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 campaigns, one on facebook and the other on Adwords and we need to determine which platform yields better results in terms of of clicks,conversions, and overall cost-effectiveness. By identifyimg the most effective platform, we can allocate our resources more efficiently and optimize our advertizing 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 numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats
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')

#loading the dataset
df = pd.read_csv('marketing_campaign.csv')

#data head
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 columns in the dataset
df.shape
```

```
(365, 17)
```

```
#find out the datatypes of each column
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'])
```

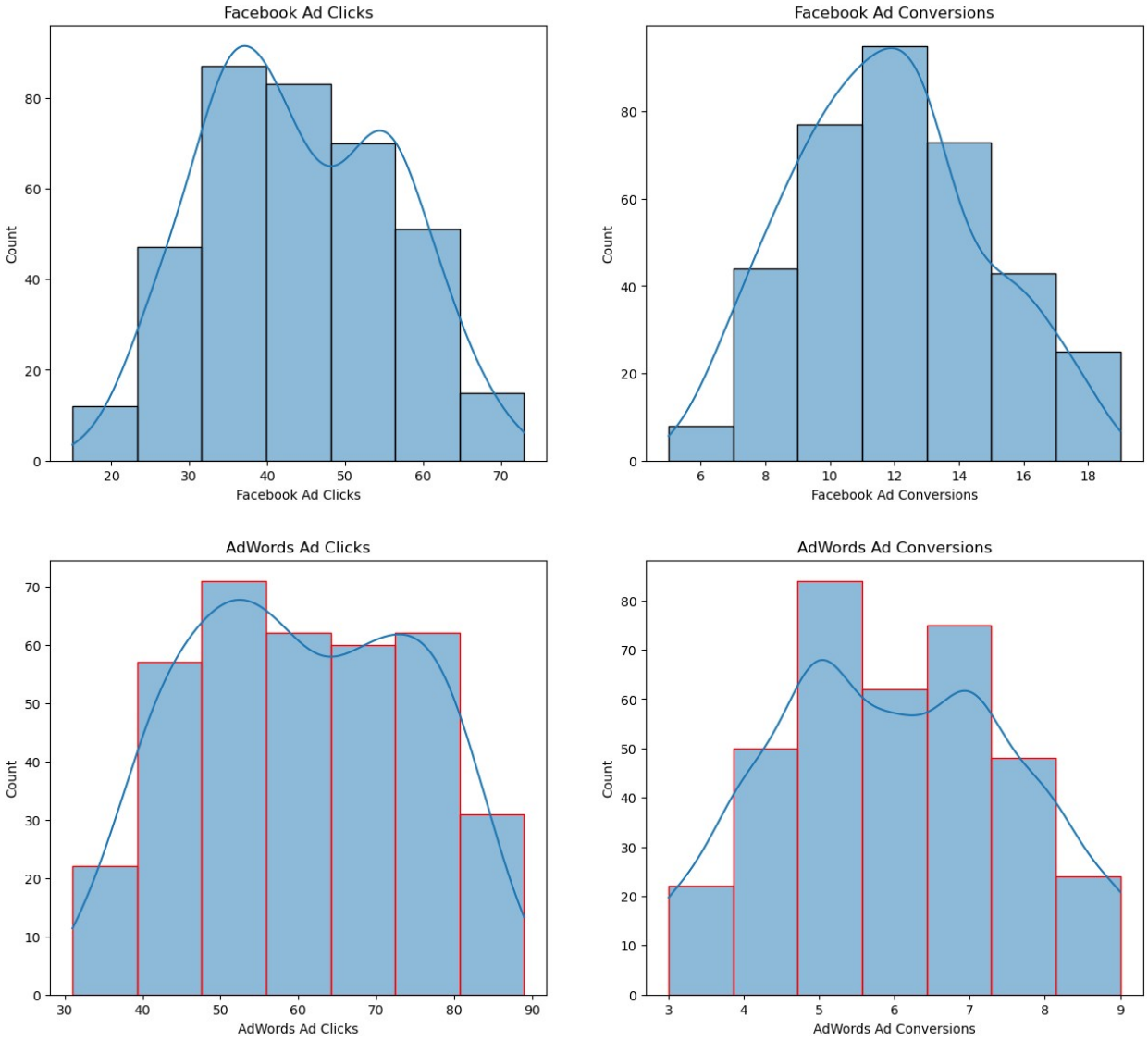
```
df.describe()
```

```
       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 Campaign Performance

```
#histogram of conversion and clicks for facebook ad campaign
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 Conversions')
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='red',kde=True)
plt.subplot(1,2,2)
plt.title('AdWords Ad Conversions')
sns.histplot(df['AdWords Ad
Conversions'],bins=7,edgecolor='red',kde=True)
plt.show()
```



Histograms are somewhat symmetrical shape which suggests that number of clicks and conversions are evenly distributed and there are not many clicks which are outliers.

Q How frequently do we observe days with high numbers of conversions compared

```
#creating function to calculate the category for conversions
def create_conversion_category(conversion_col):
    category=[]
    for conv in df[conversion_col]:
        if conv < 6:
            category.append('less than 6')
        elif 6 <= conv < 11:
            category.append('6 - 10')
        elif 11 <= conv <16:
            category.append('10 - 15')
        else:
```

```
            category.append('more than 15')
    return category

#creating column for different categories for both campaigns
df['Facebook Conversion Category'] =
create_conversion_category('Facebook Ad Conversions')
df['AdWords Conversion Category'] =
create_conversion_category('AdWords Ad Conversions')

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	10 - 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()
```

```
10 - 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={'index':'Cate
gory','Facebook Conversion Category':'Count'})
facebook
```

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

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

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={'index':'Cate
gory','AdWords Conversion Category':'Count'})
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       10 - 15      189      0.0
1        6 - 10      128    209.0
2  more than 15       47      0.0
3   less than 6        1    156.0
```

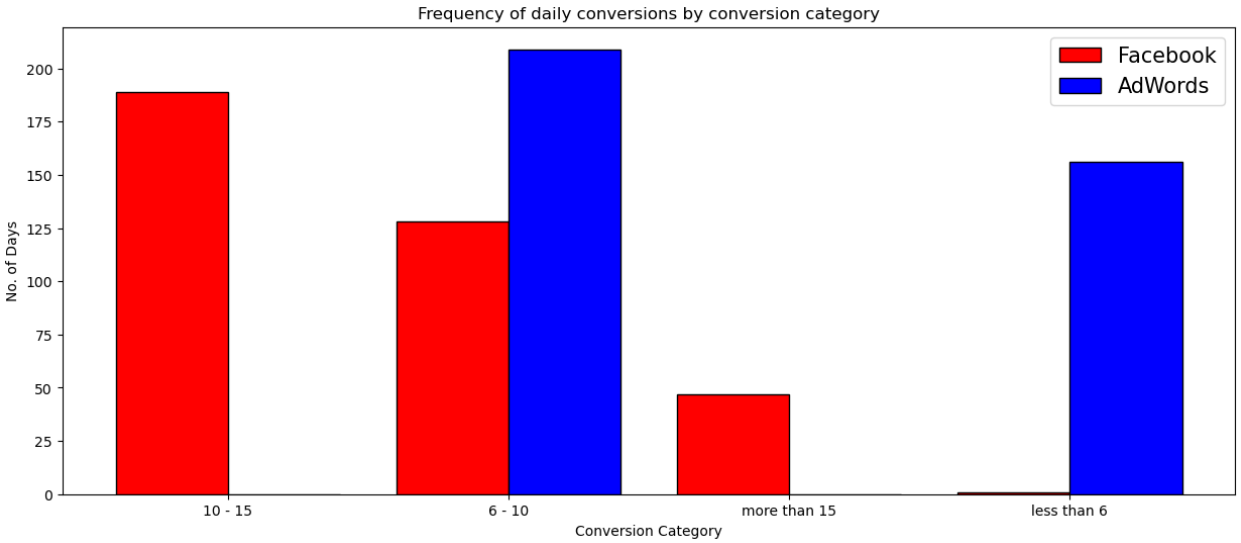
```
category_df = category_df.iloc[[3,1,0,2]]
category_df
```

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

```
#for arranging index
X_axis = np.arange(len(category_df))
X_axis
```

```
array([0, 1, 2, 3])
```

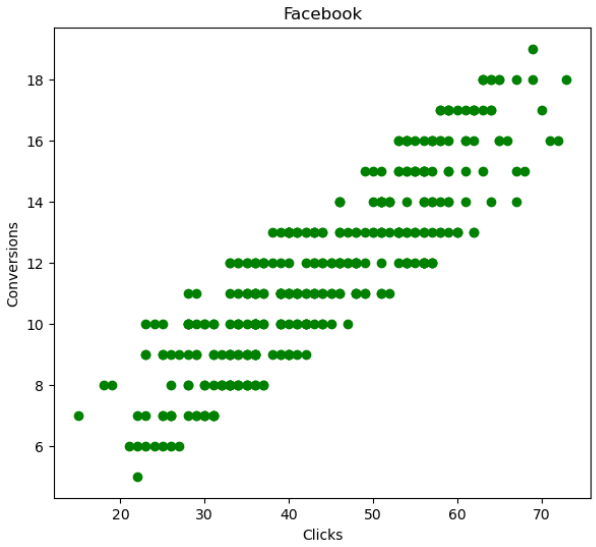
```
plt.figure(figsize=(15,6))
plt.bar(X_axis - 0.2, category_df['Count_x'],0.4, label =
'Facebook',color = 'red', linewidth =1,edgecolor = 'k')
plt.bar(X_axis + 0.2, category_df['Count_y'],0.4, label =
'AdWords',color = 'blue', linewidth =1,edgecolor = 'k')

#0.4 is bar width
plt.xticks(X_axis,category_df['Category'])
plt.xlabel('Conversion Category')
plt.ylabel('No. of Days')
plt.title('Frequency of daily conversions by conversion category')
plt.legend(fontsize =15)
plt.show()
```

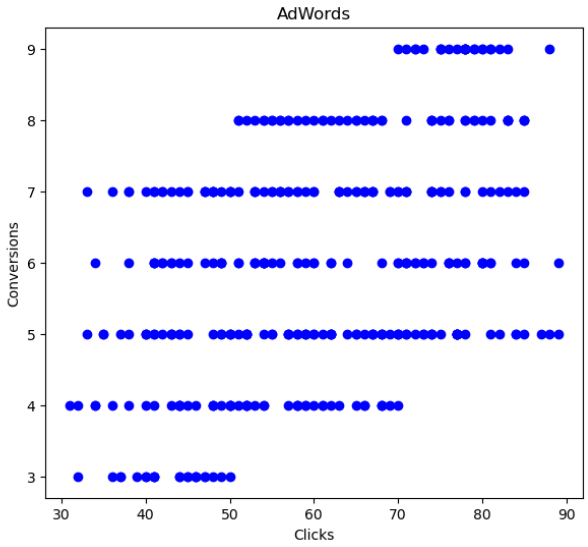


Interpretation: The above graph suggests that Facebook had higher conversion days than Adwords. There is a significant variance in the number of higher conversion days between two campaigns.

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

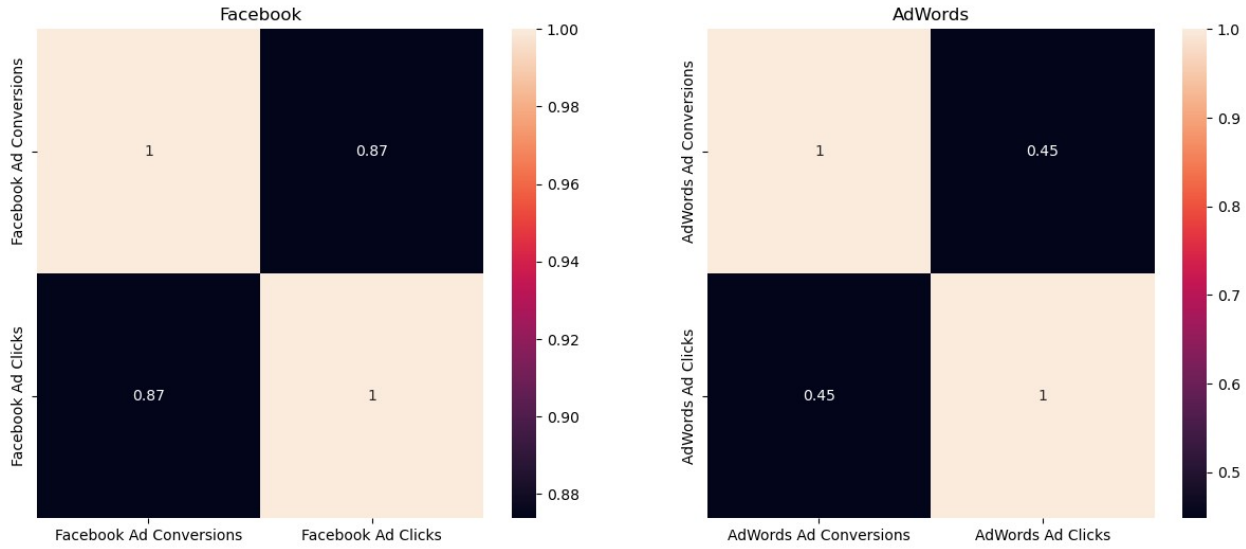
```
plt.figure(figsize=(15,6))

plt.subplot(1,2,1)
plt.title('Facebook')
plt.scatter(x=df['Facebook Ad Clicks'],y=df['Facebook Ad
Conversions'],color='green')
plt.xlabel('Clicks')
plt.ylabel('Conversions')

plt.subplot(1,2,2)
plt.title('AdWords')
plt.scatter(x=df['AdWords Ad Clicks'],y=df['AdWords Ad
Conversions'],color='blue')
plt.xlabel('Clicks')
plt.ylabel('Conversions')
plt.show()
```





Correlation heatmaps

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

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

plt.figure(figsize=(15,6))
plt.subplot(1,2,1)
plt.title('Facebook')
sns.heatmap(facebook_corr,annot=True)

plt.subplot(1,2,2)
plt.title('AdWords')
sns.heatmap(adwords_corr,annot=True)
plt.show()
```




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

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

The strong correlation suggests that Facebook ads are highly effecctive in driving sales for the business and investing in Facebook ads or optimising their performance could potentially lead to even higher sales.

Hypothesis Testing

Null hypothesis : There is no significant difference in the number of conversions between Facebook and Adwords.

Alternate Hypothesis : The number of conversions from Facebook is greater than the number of conversions from Adwords.

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

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

```
#independent two sample t-test
t_stats , p_value = stats.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 level of significance

if p_value < 0.05:
        print('\np_value is less than 0.05 we reject the null
hypothesis')
else:
        print('\np_value is greater than 0.05 we fail to reject the
null hypothesis')
```

```
p_value is less than 0.05 we reject the null hypothesis
```

The number of conversion from Facebook is higher than Adwords.

Regression Analysis

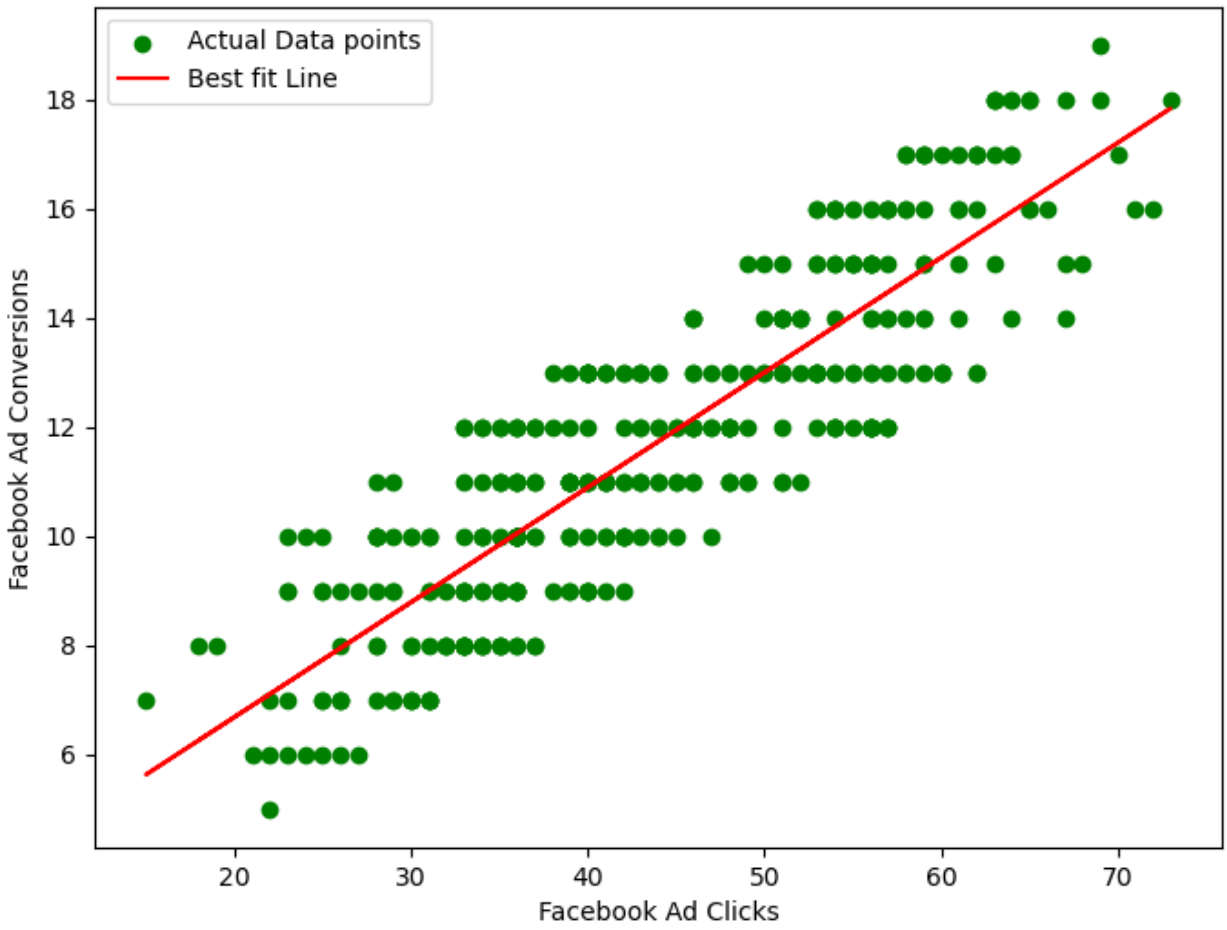
What happens if I do go with the Facebook Ad Campaign? How many ad conversions can I expect given a certain number of facebook ad clicks?

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

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

#initializing and fitting the linear regression model
model = LinearRegression()
fitmodel = model.fit(X,y)
prediction = fitmodel.predict(X)

#predict the dependent variable by feeding independent value and
compare the actual with the prediction

#model evaluation
r2 = r2_score(y,prediction)*100
mse = mean_squared_error(y,prediction)
print('\nAccuracy r2 score',round(r2,2),'%')
print('\nMean Squared Error',round(mse,2))
```

```
Accuracy r2 score 76.35 %
```

```
Mean Squared Error 2.02
```

```
plt.figure(figsize=(8,6))
plt.scatter(x= df['Facebook Ad Clicks'],y=df['Facebook Ad
Conversions'],color = 'green',label = 'Actual Data points')
plt.plot(df['Facebook Ad Clicks'],prediction, color  = 'red', label
='Best fit Line')
plt.xlabel('Facebook Ad Clicks')
plt.ylabel('Facebook Ad Conversions')
plt.legend()
plt.show()
```




```
#clk = input('Enter the click value:')
#clk = eval(clk)
#con = fitmodel.predict(clk)
#print('The conversion value is:',con)

def conversion_value(clk):
    con_value = fitmodel.predict([[clk]])
```

```
    return con_value

conversion_value(30)
```

```
array([[8.78506491]])
```

The model has a reasonably good predictive power, with r2 score as 76%. This suggests it can effectively predict Facebook ad conversions based on the number of Facebook ad clicks.

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:]))

#data cleaning before analysis
# Convert CTR (remove % sign)
df['Facebook Click-Through Rate (Clicks / View)'] = df['Facebook
Click-Through Rate (Clicks / View)'].replace('%','',
regex=True).astype(float)

# Convert Conversion Rate (remove % sign)
df['Facebook Conversion Rate (Conversions / Clicks)'] = df['Facebook
Conversion Rate (Conversions / Clicks)'].replace('%','',
regex=True).astype(float)

# Convert Cost per Click (remove $ and , sign)
df['Facebook Cost per Click (Ad Cost / Clicks)'] = df['Facebook Cost
per Click (Ad Cost / Clicks)'].replace('[$,]','',
regex=True).astype(float)

# Convert Cost per Ad (remove $ and , sign)
df['Cost per Facebook Ad'] = df['Cost per Facebook
Ad'].replace('[$,]','', regex=True).astype(float)

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                                   float64
Facebook Click-Through Rate (Clicks / View)            float64
Facebook Conversion Rate (Conversions / Clicks)        float64
Facebook Cost per Click (Ad Cost / Clicks)             float64
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
Facebook Conversion Category                            object
AdWords Conversion Category                             object
dtype: object
```

```
#filtering for facebook campaign
df2 = 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)']]
```

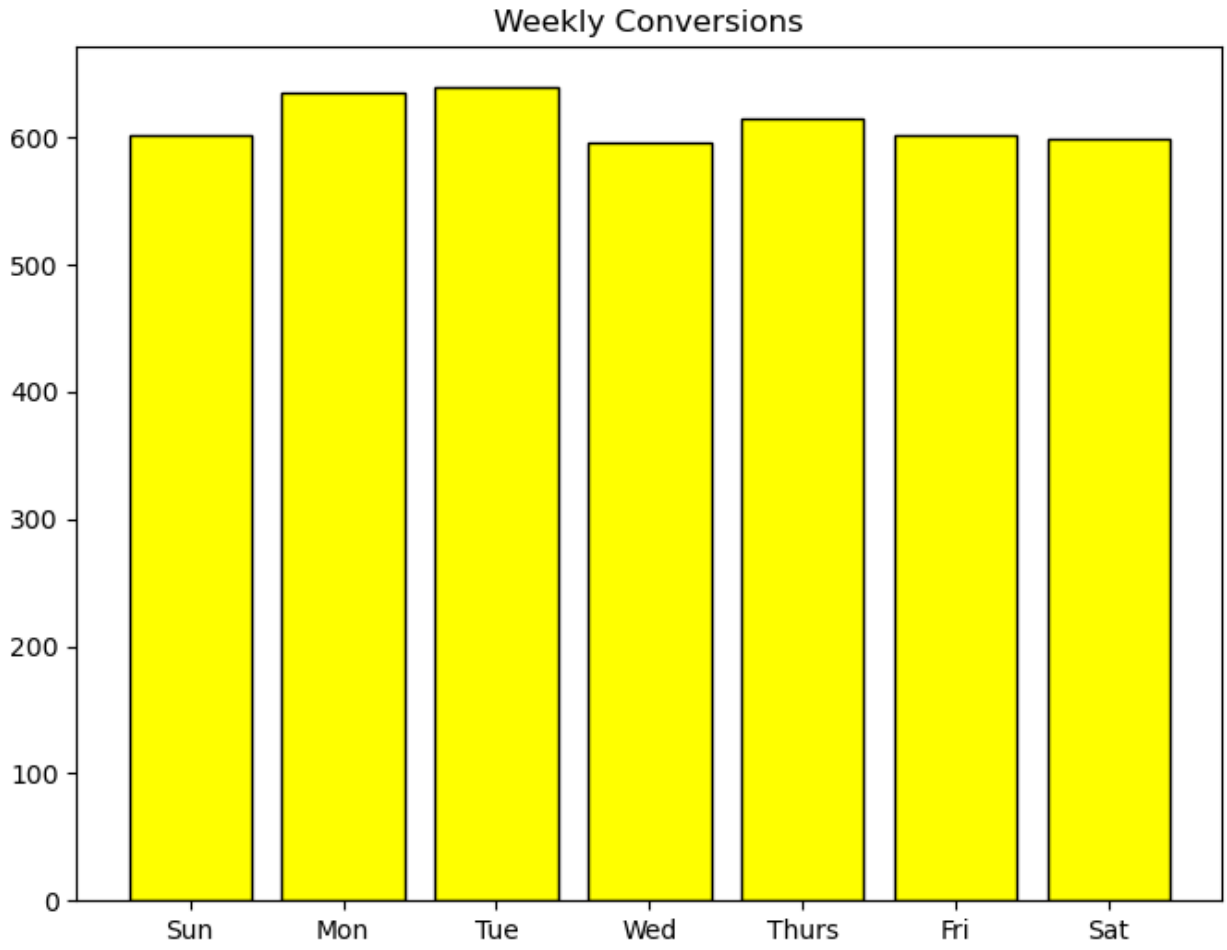
At what times of the month or days of the week do we observe the conversions?

```
#extracting month and week day from the date column
df2['month'] = df2['Date'].dt.month
df2['week'] = df2['Date'].dt.weekday
df2
```

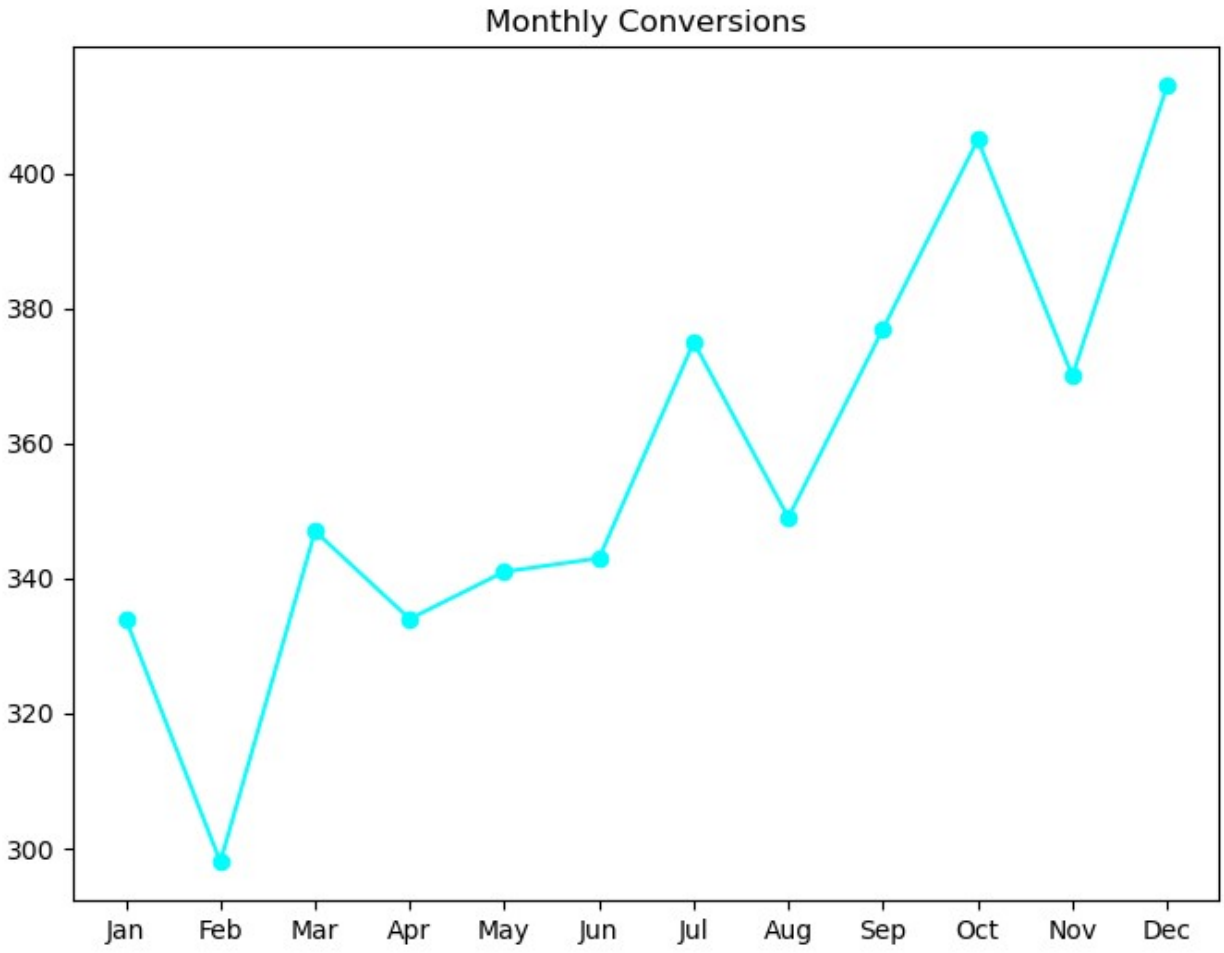
```
          Date  Facebook Ad Views  Facebook Ad Clicks  \
0   2019-01-01               2116                  18
1   2019-01-02               3106                  36
2   2019-01-03               3105                  26
3   2019-01-04               1107                  27
4   2019-01-05               1317                  15
..         ...                ...                 ...
360 2019-12-27               3240                  51
361 2019-12-28               1510                  69
362 2019-12-29               2918                  44
363 2019-12-30               2212                  37
364 2019-12-31               1470                  60

     Facebook Ad Conversions  Cost per Facebook Ad  \
0                          8                 126.0
1                         12                 104.0
2                          8                 102.0
3                          9                  71.0
```

```
4                            7                   78.0
..                         ...                    ...
360                         13                   63.0
361                         18                   97.0
362                         13                   49.0
363                          8                  102.0
364                         17                   99.0

     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)  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
..                                          ...    ...   ...
360                                        1.24     12     4
361                                        1.42     12     5
362                                        1.11     12     6
363                                        2.75     12     0
364                                        1.65     12     1

[365 rows x 10 columns]
```

```
plt.figure(figsize=(8,6))
plt.title('Weekly Conversions')
weekly_conversion = df2.groupby('week')[['Facebook Ad
Conversions']].sum()
week_names = ['Sun','Mon','Tue','Wed','Thurs','Fri','Sat']
plt.bar(week_names,weekly_conversion['Facebook Ad Conversions'],color
= 'yellow',edgecolor ='black')
plt.show()
```



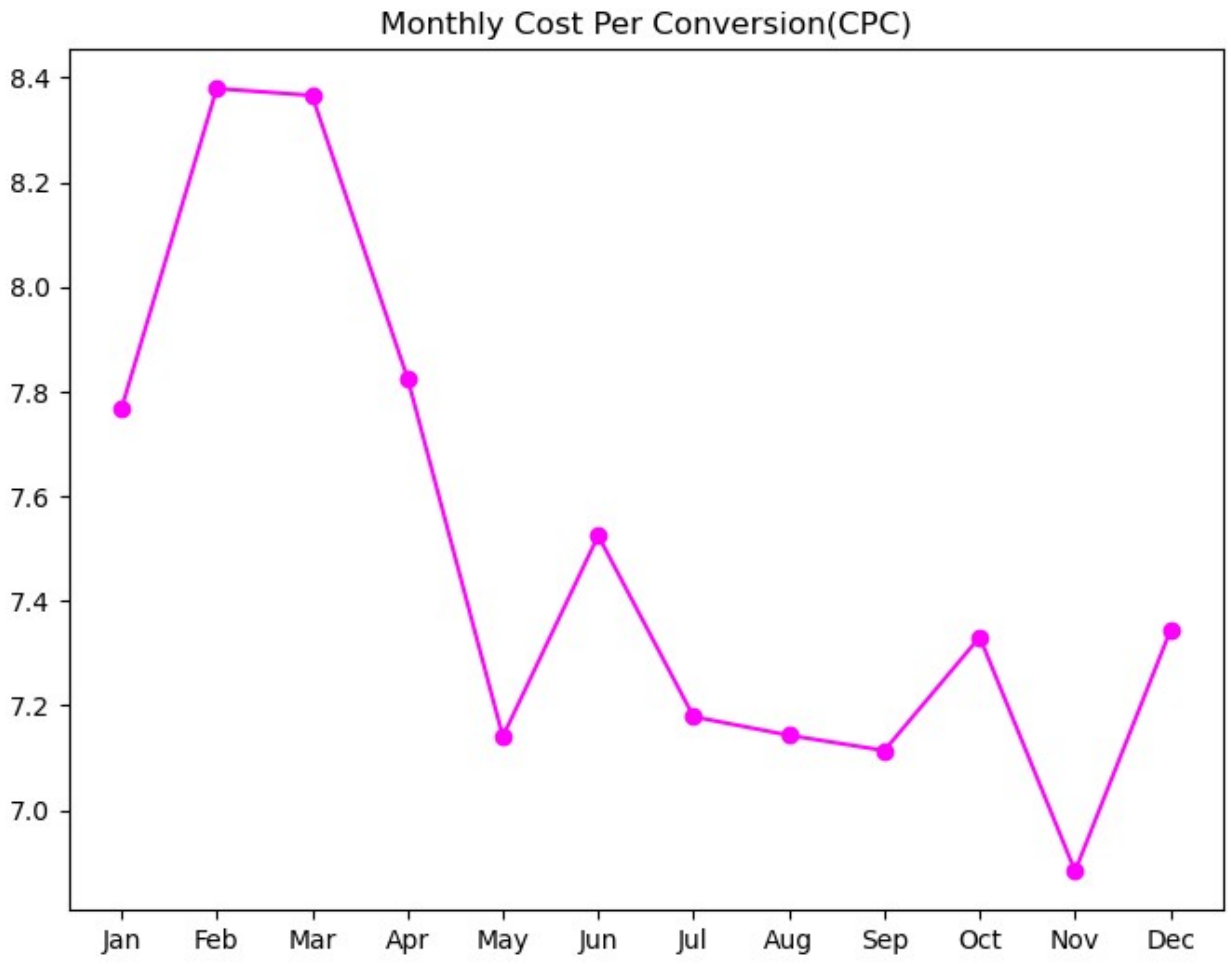

```
plt.figure(figsize=(8,6))
plt.title('Monthly Conversions')
monthly_conversion = df2.groupby('month')[['Facebook Ad
Conversions']].sum()
month_names =
['Jan','Feb','Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','De
c']
plt.plot(month_names,monthly_conversion['Facebook Ad Conversions'],'-
o',color = 'cyan')
plt.show()
```



How does the Cost per Conversion (CPC) change over time?

Cost per conversion (CPC): This metric is used to evaluate the cost effectiveness and profitability of online advertising campaign and helps marketers to understand how much they are spending on each conversion allowing them to optimize their spending.

```
plt.figure(figsize=(8,6))
plt.title('Monthly Cost Per Conversion(CPC)')
monthly_df = df2.groupby('month')[['Cost per Facebook Ad','Facebook Ad
Conversions']].sum()
monthly_df['Cost per Conversion'] = monthly_df['Cost per Facebook
Ad']/monthly_df['Facebook Ad Conversions']
month_names =
['Jan','Feb','Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','De
c']
plt.plot(month_names,monthly_df['Cost per Conversion'],'-
o',color='magenta')
plt.show()
```



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?

Null hypothesis: There is no relationship between advertising spend and conversion rates.

Alternate hypothesis: There is long term equilibrium relationship between advertising spend and conversion rates.

```
score,p_value,_ = coint(df2['Cost per Facebook Ad'],df['Facebook Ad
Conversions'])
print('Cointegration test score:',score)
print('\np_value:',p_value)
if p_value<0.05:
    print('\n The p_value is less than 0.05 so we reject the null
hypothesis')
else:
    print('\n The p_value is greater than 0.05 so we fail to reject
the null hypothesis')
```

```
Cointegration test score: -14.755428385103224
```

```
p_value: 2.1337375979060563e-26

 The p_value is less than 0.05 so we reject the null hypothesis
```

There is a long-term relationship between advertising spend(cost) and conversion rates.