In [1]:
```
#import library packages
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [57]:
```
import warnings

#filter out FutureWarnings
warnings.filterwarnings("ignore", category=FutureWarning)
```

In [46]:
```
HUES = ["Devices", "Match Types"]
```

In [3]:
```
# importing dataset
campaign_df = pd.read_csv ("final_shop_6modata.csv")
campaign_df.head()
```

Out[3]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Revenue
0	Shop - 1:1 - Desk - [shop coupon code]	July	16038	6504	0.41	1166	0.10	6669	1.03	6402
1	Shop - 1:1 - Desk - [shop coupon]	July	36462	14367	0.39	2188	0.09	13746	0.96	13262
2	Shop - 1:1 - Desk - [shop discount code]	July	3635	1458	0.40	248	0.09	1606	1.10	1723
3	Shop - 1:1 - Desk - [shop promo code]	July	26185	10418	0.40	2294	0.12	13278	1.27	13042
4	Shop - 1:1 - Desk - [shop promo]	July	808	282	0.35	61	0.15	391	1.39	337

In [64]:
```
# creating function to determine the outliers
```

```
def find_outliers(data: pd.DataFrame, feature: str) -> pd.DataFrame:
    q1 = data[feature].quantile(0.25)
    q3 = data[feature].quantile(0.75)
    iqr = q3 - q1

    low_iqr = data[feature] < q1 - 1.5*iqr
    high_iqr = data[feature] > q3 + 1.5*iqr

    outliers = data[low_iqr | high_iqr]

    print("Outliers Counts: ", len(outliers))
    top_outliers = outliers.sort_values(feature, ascending=False)[:5]

    return outliers, top_outliers
```

In [50]:
```
#creating function to create visualization
def box_and_line_plots(data: pd.DataFrame, feature: str):
    fig, axes = plt.subplots(nrows = 3, ncols=2, figsize=(15,7))

    for i, _ in enumerate (axes):
        if i == 0:
            sns.boxplot(x=data[feature], ax=axes[0,0])
            sns.lineplot(x="Month", y=campaign_df[feature], data=data,
                         ci=None, ax=axes[0, 1], markers=True)
        else:
            sns.boxplot(x=data[feature], y=data[HUES[i-1]], ax=axes[i, 0])
            sns.lineplot(x="Month",y=campaign_df[feature], data=data, ci=None,
                         hue=HUES[i-1], style=HUES[i-1], markers=True, ax=axes[i, 1
    plt.show()
```

In [12]:
```
#creating function to create multivariate plot
def multivariate_plot (data: pd.DataFrame, feature: str):
    pass
```

Data Preprocessing

In [14]:
```
#checking missing value
campaign_df.isna().sum()
```

Out[14]:
```
Ad Group       0
Month          0
Impressions    0
Clicks         0
CTR            0
Conversions    0
Conv Rate      0
Cost           0
CPC            0
Revenue        0
Sale Amount    0
P&L            0
dtype: int64
```

In [15]:
```
#Checking the duplicate data
campaign_df.duplicated().sum()
```

Out[15]:
```
0
```

In [17]:
```
#checking data type
campaign_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 190 entries, 0 to 189
Data columns (total 12 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   Ad Group     190 non-null    object 
 1   Month        190 non-null    object 
 2   Impressions  190 non-null    int64  
 3   Clicks       190 non-null    int64  
 4   CTR          190 non-null    float64
 5   Conversions  190 non-null    int64  
 6   Conv Rate    190 non-null    float64
 7   Cost         190 non-null    int64  
 8   CPC          190 non-null    float64
 9   Revenue      190 non-null    int64  
 10  Sale Amount  190 non-null    float64
 11  P&L          190 non-null    float64
dtypes: float64(5), int64(5), object(2)
memory usage: 17.9+ KB
```

In [19]:
```
#converting 'ad group' column into string type
campaign_df['Ad Group'] = campaign_df['Ad Group'].astype('string')
campaign_df.dtypes
```

Out[19]:
```
Ad Group       string[python]
Month                  object
Impressions             int64
Clicks                  int64
CTR                   float64
Conversions             int64
Conv Rate             float64
Cost                    int64
CPC                   float64
Revenue                 int64
Sale Amount           float64
P&L                   float64
dtype: object
```

Data Preparation

In [20]:
```
#Checking the contents of the Ad Group column
campaign_df['Ad Group'].value_counts()
```

Out[20]:
```
Ad Group
Shop - 1:1 - Desk - [shop coupon code]             5
Shop - 1:1 - Mob - [shop promo code]               5
Shop - Exact - Mob - Competitor                    5
Shop - 1:1 - Desk - [shop discount code]           5
Shop - 1:1 - Desk - [shop promo code]              5
Shop - 1:1 - Desk - [shop promo]                   5
Shop - 1:1 - Mob - [shop coupon code]              5
Shop - 1:1 - Mob - [shop coupon]                   5
Shop - 1:1 - Mob - [shop discount code]            5
Shop - 1:1 - Mob - [shop promo]                    5
Shop - Exact - Mob - Free Shipping                 5
Shop - Exact - Desk - Competitor                   5
Shop - Exact - Desk - Coupon Code                  5
Shop - Exact - Desk - Discount Code                5
Shop - Exact - Desk - Free Shipping                5
Shop - Exact - Desk - Offer                        5
Shop - Exact - Desk - Promo Code                   5
Shop - Exact - Desk - Sale                         5
Shop - Phrase - Desk - Promo Code                  5
Shop - Exact - Mob - Coupon Code                   5
Shop - 1:1 - Desk - [shop coupon]                  5
Shop - Phrase - Desk - Sale                        5
Shop - Exact - Mob - Offer                         5
Shop - Exact - Mob - Promo Code                    5
Shop - Exact - Mob - Sale                          5
Shop - Phrase - Desk - Coupon Code                 5
Shop - Phrase - Desk - Discount Code               5
Shop - Phrase - Desk - Free Shipping               5
Shop - Phrase - Mob - Sale                         5
Shop - Phrase - Desk - Offer                       5
Shop - Exact - Mob - Discount Code                 5
Shop - Phrase - Mob - Competitor                   5
Shop - Phrase - Mob - Coupon Code                  5
Shop - Phrase - Mob - Discount Code                5
Shop - Phrase - Mob - Free Shipping                5
Shop - Phrase - Mob - Offer                        5
Shop - Phrase - Mob - Promo Code                   5
Shop - Phrase - Desk - Competitor                  3
Shop - Exact - Desk - Black Friday/Cyber Monday    1
Shop - Exact - Mob - Black Friday/Cyber Monday     1
Name: count, dtype: Int64
```

In [23]:
```
#creating new column ('Ad Type') to unify 'Ad Group'
    #multiple Ad Groups are combined into 1 type based on the similarity of their n

campaign_df['Ad_Type'] = campaign_df['Ad Group']

campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Free Shipping')]= 'Free
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('coupon')]= 'Coupon'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Coupon')]= 'Coupon'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('promo')]= 'Promo'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Promo')]= 'Promo'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('discount')]= 'Discount'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Discount')]= 'Discount'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Competitor')]= 'Competi
```

```
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Offer')]= 'Offer'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Sale')]= 'Sale'
campaign_df['Ad_Type'][campaign_df['Ad_Type'].str.contains('Black Friday')]= 'Black

campaign_df[['Ad Group', 'Ad_Type']].head()
```

Out[23]:

	Ad Group	Ad_Type
0	Shop - 1:1 - Desk - [shop coupon code]	Coupon
1	Shop - 1:1 - Desk - [shop coupon]	Coupon
2	Shop - 1:1 - Desk - [shop discount code]	Discount
3	Shop - 1:1 - Desk - [shop promo code]	Promo
4	Shop - 1:1 - Desk - [shop promo]	Promo

In [24]:
```
#checking and counting the number of each ad_type
campaign_df['Ad_Type'].value_counts()
```

Out[24]:
```
Ad_Type
Coupon           40
Promo            40
Discount         30
Free Shipping    20
Offer            20
Sale             20
Competitor       18
Black Friday      2
Name: count, dtype: Int64
```

In [26]:
```
#creating new column 'device' from data in 'Ad Group' column
    #The device used in ad is listed in 'Ad Group'. The data will be separated in s
campaign_df['Device']= campaign_df['Ad Group']

campaign_df['Device'][campaign_df['Device'].str.contains('Desk')] = 'Desktop'
campaign_df['Device'][campaign_df['Device'].str.contains('Mob')] = 'Mobile'

campaign_df[['Ad Group', 'Device']].head()
```

Out[26]:

	Ad Group	Device
0	Shop - 1:1 - Desk - [shop coupon code]	Desktop
1	Shop - 1:1 - Desk - [shop coupon]	Desktop
2	Shop - 1:1 - Desk - [shop discount code]	Desktop
3	Shop - 1:1 - Desk - [shop promo code]	Desktop
4	Shop - 1:1 - Desk - [shop promo]	Desktop

In [41]:
```
#replacing column name for device column
campaign_df.rename(columns = {'Device':'Devices'}, inplace = True)
```

In [88]:
```
#replacing column name for 'sale amount' column
campaign_df.rename(columns = {'SalesAmount':'Sales Amount'}, inplace = True)
```

In [42]:
```
#checking and counting the number of each ad_type
campaign_df['Devices'].value_counts()
```

Out[42]:
```
Devices
Mobile     96
Desktop    94
Name: count, dtype: Int64
```

In [54]:
```
#creating new column 'Match Types' from data in 'Ad Group' column
campaign_df['Match Types'] = campaign_df['Ad Group']

campaign_df['Match Types'][campaign_df['Match Types'].str.contains('1:1')] = '1:1'
campaign_df['Match Types'][campaign_df['Match Types'].str.contains('Exact')] = 'Exa
campaign_df['Match Types'][campaign_df['Match Types'].str.contains('Phrase')] = 'Ph
```

In [55]:
```
#checking and counting the number of each match_type
campaign_df['Match Types'].value_counts()
```

Out[55]:
```
Match Types
Exact     72
Phrase    68
1:1       50
Name: count, dtype: Int64
```

In [29]:
```
#calculating Cost per Mil (CPM)
campaign_df['CPM'] = campaign_df['Cost']/campaign_df['Impressions'] * 1000
campaign_df['CPM'] = campaign_df['CPM'].round(2)

campaign_df[['Impressions','Cost', 'CPM']].head()
```

Out[29]:

	Impressions	Cost	CPM
0	16038	6669	415.82
1	36462	13746	377.00
2	3635	1606	441.82
3	26185	13278	507.08
4	808	391	483.91

In [32]:
```
#calculating Cost Per Acquisition (CPA)
campaign_df['CPA'] = campaign_df['Cost']/campaign_df['Conversions']
campaign_df['CPA'] = campaign_df['CPA'].round(2)
campaign_df['CPA'].head()
```

Out[32]:
```
0    5.72
1    6.28
2    6.48
3    5.79
4    6.41
Name: CPA, dtype: float64
```

In [35]:
```
#calculating Revenue Over Ad Spends (ROAS) Data

campaign_df['ROAS'] = campaign_df['Revenue']/campaign_df['Cost']
campaign_df['ROAS'] = campaign_df['ROAS'].round(2)
campaign_df['ROAS'].head()
```

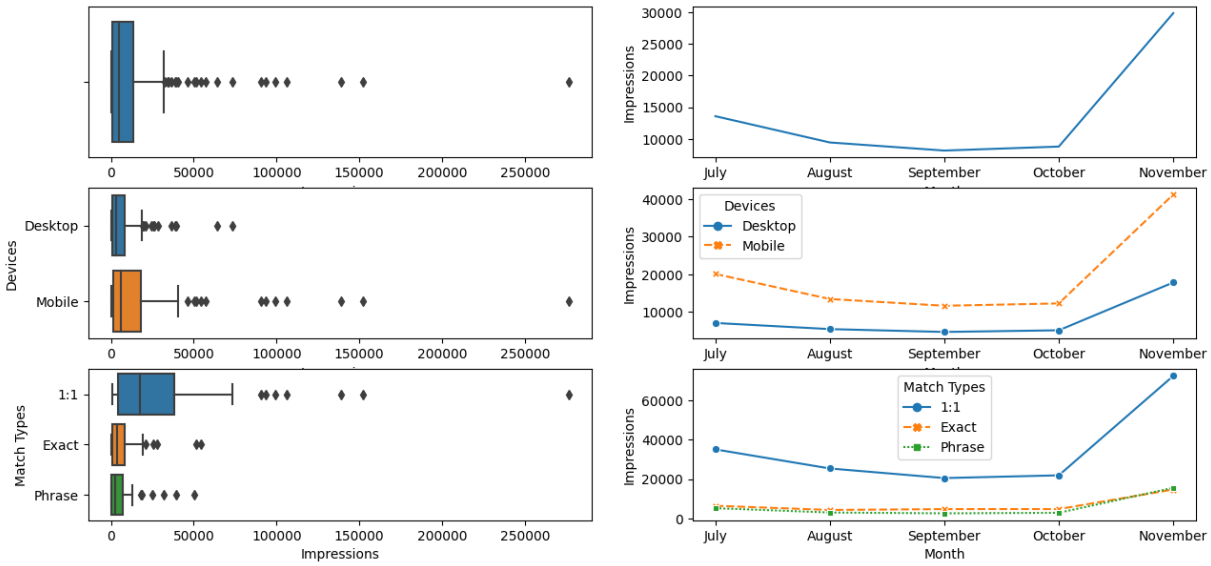
Out[35]:
```
0    0.96
1    0.96
2    1.07
3    0.98
4    0.86
Name: ROAS, dtype: float64
```

In [107…
```
#Export the processed data to .csv form
campaign_df.to_csv('campaign_data.csv', index= False)
```

Checking and Analyzing data

In [58]:
```
#checking Impressions column

feature = "Impressions"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [67]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

```
Outliers Counts:  21
```

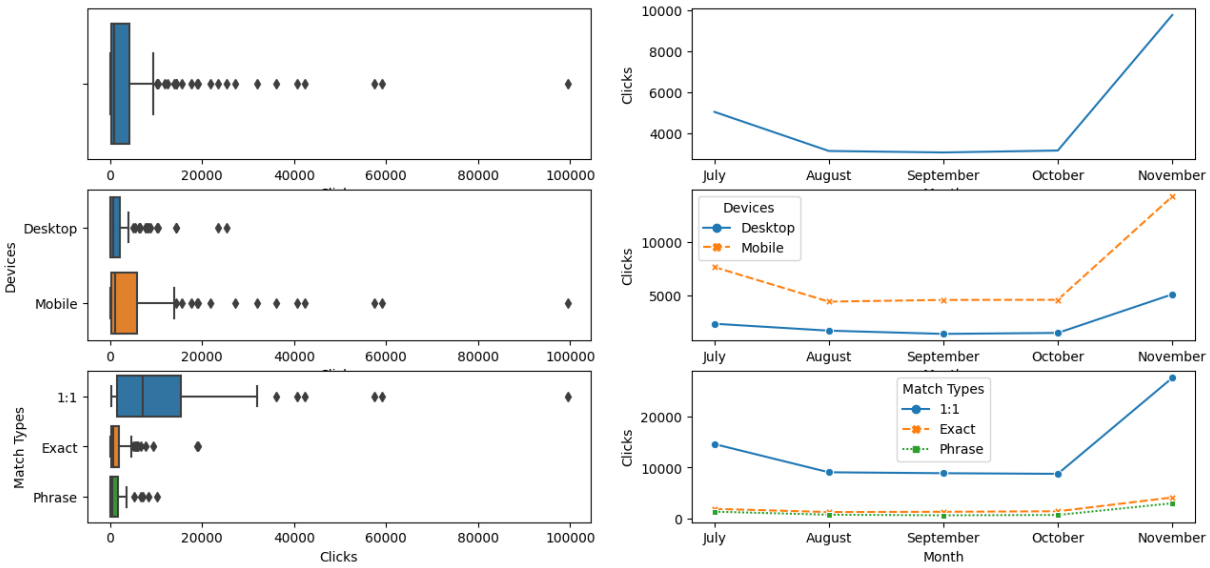
Out[67]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
151	Shop - 1:1 - Mob - [shop coupon]	November	276568	99526	0.36	5961	0.05	38273	0.38	32
6	Shop - 1:1 - Mob - [shop coupon]	July	152394	59177	0.39	2666	0.04	19371	0.33	13
159	Shop - 1:1 - Mob - [shop promo code]	November	138811	57405	0.41	7563	0.10	43542	0.76	42
40	Shop - 1:1 - Mob - [shop coupon]	August	105966	32005	0.30	1530	0.04	10713	0.33	8
175	Shop - 1:1 - Mob - [shop coupon code]	November	99258	42283	0.43	4349	0.08	24149	0.57	24

In [69]:

```
#Checking Clicks column

feature = "Clicks"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [70]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

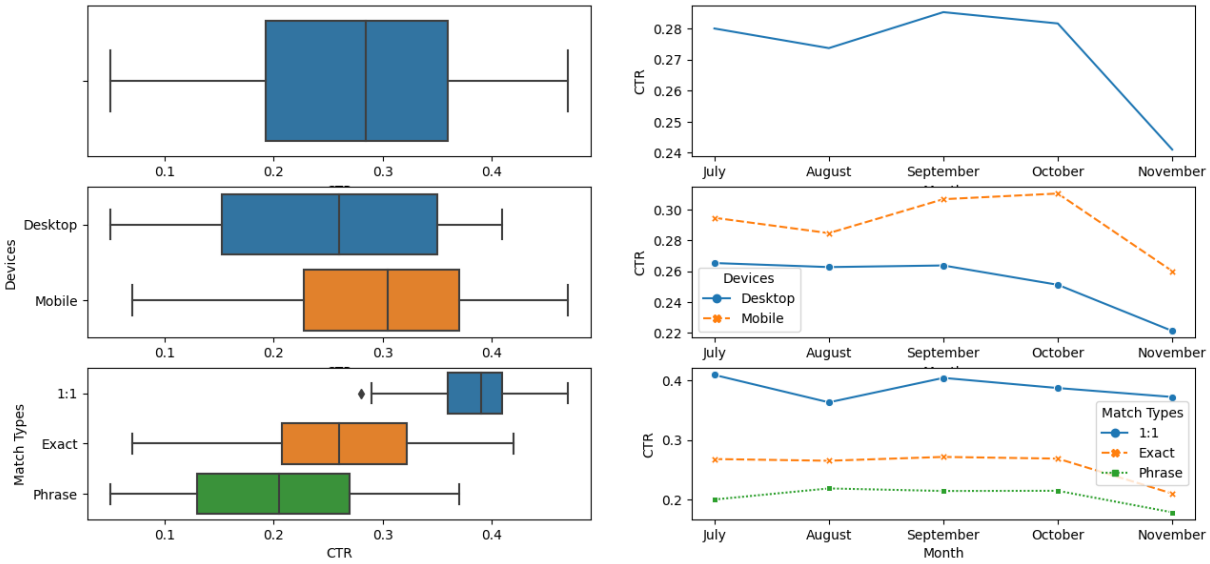
```
Outliers Counts:  24
```

Out[70]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
151	Shop - 1:1 - Mob - [shop coupon]	November	276568	99526	0.36	5961	0.05	38273	0.38	32
6	Shop - 1:1 - Mob - [shop coupon]	July	152394	59177	0.39	2666	0.04	19371	0.33	13
159	Shop - 1:1 - Mob - [shop promo code]	November	138811	57405	0.41	7563	0.10	43542	0.76	42
175	Shop - 1:1 - Mob - [shop coupon code]	November	99258	42283	0.43	4349	0.08	24149	0.57	24
76	Shop - 1:1 - Mob - [shop coupon]	September	90806	40622	0.45	1421	0.03	10904	0.27	7

In [71]:
```
#checking for CTR

feature = "CTR"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [72]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

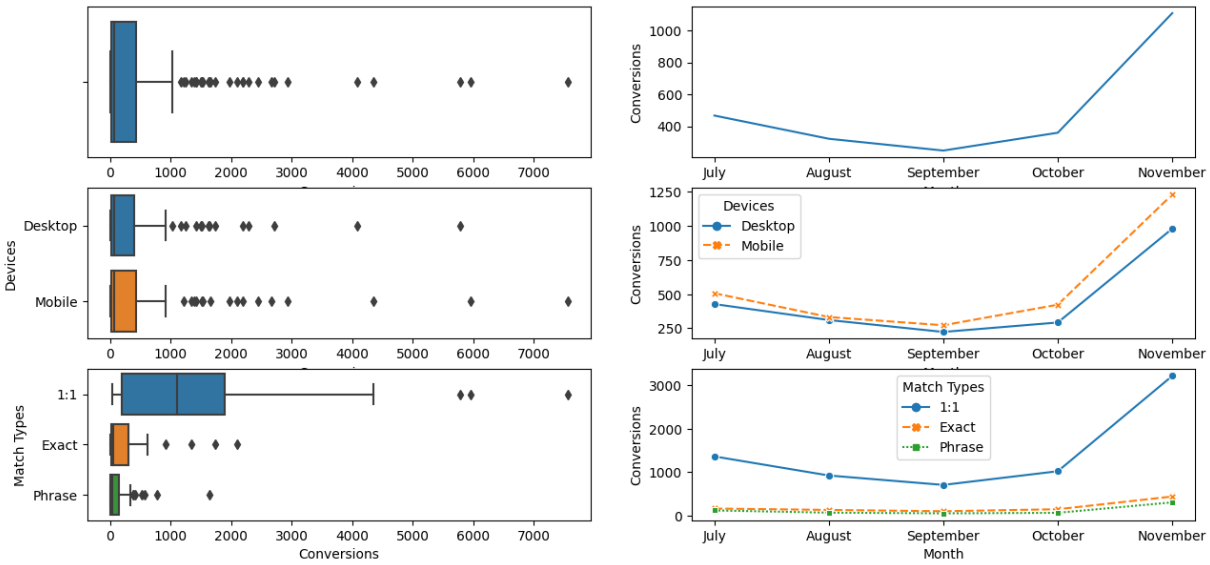
```
Outliers Counts:  0
```

Out[72]:

Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Revenue	Sale

In [73]:
```
#checking for CTR

feature = "Conversions"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [74]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

```
Outliers Counts:  29
```

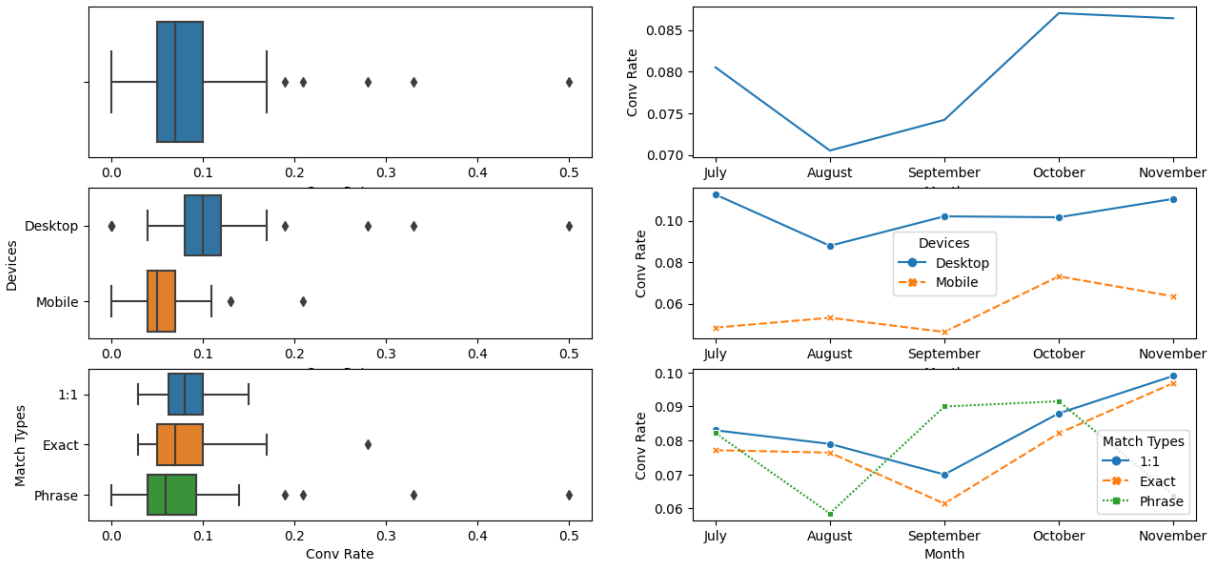
Out[74]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
159	Shop - 1:1 - Mob - [shop promo code]	November	138811	57405	0.41	7563	0.10	43542	0.76	42
151	Shop - 1:1 - Mob - [shop coupon]	November	276568	99526	0.36	5961	0.05	38273	0.38	32
153	Shop - 1:1 - Desk - [shop promo code]	November	64067	23538	0.37	5782	0.15	37729	1.60	34
175	Shop - 1:1 - Mob - [shop coupon code]	November	99258	42283	0.43	4349	0.08	24149	0.57	24
152	Shop - 1:1 - Desk - [shop coupon]	November	73448	25283	0.34	4080	0.10	27336	1.08	23

In [78]:

```
#checking for Conv Rate

feature = "Conv Rate"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [79]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

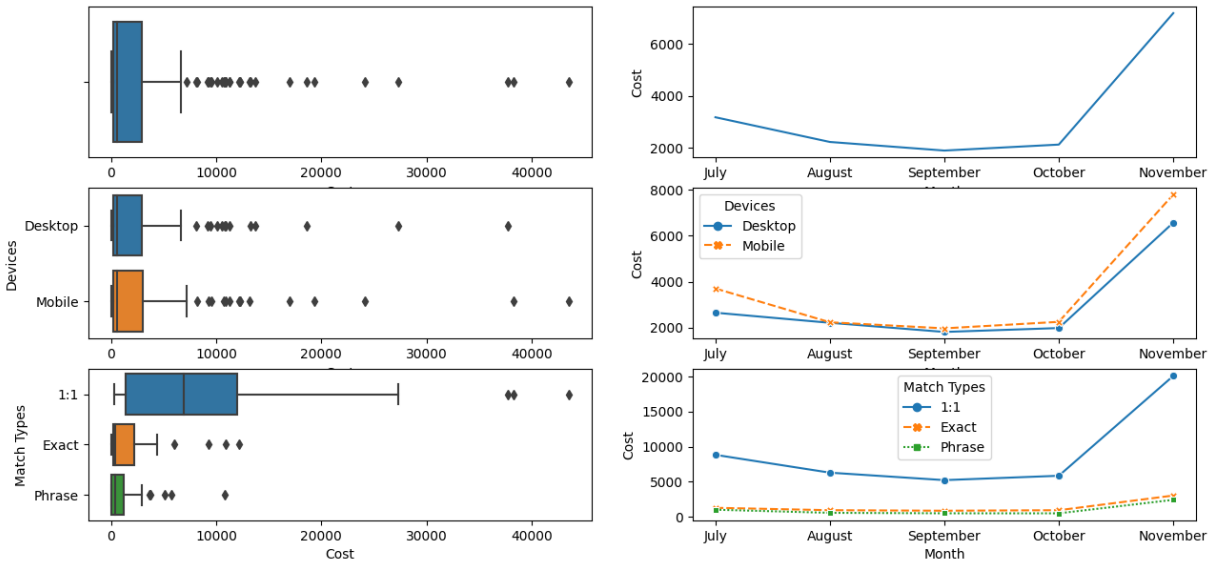
```
Outliers Counts:  5
```

Out[79]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Re
112	Shop - Phrase - Desk - Free Shipping	September	52	4	0.08	1	0.50	1	0.43	
24	Shop - Phrase - Desk - Competitor	July	36	5	0.14	2	0.33	5	1.05	
185	Shop - Exact - Desk - Black Friday/Cyber Monday	November	257	24	0.09	7	0.28	3	0.14	
150	Shop - Phrase - Mob - Free Shipping	October	100	14	0.14	3	0.21	3	0.26	
28	Shop - Phrase - Desk - Offer	July	389	54	0.14	10	0.19	58	1.09	

In [80]:
```
#checking for Cost

feature = "Cost"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [81]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

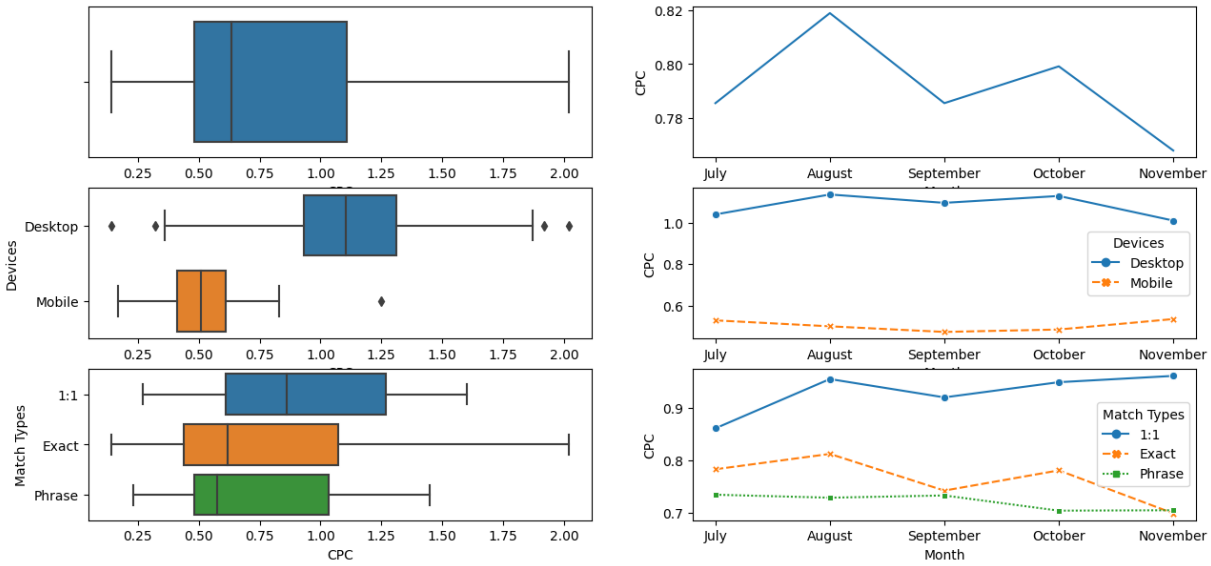
```
Outliers Counts:  29
```

Out[81]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
159	Shop - 1:1 - Mob - [shop promo code]	November	138811	57405	0.41	7563	0.10	43542	0.76	42
151	Shop - 1:1 - Mob - [shop coupon]	November	276568	99526	0.36	5961	0.05	38273	0.38	32
153	Shop - 1:1 - Desk - [shop promo code]	November	64067	23538	0.37	5782	0.15	37729	1.60	34
152	Shop - 1:1 - Desk - [shop coupon]	November	73448	25283	0.34	4080	0.10	27336	1.08	23
175	Shop - 1:1 - Mob - [shop coupon code]	November	99258	42283	0.43	4349	0.08	24149	0.57	24

In [82]:
```
#checking for CPC

feature = "CPC"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [83]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

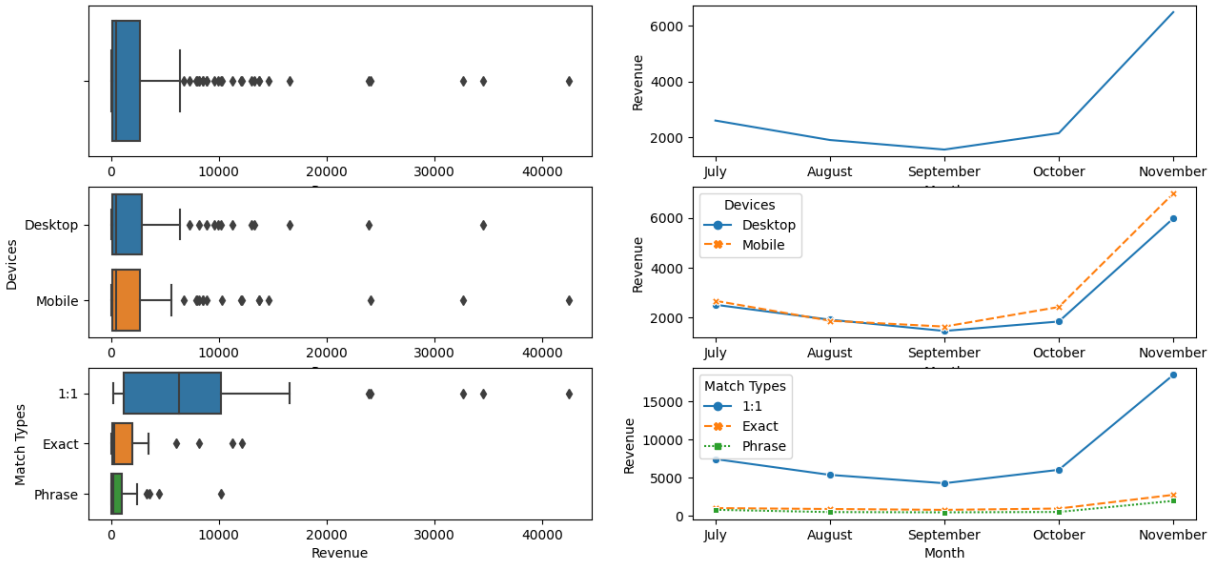
```
Outliers Counts:  0
```

Out[83]:

Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Revenue	Sale

In [84]:
```
#checking for Revenue

feature = "Revenue"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [85]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

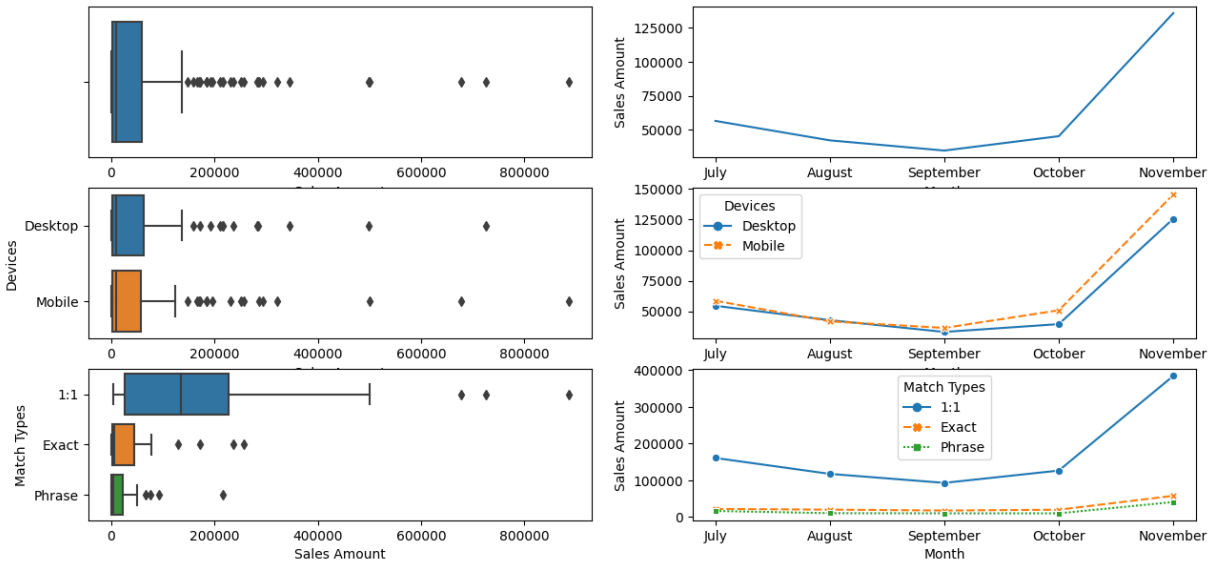
```
Outliers Counts:  28
```

Out[85]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
159	Shop - 1:1 - Mob - [shop promo code]	November	138811	57405	0.41	7563	0.10	43542	0.76	42
153	Shop - 1:1 - Desk - [shop promo code]	November	64067	23538	0.37	5782	0.15	37729	1.60	34
151	Shop - 1:1 - Mob - [shop coupon]	November	276568	99526	0.36	5961	0.05	38273	0.38	32
175	Shop - 1:1 - Mob - [shop coupon code]	November	99258	42283	0.43	4349	0.08	24149	0.57	24
152	Shop - 1:1 - Desk - [shop coupon]	November	73448	25283	0.34	4080	0.10	27336	1.08	23

In [90]:
```
#checking for Sales Amount

feature = "Sales Amount"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [91]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

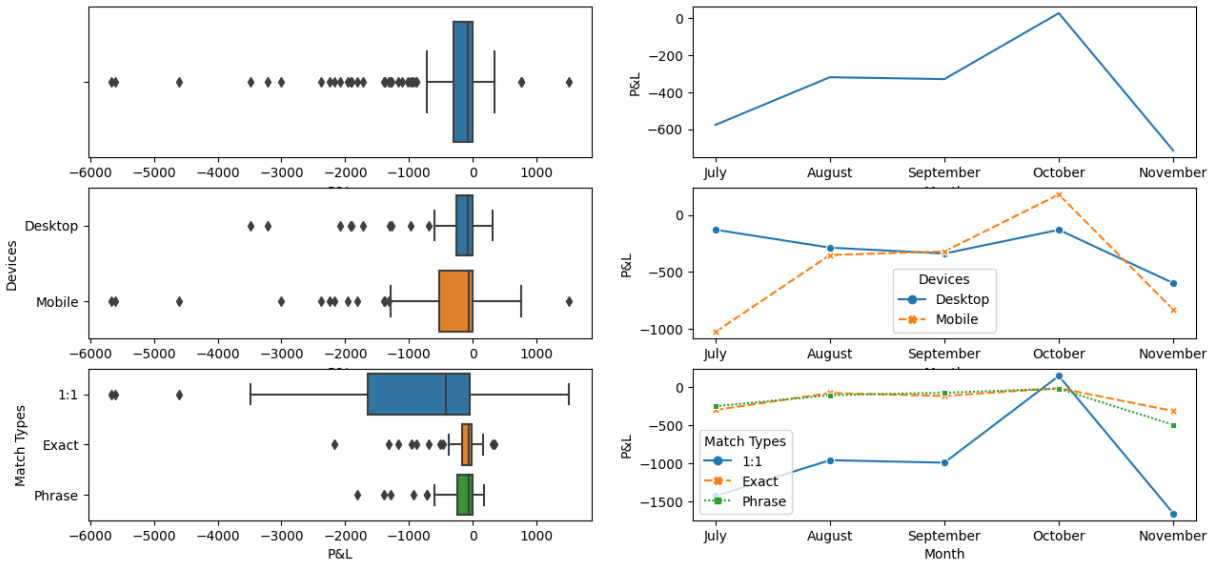
```
Outliers Counts:  28
```

Out[91]:

	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
159	Shop - 1:1 - Mob - [shop promo code]	November	138811	57405	0.41	7563	0.10	43542	0.76	42
153	Shop - 1:1 - Desk - [shop promo code]	November	64067	23538	0.37	5782	0.15	37729	1.60	34
151	Shop - 1:1 - Mob - [shop coupon]	November	276568	99526	0.36	5961	0.05	38273	0.38	32
175	Shop - 1:1 - Mob - [shop coupon code]	November	99258	42283	0.43	4349	0.08	24149	0.57	24
152	Shop - 1:1 - Desk - [shop coupon]	November	73448	25283	0.34	4080	0.10	27336	1.08	23

In [98]:
```
#checking for P&L

feature = "P&L"
box_and_line_plots (data= campaign_df, feature=feature)
```



In [99]:
```
outliers, top_outliers = find_outliers(data = campaign_df, feature=feature)
top_outliers[:]
```

```
Outliers Counts:  32
```

Out[99]:

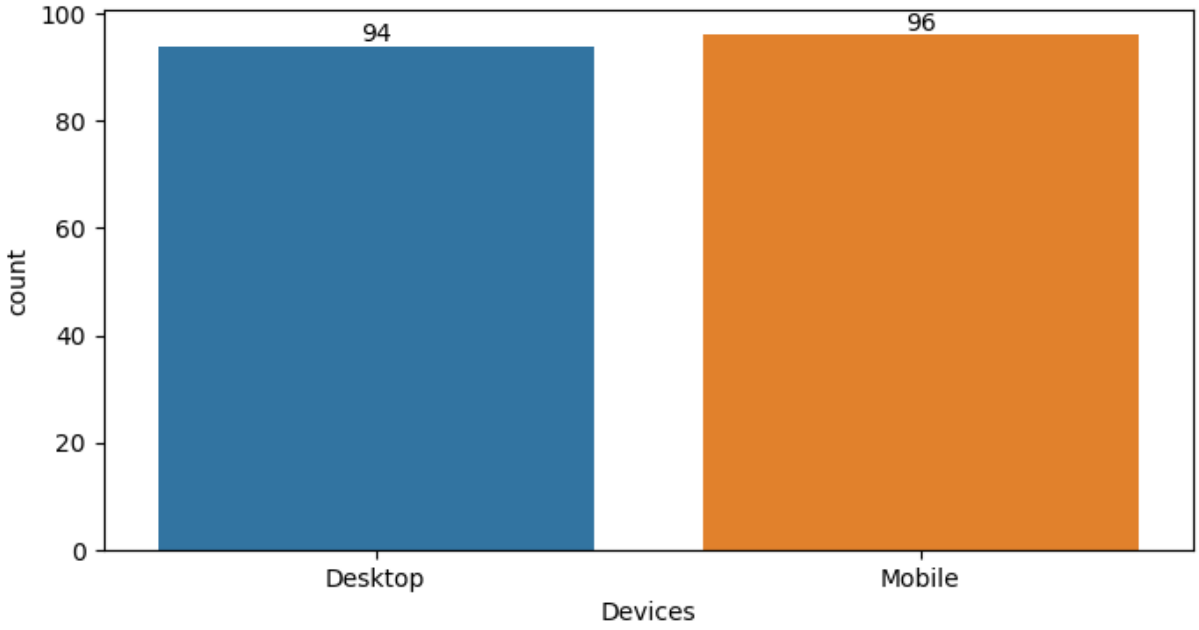
	Ad Group	Month	Impressions	Clicks	CTR	Conversions	Conv Rate	Cost	CPC	Reve
114	Shop - 1:1 - Mob - [shop coupon]	October	93406	36068	0.39	2444	0.05	12236	0.34	1
115	Shop - 1:1 - Mob - [shop promo code]	October	34929	15595	0.45	2193	0.09	11258	0.72	1
118	Shop - 1:1 - Mob - [shop coupon code]	October	28102	12485	0.44	1393	0.07	7192	0.58	
162	Shop - 1:1 - Mob - [shop discount code]	November	18275	8012	0.44	808	0.07	5651	0.71	
161	Shop - Exact - Mob - Discount Code	November	20699	5540	0.27	320	0.05	2893	0.52	

In [101…

```
#checking match type

fig, ax = plt.subplots(figsize=(8, 4))
ax = sns.countplot(x="Devices", data=campaign_df)
ax.bar_label(ax.containers[0])

plt.show()
```

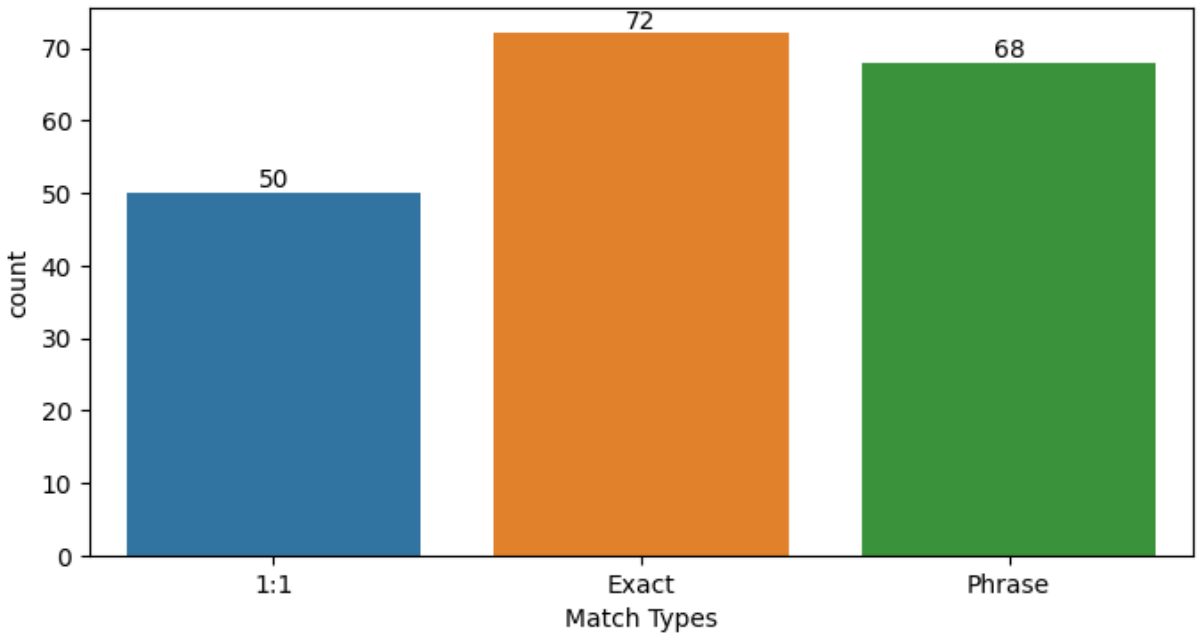


In [102…

```
#checking device

fig, ax = plt.subplots(figsize=(8, 4))
ax = sns.countplot(x="Match Types", data=campaign_df)
ax.bar_label(ax.containers[0])

plt.show()
```

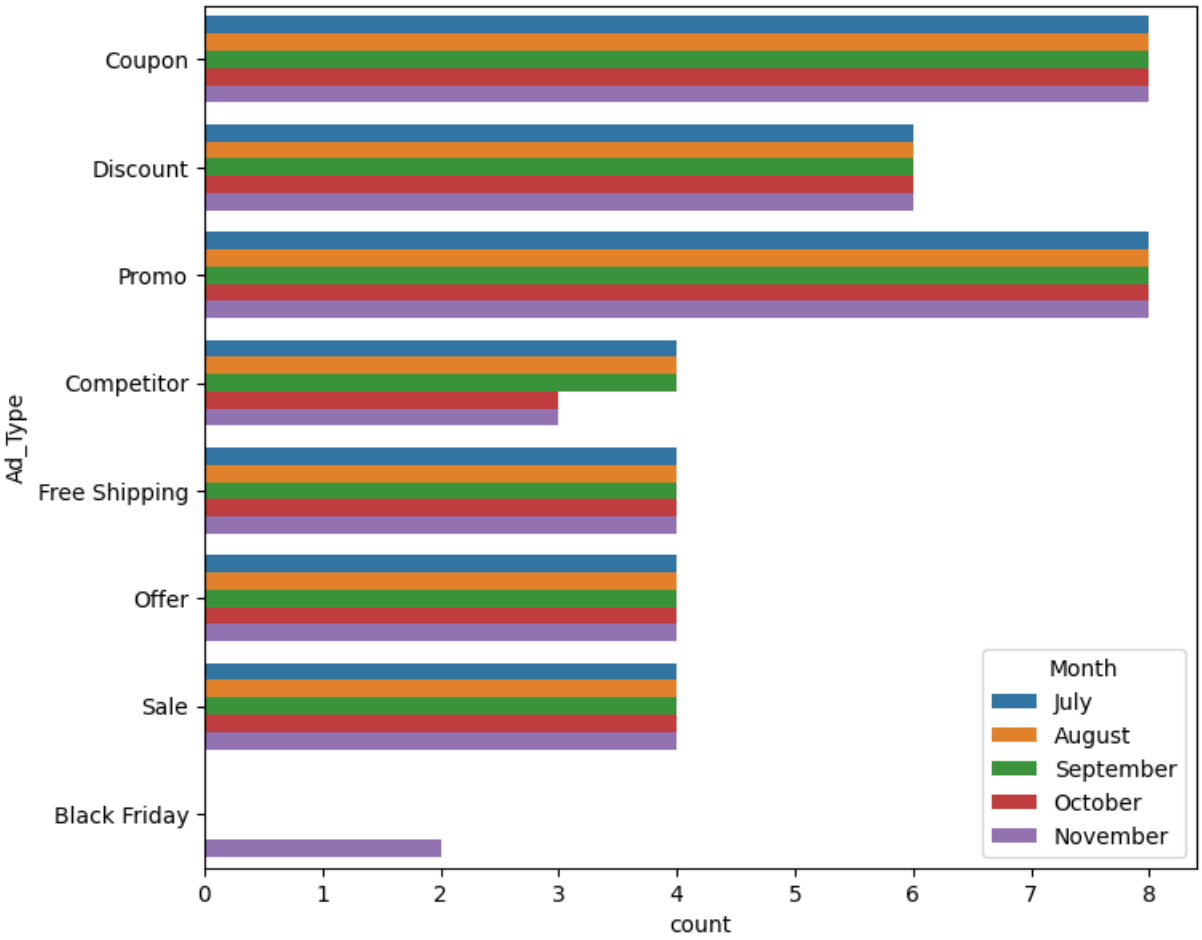


In [105…

```
#checking Ad Type

fig, ax = plt.subplots(figsize=(8, 7))
ax = sns.countplot(y="Ad_Type", hue="Month", data=campaign_df)
# ax.bar_label(ax.containers[0])

plt.show()
```


Coupon
Discount
Promo
Competitor
Free Shipping
Offer
Sale
Black Friday
Ad_Type
0
1
2
3
4
5
6
7
8
count
Month
July
August
September
October
November