App Rating Prediction

July 7, 2023

[1]:
```
#importing the neccessary libraries from sklearn to split the data and and for
↪model building
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

[2]:
```
data = pd.read_csv('googleplaystore.csv')
```

[3]:
```
data.head()
```

[3]:

	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	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	

```
3    4.2 and up
4    4.4 and up
```

[4]:
```
data.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
```

[5]:
```
data.isnull().any()
```

[5]:
```
App               False
Category          False
Rating             True
Reviews           False
Size              False
Installs          False
Type               True
Price             False
Content Rating     True
Genres            False
Last Updated      False
Current Ver        True
Android Ver        True
dtype: bool
```

[6]:
```
data.isnull().sum()
```

[6]:
```
App                0
Category           0
```

```
Rating            1474
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
```

[7]:
```
data = data.dropna()
```

[8]:
```
data.isnull().any()
```

[8]:
```
App               False
Category          False
Rating            False
Reviews           False
Size              False
Installs          False
Type              False
Price             False
Content Rating    False
Genres            False
Last Updated      False
Current Ver       False
Android Ver       False
dtype: bool
```

[9]:
```
data.shape
```

[9]:
```
(9360, 13)
```

[10]:
```
data["Size"] = [ float(i.split('M')[0]) if 'M' in i else float(0) for i in␣
↪data["Size"]  ]
```

[11]:
```
data.head()
```

[11]:
```
                                                 App        Category  Rating  \
0     Photo Editor & Candy Camera & Grid & ScrapBook  ART_AND_DESIGN     4.1
1                                 Coloring book moana  ART_AND_DESIGN     3.9
2  U Launcher Lite - FREE Live Cool Themes, Hide …  ART_AND_DESIGN     4.7
3                               Sketch - Draw & Paint  ART_AND_DESIGN     4.5
4              Pixel Draw - Number Art Coloring Book  ART_AND_DESIGN     4.3
```

```
  Reviews  Size     Installs  Type Price Content Rating  \
0     159  19.0      10,000+  Free     0       Everyone
1     967  14.0     500,000+  Free     0       Everyone
2   87510   8.7   5,000,000+  Free     0       Everyone
3  215644  25.0  50,000,000+  Free     0           Teen
4     967   2.8     100,000+  Free     0       Everyone

                      Genres      Last Updated         Current Ver  \
0               Art & Design   January 7, 2018               1.0.0
1  Art & Design;Pretend Play  January 15, 2018               2.0.0
2               Art & Design    August 1, 2018               1.2.4
3               Art & Design      June 8, 2018  Varies with device
4    Art & Design;Creativity     June 20, 2018                 1.1

    Android Ver
0  4.0.3 and up
1  4.0.3 and up
2  4.0.3 and up
3    4.2 and up
4    4.4 and up
```

[12]:
```
data["Size"] = 1000 * data["Size"]
```

[13]:
```
data
```

[13]:
```
                                                 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
…                                                    …                  …
10834                                   FR Calculator              FAMILY
10836                                Sya9a Maroc - FR              FAMILY
10837                  Fr. Mike Schmitz Audio Teachings              FAMILY
10839                     The SCP Foundation DB fr nn5n  BOOKS_AND_REFERENCE
10840      iHoroscope - 2018 Daily Horoscope & Astrology           LIFESTYLE

       Rating Reviews     Size     Installs  Type Price Content Rating  \
0         4.1     159  19000.0      10,000+  Free     0       Everyone
1         3.9     967  14000.0     500,000+  Free     0       Everyone
2         4.7   87510   8700.0   5,000,000+  Free     0       Everyone
3         4.5  215644  25000.0  50,000,000+  Free     0           Teen
4         4.3     967   2800.0     100,000+  Free     0       Everyone
…       …     …       …          …    …   …            …
10834     4.0       7   2600.0         500+  Free     0       Everyone
```

```
10836     4.5      38  53000.0       5,000+  Free     0       Everyone
10837     5.0       4   3600.0         100+  Free     0       Everyone
10839     4.5     114      0.0       1,000+  Free     0     Mature 17+
10840     4.5  398307  19000.0  10,000,000+  Free     0       Everyone

                         Genres      Last Updated         Current Ver  \
0                  Art & Design   January 7, 2018               1.0.0
1      Art & Design;Pretend Play  January 15, 2018               2.0.0
2                  Art & Design    August 1, 2018               1.2.4
3                  Art & Design      June 8, 2018  Varies with device
4        Art & Design;Creativity     June 20, 2018                 1.1
…                            …               …                   …
10834                Education     June 18, 2017               1.0.0
10836                Education     July 25, 2017                1.48
10837                Education      July 6, 2018                 1.0
10839          Books & Reference  January 19, 2015  Varies with device
10840                Lifestyle     July 25, 2018  Varies with device

              Android Ver
0            4.0.3 and up
1            4.0.3 and up
2            4.0.3 and up
3              4.2 and up
4              4.4 and up
…                    …
10834          4.1 and up
10836          4.1 and up
10837          4.1 and up
10839  Varies with device
10840  Varies with device

[9360 rows x 13 columns]
```

[14]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
 1   Category        9360 non-null   object
 2   Rating          9360 non-null   float64
 3   Reviews         9360 non-null   object
 4   Size            9360 non-null   float64
 5   Installs        9360 non-null   object
 6   Type            9360 non-null   object
```

```
 7   Price           9360 non-null   object
 8   Content Rating  9360 non-null   object
 9   Genres          9360 non-null   object
 10  Last Updated    9360 non-null   object
 11  Current Ver     9360 non-null   object
 12  Android Ver     9360 non-null   object
dtypes: float64(2), object(11)
memory usage: 1023.8+ KB
```

[15]:
```
data["Reviews"] = data["Reviews"].astype(float)
```

[16]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
 1   Category        9360 non-null   object
 2   Rating          9360 non-null   float64
 3   Reviews         9360 non-null   float64
 4   Size            9360 non-null   float64
 5   Installs        9360 non-null   object
 6   Type            9360 non-null   object
 7   Price           9360 non-null   object
 8   Content Rating  9360 non-null   object
 9   Genres          9360 non-null   object
 10  Last Updated    9360 non-null   object
 11  Current Ver     9360 non-null   object
 12  Android Ver     9360 non-null   object
dtypes: float64(3), object(10)
memory usage: 1023.8+ KB
```

[17]:
```
data["Installs"] = [ float(i.replace('+','').replace(',', '')) if '+' in i or␣
 ↪',' in i else float(0) for i in data["Installs"] ]
```

[18]:
```
data.head()
```

[18]:

	App	Category	Rating	\
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	
1	Coloring book moana	ART_AND_DESIGN	3.9	
2	U Launcher Lite – FREE Live Cool Themes, Hide …	ART_AND_DESIGN	4.7	
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	

	Reviews	Size	Installs	Type	Price	Content Rating	\

```
0     159.0  19000.0     10000.0  Free     0       Everyone
1     967.0  14000.0    500000.0  Free     0       Everyone
2   87510.0   8700.0   5000000.0  Free     0       Everyone
3  215644.0  25000.0  50000000.0  Free     0           Teen
4     967.0   2800.0    100000.0  Free     0       Everyone

                      Genres      Last Updated         Current Ver  \
0               Art & Design   January 7, 2018               1.0.0
1  Art & Design;Pretend Play  January 15, 2018               2.0.0
2               Art & Design    August 1, 2018               1.2.4
3               Art & Design      June 8, 2018  Varies with device
4    Art & Design;Creativity     June 20, 2018                 1.1

    Android Ver
0  4.0.3 and up
1  4.0.3 and up
2  4.0.3 and up
3    4.2 and up
4    4.4 and up
```

[19]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
 1   Category        9360 non-null   object
 2   Rating          9360 non-null   float64
 3   Reviews         9360 non-null   float64
 4   Size            9360 non-null   float64
 5   Installs        9360 non-null   float64
 6   Type            9360 non-null   object
 7   Price           9360 non-null   object
 8   Content Rating  9360 non-null   object
 9   Genres          9360 non-null   object
 10  Last Updated    9360 non-null   object
 11  Current Ver     9360 non-null   object
 12  Android Ver     9360 non-null   object
dtypes: float64(4), object(9)
memory usage: 1023.8+ KB
```

[20]:
```
data["Installs"] = data["Installs"].astype(int)
```

[21]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
 1   Category        9360 non-null   object
 2   Rating          9360 non-null   float64
 3   Reviews         9360 non-null   float64
 4   Size            9360 non-null   float64
 5   Installs        9360 non-null   int64
 6   Type            9360 non-null   object
 7   Price           9360 non-null   object
 8   Content Rating  9360 non-null   object
 9   Genres          9360 non-null   object
 10  Last Updated    9360 non-null   object
 11  Current Ver     9360 non-null   object
 12  Android Ver     9360 non-null   object
dtypes: float64(3), int64(1), object(9)
memory usage: 1023.8+ KB
```

[22]:
```
data['Price'] = [ float(i.split('$')[1]) if '$' in i else float(0) for i in␣
↪data['Price'] ]
```

[23]:
```
data.head()
```

[23]:

	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	159.0	19000.0	10000	Free	0.0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967.0	14000.0	500000	Free	0.0	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	87510.0	8700.0	5000000	Free	0.0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644.0	25000.0	50000000	Free	0.0	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	967.0	2800.0	100000	Free	0.0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up

```
    Android Ver
0  4.0.3 and up
1  4.0.3 and up
2  4.0.3 and up
3    4.2 and up
4    4.4 and up
```

[24]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
 1   Category        9360 non-null   object
 2   Rating          9360 non-null   float64
 3   Reviews         9360 non-null   float64
 4   Size            9360 non-null   float64
 5   Installs        9360 non-null   int64
 6   Type            9360 non-null   object
 7   Price           9360 non-null   float64
 8   Content Rating  9360 non-null   object
 9   Genres          9360 non-null   object
 10  Last Updated    9360 non-null   object
 11  Current Ver     9360 non-null   object
 12  Android Ver     9360 non-null   object
dtypes: float64(4), int64(1), object(8)
memory usage: 1023.8+ KB
```

[25]:
```
data["Price"] = data["Price"].astype(int)
```

[26]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
 1   Category        9360 non-null   object
 2   Rating          9360 non-null   float64
 3   Reviews         9360 non-null   float64
 4   Size            9360 non-null   float64
 5   Installs        9360 non-null   int64
 6   Type            9360 non-null   object
 7   Price           9360 non-null   int64
```

```
 8   Content Rating  9360 non-null   object
 9   Genres          9360 non-null   object
 10  Last Updated    9360 non-null   object
 11  Current Ver     9360 non-null   object
 12  Android Ver     9360 non-null   object
dtypes: float64(3), int64(2), object(8)
memory usage: 1023.8+ KB
```

[27]:
```
data.shape
```

[27]:
```
(9360, 13)
```

[28]:
```
#Sanity checks:
data.drop(data[(data['Reviews'] < 1) & (data['Reviews'] > 5 )].index, inplace =␣
↪True)
```

[29]:
```
data.shape
```

[29]:
```
(9360, 13)
```

[30]:
```
#Sanity checks:
data.drop(data[data['Installs'] < data['Reviews'] ].index, inplace = True)
```

[31]:
```
data.shape
```

[31]:
```
(9353, 13)
```

[32]:
```
#Sanity checks:
data.drop(data[(data['Type'] =='Free') & (data['Price'] > 0 )].index, inplace =␣
↪True)
```

[33]:
```
data.shape
```

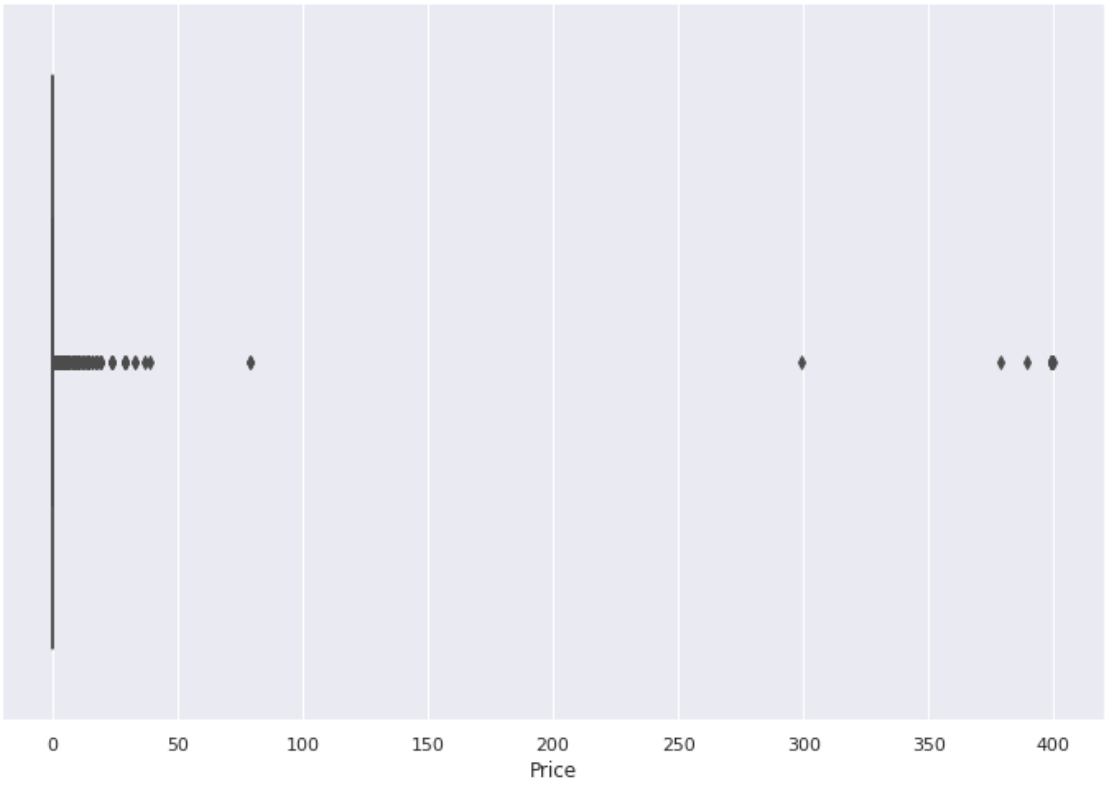
[33]:
```
(9353, 13)
```

[34]:
```
sns.set(rc={'figure.figsize':(12,8)})
```

[35]:
```
sns.boxplot(data['Price'])
```

```
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

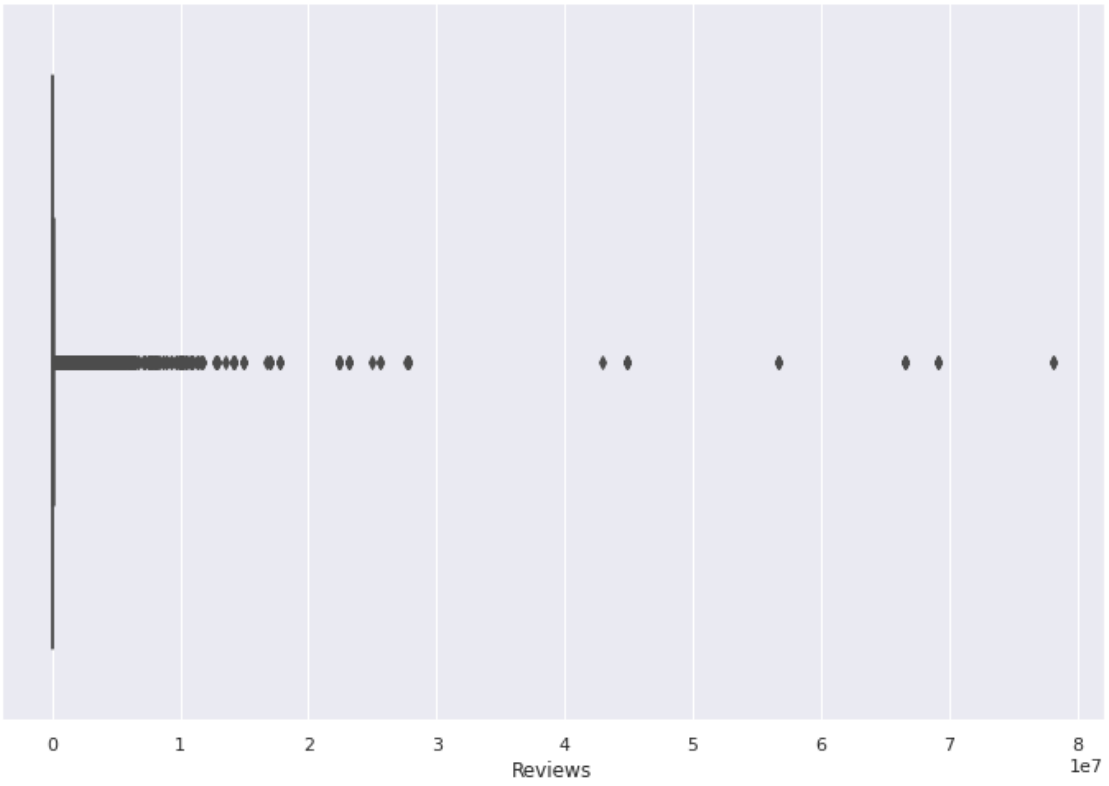
[35]:
```
<AxesSubplot:xlabel='Price'>
```



[36]:
```
sns.boxplot(data['Reviews'])
```

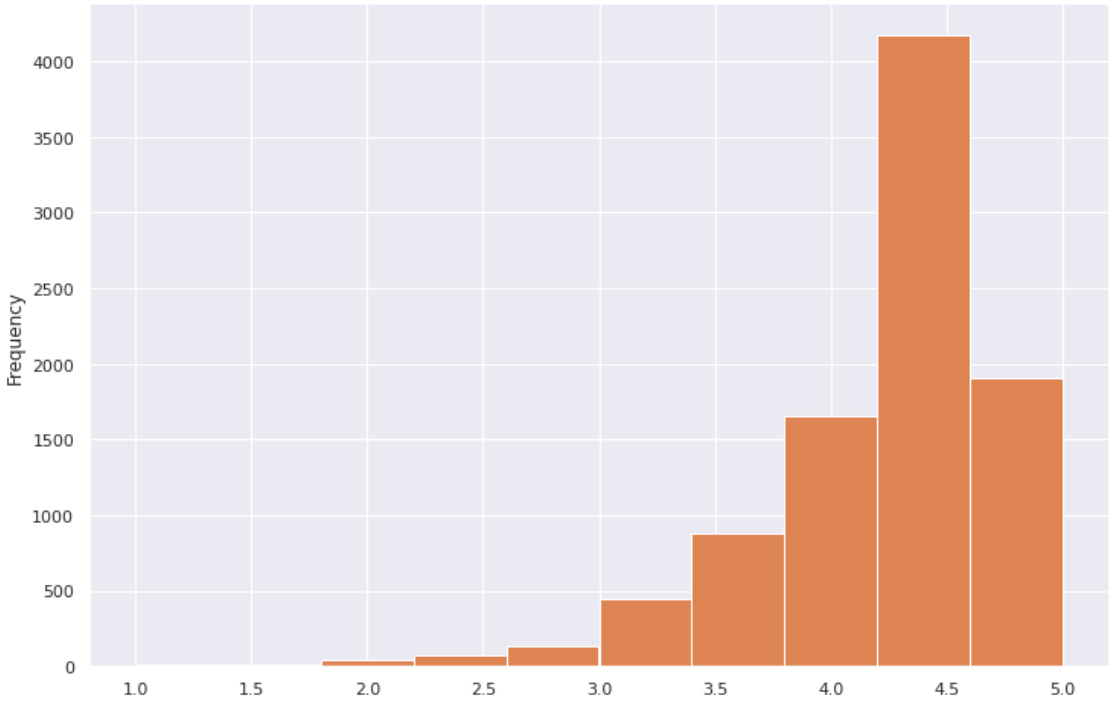
```
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

[36]:
```
<AxesSubplot:xlabel='Reviews'>
```



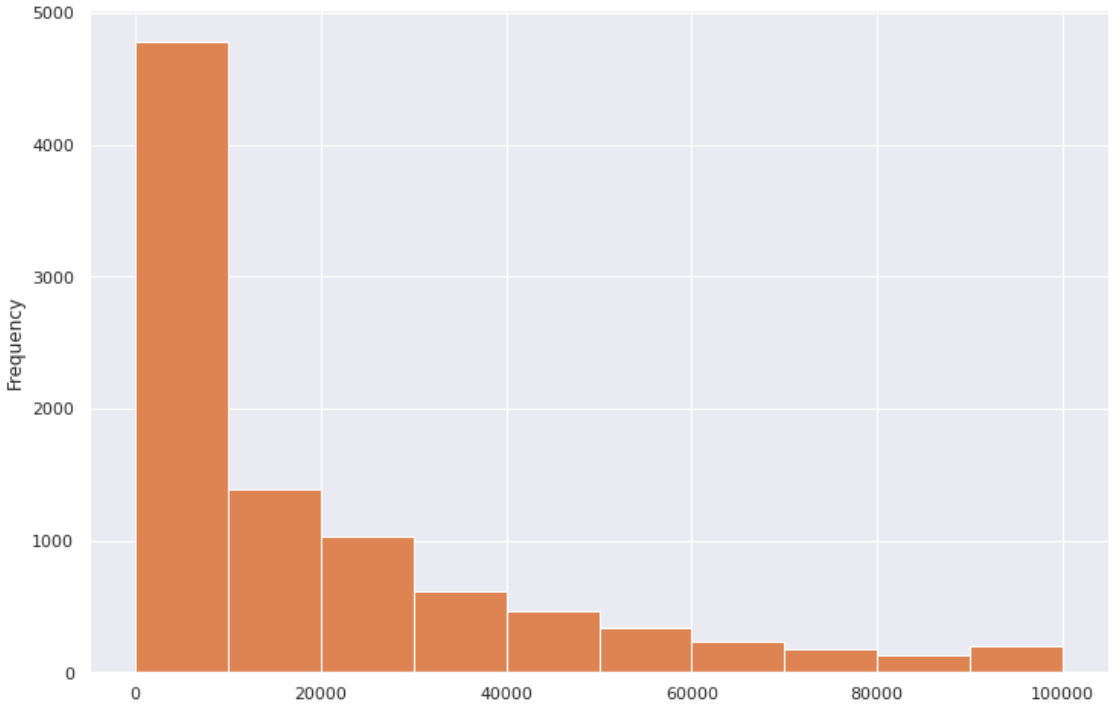
[37]:
```
# Histogram for Rating
data['Rating'].plot(kind= 'hist'); #we can use either to get the results
plt.hist(data['Rating'])
```

[37]:
```
(array([  17.,   18.,   41.,   74.,  137.,  445.,  879., 1660., 4172.,
        1910.]),
 array([1. , 1.4, 1.8, 2.2, 2.6, 3. , 3.4, 3.8, 4.2, 4.6, 5. ]),
 <BarContainer object of 10 artists>)
```



[38]:
```
# Histogram for Size
data['Size'].plot(kind= 'hist') #we can use either to get the results
plt.hist(data['Size'])
```

[38]:
```
(array([4779., 1386., 1036.,  617.,  464.,  334.,  234.,  174.,  125.,
         204.]),
 array([     0.,  10000.,  20000.,  30000.,  40000.,  50000.,  60000.,
         70000.,  80000.,  90000., 100000.]),
 <BarContainer object of 10 artists>)
```



[39]:
```
# price of $200 and above for an application is expected to be very high
price = data.apply(lambda x : True
            if x['Price'] > 200 else False, axis = 1)
```

[40]:
```
price_count = len(price[price == True].index)
```

[41]:
```
data.shape
```

[41]: (9353, 13)

[42]:
```
data.drop(data[data['Price'] > 200].index, inplace = True)
```

[43]:
```
data.shape
```

[43]: (9338, 13)

[44]:
```
#Dropping records having more than 2 million reviews
data.drop(data[data['Reviews'] > 2000000].index, inplace = True)
```

[45]:
```
data.shape
```

[45]: (8885, 13)

[46]:
```
data.quantile([.1, .25, .5, .70, .90, .95, .99], axis = 0)
```

[46]:

	Rating	Reviews	Size	Installs	Price
0.10	3.5	18.00	0.0	1000.0	0.0
0.25	4.0	159.00	2600.0	10000.0	0.0
0.50	4.3	4290.00	9500.0	500000.0	0.0
0.70	4.5	35930.40	23000.0	1000000.0	0.0
0.90	4.7	296771.00	50000.0	10000000.0	0.0
0.95	4.8	637298.00	68000.0	10000000.0	1.0
0.99	5.0	1462800.88	95000.0	100000000.0	7.0

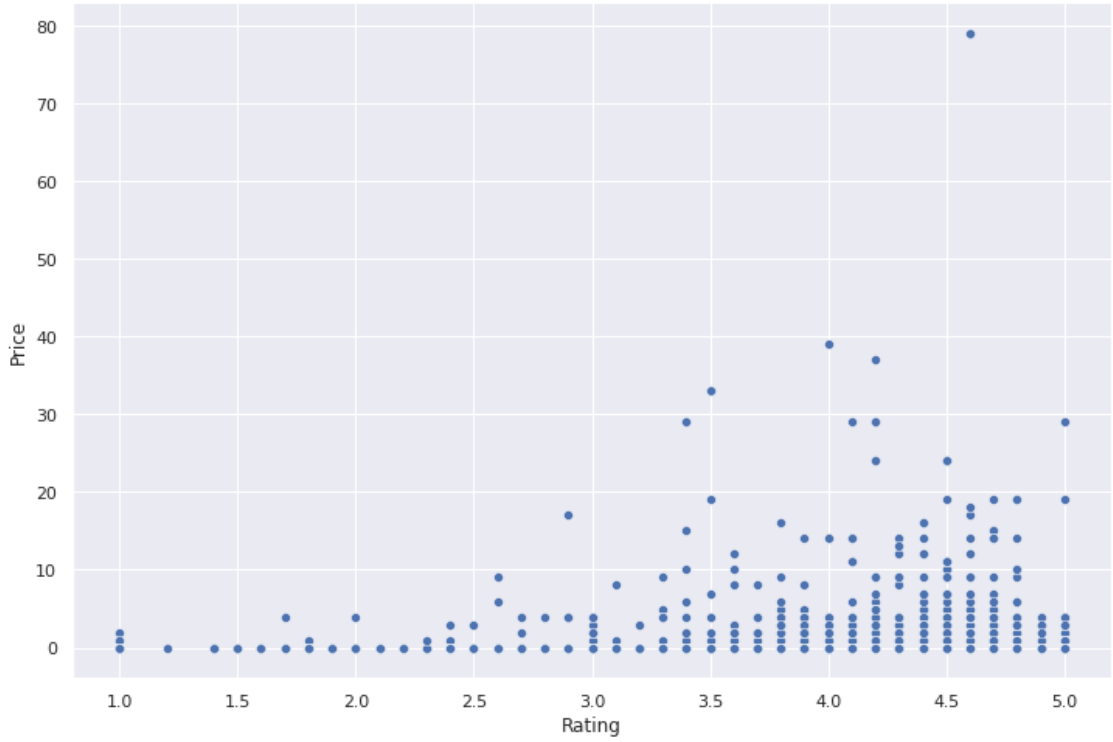
[47]:
```
# Dropping more than 10000000 Installs value
data.drop(data[data['Installs'] > 10000000].index, inplace = True)
```

[48]:
```
data.shape
```

[48]: (8496, 13)

[49]:
```
# Scatter plot/jointplot for Rating Vs. Price
sns.scatterplot(x='Rating',y='Price',data=data)
```

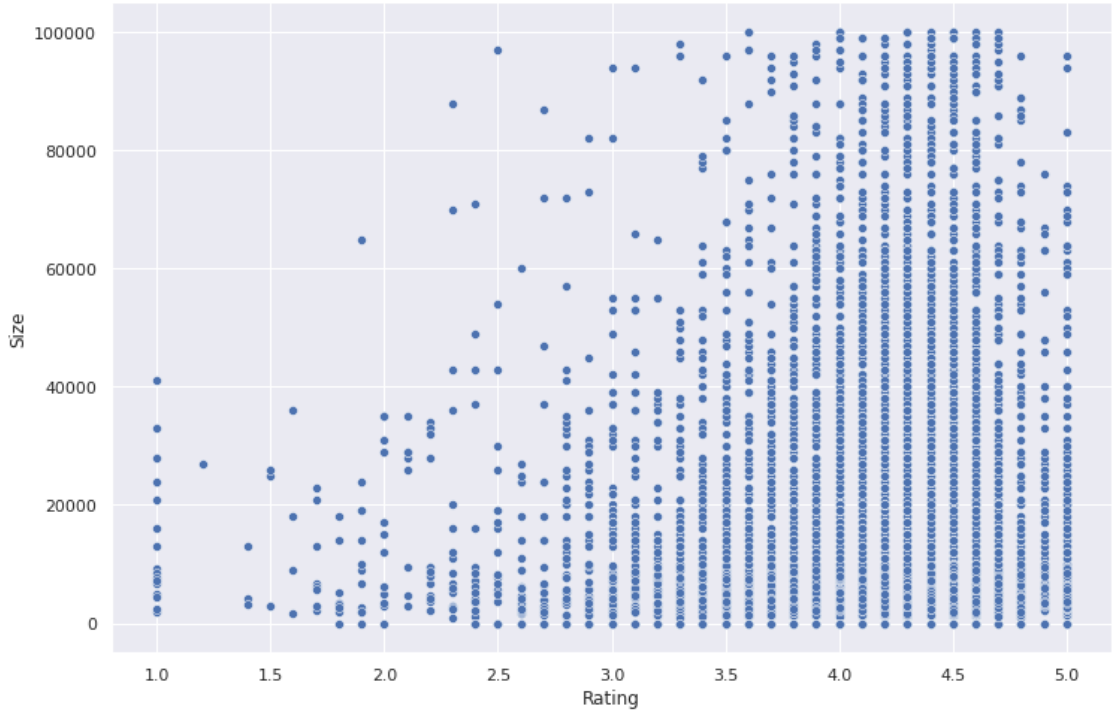
[49]: <AxesSubplot:xlabel='Rating', ylabel='Price'>



[50]:
```
# Yes, rating increase with price!
```

[51]:
```
# Scatter plot/jointplot for Rating Vs. Size
sns.scatterplot(x='Rating',y='Size',data=data)
```

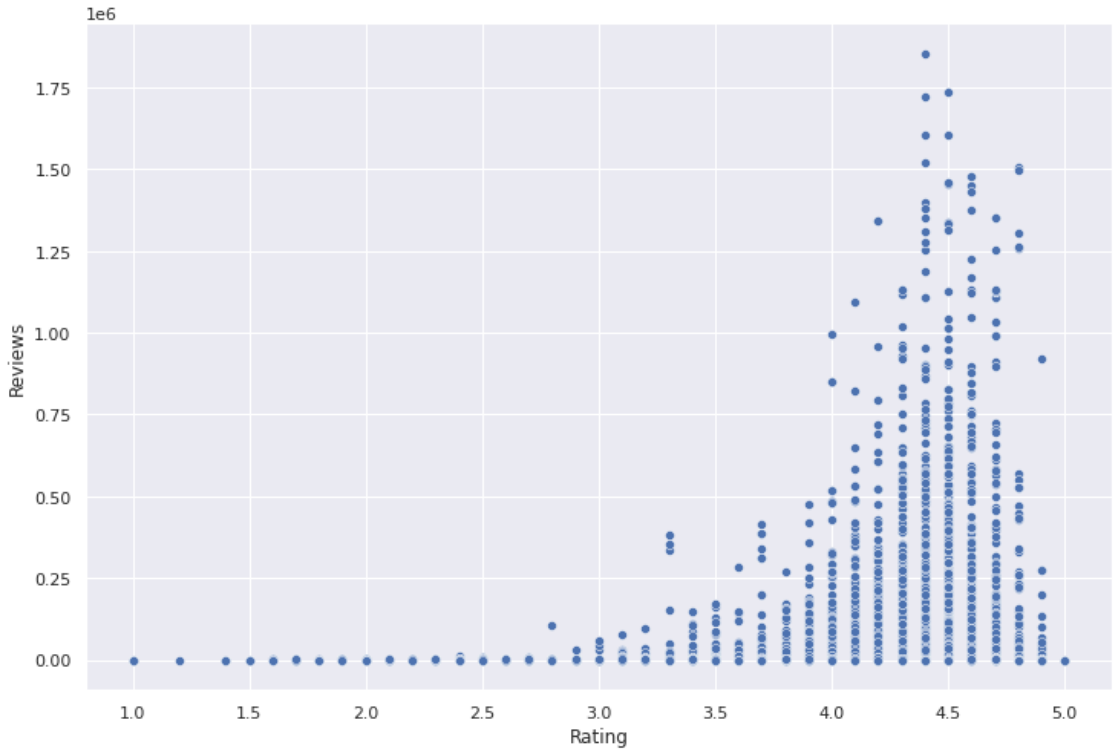
[51]: <AxesSubplot:xlabel='Rating', ylabel='Size'>



[52]:
```
# Yes, heavier apps rated better!
```

[53]:
```
# Scatter plot/jointplot for Rating Vs. Reviews
sns.scatterplot(x='Rating',y='Reviews',data=data)
```

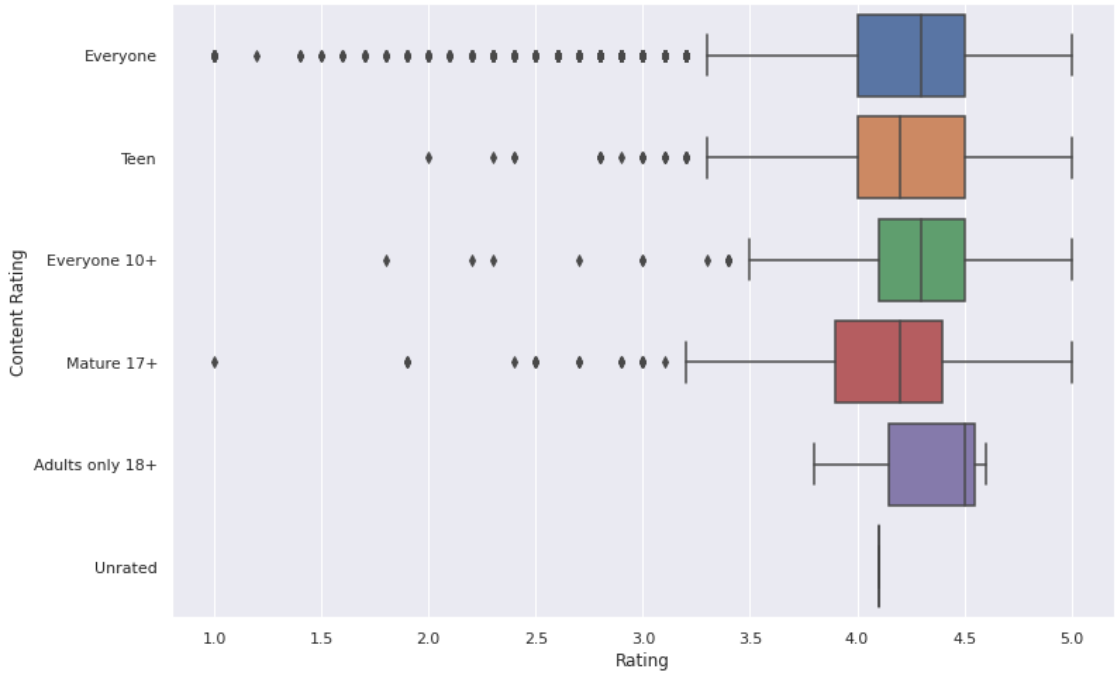
[53]: <AxesSubplot:xlabel='Rating', ylabel='Reviews'>



[54]:
```
# We can clearly see that more review mean a better rating!
```

[55]:
```
# Scatterplot for Ratings Vs. Reviews
sns.boxplot(x="Rating", y="Content Rating", data=data)
```

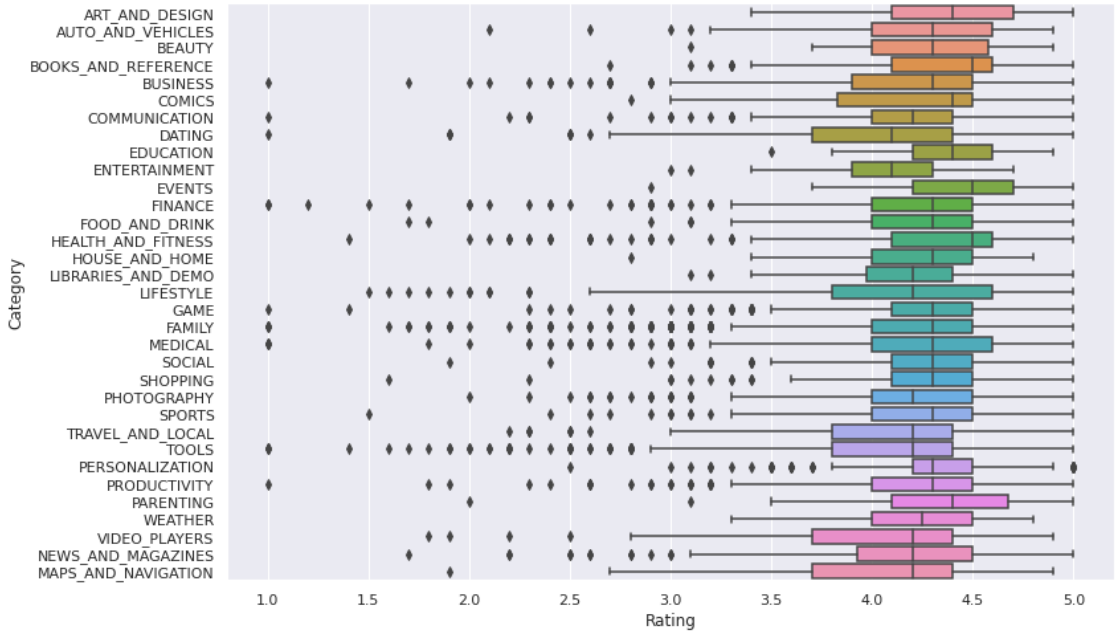
[55]:
```
<AxesSubplot:xlabel='Rating', ylabel='Content Rating'>
```



[56]:
```
# The above plot shows the apps for Everyone is worst rated as it contain the␣
↪highest number of outliers followed by apps for Mature 17+ and Everyone 10+␣
↪along with Teen.
# The catergory Adults only 18+ is rated better and falls under most liked type.
```

[57]:
```
# Boxplot for Ratings Vs. Category
sns.boxplot(x= 'Rating', y = 'Category', data= data)
```

[57]:
```
<AxesSubplot:xlabel='Rating', ylabel='Category'>
```



[58]:
```
# From the above plot the Category Events has the best Ratings out of all other app genres.
```

[59]:
```
# Model Development
#creating a copy of the data(df) to make all edits
inp1= data.copy()
```

[60]:
```
inp1.head()
```

[60]:

	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	159.0	19000.0	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	967.0	14000.0	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	87510.0	8700.0	5000000	Free	0	Everyone				
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967.0	2800.0	100000	Free	0	Everyone				
5	Paper flowers instructions	ART_AND_DESIGN	4.4	167.0	5600.0	50000	Free	0	Everyone				

```
2              Art & Design    August 1, 2018       1.2.4  4.0.3 and up
4    Art & Design;Creativity     June 20, 2018         1.1    4.4 and up
5              Art & Design    March 26, 2017         1.0    2.3 and up
```

[61]:
```
inp1.skew()
```

[61]:
```
Rating      -1.749753
Reviews      4.576494
Size         1.655917
Installs     1.543697
Price       18.074542
dtype: float64
```

[62]:
```
#1) apply log transformation to Reviews
reviews_skew = np.log1p(inp1['Reviews'])
inp1['Reviews']= reviews_skew
```

[63]:
```
reviews_skew.skew()
```

[63]:
```
-0.20039949659264134
```

[64]:
```
#1) apply log transformation to Installs
Installs_skew = np.log1p(inp1['Installs'])
inp1['Installs']
```

[64]:
```
0           10000
1          500000
2         5000000
4          100000
5           50000
           ...
10834         500
10836        5000
10837         100
10839        1000
10840    10000000
Name: Installs, Length: 8496, dtype: int64
```

[65]:
```
Installs_skew.skew()
```

[65]:
```
-0.5097286542754812
```

[66]:
```
inp1.head()
```

[66]:
```
                                                App        Category  Rating  \
0     Photo Editor & Candy Camera & Grid & ScrapBook  ART_AND_DESIGN     4.1
1                                Coloring book moana  ART_AND_DESIGN     3.9
```

```
2  U Launcher Lite - FREE Live Cool Themes, Hide …  ART_AND_DESIGN     4.7
4              Pixel Draw - Number Art Coloring Book  ART_AND_DESIGN     4.3
5                         Paper flowers instructions  ART_AND_DESIGN     4.4

     Reviews     Size  Installs  Type  Price Content Rating  \
0   5.075174  19000.0     10000  Free      0       Everyone
1   6.875232  14000.0    500000  Free      0       Everyone
2  11.379520   8700.0   5000000  Free      0       Everyone
4   6.875232   2800.0    100000  Free      0       Everyone
5   5.123964   5600.0     50000  Free      0       Everyone

                      Genres      Last Updated Current Ver   Android Ver
0               Art & Design   January 7, 2018       1.0.0  4.0.3 and up
1  Art & Design;Pretend Play  January 15, 2018       2.0.0  4.0.3 and up
2               Art & Design    August 1, 2018       1.2.4  4.0.3 and up
4    Art & Design;Creativity     June 20, 2018         1.1    4.4 and up
5               Art & Design    March 26, 2017         1.0    2.3 and up
```

[67]:
```
#2) Dropping the columns- App, Last Updated, Current Ver, Type, & Andriod Ver␣
↪as these won't be useful for our model
inp1.drop(['App','Last Updated','Current Ver','Android Ver','Type'], axis= 1,␣
↪inplace = True)
```

[68]:
```
inp1.head()
```

[68]:
```
         Category  Rating    Reviews     Size  Installs  Price Content Rating  \
0  ART_AND_DESIGN     4.1   5.075174  19000.0     10000      0       Everyone
1  ART_AND_DESIGN     3.9   6.875232  14000.0    500000      0       Everyone
2  ART_AND_DESIGN     4.7  11.379520   8700.0   5000000      0       Everyone
4  ART_AND_DESIGN     4.3   6.875232   2800.0    100000      0       Everyone
5  ART_AND_DESIGN     4.4   5.123964   5600.0     50000      0       Everyone

                      Genres
0               Art & Design
1  Art & Design;Pretend Play
2               Art & Design
4    Art & Design;Creativity
5               Art & Design
```

[69]:
```
inp1.shape
```

[69]:
```
(8496, 8)
```

[70]:
```
# As Model does not understand any Catergorical variable hence these need to be␣
↪converted to numerical
#Dummy Encoding is one way to convert these columns into numerical
```

[71]:
```
#3) create a copy of dataframe
inp2 = inp1
```

[72]:
```
inp2.head()
```

[72]:
```
          Category  Rating    Reviews     Size  Installs  Price Content Rating  \
0  ART_AND_DESIGN     4.1   5.075174  19000.0     10000      0       Everyone
1  ART_AND_DESIGN     3.9   6.875232  14000.0    500000      0       Everyone
2  ART_AND_DESIGN     4.7  11.379520   8700.0   5000000      0       Everyone
4  ART_AND_DESIGN     4.3   6.875232   2800.0    100000      0       Everyone
5  ART_AND_DESIGN     4.4   5.123964   5600.0     50000      0       Everyone

                      Genres
0               Art & Design
1  Art & Design;Pretend Play
2               Art & Design
4    Art & Design;Creativity
5               Art & Design
```

[73]:
```
#get unique values in column category
inp2['Category'].unique()
```

[73]:
```
array(['ART_AND_DESIGN', 'AUTO_AND_VEHICLES', 'BEAUTY',
       'BOOKS_AND_REFERENCE', 'BUSINESS', 'COMICS', 'COMMUNICATION',
       'DATING', 'EDUCATION', 'ENTERTAINMENT', 'EVENTS', 'FINANCE',
       'FOOD_AND_DRINK', 'HEALTH_AND_FITNESS', 'HOUSE_AND_HOME',
       'LIBRARIES_AND_DEMO', 'LIFESTYLE', 'GAME', 'FAMILY', 'MEDICAL',
       'SOCIAL', 'SHOPPING', 'PHOTOGRAPHY', 'SPORTS', 'TRAVEL_AND_LOCAL',
       'TOOLS', 'PERSONALIZATION', 'PRODUCTIVITY', 'PARENTING', 'WEATHER',
       'VIDEO_PLAYERS', 'NEWS_AND_MAGAZINES', 'MAPS_AND_NAVIGATION'],
      dtype=object)
```

[74]:
```
inp2.Category = pd.Categorical(inp2.Category)

x = inp2[['Category']]
del inp2['Category']

dummies = pd.get_dummies(x, prefix = 'Category')
inp2 = pd.concat([inp2,dummies], axis=1)
inp2.head()
```

[74]:
```
   Rating    Reviews     Size  Installs  Price Content Rating  \
0     4.1   5.075174  19000.0     10000      0       Everyone
1     3.9   6.875232  14000.0    500000      0       Everyone
2     4.7  11.379520   8700.0   5000000      0       Everyone
4     4.3   6.875232   2800.0    100000      0       Everyone
5     4.4   5.123964   5600.0     50000      0       Everyone
```

```
                     Genres  Category_ART_AND_DESIGN  \
0               Art & Design                        1
1  Art & Design;Pretend Play                        1
2               Art & Design                        1
4    Art & Design;Creativity                        1
5               Art & Design                        1

   Category_AUTO_AND_VEHICLES  Category_BEAUTY  …  Category_PERSONALIZATION  \
0                           0                0  …                         0
1                           0                0  …                         0
2                           0                0  …                         0
4                           0                0  …                         0
5                           0                0  …                         0

   Category_PHOTOGRAPHY  Category_PRODUCTIVITY  Category_SHOPPING  \
0                     0                      0                  0
1                     0                      0                  0
2                     0                      0                  0
4                     0                      0                  0
5                     0                      0                  0

   Category_SOCIAL  Category_SPORTS  Category_TOOLS  \
0                0                0               0
1                0                0               0
2                0                0               0
4                0                0               0
5                0                0               0

   Category_TRAVEL_AND_LOCAL  Category_VIDEO_PLAYERS  Category_WEATHER
0                          0                       0                 0
1                          0                       0                 0
2                          0                       0                 0
4                          0                       0                 0
5                          0                       0                 0

[5 rows x 40 columns]
```

[75]:
```
inp2.shape
```

[75]:
```
(8496, 40)
```

[76]:
```
#get unique values in Column "Genres"
inp2["Genres"].unique()
```

[76]:
```
array(['Art & Design', 'Art & Design;Pretend Play',
       'Art & Design;Creativity', 'Auto & Vehicles', 'Beauty',
```

```
'Books & Reference', 'Business', 'Comics', 'Comics;Creativity',
'Communication', 'Dating', 'Education', 'Education;Creativity',
'Education;Education', 'Education;Music & Video',
'Education;Action & Adventure', 'Education;Pretend Play',
'Education;Brain Games', 'Entertainment',
'Entertainment;Brain Games', 'Entertainment;Creativity',
'Entertainment;Music & Video', 'Events', 'Finance', 'Food & Drink',
'Health & Fitness', 'House & Home', 'Libraries & Demo',
'Lifestyle', 'Lifestyle;Pretend Play', 'Card', 'Casual', 'Puzzle',
'Action', 'Arcade', 'Word', 'Racing', 'Casual;Creativity',
'Sports', 'Board', 'Simulation', 'Role Playing', 'Adventure',
'Strategy', 'Simulation;Education', 'Action;Action & Adventure',
'Trivia', 'Casual;Brain Games', 'Simulation;Action & Adventure',
'Educational;Creativity', 'Puzzle;Brain Games',
'Educational;Education', 'Card;Brain Games',
'Educational;Brain Games', 'Educational;Pretend Play',
'Casual;Action & Adventure', 'Entertainment;Education',
'Casual;Education', 'Casual;Pretend Play', 'Music;Music & Video',
'Racing;Action & Adventure', 'Arcade;Pretend Play',
'Adventure;Action & Adventure', 'Role Playing;Action & Adventure',
'Simulation;Pretend Play', 'Puzzle;Creativity',
'Sports;Action & Adventure', 'Educational;Action & Adventure',
'Arcade;Action & Adventure', 'Entertainment;Action & Adventure',
'Puzzle;Action & Adventure', 'Strategy;Action & Adventure',
'Music & Audio;Music & Video', 'Health & Fitness;Education',
'Adventure;Education', 'Board;Brain Games',
'Board;Action & Adventure', 'Board;Pretend Play',
'Casual;Music & Video', 'Role Playing;Pretend Play',
'Entertainment;Pretend Play', 'Video Players & Editors;Creativity',
'Card;Action & Adventure', 'Medical', 'Social', 'Shopping',
'Photography', 'Travel & Local',
'Travel & Local;Action & Adventure', 'Tools', 'Tools;Education',
'Personalization', 'Productivity', 'Parenting',
'Parenting;Music & Video', 'Parenting;Brain Games',
'Parenting;Education', 'Weather', 'Video Players & Editors',
'Video Players & Editors;Music & Video', 'News & Magazines',
'Maps & Navigation', 'Health & Fitness;Action & Adventure',
'Music', 'Educational', 'Casino', 'Adventure;Brain Games',
'Lifestyle;Education', 'Books & Reference;Education',
'Puzzle;Education', 'Role Playing;Brain Games',
'Strategy;Education', 'Racing;Pretend Play',
'Communication;Creativity', 'Strategy;Creativity'], dtype=object)
```

[77]:
```
# There are too many categories under Genres.
# Hence, we will try to reduce some categories which have very few samples␣
 ↪under them and put them under one new common category i.e. "Other"
```

[78]:
```
#Create an empty list
lists = []
#Get the total genres count and gernes count of perticular gerner count less than 20 append those into the list
for i in inp2.Genres.value_counts().index:
    if inp2.Genres.value_counts()[i]<20:
        lists.append(i)
#changing the gerners which are in the list to other
inp2.Genres = ['Other' if i in lists else i for i in inp2.Genres]
```

[79]:
```
inp2["Genres"].unique()
```

[79]:
```
array(['Art & Design', 'Other', 'Auto & Vehicles', 'Beauty',
       'Books & Reference', 'Business', 'Comics', 'Communication',
       'Dating', 'Education', 'Education;Education',
       'Education;Pretend Play', 'Entertainment',
       'Entertainment;Music & Video', 'Events', 'Finance', 'Food & Drink',
       'Health & Fitness', 'House & Home', 'Libraries & Demo',
       'Lifestyle', 'Card', 'Casual', 'Puzzle', 'Action', 'Arcade',
       'Word', 'Racing', 'Sports', 'Board', 'Simulation', 'Role Playing',
       'Adventure', 'Strategy', 'Trivia', 'Educational;Education',
       'Casual;Pretend Play', 'Medical', 'Social', 'Shopping',
       'Photography', 'Travel & Local', 'Tools', 'Personalization',
       'Productivity', 'Parenting', 'Weather', 'Video Players & Editors',
       'News & Magazines', 'Maps & Navigation', 'Educational', 'Casino'],
      dtype=object)
```

[80]:
```
#Storing the genres column into x varible and delete the genres col from dataframe inp2
#And concat the encoded cols to the dataframe inp2
inp2.Genres = pd.Categorical(inp2['Genres'])
x = inp2[["Genres"]]
del inp2['Genres']
dummies = pd.get_dummies(x, prefix = 'Genres')
inp2 = pd.concat([inp2,dummies], axis=1)
```

[81]:
```
inp2.head()
```

[81]:

	Rating	Reviews	Size	Installs	Price	Content Rating	\
0	4.1	5.075174	19000.0	10000	0	Everyone	
1	3.9	6.875232	14000.0	500000	0	Everyone	
2	4.7	11.379520	8700.0	5000000	0	Everyone	
4	4.3	6.875232	2800.0	100000	0	Everyone	
5	4.4	5.123964	5600.0	50000	0	Everyone	

	Category_ART_AND_DESIGN	Category_AUTO_AND_VEHICLES	Category_BEAUTY	\
0	1	0	0	

```
1                         1                              0                 0
2                         1                              0                 0
4                         1                              0                 0
5                         1                              0                 0

   Category_BOOKS_AND_REFERENCE  …  Genres_Simulation  Genres_Social  \
0                             0  …                  0              0
1                             0  …                  0              0
2                             0  …                  0              0
4                             0  …                  0              0
5                             0  …                  0              0

   Genres_Sports  Genres_Strategy  Genres_Tools  Genres_Travel & Local  \
0              0                0             0                      0
1              0                0             0                      0
2              0                0             0                      0
4              0                0             0                      0
5              0                0             0                      0

   Genres_Trivia  Genres_Video Players & Editors  Genres_Weather  Genres_Word
0              0                               0               0            0
1              0                               0               0            0
2              0                               0               0            0
4              0                               0               0            0
5              0                               0               0            0

[5 rows x 91 columns]
```

[82]:
```
inp2.shape
```

[82]:
```
(8496, 91)
```

[83]:
```
#getting the unique values in Column "Content Rating"
inp2['Content Rating'].unique()
```

[83]:
```
array(['Everyone', 'Teen', 'Everyone 10+', 'Mature 17+',
       'Adults only 18+', 'Unrated'], dtype=object)
```

[84]:
```
inp2['Content Rating'] = pd.Categorical(inp2['Content Rating'])

x = inp2[['Content Rating']]
del inp2['Content Rating']

dummies = pd.get_dummies(x, prefix = 'Content Rating')
inp2 = pd.concat([inp2,dummies], axis=1)
inp2.head()
```

[84]:

	Rating	Reviews	Size	Installs	Price	Category_ART_AND_DESIGN	\
0	4.1	5.075174	19000.0	10000	0	1	
1	3.9	6.875232	14000.0	500000	0	1	
2	4.7	11.379520	8700.0	5000000	0	1	
4	4.3	6.875232	2800.0	100000	0	1	
5	4.4	5.123964	5600.0	50000	0	1	

	Category_AUTO_AND_VEHICLES	Category_BEAUTY	Category_BOOKS_AND_REFERENCE	\
0	0	0	0	
1	0	0	0	
2	0	0	0	
4	0	0	0	
5	0	0	0	

	Category_BUSINESS	…	Genres_Trivia	Genres_Video Players & Editors	\
0	0	…	0	0	
1	0	…	0	0	
2	0	…	0	0	
4	0	…	0	0	
5	0	…	0	0	

	Genres_Weather	Genres_Word	Content Rating_Adults only 18+	\
0	0	0	0	
1	0	0	0	
2	0	0	0	
4	0	0	0	
5	0	0	0	

	Content Rating_Everyone	Content Rating_Everyone 10+	\
0	1	0	
1	1	0	
2	1	0	
4	1	0	
5	1	0	

	Content Rating_Mature 17+	Content Rating_Teen	Content Rating_Unrated
0	0	0	0
1	0	0	0
2	0	0	0
4	0	0	0
5	0	0	0

[5 rows x 96 columns]

[85]:
```
inp2.shape
```

[85]: (8496, 96)

[86]:
```
# 9. Train test split and apply 70-30 split. Name the new dataframes df_train␣
↪and df_test.

# 10. Separate the dataframes into X_train, y_train, X_test, and y_test
```

[87]:
```
#importing the neccessary libraries from sklearn to split the data and and for␣
↪model building
from sklearn.model_selection import train_test_split as tts
from sklearn.linear_model import LinearRegression as LR
from sklearn.metrics import mean_squared_error as mse
from sklearn import metrics
```

[88]:
```
#Creating the variable X and Y which contains the X features as independent␣
↪features and Y is the target feature
d1 = inp2
X = d1.drop('Rating',axis=1)
y = d1['Rating']

Xtrain, Xtest, ytrain, ytest = tts(X,y, test_size=0.3, random_state=5)
```

[89]:
```
# Model building Use linear regression as the technique Report the R2 on the␣
↪train set
```

[90]:
```
#Create a linear reggression obj by calling the linear reggressor algorithm
reg_all = LR()
reg_all.fit(Xtrain,ytrain)
```

[90]:
```
LinearRegression()
```

[91]:
```
R2_train = round(reg_all.score(Xtrain,ytrain),3)
print("The R2 value of the Training Set is : {}".format(R2_train))
```

```
The R2 value of the Training Set is : 0.074
```

[92]:
```
R2_test = round(reg_all.score(Xtest,ytest),3)
print("The R2 value of the Testing Set is : {}".format(R2_test))
```

```
The R2 value of the Testing Set is : 0.063
```