GA4 Analysis

September 17, 2023

[1]:
```
import matplotlib as mpl
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import pyrsm as rsm
import statsmodels.formula.api as smf
import statsmodels.api as sm
import seaborn as sns
from statsmodels.genmod.families.links import logit
from sklearn.inspection import permutation_importance
from sklearn.metrics import auc, roc_curve
from math import sqrt
import xgboost as xgb
from sklearn import metrics, tree
from sklearn.linear_model import LogisticRegression
from scipy.stats import ttest_ind
```

[2]:
```
#(from data-export file)
import statsmodels.api as sm
import statsmodels.formula.api as smf
import pandas as pd

# Create your DataFrame
data = {
    'Engagement_Rate': [0.6531361711, 0.5890570157, 0.3980717924, 0.5602996735,␣
 ↪0.6939932526,
                        0.4832841691, 0.6116444446, 0.7073717178, 0.5346045198,␣
 ↪0.6469668543,
                        0.07404393816, 0.6328173453, 0.2944369064, 0.621669627,␣
 ↪0.02142857143,
                        0.6005291005, 0.5805555556, 0.6227106227, 0.6439393939,␣
 ↪0.5614973262,
                        0.3442622951, 0.525],
    'Conversions': [550, 65, 216, 142, 31, 129, 68, 42, 13, 15, 11, 0, 1, 17,␣
 ↪1, 4, 1, 1, 0, 0, 0, 0]
}
```

```python
df = pd.DataFrame(data)

# Perform linear regression using formula-style approach
reg = smf.ols(formula="Conversions ~ Engagement_Rate", data=df).fit()

# View regression summary
print(reg.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:            Conversions   R-squared:                       0.023
Model:                            OLS   Adj. R-squared:                 -0.026
Method:                 Least Squares   F-statistic:                    0.4700
Date:                Sun, 17 Sep 2023   Prob (F-statistic):              0.501
Time:                        01:36:04   Log-Likelihood:                -136.42
No. Observations:                  22   AIC:                             276.8
Df Residuals:                      20   BIC:                             279.0
Df Model:                           1
Covariance Type:            nonrobust
================================================================================
===
                      coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
---
Intercept           7.0178     80.948      0.087      0.932    -161.838
175.873
Engagement_Rate   101.0943    147.466      0.686      0.501    -206.514
408.703
==============================================================================
Omnibus:                       37.760   Durbin-Watson:                   1.014
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              104.014
Skew:                           2.979   Prob(JB):                     2.59e-23
Kurtosis:                      11.831   Cond. No.                         7.05
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
```

[3]:
```python
#The regression results provide information about the relationship between␣
↪"Engagement_Rate" and "Conversions." Here's an analysis of the key␣
↪statistics and coefficients:
```

```
#R-squared: The R-squared value is 0.023, which indicates that only a small␣
↪proportion (2.3%) of the variance in "Conversions" can be explained by␣
↪"Engagement_Rate." This suggests that "Engagement_Rate" is not a strong␣
↪predictor of "Conversions."

#Coefficients:

#Intercept: The intercept is 7.0178. In this context, it represents the␣
↪estimated value of "Conversions" when "Engagement_Rate" is zero. However,␣
↪this interpretation may not be meaningful, as "Engagement_Rate" is not␣
↪likely to be zero in your data.
#Engagement_Rate: The coefficient for "Engagement_Rate" is 101.0943. It␣
↪indicates the change in the estimated "Conversions" for a one-unit change in␣
↪"Engagement_Rate." However, the p-value for this coefficient is 0.501, which␣
↪is greater than the typical significance level of 0.05. This suggests that␣
↪"Engagement_Rate" is not statistically significant in predicting␣
↪"Conversions."
#F-statistic: The F-statistic tests whether the overall model (including all␣
↪predictors) is statistically significant. In this case, the F-statistic is 0.
↪4700, and the associated p-value is 0.501. Since the p-value is greater than␣
↪0.05, it implies that the model as a whole is not statistically significant␣
↪in predicting "Conversions."

#Adjusted R-squared: The adjusted R-squared adjusts the R-squared value for the␣
↪number of predictors in the model. It's -0.026 in this case, indicating that␣
↪adding "Engagement_Rate" to the model doesn't improve its explanatory power.

#Prob (F-statistic): This is the probability associated with the F-statistic. A␣
↪high p-value (0.501) suggests that the model doesn't explain much of the␣
↪variation in "Conversions."

#Residuals: Other statistics like the Omnibus, Durbin-Watson, Jarque-Bera,␣
↪skewness, kurtosis, and conditional number are related to the␣
↪goodness-of-fit and assumptions of the regression model. The high Omnibus␣
↪and Jarque-Bera p-values indicate that the residuals may not be normally␣
↪distributed, and the model may not meet certain assumptions.

#In summary, the regression results suggest that "Engagement_Rate" does not␣
↪appear to be a significant predictor of "Conversions" in your dataset. The␣
↪model does not explain much of the variation in "Conversions," as indicated␣
↪by the low R-squared and the non-significant coefficients and F-statistic.␣
↪Additional factors or variables may be needed to better predict "Conversions.
↪"
```

[4]:

```
#from Session default channel group and Operating System data
# Create a DataFrame from your data (
```

```
data = {
    'Engaged sessions per user': [0.7077537806, 0.8723220842, 0.4421541846, 0.
↪8318037337, 0.5196905276, 1.132783883, 1.082942239, 1.008205605, 0.
↪4934439834, 1.091603919, 1.088959565, 1.037405334, 0.9341698004, 0.
↪5850202429, 1.043448512, 0.7645965043, 0.8305084746, 0.8179669031, 0.
↪1040462428, 0.963099631, 1.102912621, 1.025052192, 1.059016393, 0.
↪007117437722, 0.003623188406, 0.0153256705, 1.008810573, 0.9301075269, 0.
↪9393939394, 0.006493506494, 0, 0.5111111111, 0.3255813953, 0.3076923077],
    'Engagement rate': [0.5647662084, 0.6323466906, 0.3792641733, 0.531221409,␣
↪0.4392082941, 0.7321193033, 0.729424997, 0.7061374973, 0.4576662562, 0.
↪6527187721, 0.6629217894, 0.6904824236, 0.5726270238, 0.5208547889, 0.
↪7121176745, 0.644716212, 0.6492113565, 0.4937214612, 0.09708737864, 0.
↪6549560853, 0.7108886108, 0.5722610723, 0.6757322176, 0.006349206349, 0.
↪006578947368, 0.03389830508, 0.7762711864, 0.6865079365, 0.6224899598, 0.
↪1428571429, 0, 0.4693877551, 0.3181818182, 0.3076923077],
}

df = pd.DataFrame(data)

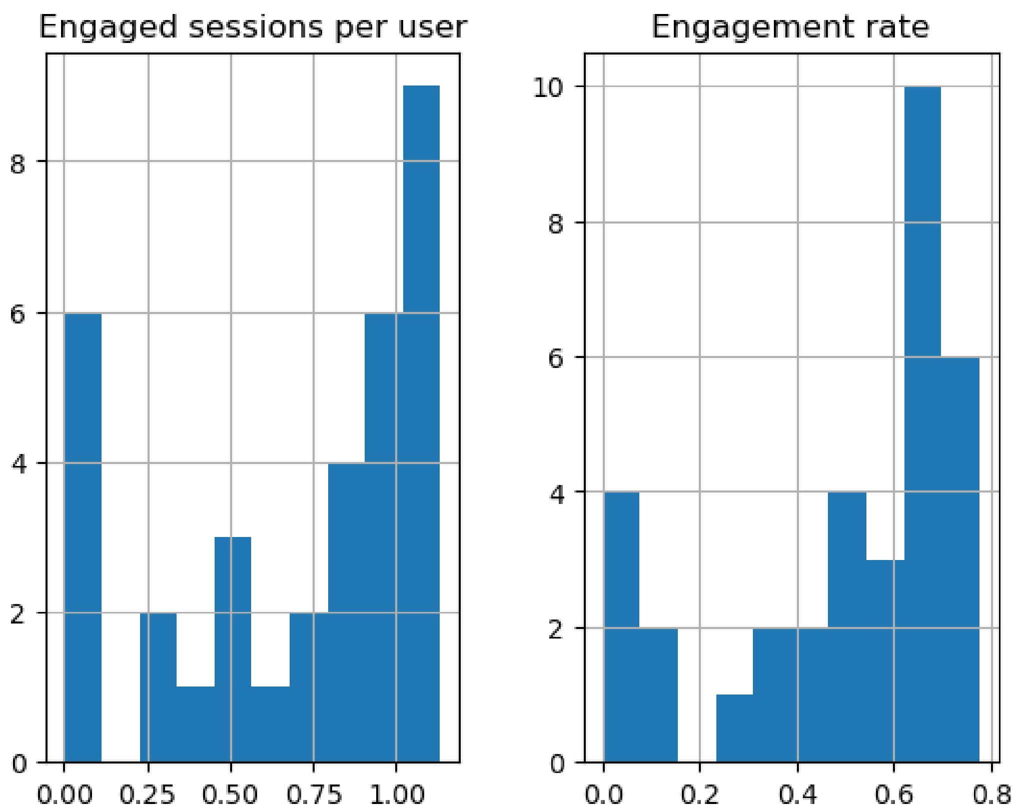
# Basic statistics
basic_stats = df.describe()
basic_stats
```

[4]:

	Engaged sessions per user	Engagement rate
count	34.000000	34.000000
mean	0.693946	0.495667
std	0.389931	0.241033
min	0.000000	0.000000
25%	0.454977	0.394250
50%	0.831156	0.572444
75%	1.020992	0.672530
max	1.132784	0.776271

[5]:
```
df.hist()
```

[5]:
```
array([[<AxesSubplot: title={'center': 'Engaged sessions per user'}>,
        <AxesSubplot: title={'center': 'Engagement rate'}>]], dtype=object)
```

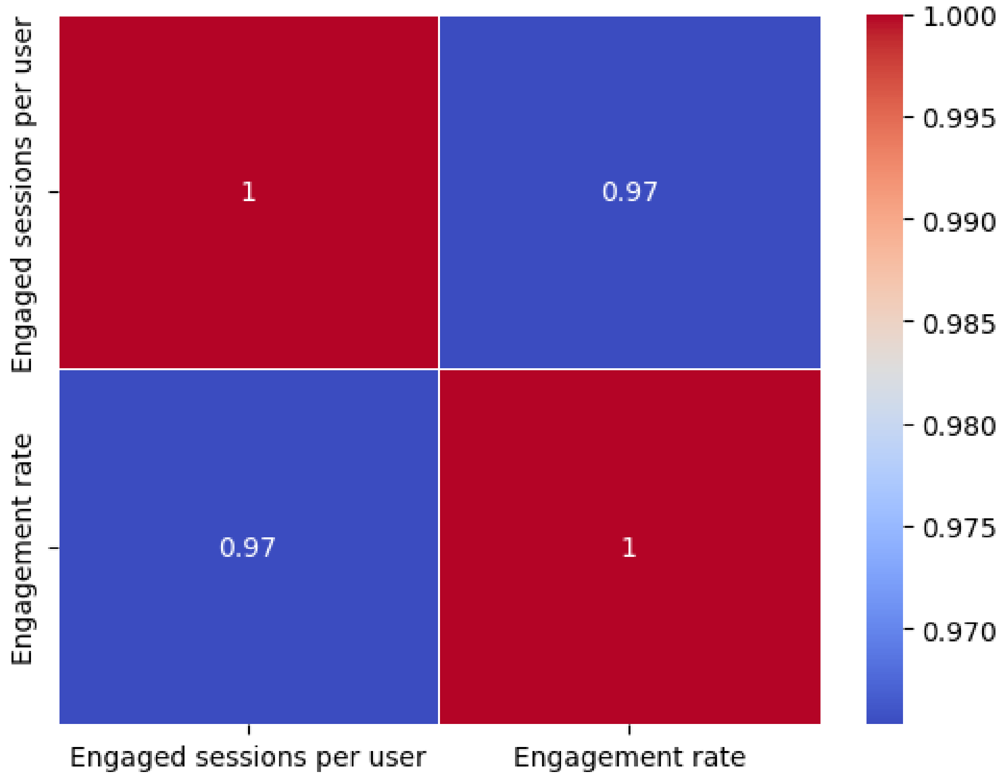


[6]:
```
# Correlation matrix
correlation_matrix = df.corr()
correlation_matrix
```

[6]:

	Engaged sessions per user	Engagement rate
Engaged sessions per user	1.00000	0.96531
Engagement rate	0.96531	1.00000

[7]:
```
# Plotting
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', linewidths=0.5)
plt.show()
```



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    'Conversions': [550, 65, 216, 142, 31, 129, 68, 42, 13, 15, 11, 0, 1, 17,␣
↪1, 4, 1, 1, 0, 0, 0, 0]
}

df = pd.DataFrame(data)

# Separate data into two groups
group1 = df[df['Conversions'] > 0]['Engagement_Rate']  # Group with Conversions␣
↪> 0
```

```python
group2 = df[df['Conversions'] == 0]['Engagement_Rate']  # Group with␣
↪Conversions = 0

# Perform a t-test to compare the mean 'Engagement_Rate' between the two groups
t_statistic, p_value = ttest_ind(group1, group2, equal_var=False)

# Define the significance level (alpha)
alpha = 0.05

# Print the results
print("T-Statistic:", t_statistic)
print("P-Value:", p_value)

# Check if the p-value is less than alpha to determine statistical significance
if p_value < alpha:
    print("Null hypothesis rejected: There is a significant difference in mean␣
↪'Engagement_Rate' between the two groups.")
else:
    print("Null hypothesis not rejected: There is no significant difference in␣
↪mean 'Engagement_Rate' between the two groups.")
```

```
T-Statistic: -0.4118859992993967
P-Value: 0.688048700938926
Null hypothesis not rejected: There is no significant difference in mean
'Engagement_Rate' between the two groups.
```

[ ]:

```python
#Based on the results of the t-test and the statement "Null hypothesis not␣
↪rejected," it suggests that, in the context of the data and analysis␣
↪performed, there is not enough evidence to conclude that engagement rate has␣
↪a statistically significant impact on conversions.
#In other words, the t-test did not find a significant difference in mean␣
↪'Engagement_Rate' between the group with Conversions > 0 and the group with␣
↪Conversions = 0. This means that, within the data you've analyzed, a high␣
↪engagement rate does not necessarily correspond to high conversions in a way␣
↪that can be detected with statistical significance.
#However, it's important to note that statistical significance doesn't␣
↪necessarily imply practical or real-world significance. It's possible that␣
↪other factors not considered in this analysis could influence conversions,␣
↪or that there might be a more complex relationship between engagement rate␣
↪and conversions that this analysis did not capture.
#To draw more robust conclusions about the relationship between engagement rate␣
↪and conversions, you may want to consider additional analyses, such as␣
↪regression analysis or exploring other variables that could be influencing␣
↪conversions.
```

[ ]:

```python

```