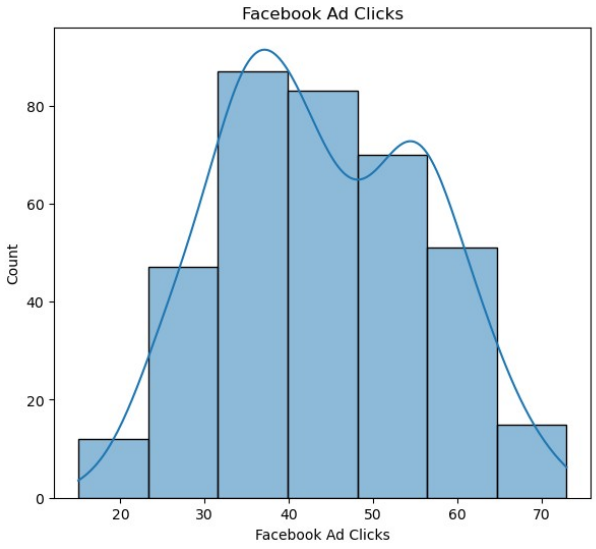
```
Date                                                datetime64[ns]
Facebook Ad Campaign                                        object
Facebook Ad Views                                            int64
Facebook Ad Clicks                                           int64
Facebook Ad Conversions                                      int64
Cost per Facebook Ad                                        object
Facebook Click-Through Rate (Clicks / View)                 object
Facebook Conversion Rate (Conversions / Clicks)             object
Facebook Cost per Click (Ad Cost / Clicks)                  object
AdWords Ad Campaign                                         object
AdWords Ad Views                                             int64
AdWords Ad Clicks                                            int64
AdWords Ad Conversions                                       int64
Cost per AdWords Ad                                         object
AdWords Click-Through Rate (Clicks / View)                  object
AdWords Conversion Rate (Conversions / Click)               object
AdWords Cost per Click (Ad Cost / Clicks)                   object
dtype: object
```

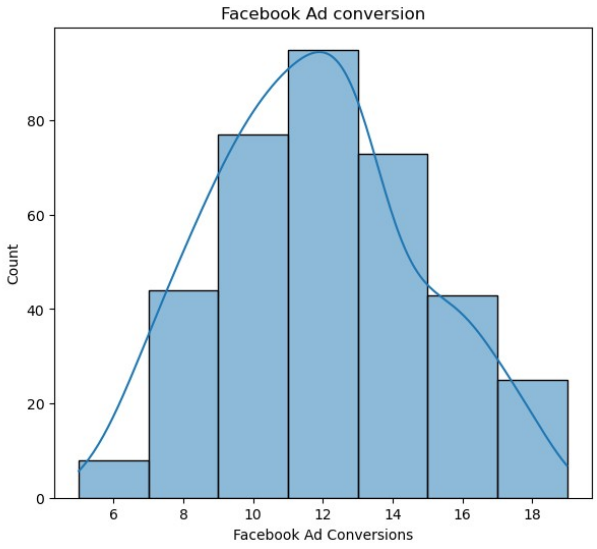
```
# Descriptive stats of the campaigs
df.describe()
```

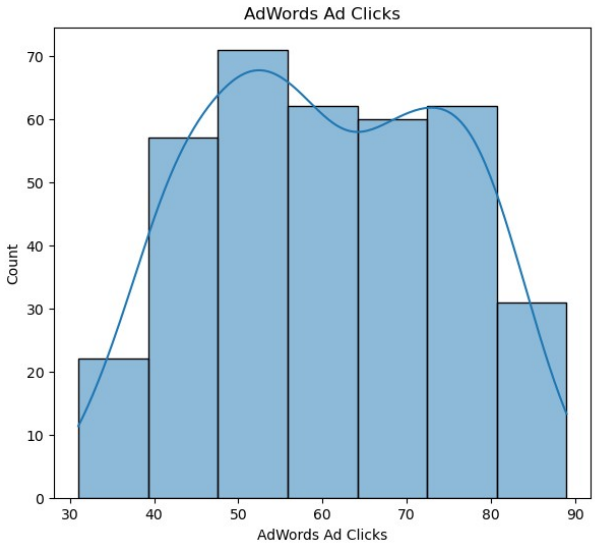
```
       Facebook Ad Views  Facebook Ad Clicks  Facebook Ad Conversions
\
count         365.000000          365.000000               365.000000

mean         2179.687671           44.049315                11.742466

std           618.074639           12.140559                 2.924786

min          1050.000000           15.000000                 5.000000

25%          1656.000000           35.000000                10.000000

50%          2202.000000           43.000000                12.000000

75%          2717.000000           54.000000                13.000000

max          3320.000000           73.000000                19.000000


       AdWords Ad Views  AdWords Ad Clicks  AdWords Ad Conversions
count         365.00000         365.000000              365.000000
mean         4717.19726          60.383562                5.980822
std           561.11406          14.368225                1.628106
min          3714.00000          31.000000                3.000000
25%          4247.00000          49.000000                5.000000
50%          4711.00000          60.000000                6.000000
75%          5190.00000          73.000000                7.000000
max          5760.00000          89.000000                9.000000
```

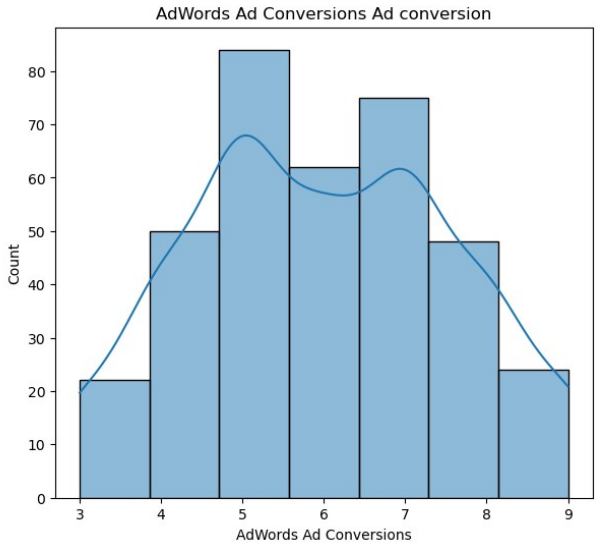
Comparing Campaigns performance

```
# if outlier is present in dataset we have to consider it , we can do
scaling at that time
# Distribuation of the clicks and conversion
plt.figure(figsize=(15,6))
plt.subplot(1,2,1)
plt.title('Facebook Ad Clicks')
sns.histplot(df['Facebook Ad Clicks'],bins=7,edgecolor='k',kde=True)
plt.subplot(1,2,2)
plt.title('Facebook Ad conversion')
sns.histplot(df['Facebook Ad
Conversions'],bins=7,edgecolor='k',kde=True)
plt.show()


plt.figure(figsize=(15,6))
plt.subplot(1,2,1)
plt.title('AdWords Ad Clicks')
sns.histplot(df['AdWords Ad Clicks'],bins=7,edgecolor='k',kde=True)
plt.subplot(1,2,2)
plt.title('AdWords Ad Conversions Ad conversion')
sns.histplot(df['AdWords Ad
Conversions'],bins=7,edgecolor='k',kde=True)
plt.show()
```









All the histogram are showing somewhat symmetrical shape. This symmetrical shape suggests that the number of clicks and conversions is relatively evenly distributed. In other words, there are not many clicks or conversions that are outliers on either the high or low end.

How frequently do we observe days with high numbers of conversions compared to days with low numbers of conversions?

```
# Cerating function to calculate the category for the conversion

def creat_conversion_category(conversion_col):
    category=[]
    for conversion in df[conversion_col]:
        if conversion <6:
            category.append('less than 6')
        elif 6<= conversion <11:
            category.append('6-10')
        elif 11<= conversion <16:
            category.append('11-15')
        else:
            category.append('more than 15')
    return category

## Applying function to different campaign conversions

df['Facebook Conversion Category']=creat_conversion_category('Facebook
Ad Conversions')
df['AdWords Conversion Category']=creat_conversion_category('AdWords
Ad Conversions')

df.head()
```

```
        Date Facebook Ad Campaign  Facebook Ad Views  Facebook Ad
Clicks  \
0 2019-01-01             FB_Jan19               2116
```

```
18
1 2019-01-02              FB_Jan19               3106
36
2 2019-01-03              FB_Jan19               3105
26
3 2019-01-04              FB_Jan19               1107
27
4 2019-01-05              FB_Jan19               1317
15

   Facebook Ad Conversions Cost per Facebook Ad  \
0                        8                 $126
1                       12                 $104
2                        8                 $102
3                        9                  $71
4                        7                  $78

  Facebook Click-Through Rate (Clicks / View)  \
0                                       0.83%
1                                       1.15%
2                                       0.84%
3                                       2.45%
4                                       1.10%

  Facebook Conversion Rate (Conversions / Clicks)  \
0                                          42.73%
1                                          34.04%
2                                          31.45%
3                                          34.76%
4                                          47.59%

  Facebook Cost per Click (Ad Cost / Clicks) AdWords Ad Campaign  \
0                                     $7.14            AW_Jan19
1                                     $2.91            AW_Jan19
2                                     $3.89            AW_Jan19
3                                     $2.62            AW_Jan19
4                                     $5.38            AW_Jan19

   AdWords Ad Views  AdWords Ad Clicks  AdWords Ad Conversions  \
0              4984                 59                       5
1              4022                 71                       6
2              3863                 44                       4
3              3911                 49                       5
4              4070                 55                       7

  Cost per AdWords Ad AdWords Click-Through Rate (Clicks / View)  \
0                $194                                      1.18%
1                 $75                                      1.77%
2                $141                                      1.13%
3                $141                                      1.26%
```

```
4                $133                                          1.36%

  AdWords Conversion Rate (Conversions / Click)  \
0                                          8.40%
1                                          7.80%
2                                          9.59%
3                                         11.08%
4                                         12.22%

  AdWords Cost per Click (Ad Cost / Clicks) Facebook Conversion
Category  \
0                                    $3.30                          6-
10
1                                    $1.05                         11-
15
2                                    $3.23                          6-
10
3                                    $2.86                          6-
10
4                                    $2.40                          6-
10

  AdWords Conversion Category
0                  less than 6
1                        6-10
2                  less than 6
3                  less than 6
4                        6-10
```

```
df[['Facebook Ad Conversions','Facebook Conversion Category','AdWords
Ad Conversions','AdWords Conversion Category']].head()
```

```
   Facebook Ad Conversions Facebook Conversion Category  \
0                        8                         6-10
1                       12                        11-15
2                        8                         6-10
3                        9                         6-10
4                        7                         6-10

   AdWords Ad Conversions AdWords Conversion Category
0                       5                 less than 6
1                       6                       6-10
2                       4                 less than 6
3                       5                 less than 6
4                       7                       6-10
```

```
df['Facebook Conversion Category'].value_counts()
```

```
11-15           189
6-10            128
more than 15     47
```

```
less than 6       1
Name: Facebook Conversion Category, dtype: int64
```

```
facebook = pd.DataFrame(df['Facebook Conversion
Category'].value_counts()).reset_index().rename(columns = {'Facebook
Conversion Category':'Count','index':'Category'})
facebook
```

```
       Category  Count
0         11-15    189
1          6-10    128
2  more than 15     47
3   less than 6      1
```

```
df['AdWords Conversion Category'].value_counts()
```

```
6-10           209
less than 6    156
Name: AdWords Conversion Category, dtype: int64
```

```
adwords = pd.DataFrame(df['AdWords Conversion
Category'].value_counts()).reset_index().rename(columns = {'AdWords
Conversion Category':'Count','index':'Category'})
adwords
```

```
      Category  Count
0         6-10    209
1  less than 6    156
```

```
category_df = pd.merge(facebook, adwords, on = 'Category', how =
'outer').fillna(0)
category_df
```

```
       Category  Count_x  Count_y
0         11-15      189      0.0
1          6-10      128    209.0
2  more than 15       47      0.0
3   less than 6        1    156.0
```

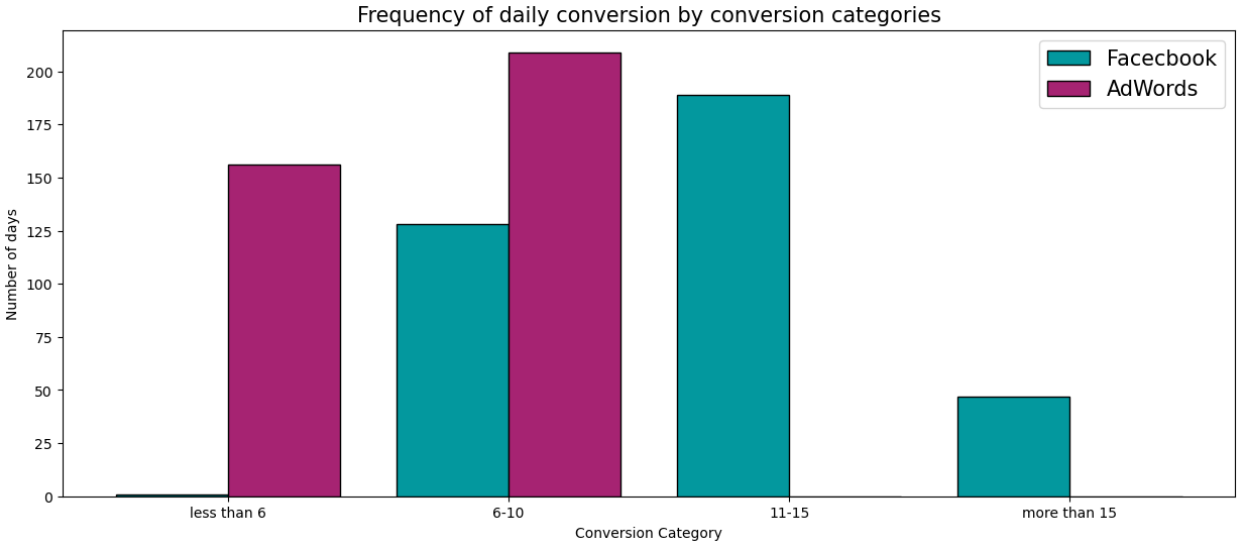
```
category_df=category_df.iloc[[3,1,0,2]]
```

```
category_df
```

```
       Category  Count_x  Count_y
3   less than 6        1    156.0
1          6-10      128    209.0
0         11-15      189      0.0
2  more than 15       47      0.0
```

```
X_axis=np.arange(len(category_df))
plt.figure(figsize=(15,6))
plt.bar(X_axis-
```

```
0.2,category_df['Count_x'],0.4,label='Facecbook',color='#03989E',linew
idth=1,edgecolor='k')
plt.bar(X_axis+0.2,category_df['Count_y'],0.4,label='AdWords',color='#
A62372',linewidth=1,edgecolor='k')

plt.xticks(X_axis,category_df['Category'])
plt.xlabel('Conversion Category')
plt.ylabel('Number of days')
plt.title('Frequency of daily conversion by conversion
categories',fontsize=15)
plt.legend(fontsize=15)
plt.show()
```

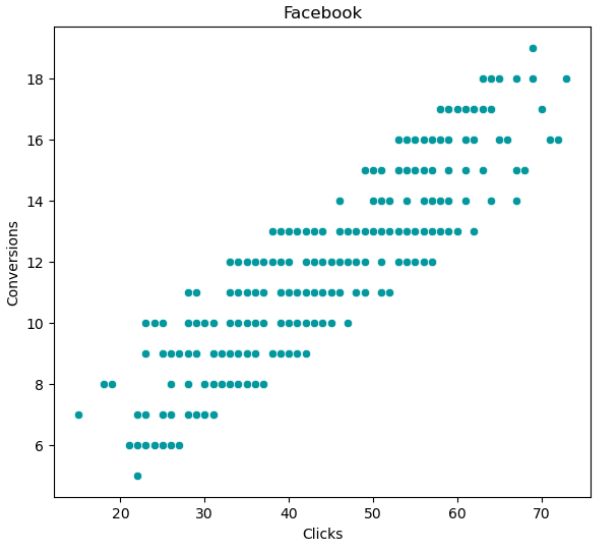


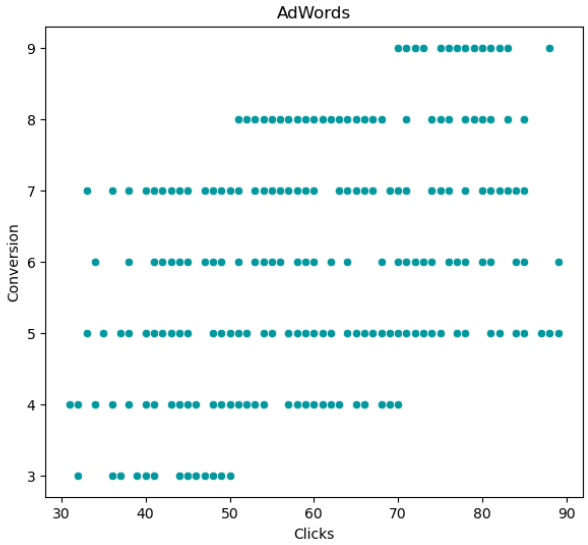
- The data suggests Facebook had more frequent higher conversion days than AdWords, which either had very low conversion rates (less than 6) or moderate ones (6 - 10).
- There is a significant variance in the number of high-conversion days between two different campaigns.
- The absence of any days with conversions between 11 - 15 and more than 15 in AdWords indicates a need to review what strategies were changed or what external factors could have influenced these numbers.

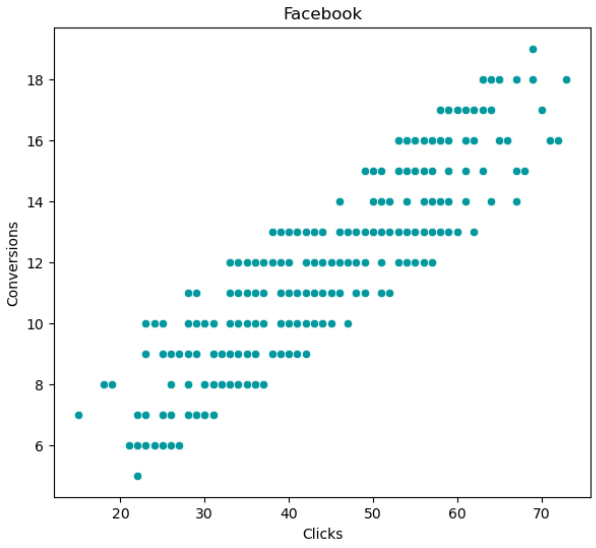
Do more clicks on the ad really lead to more sales?

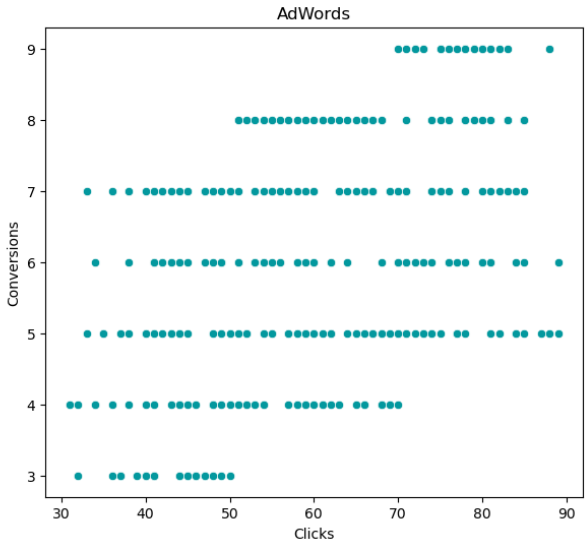
```
plt.figure(figsize=(15,6))
plt.subplot(1,2,1)
plt.title("Facebook")
sns.scatterplot(x=df['Facebook Ad Clicks'],y=df['Facebook Ad
Conversions'],color='#03989E')
plt.xlabel('Clicks')
plt.ylabel('Conversions')
plt.subplot(1,2,2)
```

```
plt.title('AdWords')
sns.scatterplot(x=df['AdWords Ad Clicks'],y=df['AdWords Ad
Conversions'],color ='#03989E')
plt.xlabel('Clicks')
plt.ylabel('Conversion')

Text(0, 0.5, 'Conversion')
```










```
facebook_corr=df[['Facebook Ad Clicks','Facebook Ad
Conversions']].corr()
facebook_corr
```

```
                          Facebook Ad Clicks  Facebook Ad Conversions
Facebook Ad Clicks                 1.000000                 0.873775
Facebook Ad Conversions            0.873775                 1.000000
```

```
AdWords_corr=df[['AdWords Ad Clicks','AdWords Ad Conversions']].corr()
AdWords_corr
```

```
                         AdWords Ad Clicks  AdWords Ad Conversions
AdWords Ad Clicks                 1.000000                0.447993
AdWords Ad Conversions            0.447993                1.000000
```

```
print('Correlation Coeff \n--------------')
print('Facebook :',round(facebook_corr.values[0,1],2))
print('AdWords : ',round(AdWords_corr.values[0,1],2))
```

```
Correlation Coeff
--------------
Facebook : 0.87
AdWords :  0.45
```

- A correlation coefficient of 0.87 indicates a strong positive linear relationship between clicks on Facebook ads and sales. This suggests that as the number of clicks on Facebook ads increases, sales tend to increase as well.
- This strong correlation suggests that Facebook ads are highly effective in driving sales, as a large portion of the variation in sales can be explained by the variation in clicks on Facebook ads.
- The strong correlation between clicks on Facebook ads and sales suggests that Facebook advertising is highly effective in driving sales for the business. Increasing investment in Facebook ads or optimizing their performance could potentially lead to even higher sales.
- A correlation coefficient of 0.45 indicates a moderate positive linear relationship between clicks on AdWords ads and sales. While there is still a positive relationship, it is not as strong as with Facebook ads.
- The moderate correlation between clicks on AdWords ads and sales indicates that while AdWords advertising does contribute to sales, its effectiveness may be influenced by other factors. Further analysis is needed to identify these factors and optimize AdWords campaigns accordingly.

Hypothesis Testing

Hypothesis: Advertising on Facebook will result in a greater number of conversions compared to advertising on AdWords.

Null Hypothesis (H0): There is no difference in the number of conversions between Facebook and AdWords, or the number of conversions from AdWords is greater than or equal to those from Facebook.

H0: $\mu_{Facebook} \leq \mu_{AdWords}$

Alternate Hypothesis (H1): The number of conversions from Facebook is greater than the number of conversions from AdWords.

H1: μ_Facebook > μ_AdWords

```
print('Mean Conversion \n--------------')
print('Facebook :', round(df['Facebook Ad Conversions'].mean(),2))
print('AdWords :', round(df['AdWords Ad Conversions'].mean(),2))
```

```
Mean Conversion
--------------
Facebook : 11.74
AdWords : 5.98
```

```
t_stats,p_value=st.ttest_ind(a=df['Facebook Ad
Conversions'],b=df['AdWords Ad Conversions'],equal_var=False)
print('\nT statistic' ,t_stats, '\np_value',p_value)
```

```
T statistic 32.88402060758184
p_value 9.348918164530465e-134
```

```
# comparing the p value with the significance of 5% or 0.05
if p_value < 0.05:
    print("\np-value is less than significance value, Reject the null
hypothesis")
else:
    print("\np-value is greater than significance value, Accept the
null hypothesis")
```

```
p-value is less than significance value, Reject the null hypothesis
```

- The mean number of conversions from Facebook ads (11.74) is substantially higher than the mean number of conversions from AdWords ads (5.98). This suggests that, on average, Facebook advertising is more effective in generating conversions compared to AdWords advertising.
- The T statistic (32.88) is a measure of the difference between the means of the two groups relative to the variation within the groups. A larger T statistic indicates a greater difference between the means of the two groups.
- The p-value (9.35e-134) is extremely small, indicating strong evidence against the null hypothesis.
- The results strongly support the alternate hypothesis, indicating that the number of conversions from Facebook advertising is indeed greater than the number of conversions from AdWords advertising.
- Facebook advertising appears to be a more effective channel for generating conversions compared to AdWords advertising, based on the sample data analyzed.
- Given the significant difference in conversion rates between Facebook and AdWords, consider reallocating resources towards Facebook advertising efforts. This could involve

increasing ad spend, expanding targeting efforts, or experimenting with different ad formats to capitalize on the platform's effectiveness in driving conversions.

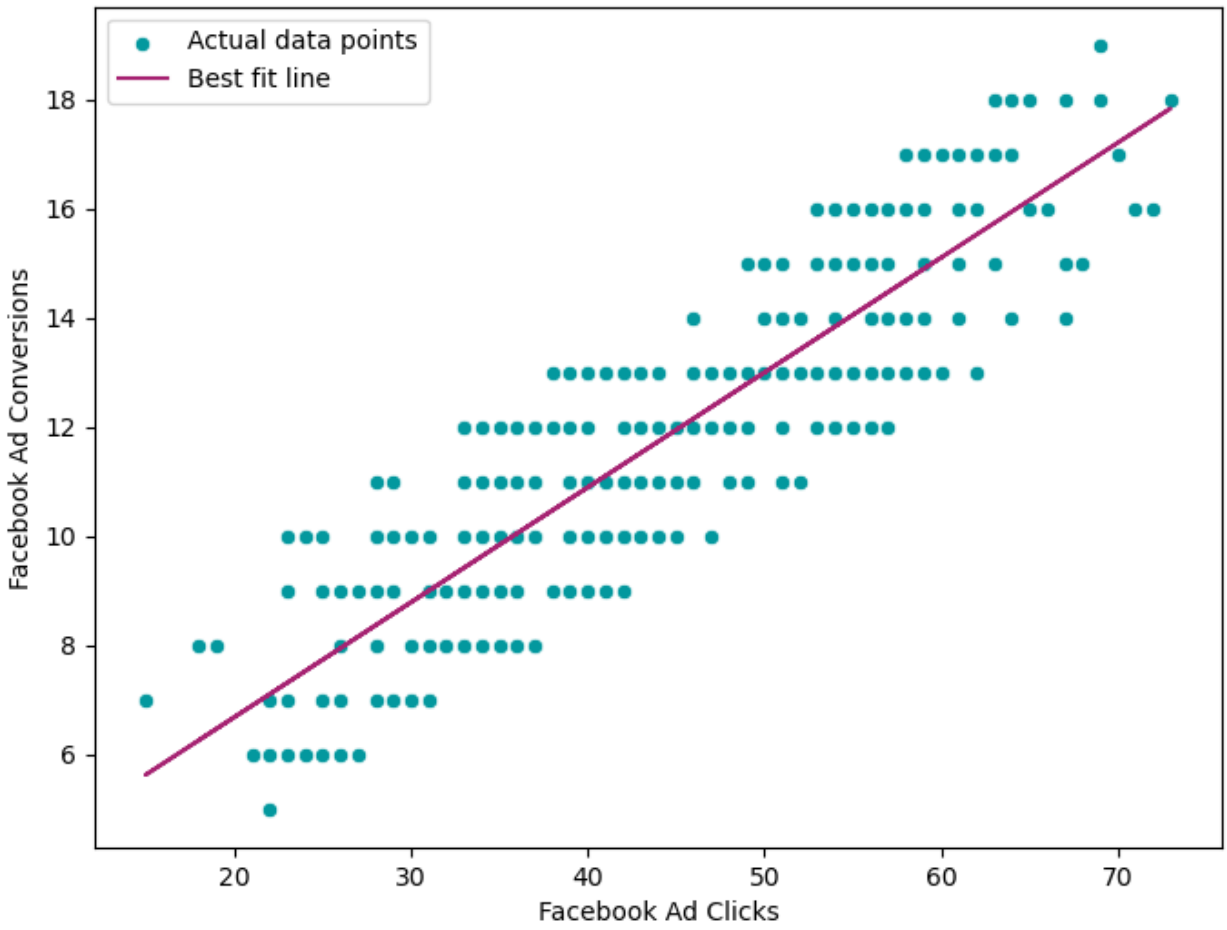
Regression Analysis

What will happen when I do go with the Facebook Ad? How many facebook ad conversions can I expect given a certain number of facebook ad clicks?

```
# independent variable
X = df[['Facebook Ad Clicks']]

# dependent variable
y = df[['Facebook Ad Conversions']]

# initializing and fitting Linear Regression model
reg_model = LinearRegression()
reg_model.fit(X,y)
prediction = reg_model.predict(X)

# model evaluation
r2 = r2_score(y, prediction)*100
mse = mean_squared_error(y, prediction)
print('Accuracy (R2 Score):',round(r2,2),'%')
print('Mean Squared Error:', round(mse,2))
```

```
Accuracy (R2 Score): 76.35 %
Mean Squared Error: 2.02
```

```
plt.figure(figsize=(8,6))
sns.scatterplot(x = df['Facebook Ad Clicks'],y = df['Facebook Ad
Conversions'], color = '#03989E', label = 'Actual data points')
plt.plot(df['Facebook Ad Clicks'], prediction, color = '#A62372',
label = 'Best fit line')
plt.legend()
plt.show()
```




```
print(f'For {50} Clicks, Expected Conversion :
{round(reg_model.predict([[50]])[0][0],2)}')
print(f'For {80} Clicks, Expected Conversion :
{round(reg_model.predict([[80]])[0][0],2)}')
```

```
For 50 Clicks, Expected Conversion : 13.0
For 80 Clicks, Expected Conversion : 19.31
```

- The model has a reasonably good predictive power, with an R2 score of 76.35%. This suggests that it can effectively predict Facebook ad conversions based on the number of Facebook ad clicks.
- With the insights provided by the Linear Regression model, businesses can make informed decisions about resource allocation, budget planning, and campaign optimization.
- For instance, knowing the expected number of Facebook ad conversions based on a certain number of Facebook ad clicks can help in setting realistic campaign goals, optimizing ad spend, and assessing the ROI of Facebook advertising efforts.

Analyzing Facebook Campaign metrics over time

```
# cleaning data ( removing unwanted symbols from the columns and
converting them to numerical columns)
df['Facebook Click-Through Rate (Clicks / View)'] = df['Facebook
Click-Through Rate (Clicks / View)'].apply(lambda x: float(x[:-1]))
df['Facebook Conversion Rate (Conversions / Clicks)'] = df['Facebook
Conversion Rate (Conversions / Clicks)'].apply(lambda x: float(x[:-
1]))
df['Facebook Cost per Click (Ad Cost / Clicks)'] = df['Facebook Cost
per Click (Ad Cost / Clicks)'].apply(lambda x: float(x[1:]))
df['Cost per Facebook Ad'] = df['Cost per Facebook Ad'].apply(lambda
x: float(x[1:]))

# filtering for facebook campaign
df = df[['Date','Facebook Ad Views',
       'Facebook Ad Clicks', 'Facebook Ad Conversions', 'Cost per
Facebook Ad',
       'Facebook Click-Through Rate (Clicks / View)',
       'Facebook Conversion Rate (Conversions / Clicks)',
       'Facebook Cost per Click (Ad Cost / Clicks)']]

# extracting month and week day from the date column
df['month'] = df['Date'].dt.month
df['week'] = df['Date'].dt.weekday
df.head()
```

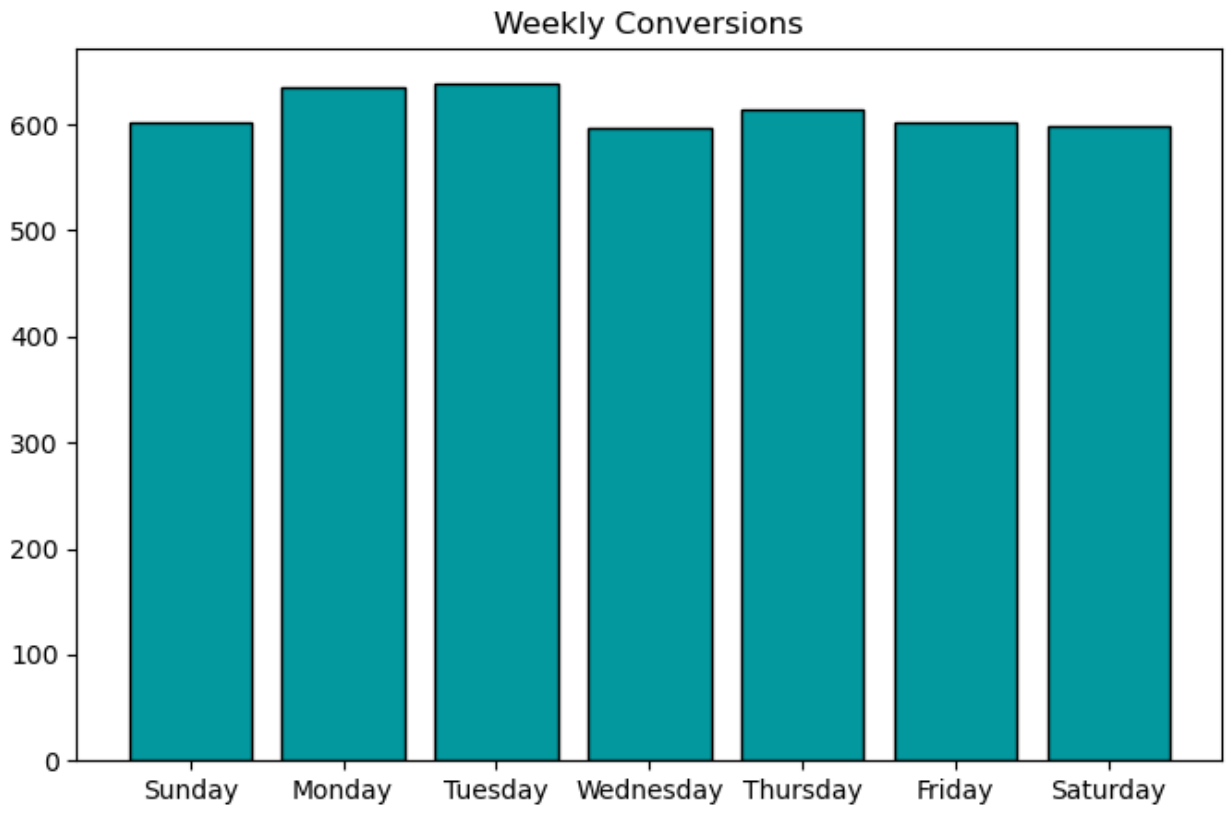
```
        Date  Facebook Ad Views  Facebook Ad Clicks  Facebook Ad
Conversions  \
0 2019-01-01               2116                  18
8
1 2019-01-02               3106                  36
12
2 2019-01-03               3105                  26
8
3 2019-01-04               1107                  27
9
4 2019-01-05               1317                  15
7

   Cost per Facebook Ad  Facebook Click-Through Rate (Clicks /
View)  \
0                 126.0                                          0.83

1                 104.0                                          1.15

2                 102.0                                          0.84
```

```
3                    71.0                                                2.45

4                    78.0                                                1.10


   Facebook Conversion Rate (Conversions / Clicks)  \
0                                            42.73
1                                            34.04
2                                            31.45
3                                            34.76
4                                            47.59

   Facebook Cost per Click (Ad Cost / Clicks)  month  week
0                                        7.14      1     1
1                                        2.91      1     2
2                                        3.89      1     3
3                                        2.62      1     4
4                                        5.38      1     5
```

```
weekly_conversion = df.groupby('week')[['Facebook Ad
Conversions']].sum()
weekly_conversion
```

```
      Facebook Ad Conversions
week
0                         601
1                         635
2                         639
3                         596
4                         614
5                         602
6                         599
```

```
plt.figure(figsize=(8,5))
plt.title('Weekly Conversions')
week_names=
['Sunday','Monday','Tuesday','Wednesday','Thursday','Friday','Saturday
']
plt.bar(week_names, weekly_conversion['Facebook Ad Conversions'],
color = '#03989E', edgecolor = 'k')
plt.show()
```

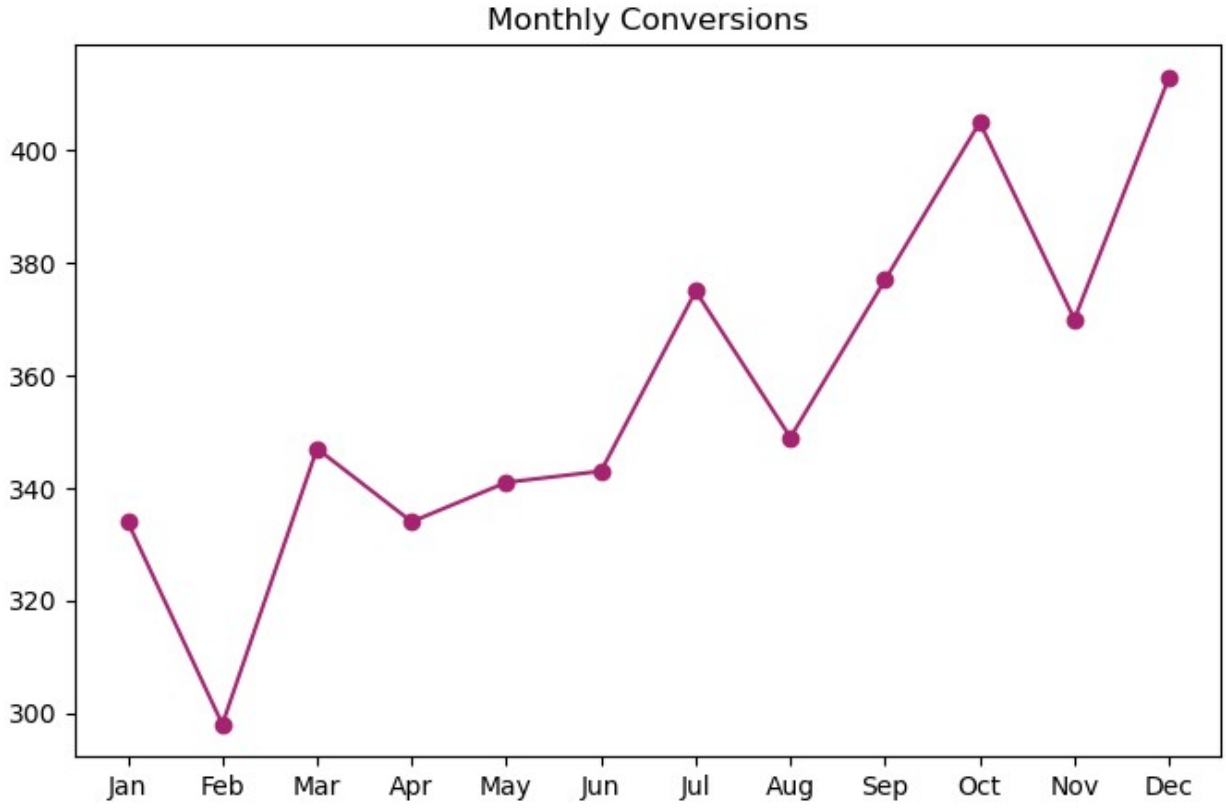



```
monthly_conversion = df.groupby('month')[['Facebook Ad
Conversions']].sum()
monthly_conversion
```

month	Facebook Ad Conversions
1	334
2	298
3	347
4	334
5	341
6	343
7	375
8	349
9	377
10	405
11	370
12	413

```
plt.figure(figsize=(8,5))
plt.title('Monthly Conversions')

month_names =
['Jan','Feb','Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','De
c']
```

```
plt.plot(month_names, monthly_conversion['Facebook Ad Conversions'],'-
o', color = '#A62372')
plt.show()
```



-Across the weekdays over a year, the total number of conversions remains relatively consistent, indicating a consistent level of engagement throughout the week. However, Mondays and Tuesdays consistently exhibit the highest conversion rates compared to other days, suggesting that the beginning of the workweek sees heightened user engagement or responsiveness to marketing efforts.

-Examining the monthly trend in conversions reveals an overall upward trajectory, indicating a general increase in conversions over time. However, certain months stand out with variations in conversion rates. February, April, May, June, August, and November experience a decline in conversions compared to neighboring months. These periods of decreased conversion rates could be influenced by factors such as seasonal fluctuations, changes in consumer behavior, or adjustments in marketing strategies.

How does the Cost Per Conversion (CPC) trend over time?

Cost Per Conversion (CPC): This metric is used to evaluate the cost effectiveness and profitability of an online advertising campaign. This metric helps marketers understand how much they are spending to obtain each conversion, allowing them to optimize their spending and targeting strategies effectively.

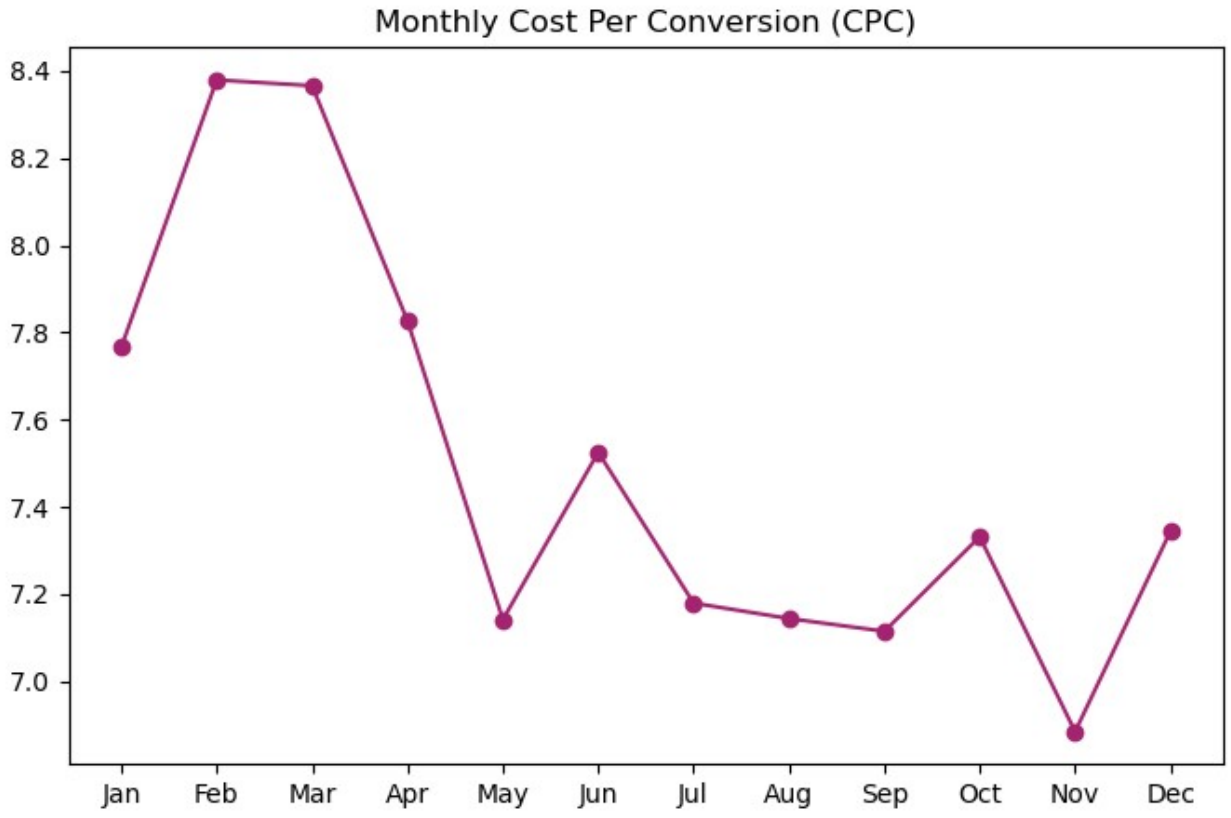
```
monthly_df = df.groupby('month')[['Facebook Ad Conversions','Cost per Facebook Ad']].sum()
monthly_df
```

month	Facebook Ad Conversions	Cost per Facebook Ad
1	334	2594.0
2	298	2497.0
3	347	2903.0
4	334	2614.0
5	341	2435.0
6	343	2581.0
7	375	2692.0
8	349	2493.0
9	377	2682.0
10	405	2969.0
11	370	2547.0
12	413	3033.0

```
monthly_df['Cost per Conversion'] = monthly_df['Cost per Facebook Ad']/monthly_df['Facebook Ad Conversions']
monthly_df
```

month	Facebook Ad Conversions	Cost per Facebook Ad	Cost per Conversion
1	334	2594.0	7.766467
2	298	2497.0	8.379195
3	347	2903.0	8.365994
4	334	2614.0	7.826347
5	341	2435.0	7.140762
6	343	2581.0	7.524781
7	375	2692.0	7.178667
8	349	2493.0	7.143266
9	377	2682.0	7.114058
10	405	2969.0	7.330864
11	370	2547.0	6.883784

```
12                              413                  3033.0
7.343826

plt.figure(figsize=(8,5))
plt.title('Monthly Cost Per Conversion (CPC)')
plt.plot(month_names, monthly_df['Cost per Conversion'],'-o', color =
'#A62372')
plt.show()
```



- The CPC trend over the 12-month period shows some fluctuations but overall maintains a relatively stable range.
- May and November have the lowest CPC values, indicating potentially more cost-effective advertising or higher conversion rates during these periods.
- February has the highest CPC value, suggesting that advertising costs may be relatively higher during this month compared to others.
- Lower CPC values in certain months (e.g., May and November) could indicate periods of higher advertising effectiveness or more favorable market conditions.
- Consider allocating more advertising budget to months with historically lower CPC values (e.g., May and November) to maximize ROI.

Is there a long-term equilibrium relationship between advertising spend and conversion rates that suggests a stable, proportional impact of budget changes on conversions over time?

```
score, p_value, _ = coint(df['Cost per Facebook Ad'], df['Facebook Ad Conversions'])
print('Cointegration test score:', score)
print('P-value:', p_value)
if p_value < 0.05:
    print("\np-value is less than significance value, Reject the null hypothesis")
else:
    print("\np-value is greater than significance value, Accept the null hypothesis")
```

```
Cointegration test score: -14.75542838510322
P-value: 2.133737597906117e-26

p-value is less than significance value, Reject the null hypothesis
```

- Since the p-value is significantly lower than the chosen significance level, we reject the null hypothesis. This indicates that there is a long-term equilibrium relationship between advertising spend (cost) and conversions.
- Businesses can use this understanding of the stable relationship between cost and conversions to optimize their advertising strategies. By investing in campaigns that demonstrate a strong return on investment (ROI) and adjusting spending based on performance, companies can maximize conversions while minimizing costs.

```

```