"A Comprehensive Analysis of Google Play Store Apps"

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PROBLEM STATEMENT

Technology is an increasing need nowadays and used everywhere. One of the features of Technology is android. Which we all use in our daily life. Android is a mobile operating system based on a modified version of the Linux kernel and other open-source software, designed primarily for touchscreen mobile devices such as smartphones and tablets. Do ETL: Extract-Transform-Load the dataset and find for me some information from this large data. This is a form of data mining. What all information can be achieved by mining this data would be brainstormed by the interns.

Find key metrics and factors and show the meaningful relationships between attributes. Do your own research and come up with your findings.

INTRODUCTION

The **Data Science Project** aims to analyze a dataset provided from the Twilearn, that contains information about various mobile applications available on the Google Play Store. The dataset includes attributes such as the Name of the App, category, rating, reviews, size, installs, genres, etc.

The goal of the project is to **use data analysis techniques to gain insights into the mobile app market**, identify trends and patterns, and make data-driven recommendations for app developers to improve their products and reach a wider audience.

In [1]:
```
# importing all necessary libraries
import numpy as np
import pandas as pd
import sklearn as sklearn
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_style('whitegrid')
```

In [2]:
```
%matplotlib inline
```

In [3]:
```
# importing the dataset
data=pd.read_csv('Google Apps data.csv')
```

In [4]:
```
data.head()
```

Out[4]:

	Unnamed: 0.1	Unnamed: 0	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Last Updated	Current Ver	Minimum Android Ver	Genres
0	0	0	Photo Editor & Candy Camera & Grid & ScrapBook	Art And Design	4.1	159	19.0	10000	Free	0.0	Others	January 7, 2018	1.0.0	4.0.3	Art & Design
1	1	1	Coloring book moana	Art And Design	3.9	967	14.0	500000	Free	0.0	Others	January 15, 2018	2.0.0	4.0.3	Art & Design
2	2	5	U Launcher Lite – FREE Live Cool Themes, Hide ...	Art And Design	4.7	87510	8.7	5000000	Free	0.0	Others	August 1, 2018	1.2.4	4.0.3	Art & Design
3	3	6	Sketch - Draw & Paint	Art And Design	4.5	215644	25.0	50000000	Free	0.0	Teen	June 8, 2018	Varies with device	4.2	Art & Design
4	4	7	Pixel Draw - Number Art Coloring Book	Art And Design	4.3	967	2.8	100000	Free	0.0	Others	June 20, 2018	1.1	4.4	Art & Design

In [5]:
```
print('The Shape of the Dataset: ',data.shape)
```

```
The Shape of the Dataset:  (8276, 15)
```

It appears that there are **8276** Records in the dataset and **15** Attributes in the Dataset.

DATA PREPROCESSING

It seems that the **Column 1:** `"Unnamed: 0.1"` is just describing the Serial Number of the Entries in the Dataset.

In [6]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8276 entries, 0 to 8275
Data columns (total 15 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   Unnamed: 0.1         8276 non-null   int64  
 1   Unnamed: 0           8276 non-null   int64  
 2   App                  8276 non-null   object 
 3   Category             8276 non-null   object 
 4   Rating               8276 non-null   float64
 5   Reviews              8276 non-null   int64  
 6   Size                 8276 non-null   float64
 7   Installs             8276 non-null   int64  
 8   Type                 8276 non-null   object 
 9   Price                8276 non-null   float64
 10  Content Rating       7915 non-null   object 
 11  Last Updated         8276 non-null   object 
 12  Current Ver          8276 non-null   object 
 13  Minimum Android Ver  8276 non-null   object 
 14  Genres               8276 non-null   object 
dtypes: float64(3), int64(4), object(8)
memory usage: 970.0+ KB
```

There is **missing values** in `Content Rating`

In [7]:
```
data['Content Rating'].isna().sum()
```

Out[7]:
```
361
```

It summarizes that there are: **8276** Records and the **Column:** `Content Rating` contains **361** missing values.

In [8]:
```
data['Content Rating'].unique()
```

Out[8]:
```
array(['Others', 'Teen', nan], dtype=object)
```

In [9]:
```
data['Content Rating']
```

Out[9]:
```
0       Others
1       Others
2       Others
3         Teen
4       Others
         ...
8271    Others
8272    Others
8273    Others
8274       NaN
8275    Others
Name: Content Rating, Length: 8276, dtype: object
```

Using Imputation Techniques to fill the missing values in the `Content Rating` Attribute.

In [10]:
```
from sklearn.impute import SimpleImputer
si=SimpleImputer(strategy='most_frequent',missing_values=np.nan)
data['Content Rating']=si.fit_transform(np.array(data['Content Rating']).reshape(-1,1))
```

In [11]:
```
data['Content Rating'].unique()
```

Out[11]:
```
array(['Others', 'Teen'], dtype=object)
```

In [12]:
```
data.describe()
```

Out[12]:

	Unnamed: 0.1	Unnamed: 0	Rating	Reviews	Size	Installs	Price
count	8276.000000	8276.000000	8276.000000	8.276000e+03	8276.000000	8.276000e+03	8276.000000
mean	4137.500000	4560.609957	4.175121	2.803270e+05	18.897761	9.658206e+06	1.028758
std	2389.219747	2560.879748	0.534762	2.096170e+06	22.376521	5.986505e+07	16.776622
min	0.000000	0.000000	1.000000	1.000000e+00	0.008300	1.000000e+00	0.000000
25%	2068.750000	2459.750000	4.000000	1.290000e+02	2.800000	1.000000e+04	0.000000
50%	4137.500000	4613.500000	4.300000	3.213500e+03	9.500000	1.000000e+05	0.000000
75%	6206.250000	6765.250000	4.500000	4.627800e+04	27.000000	1.000000e+06	0.000000
max	8275.000000	8916.000000	5.000000	7.815831e+07	100.000000	1.000000e+09	400.000000

In [13]:
```
## removing un-neccessary columns

unneccesary=['Unnamed: 0.1','Unnamed: 0','Current Ver']
data1=data.drop(columns=unneccesary,axis=1)
data1.head(3)
```

Out[13]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Last Updated	Minimum Android Ver	Genres
0	Photo Editor & Candy Camera & Grid & ScrapBook	Art And Design	4.1	159	19.0	10000	Free	0.0	Others	January 7, 2018	4.0.3	Art & Design
1	Coloring book moana	Art And Design	3.9	967	14.0	500000	Free	0.0	Others	January 15, 2018	4.0.3	Art & Design
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	Art And Design	4.7	87510	8.7	5000000	Free	0.0	Others	August 1, 2018	4.0.3	Art & Design

It appears that Columns: `Category` and `Genres` contains the same data. Let's check it.

In [14]:
```
# Checking whether Category and Genres Col. have the same entries or not

if (data1['Category'] == data1['Genres']).all():
```

```
    print("The values in the two attributes are equal.")
else:
    print("The values in the two attributes are not equal.")

# the all() method is used to check whether all the values in the two columns are equal.
```

```
The values in the two attributes are not equal.
```

In [15]:
```
data1['Category'].nunique()
```

Out[15]:
```
33
```

In [16]:
```
data1['Category'].unique()
```

Out[16]:
```
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)
```

In [17]:
```
data1['Genres'].nunique()
```

Out[17]:
```
48
```

In [18]:
```
data1['Genres'].unique()
```

Out[18]:
```
array(['Art & Design', 'Auto & Vehicles', 'Beauty', 'Books & Reference',
       'Business', 'Comics', 'Communication', 'Dating', 'Education',
       'Entertainment', 'Events', 'Finance', 'Food & Drink',
       'Health & Fitness', 'House & Home', 'Libraries & Demo',
       'Lifestyle', 'Adventure', 'Arcade', 'Casual', 'Card', 'Action',
       'Strategy', 'Puzzle', 'Sports', 'Music', 'Word', 'Racing',
       'Simulation', 'Board', 'Trivia', 'Role Playing', 'Educational',
       'Music & Audio', 'Video Players & Editors', 'Medical', 'Social',
       'Shopping', 'Photography', 'Travel & Local', 'Tools',
       'Personalization', 'Productivity', 'Parenting', 'Weather',
       'News & Magazines', 'Maps & Navigation', 'Casino'], dtype=object)
```

In [19]:
```
data['Rating'].unique()
```

Out[19]:
```
array([4.1, 3.9, 4.7, 4.5, 4.3, 4.4, 3.8, 4.2, 4.6, 4. , 4.8, 4.9, 3.6,
       3.7, 3.2, 3.3, 3.4, 3.5, 3.1, 5. , 2.6, 3. , 1.9, 2.5, 2.8, 2.7,
       1. , 2.9, 2.3, 2.2, 1.7, 2. , 1.8, 2.4, 1.6, 2.1, 1.4, 1.5, 1.2])
```

In [20]:
```
data['Reviews'].unique()
```

Out[20]:
```
array([   159,    967,  87510, ...,    603,   1195, 398307], dtype=int64)
```

In [21]:
```
data['Size'].unique()
```

Out[21]:
```
array([1.9000e+01, 1.4000e+01, 8.7000e+00, 2.5000e+01, 2.8000e+00,
       5.6000e+00, 2.9000e+01, 3.3000e+01, 3.1000e+00, 2.8000e+01,
       1.2000e+01, 2.0000e+01, 2.1000e+01, 3.7000e+01, 5.5000e+00,
       1.7000e+01, 3.9000e+01, 3.1000e+01, 4.2000e+00, 2.3000e+01,
       6.0000e+00, 6.1000e+00, 4.6000e+00, 9.2000e+00, 5.2000e+00,
       1.1000e+01, 2.4000e+01, 1.0000e+00, 9.4000e+00, 1.5000e+01,
       1.0000e+01, 1.2000e+00, 2.6000e+01, 8.0000e+00, 7.9000e+00,
       5.6000e+01, 5.7000e+01, 3.5000e+01, 5.4000e+01, 1.9629e-01,
       3.6000e+00, 5.7000e+00, 8.6000e+00, 2.4000e+00, 2.7000e+01,
       2.7000e+00, 2.5000e+00, 7.0000e+00, 1.6000e+01, 3.4000e+00,
       8.9000e+00, 3.9000e+00, 2.9000e+00, 3.8000e+01, 3.2000e+01,
       5.4000e+00, 1.8000e+01, 1.1000e+00, 2.2000e+00, 4.5000e+00,
       9.8000e+00, 5.2000e+01, 9.0000e+00, 6.7000e+00, 3.0000e+01,
       2.6000e+00, 7.1000e+00, 2.2000e+01, 6.4000e+00, 3.2000e+00,
       8.2000e+00, 4.9000e+00, 9.5000e+00, 5.0000e+00, 5.9000e+00,
       1.3000e+01, 7.3000e+01, 6.8000e+00, 3.5000e+00, 4.0000e+00,
       2.3000e+00, 2.1000e+00, 4.2000e+01, 9.1000e+00, 5.5000e+01,
       2.2460e-02, 7.3000e+00, 6.5000e+00, 1.5000e+00, 7.5000e+00,
       5.1000e+01, 4.1000e+01, 4.8000e+01, 8.5000e+00, 4.6000e+01,
       8.3000e+00, 4.3000e+00, 4.7000e+00, 3.3000e+00, 4.0000e+01,
       7.8000e+00, 8.8000e+00, 6.6000e+00, 5.1000e+00, 6.1000e+01,
       6.6000e+01, 7.7150e-02, 8.4000e+00, 3.7000e+00, 1.1523e-01,
       4.4000e+01, 6.7871e-01, 1.6000e+00, 6.2000e+00, 5.3000e+01,
       1.4000e+00, 3.0000e+00, 7.2000e+00, 5.8000e+00, 3.8000e+00,
       9.6000e+00, 4.5000e+01, 6.3000e+01, 4.9000e+01, 7.7000e+01,
       4.4000e+00, 7.0000e+01, 9.3000e+00, 8.1000e+00, 3.6000e+01,
       6.9000e+00, 7.4000e+00, 8.4000e+01, 9.7000e+01, 2.0000e+00,
       1.9000e+00, 1.8000e+00, 5.3000e+00, 4.7000e+01, 5.4297e-01,
       5.1367e-01, 7.6000e+01, 7.6000e+00, 5.9000e+01, 9.7000e+00,
       7.8000e+01, 7.2000e+01, 4.3000e+01, 7.7000e+00, 6.3000e+00,
       3.2617e-01, 9.3000e+01, 6.5000e+01, 7.9000e+01, 1.0000e+02,
       5.8000e+01, 5.0000e+01, 6.8000e+01, 6.4000e+01, 3.4000e+01,
       6.7000e+01, 6.0000e+01, 9.4000e+01, 9.9000e+00, 2.2656e-01,
       9.9000e+01, 6.0938e-01, 9.5000e+01, 8.3000e-03, 4.0040e-02,
       2.8516e-01, 8.0000e+01, 1.7000e+00, 7.4000e+01, 6.2000e+01,
       6.9000e+01, 7.5000e+01, 9.8000e+01, 8.5000e+01, 8.2000e+01,
       9.6000e+01, 8.7000e+01, 7.1000e+01, 8.6000e+01, 9.1000e+01,
       8.1000e+01, 9.2000e+01, 8.3000e+01, 8.8000e+01, 6.8750e-01,
       8.4180e-01, 8.7793e-01, 3.6914e-01, 4.8000e+00, 2.5977e-01,
       3.6621e-01, 1.3000e+00, 9.5215e-01, 9.5703e-01, 4.1000e+00,
       8.9000e+01, 6.7969e-01, 5.3125e-01, 5.1270e-01, 8.9844e-01,
```

7.6074e-01, 8.3301e-01, 7.0312e-01, 6.9629e-01, 7.5391e-01,
3.1055e-01, 5.6640e-02, 2.3535e-01, 1.9141e-01, 8.3691e-01,
4.9800e-02, 9.3066e-01, 8.4473e-01, 2.4512e-01, 9.0820e-01,
5.2734e-01, 3.0566e-01, 7.2852e-01, 1.9824e-01, 2.5390e-02,
3.0664e-01, 2.3340e-01, 3.6230e-01, 2.1484e-01, 7.1289e-01,
7.3828e-01, 8.8870e-02, 2.8613e-01, 1.6600e-02, 7.2270e-02,
1.3670e-02, 3.0957e-01, 7.6170e-02, 9.0234e-01, 7.9883e-01,
7.9100e-02, 9.1699e-01, 1.6504e-01, 4.3950e-02, 9.4238e-01,
9.0000e+01, 5.3223e-01, 5.9570e-02, 2.7637e-01, 6.3965e-01,
6.9727e-01, 9.0820e-02, 8.5156e-01, 1.1816e-01, 3.1445e-01,
9.5312e-01, 2.0117e-01, 9.3164e-01, 4.3359e-01, 7.0020e-01,
2.0508e-01, 5.9473e-01, 3.0078e-01, 2.9883e-01, 1.7090e-01,
3.4180e-01, 3.7402e-01, 4.4336e-01, 6.8360e-02, 7.9297e-01,
4.3164e-01, 8.2227e-01, 4.0723e-01, 4.0234e-01, 4.4824e-01,
4.6680e-01, 3.2715e-01, 7.6367e-01, 7.0410e-01, 4.1992e-01,
4.1895e-01, 1.8750e-01, 4.4922e-01, 7.1094e-01, 4.8438e-01,
7.9688e-01, 4.0430e-01, 4.9414e-01, 8.6621e-01, 5.9863e-01,
7.5977e-01, 6.6699e-01, 5.7812e-01, 1.8164e-01, 8.2031e-01,
6.3184e-01, 3.6426e-01, 4.2676e-01, 5.8398e-01, 6.9922e-01,
5.7129e-01, 9.5898e-01, 2.1387e-01, 5.3710e-02, 3.1543e-01,
6.7480e-01, 4.9902e-01, 9.2871e-01, 9.4043e-01, 2.4410e-02,
5.4102e-01, 3.4277e-01, 2.6370e-02, 8.0080e-02, 2.0312e-01,
5.3809e-01, 2.8320e-02, 1.0059e-01, 1.1328e-01, 1.4941e-01,
2.0410e-01, 4.8730e-01, 1.6895e-01, 5.8301e-01, 7.9004e-01,
1.1914e-01, 4.0137e-01, 3.9062e-01, 7.8223e-01, 7.6855e-01,
4.8830e-02, 6.2793e-01, 9.6289e-01, 5.0391e-01, 8.1738e-01,
7.6172e-01, 1.9530e-02, 4.8633e-01, 5.8594e-01, 6.4062e-01,
2.1582e-01, 2.2266e-01, 1.7188e-01, 3.3200e-02, 2.5293e-01,
1.6016e-01, 4.4727e-01, 6.1426e-01, 2.7340e-02, 2.8125e-01,
7.5684e-01, 7.6660e-01, 6.2109e-01, 8.9453e-01, 9.7070e-01,
3.0176e-01, 4.7363e-01, 8.9258e-01, 8.8184e-01, 5.9375e-01,
4.8828e-01, 5.2730e-02, 5.4883e-01, 8.2715e-01, 9.2578e-01,
7.9199e-01, 2.6367e-01, 4.6880e-02, 5.1074e-01, 7.6562e-01,
2.7344e-01, 2.3440e-02, 8.7109e-01, 1.5039e-01, 1.7580e-02,
3.2230e-02, 8.3984e-01, 3.5547e-01, 3.7793e-01, 6.1133e-01,
1.5723e-01, 8.5840e-01, 3.8090e-02, 1.6602e-01, 1.3770e-01,
1.5625e-01, 1.4062e-01, 1.3965e-01, 1.8555e-01, 3.6719e-01,
1.8848e-01, 4.6191e-01, 2.4023e-01, 7.1290e-02, 2.4707e-01,
9.3457e-01, 4.1016e-01, 7.0310e-02, 3.9453e-01, 4.5898e-01,
2.2070e-01, 2.3438e-01, 8.6910e-02, 2.2852e-01, 2.5098e-01,

```
       8.4082e-01, 4.5605e-01, 6.6016e-01, 5.3906e-01, 5.6836e-01,
       6.0449e-01])
```

In [22]:
```
data1['Installs'].unique()
```

Out[22]:
```
array([     10000,     500000,    5000000,   50000000,     100000,
            50000,    1000000,   10000000,       5000,  100000000,
       1000000000,       1000,  500000000,        100,        500,
               10,          5,         50,          1], dtype=int64)
```

In [23]:
```
data1['Type'].unique()
```

Out[23]:
```
array(['Free', 'Paid'], dtype=object)
```

In [24]:
```
data1['Price'].unique()
```

Out[24]:
```
array([  0.  ,   4.99,   3.99,   6.99,   7.99,   5.99,   2.99,   3.49,
         1.99,   9.99,   7.49,   0.99,   9.  ,   5.49,  10.  ,  24.99,
        11.99,  79.99,  16.99,  14.99,  29.99,  12.99,   2.49,  10.99,
         1.5 ,  19.99,  15.99,  33.99,  39.99,   3.95,   4.49,   1.7 ,
         8.99,   1.49,   3.88, 399.99,  17.99, 400.  ,   3.02,   1.76,
         4.84,   4.77,   1.61,   2.5 ,   1.59,   6.49,   1.29, 299.99,
       379.99,  37.99,  18.99, 389.99,   8.49,   1.75,  14.  ,   2.  ,
         3.08,   2.59,  19.4 ,   3.9 ,   4.59,  15.46,   3.04,  13.99,
         4.29,   3.28,   4.6 ,   1.  ,   2.95,   2.9 ,   1.97,   2.56,
         1.2 ])
```

In [25]:
```
data1['Minimum Android Ver'].unique()
```

Out[25]:
```
array(['4.0.3', '4.2', '4.4', '2.3', '3.0', '4.1', '4.0', '2.3.3', '-1',
       '2.2', '5.0', '6.0', '1.6', '1.5', '2.1', '7.0', '4.3', '2.0',
       '3.2', '5.1', '7.1', '8.0', '3.1', '2.0.1', '1.0'], dtype=object)
```

We can observe that there is a data point with **Minimum Android Version as -1**, it states that the particular application has no Minimum Android Ver. and can work perfectly with any version.

In [26]:
```
# rechecking dataset again
data1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8276 entries, 0 to 8275
Data columns (total 12 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   App                  8276 non-null   object 
 1   Category             8276 non-null   object 
 2   Rating               8276 non-null   float64
 3   Reviews              8276 non-null   int64  
 4   Size                 8276 non-null   float64
 5   Installs             8276 non-null   int64  
 6   Type                 8276 non-null   object 
 7   Price                8276 non-null   float64
 8   Content Rating       8276 non-null   object 
 9   Last Updated         8276 non-null   object 
 10  Minimum Android Ver  8276 non-null   object 
 11  Genres               8276 non-null   object 
dtypes: float64(3), int64(2), object(7)
memory usage: 776.0+ KB
```

EXPLORATORY DATA ANALYSIS (EDA) AND VISUALIZATION

1. Let's See which Application is mostly installed.

In [27]:
```
app_with_most_installs = data1.loc[data1['Installs'].idxmax(), 'App']
print("App with the most installs:", app_with_most_installs)
```

```
App with the most installs: Google Play Books
```

2. Apps having <10 Installs

In [28]:
```
data1[data1['Installs']<10].sort_values(by='Installs')
```

Out[28]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Last Updated	Minimum Android Ver	Genres
1844	KBA-EZ Health Guide	Medical	5.0	4	25.0	1	Free	0.00	Others	August 2, 2018	4.0.3	Medical
4616	Ra Ga Ba	Game	5.0	2	20.0	1	Paid	1.49	Others	February 8, 2017	2.3	Arcade
8181	Mu.F.O.	Game	5.0	2	16.0	1	Paid	0.99	Others	March 3, 2017	2.3	Arcade
1842	Tablet Reminder	Medical	5.0	4	2.5	5	Free	0.00	Others	August 3, 2018	4.1	Medical
1848	Anatomy & Physiology Vocabulary Exam Review App	Medical	5.0	1	4.6	5	Free	0.00	Others	August 2, 2018	4.0	Medical
1856	Clinic Doctor EHr	Medical	5.0	2	7.1	5	Free	0.00	Others	August 3, 2018	8.0	Medical
5187	Brick Breaker BR	Game	5.0	7	19.0	5	Free	0.00	Others	July 23, 2018	4.1	Arcade
5498	CB Heroes	Social	5.0	5	1.8	5	Free	0.00	Others	August 4, 2018	5.0	Social
5913	CQ ESPM	Business	5.0	2	3.4	5	Free	0.00	Others	June 3, 2017	4.1	Business
6251	CZ-Help	Books And Reference	5.0	2	1.4	5	Free	0.00	Others	July 13, 2018	4.4	Books & Reference
7083	EB Cash Collections	Business	5.0	1	4.3	5	Free	0.00	Others	July 31, 2018	4.4	Business
8082	FK Atlantas	Sports	1.5	2	26.0	5	Free	0.00	Others	February 21, 2018	4.1	Sports

We can observe that we have **3 Applications** (KBA-EZ Health Guide, Ra Ga Ba, Mu.F.O.) having only single Installs and **9 Applications** having only 5 installs.

3. Number of Apps in each Android Version

In [29]:
```
res4=data1['Minimum Android Ver'].value_counts()
```

In [93]:
```
res4
```

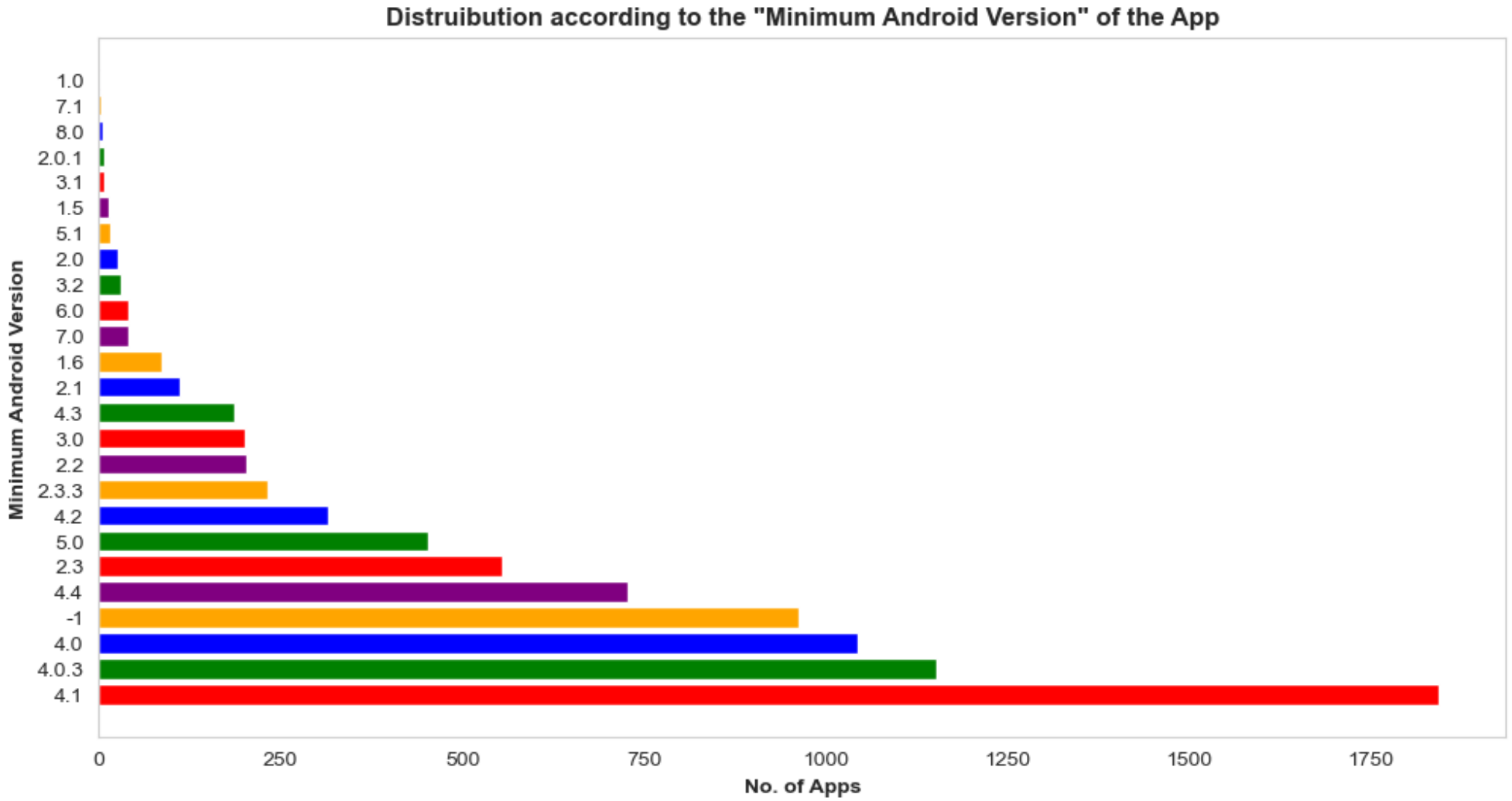
Out[93]:
```
4.1      1843
4.0.3    1152
4.0      1045
-1        963
4.4       728
2.3       554
5.0       454
4.2       315
2.3.3     233
2.2       203
3.0       202
4.3       187
2.1       112
1.6        87
7.0        42
6.0        42
3.2        31
2.0        27
5.1        16
1.5        15
3.1         8
2.0.1       7
8.0         5
7.1         3
1.0         2
Name: Minimum Android Ver, dtype: int64
```

Here we can make the following conclusions:

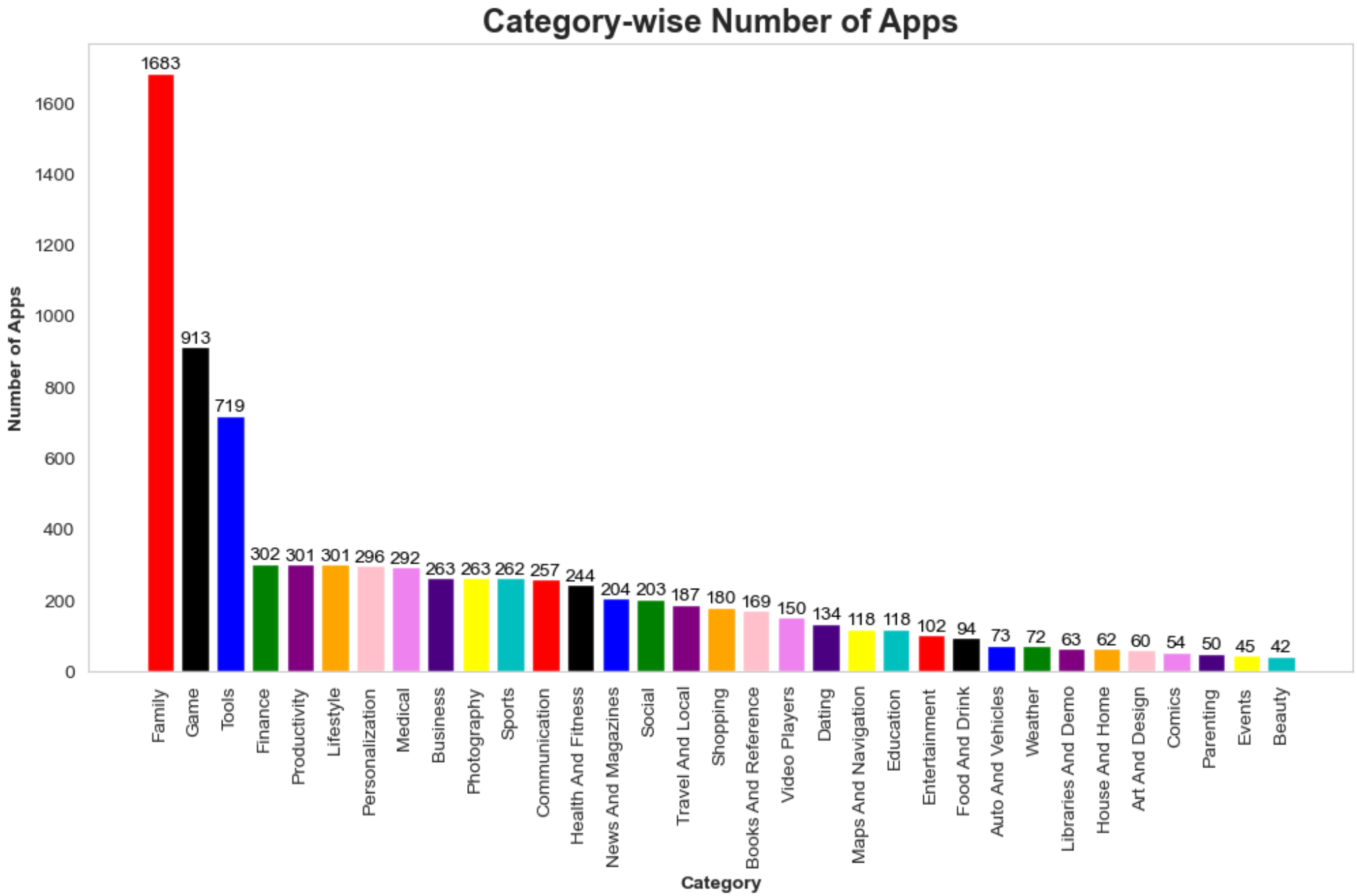
1. 2 Applications support a Minimum Android Version of -1.
2. 963 Applications does not require any Minimum Android Version.
3. 1843 Applications support (highest) requires a Minimum Android Version of 4.1.

In [30]:
```
fig,ax=plt.subplots(figsize=(12,6))
plt.title('Distruibution according to the "Minimum Android Version" of the App',fontweight=600)
plt.ylabel('Minimum Android Version',fontweight='bold')
plt.xlabel('No. of Apps',fontweight='bold')
```

```
plt.grid(False)
bar_colors = ['red', 'green', 'blue', 'orange', 'purple']
plt.barh(res4.index,res4.values,color=bar_colors)
plt.show()
```



In [52]:
```
# creating a bar chart of app categories

cd=['red','black','blue','green','purple','orange','pink','violet','indigo','yellow','c']
fig,ax=plt.subplots(figsize=(12,6))
category_counts = data1['Category'].value_counts()
plt.bar(category_counts.index, category_counts.values,color=cd)
plt.xticks(rotation=90)
fig.set_facecolor('w')
plt.grid(False)
plt.xlabel('Category',fontweight='bold')
plt.ylabel('Number of Apps',fontweight='bold')
plt.title("Category-wise Number of Apps",size=17, fontweight='bold')
for i, v in enumerate(category_counts):
   plt.annotate(str(v), xy=(i, v),ha='center',color='black',va='bottom')

plt.show()
```


Category-wise Number of Apps
Number of Apps
0
200
400
600
800
1000
1200
1400
1600
1683
913
719
302
301
301
296
292
263
263
262
257
244
204
203
187
180
169
150
134
118
118
102
94
73
72
63
62
60
54
50
45
42
Family
Game
Tools
Finance
Productivity
Lifestyle
Personalization
Medical
Business
Photography
Sports
Communication
Health And Fitness
News And Magazines
Social
Travel And Local
Shopping
Books And Reference
Video Players
Dating
Maps And Navigation
Education
Entertainment
Food And Drink
Auto And Vehicles
Weather
Libraries And Demo
House And Home
Art And Design
Comics
Parenting
Events
Beauty
Category

Observing the Barchart we can see that `Family` and `Games` are the Categories which are having the most number of applications.

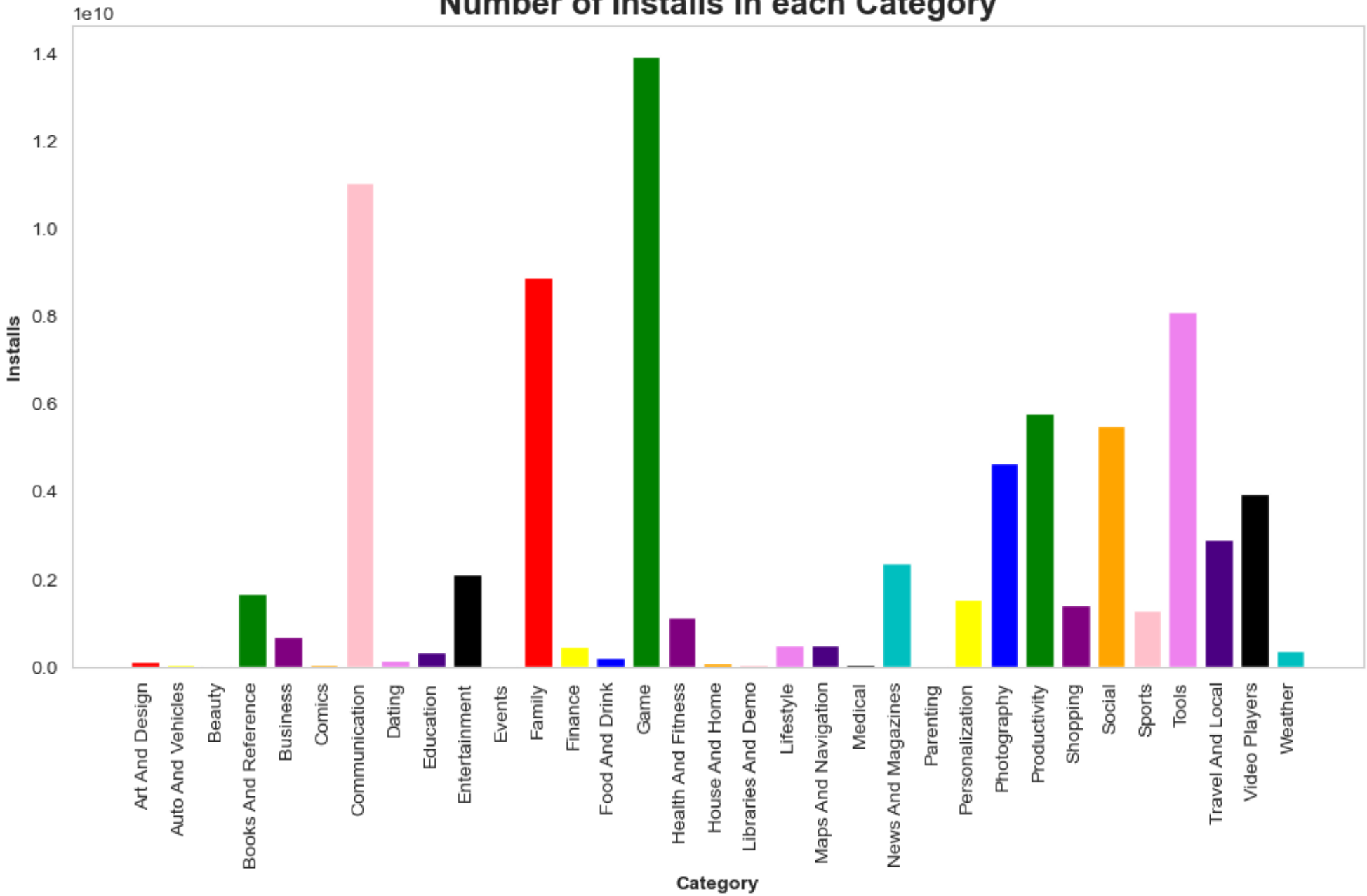
In [32]:
```
res=data1.groupby(['Category'])['Installs'].sum()
```

In [33]:
```
res
```

Out[33]:
```
Category
Art And Design           114228100
Auto And Vehicles         53129800
Beauty                    26916200
Books And Reference     1665791655
Business                 697018120
Comics                    44931100
Communication          11039241530
Dating                   140912410
Education                352852000
Entertainment           2113660000
Events                    15949410
Family                  8885030590
Finance                  455312400
Food And Drink           211677750
Game                   13928762717
Health And Fitness      1144006220
House And Home            97082000
Libraries And Demo        51083000
Lifestyle                503741120
Maps And Navigation      503267560
Medical                   39252676
News And Magazines      2369110650
Parenting                 31116110
Personalization         1532341930
Photography             4649143130
Productivity            5793070180
Shopping                1400331540
Social                  5487841475
Sports                  1296431465
Tools                   8100224500
Travel And Local        2894859300
Video Players           3931897200
Weather                  361096500
Name: Installs, dtype: int64
```

In [34]:
```
cd=['red','yellow','blue','green','purple','orange','pink','violet','indigo','black','c']
fig,ax=plt.subplots(figsize=(12,6))
plt.bar(res.index, res.values,color=cd)
plt.xlabel('Category',fontweight='bold')
plt.ylabel('Installs',fontweight='bold')
```

```
plt.grid(False)
plt.xticks(rotation=90)
plt.title("Number of Installs in each Category",size=17, fontweight='bold')
plt.show()
```


Number of Installs in each Category
1e10
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Installs
Art And Design
Auto And Vehicles
Beauty
Books And Reference
Business
Comics
Communication
Dating
Education
Entertainment
Events
Family
Finance
Food And Drink
Game
Health And Fitness
House And Home
Libraries And Demo
Lifestyle
Maps And Navigation
Medical
News And Magazines
Parenting
Personalization
Photography
Productivity
Shopping
Social
Sports
Tools
Travel And Local
Video Players
Weather
Category

It can be observed from the above graph, that the **Most Number of Installs** are from:

1. Games (13928762717 Installs)
2. Communication (11039241530 Installs)
3. Family (885030590 Installs)
4. Tools (8100224500 Installs)
5. Productivity (5793070180 Installs)

The **Least Number of Installs** are from:

1. Events (15949410 Installs)
2. Beauty (26916200 Installs)
3. Parenting (31116110 Installs)
4. Medical (39252676 Installs)
5. Comics (44931100 Installs)

In [35]:
```
res2=data1.groupby(['Category'])['Rating'].mean()
res2
```

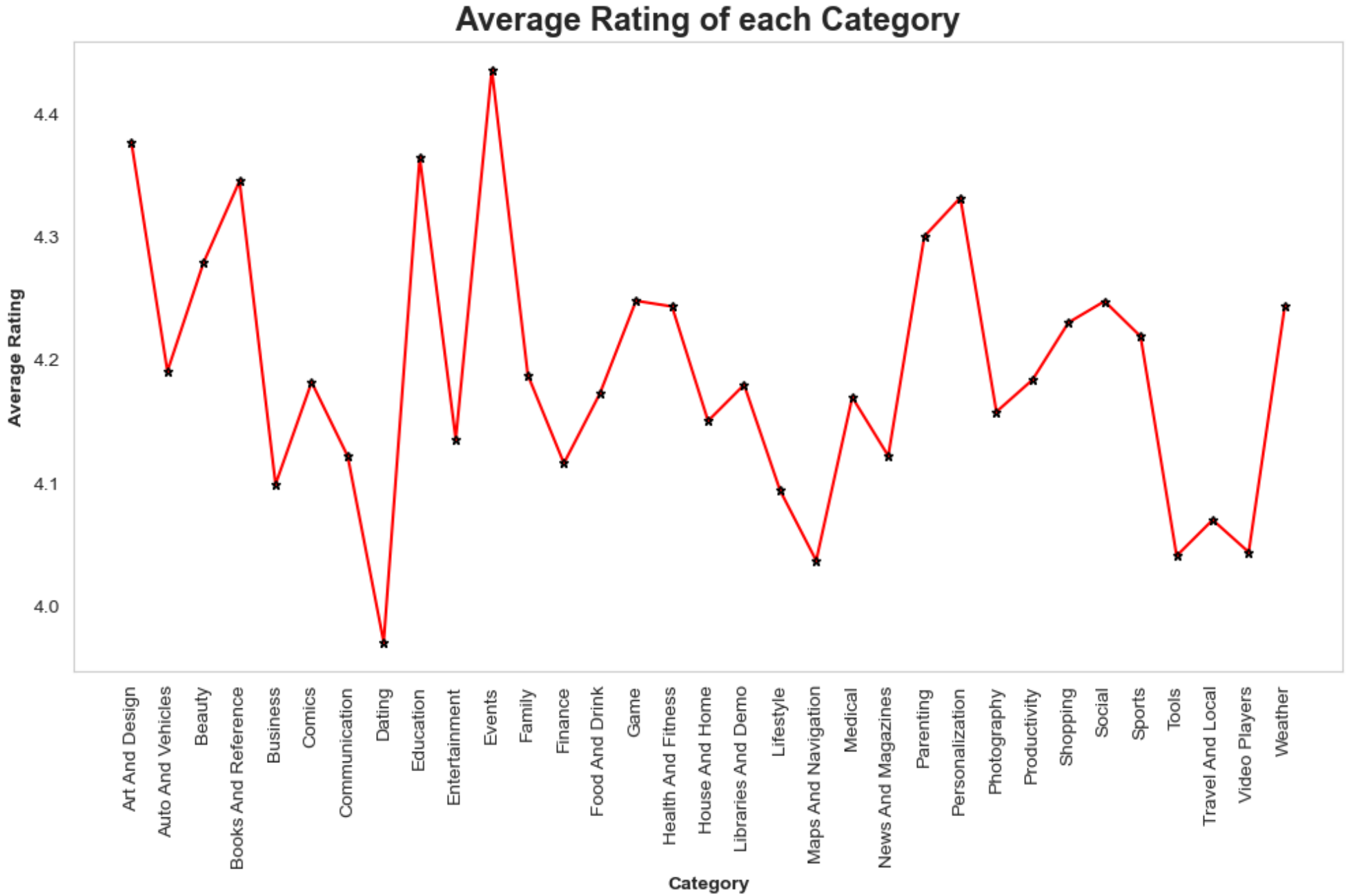
Out[35]:

```
Category
Art And Design         4.376667
Auto And Vehicles      4.190411
Beauty                 4.278571
Books And Reference    4.344970
Business               4.098479
Comics                 4.181481
Communication          4.121401
Dating                 3.970149
Education              4.364407
Entertainment          4.135294
Events                 4.435556
Family                 4.187285
Finance                4.115563
Food And Drink         4.172340
Game                   4.247645
Health And Fitness     4.243033
House And Home         4.150000
Libraries And Demo     4.179365
Lifestyle              4.093355
Maps And Navigation    4.036441
Medical                4.169178
News And Magazines     4.121569
Parenting              4.300000
Personalization        4.331419
Photography            4.157414
Productivity           4.183389
Shopping               4.230000
Social                 4.247291
Sports                 4.218702
Tools                  4.040334
Travel And Local       4.069519
Video Players          4.043333
Weather                4.243056
Name: Rating, dtype: float64
```

In [36]:

```
fig,ax=plt.subplots(figsize=(12,6))
plt.plot(res2,marker='*',color='red',ms=5,mec='black')
plt.xlabel('Category',fontweight='bold')
plt.ylabel('Average Rating',fontweight='bold')
plt.grid(False)
```

```
plt.xticks(rotation=90)
plt.title("Average Rating of each Category",size=17, fontweight='bold')
plt.show()
```


Average Rating of each Category
Average Rating
4.4
4.3
4.2
4.1
4.0
Art And Design
Auto And Vehicles
Beauty
Books And Reference
Business
Comics
Communication
Dating
Education
Entertainment
Events
Family
Finance
Food And Drink
Game
Health And Fitness
House And Home
Libraries And Demo
Lifestyle
Maps And Navigation
Medical
News And Magazines
Parenting
Personalization
Photography
Productivity
Shopping
Social
Sports
Tools
Travel And Local
Video Players
Weather
Category

It can be observed from the above graph, that the **Top 2 Most Rated App Categories are:**

1. Events (4.43)
2. Art and Design (4.37)

Least Rated App Categories are:

1. Dating (3.97)

In [37]:
```
correlation=data1.corr()
```

In [38]:
```
fig,ax=plt.subplots(figsize=(8,5))
sns.heatmap(correlation,annot=True)
```

Out[38]:
```
<AxesSubplot:>
```

Using the **Correlation Matrix**, we can understand the relationship between the Attributes of the Dataset, here we can observe that `Reviews` and `Installs` have the highest correlation.

4. Finding out Number of Paid and Free Apps and their Distribution

In [39]:
```
free_or_paid_df=data1.groupby('Type')[['App']].count()
```

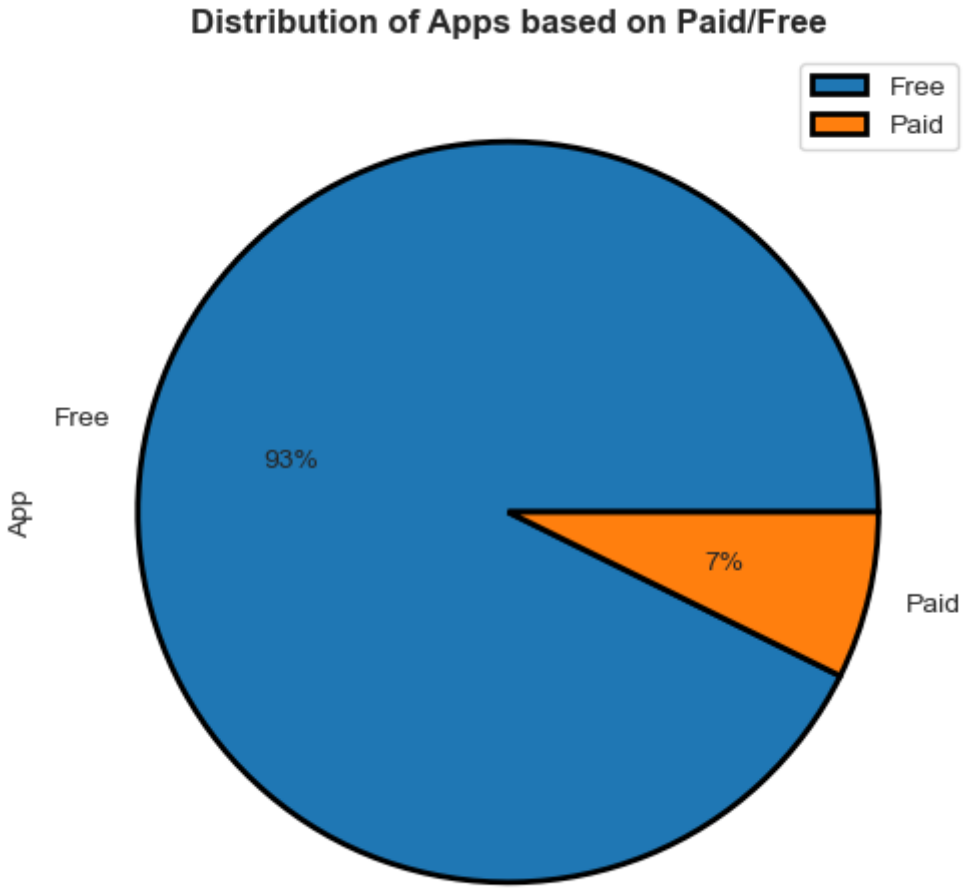
In [40]:
```
free_or_paid_df
```

Out[40]:

Type	App
Free	7672
Paid	604

In [41]:
```
free_or_paid_df.plot.pie(subplots=True, figsize=(12, 6), wedgeprops={"edgecolor":"0",'linewidth': 2, 'antialiased': True},
                         autopct='%1.0f%%')
plt.title('Distribution of Apps based on Paid/Free',fontweight=600)
```

Out[41]:
```
Text(0.5, 1.0, 'Distribution of Apps based on Paid/Free')
```



5. Price Range Specific Distribution

In [42]:
```
# Defining the price ranges
price_ranges = [-0.01, 1, 3, 5, 7, 10, 13, 15, 18, 21, float('inf')]
price_labels = ['<1', '1-3', '3-5', '5-7', '7-10', '10-13','13-15','15-18','18-21', '21+']

# Grouping data points based on price ranges
data1['Price Range'] = pd.cut(data1['Price'], bins=price_ranges, labels=price_labels)
```

```
# Display the data grouped by price ranges
grouped_data = data1.groupby('Price Range')['App'].count()
grouped_data
```

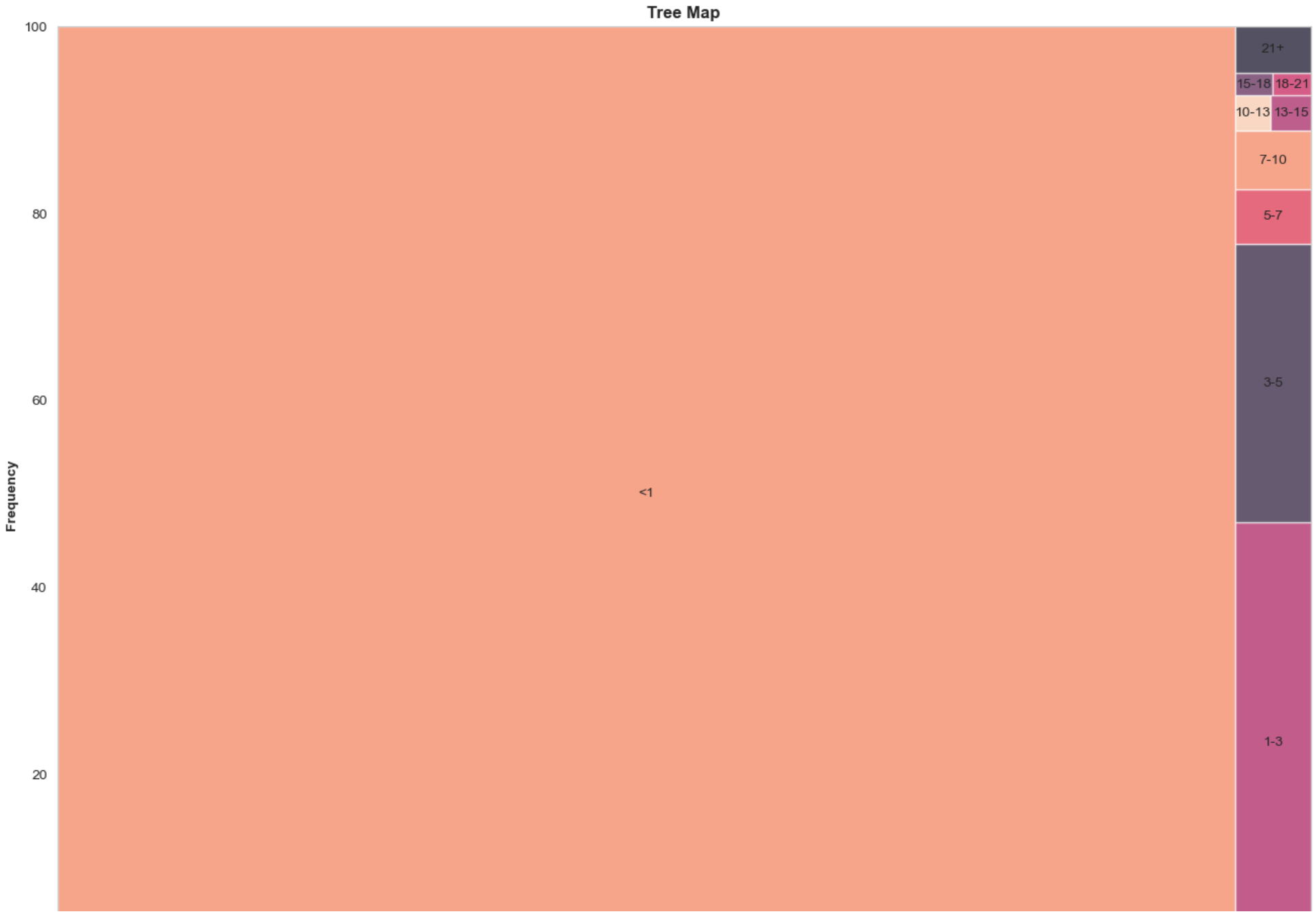
Out[42]:
```
Price Range
<1       7777
1-3       234
3-5       149
5-7        29
7-10       31
10-13       9
13-15      10
15-18       6
18-21       6
21+        25
Name: App, dtype: int64
```

In [149…
```
pip install squarify
```

```
Defaulting to user installation because normal site-packages is not writeableNote: you may need to restart the kernel to use updated pac
kages.

Collecting squarify
  Downloading squarify-0.4.3-py3-none-any.whl (4.3 kB)
Installing collected packages: squarify
Successfully installed squarify-0.4.3
```

In [56]:
```
import squarify

fig,ax=plt.subplots(figsize=(16,12))
categories=np.array(grouped_data.index)
values=np.array(grouped_data.values)
# Calculating the sizes for the tree map
sizes = [value / sum(values) for value in values]
# Creating the tree map
squarify.plot(sizes=sizes, label=categories, alpha=0.7)

# Set the axis labels and title
plt.xlabel('Price',fontweight='bold')
plt.grid(False)
plt.ylabel('Frequency',fontweight='bold')
```

```
plt.title('Tree Map',fontweight='bold')
plt.show()
```


Tree Map
Frequency
100
80
60
40
20
<1
21+
15-18
18-21
10-13
13-15
7-10
5-7
3-5
1-3

We can observe that: **7777 Apps** are priced **0.0 (Free)** and **499 Apps** are **>0.0 (Paid).**

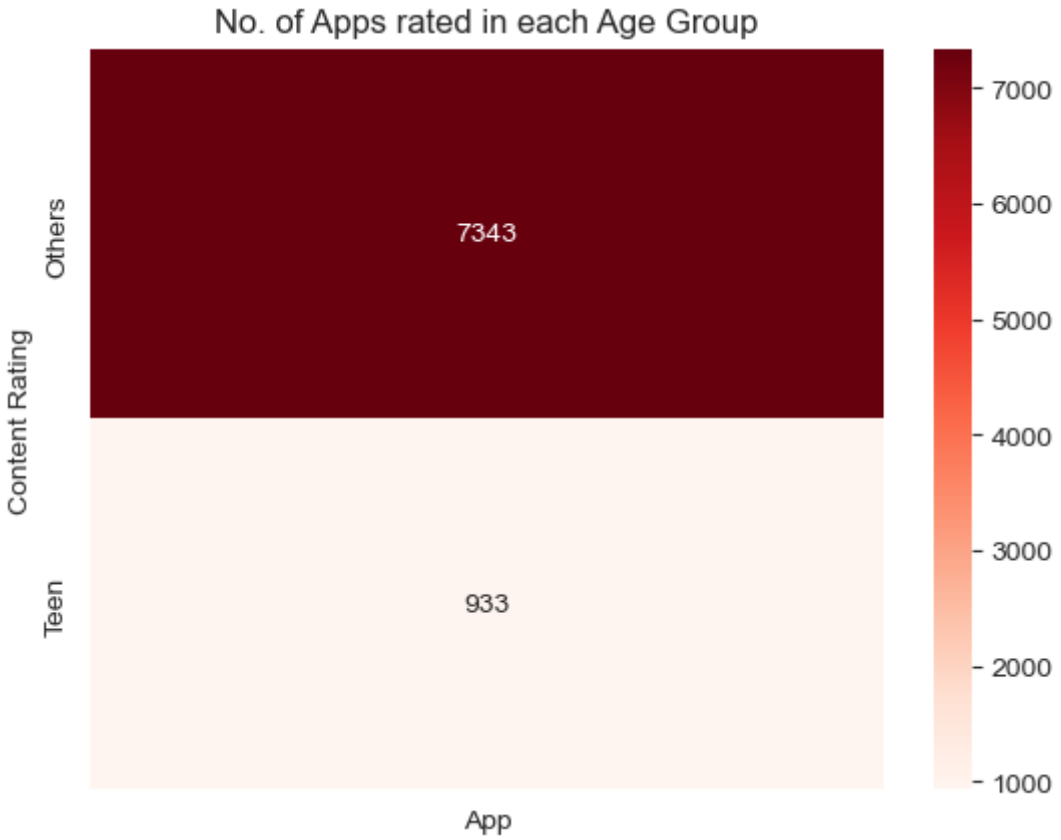
```
Out of the Paid Apps: (Amt. in Dollars)
    1-3 ---> 234
    3-5 ---> 149
    5-7 ---> 29
    7-10 --> 31
    10-13 -> 9
    13-15 -> 10
    15-18 -> 6
    18-21 -> 6
    21+ ---> 25
```

Apps greater than 15$ can be considered **EXPENSIVE APPS.**

6. Plotting Heatmap for Number of Apps in each age group.

In [44]:
```
plt.title("No. of Apps rated in each Age Group")
sns.heatmap(data1.groupby('Content Rating')[['App']].count(),fmt="d", annot=True, cmap='Reds')
```

Out[44]:
```
<AxesSubplot:title={'center':'No. of Apps rated in each Age Group'}, ylabel='Content Rating'>
```



7. Apps have large Number of Reviews

In [45]:
```
data1.sort_values(by=['Reviews'],ascending=False).head(10)
```

Out[45]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Last Updated	Minimum Android Ver	Genres	Price Range
1892	Facebook	Social	4.1	78158306	1.0	1000000000	Free	0.0	Teen	August 3, 2018	-1	Social	<1
287	WhatsApp Messenger	Communication	4.4	69119316	1.0	1000000000	Free	0.0	Others	August 3, 2018	-1	Communication	<1
1893	Instagram	Social	4.5	66577313	1.0	1000000000	Free	0.0	Teen	July 31, 2018	-1	Social	<1
286	Messenger – Text and Video Chat for Free	Communication	4.0	56642847	1.0	1000000000	Free	0.0	Others	August 1, 2018	-1	Communication	<1
1291	Clash of Clans	Game	4.6	44891723	98.0	100000000	Free	0.0	Others	July 15, 2018	4.1	Strategy	<1
3054	Clash of Clans	Family	4.6	44881447	98.0	100000000	Free	0.0	Others	July 15, 2018	4.1	Strategy	<1
3072	Clean Master- Space Cleaner & Antivirus	Tools	4.7	42916526	1.0	500000000	Free	0.0	Others	August 3, 2018	-1	Tools	<1
1275	Subway Surfers	Game	4.5	27722264	76.0	1000000000	Free	0.0	Others	July 12, 2018	4.1	Arcade	<1
2787	YouTube	Video Players	4.3	25655305	1.0	1000000000	Free	0.0	Teen	August 2, 2018	-1	Video Players & Editors	<1
5746	Security Master - Antivirus, VPN, AppLock, Boo...	Tools	4.7	24900999	1.0	500000000	Free	0.0	Others	August 4, 2018	-1	Tools	<1

8. Top 15 Apps with the Largest Size

In [46]:
```
data1.sort_values(by=['Size'],ascending=False).head(10)
```

Out[46]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Last Updated	Minimum Android Ver	Genres	Price Range
4568	Gangster Town: Vice District	Family	4.3	65146	100.0	10000000	Free	0.00	Others	May 31, 2018	4.0	Simulation	<1
6442	Car Crash III Beam DH Real Damage Simulator 2018	Game	3.6	151	100.0	10000	Free	0.00	Others	May 20, 2018	4.1	Racing	<1
3629	Vi Trainer	Health And Fitness	3.6	124	100.0	5000	Free	0.00	Others	August 2, 2018	5.0	Health & Fitness	<1
7047	Stickman Legends: Shadow Wars	Game	4.4	38419	100.0	1000000	Paid	0.99	Others	August 3, 2018	4.1	Action	<1
1737	Navi Radiography Pro	Medical	4.7	11	100.0	500	Paid	15.99	Others	January 14, 2018	4.0.3	Medical	15-18
4304	The Walking Dead: Our World	Game	4.0	22435	100.0	1000000	Free	0.00	Teen	August 1, 2018	5.0	Action	<1
4566	Miami crime simulator	Game	4.0	254518	100.0	10000000	Free	0.00	Others	July 9, 2018	4.0	Action	<1
4221	Ultimate Tennis	Sports	4.3	183004	100.0	10000000	Free	0.00	Others	July 19, 2018	4.0.3	Sports	<1
6793	Draft Simulator for FUT 18	Sports	4.6	162933	100.0	5000000	Free	0.00	Others	May 11, 2018	4.1	Sports	<1
1196	Talking Babsy Baby: Baby Games	Lifestyle	4.0	140995	100.0	10000000	Free	0.00	Others	July 16, 2018	4.0	Lifestyle	<1

9. Number of Paid Apps in each Category.

In [47]:
```
# Number of paid apps in each category
paid_apps_by_category = data[data['Type'] == 'Paid'].groupby('Category').size()
print("\nNumber of Paid Apps in Each Category:")
print(paid_apps_by_category)
```

```
Number of Paid Apps in Each Category:
Category
Art And Design           3
Auto And Vehicles        1
Books And Reference      8
Business                 9
Communication           22
Dating                   3
Education                4
Entertainment            2
Family                 155
Finance                 13
Food And Drink           2
Game                    76
Health And Fitness      11
Lifestyle               18
Maps And Navigation      5
Medical                 63
News And Magazines       2
Parenting                2
Personalization         64
Photography             15
Productivity            18
Shopping                 2
Social                   2
Sports                  22
Tools                   63
Travel And Local         8
Video Players            4
Weather                  7
dtype: int64
```

THANK YOU