Prediction of App Ratings

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The dataset chosen for this project was from the popular data website Kaggle.

It contains over 10k application data, capturing various details like category, reviews, installs, size, etc. The aim of the project was to first generally visualize the distribution of the dataset across categories, identify correlations among the parameters.

To then find an accurate machine learning model which could fairly accurately predict user ratings on any app when similar data is available.

Seaborn & Matplotlib libraries of python were used to perform visualizations on python. Subsequently, four different machine learning models were used and trained on this data

Importing Libraries

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

%matplotlib inline
```

In [2]:
```
data = pd.read_csv(r"C:\Users\krishna\Downloads\googleplaystore.csv")
```

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

Out[3]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10,000+	Free	0	Everyone	A
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500,000+	Free	0	Everyone	Des
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8.7M	5,000,000+	Free	0	Everyone	A
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25M	50,000,000+	Free	0	Teen	A
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2.8M	100,000+	Free	0	Everyone	Desig

- App: Application name
- Category: Category the app belongs to
- Rating: Overall user rating of the app (as when scraped)
- Reviews: Number of user reviews for the app (as when scraped)
- Size: Size of the app (as when scraped)
- Installs: Number of user downloads/installs for the app (as when scraped)
- Type: Paid or Free
- Price: Price of the app (as when scraped)
- Content Rating: Age group the app is targeted at - Children / Mature 21+ / Adult
- Genres: An app can belong to multiple genres (apart from its main category). For eg, a musical family game will belong to Music, Game, Family genres.
- Last Updated: Date when the app was last updated on Play Store (as when scraped)
- Current Ver: Current version of the app available on Play Store (as when scraped)
- Android Ver: Min required Android version (as when scraped)

Data Preprocessing

In [4]:
```
1 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
```

In [5]:
```
1 data.describe(include=['object', 'float', 'int'])
```

Out[5]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Ge
count	10841	10841	9367.000000	10841	10841	10841	10840	10841	10840	1
unique	9660	34	NaN	6002	462	22	3	93	6	
top	ROBLOX	FAMILY	NaN	0	Varies with device	1,000,000+	Free	0	Everyone	
freq	9	1972	NaN	596	1695	1579	10039	10040	8714	
mean	NaN	NaN	4.193338	NaN	NaN	NaN	NaN	NaN	NaN	
std	NaN	NaN	0.537431	NaN	NaN	NaN	NaN	NaN	NaN	
min	NaN	NaN	1.000000	NaN	NaN	NaN	NaN	NaN	NaN	
25%	NaN	NaN	4.000000	NaN	NaN	NaN	NaN	NaN	NaN	
50%	NaN	NaN	4.300000	NaN	NaN	NaN	NaN	NaN	NaN	
75%	NaN	NaN	4.500000	NaN	NaN	NaN	NaN	NaN	NaN	
max	NaN	NaN	19.000000	NaN	NaN	NaN	NaN	NaN	NaN	

In [6]:
```
1 data.shape
```

Out[6]: (10841, 13)

In [7]:
```
1 data.isnull().sum()
```

Out[7]:
```
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
```

In [8]:
```
1 for i in data.columns:
2     print('{} has {} % missing values'.format(i,np.round(data[i].isnull().su
```

```
App has 0.0 % missing values
Category has 0.0 % missing values
Rating has 13.597 % missing values
Reviews has 0.0 % missing values
Size has 0.0 % missing values
Installs has 0.0 % missing values
Type has 0.009 % missing values
Price has 0.0 % missing values
Content Rating has 0.009 % missing values
Genres has 0.0 % missing values
Last Updated has 0.0 % missing values
Current Ver has 0.074 % missing values
Android Ver has 0.028 % missing values
```

In [9]:
```
1 def printinfo():
2     temp = pd.DataFrame(index=data.columns)
3     temp['data_type'] = data.dtypes
4     temp['null_count'] = data.isnull().sum()
5     temp['unique_count'] = data.nunique()
6     return temp
```

In [10]:
```
1 printinfo()
```

Out[10]:

	data_type	null_count	unique_count
App	object	0	9660
Category	object	0	34
Rating	float64	1474	40
Reviews	object	0	6002
Size	object	0	462
Installs	object	0	22
Type	object	1	3
Price	object	0	93
Content Rating	object	1	6
Genres	object	0	120
Last Updated	object	0	1378
Current Ver	object	8	2784
Android Ver	object	3	33

We have some useful information about the dataset. i.e., we can now see the missing number of values of any attribute, its unique count, and its respective data types.

Data Cleaning

Now we can start the process of data cleaning, lets start with the column Type:

In [11]:
```
1 data[data.Type.isnull()]
```

Out[11]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	L Upda
9148	Command & Conquer: Rivals	FAMILY	NaN	0	Varies with device	0	NaN	0	Everyone 10+	Strategy	28-.

Since there is only one missing value in this column, So, let's fill the missing value. After cross-checking in the play store the missing value is found to be Free, So now we can fill the missing value with free .

In [12]:
```
1 data['Type'].fillna("Free", inplace = True)
```

In [13]:
```
1 data.isnull().sum()
```

Out[13]:
```
App                0
Category           0
Rating          1474
Reviews            0
Size               0
Installs           0
Type               0
Price              0
Content Rating     1
Genres             0
Last Updated       0
Current Ver        8
Android Ver        3
dtype: int64
```

Now, we can move on to the column Content Rating :

In [14]:
```
1 data[data['Content Rating'].isnull()]
```

Out[14]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres
10472	Life Made WI-Fi Touchscreen Photo Frame	1.9	19.0	3.0M	1,000+	Free	0	Everyone	NaN	11-Feb-18

In [15]:
```
1 # data.loc[10468:10477, :]
```

In [16]:
```
1 data.dropna(subset = ['Content Rating'], inplace=True)
```

In [17]:
```
1 printinfo()
```

Out[17]:

	data_type	null_count	unique_count
App	object	0	9659
Category	object	0	33
Rating	float64	1474	39
Reviews	object	0	6001
Size	object	0	461
Installs	object	0	21
Type	object	0	2
Price	object	0	92
Content Rating	object	0	6
Genres	object	0	119
Last Updated	object	0	1377
Current Ver	object	8	2783
Android Ver	object	2	33

We are having some of the unwanted columns which will be of not much use in the analysis process. So let's drop those columns.

data.drop(['Current Ver','Last Updated', 'Android Ver'], axis=1, inplace=True)

Now, we can fix the Rating column which contains a total of 1474 of missing values. Replacing the missing values with the Modevalue of that entire column

In [18]:
```
1 modeValueRating = data['Rating'].mode()
```

In [19]:
```
1 data['Rating'].fillna(value=modeValueRating[0], inplace = True)
```

Finally, after fixing all the missing values, we should have a look at our data frame, We defined a function as printinfo() . So, it's time to use that function.

In [20]:
```
1 printinfo()
```

Out[20]:

	data_type	null_count	unique_count
App	object	0	9659
Category	object	0	33
Rating	float64	0	39
Reviews	object	0	6001
Size	object	0	461
Installs	object	0	21
Type	object	0	2
Price	object	0	92
Content Rating	object	0	6
Genres	object	0	119
Last Updated	object	0	1377
Current Ver	object	8	2783
Android Ver	object	2	33

In [21]:
```
1 data.shape
```

Out[21]: (10840, 13)

In [22]:
```
1 data.head(3)
```

Out[22]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10,000+	Free	0	Everyone	Art
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500,000+	Free	0	Everyone	Desigr
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8.7M	5,000,000+	Free	0	Everyone	Art

Columns like Reviews, Size, Installs, & priceshould have an intor floatdatatype, But here we can

see of objecttype, So let's convert them to their respective correct type.

Starting with the column Reviews , converting its type to int .

In [23]:
```
data['Reviews'] = data.Reviews.astype(int)
```

In [24]:
```
printinfo()
```

Out[24]:

	data_type	null_count	unique_count
App	object	0	9659
Category	object	0	33
Rating	float64	0	39
Reviews	int32	0	6001
Size	object	0	461
Installs	object	0	21
Type	object	0	2
Price	object	0	92
Content Rating	object	0	6
Genres	object	0	119
Last Updated	object	0	1377
Current Ver	object	8	2783
Android Ver	object	2	33

(Now Size column) Converting the Size Column from object to integer, but this column contains some of the special characters like , , + , M , K & also it has a some of the value as Varies with device . We need to remove all of these and then convert it to int or float .

Removing the +Symbol:

Type *Markdown* and LaTeX: α^2

In [25]:
```
data['Size'] = data.Size.apply(lambda x: x.strip('+'))# Removing the + Sign
```

Removing the , symbol:

In [26]:
```
data['Size'] =data.Size.apply(lambda x: x.replace(',', ''))# For removing th
```

Replacing the M symbol by multiplying the value with 1000000:

In [27]:
```
data['Size'] = data.Size.apply(lambda x: x.replace('M', 'e+6'))# For convert
```

Replacing the k by multiplying the value with 1000:

In [28]:
```
data['Size'] =data.Size.apply(lambda x: x.replace('k', 'e+3'))# For converti
```

Replacing the Varies with device value with Nan :

In [29]:
```
data['Size'] = data.Size.replace('Varies with device', np.NaN)
```

Now, finally converting all these values to numeric type:

In [30]:
```
data['Size'] = pd.to_numeric(data['Size']) # Converting the string to Numeri
```

In [31]:
```
printinfo()
```

Out[31]:

	data_type	null_count	unique_count
App	object	0	9659
Category	object	0	33
Rating	float64	0	39
Reviews	int32	0	6001
Size	float64	1695	459
Installs	object	0	21
Type	object	0	2
Price	object	0	92
Content Rating	object	0	6
Genres	object	0	119
Last Updated	object	0	1377
Current Ver	object	8	2783
Android Ver	object	2	33

In [32]:
```
data.dropna(subset = ['Size'], inplace=True)
```

Column: Installs : To convert this column from object to integer type. First of all, we will need to remove the +symbol from these values.

In [33]:
```
data['Installs'] = data.Installs.apply(lambda x: x.strip('+'))
```

In [34]:
```
data['Installs'] = data.Installs.apply(lambda x: x.replace(',', ''))
```

Lastly, we can now convert it from string type to numeric type, and then have a look at our dataset.

In [35]:
```
1 data['Installs'] = pd.to_numeric(data['Installs'])
```

In [36]:
```
1 printinfo()
```

Out[36]:

	data_type	null_count	unique_count
App	object	0	8434
Category	object	0	33
Rating	float64	0	39
Reviews	int32	0	4680
Size	float64	0	459
Installs	int64	0	20
Type	object	0	2
Price	object	0	87
Content Rating	object	0	6
Genres	object	0	116
Last Updated	object	0	1358
Current Ver	object	8	2665
Android Ver	object	2	33

now we are only left with the Price column. Column: Price : Converting this column from objectto Numeric type.

In [37]:
```
1 data['Price'].value_counts()
```

Out[37]:
```
0           8421
$0.99        145
$2.99        114
$1.99         66
$4.99         65
            ...
$1.59           1
$1.50           1
$89.99          1
$3.04           1
$299.99         1
Name: Price, Length: 87, dtype: int64
```

The values contain a special symbol $ which can be removed and then converted to the numeric type.

In [38]:
```
1 data['Price'] = data.Price.apply(lambda x: x.strip('$'))
```

In [39]:
```
1 data['Price'] = pd.to_numeric(data['Price'])
```

In [40]:
```
1 printinfo()
```

Out[40]:

	data_type	null_count	unique_count
App	object	0	8434
Category	object	0	33
Rating	float64	0	39
Reviews	int32	0	4680
Size	float64	0	459
Installs	int64	0	20
Type	object	0	2
Price	float64	0	87
Content Rating	object	0	6
Genres	object	0	116
Last Updated	object	0	1358
Current Ver	object	8	2665
Android Ver	object	2	33

Finally Data Preparation and Cleaning Completed

In [41]:
```
1 data[data['Rating']>5]
```

Out[41]:

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

In [42]:
```
1 data['Rating'].max()
```

Out[42]:
```
5.0
```

In [43]:
```
1 data.head()
```

Out[43]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19000000.0	10000	Free	0.0	Everyone
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14000000.0	500000	Free	0.0	Everyone
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8700000.0	5000000	Free	0.0	Everyone
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25000000.0	50000000	Free	0.0	Teen
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2800000.0	100000	Free	0.0	Everyone

In [44]:
```
1 data.head(3)
```

Out[44]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19000000.0	10000	Free	0.0	Everyone	
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14000000.0	500000	Free	0.0	Everyone	De
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8700000.0	5000000	Free	0.0	Everyone	

In [45]:
```
1 data["Last Updated"] = pd.to_datetime(data['Last Updated'])
2 data['year_added']=data['Last Updated'].dt.year
3 data['month_added']=data['Last Updated'].dt.month
```

In [46]:
```
1 df=data[:]
```

In [47]:
```
1 df.head()
```

Out[47]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19000000.0	10000	Free	0.0	Everyone
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14000000.0	500000	Free	0.0	Everyone
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8700000.0	5000000	Free	0.0	Everyone
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25000000.0	50000000	Free	0.0	Teen
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2800000.0	100000	Free	0.0	Everyone

Here we added 2 more columns in the data set by spliting the last updated attribute, by doing this we find that in which year apps are added or updated on playstore.

Data Visualization

In [48]:
```
1 data.columns
```

Out[48]:
```
Index(['App', 'Category', 'Rating', 'Reviews', 'Size', 'Installs', 'Type',
       'Price', 'Content Rating', 'Genres', 'Last Updated', 'Current Ver',
       'Android Ver', 'year_added', 'month_added'],
      dtype='object')
```

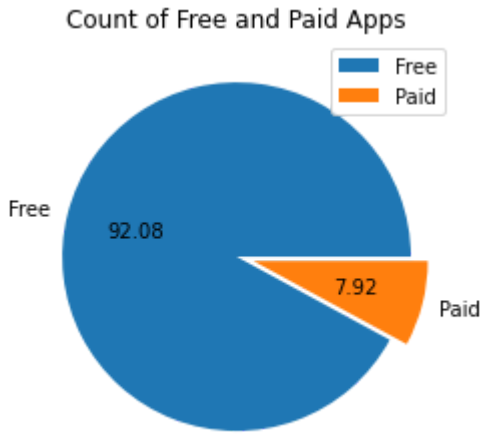
Type of Application (Paid OR Free)

In [49]:
```
grouped = data["Type"].value_counts().reset_index()
grouped=grouped.rename(columns={'index':'Type','Type':'Count'})
grouped
```

Out[49]:

	Type	Count
0	Free	8421
1	Paid	724

In [50]:
```
fig=plt.pie(grouped['Count'],labels=grouped['Type'],autopct="%.2f",explode=[
plt.title("Count of Free and Paid Apps")
plt.legend()
plt.show()
```



Here we see that 92.08% apps are freee and 7.92% apps are paid on google playstore. so we say that Most of the people love free services

App updated or added over the years

In [51]:
```
d1=data[data['Type']=='Free']
d1.head(1)
```

Out[51]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Ge
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19000000.0	10000	Free	0.0	Everyone	De

In [52]:
```
d2=data[data['Type']=='Paid']
d2.head(1)
```

Out[52]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres
234	TurboScan: scan documents and receipts in PDF	BUSINESS	4.7	11442	6800000.0	100000	Paid	4.99	Everyone	Business

In [53]:
```
d1.head()
```

Out[53]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19000000.0	10000	Free	0.0	Everyone
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14000000.0	500000	Free	0.0	Everyone
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8700000.0	5000000	Free	0.0	Everyone
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25000000.0	50000000	Free	0.0	Teen
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2800000.0	100000	Free	0.0	Everyone

In [54]:
```
free_year=d1['year_added'].value_counts().reset_index()
#print(free_year)
free_year=free_year.rename(columns={"index":"year_added","year_added":"count
free_year
```

Out[54]:

	year_added	count
0	2018	5567
1	2017	1575
2	2016	660
3	2015	365
4	2014	144
5	2013	77
6	2012	20
7	2011	12
8	2010	1

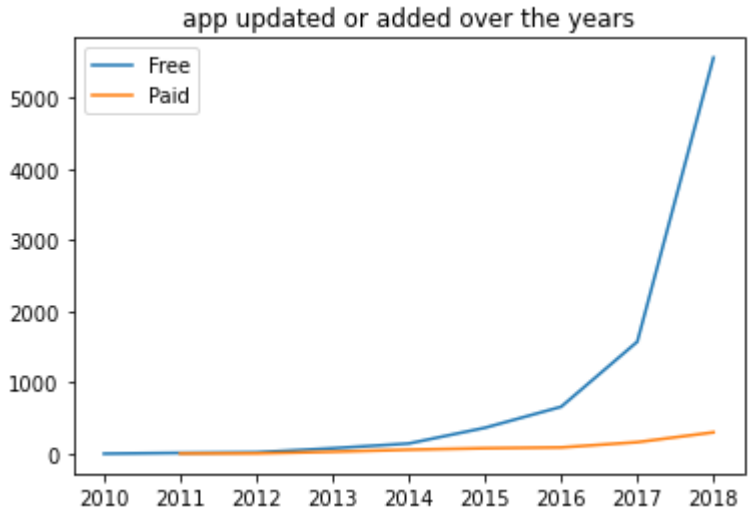
In [55]:
```
paid_year=d2['year_added'].value_counts().reset_index()
#print(paid_year)
paid_year=paid_year.rename(columns={"index":"year_added","year_added":"count
paid_year
```

Out[55]:

	year_added	count
0	2018	301
1	2017	163
2	2016	89
3	2015	78
4	2014	57
5	2013	28
6	2012	5
7	2011	3

In [56]:

```
plt.plot(free_year['year_added'],free_year['count'],label="Free")
plt.plot(paid_year['year_added'],paid_year['count'],label="Paid")
plt.legend()
plt.title("app updated or added over the years")
plt.show()
```



In the above plot we plot the app updated or added over the year Free vs Paid. By observing this plot we conclude that before 2011 there were no paid apps.But with the year free apps are added in huge amount in comparision to paid apps. We can conclude that people like free service more than paid service.

Content Ratings of the free vs paid app

In [57]:
```
free_content=d1["Content Rating"].value_counts().reset_index()
free_content=free_content.rename(columns={"index":"Content Rating","Content
free_content
```

Out[57]:

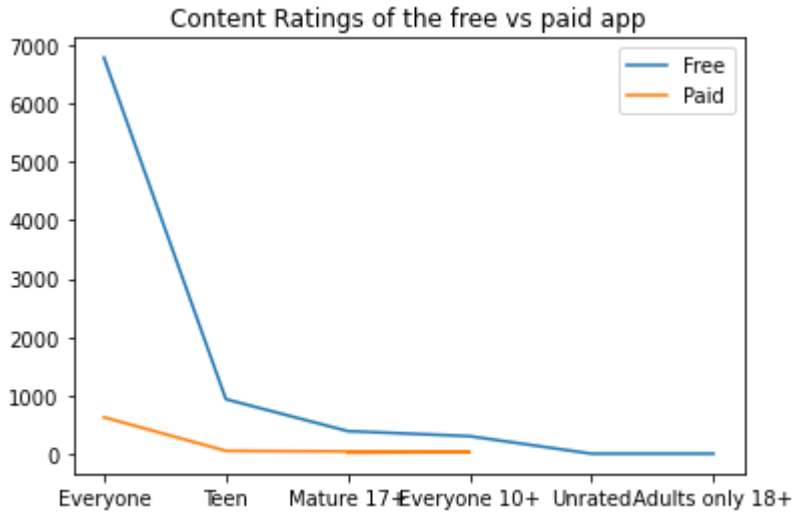
	Content Rating	Count
0	Everyone	6790
1	Teen	936
2	Mature 17+	389
3	Everyone 10+	302
4	Unrated	2
5	Adults only 18+	2

In [58]:
```
paid_content=d2["Content Rating"].value_counts().reset_index()
paid_content=paid_content.rename(columns={"index":"Content Rating","Content
paid_content
```

Out[58]:

	Content Rating	Count
0	Everyone	626
1	Teen	51
2	Everyone 10+	30
3	Mature 17+	17

In [59]:
```
plt.plot(free_content["Content Rating"],free_content['Count'],label="Free")
plt.plot(paid_content["Content Rating"],paid_content['Count'],label="Paid")
plt.title("Content Ratings of the free vs paid app")
plt.legend()
plt.show()
```



In [60]:

```
category=d1["Category"].value_counts().reset_index()
category=category.rename(columns={"index":"Category","Category":"Count"})
category
```

Out[60]:

	Category	Count
0	FAMILY	1654
1	GAME	936
2	TOOLS	670
3	BUSINESS	387
4	MEDICAL	336
5	LIFESTYLE	328
6	FINANCE	290
7	SPORTS	289
8	PRODUCTIVITY	279
9	PERSONALIZATION	276
10	HEALTH_AND_FITNESS	252
11	COMMUNICATION	242
12	PHOTOGRAPHY	235
13	NEWS_AND_MAGAZINES	214
14	SOCIAL	207
15	DATING	207
16	SHOPPING	199
17	TRAVEL_AND_LOCAL	182
18	BOOKS_AND_REFERENCE	170
19	VIDEO_PLAYERS	130
20	EDUCATION	107
21	MAPS_AND_NAVIGATION	104
22	FOOD_AND_DRINK	99
23	ENTERTAINMENT	89
24	LIBRARIES_AND_DEMO	81
25	AUTO_AND_VEHICLES	73
26	HOUSE_AND_HOME	68
27	ART_AND_DESIGN	59
28	EVENTS	56
29	PARENTING	53
30	COMICS	51
31	WEATHER	51
32	BEAUTY	47

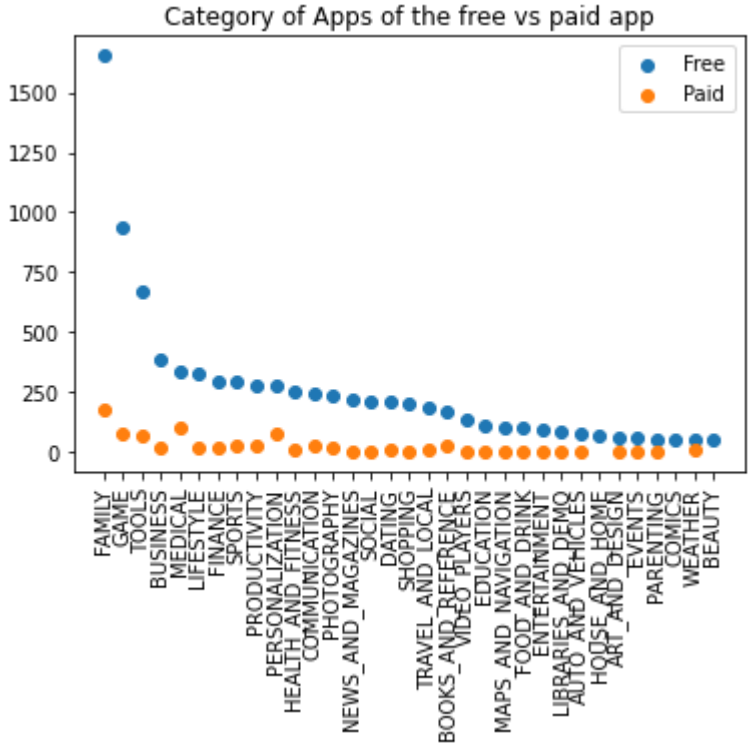
In [61]:

```
category1=d2["Category"].value_counts().reset_index()
category1=category1.rename(columns={"index":"Category","Category":"Count"})
category1
```

Out[61]:

	Category	Count
0	FAMILY	178
1	MEDICAL	98
2	PERSONALIZATION	79
3	GAME	79
4	TOOLS	69
5	BOOKS_AND_REFERENCE	27
6	PRODUCTIVITY	24
7	COMMUNICATION	23
8	SPORTS	22
9	PHOTOGRAPHY	19
10	LIFESTYLE	17
11	FINANCE	17
12	BUSINESS	13
13	HEALTH_AND_FITNESS	12
14	TRAVEL_AND_LOCAL	10
15	WEATHER	6
16	DATING	5
17	EDUCATION	4
18	MAPS_AND_NAVIGATION	4
19	ART_AND_DESIGN	3
20	SOCIAL	3
21	SHOPPING	2
22	NEWS_AND_MAGAZINES	2
23	AUTO_AND_VEHICLES	2
24	ENTERTAINMENT	1
25	LIBRARIES_AND_DEMO	1
26	VIDEO_PLAYERS	1
27	EVENTS	1
28	PARENTING	1
29	FOOD_AND_DRINK	1

In [62]:
```
plt.scatter(category["Category"],category['Count'],label="Free")
plt.scatter(category1["Category"],category1['Count'],label="Paid")
plt.title("Category of Apps of the free vs paid app")
plt.xticks(rotation=90)
plt.legend()
plt.show()
```



The above plot shows that most of the app content rating are for everyone and most of them are Free.

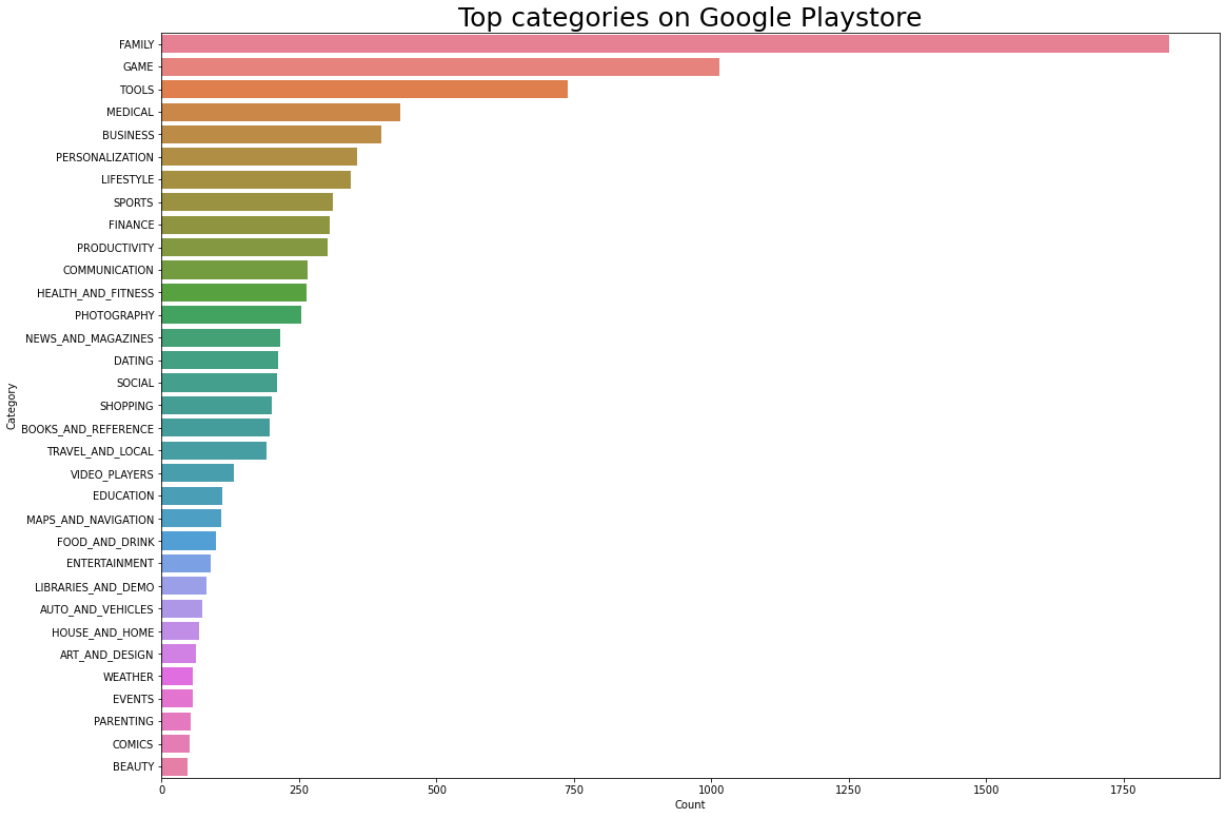
what are the top categories in the play store, which contains the highest number of apps?

In [63]:
```
y = data['Category'].value_counts().index
x = data['Category'].value_counts()
xsis = []
ysis = []
for i in range(len(x)):
    xsis.append(x[i])
    ysis.append(y[i])
```

In [64]:

```
plt.figure(figsize=(18,13))
plt.xlabel("Count")
plt.ylabel("Category")

graph = sns.barplot(x = xsis, y = ysis, palette= "husl")
graph.set_title("Top categories on Google Playstore", fontsize = 25);
```



So there are all total of 33 categories in the dataset from the above output we can come to the conclusion that in the play store most of the apps are under Family & Game category and least are of Beauty & Comics Category.

In [ ]:

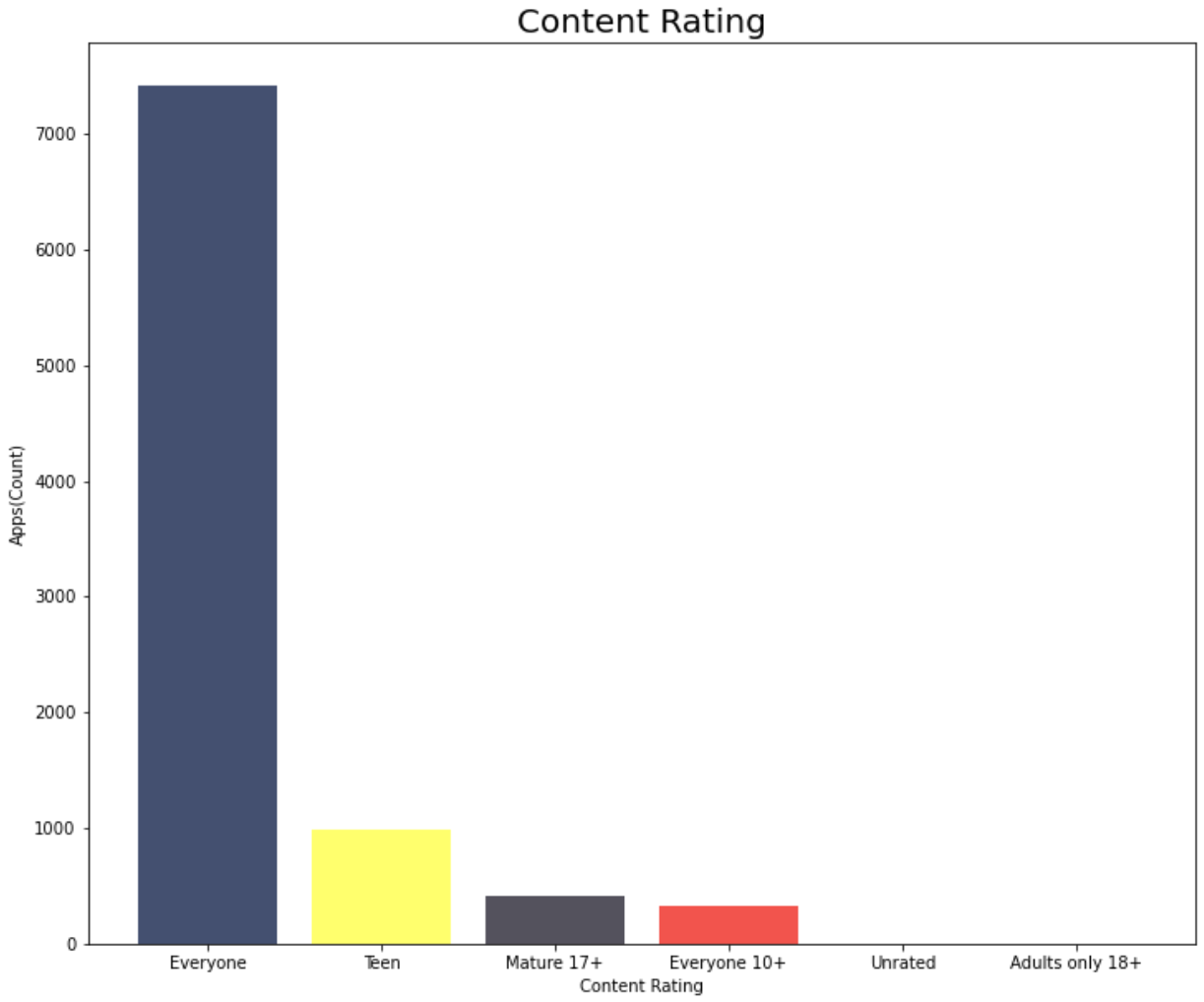
```
1
```

Which category of Apps from the ‘Content Rating’ column is found more on the play store?

In [65]:
```
x2 = data['Content Rating'].value_counts().index
y2 = data['Content Rating'].value_counts()

x2sis = []
y2sis = []
for i in range(len(x2)):
    x2sis.append(x2[i])
    y2sis.append(y2[i])
```

In [66]:
```
plt.figure(figsize=(12,10))
plt.bar(x2sis,y2sis,width=0.8,color=['#15244C','#FFFF48','#292734','#EF2920'
plt.title('Content Rating',size = 20);
plt.ylabel('Apps(Count)');
plt.xlabel('Content Rating');
```

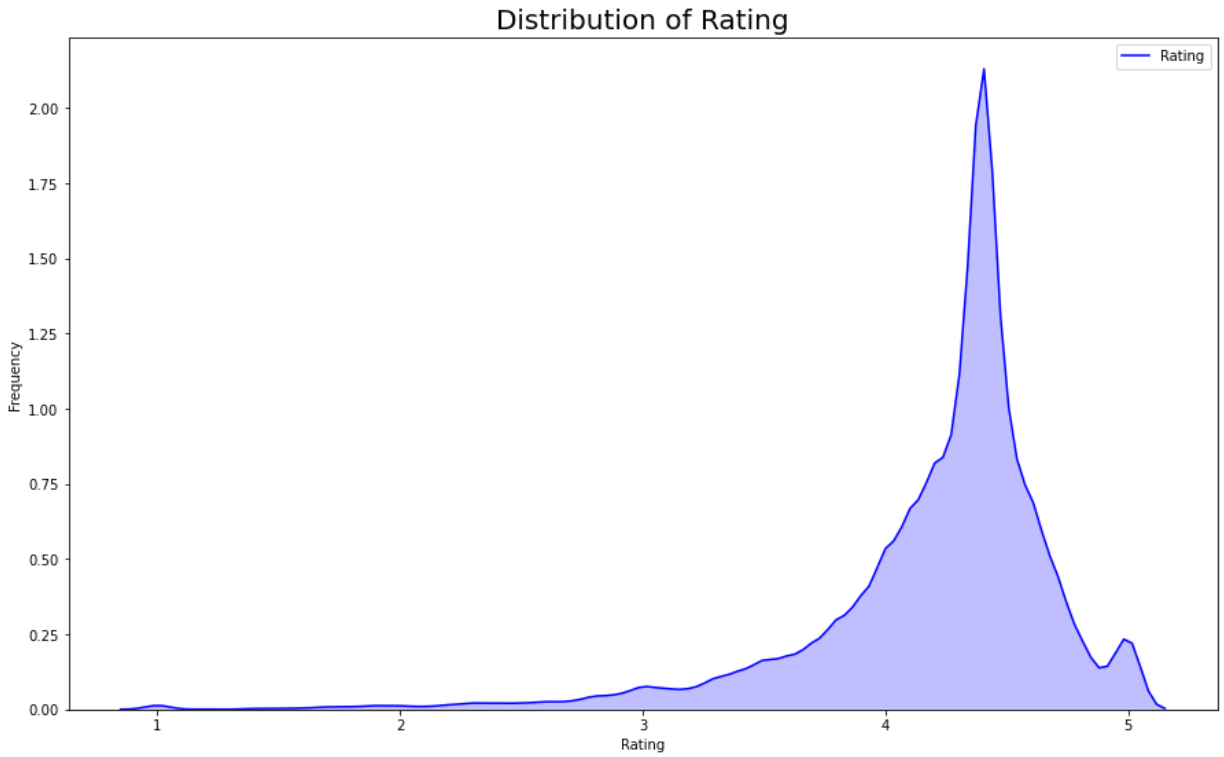


From the above plot, we can see that the Everyone category has the highest number of apps.

In [ ]:
```
```

distribution of the ratings of the data frame.

In [67]:
```
plt.figure(figsize=(15,9))
plt.xlabel("Rating")
plt.ylabel("Frequency")
graph = sns.kdeplot(data.Rating, color="Blue", shade = True)
plt.title('Distribution of Rating',size = 20);
```



From the above graph, we can come to the conclusion that most of the apps in the google play store are rated between 3.5 to 4.8.

Data Preparation

In [68]:
```
data.head(2)
```

Out[68]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19000000.0	10000	Free	0.0	Everyone	
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14000000.0	500000	Free	0.0	Everyone	Des

In [69]:
```
1 printinfo()
```

Out[69]:

	data_type	null_count	unique_count
App	object	0	8434
Category	object	0	33
Rating	float64	0	39
Reviews	int32	0	4680
Size	float64	0	459
Installs	int64	0	20
Type	object	0	2
Price	float64	0	87
Content Rating	object	0	6
Genres	object	0	116
Last Updated	datetime64[ns]	0	1358
Current Ver	object	8	2665
Android Ver	object	2	33
year_added	int64	0	9
month_added	int64	0	12

In [ ]:
```
1
```

New

We are having some of the unwanted columns which will be of not much use in the analysis process. So let's drop those columns.

In [70]:
```
1 data.drop(['App','Size','Price','Current Ver','Last Updated', 'Android Ver']
```

In [71]:
```
1 df=data.copy()
```

In [72]:
```
1 df.head()
```

Out[72]:

	Category	Rating	Reviews	Installs	Type	Content Rating	Genres	year_added	m
0	ART_AND_DESIGN	4.1	159	10000	Free	Everyone	Art & Design	2018	
1	ART_AND_DESIGN	3.9	967	500000	Free	Everyone	Art & Design;Pretend Play	2018	
2	ART_AND_DESIGN	4.7	87510	5000000	Free	Everyone	Art & Design	2018	
3	ART_AND_DESIGN	4.5	215644	50000000	Free	Teen	Art & Design	2018	
4	ART_AND_DESIGN	4.3	967	100000	Free	Everyone	Art & Design;Creativity	2018	

In [73]:
```
1 print(df['Category'].unique())
2 print(df['Category'].nunique())
```

```
['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']
33
```

In [74]:
```
1 print(df['Content Rating'].unique())
2 print(df['Content Rating'].nunique())
```

```
['Everyone' 'Teen' 'Everyone 10+' 'Mature 17+' 'Adults only 18+' 'Unrated']
6
```

In [75]:

```
print(df['Genres'].unique())
print(df['Genres'].nunique())
```

```
['Art & Design' 'Art & Design;Pretend Play' 'Art & Design;Creativity'
 'Art & Design;Action & Adventure' 'Auto & Vehicles' 'Beauty'
 'Books & Reference' 'Business' 'Comics' 'Comics;Creativity'
 'Communication' 'Dating' 'Education' 'Education;Creativity'
 'Education;Education' 'Education;Action & Adventure'
 'Education;Pretend Play' 'Education;Brain Games' 'Entertainment'
 'Entertainment;Brain Games' 'Entertainment;Music & Video' 'Events'
 'Finance' 'Food & Drink' 'Health & Fitness' 'House & Home'
 'Libraries & Demo' 'Lifestyle' 'Lifestyle;Pretend Play'
 'Adventure;Action & Adventure' 'Arcade' 'Casual' 'Card'
 'Casual;Pretend Play' 'Strategy' 'Action' 'Puzzle' 'Sports' 'Word'
 'Racing' 'Casual;Creativity' 'Simulation' 'Adventure' 'Board' 'Trivia'
 'Role Playing' 'Simulation;Education' 'Action;Action & Adventure'
 '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'
 'Music;Music & Video' 'Arcade;Pretend Play' 'Simulation;Pretend Play'
 'Puzzle;Creativity' 'Racing;Action & Adventure'
 'Educational;Action & Adventure' 'Arcade;Action & Adventure'
 'Entertainment;Action & Adventure' 'Puzzle;Action & Adventure'
 'Role Playing;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' 'Education;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' 'Personalization'
 'Productivity' 'Parenting' 'Parenting;Education' 'Parenting;Brain Games'
 'Parenting;Music & Video' 'Weather' 'Video Players & Editors'
 'News & Magazines' 'Maps & Navigation'
 'Health & Fitness;Action & Adventure' 'Music' 'Educational' 'Casino'
 'Adventure;Brain Games' 'Video Players & Editors;Music & Video'
 'Trivia;Education' 'Entertainment;Creativity' 'Sports;Action & Adventure'
 'Books & Reference;Creativity' 'Books & Reference;Education'
 'Puzzle;Education' 'Role Playing;Education' 'Role Playing;Brain Games'
 'Strategy;Education' 'Racing;Pretend Play' 'Strategy;Creativity']
116
```

In [76]:

```
l=[]
for i in df['Genres']:
  if i not in l:
     l.append(i)
print(l)
len(l)
```

```
['Art & Design', 'Art & Design;Pretend Play', 'Art & Design;Creativity', 'Art &
Design;Action & Adventure', 'Auto & Vehicles', 'Beauty', 'Books & Reference',
'Business', 'Comics', 'Comics;Creativity', 'Communication', 'Dating', 'Educatio
n', 'Education;Creativity', 'Education;Education', 'Education;Action & Adventur
e', 'Education;Pretend Play', 'Education;Brain Games', 'Entertainment', 'Entert
ainment;Brain Games', 'Entertainment;Music & Video', 'Events', 'Finance', 'Food
& Drink', 'Health & Fitness', 'House & Home', 'Libraries & Demo', 'Lifestyle',
'Lifestyle;Pretend Play', 'Adventure;Action & Adventure', 'Arcade', 'Casual',
'Card', 'Casual;Pretend Play', 'Strategy', 'Action', 'Puzzle', 'Sports', 'Wor
d', 'Racing', 'Casual;Creativity', 'Simulation', 'Adventure', 'Board', 'Trivi
a', 'Role Playing', 'Simulation;Education', 'Action;Action & Adventure', 'Casua
l;Brain Games', 'Simulation;Action & Adventure', 'Educational;Creativity', 'Puz
zle;Brain Games', 'Educational;Education', 'Card;Brain Games', 'Educational;Bra
in Games', 'Educational;Pretend Play', 'Casual;Action & Adventure', 'Entertainm
ent;Education', 'Casual;Education', 'Music;Music & Video', 'Arcade;Pretend Pla
y', 'Simulation;Pretend Play', 'Puzzle;Creativity', 'Racing;Action & Adventur
e', 'Educational;Action & Adventure', 'Arcade;Action & Adventure', 'Entertainme
nt;Action & Adventure', 'Puzzle;Action & Adventure', 'Role Playing;Action & Adv
enture', 'Strategy;Action & Adventure', 'Music & Audio;Music & Video', 'Health
& Fitness;Education', 'Adventure;Education', 'Board;Brain Games', 'Board;Action
& Adventure', 'Board;Pretend Play', 'Casual;Music & Video', 'Education;Music &
Video', 'Role Playing;Pretend Play', 'Entertainment;Pretend Play', 'Video Playe
rs & Editors;Creativity', 'Card;Action & Adventure', 'Medical', 'Social', 'Shop
ping', 'Photography', 'Travel & Local', 'Travel & Local;Action & Adventure', 'T
ools', 'Personalization', 'Productivity', 'Parenting', 'Parenting;Education',
'Parenting;Brain Games', 'Parenting;Music & Video', 'Weather', 'Video Players &
Editors', 'News & Magazines', 'Maps & Navigation', 'Health & Fitness;Action & A
dventure', 'Music', 'Educational', 'Casino', 'Adventure;Brain Games', 'Video Pl
ayers & Editors;Music & Video', 'Trivia;Education', 'Entertainment;Creativity',
'Sports;Action & Adventure', 'Books & Reference;Creativity', 'Books & Referenc
e;Education', 'Puzzle;Education', 'Role Playing;Education', 'Role Playing;Brain
Games', 'Strategy;Education', 'Racing;Pretend Play', 'Strategy;Creativity']
```

Out[76]: 116

In [77]:
```
printinfo()
```

Out[77]:

	data_type	null_count	unique_count
Category	object	0	33
Rating	float64	0	39
Reviews	int32	0	4680
Installs	int64	0	20
Type	object	0	2
Content Rating	object	0	6
Genres	object	0	116
year_added	int64	0	9
month_added	int64	0	12

Converting Numerical data into Categorical data

In [78]:
```
'''data['Category']=data.Category.astype("category").cat.codes
data['Type']=data.Type.astype("category").cat.codes
data['Genres']=data.Genres.astype("category").cat.codes
data=data.rename(columns={"Content Rating":"Content"})
data['Content']=data.Content.astype("category").cat.codes
data['Installs']=data.Installs.astype("category").cat.codes'''

```

Out[78]:
```
'data[\'Category\']=data.Category.astype("category").cat.codes\ndata[\'Type\']=
data.Type.astype("category").cat.codes\ndata[\'Genres\']=data.Genres.astype("ca
tegory").cat.codes\ndata=data.rename(columns={"Content Rating":"Content"})\ndat
a[\'Content\']=data.Content.astype("category").cat.codes\ndata[\'Installs\']=da
ta.Installs.astype("category").cat.codes'
```

In [79]:
```
1 data
```

Out[79]:

	Category	Rating	Reviews	Installs	Type	Content Rating	Genres	year_added
0	ART_AND_DESIGN	4.1	159	10000	Free	Everyone	Art & Design	2018
1	ART_AND_DESIGN	3.9	967	500000	Free	Everyone	Art & Design;Pretend Play	2018
2	ART_AND_DESIGN	4.7	87510	5000000	Free	Everyone	Art & Design	2018
3	ART_AND_DESIGN	4.5	215644	50000000	Free	Teen	Art & Design	2018
4	ART_AND_DESIGN	4.3	967	100000	Free	Everyone	Art & Design;Creativity	2018
...	...	...	...	...	...	...	...	..
10835	BUSINESS	4.4	0	10	Free	Everyone	Business	2016
10836	FAMILY	4.5	38	5000	Free	Everyone	Education	2017
10837	FAMILY	5.0	4	100	Free	Everyone	Education	2018
10838	MEDICAL	4.4	3	1000	Free	Everyone	Medical	2017
10840	LIFESTYLE	4.5	398307	10000000	Free	Everyone	Lifestyle	2018

9145 rows × 9 columns

In [ ]:
```
1
```

In [80]:
```
1 final_df=data.copy()
```

In [81]:
```
1 final_df
```

Out[81]:

	Category	Rating	Reviews	Installs	Type	Content Rating	Genres	year_added
0	ART_AND_DESIGN	4.1	159	10000	Free	Everyone	Art & Design	2018
1	ART_AND_DESIGN	3.9	967	500000	Free	Everyone	Art & Design;Pretend Play	2018
2	ART_AND_DESIGN	4.7	87510	5000000	Free	Everyone	Art & Design	2018
3	ART_AND_DESIGN	4.5	215644	50000000	Free	Teen	Art & Design	2018
4	ART_AND_DESIGN	4.3	967	100000	Free	Everyone	Art & Design;Creativity	2018
...	...	...	...	...	...	...	...	..
10835	BUSINESS	4.4	0	10	Free	Everyone	Business	2016
10836	FAMILY	4.5	38	5000	Free	Everyone	Education	2017
10837	FAMILY	5.0	4	100	Free	Everyone	Education	2018
10838	MEDICAL	4.4	3	1000	Free	Everyone	Medical	2017
10840	LIFESTYLE	4.5	398307	10000000	Free	Everyone	Lifestyle	2018

9145 rows × 9 columns

In [82]:
```
1 !pip install category_encoders
```

```
Requirement already satisfied: category_encoders in c:\users\krishna\anaconda3
\lib\site-packages (2.5.0)
Requirement already satisfied: pandas>=1.0.5 in c:\users\krishna\anaconda3\lib
\site-packages (from category_encoders) (1.0.5)
Requirement already satisfied: scipy>=1.0.0 in c:\users\krishna\anaconda3\lib\s
ite-packages (from category_encoders) (1.5.0)
Requirement already satisfied: patsy>=0.5.1 in c:\users\krishna\anaconda3\lib\s
ite-packages (from category_encoders) (0.5.1)
Requirement already satisfied: scikit-learn>=0.20.0 in c:\users\krishna\anacond
a3\lib\site-packages (from category_encoders) (0.23.1)
Requirement already satisfied: numpy>=1.14.0 in c:\users\krishna\anaconda3\lib
\site-packages (from category_encoders) (1.22.3)
Requirement already satisfied: statsmodels>=0.9.0 in c:\users\krishna\anaconda3
\lib\site-packages (from category_encoders) (0.11.1)
Requirement already satisfied: pytz>=2017.2 in c:\users\krishna\anaconda3\lib\s
ite-packages (from pandas>=1.0.5->category_encoders) (2020.1)
Requirement already satisfied: python-dateutil>=2.6.1 in c:\users\krishna\anaco
nda3\lib\site-packages (from pandas>=1.0.5->category_encoders) (2.8.1)
Requirement already satisfied: six in c:\users\krishna\anaconda3\lib\site-packa
ges (from patsy>=0.5.1->category_encoders) (1.15.0)
Requirement already satisfied: joblib>=0.11 in c:\users\krishna\anaconda3\lib\s
ite-packages (from scikit-learn>=0.20.0->category_encoders) (0.16.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\krishna\anacond
a3\lib\site-packages (from scikit-learn>=0.20.0->category_encoders) (2.1.0)
```

In [83]:

```
import category_encoders as ce
import pandas as pd



#Create object for binary encoding
encoder= ce.BinaryEncoder(cols=['Category','Type','Content Rating','Genres'])

#Original Data
data
```

Out[83]:

	Category	Rating	Reviews	Installs	Type	Content Rating	Genres	year_added
0	ART_AND_DESIGN	4.1	159	10000	Free	Everyone	Art & Design	2018
1	ART_AND_DESIGN	3.9	967	500000	Free	Everyone	Art & Design;Pretend Play	2018
2	ART_AND_DESIGN	4.7	87510	5000000	Free	Everyone	Art & Design	2018
3	ART_AND_DESIGN	4.5	215644	50000000	Free	Teen	Art & Design	2018
4	ART_AND_DESIGN	4.3	967	100000	Free	Everyone	Art & Design;Creativity	2018
...	...	...	...	...	...	...	...	..
10835	BUSINESS	4.4	0	10	Free	Everyone	Business	2016
10836	FAMILY	4.5	38	5000	Free	Everyone	Education	2017
10837	FAMILY	5.0	4	100	Free	Everyone	Education	2018
10838	MEDICAL	4.4	3	1000	Free	Everyone	Medical	2017
10840	LIFESTYLE	4.5	398307	10000000	Free	Everyone	Lifestyle	2018

9145 rows × 9 columns

In [ ]:

```
1
```

In [84]:
```
#Fit and Transform Data
data_encoded=encoder.fit_transform(data)
data_encoded

```

Out[84]:

	Category_0	Category_1	Category_2	Category_3	Category_4	Category_5	Rating	Reviews
0	0	0	0	0	0	1	4.1	159
1	0	0	0	0	0	1	3.9	967
2	0	0	0	0	0	1	4.7	87510
3	0	0	0	0	0	1	4.5	215644
4	0	0	0	0	0	1	4.3	967
...	...	...	...	...	...	...	...	...
10835	0	0	0	1	0	1	4.4	0
10836	0	1	0	0	1	1	4.5	38
10837	0	1	0	0	1	1	5.0	4
10838	0	1	0	1	0	0	4.4	3
10840	0	1	0	0	0	1	4.5	398307

9145 rows × 23 columns

In [85]:
```
data_encoded.columns
```

Out[85]:
```
Index(['Category_0', 'Category_1', 'Category_2', 'Category_3', 'Category_4',
       'Category_5', 'Rating', 'Reviews', 'Installs', 'Type_0', 'Type_1',
       'Content Rating_0', 'Content Rating_1', 'Content Rating_2', 'Genres_0',
       'Genres_1', 'Genres_2', 'Genres_3', 'Genres_4', 'Genres_5', 'Genres_6',
       'year_added', 'month_added'],
      dtype='object')
```

In [86]:
```
data=data_encoded.copy()
```

Feature selection

In [87]:
```
X=data.drop('Rating',axis=1)
X.head(3)
```

Out[87]:

	Category_0	Category_1	Category_2	Category_3	Category_4	Category_5	Reviews	Installs	T
0	0	0	0	0	0	1	159	10000	
1	0	0	0	0	0	1	967	500000	
2	0	0	0	0	0	1	87510	5000000	

3 rows × 22 columns

In [88]:
```
y=data['Rating'].values
y=y.astype('int')
y
```

Out[88]:
```
array([4, 3, 4, ..., 5, 4, 4])
```

Training & Testing of Model

Spliting the 80% of the dataset into train_data and 20% of the dataset into test_data

In [89]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, r
```

In [90]:
```
print(X_train.shape)
print(y_train.shape)
print(X_test.shape)
print(y_test.shape)
```

```
(6401, 22)
(6401,)
(2744, 22)
(2744,)
```

In [91]:
```
1 X_train
```

Out[91]:

	Category_0	Category_1	Category_2	Category_3	Category_4	Category_5	Reviews	Insta
7525	0	1	0	0	1	1	488039	100000
854	0	0	1	0	0	1	3528	1000
1839	0	1	0	0	1	0	9394	1000
10700	0	0	0	1	1	1	4	10
7224	0	1	1	0	1	0	0	
...	...	...	...	...	...	...	...	
7157	1	0	0	0	0	0	6	1
6575	0	1	0	0	1	1	70903	50000
6793	0	1	1	0	1	0	4	5
1170	0	0	1	1	0	0	24729	10000
8812	0	1	1	0	1	0	4908	5000

6401 rows × 22 columns

In [92]:
```
1 X_test
```

Out[92]:

	Category_0	Category_1	Category_2	Category_3	Category_4	Category_5	Reviews	Install
2686	0	1	0	1	1	0	171584	1000000
8538	0	1	1	1	1	1	24565	100000
957	0	0	1	0	1	0	8674	100000
6830	0	1	0	0	1	1	38	100
3328	0	1	1	0	1	0	1107320	5000000
...	...	...	...	...	...	...	...	
3793	1	0	0	0	0	0	78154	100000
7814	0	0	0	1	1	1	25	100
409	0	0	0	1	1	1	15880	100000
3496	0	1	1	1	0	0	212	100000
6676	0	1	0	0	1	0	20691	100000

2744 rows × 22 columns

In [93]:
```
import pandas as pd # data processing
import numpy as np # working with arrays
import matplotlib.pyplot as plt # visualization

from sklearn.linear_model import LinearRegression

from sklearn.preprocessing import StandardScaler # data normalization
from sklearn.model_selection import train_test_split # data split
from sklearn.tree import DecisionTreeRegressor # Decision tree algorithm
from sklearn.neighbors import KNeighborsRegressor # KNN algorithm

from xgboost import XGBRegressor # XGBoost algorithm
from sklearn.ensemble import RandomForestRegressor
```

In [94]:
```
#Linear Regression

regressor =LinearRegression()
regressor.fit(X_train, y_train)
lr_yhat = regressor.predict(X_test)
```

In [95]:
```
# 1. Decision Tree

tree_model = DecisionTreeRegressor(max_depth = 6, criterion = 'mse')
tree_model.fit(X_train, y_train)
tree_yhat = tree_model.predict(X_test)
```

In [96]:
```
# K-Nearest Neighbors
n = 15

knn = KNeighborsRegressor(n_neighbors = n)
knn.fit(X_train, y_train)
knn_yhat = knn.predict(X_test)
```

In [97]:
```
#random forest regressor
model = RandomForestRegressor(n_jobs=-1)
estimators = np.arange(10,200,10)
scores=[]
for n in estimators:
    model.set_params(n_estimators=n)
    model.fit(X_train,y_train)
    scores.append(model.score(X_test,y_test))

#plt.figure(figsize=(7,5))
#plt.title("effect of estimators")
#plt.xlabel("no.of estimators")
#plt.ylabel("score")
#plt.plot(estimators,scores)

#results=list(zip(estimators,scores))
#results
```

In [98]:
```
model = RandomForestRegressor(n_jobs=-1)
estimators = 190
#scores=[]
model.set_params(n_estimators=n)
model.fit(X_train,y_train)
#scores.append(model.score(X_test,y_test))
model_yhat = model.predict(X_test)

```

model.score()

In [99]:
```
y_test
```

Out[99]:
```
array([4, 4, 3, ..., 4, 4, 4])
```

In [100]:
```
from sklearn.metrics import mean_absolute_error
print("Mean absolute error of the linear regression is",mean_absolute_error(
print("Mean absolute error of the Decision tree is",mean_absolute_error(y_te
print("Mean absolute error of the KNN is",mean_absolute_error(y_test,knn_yha
print("Mean absolute error of the Random Forest Regressor is",mean_absolute_
```

```
Mean absolute error of the linear regression is 0.377607804556337
Mean absolute error of the Decision tree is 0.36725558884991244
Mean absolute error of the KNN is 0.35612244897959183
Mean absolute error of the Random Forest Regressor is 0.35366036492470243
```

In [101]:
```
from sklearn.metrics import mean_squared_error
print("Mean squared error of the linear regression is ",mean_squared_error(y
print("Mean squared error of the Decision Tree is ",mean_squared_error(y_tes
print("Mean squared error of the KNN is ",mean_squared_error(y_test,knn_yhat
print("Mean squared error of the Random Forest Regressor is ",mean_squared_e
```

```
Mean squared error of the linear regression is  0.2954317002836223
Mean squared error of the Decision Tree is  0.29955433502562934
Mean squared error of the KNN is  0.2806608357628766
Mean squared error of the Random Forest Regressor is  0.284949212887829
```

In [102]:
```
from sklearn.metrics import mean_squared_error
print("Root Mean squared error of the linear regressione is ",np.sqrt(mean_s
print("Root Mean squared error of the Decision Tree is ",np.sqrt(mean_square
print("Root Mean squared error of the KNN is ",np.sqrt(mean_squared_error(y_
print("Root Mean squared error of the Random Forest Regressor is ",np.sqrt(m
#print("root Mean squared error of the Random Forest Regressor is",np.sqrt(m
```

```
Root Mean squared error of the linear regressione is  0.543536291597555
Root Mean squared error of the Decision Tree is  0.5473155717003029
Root Mean squared error of the KNN is  0.529774325314918
Root Mean squared error of the Random Forest Regressor is  0.5338063439936144
```

In [103]:
```
from sklearn.metrics import r2_score
print("R SQUARED (R2) of the linear regression  is",r2_score(y_test,lr_yhat))
print("R SQUARED (R2) of the Decision tree  is",r2_score(y_test,tree_yhat))
print("R SQUARED (R2) of the KNN is",r2_score(y_test,knn_yhat))
print("R SQUARED (R2) of the Random Forest Regressor is",r2_score(y_test,mod
```

```
R SQUARED (R2) of the linear regression  is 0.005994683882933671
R SQUARED (R2) of the Decision tree  is -0.007876274602664823
R SQUARED (R2) of the KNN is 0.05569252552677484
R SQUARED (R2) of the Random Forest Regressor is 0.041263912566062655
```

In [104]:
```
final={}
d_category={}

for i in range(len(df.Category)):
  d_category[df['Category'].iloc[i]]=str(data['Category_0'].iloc[i])+str(dat

d_category
final['Category']=d_category
```

In [105]:
```
d_type={}
for i in range(len(df.Type)):
  d_type[df['Type'].iloc[i]]=str(data['Type_0'].iloc[i])+str(data['Type_1'].

final['Type']=d_type
```

In [106]:
```
d_content_rating={}
for i in range(len(df['Content Rating'])):
  d_content_rating[df['Content Rating'].iloc[i]]=str(data['Content Rating_0'


final['Content Rating']=d_content_rating
```

In [ ]:
```

```

In [107]:
```
d_genres={}
for i in range(len(df['Genres'])):
  d_genres[df['Genres'].iloc[i]]=str(data['Genres_0'].iloc[i])+str(data['Gen


final['Genres']=d_genres

```

In [108]:
```
df1=df.copy()
```

In [109]:
```
df1.drop('Rating',axis=1,inplace=True)
```

In [110]:
```
df1.drop(['Reviews','Installs','year_added','month_added'],axis=1,inplace=Tr
```

In [111]:
```
cols=df1.columns
columns=cols.tolist()

```

In [112]:

```
def fun(final,l):
  z=[]

  for i in range(8):
    if i==0:
      res=final['Category'][l[0]]
      for i in res:
        z.append(int(i))
    if i==1:
      z.append(l[1])
    if i==2:
      z.append(l[2])
    if i==3:
      res=final['Type'][l[3]]
      for i in res:
        z.append(int(i))
    if i==4:
      res=final['Content Rating'][l[4]]
      for i in res:
        z.append(int(i))
    if i==5:
      res=final['Genres'][l[5]]
      for i in res:
        z.append(int(i))
    if i==6:
      z.append(l[6])
    if i==7:
      z.append(l[7])

  return z



category=input("Enter the Category of the app\n")
reviews=int(input("no. of reviews\n"))
installs=int(input("no.of Installs\n"))
type=input("type of the app (free or paid)\n")
content_rating=input('Content rating of the app\n')
genres=input("genre of the app\n")
year_added=int(input("Year added \n"))
month_added = int(input("month added\n"))
l=[]
l.extend([category,reviews,installs,type,content_rating,genres,year_added,mo

z=fun(final,l)

print("#########################################################################
print()
print()
print("The Rating of the App is",knn.predict([z]).tolist())
print()
print()

print("#########################################################################
```

```
Enter the Category of the app
```

```
BEAUTY
no. of reviews
1000
no.of Installs
100000
type of the app (free or paid)
Free
Content rating of the app
Everyone
genre of the app
Art & Design
Year added
2022
month added
6
################################################################################
################


The Rating of the App is [3.6666666666666665]


################################################################################
################
```

ART_AND_DESIGN 4.1 159 10000 Free Everyone Art & Design 2018 1

'BEAUTY', 4, 100, 'Free', 'Everyone', 'Art & Design\t', 2000, 3]

The end