Exploratory Anaylysis of Google Play Store Applications

Contents

1. Introduction

1.1 Background

There are quite a number of numerous applications on mobile phone store apps such as apple store, amazon store, google play store etc. These applications have a wide range of characteristics viz classification of apps and games, some paid and most free, all in different categories (Family, Education, Communication etc.) etc. As a mobile application developer, I am motivated to explore know how these characteristics/the features of applications listed relates together for a successful deployment of an application in the Android market.

1.2 Aims

With the diverse nature of these applications, the reserach **aims** at exploring the dataset inorder to:

1. Determine the app category of the most & least popular and most & least rated applications
2. Determine the correlation between rating and review of applications
3. How the size of an application affects other features of the application
4. How demographics such as content rating, age impact other features of the application
5. Analyse Characteristics of rated applications
6. Predict what the rating of an application based on other features
7. Predict the number of downloads based on other features of the application

1.3 Objectives

At the end of this exploratory analysis, the objective is to:

1. Perform statistical analysis and data exploration.
2. Be able to draw useful facts and inisight from the data.
3. Provide insights that will help developers to understand what type and category of apps are likely to attract more users on Google Play.

1.4 Data Source & Pipeline

The data set used for this analysis is taken from kaggle which can be found here. It was initially scraped from the Google Play Store according to the author:

> While there are a large number of public datasets that provide data from the Apple App Store (such as those found on Kaggle and other similar websites), there are not nearly as many public datasets that provide data from the Google Play Store. After doing some additional research, It was discovered that the page for the iTunes App Store used a beautifully indexed appendix-like structure, which makes it possible for simple and easy web scraping. (Lavanya Gupta, 2018)

This dataset (in csv) was choosen because it contains the basic properties,characteristics and details needed to describe an application. It has 10841 rows and 13 columns. The rows are the applications and the column are the feature of the application for analysis with the following 13 features: App, Category, Rating, Reviews, Size, Installs, Type, Price, Content Rating, Genres, Last Updated, Current Ver, Android Ver.

Nevertheless, this dataset does not include recently released applications, plans were made to update the data set to the recent playstore data through web scraping. The data was scraped on August 2018. The dataset was licensed to be used open and free under the Creative Commons CC0 1.0 Universal (CC0 1.0) Public Domain Dedication.

Facts and findings from this analysis is credited to Lavanya Gupta and Google Play Store because the app information would not have been available without these two entities. All outcome are only meant for understanding the android application market and not for any other purpose and the accuracy of any findings can't exceed the accuracy of the data used for the analysis.

The dataset is loaded into the notebook from the base directory of the project and resulting dataset after cleaning is saved in the same base directory of the project. The data is distributed amidst the available application category. It was firstly cleaned by replacing/removing the duplicates, inconsistent and null values. Then it was analysed using the pandas library and then visualized using the matplotlib and seaborn libraries in python. I have choosen to use the dataset consisting only aggregate reviews of applications and not the detailed review provided from the data source, because no sentiment analysis is intended to be carried out in this analysis. At the end of the analysis, the conclusions were made based on the aims and objectives of this research which are deduced from the analysis and visualizations.

Impoting Libraries

In [ ]:

```python
# import libraries
import seaborn as sns
import statistics as stat
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import warnings
import re
warnings.filterwarnings('ignore') # to ignore warnings in the notebook that are not important
```

Data Overview

In [ ]:

```python
data = pd.read_csv('googleplaystore.csv')  # read the data
data.sample(10)  # this will show 10 random rows from the data
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Ge
9690	Out There Chronicles - Ep. 1	FAMILY	4.4	1516	44M	50,000+	Paid	$2.99	Everyone	Role Pla
8589	e-DN - den digitala tidningen från Dagens Nyheter	NEWS_AND_MAGAZINES	2.2	160	32M	50,000+	Free	0	Everyone 10+	Nev Magaz
10192	Facejjang	PHOTOGRAPHY	4.1	100179	96M	10,000,000+	Free	0	Everyone	Photogra
2516	RT 516 VET	MEDICAL	NaN	0	29M	10+	Free	0	Everyone	Me
5443	3D Holograms Joke	FAMILY	2.9	31596	31M	5,000,000+	Free	0	Teen	Simula
284	SignEasy | Sign and Fill PDF and other Documents	BUSINESS	4.3	8978	Varies with device	1,000,000+	Free	0	Everyone	Busi
1926	Swamp Attack	GAME	4.4	2119218	70M	50,000,000+	Free	0	Everyone 10+	Ac
8677	DP Editor	PHOTOGRAPHY	4.3	18	15M	5,000+	Free	0	Teen	Photogra
3073	NCAA March Madness Live	SPORTS	4.1	34123	19M	5,000,000+	Free	0	Everyone	Sp
486	Hinge: Dating & Relationships	DATING	4.2	7779	12M	500,000+	Free	0	Mature 17+	Da

In [ ]:

```
data.shape  # to see the shape of the data i.e. no. of rows and columns
```

Out[ ]:

```
(10841, 13)
```

In [ ]:

```
data.info()  # see the information of the data and the data types of the columns
```

```
<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 [ ]:

```python
# see the description of the data, the include='O' is used to see the description of the object
data.describe(include='O')
```

Out[ ]:

	App	Category	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Andr
count	10841	10841	10841	10841	10841	10840	10841	10840	10841	10841	10833	108
unique	9660	34	6002	462	22	3	93	6	120	1378	2832	
top	ROBLOX	FAMILY	0	Varies with device	1,000,000+	Free	0	Everyone	Tools	August 3, 2018	Varies with device	4.1 a
freq	9	1972	596	1695	1579	10039	10040	8714	842	326	1459	24

In [ ]:

```python
data.describe()  # to see the description of other data types not object type (Rating)
```

Out[ ]:

	Rating
count	9367.000000
mean	4.193338
std	0.537431
min	1.000000
25%	4.000000
50%	4.300000
75%	4.500000
max	19.000000

In [ ]:

```python
# This list total number of applications in each category
data['Category'].value_counts()
```

```
Out[ ]: FAMILY                 1972
        GAME                   1144
        TOOLS                   843
        MEDICAL                 463
        BUSINESS                460
        PRODUCTIVITY            424
        PERSONALIZATION         392
        COMMUNICATION           387
        SPORTS                  384
        LIFESTYLE               382
        FINANCE                 366
        HEALTH_AND_FITNESS      341
        PHOTOGRAPHY             335
        SOCIAL                  295
        NEWS_AND_MAGAZINES      283
        SHOPPING                260
        TRAVEL_AND_LOCAL        258
        DATING                  234
        BOOKS_AND_REFERENCE     231
        VIDEO_PLAYERS           175
        EDUCATION               156
        ENTERTAINMENT           149
        MAPS_AND_NAVIGATION     137
        FOOD_AND_DRINK          127
        HOUSE_AND_HOME           88
        LIBRARIES_AND_DEMO       85
        AUTO_AND_VEHICLES        85
        WEATHER                  82
        ART_AND_DESIGN           65
        EVENTS                   64
        PARENTING                60
        COMICS                   60
        BEAUTY                   53
        1.9                       1
        Name: Category, dtype: int64
```

Observations after overview

The datatype of all the features (including price and reviews) are objects except for rating which is float. This is because the price and reviews features contain commas and dollar signs. Removing the commas and dollar signs will be appropriate so as to convert the datatype of the features. Some features with missing values are rating, reviews, size, current ver and android ver, with ratings being the highest. There are 10841 rows (Apps) with 13 columns (features) The name of the apps are expected to be unique but there are $10841 - 9659 = 1182$ apps. All App is expected to be unique throughout, but no, it isn't. 9659 out of 10841 are unique. Others have exactly the same name. Is it possible to have two apps with exactly the same name? I don't think so, but it seems play store uses only app id to identify apps and likewise there is a possibility of having duplicate app info recorded in the data. I also observed many irregular data entries, Some current version have non float data type as integers. Based on the dataset most category of application falls into the family category, most of the application are installed 1,000,000+ times, most of the application are of free type i.e most of the application are price 0, most of the application are content rating everyone, most of the application are genres family, most of the application are last updated 2018-08-03, most of the application are current ver 1.0 and most of the application are android ver 4.1 and up.

This observation from the data overview has really helped me to understand the data better and also to know what to expect from the data and it has quickly answered some analytic questions. It has also helped me to know what to do next in the data cleaning process.

Data Cleaning

To easily know data that should be dropped or replaced, visualization will be needed to see the distribution of the data.

The code fragments below are reusable and useful for the purpose of visualization and cleaning of the data.

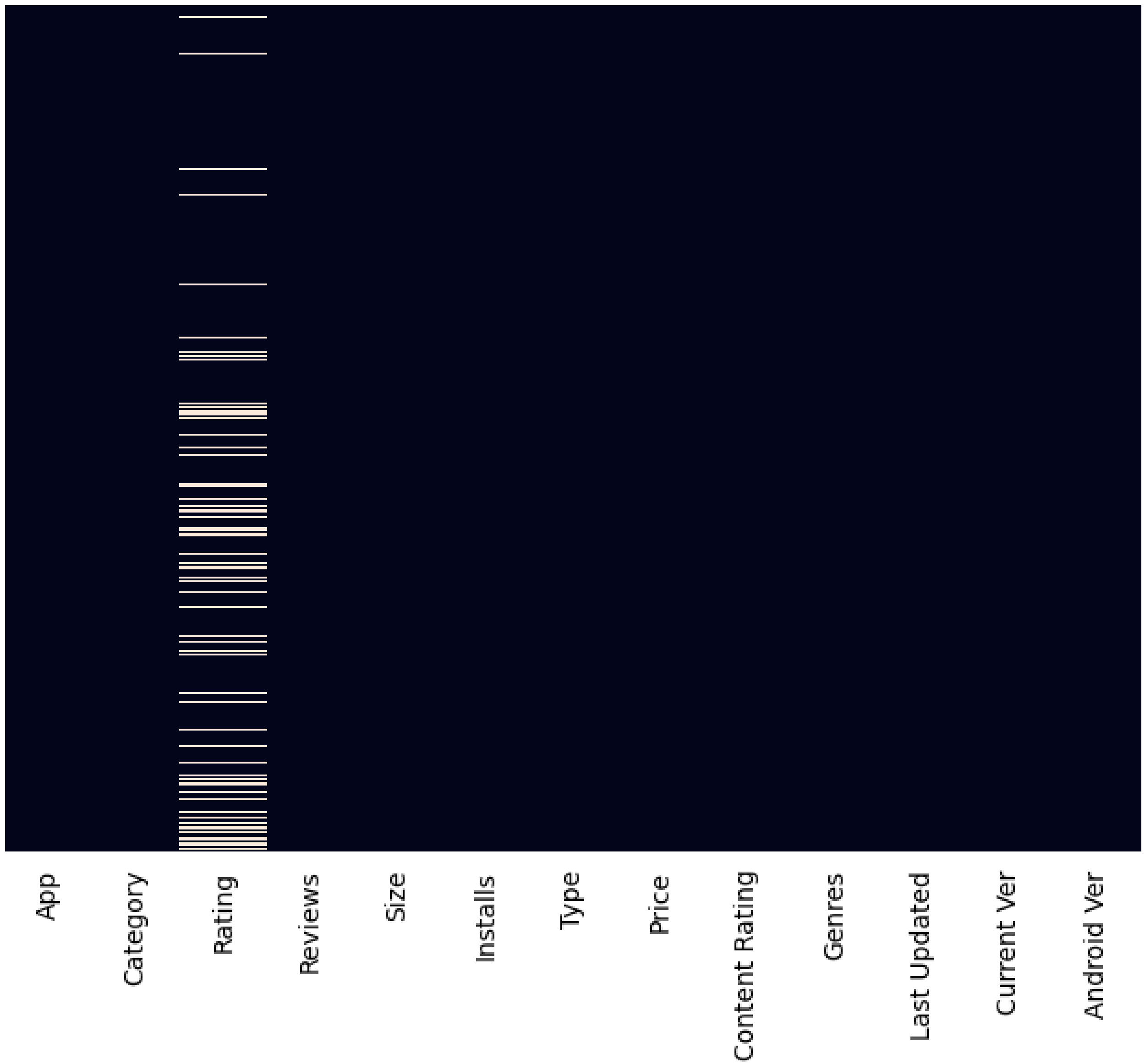
In [ ]:

```
# this plot will show the distribution of the rating
def plot_dist(data, col):
    fig, ax = plt.subplots(figsize=(8, 6))  # to set the size of the plot
    sns.heatmap(data.isnull(), cbar=False, ax=ax)  # to plot the heatmap
    ax.set_yticks([])  # to remove the yticks
    ax.tick_params(bottom='')  # to remove the bottom ticks


def remove_spines_on_plot(ax, spines):  # to remove the spines on the plot
    for spine in spines:
        ax.spines[spine].set_visible(False)


def fill_with_mode(cols):
    for col in cols:  # Loop through the columns
        mode = stat.mode(data[col])  # get the mode of the column
        data[col].fillna(mode)  # fill the null values with the mode
    return data


def fill_with_mean(cols):
    for col in cols:  # Loop through the columns
        # get the mean of the column excluding the null values
        mean = data[col].mean(skipna=True)
        # print(mean)
        # fill the null values with the mean
        data[col] = data[col].fillna(mean)
    return data
```

Handling Mising values

In [ ]:

```
plot_dist(data, 'Rating')
```



```
In [ ]: data.isnull().sum()  # to see the null values in the data
```

```
Out[ ]: 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
```

All object dtypes with missing values will be **replaced** with the most occuring entry in their column (mode), because there is high probability that those values are the most occuring values in their column. Rating, a float dtype will be **replaced** with the mean of Rating column for the gerne each missing value belong to. The mean is used because it is less sensitive to outliers than other measures of central tendency such as the median.

Replacing this missing values will make the data more coherent and consistent. It will also make the data more reliable and accurate.

In [ ]:

```
# list of the columns with object data type and having missing values
missing_obj_dype_cols = [
    'Type', 'Content Rating', 'Current Ver', 'Android Ver'
]

# call the function to fill the missing values
fill_with_mode(missing_obj_dype_cols)
# check the null values
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	G
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10,000+	Free	0	Everyone	Art & I
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500,000+	Free	0	Everyone	Design;P
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8.7M	5,000,000+	Free	0	Everyone	Art & I
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25M	50,000,000+	Free	0	Teen	Art & I
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2.8M	100,000+	Free	0	Everyone	Design;Cre
...	...	...	...	...	...	...	...	...	...	
10836	Sya9a Maroc - FR	FAMILY	4.5	38	53M	5,000+	Free	0	Everyone	Edu
10837	Fr. Mike Schmitz Audio Teachings	FAMILY	5.0	4	3.6M	100+	Free	0	Everyone	Edu
10838	Parkinson Exercices FR	MEDICAL	NaN	3	9.5M	1,000+	Free	0	Everyone	M
10839	The SCP Foundation DB fr nn5n	BOOKS_AND_REFERENCE	4.5	114	Varies with device	1,000+	Free	0	Mature 17+	Bo Refe
10840	iHoroscope - 2018 Daily Horoscope & Astrology	LIFESTYLE	4.5	398307	19M	10,000,000+	Free	0	Everyone	Li

10841 rows × 13 columns

In [ ]:

```
# get the round of average rating per genre
avg_per_gerne = round(data.groupby('Genres').mean(), 1)
# get the dictionary of the average rating per genre for filling the missing values
fill_to = avg_per_gerne.to_dict()['Rating']
# this will set the index of the data to the genre so that we can fill the missing values with t
data.Rating.index = data.Genres.values
# fill the missing values with the average rating per genre
data['Rating'] = pd.Series(data['Rating'].fillna(fill_to).values)
```

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

Out[ ]:
```
App               0
Category          0
Rating            5
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
```

What's with these redundant five nans (missing values)?! Let's have a look .

In [ ]:
```
redundant = data[data.Rating.isnull()] # shows all the rows with null values in the rating colum
redundant
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	U
23	Mcqueen Coloring pages	ART_AND_DESIGN	NaN	61	7.0M	100,000+	Free	0	Everyone	Art & Design;Action & Adventure	M
2111	Mcqueen Coloring pages	FAMILY	NaN	65	7.0M	100,000+	Free	0	Everyone	Art & Design;Action & Adventure	M
6829	Bu Hangi Firma?	FAMILY	NaN	8	26M	100+	Free	0	Everyone	Trivia;Education	De 1
7629	Wuwu & Co.	FAMILY	NaN	9	77M	100+	Paid	$2.99	Everyone	Books & Reference;Creativity	Ma
9672	Masha and the Bear - Hair Salon and MakeUp Games	FAMILY	NaN	1	83M	100+	Paid	$2.49	Everyone	Role Playing;Education	M

Their genres belong to either 'Art & Design;Action & Adventure', 'Trivia;Education', 'Books & Reference;Creativity' or 'Role Playing;Education'.

> Let's check for the values these keys belong to in the 'fill_to' dictionary.

In [ ]:
```
fill_to.values() # show the values of the dictionary
```

Out[ ]:
```
dict_values([4.3, 4.3, 4.2, 4.4, 4.6, 4.1, 4.3, 4.3, 4.5, 4.4, nan, 4.4, 3.9, 4.2, 4.3, 4.3, 4.
0, 4.3, 4.8, 4.3, nan, 4.2, 4.1, 4.1, 4.3, 4.4, 4.3, 4.2, 4.3, 4.5, 4.3, 4.3, 4.1, 4.2, 4.1, 4.
8, 4.2, 4.2, 4.0, 4.3, 4.3, 4.4, 4.3, 4.4, 4.2, 4.4, 3.9, 4.2, 4.2, 4.0, 4.2, 4.2, 4.1, 4.2, 4.
3, 4.5, 4.4, 4.2, 4.0, 4.4, 19.0, 4.1, 4.2, 4.3, 3.9, 4.7, 4.2, 4.2, 4.1, 4.3, 4.0, 4.1, 4.2, 4.
2, 4.3, 4.5, 4.1, 4.3, 3.8, 3.9, 4.3, 4.3, 4.2, 4.2, 4.4, 4.3, 4.4, 4.4, 4.6, 4.2, 4.3, 4.5, 4.
3, 4.3, 4.3, nan, 4.0, 4.3, 4.2, 4.4, 4.4, 4.4, 4.3, 4.2, 4.4, 4.2, 4.6, 4.4, 4.5, 4.0, 4.5, 4.
1, 4.1, 4.0, nan, 4.1, 4.1, 4.0, 4.2, 4.4])
```

In [ ]:

```
fill_to['Trivia;Education'] # get the value of the key 'Trivia;Education'
```

Out[ ]:

```
nan
```

The average value of these Genres was nan all along.

These missing values were replaced with a missing value! Hence, the missing value turned redundant.

There's nothing left to do than to drop these, or fill them with the overall mean.

In [ ]:

```
# fill the missing values with the mean of the rating column
fill_with_mean(['Rating'])
# data['Rating'] = data['Rating'].fillna(data['Rating'].mean())
```

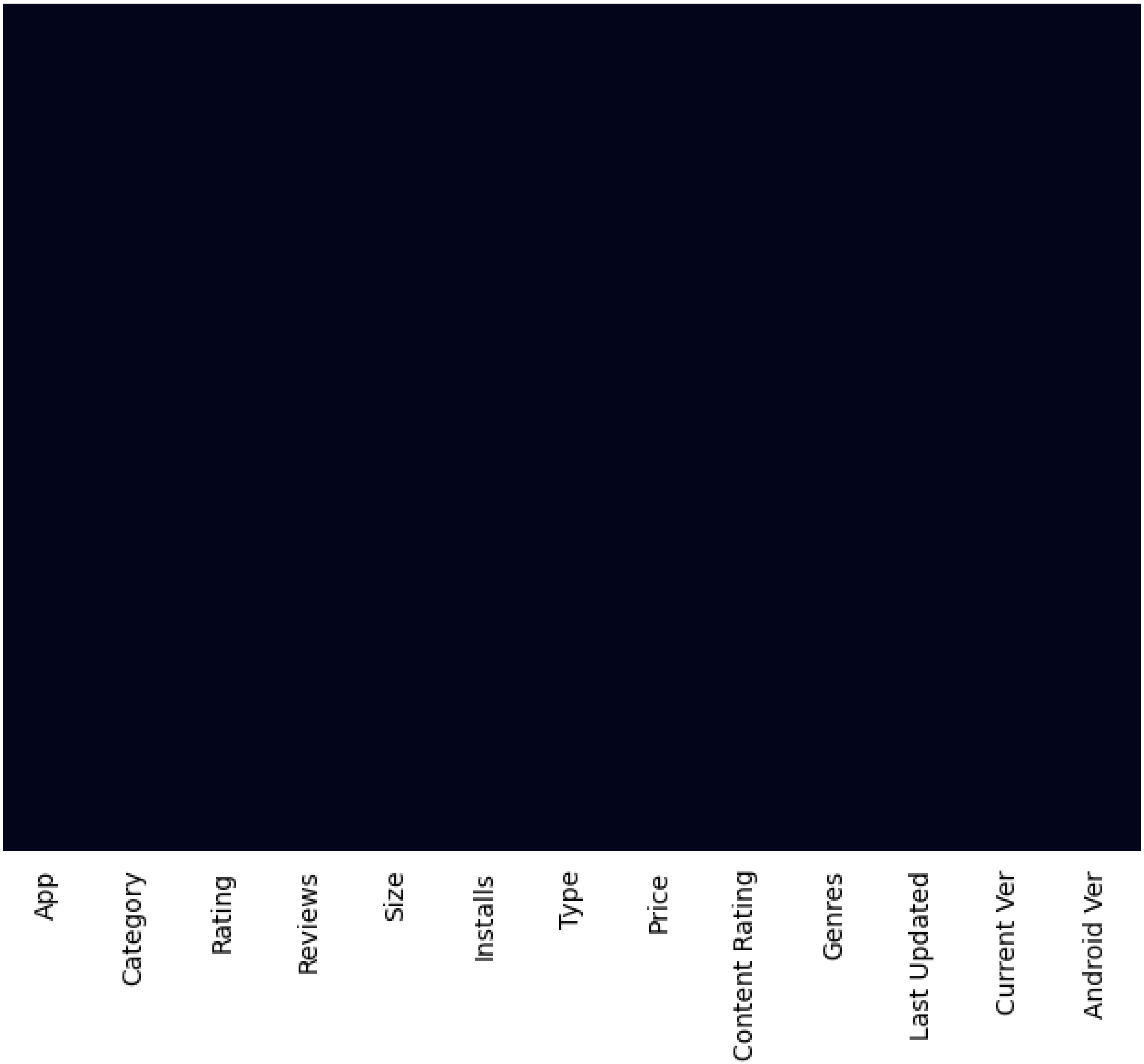
Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	C
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159	19M	10,000+	Free	0	Everyone	Art & I
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14M	500,000+	Free	0	Everyone	Design;P
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	8.7M	5,000,000+	Free	0	Everyone	Art & I
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	25M	50,000,000+	Free	0	Teen	Art & I
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2.8M	100,000+	Free	0	Everyone	Design;Cre
...	...	...	...	...	...	...	...	...	...	
10836	Sya9a Maroc - FR	FAMILY	4.5	38	53M	5,000+	Free	0	Everyone	Edu
10837	Fr. Mike Schmitz Audio Teachings	FAMILY	5.0	4	3.6M	100+	Free	0	Everyone	Edu
10838	Parkinson Exercices FR	MEDICAL	4.2	3	9.5M	1,000+	Free	0	Everyone	M
10839	The SCP Foundation DB fr nn5n	BOOKS_AND_REFERENCE	4.5	114	Varies with device	1,000+	Free	0	Mature 17+	Bo Refe
10840	iHoroscope - 2018 Daily Horoscope & Astrology	LIFESTYLE	4.5	398307	19M	10,000,000+	Free	0	Everyone	Li

10841 rows × 13 columns

In [ ]:

```
plot_dist(data,'Rating') # plot the heatmap to see the missing values
```



In [ ]:

```
data.isnull().sum() # check the null values, we can see that there are no null values in the rat
```

Out[ ]:

```
App               0
Category          0
Rating            0
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
```

I noticed that some of the rating are out of bound. Google play rating is usually on a scale of 1 to 5.
See below.

In [ ]:

```
# get maximum value of the rating column
data['Rating'].max()
```

Out[ ]:

```
19.0
```

In [ ]:

```
# get minimum value of the rating column
data['Rating'].min()
```

Out[ ]:

```
1.0
```

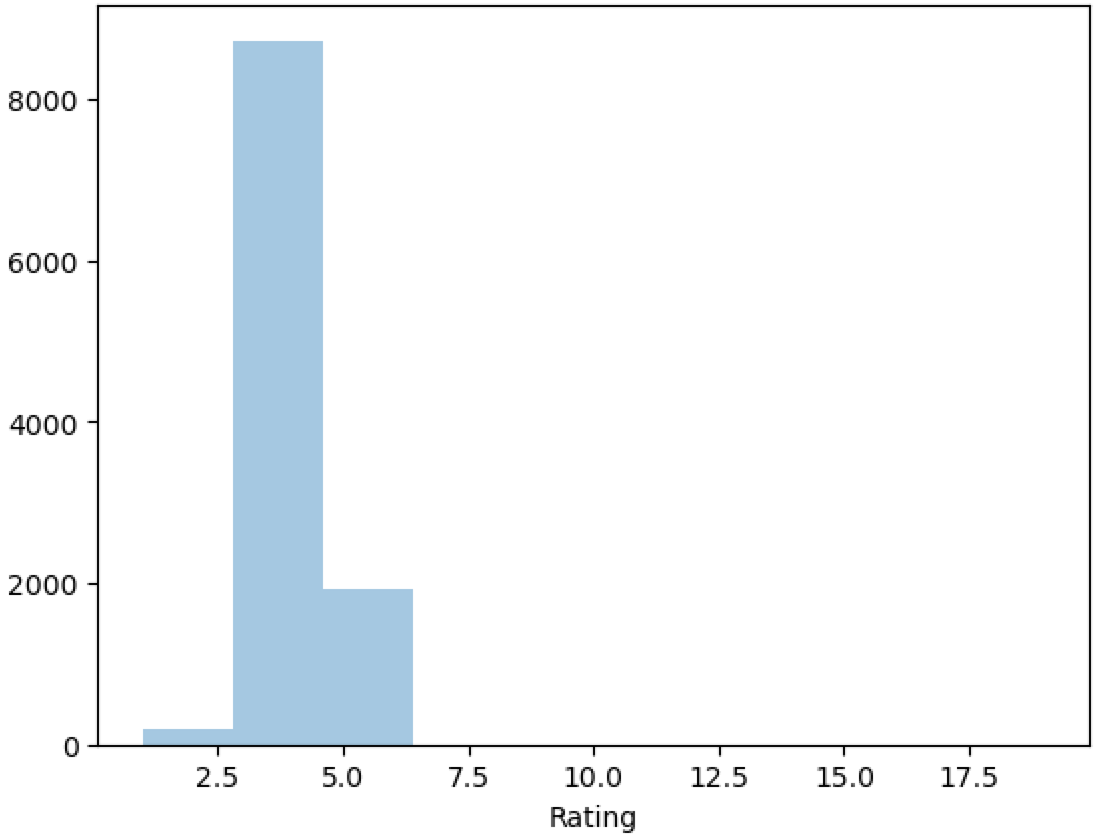
The maximum looks odd. Let's have a look at the distribution of the ratings.

In [ ]:

```
# Distribution of the rating column
sns.distplot(data['Rating'], bins=10, kde=False)
```

Out[ ]:

```
<AxesSubplot:xlabel='Rating'>
```



With the distribution of the ratings, it is clear that the maximum rating is 5.0. The maximum rating of 19.0 is an outlier. It will be replaced with the mean of the ratings for the genre it belongs to.

In [ ]:

```
# Replace the values of the rating column with the mean of the rating column
data['Rating'] = data['Rating'].replace(19.0, data['Rating'].mean())
data['Rating'].max()  # check the maximum value of the rating column
```

Out[ ]:

```
5.0
```

Cleaning Inconsistent Data Entries.

The dtypes of come columns would also be changed here.

In [ ]:

```
data.sample(10)  # view 10 random rows from the data
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	U
8745	World Webcams	WEATHER	3.7	7896	Varies with device	1,000,000+	Free	0	Everyone	Weather	No 2
2909	Candy Camera - selfie, beauty camera, photo ed...	PHOTOGRAPHY	4.4	3368646	Varies with device	100,000,000+	Free	0	Everyone	Photography	
10239	FC Barcelona Fantasy Manager: Real football mo...	SPORTS	4.4	15221	30M	1,000,000+	Free	0	Everyone	Sports	Oct
2687	Club Factory Everything, Unbeaten Price	SHOPPING	4.2	244141	7.3M	10,000,000+	Free	0	Everyone	Shopping	Au
5064	Tafsiir Quraan MP3 Af Soomaali Quraanka Kariimka	LIFESTYLE	5.0	7	3.4M	1,000+	Free	0	Everyone	Lifestyle	
5189	Youper - AI Therapy	MEDICAL	4.6	1976	69M	50,000+	Free	0	Everyone	Medical	Au
2676	Home & Shopping - Only in apps. 10% off + 10% off	SHOPPING	4.2	42750	9.9M	10,000,000+	Free	0	Everyone	Shopping	Au
10093	EY Digi India Personal Tax	BUSINESS	4.0	2	1.7M	100+	Free	0	Everyone	Business	N
7434	Pekalongan CJ	SOCIAL	4.3	0	5.9M	0+	Free	0	Teen	Social	
1645	Relax Ocean ~ Nature Sounds	LIFESTYLE	4.5	9464	Varies with device	500,000+	Free	0	Everyone	Lifestyle	

Reviewing each column for any irregularities

App : Seems normal. Anyone could name their app anything. Category : I'd love to remove these 'harmless' underscores. Besides, there could be meaningless or repeated categories. We'd check for this too. Rating : Perfectly filled! Reviews : Hmmm, I'm unsure it's perfect. We'd try converting them to integers to be sure. Having a ValueError means the column needs cleaning. Size : Nicely filled. I should still check to be sure.

Installs : Normal. I should still check to be sure. Type : Normal too. I should still check to be sure. Price : I will remove the dollar sign, change its dtype to float and rename it. Content Rating : I found something strange here. See below:

```
In [ ]: data.iloc[141:142] # view the row with index 141
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	La Updat
141	Download free book with green book	BOOKS_AND_REFERENCE	4.6	4478	9.5M	100,000+	Free	0	Everyone 10+	Books & Reference	July 20

'Everyone 10+'

Downloading the game is restricted to those 10 or above. Why then, should Everyone be included? For all occurences similar to this, we'd remove Everyone from there. We'd also check other values to be sure.

Genre : Seems normal. I will still check to be sure.

Last Updated : This would be converted to datetime.

Current Ver : Looks nice. We'd still check to be sure.

Android Ver : Very perfect, but we'd still check to be sure.

```
In [ ]: data['Category']= data['Category'].str.replace('_','  ') # replace the _ with space
```

```
In [ ]: data['Category'].unique() # get the unique values of the category column
```

```
Out[ ]: 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', '1.9'], dtype=object)
```

The last element in the output above seems off.

Let's peep at the whole data of rows with their category being '1.9'.

```
In [ ]: data[data['Category']=='1.9'] # get the row with category 1.9
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	C
10472	Life Made WI-Fi Touchscreen Photo Frame	1.9	4.190808	3.0M	1,000+	Free	0	Everyone	NaN	February 11, 2018	1.0.19	4

I observed that:

1. Its category is numerical.

2. Its rating is above 5.

3. **Last Updated is a datetype, but its has a perplexing entry itself.**
4. **Its gerne is 'February 11, 2018' - an odd value.**
5. **Its type is odd as well.**
6. **While most of the entries in Reviews are integers, this one chose to be 3.0M.**

As a result of the irregularities, the row will be dropped.

In [ ]:

```
data = data.drop(10472) # drop the row with index 10472
```

In [ ]:

```
#Reviews

data['Reviews'] = data['Reviews'].astype('int') # convert the reviews column to int type
```

In [ ]:

```
#Size

data['Size'].unique() # get the unique values of the size column
```

```
Out[ ]: array(['19M', '14M', '8.7M', '25M', '2.8M', '5.6M', '29M', '33M', '3.1M',
               '28M', '12M', '20M', '21M', '37M', '2.7M', '5.5M', '17M', '39M',
               '31M', '4.2M', '7.0M', '23M', '6.0M', '6.1M', '4.6M', '9.2M',
               '5.2M', '11M', '24M', 'Varies with device', '9.4M', '15M', '10M',
               '1.2M', '26M', '8.0M', '7.9M', '56M', '57M', '35M', '54M', '201k',
               '3.6M', '5.7M', '8.6M', '2.4M', '27M', '2.5M', '16M', '3.4M',
               '8.9M', '3.9M', '2.9M', '38M', '32M', '5.4M', '18M', '1.1M',
               '2.2M', '4.5M', '9.8M', '52M', '9.0M', '6.7M', '30M', '2.6M',
               '7.1M', '3.7M', '22M', '7.4M', '6.4M', '3.2M', '8.2M', '9.9M',
               '4.9M', '9.5M', '5.0M', '5.9M', '13M', '73M', '6.8M', '3.5M',
               '4.0M', '2.3M', '7.2M', '2.1M', '42M', '7.3M', '9.1M', '55M',
               '23k', '6.5M', '1.5M', '7.5M', '51M', '41M', '48M', '8.5M', '46M',
               '8.3M', '4.3M', '4.7M', '3.3M', '40M', '7.8M', '8.8M', '6.6M',
               '5.1M', '61M', '66M', '79k', '8.4M', '118k', '44M', '695k', '1.6M',
               '6.2M', '18k', '53M', '1.4M', '3.0M', '5.8M', '3.8M', '9.6M',
               '45M', '63M', '49M', '77M', '4.4M', '4.8M', '70M', '6.9M', '9.3M',
               '10.0M', '8.1M', '36M', '84M', '97M', '2.0M', '1.9M', '1.8M',
               '5.3M', '47M', '556k', '526k', '76M', '7.6M', '59M', '9.7M', '78M',
               '72M', '43M', '7.7M', '6.3M', '334k', '34M', '93M', '65M', '79M',
               '100M', '58M', '50M', '68M', '64M', '67M', '60M', '94M', '232k',
               '99M', '624k', '95M', '8.5k', '41k', '292k', '11k', '80M', '1.7M',
               '74M', '62M', '69M', '75M', '98M', '85M', '82M', '96M', '87M',
               '71M', '86M', '91M', '81M', '92M', '83M', '88M', '704k', '862k',
               '899k', '378k', '266k', '375k', '1.3M', '975k', '980k', '4.1M',
               '89M', '696k', '544k', '525k', '920k', '779k', '853k', '720k',
               '713k', '772k', '318k', '58k', '241k', '196k', '857k', '51k',
               '953k', '865k', '251k', '930k', '540k', '313k', '746k', '203k',
               '26k', '314k', '239k', '371k', '220k', '730k', '756k', '91k',
               '293k', '17k', '74k', '14k', '317k', '78k', '924k', '902k', '818k',
               '81k', '939k', '169k', '45k', '475k', '965k', '90M', '545k', '61k',
               '283k', '655k', '714k', '93k', '872k', '121k', '322k', '1.0M',
               '976k', '172k', '238k', '549k', '206k', '954k', '444k', '717k',
               '210k', '609k', '308k', '705k', '306k', '904k', '473k', '175k',
               '350k', '383k', '454k', '421k', '70k', '812k', '442k', '842k',
               '417k', '412k', '459k', '478k', '335k', '782k', '721k', '430k',
               '429k', '192k', '200k', '460k', '728k', '496k', '816k', '414k',
               '506k', '887k', '613k', '243k', '569k', '778k', '683k', '592k',
               '319k', '186k', '840k', '647k', '191k', '373k', '437k', '598k',
               '716k', '585k', '982k', '222k', '219k', '55k', '948k', '323k',
               '691k', '511k', '951k', '963k', '25k', '554k', '351k', '27k',
               '82k', '208k', '913k', '514k', '551k', '29k', '103k', '898k',
               '743k', '116k', '153k', '209k', '353k', '499k', '173k', '597k',
               '809k', '122k', '411k', '400k', '801k', '787k', '237k', '50k',
               '643k', '986k', '97k', '516k', '837k', '780k', '961k', '269k',
               '20k', '498k', '600k', '749k', '642k', '881k', '72k', '656k',
               '601k', '221k', '228k', '108k', '940k', '176k', '33k', '663k',
               '34k', '942k', '259k', '164k', '458k', '245k', '629k', '28k',
               '288k', '775k', '785k', '636k', '916k', '994k', '309k', '485k',
               '914k', '903k', '608k', '500k', '54k', '562k', '847k', '957k',
               '688k', '811k', '270k', '48k', '329k', '523k', '921k', '874k',
               '981k', '784k', '280k', '24k', '518k', '754k', '892k', '154k',
               '860k', '364k', '387k', '626k', '161k', '879k', '39k', '970k',
               '170k', '141k', '160k', '144k', '143k', '190k', '376k', '193k',
               '246k', '73k', '658k', '992k', '253k', '420k', '404k', '470k',
               '226k', '240k', '89k', '234k', '257k', '861k', '467k', '157k',
               '44k', '676k', '67k', '552k', '885k', '1020k', '582k', '619k'],
              dtype=object)
```

As expected, everything seems alright.

```
In [ ]: #Installs

        data['Installs'].unique()   # get the unique values of the installs column
```

Out[ ]:

```
array(['10,000+', '500,000+', '5,000,000+', '50,000,000+', '100,000+',
       '50,000+', '1,000,000+', '10,000,000+', '5,000+', '100,000,000+',
       '1,000,000,000+', '1,000+', '500,000,000+', '50+', '100+', '500+',
       '10+', '1+', '5+', '0+', '0'], dtype=object)
```

As expected, everything seems alright.

In [ ]:

```
# Type
data['Type'].unique()  # get the unique values of the type column
```

Out[ ]:

```
array(['Free', 'Paid', nan], dtype=object)
```

Nice.

In [ ]:

```
# Price
# this will remove the $ sign from the price column
data['Price'] = data['Price'].str.replace('$', '')
# this will convert the price column to float type
data['Price'] = data['Price'].astype('float')
```

Nice

In [ ]:

```
# get the unique values of the content rating column
data['Content Rating'].unique()
```

Out[ ]:

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

Everyones 10+ are absurd for content rating.

In [ ]:

```
# Content Rating
# this will get the rows with the absurd content rating i.e. Everyone with a space
absurd = data[data['Content Rating'].str.contains('Everyone ')]
absurd
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Las Updatec
22	Superheroes Wallpapers | 4K Backgrounds	ART AND DESIGN	4.7	7699	4.2M	500,000+	Free	0.0	Everyone 10+	Art & Design	July 12 2018
77	Police Detector (Speed Camera Radar)	AUTO AND VEHICLES	4.3	3574	3.9M	1,000,000+	Free	0.0	Everyone 10+	Auto & Vehicles	July 4 2018
113	Wrinkles and rejuvenation	BEAUTY	4.3	182	5.7M	100,000+	Free	0.0	Everyone 10+	Beauty	Septembe 20, 2017
130	Recipes and tips for losing weight	BEAUTY	4.3	35	3.1M	10,000+	Free	0.0	Everyone 10+	Beauty	Decembe 11, 2017
141	Download free book with green book	BOOKS AND REFERENCE	4.6	4478	9.5M	100,000+	Free	0.0	Everyone 10+	Books & Reference	July 31 2017
...	...	...	...	...	...	...	...	...	...	...	..
10419	Fast Motorcycle Driver 2016	GAME	4.2	28151	49M	1,000,000+	Free	0.0	Everyone 10+	Racing	Decembe 25, 2016
10639	Florida Today	NEWS AND MAGAZINES	3.3	202	38M	10,000+	Free	0.0	Everyone 10+	News & Magazines	June 20 2018
10779	Fortune Quest: Savior	FAMILY	3.6	135	75M	10,000+	Free	0.0	Everyone 10+	Role Playing	June 1 2018
10784	Big Hunter	GAME	4.3	245455	84M	10,000,000+	Free	0.0	Everyone 10+	Action	May 31 2018
10789	Modern Counter Global Strike 3D V2	GAME	4.0	368	48M	50,000+	Free	0.0	Everyone 10+	Action	March 28 2018

414 rows × 13 columns

In [ ]:

```python
absurd['Content Rating'].unique() # get the unique values of the absurd content rating
```

Out[ ]:

```
array(['Everyone 10+'], dtype=object)
```

With this observation

More than 400 rows are 'absurd'

In [ ]:

```python
data['Content Rating'] = data['Content Rating'].str.replace(
    'Everyone 10', '10')  # replace the absurd content rating with 10

# get the value counts of the content rating column
data['Content Rating'].value_counts()
```

Out[ ]:

```
Everyone           8714
Teen               1208
Mature 17+          499
10+                 414
Adults only 18+       3
Unrated               2
Name: Content Rating, dtype: int64
```

'Unrated' should also fall under 'Everyone'.

In [ ]:

```
data['Content Rating'] = data['Content Rating'].str.replace(
    'Unrated', 'Everyone')  # replace the absurd content rating with Everyone

# get the value counts of the content rating column
data['Content Rating'].value_counts()
```

Out[ ]:

```
Everyone           8716
Teen               1208
Mature 17+          499
10+                 414
Adults only 18+       3
Name: Content Rating, dtype: int64
```

In [ ]:

```
# Genres
data['Genres'].unique() # get the unique values of the genres column
```

Out[ ]:

```
array(['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', 'Education', 'Education;Creativity',
       'Education;Music & Video', 'Education;Action & Adventure',
       'Education;Pretend Play', 'Education;Brain Games', 'Entertainment',
       'Entertainment;Music & Video', 'Entertainment;Brain Games',
       'Entertainment;Creativity', 'Events', 'Finance', 'Food & Drink',
       'Health & Fitness', 'House & Home', 'Libraries & Demo',
       'Lifestyle', 'Lifestyle;Pretend Play',
       'Adventure;Action & Adventure', 'Arcade', 'Casual', 'Card',
       'Casual;Pretend Play', 'Action', 'Strategy', 'Puzzle', 'Sports',
       'Music', 'Word', 'Racing', 'Casual;Creativity',
       'Casual;Action & Adventure', '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',
       'Entertainment;Education', 'Casual;Education',
       'Music;Music & Video', 'Racing;Action & Adventure',
       'Arcade;Pretend Play', '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;Education',
       'Parenting;Brain Games', 'Weather', 'Video Players & Editors',
       'Video Players & Editors;Music & Video', 'News & Magazines',
       'Maps & Navigation', 'Health & Fitness;Action & Adventure',
       'Educational', 'Casino', 'Adventure;Brain Games',
       'Trivia;Education', 'Lifestyle;Education',
       'Books & Reference;Creativity', 'Books & Reference;Education',
       'Puzzle;Education', 'Role Playing;Education',
       'Role Playing;Brain Games', 'Strategy;Education',
       'Racing;Pretend Play', 'Communication;Creativity',
       'Strategy;Creativity'], dtype=object)
```

It Seems so dirty.

In [ ]:

```
data['Content Rating'] = data['Content Rating'].str.replace(
    'Unrated', 'Everyone')  # this will replace the unrated with everyone
# get the value counts of the content rating column
data['Content Rating'].value_counts()
```

Out[ ]:

```
Everyone           8716
Teen               1208
Mature 17+          499
10+                 414
Adults only 18+       3
Name: Content Rating, dtype: int64
```

In [ ]:

```
data['Genres'].value_counts()[:20] # this will show the top 20 genres
```

Out[ ]:

```
Tools                 842
Entertainment         623
Education             549
Medical               463
Business              460
Productivity          424
Sports                398
Personalization       392
Communication         387
Lifestyle             381
Finance               366
Action                365
Health & Fitness      341
Photography           335
Social                295
News & Magazines      283
Shopping              260
Travel & Local        257
Dating                234
Books & Reference     231
Name: Genres, dtype: int64
```

Of 117 unique values, the first 20 seem ideal

In [ ]:

```
data['Genres'].value_counts()[20:40]  # this will show the next 20 genres
```

Out[ ]:

```
Arcade                        220
Simulation                    200
Casual                        193
Video Players & Editors       173
Puzzle                        140
Maps & Navigation             137
Food & Drink                  127
Role Playing                  109
Strategy                      107
Racing                         98
House & Home                   88
Libraries & Demo               85
Auto & Vehicles                85
Weather                        82
Adventure                      75
Events                         64
Comics                         59
Art & Design                   58
Beauty                         53
Education;Education            50
Name: Genres, dtype: int64
```

In [ ]:

```
data['Genres'].value_counts()[40:60] # this will show the next 20 genres
```

```
Out[ ]: Card                            48
        Parenting                       46
        Board                           44
        Educational;Education           41
        Casino                          39
        Trivia                          38
        Educational                     37
        Casual;Pretend Play             31
        Word                            29
        Entertainment;Music & Video     27
        Education;Pretend Play          23
        Music                           22
        Casual;Action & Adventure       21
        Racing;Action & Adventure       20
        Puzzle;Brain Games              19
        Educational;Pretend Play        19
        Action;Action & Adventure       17
        Arcade;Action & Adventure       16
        Board;Brain Games               15
        Casual;Brain Games              13
        Name: Genres, dtype: int64
```

Up till music, everything seems perfect. 'Puzzle;Brain Games' should not be a separate gerne, but should be merged with 'Puzzle'. The same goes for the rest, downwards.

```
In [ ]: data['Genres'].value_counts()[60:] # this will show the rest of the genres
```

Out[ ]:

```
Adventure;Action & Adventure             13
Simulation;Action & Adventure            11
Entertainment;Brain Games                 8
Art & Design;Creativity                   7
Education;Creativity                      7
Casual;Creativity                         7
Role Playing;Action & Adventure           7
Parenting;Education                       7
Educational;Brain Games                   6
Education;Action & Adventure              6
Parenting;Music & Video                   6
Education;Brain Games                     5
Educational;Creativity                    5
Puzzle;Action & Adventure                 5
Role Playing;Pretend Play                 5
Education;Music & Video                   5
Educational;Action & Adventure            4
Simulation;Pretend Play                   4
Sports;Action & Adventure                 4
Entertainment;Creativity                  3
Video Players & Editors;Music & Video     3
Simulation;Education                      3
Music;Music & Video                       3
Casual;Education                          3
Board;Action & Adventure                  3
Entertainment;Action & Adventure          3
Strategy;Action & Adventure               2
Books & Reference;Education               2
Art & Design;Pretend Play                 2
Art & Design;Action & Adventure           2
Video Players & Editors;Creativity        2
Puzzle;Creativity                         2
Entertainment;Pretend Play                2
Casual;Music & Video                      2
Adventure;Education                       2
Card;Action & Adventure                   2
Adventure;Brain Games                     1
Communication;Creativity                  1
Racing;Pretend Play                       1
Strategy;Education                        1
Role Playing;Brain Games                  1
Role Playing;Education                    1
Puzzle;Education                          1
Books & Reference;Creativity              1
Lifestyle;Education                       1
Trivia;Education                          1
Health & Fitness;Education                1
Music & Audio;Music & Video               1
Board;Pretend Play                        1
Health & Fitness;Action & Adventure       1
Comics;Creativity                         1
Entertainment;Education                   1
Card;Brain Games                          1
Arcade;Pretend Play                       1
Parenting;Brain Games                     1
Travel & Local;Action & Adventure         1
Lifestyle;Pretend Play                    1
Tools;Education                           1
Strategy;Creativity                       1
Name: Genres, dtype: int64
```

In [ ]:

```python
# this will remove the sub genres using regular expression
# will only replace those that match the form ;subgenre
data['Genres'] = data['Genres'].str.replace(r';[a-z &]*', '', flags=re.I)
```

In [ ]:

```
data['Genres'].value_counts() # shoe the value counts of the genres column
```

Out[ ]:

```
Tools                      843
Entertainment              667
Education                  645
Medical                    463
Business                   460
Productivity               424
Sports                     402
Personalization            392
Communication              388
Lifestyle                  383
Action                     382
Finance                    366
Health & Fitness           343
Photography                335
Social                     295
News & Magazines           283
Casual                     270
Shopping                   260
Travel & Local             258
Arcade                     237
Books & Reference          234
Dating                     234
Simulation                 218
Video Players & Editors    178
Puzzle                     167
Maps & Navigation          137
Food & Drink               127
Role Playing               123
Racing                     119
Educational                112
Strategy                   111
Adventure                   91
House & Home                88
Auto & Vehicles             85
Libraries & Demo            85
Weather                     82
Art & Design                69
Events                      64
Board                       63
Parenting                   60
Comics                      60
Beauty                      53
Card                        51
Trivia                      39
Casino                      39
Word                        29
Music                       25
Music & Audio                1
Name: Genres, dtype: int64
```

Educational should be merged with Education

Music & Audio should be merged with Music.

In [ ]:

```
data['Genres'] = data['Genres'].str.replace('Educational', 'Education').str.replace(
    'Music & Audio', 'Music')  # replace the genres with the same meaning

data['Genres'].unique() # get the unique values of the genres column
```

```
Out[ ]: 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',
               'Video Players & Editors', 'Medical', 'Social', 'Shopping',
               'Photography', 'Travel & Local', 'Tools', 'Personalization',
               'Productivity', 'Parenting', 'Weather', 'News & Magazines',
               'Maps & Navigation', 'Casino'], dtype=object)
```

This is nice and clean.

```
In [ ]: # Last Updated

        # this will convert the last updated column to datetime type
        data['Last Updated'] = pd.to_datetime(data['Last Updated'])
```

There is an inconsistent data entry here. I will deal with that after this.

```
In [ ]: # Current Ver

        # this will show the unique values of the android version column
        data['Android Ver'].unique()
```

```
Out[ ]: array(['4.0.3 and up', '4.2 and up', '4.4 and up', '2.3 and up',
               '3.0 and up', '4.1 and up', '4.0 and up', '2.3.3 and up',
               'Varies with device', '2.2 and up', '5.0 and up', '6.0 and up',
               '1.6 and up', '1.5 and up', '2.1 and up', '7.0 and up',
               '5.1 and up', '4.3 and up', '4.0.3 - 7.1.1', '2.0 and up',
               '3.2 and up', '4.4W and up', '7.1 and up', '7.0 - 7.1.1',
               '8.0 and up', '5.0 - 8.0', '3.1 and up', '2.0.1 and up',
               '4.1 - 7.1.1', nan, '5.0 - 6.0', '1.0 and up', '2.2 - 7.1.1',
               '5.0 - 7.1.1'], dtype=object)
```

```
In [ ]: # this will remove the W from the android version column
        data['Android Ver'] = data['Android Ver'].str.replace('W', '')
```

```
In [ ]: # get the unique values of the android version column
        data['Android Ver'].unique()
```

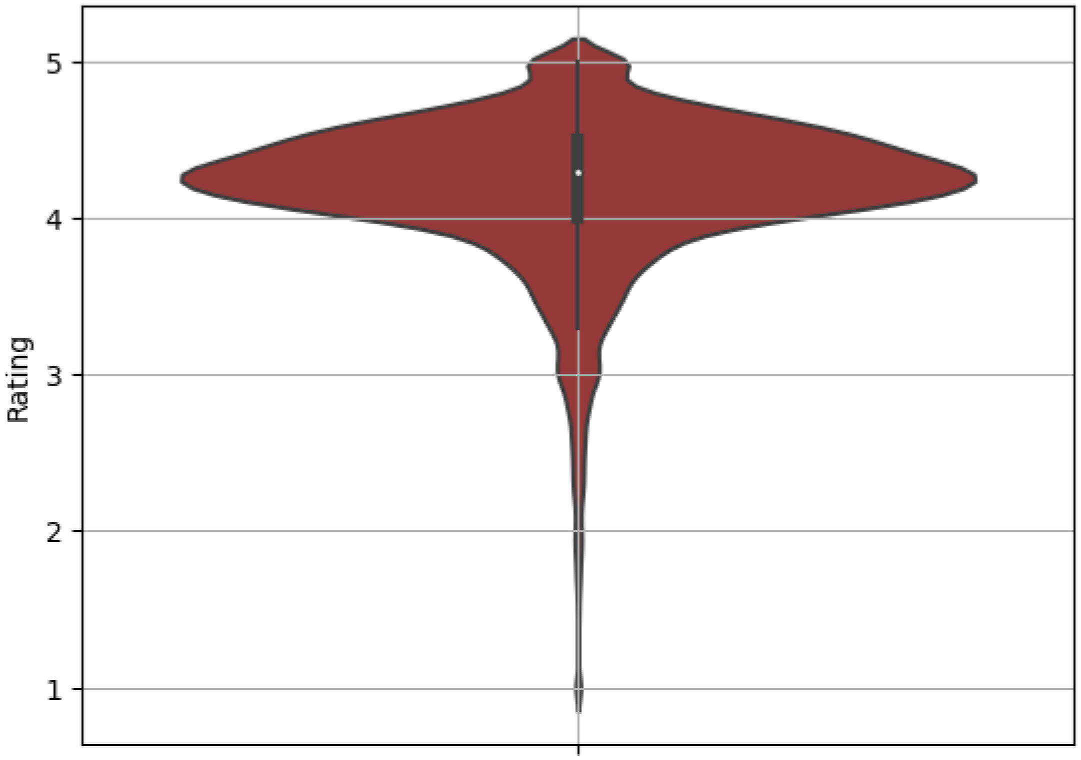
```
Out[ ]: array(['4.0.3 and up', '4.2 and up', '4.4 and up', '2.3 and up',
               '3.0 and up', '4.1 and up', '4.0 and up', '2.3.3 and up',
               'Varies with device', '2.2 and up', '5.0 and up', '6.0 and up',
               '1.6 and up', '1.5 and up', '2.1 and up', '7.0 and up',
               '5.1 and up', '4.3 and up', '4.0.3 - 7.1.1', '2.0 and up',
               '3.2 and up', '7.1 and up', '7.0 - 7.1.1', '8.0 and up',
               '5.0 - 8.0', '3.1 and up', '2.0.1 and up', '4.1 - 7.1.1', nan,
               '5.0 - 6.0', '1.0 and up', '2.2 - 7.1.1', '5.0 - 7.1.1'],
              dtype=object)
```

Review Aftermath

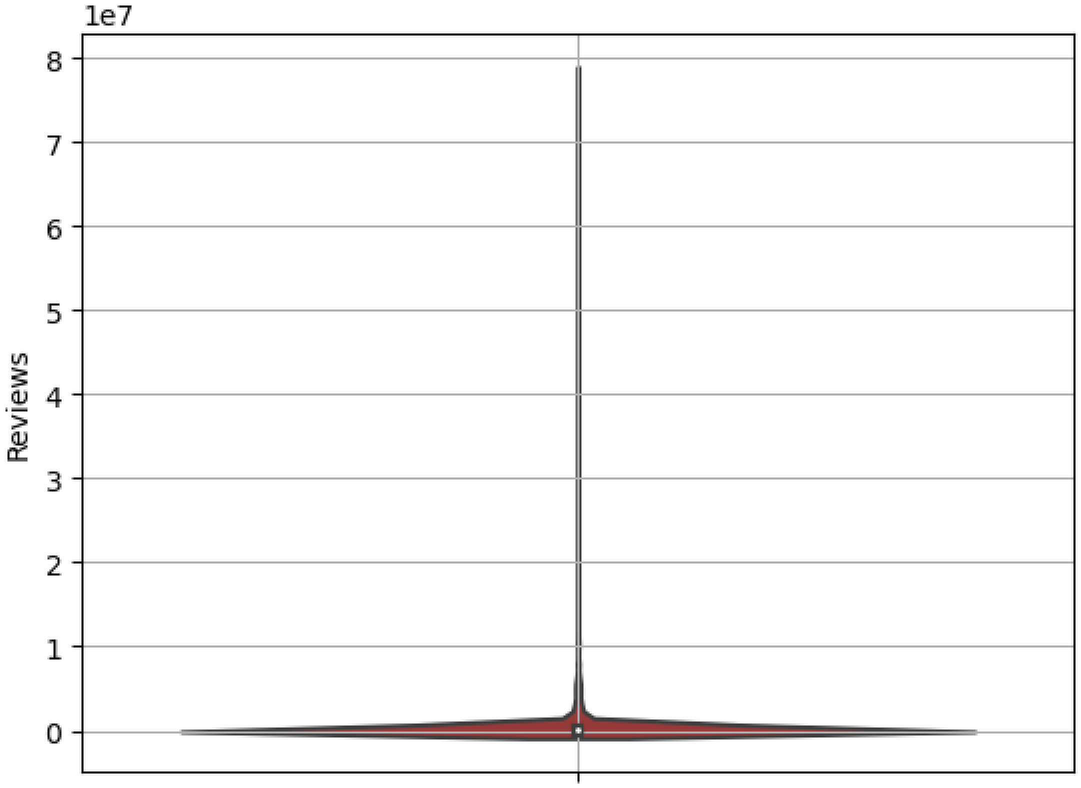
Removing outliers, if any

Outliers can only be seen in number.

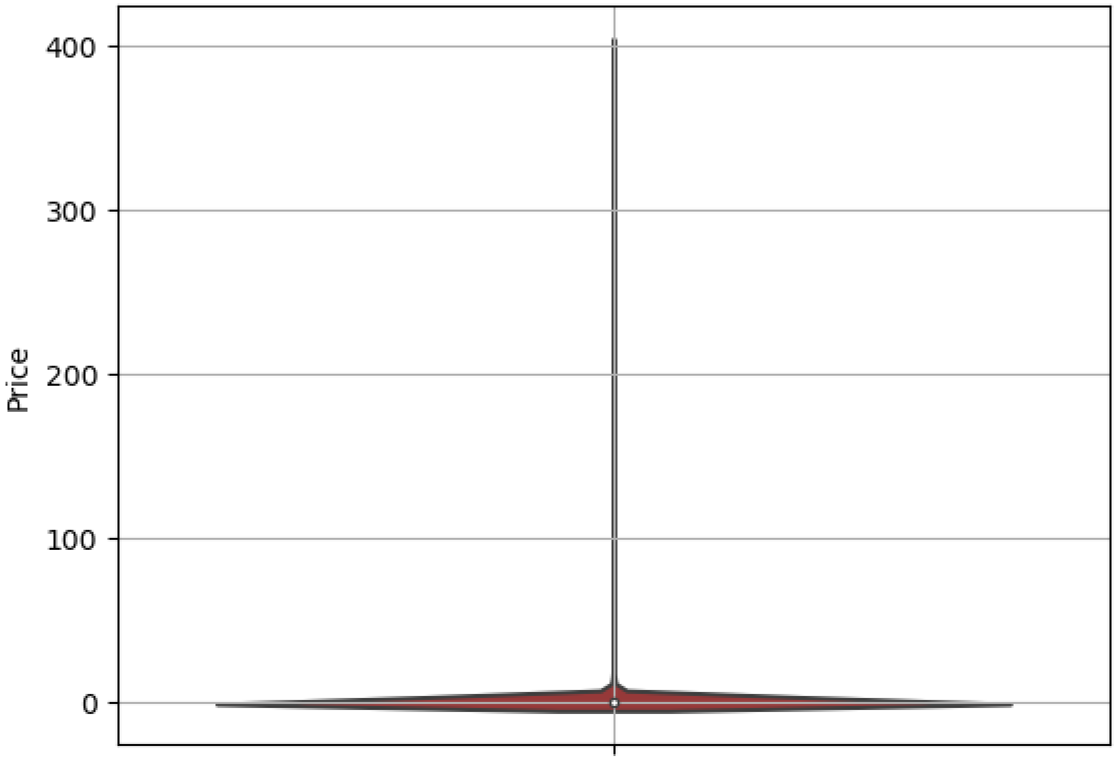
```
In [ ]: # loop through the int and float columns
        for i in data.select_dtypes(['int', 'float']):
            sns.violinplot(y=data[i], color='brown')  # plot the violin plot
            plt.grid()  # show the grid
            plt.show()  # show the plot
```



5
4
3
2
1
Rating



1e7
8
7
6
5
4
3
2
1
0
Reviews



They all seems to be without 'outliers' since they are all within resonable ranges.

App is expected to be unique throughout, but it isn't. I deal with that here.

In [ ]:

```
# Before dropping
Apps = data['App'].value_counts()  # get the value counts of the app column
Apps[Apps > 1]  # show the apps that have more than one entry
```

Out[ ]:

```
ROBLOX                                                9
CBS Sports App - Scores, News, Stats & Watch Live     8
ESPN                                                  7
Duolingo: Learn Languages Free                        7
Candy Crush Saga                                      7
                                                     ..
Transenger – Ts Dating and Chat for Free              2
Random Video Chat                                     2
Clover Dating App                                     2
Docs To Go™ Free Office Suite                         2
English Dictionary - Offline                          2
Name: App, Length: 798, dtype: int64
```

There are almost 800 apps repeated.

Let's check a few of them.

In [ ]:

```
data[data['App'] == 'ROBLOX'] # show the rows with the app ROBLOX
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Currer
1653	ROBLOX	GAME	4.5	4447388	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
1701	ROBLOX	GAME	4.5	4447346	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
1748	ROBLOX	GAME	4.5	4448791	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
1841	ROBLOX	GAME	4.5	4449882	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
1870	ROBLOX	GAME	4.5	4449910	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
2016	ROBLOX	FAMILY	4.5	4449910	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
2088	ROBLOX	FAMILY	4.5	4450855	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
2206	ROBLOX	FAMILY	4.5	4450890	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2
4527	ROBLOX	FAMILY	4.5	4443407	67M	100,000,000+	Free	0.0	10+	Adventure	2018-07-31	2.347.2

This is definitely a duplicate!

In [ ]:

```
data[data.App == 'ESPN']  # show the rows with the app ESPN
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	An
2959	ESPN	SPORTS	4.2	521138	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5
3010	ESPN	SPORTS	4.2	521138	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5
3018	ESPN	SPORTS	4.2	521138	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5
3048	ESPN	SPORTS	4.2	521140	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5
3060	ESPN	SPORTS	4.2	521140	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5
3072	ESPN	SPORTS	4.2	521140	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5
4069	ESPN	SPORTS	4.2	521081	Varies with device	10,000,000+	Free	0.0	10+	Sports	2018-07-19	Varies with device	5

In [ ]:

```
# show the rows with the app Clover Dating App
data[data.App == 'Clover Dating App']
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Androi Ve
495	Clover Dating App	DATING	4.1	11633	23M	500,000+	Free	0.0	Mature 17+	Dating	2018-07-24	2.5.1	4.1 an u
550	Clover Dating App	DATING	4.1	11633	23M	500,000+	Free	0.0	Mature 17+	Dating	2018-07-24	2.5.1	4.1 an u

```
It would not be too much if an assumption to say that there are many apps were
duplicated
when gathering the data. This will be problematic and it'll make the analysis
inaccurate.
I'd, therefore, be dropping duplicates.
```

In [ ]:

```
# Before dropping
data.shape # get the shape of the data
```

Out[ ]:

```
(10840, 13)
```

In [ ]:

```
duplicate = data[data.App.duplicated()]  # get the duplicate rows
duplicate
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres
229	Quick PDF Scanner + OCR FREE	BUSINESS	4.2	80805	Varies with device	5,000,000+	Free	0.0	Everyone	Business
236	Box	BUSINESS	4.2	159872	Varies with device	10,000,000+	Free	0.0	Everyone	Business
239	Google My Business	BUSINESS	4.4	70991	Varies with device	5,000,000+	Free	0.0	Everyone	Business
256	ZOOM Cloud Meetings	BUSINESS	4.4	31614	37M	10,000,000+	Free	0.0	Everyone	Business
261	join.me - Simple Meetings	BUSINESS	4.0	6989	Varies with device	1,000,000+	Free	0.0	Everyone	Business
...	...	...	...	...	...	...	...	...	...	...
10715	FarmersOnly Dating	DATING	3.0	1145	1.4M	100,000+	Free	0.0	Mature 17+	Dating
10720	Firefox Focus: The privacy browser	COMMUNICATION	4.4	36981	4.0M	1,000,000+	Free	0.0	Everyone	Communication
10730	FP Notebook	MEDICAL	4.5	410	60M	50,000+	Free	0.0	Everyone	Medical
10753	Slickdeals: Coupons & Shopping	SHOPPING	4.5	33599	12M	1,000,000+	Free	0.0	Everyone	Shopping
10768	AAFP	MEDICAL	3.8	63	24M	10,000+	Free	0.0	Everyone	Medical

1181 rows × 13 columns

In [ ]:

```
data = data.drop(duplicate.index) # drop the duplicate rows
```

In [ ]:

```
# After dropping
data.shape  # get the shape of the data
```

Out[ ]:

```
(9659, 13)
```

In [ ]:

```
# After dropping
Apps = data['App'].value_counts()  # get the value counts of the app column
Apps[Apps > 1]  # show the apps that have more than one entry
```

Out[ ]:

```
Series([], Name: App, dtype: int64)
```

Data Cleaned.

I'd go ahead and save the cleaned version of it.

In [ ]:

```
# save the cleaned data to a csv file
```

```
data.to_csv('Cleaned Google Playstore App Dataset.csv')
```

Exploratory Data Analysis.

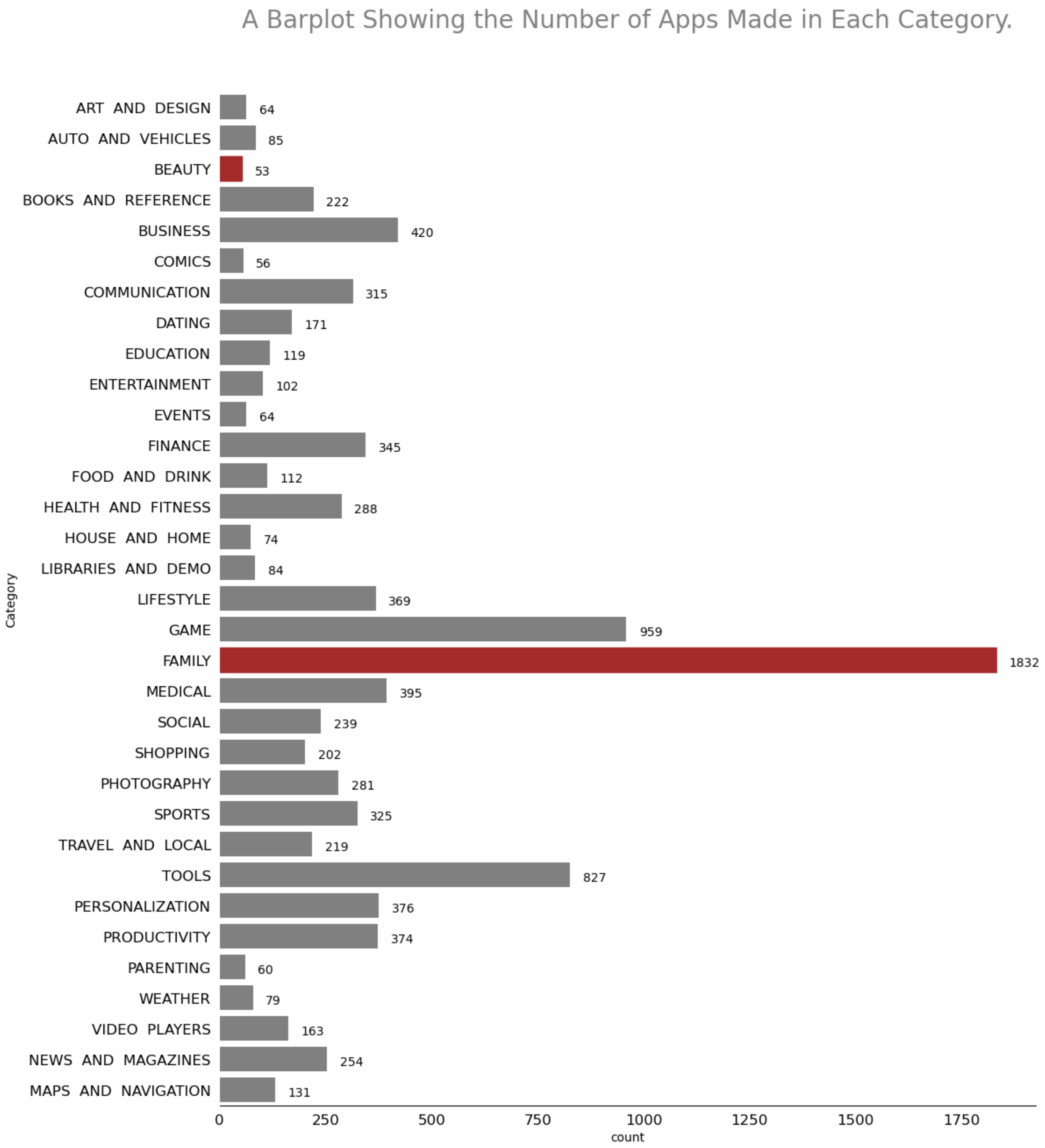
Google Play Store has a whole lot of category. I'm curious to know which category most of the apps there fall to.

In [ ]:

```
# sets the size of the plot as 12 by 15
fig, ax = plt.subplots(figsize=(12, 15))
plot = sns.countplot(y=data['Category'], ax=ax,
                     color='grey')  # plots the countplot
for i in plot.patches:  # this will loop through the patches
    # this will annotate the countplot and add the count on the plot
    plot.annotate(i.get_width(), (i.get_width()+30, i.get_y()+0.6))
    # this will highlight the maximum value
    if i.get_width() == data['Category'].value_counts().max():
        i.set_color('brown')
    # this will highlight the minimum value
    if i.get_width() == data['Category'].value_counts().min():
        i.set_color('brown')
remove_spines_on_plot(ax, ['left', 'right', 'top'])  # this will remove the spines on the plot
# this will remove the ticks on the plot
ax.tick_params(bottom=False, left="", labelsize='large')
plt.title('A Barplot Showing the Number of Apps Made in Each Category.\n\n',
          fontsize=20, color='grey')  # this will set the title of the plot
```

Out[ ]:

```
Text(0.5, 1.0, 'A Barplot Showing the Number of Apps Made in Each Category.\n\n')
```



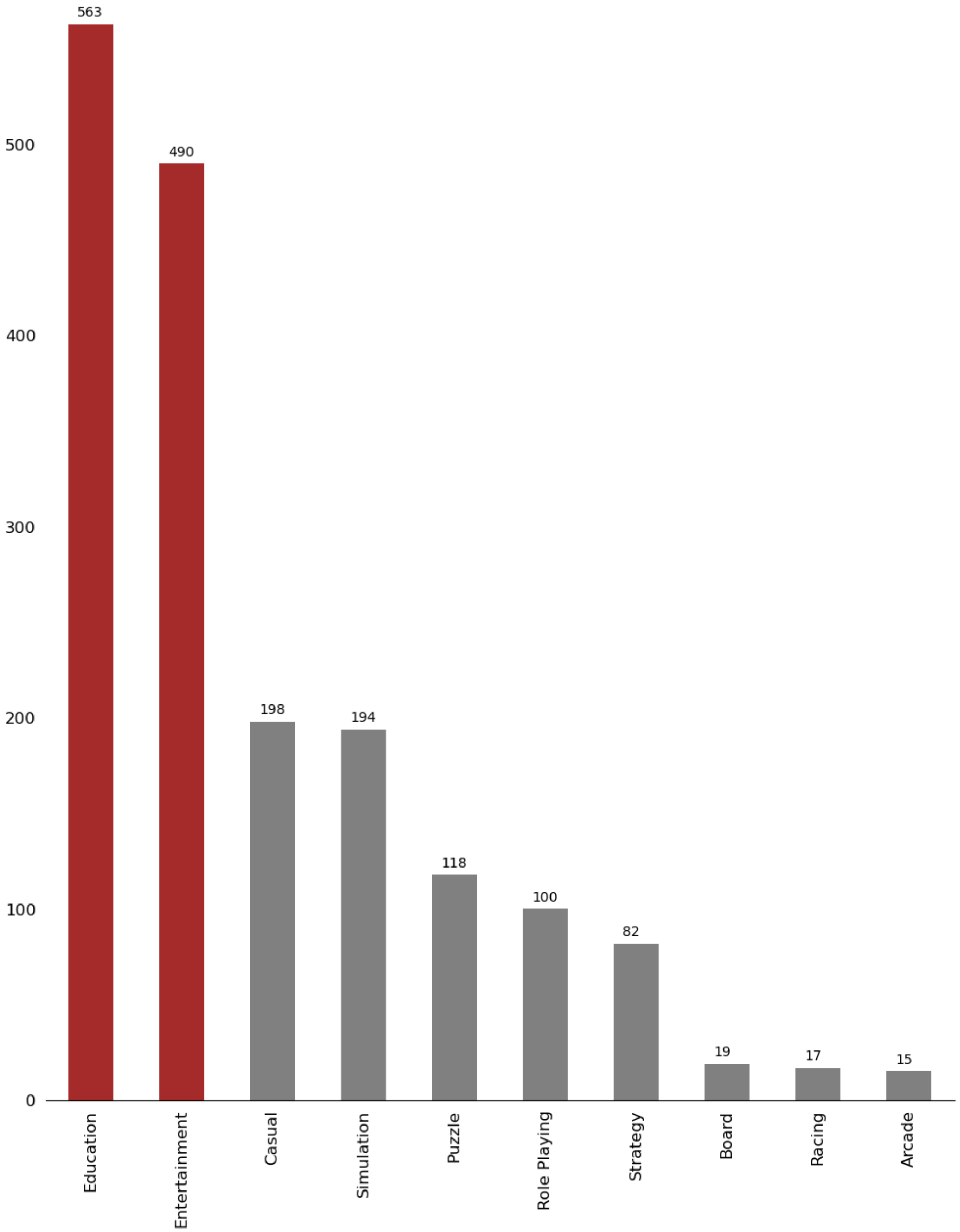
Family!

Most of the Google Play Store Apps are of the Family category, while the least is Comics.

Of the Family Category, which genre (sub-category) is the most famous?

```
In [ ]: # sets the size of the plot as 12 by 15
        fig, ax = plt.subplots(figsize=(12, 15))
        # this will get the genres of the family category
        Family_genre = data['Genres'][data['Category'] == 'FAMILY']
        plott = Family_genre.value_counts()[:10].plot.bar(  # plots the barplot
            color=['brown', 'brown', 'grey', 'grey', 'grey', 'grey', 'grey', 'grey', 'grey', 'grey'])

        for i in plott.patches:  # this will loop through the patches
            # this will annotate the barplot and add the count on the plot
            plott.annotate(i.get_height(), (i.get_x()+0.1, i.get_height()+4))
```

```
# this will remove the spines on the plot
remove_spines_on_plot(ax, ['left', 'top', 'right'])
# this will remove the ticks on the plot
ax.tick_params(bottom=False, left=False, labelsize='large')
```



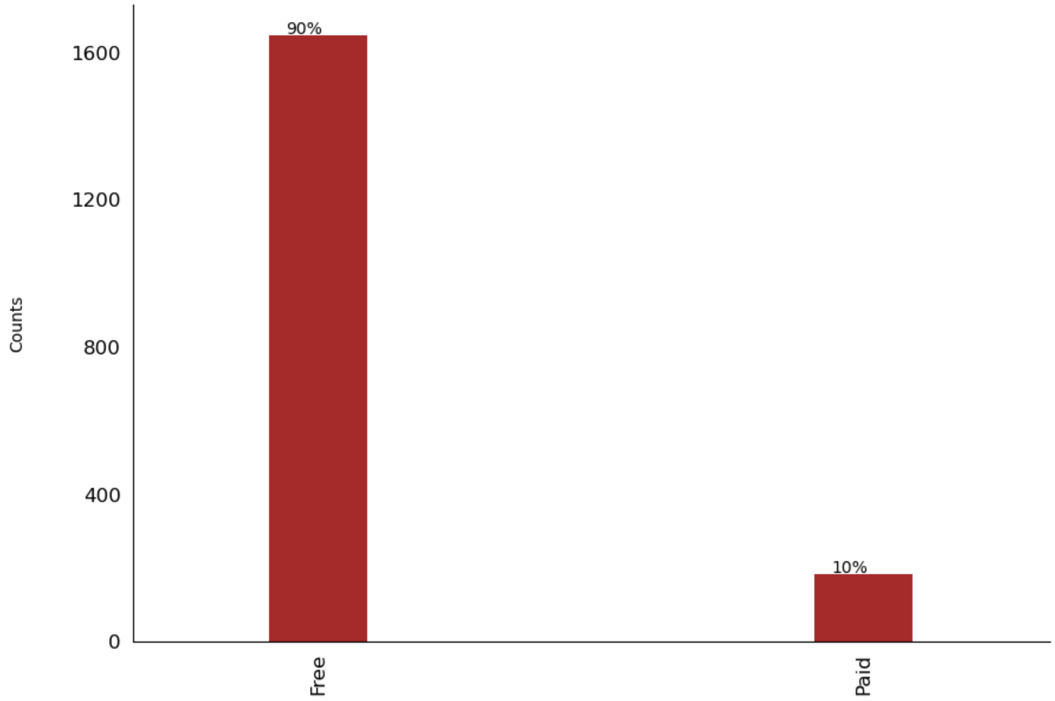
"Around the world in 2018, a larger fraction of developers are developing apps in the Family Category to majorly educate or entertain them." - The data just revealed this!

Do they sell most of their apps or place them for free?

```
In [ ]: fig, ax = plt.subplots(figsize=(10, 7))  # sets the size of the plot as 10 by 7
        # this will get the type of the family category
        Family_Type = data['Type'][data['Category'] == 'FAMILY']
        plottt = Family_Type.value_counts().plot.bar(color='brown', width=.18)
        for i in plottt.patches:
            # this will annotate the plot and add the percentage on the plot
            plottt.annotate('{}%'.format(
                round(i.get_height()/len(Family_Type)*100)), (i.get_x()+0.03, i.get_height()+3))
        remove_spines_on_plot(ax, ['top', 'right'])  # this will remove the spines on the plot
        plt.ylabel('Counts\n\n')
        plt.yticks([0, 400, 800, 1200, 1600])
        ax.tick_params(bottom=False, left=False, labelsize='larger')
        plt.title('A Barplot Showing the Proportion of the Type of Apps Made in the FAMILY Category.\n\n
                  fontsize=20, color='grey')
```

```
Out[ ]: Text(0.5, 1.0, 'A Barplot Showing the Proportion of the Type of Apps Made in the FAMILY Categor
        y.\n\n')
```

A Barplot Showing the Proportion of the Type of Apps Made in the FAMILY Category.



A whole lot of the apps made under this 'popular' category are free! Infact, most apps from our data are free to download.

Do they get a high rating for their apps, compared to other categories?

```
In [ ]: Family_Rating = data['Rating'].groupby(
            data['Category']).mean().sort_values(ascending=False)  # get the mean rating of each categor
        Family_Rating
```

Out[ ]:

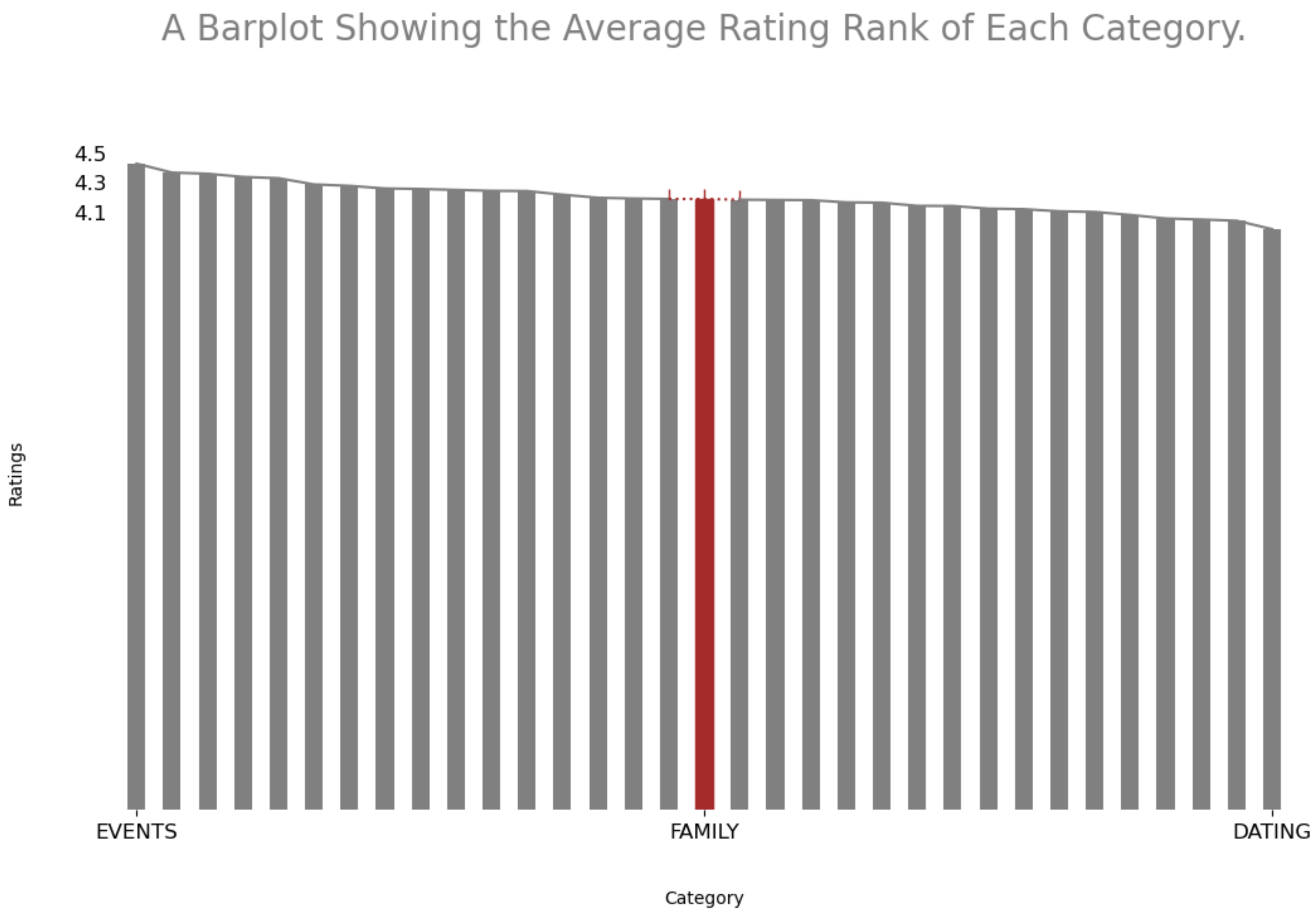
```
Category
EVENTS                   4.425000
EDUCATION                4.363866
ART  AND  DESIGN         4.356106
BOOKS  AND  REFERENCE    4.334234
PERSONALIZATION          4.325532
BEAUTY                   4.283019
PARENTING                4.273333
SOCIAL                   4.255230
HEALTH  AND  FITNESS     4.251736
GAME                     4.245464
WEATHER                  4.239241
SHOPPING                 4.237624
SPORTS                   4.212923
AUTO  AND  VEHICLES      4.191765
PRODUCTIVITY             4.186631
LIBRARIES  AND  DEMO     4.183333
FAMILY                   4.183173
COMICS                   4.178571
FOOD  AND  DRINK         4.176786
MEDICAL                  4.175443
PHOTOGRAPHY              4.160142
HOUSE  AND  HOME         4.158108
COMMUNICATION            4.136190
ENTERTAINMENT            4.135294
NEWS  AND  MAGAZINES     4.117323
FINANCE                  4.113623
BUSINESS                 4.099048
LIFESTYLE                4.094580
TRAVEL  AND  LOCAL       4.073973
VIDEO  PLAYERS           4.049693
MAPS  AND  NAVIGATION    4.042748
TOOLS                    4.034341
DATING                   3.976608
Name: Rating, dtype: float64
```

In [ ]:

```python
fig, ax = plt.subplots(figsize=(12, 7))  # sets the size of the plot as 12 by 7
# this plots the lineplot and sets the color to grey for the first 16 values
ax.plot(Family_Rating[:16], color='grey',)
# this plots the lineplot and sets the color to brown for the last 3 values
ax.plot(Family_Rating[15:18], color='brown', alpha=1, marker=2, ls=':')
# this plots the lineplot and sets the color to grey for the last 3 values
ax.plot(Family_Rating[17:], color='grey')
# this plots the barplot and sets the color to grey
plot = Family_Rating.plot.bar(color='grey')
for i in plot.patches:
    if i.get_height() == Family_Rating[16]:
        i.set_color('brown')

for i in ['top', 'right', 'left', 'bottom']:
    ax.spines[i].set_visible(False)
ax.tick_params(left=False, labelsize='large')
plt.xticks(['EVENTS', 'FAMILY', 'DATING'], rotation=0)
plt.xlabel('\n\nCategory')
plt.ylabel('Ratings\n\n')
plt.title('A Barplot Showing the Average Rating Rank of Each Category.\n\n',
          fontsize=20, color='grey')
plt.yticks([4.1, 4.3, 4.5])
```

Out[ ]:

```
([<matplotlib.axis.YTick at 0x22bde345700>,
  <matplotlib.axis.YTick at 0x22bde33ef40>,
  <matplotlib.axis.YTick at 0x22bde33e070>],
 [Text(0, 0, ''), Text(0, 0, ''), Text(0, 0, '')])
```


A Barplot Showing the Average Rating Rank of Each Category.

Though the FAMILY Category has the highest number of apps, it has no important Rating rank among other categories.
EVENTS and DATING have the highest and lowest ranks, respectively.

Still on the FAMILY Category:
What is the minimum number of Installs they get? What's the maximum? What's the avarage, with respect to the other categories?

In [ ]:

```
# this will get the minimum number of installs in each category
data['Installs'].groupby(data['Category']).min().sort_values(ascending=False)
```

Out[ ]:

```
Category
ENTERTAINMENT            1,000,000+
WEATHER                      1,000+
BEAUTY                       1,000+
VIDEO  PLAYERS               1,000+
COMICS                       1,000+
SHOPPING                     1,000+
EDUCATION                    1,000+
PHOTOGRAPHY                  1,000+
PARENTING                    1,000+
MAPS  AND  NAVIGATION        1,000+
LIBRARIES  AND  DEMO         1,000+
HEALTH  AND  FITNESS             1+
TOOLS                            1+
SPORTS                           1+
AUTO  AND  VEHICLES              1+
HOUSE  AND  HOME                 1+
GAME                             1+
FOOD  AND  DRINK                 1+
BOOKS  AND  REFERENCE            1+
COMMUNICATION                    1+
DATING                           1+
EVENTS                           1+
PERSONALIZATION                  0+
NEWS  AND  MAGAZINES             0+
PRODUCTIVITY                     0+
MEDICAL                          0+
SOCIAL                           0+
FINANCE                          0+
BUSINESS                         0+
TRAVEL  AND  LOCAL               0+
LIFESTYLE                        0+
ART  AND  DESIGN                 0+
FAMILY                            0
Name: Installs, dtype: object
```

The FAMILY Category ranks the lowest in both Series. Its maximum Installs value is so low!

Which apps in the Google Play Store are famous? Apps with the highest installs would reveal this.

Under which category do most of them fall?

In [ ]:

```
# get the apps with the maximum number of installs
famous_apps = data[data.Installs == data.Installs.max()]
famous_apps
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres
342	Viber Messenger	COMMUNICATION	4.3	11334799	Varies with device	500,000,000+	Free	0.0	Everyone	Communication
347	imo free video calls and chat	COMMUNICATION	4.3	4785892	11M	500,000,000+	Free	0.0	Everyone	Communication
371	Google Duo - High Quality Video Calls	COMMUNICATION	4.6	2083237	Varies with device	500,000,000+	Free	0.0	Everyone	Communication
378	UC Browser - Fast Download Private & Secure	COMMUNICATION	4.5	17712922	40M	500,000,000+	Free	0.0	Teen	Communication
403	LINE: Free Calls & Messages	COMMUNICATION	4.2	10790289	Varies with device	500,000,000+	Free	0.0	Everyone	Communication
1655	Candy Crush Saga	GAME	4.4	22426677	74M	500,000,000+	Free	0.0	Everyone	Casual
1661	Temple Run 2	GAME	4.3	8118609	62M	500,000,000+	Free	0.0	Everyone	Action
1662	Pou	GAME	4.3	10485308	24M	500,000,000+	Free	0.0	Everyone	Casual
1722	My Talking Tom	GAME	4.5	14891223	Varies with device	500,000,000+	Free	0.0	Everyone	Casual
2546	Facebook Lite	SOCIAL	4.3	8606259	Varies with device	500,000,000+	Free	0.0	Teen	Social
2550	Snapchat	SOCIAL	4.0	17014787	Varies with device	500,000,000+	Free	0.0	Teen	Social
3235	Google Translate	TOOLS	4.4	5745093	Varies with device	500,000,000+	Free	0.0	Everyone	Tools
3255	SHAREit - Transfer & Share	TOOLS	4.6	7790693	17M	500,000,000+	Free	0.0	Everyone	Tools
3265	Gboard - the Google Keyboard	TOOLS	4.2	1859115	Varies with device	500,000,000+	Free	0.0	Everyone	Tools
3450	Microsoft Word	PRODUCTIVITY	4.5	2084126	Varies with device	500,000,000+	Free	0.0	Everyone	Productivity

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres
3473	Dropbox	PRODUCTIVITY	4.4	1861310	61M	500,000,000+	Free	0.0	Everyone	Productivity
3476	Google Calendar	PRODUCTIVITY	4.2	858208	Varies with device	500,000,000+	Free	0.0	Everyone	Productivity
3574	Cloud Print	PRODUCTIVITY	4.1	282460	Varies with device	500,000,000+	Free	0.0	Everyone	Productivity
3703	MX Player	VIDEO PLAYERS	4.5	6474426	Varies with device	500,000,000+	Free	0.0	Everyone	Video Players & Editors
3739	Twitter	NEWS AND MAGAZINES	4.3	11667403	Varies with device	500,000,000+	Free	0.0	Mature 17+	News & Magazines
3755	Flipboard: News For Our Time	NEWS AND MAGAZINES	4.4	1284017	Varies with device	500,000,000+	Free	0.0	10+	News & Magazines
4005	Clean Master- Space Cleaner & Antivirus	TOOLS	4.7	42916526	Varies with device	500,000,000+	Free	0.0	Everyone	Tools
5596	Samsung Health	HEALTH AND FITNESS	4.3	480208	70M	500,000,000+	Free	0.0	Everyone	Health & Fitness
7536	Security Master - Antivirus, VPN, AppLock, Boo...	TOOLS	4.7	24900999	Varies with device	500,000,000+	Free	0.0	Everyone	Tools

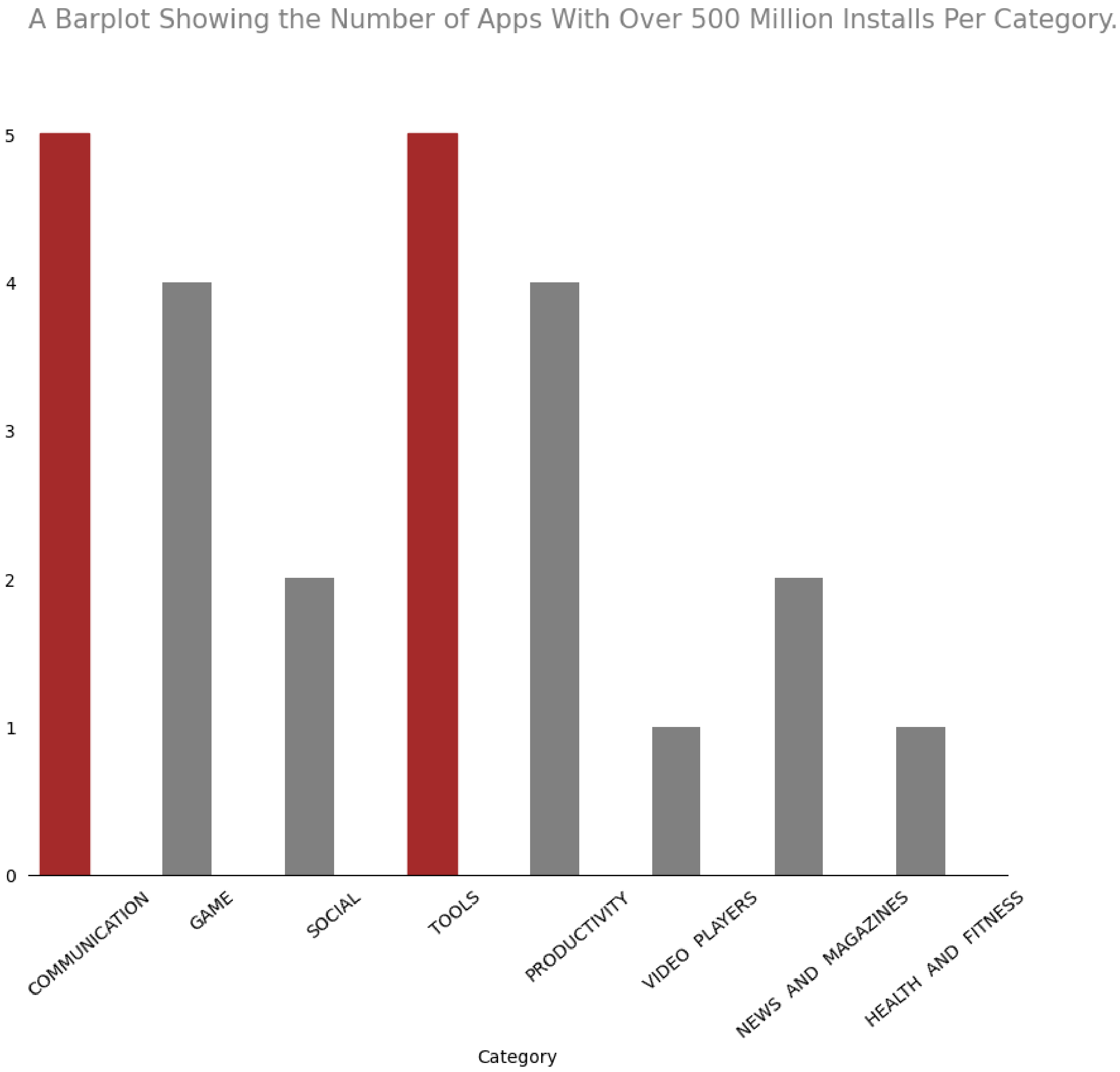
As expected, they are all free to download, and most of them do not limit any age group from downloading them.

In [ ]:

```
fig, ax = plt.subplots(figsize=(10, 8))  # sets the size of the plot as 10 by 8
plot = sns.countplot(famous_apps['Category'],
                     color='grey')  # plots the countplot
for i in plot.patches:  # this will loop through the patches
    i.set_width(0.4)  # this will set the width of the patches
    # this will highlight the maximum value
    if i.get_height() == famous_apps['Category'].value_counts().max():
        # this will set the color of the maximum value to brown
        i.set_color('brown')
# this will remove the spines on the plot
remove_spines_on_plot(ax, ['left', 'top', 'right'])
# this will remove the ticks on the plot
ax.tick_params(bottom=False, left=False)
plt.xticks(rotation=40)  # this will rotate the xticks by 40 degrees
plt.ylabel('')  # this will remove the ylabel
plt.title('A Barplot Showing the Number of Apps With Over 500 Million Installs Per Category.\n\n
          fontsize=15, color='grey', loc='left')  # this will set the title of the plot
```

Out[ ]:

```
Text(0.0, 1.0, 'A Barplot Showing the Number of Apps With Over 500 Million Installs Per Categor
y.\n\n')
```



A whole lot of people have downloaded more apps in the COMMUNICATION and TOOLS Categories, than any other Category.
W'd look deeper into the apps under these 'famous' Categories.

```
In [ ]: famous_apps[(famous_apps['Category'] == 'COMMUNICATION') |
                    (famous_apps['Category'] == 'TOOLS')]['App'].values
        # this will get the apps with the maximum number of installs in the communication category
```

```
Out[ ]: array(['Viber Messenger', 'imo free video calls and chat',
               'Google Duo - High Quality Video Calls',
               'UC Browser - Fast Download Private & Secure',
               'LINE: Free Calls & Messages', 'Google Translate',
               'SHAREit - Transfer & Share', 'Gboard - the Google Keyboard',
               'Clean Master- Space Cleaner & Antivirus',
               'Security Master - Antivirus, VPN, AppLock, Booster'], dtype=object)
```

These are popular apps indeed.

Which app(s) in the Google Play Store are the least famous?

In [ ]:

```
# get the apps with the minimum number of installs
infamous_apps = data[data.Installs == data.Installs.min()]
infamous_apps
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	A
9148	Command & Conquer: Rivals	FAMILY	4.2	0	Varies with device	0	NaN	0.0	10+	Strategy	2018-06-28	Varies with device	

Though it is free to download, it still has no downloads.

About how many years does this data span about? When is the latest date?

In [ ]:

```
# get the minimum and maximum date
data['Last Updated'].min(), data['Last Updated'].max()
```

Out[ ]:

```
(Timestamp('2010-05-21 00:00:00'), Timestamp('2018-08-08 00:00:00'))
```

Last Updated spans for about eight years, from the 21st of May 2010, to the 8th of August, 2018.

No app was updated beyond this range.

The highest number of updates took place in what year?

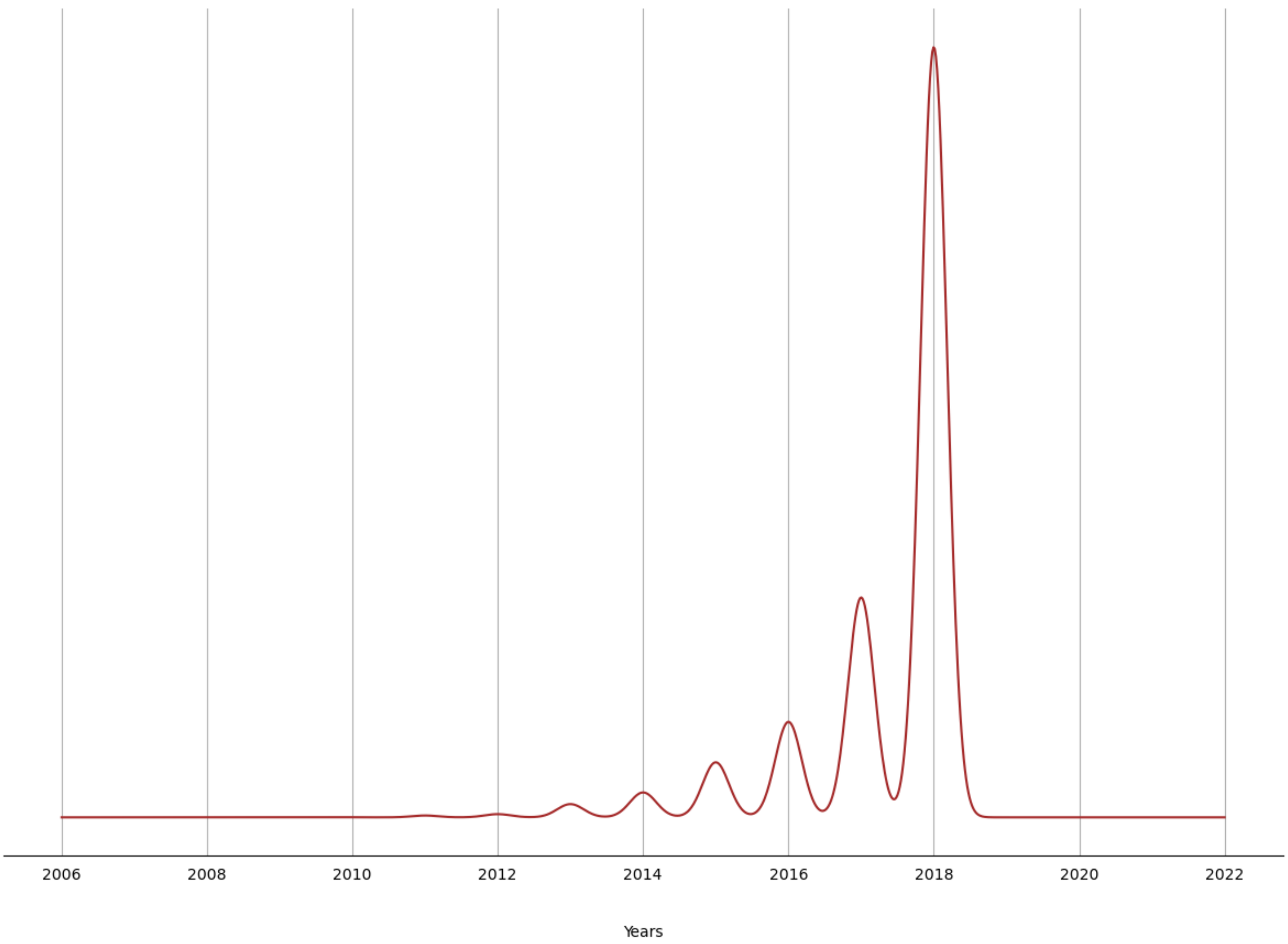
In [ ]:

```
# sets the size of the plot as 15 by 10
fig, ax = plt.subplots(figsize=(15, 10))
# this plots the kdeplot and sets the color to brown
data['Last Updated'].dt.year.plot(kind='kde', color='brown')
remove_spines_on_plot(ax, ['left', 'top', 'right'])  # this will remove the spines on the plot
# this will remove the ticks on the plot
ax.tick_params(bottom=False, left=False, labelleft='')
plt.ylabel('')  # this will remove the ylabel
plt.xlabel('\n\nYears')  # this will set the xlabel
plt.grid(axis='x')  # this will add a grid to the plot
plt.title('Distribution of Apps Over Last Updated Years.\n\n\n',
          loc='left', color='grey', fontsize=17)  # this will set the title of the plot
```

Out[ ]:

```
Text(0.0, 1.0, 'Distribution of Apps Over Last Updated Years.\n\n\n')
```

Distribution of Apps Over Last Updated Years.

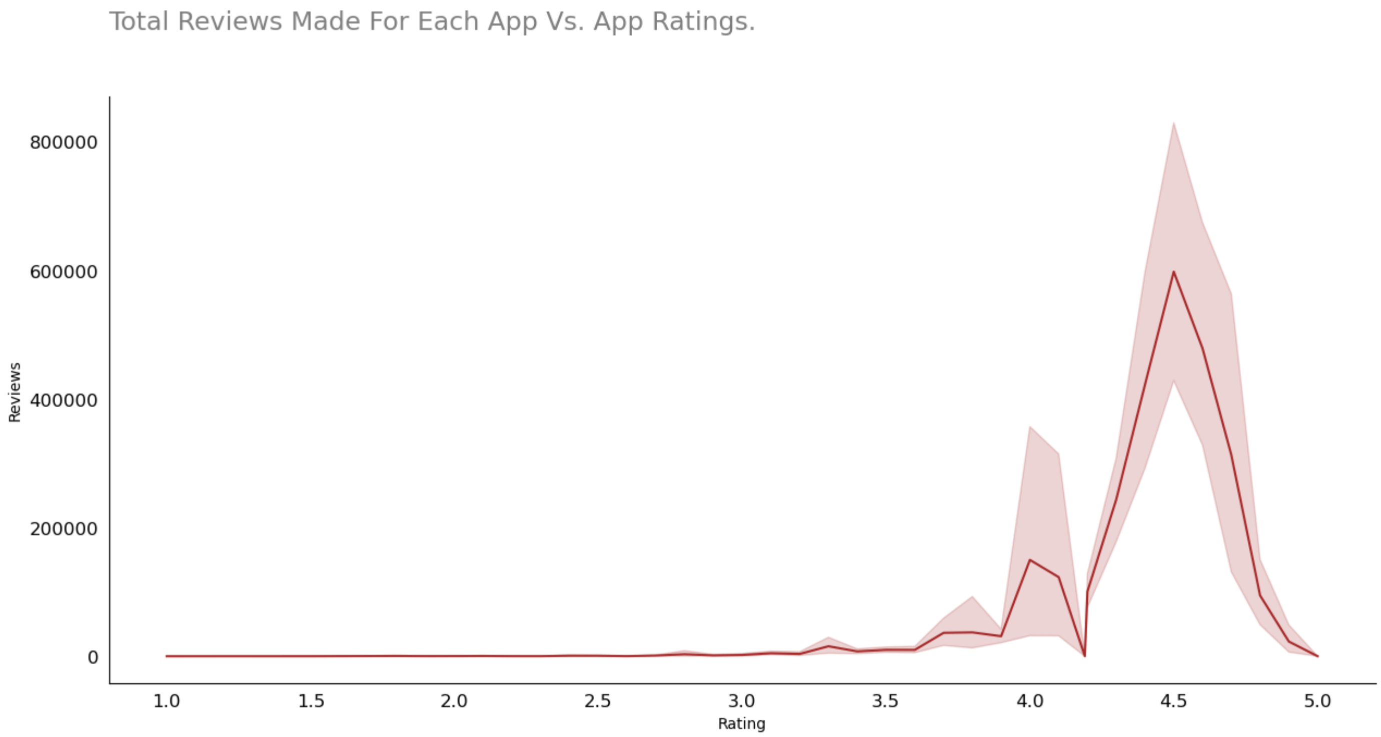


Which month does updates occur more frequently? Least freqently? The answer to the latter question would be deduced from years having complete months (Years excluding 2010 and 2018).

If my app has a high number of reviews, will it be highly rated?

```
In [ ]: fig, ax = plt.subplots(figsize=(15, 7)) # sets the size of the plot as 15 by 7
        plot = sns.lineplot(x=data['Rating'], y=data['Reviews'], color='brown', ax=ax) # plots the linep
        remove_spines_on_plot(ax, ['top', 'right']) # this will remove the spines on the plot
        ax.tick_params(bottom=False, left=False, labelsize='large') # this will remove the ticks on the 
        plt.title('Total Reviews Made For Each App Vs. App Ratings.\n\n',
                  loc='left', color='grey', fontsize=17)
```

```
Out[ ]: Text(0.0, 1.0, 'Total Reviews Made For Each App Vs. App Ratings.\n\n')
```



```
In [ ]: # this will get the index of the apps with ratings greater than 5
        np.where(data['Rating'] > 5.0)
```

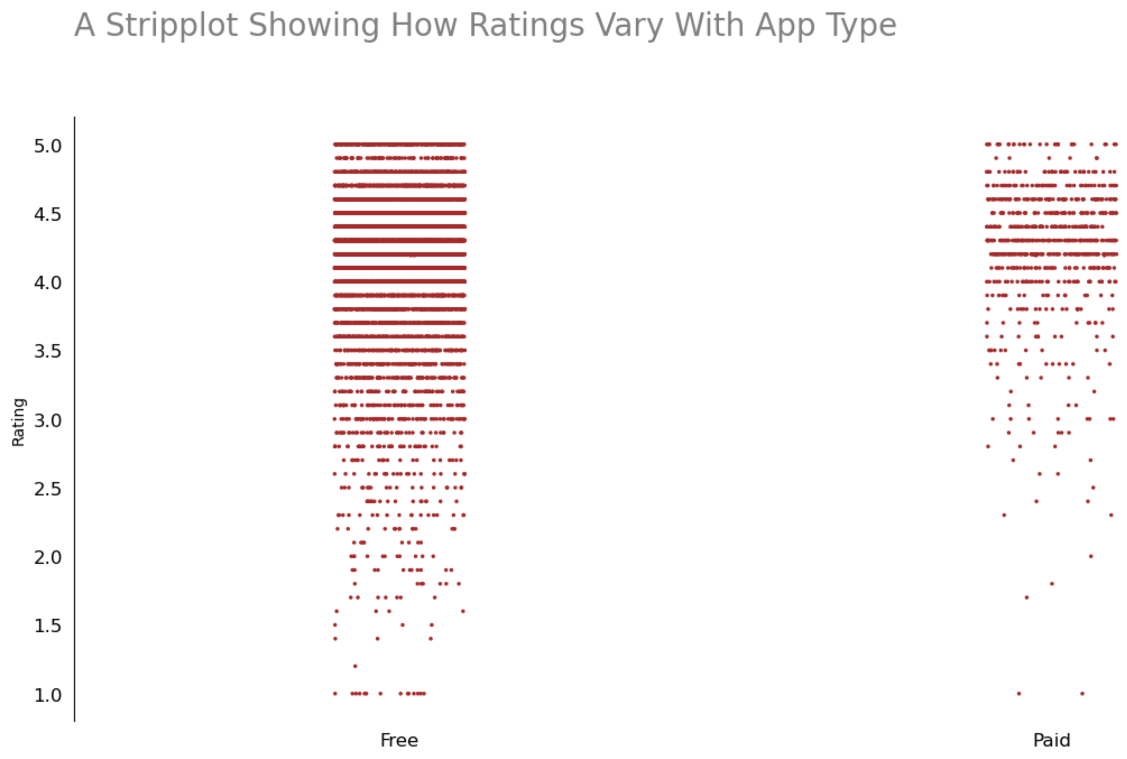
```
Out[ ]: (array([], dtype=int64),)
```

Yes, a highly rated app has a lot of people passing down their reviews. The higher the Rating , the higher the Reviews . Between free and paid apps, which one of them has a higher chance of being highly rated?

Between free and paid apps, which one of them has a higher chance of being highly rated?

```
In [ ]: fig, ax = plt.subplots(figsize=(15, 7))  # sets the size of the plot as 15 by 7
        sns.stripplot(y='Rating', x='Type', color='brown',
                      marker='.', data=data)  # plots the stripplot
        remove_spines_on_plot(ax, ['right', 'top', 'bottom'])
        # this will remove the ticks on the plot
        ax.tick_params(bottom=False, left=False, labelsize='large')
        plt.xlabel('')  # this will remove the xlabel
        plt.title('A Stripplot Showing How Ratings Vary With App Type\n\n',
                  loc='left', color='grey', fontsize=20) # this will set the title of the plot
```

```
Out[ ]: Text(0.0, 1.0, 'A Stripplot Showing How Ratings Vary With App Type\n\n')
```



Content Rating - What is the proportion of each group?

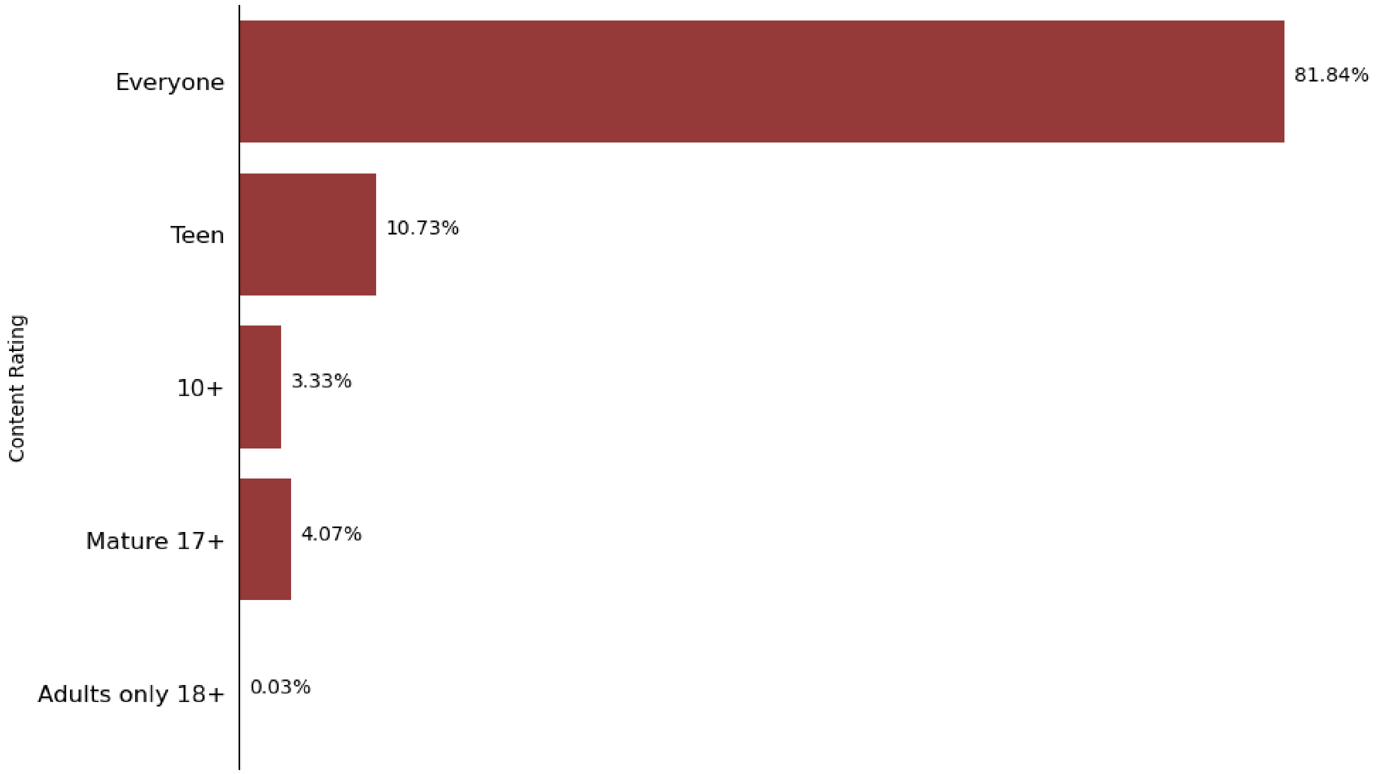
In [ ]:

```
fig, ax = plt.subplots(figsize=(10, 7))  # sets the size of the plot as 10 by 7
plot = sns.countplot(y=data['Content Rating'],
                     color='brown')  # plots the countplot
for i in plot.patches:  # this will loop through the patches
    # this will get the percentage of each category
    text = i.get_width()*100/data.shape[0]
    # this will annotate the plot
    plot.annotate('{:.2f}%'.format(text), (i.get_width()+70, i.get_y()+0.4))
remove_spines_on_plot(ax, ['right', 'top', 'bottom'])
ax.tick_params(bottom=False, left=False, labelsize='large',
               labelbottom='')  # this will remove the ticks on the plot
plt.xlabel('')  # this will remove the xlabel
plt.title('A Barplot Showing the Count of the Various Content Rating Groups.\n\n',
          loc='left', color='grey', fontsize=17)  # this will set the title of the plot
```

Out[ ]:

```
Text(0.0, 1.0, 'A Barplot Showing the Count of the Various Content Rating Groups.\n\n')
```

A Barplot Showing the Count of the Various Content Rating Groups.



Most apps have no age group restriction. Anyone can download them. However, a few apps are solely for adults. A closer peep, please.

In [ ]:
```
# this will get the apps with the adult content rating
data[data['Content Rating'] == 'Adults only 18+']
```

Out[ ]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver
298	Manga Master - Best manga & comic reader	COMICS	4.6	24005	4.9M	500,000+	Free	0.0	Adults only 18+	Comics	2018-07-04	1.1.7.0
3043	DraftKings - Daily Fantasy Sports	SPORTS	4.5	50017	41M	1,000,000+	Free	0.0	Adults only 18+	Sports	2018-07-24	3.21.324
6424	Manga Books	COMICS	3.8	7326	Varies with device	500,000+	Free	0.0	Adults only 18+	Comics	2018-08-03	Varies with device

These apps have an average high rating, are free to download, and are of two Genres - Comics and Sports.

For apps with the following:

1. maximum rating
2. minimum rating

   Most of them fall under which Category ?

Most of them are of which Type ?

In [ ]:

```
# this will get the apps with the minimum rating
minimum = data[data.Rating == data.Rating.min()]
# this will get the apps with the maximum rating
maximum = data[data.Rating == data.Rating.max()]
```

In [ ]:

```
# this will get the number of apps with the maximum rating per category
maximum.Category.value_counts()
```

Out[ ]:

```
FAMILY                 67
LIFESTYLE              29
MEDICAL                25
BUSINESS               18
TOOLS                  17
GAME                   12
HEALTH  AND  FITNESS   12
PERSONALIZATION        10
SOCIAL                  8
PRODUCTIVITY            8
FINANCE                 8
NEWS  AND  MAGAZINES    7
BOOKS  AND  REFERENCE   6
DATING                  6
SHOPPING                6
EVENTS                  6
PHOTOGRAPHY             6
COMMUNICATION           5
SPORTS                  4
TRAVEL  AND  LOCAL      3
COMICS                  2
FOOD  AND  DRINK        2
LIBRARIES  AND  DEMO    2
PARENTING               1
ART  AND  DESIGN        1
Name: Category, dtype: int64
```

In [ ]:

```
# this will get the number of apps with the minimum rating per category
minimum.Category.value_counts()
```

Out[ ]:

```
FAMILY           3
MEDICAL          3
TOOLS            3
FINANCE          2
DATING           1
GAME             1
PRODUCTIVITY     1
COMMUNICATION    1
BUSINESS         1
Name: Category, dtype: int64
```

The highest rated apps, as well as the least rated apps are found mainly in the FAMILY Category and are definitely free to download.

Considering Size

In [ ]:

```
data.Size.value_counts().head()  # this will get the top 5 sizes of apps
```

Out[ ]:

```
Varies with device    1227
11M                    182
12M                    181
14M                    177
13M                    177
Name: Size, dtype: int64
```

Most of the sizes recorded are not definite. Hence, we cannot really work with this column as we ought to. I'd create a temporal custom dataframe with rows having "Varies with device" as Size filtered out

In [ ]:

```
# this will get the apps with a fixed size
dataframe = data[data.Size != 'Varies with device']
dataframe.Size.value_counts().head()  # this will get the top 5 sizes of apps
```

Out[ ]:

```
11M    182
12M    181
13M    177
14M    177
15M    163
Name: Size, dtype: int64
```

```
This can now be work with.
The target is to make Size column an integer type.
This column should have megabyte as its unit.
First, 'M' (symbolizing megabyte) will be removed.
Second, those ending with 'k' (symbolizing kilobyte) will have their integer
part divided by 1024 (1024Kb makes 1Mb)
Third, 'k' will be removed.
Lastly, the column would be converted to a float type and renamed.
Doing all these will make the column have only megabyte as its unit, so that
correct analysis can be done.
```

In [ ]:

```
# the lamda function converts the size of the app to megabytes
dataframe.Size = dataframe.Size.str.replace('M', '').apply(lambda x: float(x[:-1])/1024 if x[-1]
    'float')  # this replaces the M with nothing and converts the size to megabytes
# add a new column to the dataframe called Size in Mb
dataframe['Size In Mb'] = dataframe.Size
```

In [ ]:

```
# this will get the summary statistics of the size of the apps
dataframe['Size In Mb'].describe()
```

Out[ ]:

```
count    8432.000000
mean       20.394897
std        21.827898
min         0.008301
25%         4.600000
50%        12.000000
75%        28.000000
max       100.000000
Name: Size In Mb, dtype: float64
```

Based on the dataset, the average size an app from Play Store has is about 20 Mb.

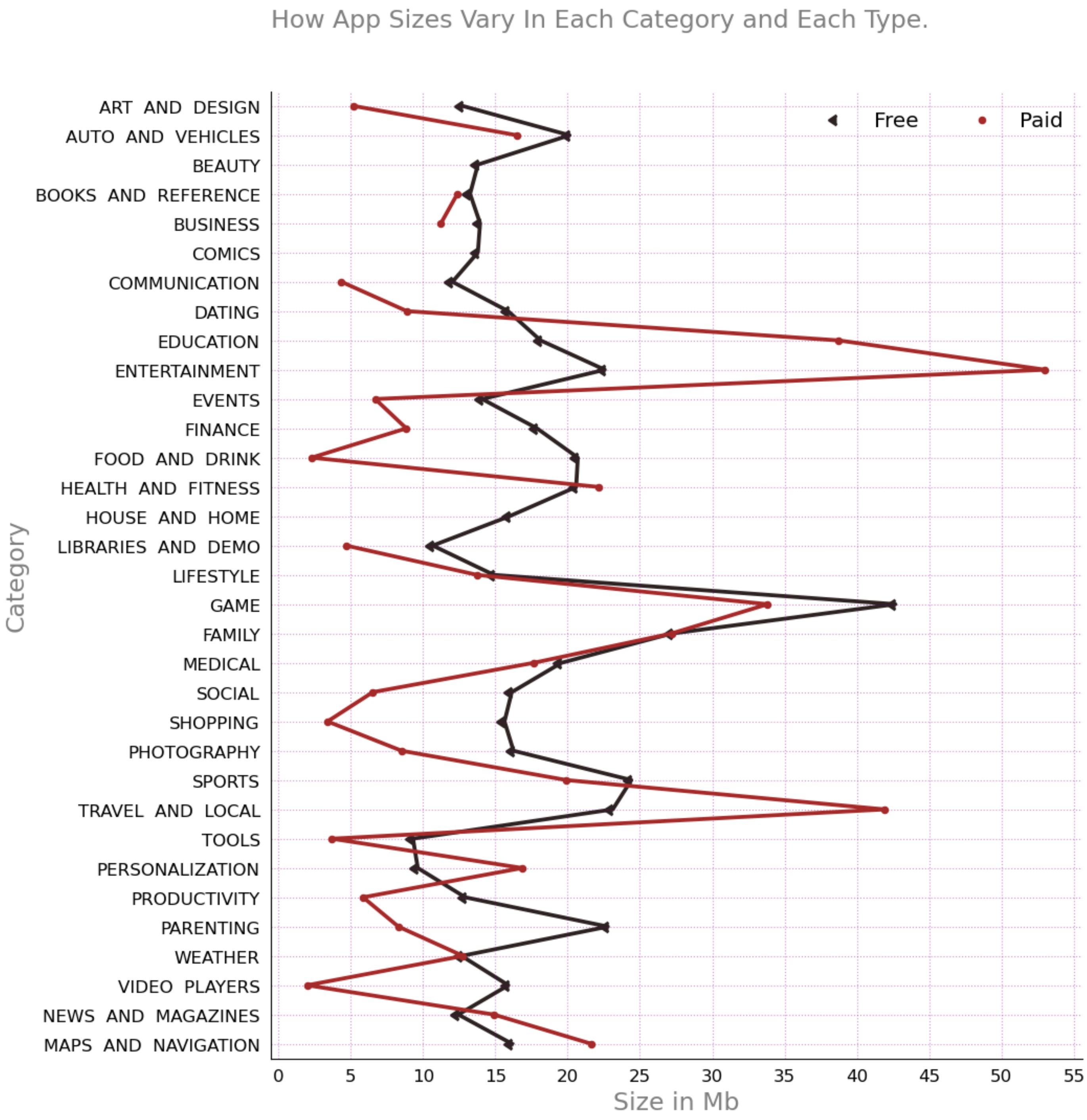
Does the Category an app belong to affect how sized the app is? Which category has the least app size? Which one has the highest?

In [ ]:

```
# this sets the size of the plot as 10 by 12
fig, ax = plt.subplots(figsize=(10, 12))
sns.pointplot('Size In Mb', 'Category', data=dataframe, hue='Type', color='brown',
              ci=None, markers=[8, '.'], ax=ax)  # this plots the pointplot
```

```
# this adds the legend to the plot
plt.legend(ncol=2, frameon=False, fontsize='x-large')
remove_spines_on_plot(ax, ['right', 'top'])  # this will remove the spines on the plot
# this removes the ticks on the plot
ax.tick_params(bottom=False, left=False, labelsize='large')
plt.xlabel('Size in Mb', color='grey', fontsize=17)  # this sets the xlabel
plt.ylabel('Category', color='grey', fontsize=17)  # this sets the ylabel
plt.xticks(np.arange(0, 56, 5))  # this sets the xticks
plt.grid(color='purple', ls=':', alpha=.4)  # this adds a grid to the plot
plt.title('How App Sizes Vary In Each Category and Each Type.\n\n',
          loc='left', color='grey', fontsize=17)  # this sets the title of the plot
```

```
Out[ ]: Text(0.0, 1.0, 'How App Sizes Vary In Each Category and Each Type.\n\n')
```



For Paid apps (brown colored line), two spikes are seen in the ENTERTAINMENT
and TRADE AND LOCAL Categories with
average sizes of about 53 Mb and 42 Mb respectively.
Free apps' (most apps fall under this type, denoted by the black colored line),
however has a lower spike and this is found in the

```
GAME Category. It has an average size of about 43 Mb.
Paid apps are usually larger in size.
```

Predictive Modelling

To choose a suitable model to train our data with, checking out for the correlation between these features is essential.

In [ ]:

```
dataframe.corr()  # this will get the correlation between the numerical columns
```

Out[ ]:

	Rating	Reviews	Size	Price	Size In Mb
Rating	1.000000	0.066669	0.058595	-0.019598	0.058595
Reviews	0.066669	1.000000	0.179321	-0.008649	0.179321
Size	0.058595	0.179321	1.000000	-0.022441	1.000000
Price	-0.019598	-0.008649	-0.022441	1.000000	-0.022441
Size In Mb	0.058595	0.179321	1.000000	-0.022441	1.000000

```
Aim is to predict how many installs an app will have, based on other features.
Splting the data into dependent (y) and independent (X) features.
To determine which feature could affect Installs , I will examine each of the
features.
```

Review

```
App : The name of the app definitely has no impact on if I'd get 20 or 200000
Installs.
Category : The number of Installs could depend on the category an app is.
Rating : A highly installed app could attract high ratings.
Reviews : Ealier on (in the EDA section), we saw that a highly rated app
attracts
more reviews. Thus, an app is meant to have a lot of users (pontential
reviewers)
because it has a high number of reviews
Size : Installs would definitely depend on the app size. 'Varies with device'
as an entry would have no certain impact on Installs, thus would be dropped
('dataframe' would be used for the data modelling rather than 'data', for
obvious reasons).
Type : A free app could have more users installing them.
Price : The same thing goes for this feature.
Content Rating : This, as well.
Last Updated : The number of installs cannot be predicted from when last an app
was updated.
Current Ver : Likewise this.
Android Ver : This could affect Installs. If my android version is not
compatible with the
app's required version, I would decide not to download it. I'd rather go with
an alternative app.
```

In [ ]:

```
# Importing libraries from scikit learn.
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.metrics import r2_score, accuracy_score
```

In [ ]:

```
# this will drop the columns that are not needed
X = dataframe.drop(['App', 'Last Updated', 'Current Ver'], axis=1)
y = dataframe['Installs']  # this will set the target variable
```

In [ ]:

```
Encoder = LabelEncoder()  # this will instantiate the label encoder
for i in X.select_dtypes('O'):  # this will loop through the categorical columns
    # this will encode the categorical columns
    X[i] = Encoder.fit_transform(X[i])
```

In [ ]:

```
# this will split the data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(
    X, y, stratify=y, random_state=0)
```

In [ ]:

```
# this will instantiate the decision tree classifier for fitting
model = DecisionTreeClassifier()
model.fit(X_train, y_train)  # this will fit the model to the training data
```

Out[ ]:

```
DecisionTreeClassifier()
```

In [ ]:

```
y_pred = model.predict(X_test)  # this will make predictions on the test data
```

In [ ]:

```
accuracy_score(y_test, y_pred)  # this will get the accuracy score
```

Out[ ]:

```
1.0
```

Accurate!

Regression Model

The aim is to predict what the rating of an app will be, based on other features

Review

```
App : The name of the app definitely has no impact on if I'd get a star or 5
stars.
Category : The rating could depend on the category an app is.
Installs : A highly installed app could attract high ratings.
Reviews : Everone who drops a review drops a rating.
Size : Rating would definitely depend on the app size.
Type : A free app could have more users highly rating it.
Price : The same thing goes for this feature.
Content Rating : This, as well.
Last Updated : Rating cannot be predicted from when last an app was updated.
Current Ver : Likewise this.
Android Ver : This could affect Rating . If my android version is not
compatible
with the app's required version, I could get furious and give it just a star.
```

In [ ]:

```
# this will drop the columns that are not needed
X = dataframe.drop(['App', 'Last Updated', 'Current Ver'], axis=1)
y = dataframe['Rating']  # this will set the target variable
```

In [ ]:

```
Encoder = LabelEncoder()  # this will instantiate the label encoder
for i in X.select_dtypes('O'):  # this will loop through the categorical columns
    # this will encode the categorical columns
    X[i] = Encoder.fit_transform(X[i])
```

In [ ]:

```
# this will split the data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=2)
```

In [ ]:

```
# this will instantiate the decision tree regressor
model = DecisionTreeRegressor(random_state=2)
model.fit(X_train, y_train)  # this will fit the model to the training data
```

Out[ ]:

```
DecisionTreeRegressor(random_state=2)
```

In [ ]:

```
y_pred = model.predict(X_test)  # this will make predictions on the test data
```

In [ ]:

```
r2_score(y_test, y_pred)  # this will evaluate the model
```

Out[ ]:

```
1.0
```

Great! This is accurate!.

Conclusion

Based on the exploratory data analysis, I can conclude that:

1. Most of the Google Play Store Apps are of the Family category, while the least is Comics.
2. A whole lot of the apps made under that are popular are free!.
3. "In 2018, a larger fraction of developers are developing apps in the Family Category to majorly educate or entertain them."
4. A highly rated app has a lot of people passing down their reviews.
5. The higher the Rating, the higher the Reviews.
6. Most apps have no age group restriction. Anyone can download them.
7. The highest rated apps, as well as the least rated apps are found mainly in the FAMILY Category and are definitely free to download.
8. Paid apps are usually larger in size.

References

- Google Play Store Dataset Kaggle
- Google Play Store
- Visualizations Seaborn
- Pandas
- Dr Sean Mc Grath Labs
- Stack Overflow
- Cephas ICT HUB Lab Notes - Cephas ICT HUB