WTF23 DATA SCIENCE AND ARTIFICIAL INTELLIGENCE

GROUP C SUBGROUP 1

FIRST PROJECT ON PYTHON

GOOGLE APPS REVIEWS AND EXPLORATION

App Profiles for Google Play

Our aim in this project is to explore mobile app profiles for the Google Play markets. Our goal for this project is to analyze data to help our developers understand what kinds of apps are likely to attract more users.

```
from mpl_toolkits.mplot3d import Axes3D
from sklearn.preprocessing import StandardScaler
import plotly.express as px
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from csv import reader
from google.colab import files
uploaded = files.upload()
```

Choose Files Ggleplaystore.csv

- **Ggleplaystore.csv**(text/csv) - 1360155 bytes, last modified: 10/25/2022 - 100% done

```
Saving Ggleplaystore.csv to Ggleplaystore.csv
```

```
apps = pd.read_csv('Ggleplaystore.csv')
apps.head()
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10,000+	Free	0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500,000+	Free	0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8.7M	5,000,000+	Free	0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25M	50,000,000+	Free	0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2.8M	100,000+	Free	0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up

```
apps.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10841 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype 
---  ------          --------------  ----- 
```

```
 0   App             10841 non-null  object 
 1   Category        10841 non-null  object 
 2   Rating          9367 non-null   float64
 3   Reviews         10841 non-null  object 
 4   Size            10841 non-null  object 
 5   Installs        10841 non-null  object 
 6   Type            10840 non-null  object 
 7   Price           10841 non-null  object 
 8   Content Rating  10840 non-null  object 
 9   Genres          10841 non-null  object 
 10  Last Updated    10841 non-null  object 
 11  Current Ver     10833 non-null  object 
 12  Android Ver     10838 non-null  object 
dtypes: float64(1), object(12)
memory usage: 1.1+ MB
```

```
#Checking column names in the dataset
apps.columns
```

```
Index(['App', 'Category', 'Rating', 'Reviews', 'Size', 'Installs', 'Type',
       'Price', 'Content Rating', 'Genres', 'Last Updated', 'Current Ver',
       'Android Ver'],
      dtype='object')
```

DATA CLEANING

Clean the Installs and Price columns by removing the characters in them

```
#define the columns to clean
cols_to_clean = ['Installs','Price']

# define the characters to remove
chars_to_remove = ['+',',','$']

#loop through the cols list
for col in cols_to_clean:
  #loop through the chars list
  for char in chars_to_remove:
    #Replace the character with an empty string
    apps[col] = apps[col].apply(lambda x : x.replace(char,''))

apps.head()
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10000	Free	0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8.7M	5000000	Free	0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25M	50000000	Free	0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2.8M	100000	Free	0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up

```
#check for duplicates
apps.duplicated().sum()
```

```
     483
```

```
apps[apps.duplicated()]
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
229	Quick PDF Scanner + OCR FREE	BUSINESS	4.2	80805	Varies with device	5000000	Free	0	Everyone	Business	February 26, 2018	Varies with device	4.0.3 and up
236	Box	BUSINESS	4.2	159872	Varies with device	10000000	Free	0	Everyone	Business	July 31, 2018	Varies with device	Varies with device
239	Google My Business	BUSINESS	4.4	70991	Varies with device	5000000	Free	0	Everyone	Business	July 24, 2018	2.19.0.204537701	4.4 and up
256	ZOOM Cloud	BUSINESS	4.4	31614	37M	10000000	Free	0	Everyone	Business	July 20,	4.1.28165.0716	4.0 and

```
# drop the duplicates
apps = apps.drop_duplicates()
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
261	Simple	BUSINESS	4.0	6989	with	1000000	Free	0	Everyone	Business	July 10,	4.3.0.508	4.4 and

```
#check for missing values
apps.isnull().sum()
```

```
App                  0
Category             0
Rating            1465
Reviews              0
Size                 0
Installs             0
Type                 1
Price                0
Content Rating       1
Genres               0
Last Updated         0
Current Ver          8
Android Ver          3
dtype: int64
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
	Anesthetize.	MEDICAL									2018		up

```
#drop duplicates in selected columns
apps = apps.dropna(subset = ["Type", "Content Rating","Current Ver", "Android Ver"])
apps
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10000	Free	0	Everyone	Art & Design	January 7, 2018	1.0.0
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0
2	U Launcher Lite – FREE Live	ART_AND_DESIGN	4.7	87510	8.7M	5000000	Free	0	Everyone	Art & Design	August	1.2.4

```
#summary statistics of the Rating column
apps.describe()
```

	Rating
count	8886.000000
mean	4.187959
std	0.522428
min	1.000000
25%	4.000000
50%	4.300000
75%	4.500000
max	5.000000

Audio 2018

```
apps["Rating"]= apps["Rating"].fillna(apps["Rating"].mean())
apps.head()
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10000	Free	0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
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3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25M	50000000	Free	0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2.8M	100000	Free	0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up

```
apps["Installs"]
```

```
0           10000
1          500000
2         5000000
3        50000000
4          100000
```

```
              ...
10836        5000
10837         100
10838        1000
10839        1000
10840    10000000
Name: Installs, Length: 10346, dtype: object
```

CORRECTING DATA TYPES AND EDA

Change the columns Installs and Price to float

```
#Installs column to float
apps['Installs'] = apps['Installs'].astype('int')

#Price column to float
apps['Price'] = apps['Price'].astype('float')

# Rating column to object
#apps['Rating'] = apps['Rating'].astype('float')

#check the apps info for changes
apps.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10346 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             10346 non-null  object
 1   Category        10346 non-null  object
 2   Rating          10346 non-null  float64
 3   Reviews         10346 non-null  object
 4   Size            10346 non-null  object
 5   Installs        10346 non-null  int64
 6   Type            10346 non-null  object
 7   Price           10346 non-null  float64
 8   Content Rating  10346 non-null  object
 9   Genres          10346 non-null  object
 10  Last Updated    10346 non-null  object
 11  Current Ver     10346 non-null  object
 12  Android Ver     10346 non-null  object
dtypes: float64(2), int64(1), object(10)
memory usage: 1.1+ MB
```

change Last Updated Datatype to datetime

```
apps['Last Updated']= pd.to_datetime(apps['Last Updated'], infer_datetime_format= True, errors='coerce')
```

```
apps['Last Updated'].sort_values(ascending=True)
```

```
7479    2010-05-21
7430    2011-01-30
10282   2011-03-16
8418    2011-04-11
8084    2011-04-16
           ...
10408   2018-08-08
10712   2018-08-08
10760   2018-08-08
10209   2018-08-08
10718   2018-08-08
Name: Last Updated, Length: 10346, dtype: datetime64[ns]
```

EDA OF DATA SET USING DISTRIBUTION PLOTS, SCATTER PLOTS AND CORRELATION MATRIX DISTRIBUTION PLOTS

DISTRIBUTION OF APPS ACROSS CATEGORIES

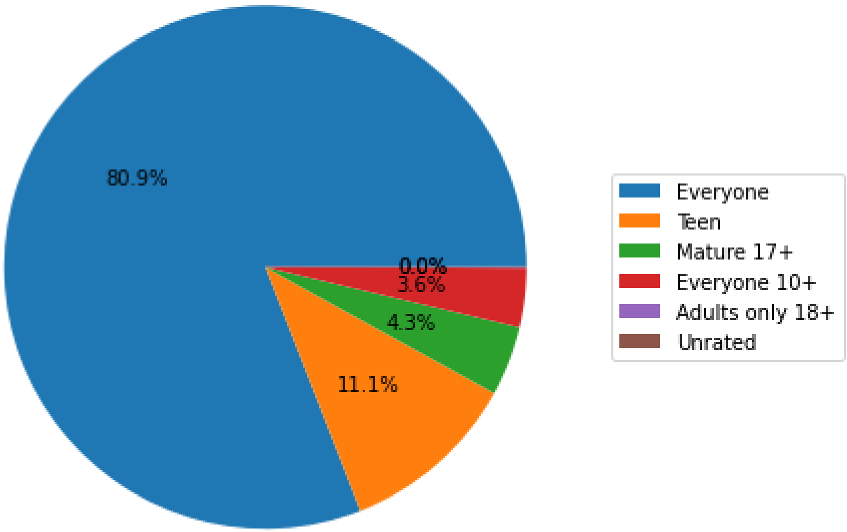
```
apps['Content Rating'].value_counts()
```

```
apps["Content Rating"].value_counts()
```

```
     Everyone            8372
     Teen                1146
     Mature 17+           447
     Everyone 10+         376
     Adults only 18+        3
     Unrated                2
     Name: Content Rating, dtype: int64
```

```
fig, ax = plt.subplots(figsize=(6, 6), subplot_kw=dict(aspect="equal"))
number_of_apps = apps["Content Rating"].value_counts()
labels = number_of_apps.index
sizes = number_of_apps.values
ax.pie(sizes,labeldistance=2,autopct='%1.1f%%')
ax.legend(labels=labels,loc="right",bbox_to_anchor=(0.9, 0, 0.5, 1))
```

```
     <matplotlib.legend.Legend at 0x7fe744f9cc10>
```



TOP 10 INSTALLED, RATED AND REVIEWED APPS

To sieve the top 10 installed, rated and reviewed app, we will filter based on our factor of interest viz: Most installed, most rated and most reviewed. We will then plot the data set based on each of the factor of interest.

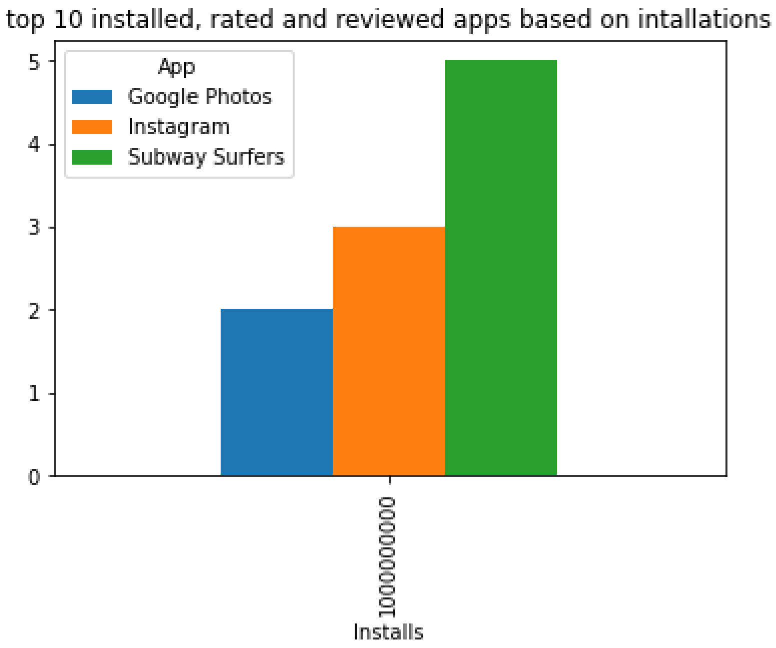
From the result we noticed the following:

1. Plotting the bar chart for top 10 installs, rating and review with cross comparision based on installations, subwaysurfers had the highest rating, reviews and installs followed by instagram and finally goggle photos.
2. Similar results was discovered when we cross examine with Rating. Subway Surfers came top, followed by instagram and finaly google photos.
3. We also discovered same result when we cross examine with reviews as well.

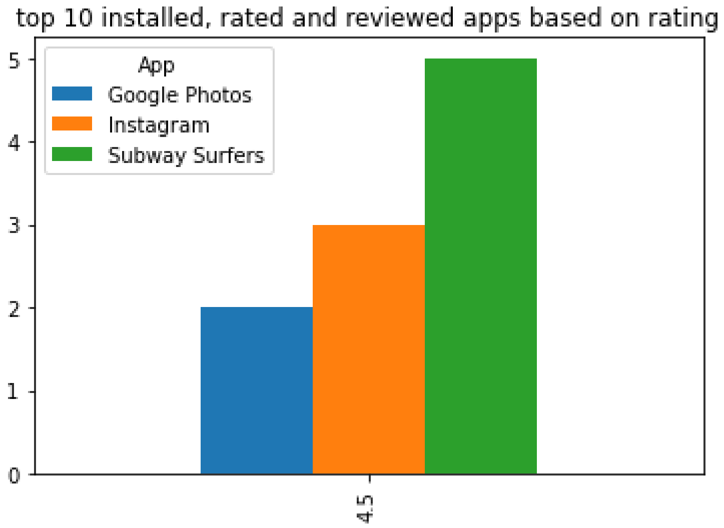
```
#dataframe that gives most installed, most rated and reviewed apps
top_installed_rated_review_apps = apps.sort_values(by=["Installs", "Rating", "Reviews"], ascending=False)
top_installed_rated_review_apps.head() # main top apps
```

App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver

```
# top ten group by installation
top10app=top_installed_rated_review_apps.head(10)
topapps=top10app.groupby(["Installs", "App"]).size().unstack()
topapps.plot(kind="bar",stacked=False)
plt.title('top 10 installed, rated and reviewed apps based on intallations')
ax=plt.gca()
plt.show()
```



```
# top ten group by Rating
top10app=top_installed_rated_review_apps.head(10)
topapps=top10app.groupby(["Rating", "App"]).size().unstack()
topapps.plot(kind="bar",stacked=False)
plt.title('top 10 installed, rated and reviewed apps based on rating')
ax=plt.gca()
plt.show()
```

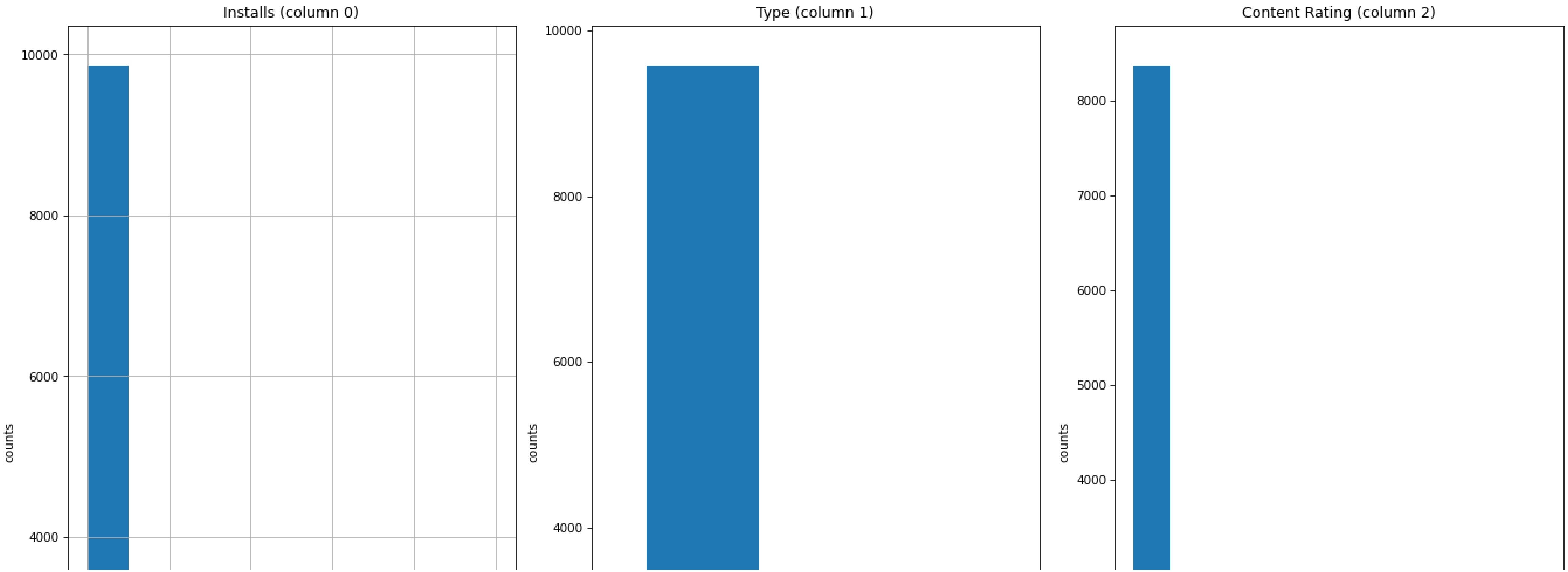


```
# top ten group by Reviews
top10app=top_installed_rated_review_apps.head(10)
topapps=top10app.groupby(["Reviews", "App"]).size().unstack()
topapps.plot(kind="bar",stacked=False)
plt.title('top 10 installed, rated and reviewed apps based on reviews')
ax=plt.gca()
plt.show()
```

top 10 installed, rated and reviewed apps based on reviews

Distribution plots of graphs (histogram/bar graph) of column data

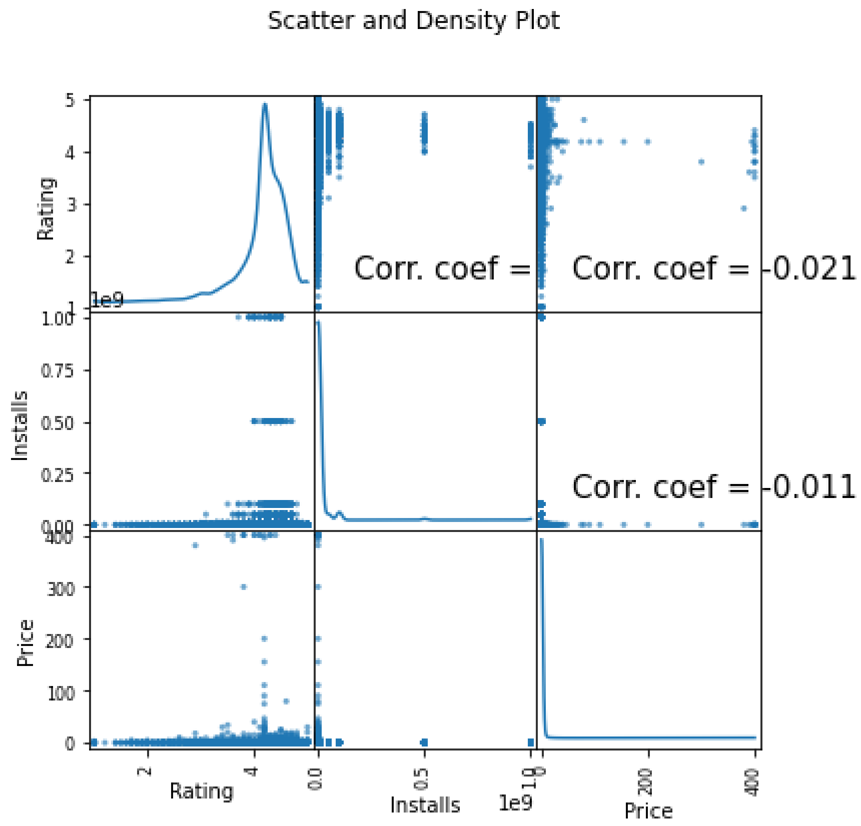
```
# Distribution plots of graphs (histogram/bar graph) of column data
def plotPerColumnDistribution(apps, nGraphShown, nGraphPerRow):
    nunique = apps.nunique()
    apps = apps[[col for col in apps if nunique[col] > 1 and nunique[col] < 30]] # For displaying purposes, pick columns that have between 1 a
    nRow, nCol = apps.shape
    columnNames = list(apps)
    nGraphRow = (nCol + nGraphPerRow - 1) / nGraphPerRow
    plt.figure(num = None, figsize = (6 * nGraphPerRow, 8 * nGraphRow), dpi = 75, facecolor = 'w', edgecolor = 'k')
    for i in range(min(nCol, nGraphShown)):
        plt.subplot(nGraphRow, nGraphPerRow, i + 1)
        columnapps = apps.iloc[:, i]
        if (not np.issubdtype(type(columnapps.iloc[0]), np.number)):
            valueCounts = columnapps.value_counts()
            valueCounts.plot.bar()
        else:
            columnapps.hist()
        plt.ylabel('counts')
        plt.xticks(rotation = 90)
        plt.title(f'{columnNames[i]} (column {i})')
    plt.tight_layout(pad = 1.0, w_pad = 1.0, h_pad = 1.0)
    plt.show()



## Call the column distribution plots
plotPerColumnDistribution(apps, 10, 5)
```



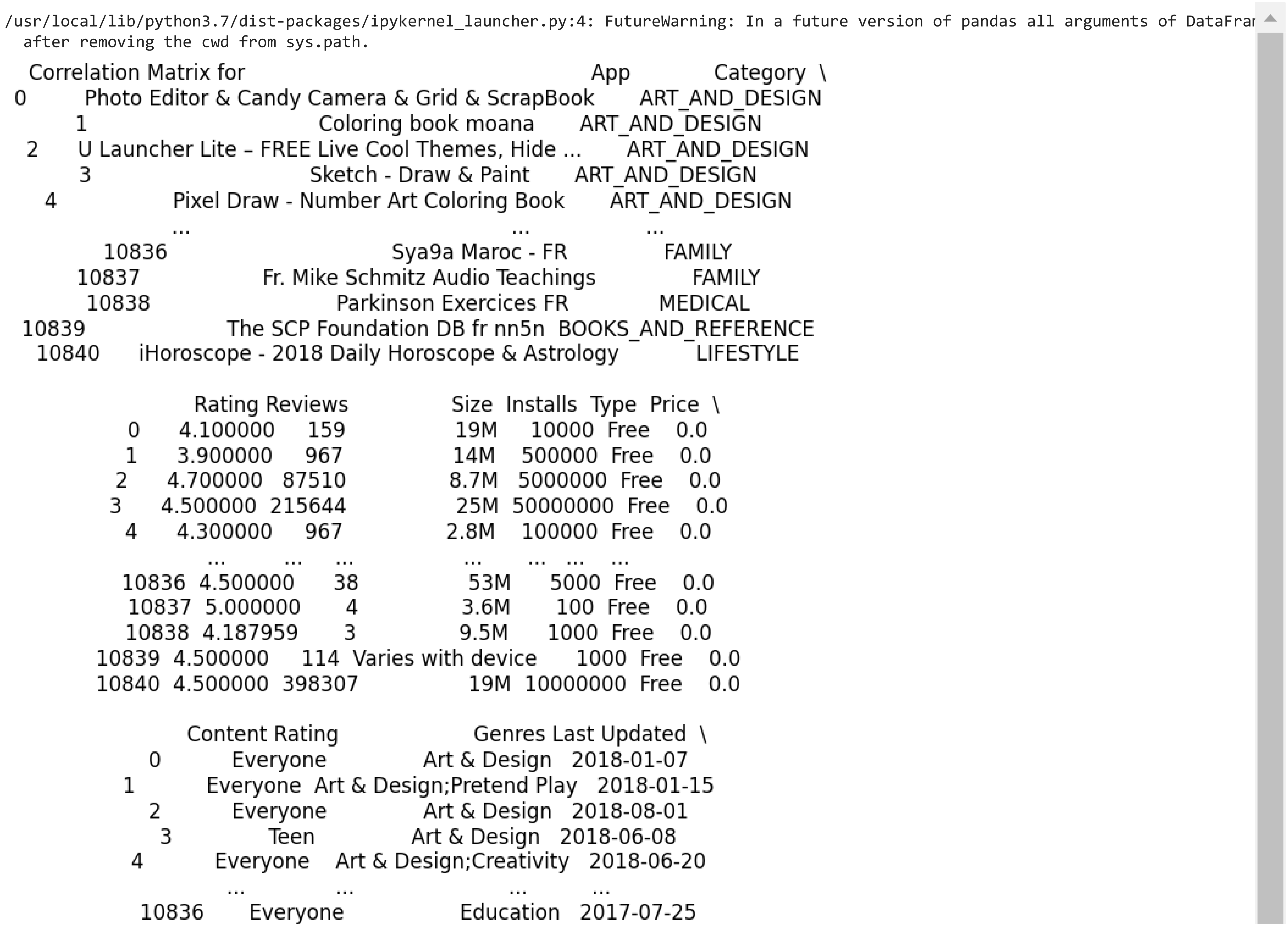
```
# Scatter and density plots
def plotScatterMatrix(apps, plotSize, textSize):
    apps = apps.select_dtypes(include =[np.number]) # keep only numerical columns
    # Remove rows and columns that would lead to data frame being singular
    apps = apps.dropna('columns')
    apps = apps[[col for col in apps if apps[col].nunique() > 1]] # keep columns where there are more than 1 unique values
    columnNames = list(apps)
    if len(columnNames) > 10: # reduce the number of columns for matrix inversion of kernel density plots
        columnNames = columnNames[:10]
    apps = apps[columnNames]
    ax = pd.plotting.scatter_matrix(apps, alpha=0.65, figsize=[plotSize, plotSize], diagonal='kde')
    corrs = apps.corr().values
    for i, j in zip(*plt.np.triu_indices_from(ax, k = 1)):
        ax[i, j].annotate('Corr. coef = %.3f' % corrs[i, j], (0.8, 0.2), xycoords='axes fraction', ha='center', va='center', size=textSize)
    plt.suptitle('Scatter and Density Plot')
    plt.show()


## Call the scatter and density plot
```

```
plotScatterMatrix(apps, 6, 15)
```

```
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:5: FutureWarning: In a future version of pandas all arguments of DataFrame.d
      """
```

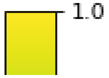


```
# Correlation matrix
def plotCorrelationMatrix(apps, graphWidth):
    filename = apps
    apps = apps.dropna('columns') # drop columns with NaN
    apps = apps[[col for col in apps if apps[col].nunique() > 1]] # keep columns where there are more than 1 unique values
    if apps.shape[1] < 2:
        print(f'No correlation plots shown: The number of non-NaN or constant columns ({apps.shape[1]}) is less than 2')
        return
    corr = apps.corr()
    plt.figure(num=None, figsize=(graphWidth, graphWidth), dpi=80, facecolor='w', edgecolor='k')
    corrMat = plt.matshow(corr, fignum = 1)
    plt.xticks(range(len(corr.columns)), corr.columns, rotation=90)
    plt.yticks(range(len(corr.columns)), corr.columns)
    plt.gca().xaxis.tick_bottom()
    plt.colorbar(corrMat)
    plt.title(f'Correlation Matrix for {filename}', fontsize=15)
    plt.show()



### Call the correlation matrix plot
plotCorrelationMatrix(apps, 8)
```



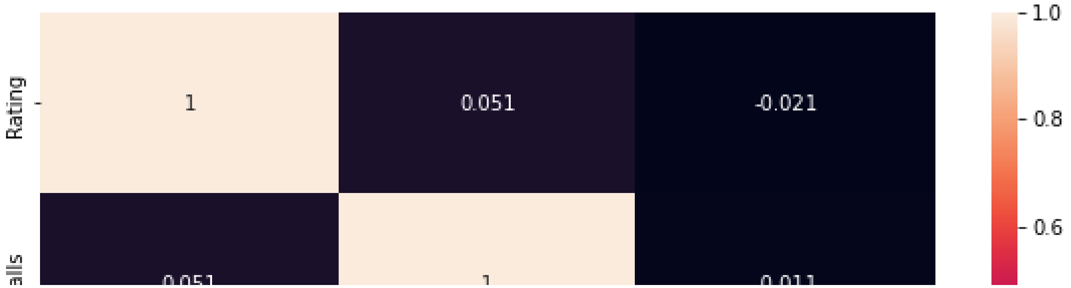
```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:4: FutureWarning: In a future version of pandas all arguments of DataFrar
  after removing the cwd from sys.path.
  Correlation Matrix for                                                App            Category  \
0        Photo Editor & Candy Camera & Grid & ScrapBook        ART_AND_DESIGN
1                                   Coloring book moana        ART_AND_DESIGN
2       U Launcher Lite – FREE Live Cool Themes, Hide ...        ART_AND_DESIGN
3                                Sketch - Draw & Paint        ART_AND_DESIGN
4                  Pixel Draw - Number Art Coloring Book        ART_AND_DESIGN
...                                                  ...                 ...
10836                                 Sya9a Maroc - FR              FAMILY
10837                  Fr. Mike Schmitz Audio Teachings              FAMILY
10838                            Parkinson Exercices FR             MEDICAL
10839                     The SCP Foundation DB fr nn5n  BOOKS_AND_REFERENCE
10840         iHoroscope - 2018 Daily Horoscope & Astrology           LIFESTYLE

         Rating Reviews                Size  Installs  Type  Price  \
0      4.100000     159                 19M     10000  Free    0.0
1      3.900000     967                 14M    500000  Free    0.0
2      4.700000   87510                8.7M   5000000  Free    0.0
3      4.500000  215644                 25M  50000000  Free    0.0
4      4.300000     967                2.8M    100000  Free    0.0
...         ...     ...                 ...       ...   ...    ...
10836  4.500000      38                 53M      5000  Free    0.0
10837  5.000000       4                3.6M       100  Free    0.0
10838  4.187959       3                9.5M      1000  Free    0.0
10839  4.500000     114  Varies with device      1000  Free    0.0
10840  4.500000  398307                 19M  10000000  Free    0.0

      Content Rating                     Genres Last Updated  \
0           Everyone               Art & Design   2018-01-07
1           Everyone  Art & Design;Pretend Play   2018-01-15
2           Everyone               Art & Design   2018-08-01
3               Teen               Art & Design   2018-06-08
4           Everyone    Art & Design;Creativity   2018-06-20
...              ...                        ...          ...
10836       Everyone                  Education   2017-07-25
```

```
10837       Everyone              Education   2018-07-06
 10838       Everyone              Medical   2017-01-20
10839     Mature 17+        Books & Reference   2015-01-19
 10840       Everyone              Lifestyle   2018-07-25

               Current Ver         Android Ver
0                 1.0.0        4.0.3 and up
1                 2.0.0        4.0.3 and up
2                 1.2.4        4.0.3 and up
3      Varies with device          4.2 and up
4                   1.1          4.4 and up
...                 ...                 ...
10836              1.48          4.1 and up
10837               1.0          4.1 and up
10838               1.0          2.2 and up
10839  Varies with device  Varies with device
10840  Varies with device  Varies with device

[10346 rows x 13 columns]
```



CORRELATION HEATMAP PLOT OF PRICE, RATINGS AND INSTALATIONS

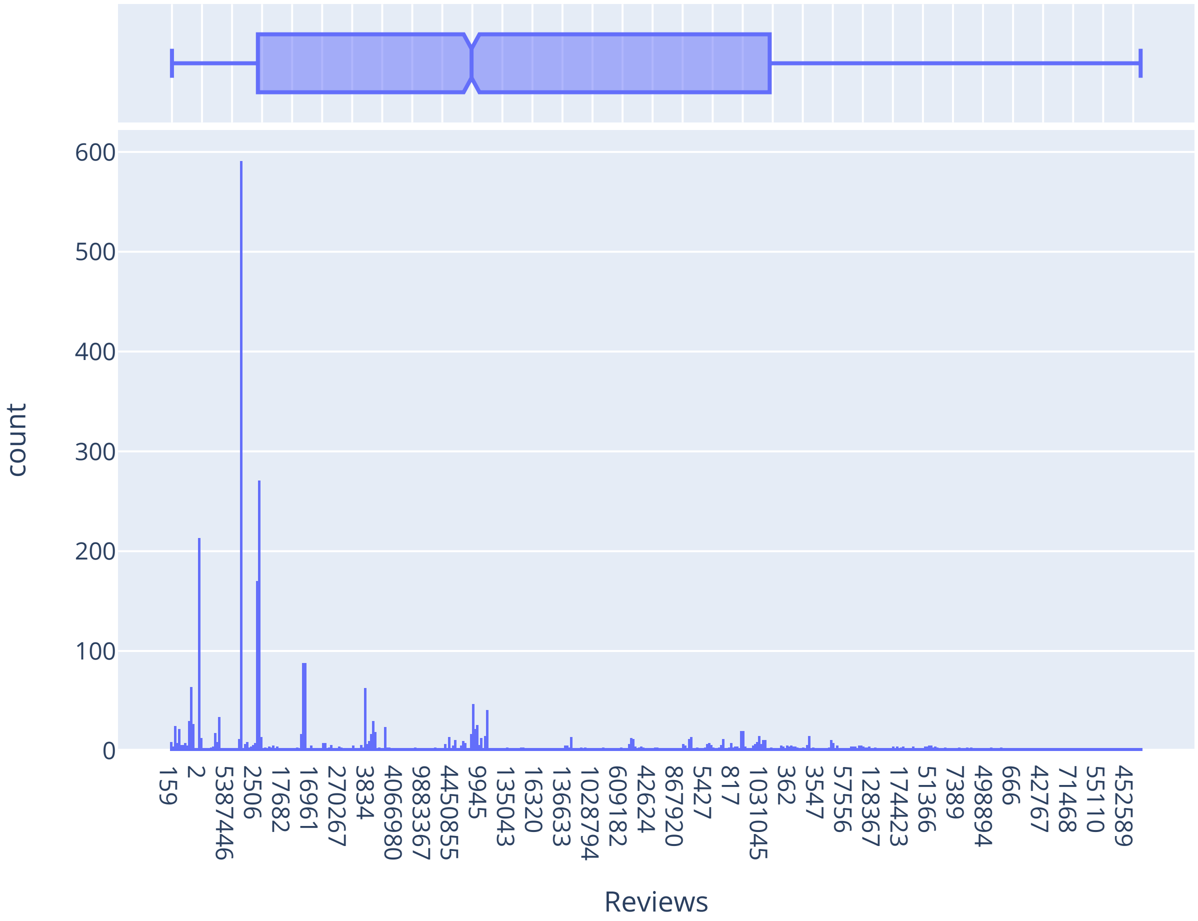
```
#Correlation Heatmap
plt.figure(figsize=(10,5))
corr= apps.corr()
sns.heatmap(corr, annot=True)
plt.show()
```



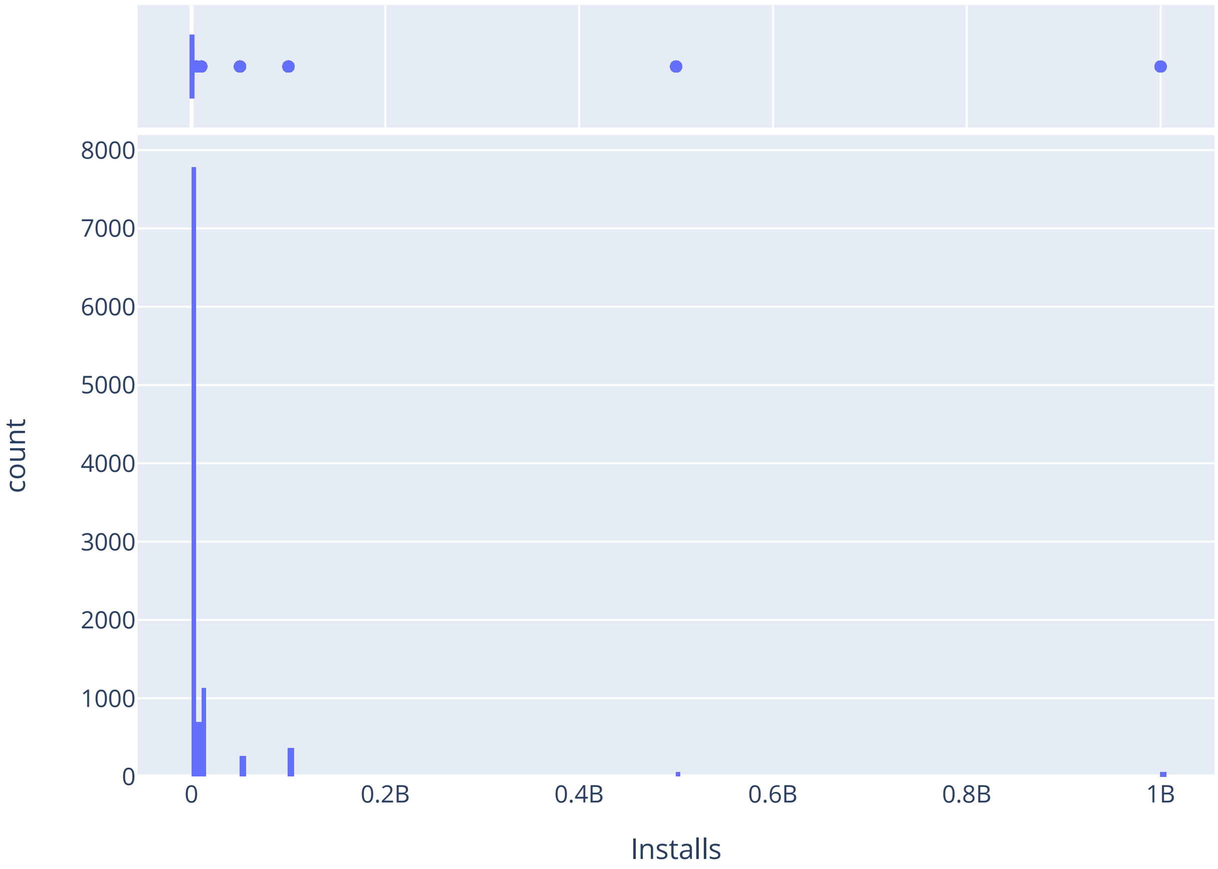
HISTOGRAM PLOT OF AVERAGE APPS RATING

```
px.histogram(apps, x="Rating", marginal='box')
```

```
##HISTOGRAM /BOX PLOT OF REVIEWS
px.histogram(apps, x="Reviews", marginal='box')
```

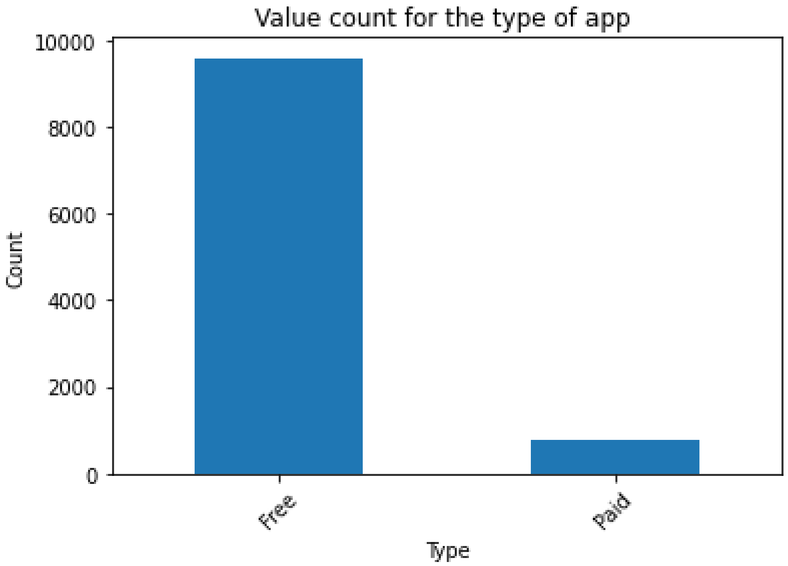


```
##HISTOGRAM /BOX PLOT OF INSTALLS
px.histogram(apps, x="Installs", marginal='box')
```



BAR PLOT OF TYPES OF APPS

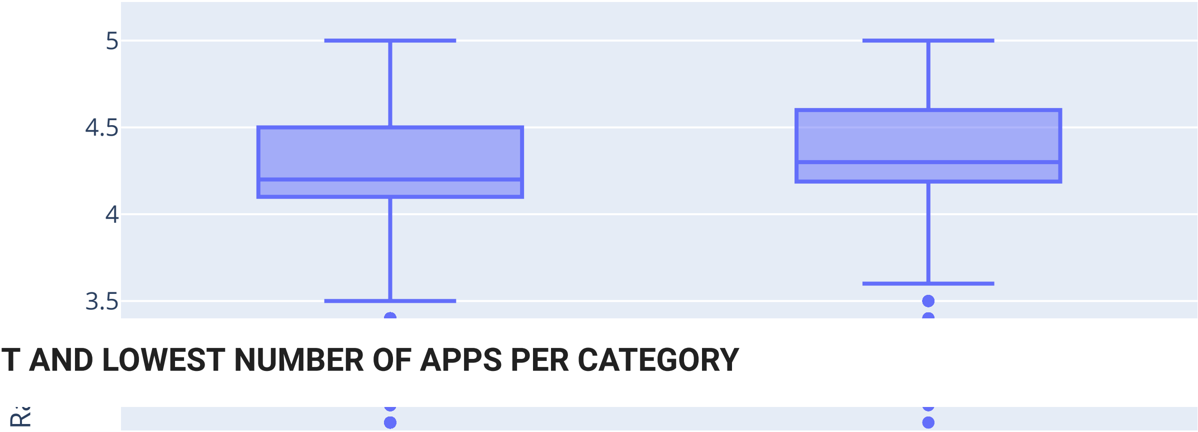
```
apps["Type"].value_counts().plot.bar()
plt.ylabel("Count")
plt.xlabel("Type")
plt.title("Value count for the type of app ")
plt.xticks(rotation=45)

plt.show()
```



AVERAGE RATING OF PAID AND FREE APPS

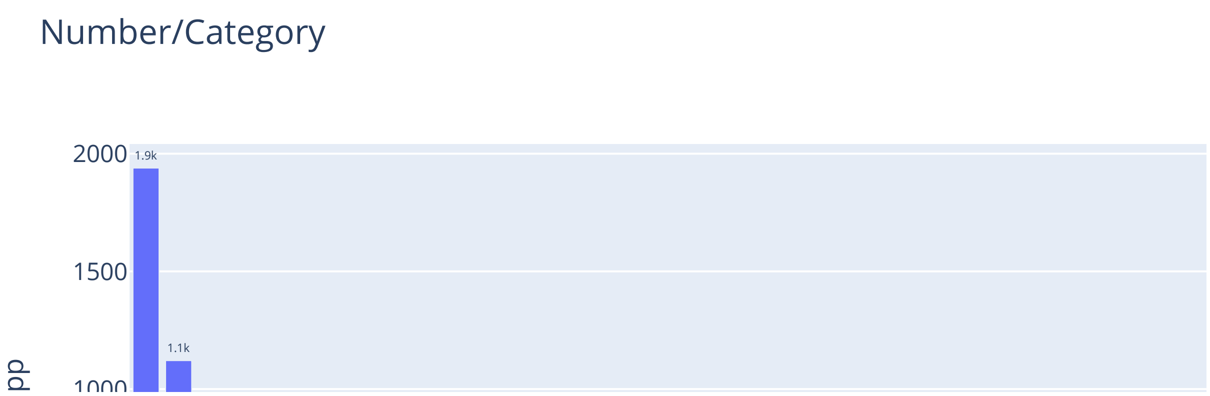
```
print('Average rating of Free apps',round(apps.loc[apps['Type']=='Free','Rating'].mean(),2))
print('Average rating of paid apps',round(apps.loc[apps['Type']=='Paid','Rating'].mean(),2))
px.box(apps, x='Type',y='Rating')
```

```
Average rating of Free apps 4.18
Average rating of paid apps 4.25
```



HIGHEST AND LOWEST NUMBER OF APPS PER CATEGORY

```
no_of_apps = apps.groupby('Category',as_index=False)['App'].count().sort_values('App',ascending=False)

diag = px.bar(no_of_apps,x='Category',y='App',title='Number/Category',text_auto='.2s')

diag.update_traces(textfont_size=12,textangle=0,textposition='outside',cliponaxis=False)
```



MERGE APPS DATA WITH THE REVIEW DATA FOR FURTHER ANALYSIS

Upload the review data set

We will merge the google data set with its corresponding google reviews data set. Attempt to clean and perform some general exploratory data analysis on it. But first, let us load the reviews data set.

```
uploaded = files.upload()
```

Choose Files gplyuser_reviews.csv

- **gplyuser_reviews.csv**(text/csv) - 7669276 bytes, last modified: 10/25/2022 - 100% done

```
Saving gplyuser_reviews.csv to gplyuser_reviews.csv
```

```
#read the data set into the notebook
reviews = pd.read_csv('gplyuser_reviews.csv')
reviews.head()
```

	App	Translated_Review	Sentiment	Sentiment_Polarity	Sentiment_Subjectivity
0	10 Best Foods for You	I like eat delicious food. That's I'm cooking ...	Positive	1.00	0.533333
1	10 Best Foods for You	This help eating healthy exercise regular basis	Positive	0.25	0.288462
2	10 Best Foods for You	NaN	NaN	NaN	NaN
3	10 Best Foods for You	Works great especially going grocery store	Positive	0.40	0.875000
4	10 Best Foods for You	Best idea us	Positive	1.00	0.300000

```
reviews.shape
```

```
(64295, 5)
```

```
#merge the apps and reviews dataset into one
apps_reviews = apps.merge(reviews)
apps_reviews.head()
```

App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver	Translated

```
#check for duplicates
apps_reviews.duplicated().sum()
```

```
    58558
```

moana Play 01-15 and up

```
#drop the duplicates
apps_reviews = apps_reviews.drop_duplicates()
```

moana Play

```
#check for missing values
apps_reviews.isnull().sum()
```

```
    App                           0
    Category                      0
    Rating                        0
    Reviews                       0
    Size                          0
    Installs                      0
    Type                          0
    Price                         0
    Content Rating                0
    Genres                        0
    Last Updated                  0
    Current Ver                   0
    Android Ver                   0
    Translated_Review          1247
    Sentiment                  1239
    Sentiment_Polarity         1239
    Sentiment_Subjectivity     1239
    dtype: int64
```

In the corresponding codes We will check data counts, missing values and fil up NANs using appropriate methods: Mean for numeric data, backfill, forwardfill and interpolation fill to fill up missing values.

```
apps_reviews['Translated_Review'].value_counts()
```

```
     Good
     156
     Nice
     118
     Great
     104
     Love
     95
     Awesome
     67

     ...
     This game could alot better. The damage guns atrocious, basically impossible kill someone. Please buff guns, ill give game 5 star
     rating.
     1
     The explosion radius missile launcher needs reduced, since literally shots. People without battle passes need rewards, like dances
     emotes. Longer game mode would fun too.
     1
     This really cool game kinda like fortnite/Pub I think everyone chance level get money time I started I realised can't get battle pass I
     want wait long, others hand really cool game! Keep
     1
     This game perfect small, fun battleroyale game play store. However though game amazing definitely lacks key features. Some key features
     I'm talking balance weapon damage. The damage overall good lacks balancement. Another key feature I found report button. This I'm seeing
     key players end game kills. Other 2 things I mentioned, I'm sold game. There pretty expensive purchases get coin able spend battlepass
     necessary part game. Hope devs see helps persuade users play      1
     It's good best gallery phone
     1
     Name: Translated_Review, Length: 26682, dtype: int64
```

```
##Sentiment value count
apps_reviews['Sentiment'].value_counts()
```

```
     Positive    25693
     Negative     9659
     Neutral      5070
     Name: Sentiment, dtype: int64
```

```
##Sentimental Polarity counts
apps_reviews['Sentiment_Polarity'].value_counts()
```

```
      0.000000    5070
      0.500000    1595
      1.000000     919
      0.700000     893
      0.300000     615
                  ...
     -0.242500       1
     -0.314286       1
     -0.151302       1
      0.133102       1
      0.509821       1
     Name: Sentiment_Polarity, Length: 5295, dtype: int64
```

```
##Sentiment subjectivity counts
apps_reviews['Sentiment_Subjectivity'].value_counts()
```

```
     0.000000    4276
     0.500000    1773
     1.000000    1700
     0.600000    1230
     0.750000    1142
                 ...
     0.581746       1
     0.605952       1
     0.290476       1
     0.444242       1
     0.545714       1
     Name: Sentiment_Subjectivity, Length: 4382, dtype: int64
```

```
#fill missing values in the Translated_Review with the mode
apps_reviews['Translated_Review'] = apps_reviews['Translated_Review'].fillna(apps_reviews['Translated_Review'].mode())
```

```
#fill missing values in Sentiment column with mode
apps_reviews['Sentiment'] = apps_reviews['Sentiment'].fillna(apps_reviews['Sentiment'].mode())
```

```
#fill missing values in the Sentiment_Polarity column with mean
apps_reviews['Sentiment_Polarity'] = apps_reviews['Sentiment_Polarity'].fillna(apps_reviews['Sentiment_Polarity'].mean())
```

```
#fill missing values in the Sentiment_Subjectivity column with mean
apps_reviews['Sentiment_Subjectivity'] = apps_reviews['Sentiment_Subjectivity'].fillna(apps_reviews['Sentiment_Subjectivity'].mean())
```

```
apps_reviews.isnull().sum()
```

```
     App                          0
     Category                     0
     Rating                       0
     Reviews                      0
     Size                         0
     Installs                     0
     Type                         0
     Price                        0
     Content Rating               0
     Genres                       0
     Last Updated                 0
     Current Ver                  0
     Android Ver                  0
     Translated_Review         1247
     Sentiment                 1239
     Sentiment_Polarity           0
     Sentiment_Subjectivity       0
     dtype: int64
```

```
# replace all NA's with interpolation with nearest
apps_reviews = apps_reviews.fillna(method= 'bfill', axis = 1)
apps_reviews.isna().sum()
```

```
     App                       0
     Category                  0
     Rating                    0
     Reviews                   0
     Size                      0
     Installs                  0
     Type                      0
     Price                     0
     Content Rating            0
     Genres                    0
     Last Updated              0
     Current Ver               0
```

```
Android Ver               0
Translated_Review         0
Sentiment                 0
Sentiment_Polarity        0
Sentiment_Subjectivity    0
dtype: int64
```

EDA OF MERGED DATA SET USING SUITABLE METRICES

```
apps_reviews.head()
```

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver	Translated
0	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0.0	Everyone	Art & Design;Pretend Play	2018-01-15	2.0.0	4.0.3 and up	A kid's e ads. The t all
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0.0	Everyone	Art & Design;Pretend Play	2018-01-15	2.0.0	4.0.3 and up	
2	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0.0	Everyone	Art & Design;Pretend Play	2018-01-15	2.0.0	4.0.3 and up	
3	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0.0	Everyone	Art & Design;Pretend Play	2018-01-15	2.0.0	4.0.3 and up	(
4	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500000	Free	0.0	Everyone	Art & Design;Pretend Play	2018-01-15	2.0.0	4.0.3 and up	I lo in

```
apps_reviews.info()
```

```
    <class 'pandas.core.frame.DataFrame'>
    Int64Index: 41661 entries, 0 to 100218
    Data columns (total 17 columns):
     #   Column                  Non-Null Count  Dtype
    ---  ------                  --------------  -----
     0   App                     41661 non-null  object
     1   Category                41661 non-null  object
     2   Rating                  41661 non-null  object
     3   Reviews                 41661 non-null  object
     4   Size                    41661 non-null  object
     5   Installs                41661 non-null  object
     6   Type                    41661 non-null  object
     7   Price                   41661 non-null  object
     8   Content Rating          41661 non-null  object
     9   Genres                  41661 non-null  object
     10  Last Updated            41661 non-null  datetime64[ns]
     11  Current Ver             41661 non-null  object
     12  Android Ver             41661 non-null  object
     13  Translated_Review       41661 non-null  object
     14  Sentiment               41661 non-null  object
     15  Sentiment_Polarity      41661 non-null  object
     16  Sentiment_Subjectivity  41661 non-null  object
    dtypes: datetime64[ns](1), object(16)
    memory usage: 5.7+ MB
```

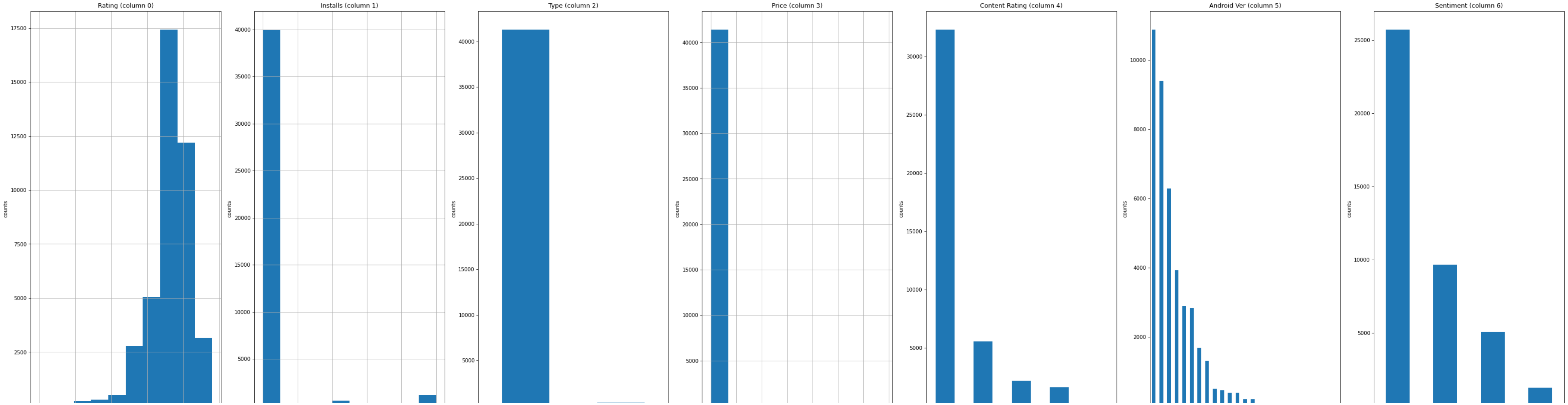
```
apps_reviews.columns
```

```
    Index(['App', 'Category', 'Rating', 'Reviews', 'Size', 'Installs', 'Type',
           'Price', 'Content Rating', 'Genres', 'Last Updated', 'Current Ver',
           'Android Ver', 'Translated_Review', 'Sentiment', 'Sentiment_Polarity',
           'Sentiment_Subjectivity'],
          dtype='object')
```

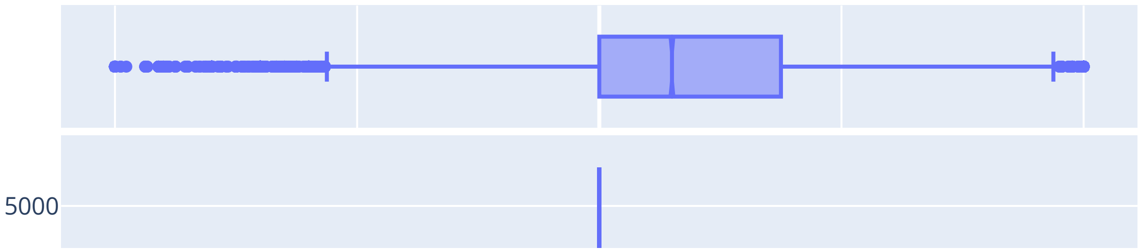
```
#check for duplicates
apps_reviews.duplicated().sum()
```

```
    0
```

```
# Distribution plots of graphs (histogram/bar graph) of column data of the mergerd data
## Call the column distribution plots for the merged data
plotPerColumnDistribution(apps_reviews, 10, 10)
plotPerColumnDistribution(apps_reviews, 10, 10)
```

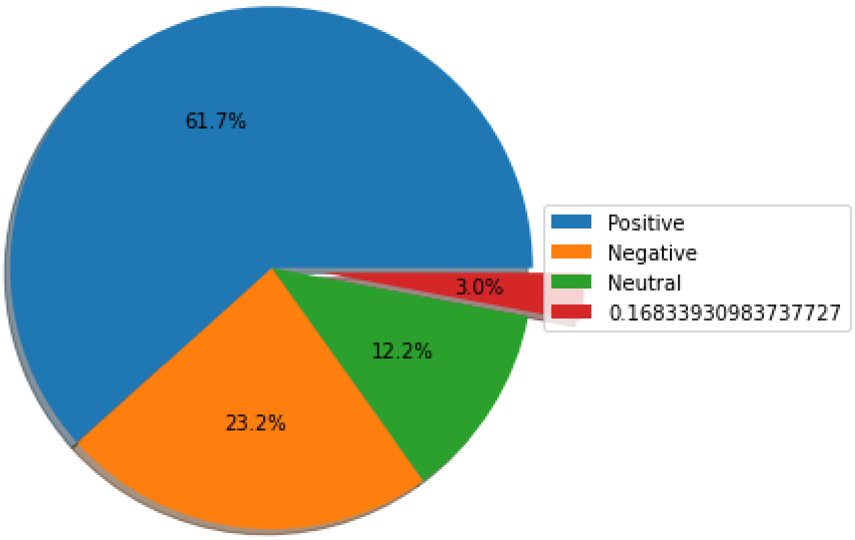


```
##HISTOGRAM /BOX PLOT OF SENTIMENT POLARITY
px.histogram(apps_reviews, x='Sentiment_Polarity', marginal='box')
```



```
##BOX PLOT OF SENTIMENT

fig, ax = plt.subplots(figsize=(6, 6), subplot_kw=dict(aspect="equal"))
number_of_sentiment = apps_reviews["Sentiment"].value_counts()
labels = number_of_sentiment.index
sizes = number_of_sentiment.values
ax.pie(sizes,labeldistance=2,autopct='%1.1f%%', explode = [0,0,0,0.2], shadow=True)
ax.legend(labels=labels,loc="right",bbox_to_anchor=(0.9, 0, 0.5, 1))
```

```
     <matplotlib.legend.Legend at 0x7fe744717050>
```



CONCLUSION

In this project, we analyzed data about the Google Play mobile apps with the goal of exploring and performing sentimental analysis over the app profile that can be profitable for both markets and users.

Before making conclusions, further considerations of other data sources should be made, prior to making a final decision. We will want to consider the life-cycle for the apps. We should also look at how frequently people use the apps in any interesting category. We might find for example that a multi-player game with an active community and developing storyline may have a better ROI.

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