App Rating Prediction (GooglePlayStore)

In [1]:
```
# importing essential libraries
import numpy as np
import pandas as pd
```

1. Load the data file using pandas

In [2]:
```
# 1. Load the data file using pandas

PlayStoreData = pd.read_csv('G:\\DS----PYTHON\\PYTHON ----   MAY ---08\\PROJECT --- PYTHON\\1569582940_googleplaystore\\googlepla
PlayStoreData.head()
```

Out[2]:

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

In [3]:
```
# Technique we want to follow for PlayStoreData preprocessing steps in order to do further analysis

## Check the distribution and type of the data
## Identify and remove outliers
## Identify to deal with inappropriate data
## Identify and deal with missing values
```

In [4]:
```
# to know for how many rows and columns are there in our dataset

PlayStoreData.shape

# We got 13 columns and 10841 rows/records
# (10841, 13)
```

Out[4]: (10841, 13)

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```
PlayStoreData.shape

# We got 13 columns and 10841 rows/records
# (10841, 13)
```

Out[4]: (10841, 13)

In [5]:
```
## Check the  datatype of each column present in our dataset using info function

PlayStoreData.info()

 #   Column          Non-Null Count  Dtype
#---  ------          --------------  -----
# 0   App             10841 non-null  object -------- categorical (unique entries)
# 1   Category        10841 non-null  object -------- categorical
# 2   Rating          9367 non-null   float64 ------- numerical ---- discrete (need to convert it into categorical)
# 3   Reviews         10841 non-null  object --------  ordinal
# 4   Size            10841 non-null  object -------- ordinal (need to convert it into numeric)
# 5   Installs        10841 non-null  object -------- ordinal (need to convert it into numeric)
# 6   Type            10840 non-null  object -------- Categorical
# 7   Price           10841 non-null  object -------- ordinal  (need to convert it into numeric)
# 8   Content Rating  10840 non-null  object -------- categorical
# 9   Genres          10841 non-null  object -------- categorical
# 10  Last Updated    10841 non-null  object -------- ordinal
# 11  Current Ver     10833 non-null  object -------- ordinal
# 12  Android Ver     10838 non-null  object -------- ordinal
```

```
<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 [6]:
```
PlayStoreData['Android Ver'].unique()
```

Out[6]:
```
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',
```

```
       '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 [7]:
```
## Identify and remove outliers
# Identifying columns for checking outliers and statistical description usning describe function

PlayStoreData.describe()
```

Out[7]:

	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

2. Check for null values in the data. Get the number of null values for each column.

In [8]:
```

# We will check for null values in our dataset of each column using isna() function

PlayStoreData.isna().sum()

# PlayStoreData.isna().sum() helps us to get number of null values present of each column

# Rating           1474
# Type                1
# Content Rati## Check the  datatype of each column present in our dataset using info function

PlayStoreData.info()
ng       1
# Current Ver         8
# Android Ver         3

## These columns have null values
```

Out[8]:
```
App                0
Category           0
Rating          1474
Reviews            0
Size               0
Installs           0
```

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5. Drop records with nulls in any of the columns.

In [9]:
```
# We will drop records where null values are present using dropna() function
# dropna() is used for dropping those NaN present records

PlayStoreData.dropna(inplace=True)
# This will remove those records containing null values
```

In [10]:
```
# We can check again where null values records removed or not using
PlayStoreData.isna().sum()

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

# We can see no records are there whose containing null values
```

Out[10]:
```
App             0
Category        0
Rating          0
Reviews         0
Size            0
Installs        0
Type            0
Price           0
Content Rating  0
Genres          0
Last Updated    0
Current Ver     0
Android Ver     0
dtype: int64
```

In [11]:
```
# checking how many records are present in the dataset after droping records containing null values
PlayStoreData.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9360 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             9360 non-null   object
```

4. Variables seem to have incorrect type and inconsistent formatting. You need to fix them

In [13]:
```
## 1> Size column has sizes in Kb as well as Mb. To analyze, you'll need to convert these to numeric.

### 1.Extract the numeric value from the column

### 2. Multiply the value by 1,000, if size is mentioned in Mb

## 2> Reviews is a numeric field that is loaded as a string field. Convert it to numeric (int/float).

## 3> Installs field is currently stored as string and has values like 1,000,000+.

### 1.Treat 1,000,000+ as 1,000,000

### 2. remove '+', ',' from the field, convert it to integer

## 4> Price field is a string and has $ symbol. Remove '$' sign, and convert it to numeric.
```

In [14]:
```
# check for datatype of Size column

PlayStoreData.info()
# 4   Size            9360 non-null   object
```

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

1> Size column has sizes in Kb as well as Mb. To analyze, you'll need to convert these to numeric.

In [15]:

```
### 2. Multiply the value by 1,000, if size is mentioned in Mb
```

In [16]:
```
# Check for the values which are present in the Size column using unique() function
PlayStoreData['Size'].unique()
```

Out[16]:
```
array(['19M', '14M', '8.7M', '25M', '2.8M', '5.6M', '29M', '33M', '3.1M',
       '28M', '12M', '20M', '21M', '37M', '5.5M', '17M', '39M', '31M',
       '4.2M', '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', '2.7M', '2.5M', '7.0M', '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', '22M', '6.4M', '3.2M', '8.2M', '4.9M', '9.5M', '5.0M',
       '5.9M', '13M', '73M', '6.8M', '3.5M', '4.0M', '2.3M', '2.1M',
       '42M', '9.1M', '55M', '23k', '7.3M', '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',
       '3.7M', '118k', '44M', '695k', '1.6M', '6.2M', '53M', '1.4M',
       '3.0M', '7.2M', '5.8M', '3.8M', '9.6M', '45M', '63M', '49M', '77M',
       '4.4M', '70M', '9.3M', '8.1M', '36M', '6.9M', '7.4M', '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',
       '93M', '65M', '79M', '100M', '58M', '50M', '68M', '64M', '34M',
       '67M', '60M', '94M', '9.9M', '232k', '99M', '624k', '95M', '8.5k',
       '41k', '292k', '80M', '1.7M', '10.0M', '74M', '62M', '69M', '75M',
       '98M', '85M', '82M', '96M', '87M', '71M', '86M', '91M', '81M',
       '92M', '83M', '88M', '704k', '862k', '899k', '378k', '4.8M',
       '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', '818k', '81k', '939k', '169k',
       '45k', '965k', '90M', '545k', '61k', '283k', '655k', '714k', '93k',
       '872k', '121k', '322k', '976k', '206k', '954k', '444k', '717k',
       '210k', '609k', '308k', '306k', '175k', '350k', '383k', '454k',
       '1.0M', '70k', '812k', '442k', '842k', '417k', '412k', '459k',
       '478k', '335k', '782k', '721k', '430k', '429k', '192k', '460k',
       '728k', '496k', '816k', '414k', '506k', '887k', '613k', '778k',
       '683k', '592k', '186k', '840k', '647k', '373k', '437k', '598k',
       '716k', '585k', '982k', '219k', '55k', '323k', '691k', '511k',
       '951k', '963k', '25k', '554k', '351k', '27k', '82k', '208k',
       '551k', '29k', '103k', '116k', '153k', '209k', '499k', '173k',
       '597k', '809k', '122k', '411k', '400k', '801k', '787k', '50k',
       '643k', '986k', '516k', '837k', '780k', '20k', '498k', '600k',
       '656k', '221k', '228k', '176k', '34k', '259k', '164k', '458k',
       '629k', '28k', '288k', '775k', '785k', '636k', '916k', '994k',
       '309k', '485k', '914k', '903k', '608k', '500k', '54k', '562k',
       '847k', '948k', '811k', '270k', '48k', '523k', '784k', '280k',
       '24k', '892k', '154k', '18k', '33k', '860k', '364k', '387k',
```

```
       '234k', '257k', '861k', '467k', '676k', '552k', '582k', '619k'],
      dtype=object)
```

In [17]:
```
# checking for the types of values in column
PlayStoreData['Size']
```

Out[17]:
```
0                     19M
1                     14M
2                    8.7M
3                     25M
4                    2.8M
                   ...
10834                2.6M
10836                 53M
10837                3.6M
10839    Varies with device
10840                 19M
Name: Size, Length: 9360, dtype: object
```

In [18]:
```
# Define a function for removing 'M' and 'k' from the dataset
# multiply by 1000 in place of M contains column

def sizes(x):
    if 'M' in x:
        return float(x.replace("M",""))*1000
    if 'k' in x:
        return float(x.replace('k',''))
    return 0.0

# applying the function with the column to know whether M and K removed or not
PlayStoreData['Size']=PlayStoreData['Size'].apply(sizes)
PlayStoreData['Size']

# # we have successfully removed 'M' and 'k' sign and converted into float datatype from string datatype
```

Out[18]:
```
0       19000.0
1       14000.0
2        8700.0
3       25000.0
4        2800.0
          ...
10834    2600.0
10836   53000.0
10837    3600.0
10839       0.0
10840   19000.0
Name: Size, Length: 9360, dtype: float64
```

In [19]:
```
# check for datatype of Size column after applying our defined function

PlayStoreData.info()
```

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In [20]:
```
PlayStoreData['Reviews']=PlayStoreData['Reviews'].astype(float)
PlayStoreData['Reviews']

# Name: Reviews, Length: 9360, dtype: float64
```

Out[20]:
```
0          159.0
1          967.0
2        87510.0
3       215644.0
4          967.0
          ...
10834        7.0
10836       38.0
10837        4.0
10839      114.0
10840    398307.0
Name: Reviews, Length: 9360, dtype: float64
```

In [21]:
```
## 3> Installs field is currently stored as string and has values like 1,000,000+.
```

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

Out[22]:
```
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+', '100+', '500+', '10+',
       '5+', '50+', '1+'], dtype=object)
```

In [23]:
```
### 1.Treat 1,000,000+ as 1,000,000

### 2. remove '+', ',' from the field, convert it to integer
```

In [24]:
```
def pluss(x):
    if '+' in x:
        return x.replace('+','')
    return 0.0
```

In [25]:
```
PlayStoreData['Installs']=PlayStoreData['Installs'].apply(pluss)
```

In [26]:
```
PlayStoreData['Installs']
```

Out[26]:
```
0           10,000
1          500,000
2        5,000,000
3       50,000,000
4          100,000
           ...
10834          500
10836        5,000
10837          100
10839        1,000
10840   10.000.000
```

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Run Code

In [27]:
```
def coma(x):
    if ',' in x:
        return float(x.replace(',',''))
    return 0.0
```

In [28]:
```
PlayStoreData['Installs']=PlayStoreData['Installs'].apply(coma)
```

In [29]:
```
PlayStoreData['Installs']

# we have successfully removed ',' and '+' sign and converted into float datatype from string datatype
```

Out[29]:
```
0          10000.0
1         500000.0
2        5000000.0
3       50000000.0
4         100000.0
            ...
10834          0.0
10836       5000.0
10837          0.0
10839       1000.0
10840    10000000.0
Name: Installs, Length: 9360, dtype: float64
```

In [30]:
```
PlayStoreData.info()

#  5   Installs        9360 non-null   float64
```

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

In [31]:
```
PlayStoreData['Price'].unique()
```

Out[31]: array(['0', '$4.99', '$3.99', '$6.99', '$7.99', '$5.99', '$2.99', '$3.49'

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Run Code

In [32]:
```
# removing '$' sign from price column
def dollar(x):
    if '$' in x:
        return float(x.replace('$',''))
    return 0.0
```

In [33]:
```
PlayStoreData['Price']=PlayStoreData['Price'].apply(dollar)
```

In [34]:
```
PlayStoreData['Price']
```

Out[34]:
```
0        0.0
1        0.0
2        0.0
3        0.0
4        0.0
        ...
10834    0.0
10836    0.0
10837    0.0
10839    0.0
10840    0.0
Name: Price, Length: 9360, dtype: float64
```

In [35]:
```
PlayStoreData['Price'].unique()
```

Out[35]:
```
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 [36]:
```
PlayStoreData.info()

#  7   Price          9360 non-null   float64
```

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

5. Sanity checks:

In [37]:
```
# 1. Average rating should be between 1 and 5 as only these values are allowed on the play store. Drop the rows that have a value

# 2. Reviews should not be more than installs as only those who installed can review the app. If there are any such records, drop

# 3. For free apps (type = "Free"), the price should not be >0. Drop any such rows.
```

In [59]:
```
# 1. Average rating should be between 1 and 5 as only these values are allowed on the play store.
#    Drop the rows that have a value outside following range.
# [(PlayStoreData['Rating']<1) & (PlayStoreData['Rating']>5)]

PlayStoreData[(PlayStoreData['Rating']<1) & (PlayStoreData['Rating']>5)].round(1)

# We found NO such records are there in our dataset in the range
# between [(PlayStoreData['Rating']<1) & (PlayStoreData['Rating']>5)]
```

Out[59]:

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

In [39]:
```
# 2. Reviews should not be more than installs as only those who installed can review the app.
#    If there are any such records, drop them.

print(len(PlayStoreData['Reviews']))

print(len(PlayStoreData['Installs']))

# There are equal length of Reviews and Install column
# i.e. those who install the app can only able to review the app
```

```
9360
9360
```

In [40]:
```
# 3. For free apps (type = "Free"), the price should not be >0. Drop any such rows.
# [(PlayStoreData['Type']=='Free') & (PlayStoreData['Price']>0)]

PlayStoreData[(PlayStoreData['Type']=='Free') & (PlayStoreData['Price']>0)]

# There are NO such apps which is free and price is greater than 0
# Range between [(PlayStoreData['Type']=='Free') & (PlayStoreData['Price']>0)]
```

Out[40]:

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

5. Performing univariate analysis:

5. Performing univariate analysis:

In [41]:

```
#Boxplot for Price

#Are there any outliers? Think about the price of usual apps on Play Store.

#Boxplot for Reviews

#Are there any apps with very high number of reviews? Do the values seem right?

#Histogram for Rating

#How are the ratings distributed? Is it more toward higher ratings?

#Histogram for Size

#Note down your observations for the plots made above. Which of these seem to have outliers?
```

In [42]:

```
# importing Visualization libraries

import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
```

In [43]:

```
#Boxplot for Price
# Creating a boxplot for checking whether outliers are present or not in the column

sns.set_style(style='whitegrid')
sns.boxplot(PlayStoreData['Price'])
plt.title('Prices of different apps', fontsize=18)
plt.xlabel('Price', fontsize=14)

# We can see that there are many outliers in Price column
```

Out[43]: Text(0.5, 0, 'Price')

In [44]:
```
PlayStoreData.groupby('Price').max()['App']

# Following apps has highest price

#299.99                                    I am rich VIP
#379.99                                I am extremely Rich
#389.99                                        I Am Rich
#399.99                                    💎 I'm rich
#400.00                            I'm Rich - Trump Edition
```

Out[44]:
```
Price
0.00      🔥 Football Wallpapers 4K | Full HD Backgrounds 😍
0.99                                pretty Easy privacy p=p
1.00                                Wi-Fi Rabbit Unlock Key
1.20                                            sugar, sugar
1.29                           Ad Remove Plugin for App2SD
                                    ...
299.99                                     I am rich VIP
379.99                                 I am extremely Rich
389.99                                         I Am Rich
399.99                                     💎 I'm rich
400.00                             I'm Rich - Trump Edition
Name: App, Length: 73, dtype: object
```

In [60]:
```
#Boxplot for Reviews

PlayStoreData.describe()
# we can see that in Reviews column, has many outliers
```

Out[60]:

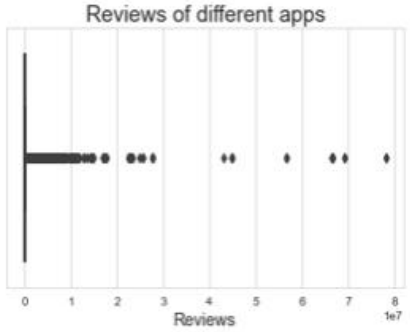
	Rating	Reviews	Size	Installs	Price
count	8892.000000	8.892000e+03	8892.000000	8.892000e+03	8892.000000
mean	4.180139	1.048333e+05	18547.061122	6.262431e+06	0.350172
std	0.524259	2.673779e+05	22219.190476	3.538610e+07	2.220943
min	1.000000	1.000000e+00	0.000000	0.000000e+00	0.000000
25%	4.000000	1.590000e+02	2675.000000	1.000000e+04	0.000000
50%	4.300000	4.284500e+03	9500.000000	5.000000e+05	0.000000
75%	4.500000	5.681725e+04	26000.000000	5.000000e+06	0.000000
max	5.000000	1.986068e+06	100000.000000	1.000000e+09	79.990000

In [46]:
```
PlayStoreData.groupby('App').max()['Reviews']

# following apps has highest number of reviews
```

```
Smart Ruler ↔ cm/inch measuring for homework!      19.0
Football Wallpapers 4K | Full HD Backgrounds 😍    11661.0
Name: Reviews, Length: 8190, dtype: float64
```

In [47]:
```
# Creating a boxplot for checking whether outliers are present or not in the column
sns.boxplot(PlayStoreData['Reviews'])
plt.title('Reviews of different apps', fontsize=18)
plt.xlabel('Reviews', fontsize=14)

# We can see that there are many outliers in Price column
```

Out[47]: Text(0.5, 0, 'Reviews')

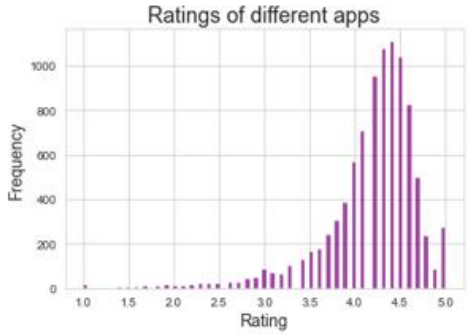


In [48]:
```
#Histogram for Rating

#How are the ratings distributed? Is it more toward higher ratings?

sns.histplot(PlayStoreData['Rating'],color='purple')
plt.title('Ratings of different apps', fontsize=18)
plt.xlabel('Rating', fontsize=14)
plt.ylabel('Frequency', fontsize=14)

# Rating is distributed as left skewed which we can say as Negetively skewed and it is towards higher ratings
# It is looking a very good distribution as left skewed
```

Out[48]: Text(0, 0.5, 'Frequency')

```
#How are the ratings distributed? Is it more toward higher ratings?

sns.histplot(PlayStoreData['Rating'],color='purple')
plt.title('Ratings of different apps', fontsize=18)
plt.xlabel('Rating', fontsize=14)
plt.ylabel('Frequency', fontsize=14)

# Rating is distributed as left skewed which we can say as Negetively skewed and it is towards higher ratings
# It is looking a very good distribution as Left skewed
```

Out[48]: Text(0, 0.5, 'Frequency')



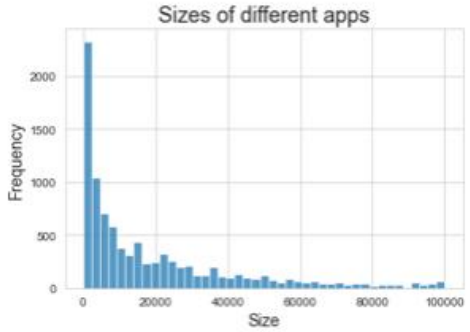
In [ ]:

In [49]:
```
#Histogram for Size

sns.histplot(PlayStoreData['Size'], palette='Blues_r')
plt.title('Sizes of different apps', fontsize=18)
plt.xlabel('Size', fontsize=14)
plt.ylabel('Frequency', fontsize=14)

# we can see that the distribution is a right skewed type and it starts from higher Size and continue to lower Size
```

Out[49]: Text(0, 0.5, 'Frequency')

In [49]:
```
#Histogram for Size

sns.histplot(PlayStoreData['Size'], palette='Blues_r')
plt.title('Sizes of different apps', fontsize=18)
plt.xlabel('Size', fontsize=14)
plt.ylabel('Frequency', fontsize=14)

# we can see that the distribution is a right skewed type and it starts from higher Size and continue to lower Size
```

Out[49]: Text(0, 0.5, 'Frequency')



In [ ]:

6. Outlier treatment:

In [50]:
```
## Identify and remove outliers

#Price: From the box plot, it seems like there are some apps with very high price. A price of $200 for an application on the Play

#Check out the records with very high price

#Is 200 indeed a high price?

#Drop these as most seem to be junk apps

#Reviews: Very few apps have very high number of reviews. These are all star apps that don't help with the analysis and, in fact,

#Installs:  There seems to be some outliers in this field too. Apps having very high number of installs should be dropped from th

#Find out the different percentiles - 10, 25, 50, 70, 90, 95, 99

#Decide a threshold as cutoff for outlier and drop records having values more than that
```

6. Outlier treatment:

In [50]:
```
## Identify and remove outliers

#Price: From the box plot, it seems like there are some apps with very high price. A price of $200 for an application on the Play

#Check out the records with very high price

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#Reviews: Very few apps have very high number of reviews. These are all star apps that don't help with the analysis and, in fact,

#Installs:  There seems to be some outliers in this field too. Apps having very high number of installs should be dropped from th

#Find out the different percentiles - 10, 25, 50, 70, 90, 95, 99

#Decide a threshold as cutoff for outlier and drop records having values more than that
```

In [51]:
```
#Price: From the box plot, it seems like there are some apps with very high price. A price of $200 for an application on the Play

#Check out the records with very high price

#Is 200 indeed a high price?

PlayStoreData['Price'].max()

# We can see that 400 is the highest price
```

Out[51]:
```
400.0
```

In [52]:
```
#Drop these as most seem to be junk apps
# check for records which are greater than 200

PlayStoreData1=PlayStoreData[PlayStoreData['Price']>=200]
PlayStoreData1

# Assign that range in a new variable and get records for above mentioned condition
```

Out[52]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
4197	most expensive app (H)	FAMILY	4.3	6.0	1500.0	0.0	Paid	399.99	Everyone	Entertainment	July 16, 2018	1.0	7.0 and up
4362	💎 I'm rich	LIFESTYLE	3.8	718.0	26000.0	10000.0	Paid	399.99	Everyone	Lifestyle	March 11, 2018	1.0.0	4.4 and up
4367	I'm Rich - Trump Edition	LIFESTYLE	3.6	275.0	7300.0	10000.0	Paid	400.00	Everyone	Lifestyle	May 3, 2018	1.0.1	4.1 and up

```
PlayStoreData=PlayStoreData.drop(PlayStoreData1.index, axis=0)
PlayStoreData.head()
```

Out[53]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159.0	19000.0	10000.0	Free	0.0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967.0	14000.0	500000.0	Free	0.0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510.0	8700.0	5000000.0	Free	0.0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644.0	25000.0	50000000.0	Free	0.0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967.0	2800.0	100000.0	Free	0.0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up

In [54]:

```
# Resetting the index

PlayStoreData.set_index( np.arange(0,len(PlayStoreData)) , inplace=True)

PlayStoreData
```

Out[54]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159.0	19000.0	10000.0	Free	0.0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967.0	14000.0	500000.0	Free	0.0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510.0	8700.0	5000000.0	Free	0.0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644.0	25000.0	50000000.0	Free	0.0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967.0	2800.0	100000.0	Free	0.0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up
...	...	...	...	...	...	...	...	...	...	...	...	...	...
9340	FR Calculator	FAMILY	4.0	7.0	2600.0	0.0	Free	0.0	Everyone	Education	June 18, 2017	1.0.0	4.1 and

```
PlayStoreData['Price'].max()

# We successfully drop those higher price apps and now highest Price is 79.99
```

Out[55]: 79.99

In [56]:
```
# Reviews: Very few apps have very high number of reviews. These are all star apps that don't help with the analysis and,
# in fact, will skew it. Drop records having more than 2 million reviews.

highreview=PlayStoreData[PlayStoreData['Reviews']>2000000]
highreview
```

Out[56]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
131	Wattpad Free Books	BOOKS_AND_REFERENCE	4.6	2914724.0	0.0	1.000000e+08	Free	0.0	Teen	Books & Reference	August 1, 2018	Varies with device	Varies with device
322	Messenger – Text and Video Chat for Free	COMMUNICATION	4.0	56642847.0	0.0	1.000000e+09	Free	0.0	Everyone	Communication	August 1, 2018	Varies with device	Varies with device
323	WhatsApp Messenger	COMMUNICATION	4.4	69119316.0	0.0	1.000000e+09	Free	0.0	Everyone	Communication	August 3, 2018	Varies with device	Varies with device
325	Google Chrome: Fast & Secure	COMMUNICATION	4.3	9642995.0	0.0	1.000000e+09	Free	0.0	Everyone	Communication	August 1, 2018	Varies with device	Varies with device
327	Gmail	COMMUNICATION	4.3	4604324.0	0.0	1.000000e+09	Free	0.0	Everyone	Communication	August 2, 2018	Varies with device	Varies with device
...	...	...	...	...	...	...	...	...	...	...	...	...	...
8061	Modern Combat 5: eSports FPS	GAME	4.3	2903386.0	58000.0	1.000000e+08	Free	0.0	Mature 17+	Action	July 24, 2018	3.2.1c	4.0 and up
8607	Google Earth	TRAVEL_AND_LOCAL	4.3	2339098.0	0.0	1.000000e+08	Free	0.0	Everyone	Travel & Local	June 18, 2018	9.2.17.13	4.1 and up
8868	Farm Heroes Saga	FAMILY	4.4	7615646.0	71000.0	1.000000e+08	Free	0.0	Everyone	Casual	August 7, 2018	5.2.6	2.3 and up
8871	Fallout Shelter	FAMILY	4.6	2721923.0	25000.0	1.000000e+07	Free	0.0	Teen	Simulation	June 11, 2018	1.13.12	4.1 and up
9000	Garena Free Fire	GAME	4.5	5534114.0	53000.0	1.000000e+08	Free	0.0	Teen	Action	August 3, 2018	1.21.0	4.0.3 and up

453 rows × 13 columns

In [57]:
```
# Now droping those records from the dataset

PlayStoreData=PlayStoreData.drop(highreview.index, axis=0)
```

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453 rows × 13 columns

In [57]:
```
# Now droping those records from the dataset

PlayStoreData=PlayStoreData.drop(highreview.index, axis=0)
PlayStoreData.head()

# Now we have all records which has less than 2 million reviews
```

Out[57]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159.0	19000.0	10000.0	Free	0.0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967.0	14000.0	500000.0	Free	0.0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510.0	8700.0	5000000.0	Free	0.0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644.0	25000.0	50000000.0	Free	0.0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967.0	2800.0	100000.0	Free	0.0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up

In [58]:
```
#Installs:  There seems to be some outliers in this field too. Apps having very high number of installs should be dropped from th

#Find out the different percentiles - 10, 25, 50, 70, 90, 95, 99

np.percentile(PlayStoreData['Installs'], [10, 25, 50, 70, 90, 95, 99])

# array([1.e+03, 1.e+04, 5.e+05, 1.e+06, 1.e+07, 1.e+07, 1.e+08])
```

Out[58]:
```
array([1.e+03, 1.e+04, 5.e+05, 1.e+06, 1.e+07, 1.e+07, 1.e+08])
```

In [58]:
```
PlayStoreData.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 8892 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             8892 non-null   object
 1   Category        8892 non-null   object
 2   Rating          8892 non-null   float64
 3   Reviews         8892 non-null   float64
 4   Size            8892 non-null   float64
 5   Installs        8892 non-null   float64
 6   Type            8892 non-null   object
 7   Price           8892 non-null   float64
```

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```
# We will make a thresold using lowerrange and upperrange
```

In [66]:
```
PlayStoreData2 = PlayStoreData[(PlayStoreData['Installs'] >= -7475000.0) & (PlayStoreData['Installs'] <= 12485000.0)]
```

In [67]:
```
PlayStoreData2['Installs'].mean()
```

Out[67]:
```
2132839.9388451134
```

In [68]:
```
PlayStoreData2.describe()
```

Out[68]:

	Rating	Reviews	Size	Installs	Price
count	8503.000000	8.503000e+03	8503.000000	8.503000e+03	8503.000000
mean	4.174068	6.560943e+04	18647.896919	2.132840e+06	0.366192
std	0.533307	1.680046e+05	22140.239563	3.525003e+06	2.269891
min	1.000000	1.000000e+00	0.000000	0.000000e+00	0.000000
25%	4.000000	1.330000e+02	2900.000000	1.000000e+04	0.000000
50%	4.300000	3.322000e+03	9800.000000	1.000000e+05	0.000000
75%	4.500000	4.198050e+04	26000.000000	1.000000e+06	0.000000
max	5.000000	1.852384e+06	100000.000000	1.000000e+07	79.990000

In [69]:
```
# 7.Bivariate analysis: Let's look at how the available predictors relate to the variable of interest, i.e., our target variable
# rating. Make scatter plots (for numeric features) and box plots (for character features)
# to assess the relations between rating and the other features.

# Make scatter plot/joinplot for Rating vs. Price

# What pattern do you observe? Does rating increase with price?

# Make scatter plot/joinplot for Rating vs. Size

# Are heavier apps rated better?

# Make scatter plot/joinplot for Rating vs. Reviews

# Does more review mean a better rating always?

# Make boxplot for Rating vs. Content Rating

# Is there any difference in the ratings? Are some types liked better?

# Make boxplot for Ratings vs. Category

# Which genre has the best ratings?

# For each of the plots above, note down your observation.
```

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```
# What pattern do you observe? Does rating increase with price?

plt.figure(figsize=(10,6))
sns.set_style(style='whitegrid',)
sns.set(font_scale=1.2)

sns.scatterplot(x=PlayStoreData2['Price'], y=PlayStoreData2['Rating'],hue= PlayStoreData2['Rating'],palette='autumn_r')
plt.title('Prices vs Ratings', fontsize=18)
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Price', fontsize=14)
plt.show()

# Rating is not dependent on increase with price. Rating between 2.5 to 4, there are quite good amount of app lies with price
# around 10 to 35. Most of app rating lies within price 40.
# Apps with rating in the range of 4 to 5, price of those apps varies 0 to 40.
# Only one app with rating 4.5 has highest price say around 80.
```

In [72]:

```
# Make scatter plot/joinplot for Rating vs. Size
# Are heavier apps rated better?

plt.figure(figsize=(10,6))
sns.scatterplot(x=PlayStoreData2['Size'], y=PlayStoreData2['Rating'], hue= PlayStoreData2['Rating'],palette='rocket_r')
plt.title('Sizes vs Ratings', fontsize=18)
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Size', fontsize=14)
plt.show()

# Here, very few apps has rating 1 and size lies b/w 0 to 40000.
# Apps which ratings b/w 1 to 3 are scatterly spread with the size of maximum around 80000,
```

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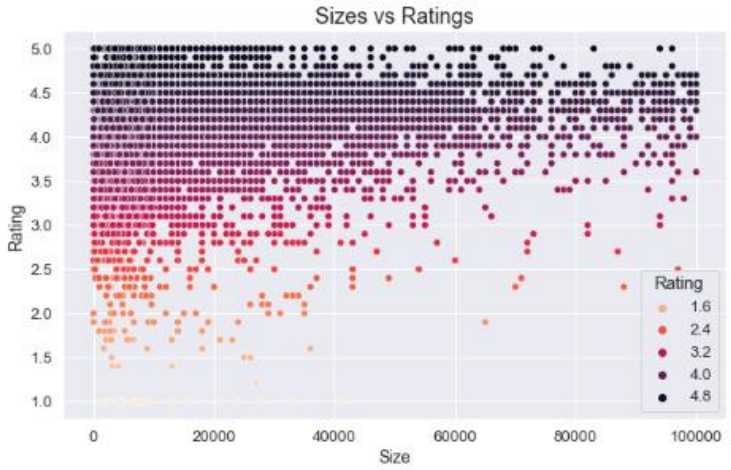
In [72]:
```
# Make scatter plot/joinplot for Rating vs. Size
# Are heavier apps rated better?

plt.figure(figsize=(10,6))
sns.scatterplot(x=PlayStoreData2['Size'], y=PlayStoreData2['Rating'], hue= PlayStoreData2['Rating'],palette='rocket_r')
plt.title('Sizes vs Ratings', fontsize=18)
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Size', fontsize=14)
plt.show()

# Here, very few apps has rating 1 and size lies b/w 0 to 40000.
# Apps which ratings b/w 1 to 3 are scatterly spread with the size of maximum around 80000,
# But if we notice higher ratings apps, moderate number of apps size are around 100000 .
# Most of the apps has ratings between 3.5 to nearly 5 as seen in histograms.
# It is cleared that most of the app are rated higher.
# So, we can say that most of the heavier apps rated better.
```



In [73]:
```
# Make scatter plot/joinplot for Rating vs. Reviews
# Does more review mean a better rating always?

plt.figure(figsize=(10,6))
sns.scatterplot(x=PlayStoreData2['Reviews'], y=PlayStoreData2['Rating'], hue= PlayStoreData2['Rating'], palette='mako_r')
plt.title('Reviews vs Ratings', fontsize=18)
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Reviews', fontsize=14)
plt.show()

# In our plot,
```

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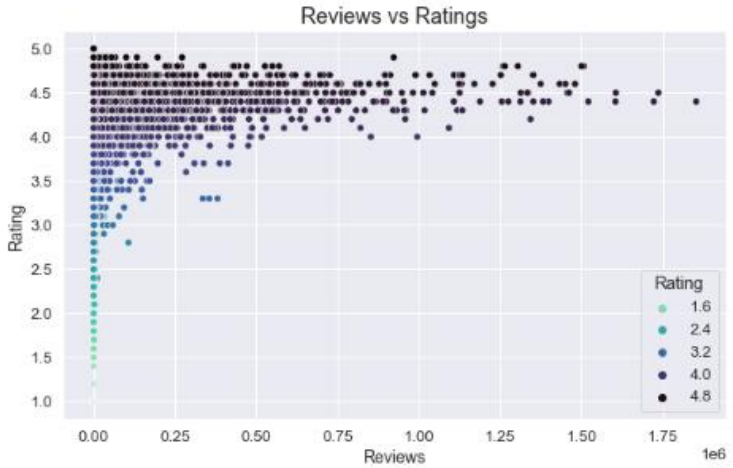
Size

In [73]:
```
# Make scatter plot/joinplot for Rating vs. Reviews
# Does more review mean a better rating always?

plt.figure(figsize=(10,6))
sns.scatterplot(x=PlayStoreData2['Reviews'], y=PlayStoreData2['Rating'], hue= PlayStoreData2['Rating'], palette='mako_r')
plt.title('Reviews vs Ratings', fontsize=18)
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Reviews', fontsize=14)
plt.show()

# In our plot,
       # we noticed that lower ratings apps has very low reviews nearly zero.
       # Ratings b/w 3.5 to 4 has moderate number of Reviews.
       # Ratings from 4 and higher has higher number of reviews, and some of the apps has higher reviews .
       # If we see the histograms for ratings, most of records lies b/w 3.5 to nearly 5.
       # We conclude that more review means a better rating always.
```



In [74]:
```
# Make boxplot for Rating vs. Content Rating
# Is there any difference in the ratings? Are some types liked better?

plt.figure(figsize= (10,6))
sns.boxplot(x = 'Content Rating', y = 'Rating', data = PlayStoreData2, palette='hls')
plt.title('Content Rating vs Ratings', fontsize=18)
plt.xticks(fontsize=12, rotation='45')
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Content Rating', fontsize=14)
plt.show()
```

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In [74]:
```
# Make boxplot for Rating vs. Content Rating
# Is there any difference in the ratings? Are some types liked better?

plt.figure(figsize= (10,6))
sns.boxplot(x = 'Content Rating', y = 'Rating', data = PlayStoreData2, palette='hls')
plt.title('Content Rating vs Ratings', fontsize=18)
plt.xticks(fontsize=12, rotation='45')
plt.ylabel('Rating',fontsize=14)
plt.xlabel('Content Rating', fontsize=14)
plt.show()

# Everyone: here, max rating given is 5 and low rating is around 3.3, but lots of people gave lower rating in this kind of apps.
#           median is lies around 4.4.

# Teen: In this type of apps, max and min ratings are 5 and closely 3.4, median lies around close to 4.
#       Some people gave relatively low ratings as well.

# Everyone 10: This kind of apps, max and min ratings are around 3.5 to 5 and median is around 4.4.
#              few people gave some low ratings also.

# Mature 17:  This kind of app, max and min ratings are around 3.1 to 5 and median is around 4.3.
#             it has also some low ratings.

# Adults only 18+: This kind of apps, max and min ratings are around 3.8 to 4.5 and median is around 4.5.
#                  Here, no lower rating has provided by users and this is most compact app and here no ouliers present.

# Unrated: all values are same.

# so, we noticed that there are quite variation between all kinds of apps.
# it can be said that  "Adults only 18+"  more better apps than others.
```

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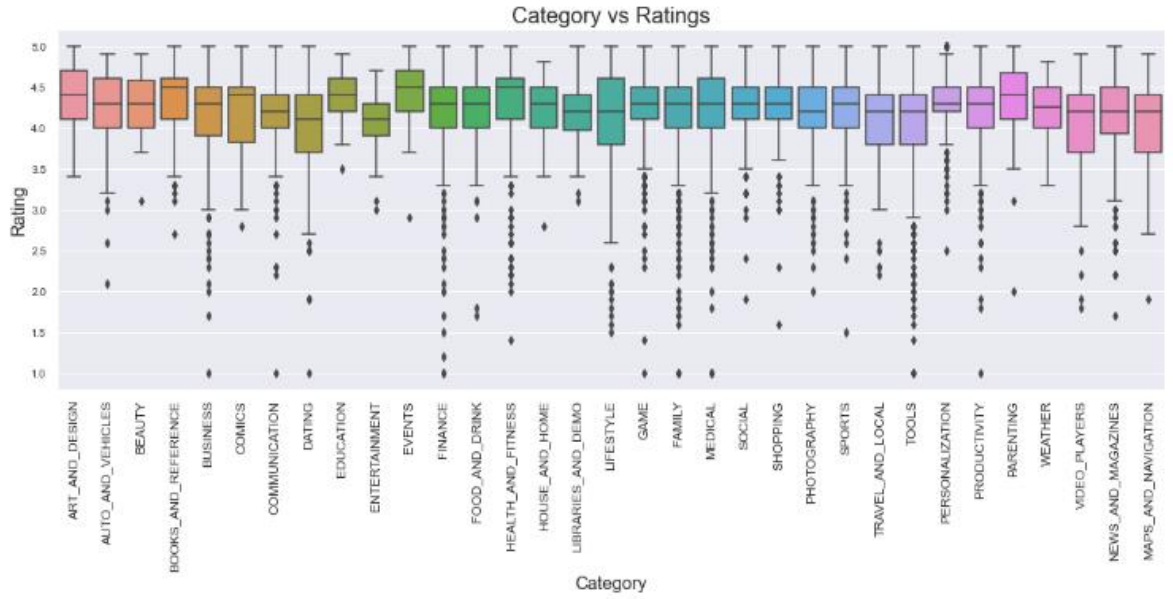
dtype=object)

In [76]:
```
# Make boxplot for Ratings vs. Category

plt.figure(figsize= (18,6))
sns.boxplot(x = 'Category', y = 'Rating', data = PlayStoreData2)
plt.title('Category vs Ratings', fontsize=20)
plt.xticks(fontsize=12, rotation = 'vertical')
plt.yticks(fontsize=10)
plt.xlabel("Category",fontsize=16)
plt.ylabel("Rating",fontsize=16)

# 'ART_AND_DESIGN' and 'WEATHER' has no outliers.
# 'EDUCATION' has minimum no of ratings, means users are not interested to install this knds of apps
# FINANCE, BUSINESS, LIFESTYLE ,GAME, FAMILY have highst no of ratings means most of the people installed these kind of apps.
# In this figure, we noticed that in most of the apps users gave ratings b/w 1 to 5.
# Users are interrested more about FINANCE, BUSINESS, LIFESTYLE ,GAME, FAMILY apps, so we can say creater of these kinds of apps
# need to create more apps related to this.
# In DATING and LIFESTYLE apps difference b/w min value and Q1 are quite high.
# Here are somme apps which has lower ratings also.
```

Out[76]: Text(0, 0.5, 'Rating')



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Run Code

In [77]:
```
# Which genre has the best ratings?

PlayStoreData2['Genres'].value_counts()

# Following Genres has highest number of ratings
# Tools                          672
# Entertainment                  501
# Education                      468
# Medical                        350
# Finance                        311
```

Out[77]:
```
Tools                  672
Entertainment          501
Education              468
Medical                350
Finance                311
                      ...
Strategy;Education       1
Racing;Pretend Play      1
Adventure;Brain Games    1
Puzzle;Education         1
Parenting;Brain Games    1
Name: Genres, Length: 115, dtype: int64
```

In [ ]:

In [ ]:

In [78]:
```
PlayStoreData2.columns.tolist()
```

Out[78]:
```
['App',
 'Category',
 'Rating',
 'Reviews',
 'Size',
 'Installs',
 'Type',
 'Price',
 'Content Rating',
 'Genres',
 'Last Updated',
 'Current Ver',
 'Android Ver']
```

In [79]:
```
PlayStoreData2['Category'].unique()
```

Out[79]:
```
array(['ART_AND_DESIGN', 'AUTO_AND_VEHICLES', 'BEAUTY',
```

8. Data preprocessing

In [82]:

```
# For the steps below, create a copy of the dataframe to make all the edits. Name it inp1.

inp1 = PlayStoreData2.copy(deep=True)
inp1

# we have copied our dataframe in inp1, because what we will change our dataframe for further steps
# Our main dataframe will be intact.
```

Out[82]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
0	Photo Editor & Candy Camera & Grid & ScrapBook	ART_AND_DESIGN	4.1	159.0	19000.0	10000.0	Free	0.0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up
1	Coloring book moana	ART_AND_DESIGN	3.9	967.0	14000.0	500000.0	Free	0.0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510.0	8700.0	5000000.0	Free	0.0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967.0	2800.0	100000.0	Free	0.0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up
5	Paper flowers instructions	ART_AND_DESIGN	4.4	167.0	5600.0	50000.0	Free	0.0	Everyone	Art & Design	March 26, 2017	1.0	2.3 and up
...	...	...	...	...	...	...	...	...	...	...	...	...	...
9340	FR Calculator	FAMILY	4.0	7.0	2600.0	0.0	Free	0.0	Everyone	Education	June 18, 2017	1.0.0	4.1 and up
9341	Sya9a Maroc - FR	FAMILY	4.5	38.0	53000.0	5000.0	Free	0.0	Everyone	Education	July 25, 2017	1.48	4.1 and up
9342	Fr. Mike Schmitz Audio Teachings	FAMILY	5.0	4.0	3600.0	0.0	Free	0.0	Everyone	Education	July 6, 2018	1.0	4.1 and up
9343	The SCP Foundation DB fr nn5n	BOOKS_AND_REFERENCE	4.5	114.0	0.0	1000.0	Free	0.0	Mature 17+	Books & Reference	January 19, 2015	Varies with device	Varies with device
9344	iHoroscope - 2018 Daily Horoscope & Astrology	LIFESTYLE	4.5	398307.0	19000.0	10000000.0	Free	0.0	Everyone	Lifestyle	July 25, 2018	Varies with device	Varies with device

8503 rows × 13 columns

9344	2018 Daily Horoscope & Astrology	LIFESTYLE	4.5	398307.0	19000.0	10000000.0	Free	0.0	Everyone	Lifestyle	July 25, 2018	with device	with device

8503 rows × 13 columns

In [83]:
```
# Reviews and Install have some values that are still relatively very high. Before building a linear regression model,
# you need to reduce the skew. Apply log transformation (np.log1p) to Reviews and Installs.

inp1['Reviews'] = np.log(inp1['Reviews'])
```

In [84]:
```
inp1['Reviews'].head()

# We have successfully converted values with log function
#0     5.075174
#1     6.875232
#2    11.379520
#4     6.875232
#5     5.123964
```

Out[84]:
```
0     5.068904
1     6.874198
2    11.379508
4     6.874198
5     5.117994
Name: Reviews, dtype: float64
```

In [85]:
```
inp1['Installs'] = np.log1p(inp1['Installs'])
```

In [86]:
```
inp1['Installs'].head()

# We have successfully converted values with log function
#0     9.210440
#1    13.122365
#2    15.424949
#4    11.512935
#5    10.819798
```

Out[86]:
```
0     9.210440
1    13.122365
2    15.424949
4    11.512935
5    10.819798
Name: Installs, dtype: float64
```

In [87]:
```
inp1.describe()
```

Out[87]:

	Rating	Reviews	Size	Installs	Price
count	8503.000000	8503.000000	8503.000000	8503.000000	8503.000000
mean	4.174068	7.743829	18647.896919	11.339223	0.366192

```
inp1.drop(['App','Last Updated','Current Ver','Android Ver'], axis = 1,inplace=True)
inp1.head()
```

Out[89]:

	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres
0	ART_AND_DESIGN	4.1	5.068904	19000.0	9.210440	Free	0.0	Everyone	Art & Design
1	ART_AND_DESIGN	3.9	6.874198	14000.0	13.122365	Free	0.0	Everyone	Art & Design;Pretend Play
2	ART_AND_DESIGN	4.7	11.379508	8700.0	15.424949	Free	0.0	Everyone	Art & Design
4	ART_AND_DESIGN	4.3	6.874198	2800.0	11.512935	Free	0.0	Everyone	Art & Design;Creativity
5	ART_AND_DESIGN	4.4	5.117994	5600.0	10.819798	Free	0.0	Everyone	Art & Design

In [90]:
```
# Converting Type column with dummy variables and concatenating with main DataFrame

inp1 = pd.concat( [ pd.get_dummies(inp1['Type']) , inp1.iloc[:,[0,1,2,3,4,6,7,8]] ] , axis = 1)
```

In [91]:
```
inp1
```

Out[91]:

	Free	Paid	Category	Rating	Reviews	Size	Installs	Price	Content Rating	Genres
0	1	0	ART_AND_DESIGN	4.1	5.068904	19000.0	9.210440	0.0	Everyone	Art & Design
1	1	0	ART_AND_DESIGN	3.9	6.874198	14000.0	13.122365	0.0	Everyone	Art & Design;Pretend Play
2	1	0	ART_AND_DESIGN	4.7	11.379508	8700.0	15.424949	0.0	Everyone	Art & Design
4	1	0	ART_AND_DESIGN	4.3	6.874198	2800.0	11.512935	0.0	Everyone	Art & Design;Creativity
5	1	0	ART_AND_DESIGN	4.4	5.117994	5600.0	10.819798	0.0	Everyone	Art & Design
...	...	...	...	...	...	...	...	...	...	...
9340	1	0	FAMILY	4.0	1.945910	2600.0	0.000000	0.0	Everyone	Education
9341	1	0	FAMILY	4.5	3.637586	53000.0	8.517393	0.0	Everyone	Education
9342	1	0	FAMILY	5.0	1.386294	3600.0	0.000000	0.0	Everyone	Education
9343	1	0	BOOKS_AND_REFERENCE	4.5	4.736198	0.0	6.908755	0.0	Mature 17+	Books & Reference
9344	1	0	LIFESTYLE	4.5	12.894978	19000.0	16.118096	0.0	Everyone	Lifestyle

8503 rows × 10 columns

In [92]:
```
# Get dummy columns for Category, Genres, and Content Rating. This needs to be done as the models do not understand categorical d
# and all data should be numeric. Dummy encoding is one way to convert character fields to numeric.
# Name of dataframe should be inp2.

cat_cols = ['Category', 'Genres', 'Content Rating']
inp2=pd.concat( [pd.get_dummies(inp1,columns=cat_cols,drop_first=True),inp1.iloc[:,[0,1,3,4,5,6,7]] ] , axis = 1)
print(inp2.columns)
```

```
Index(['Free', 'Paid', 'Rating', 'Reviews', 'Size', 'Installs', 'Price',
```

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8503 rows × 10 columns

In [92]:
```
# Get dummy columns for Category, Genres, and Content Rating. This needs to be done as the models do not understand categorical d
# and all data should be numeric. Dummy encoding is one way to convert character fields to numeric.
# Name of dataframe should be inp2.

cat_cols = ['Category', 'Genres', 'Content Rating']
inp2=pd.concat( [pd.get_dummies(inp1,columns=cat_cols,drop_first=True),inp1.iloc[:,[0,1,3,4,5,6,7]] ] , axis = 1)
print(inp2.columns)
```

```
Index(['Free', 'Paid', 'Rating', 'Reviews', 'Size', 'Installs', 'Price',
       'Category_AUTO_AND_VEHICLES', 'Category_BEAUTY',
       'Category_BOOKS_AND_REFERENCE',
       ...
       'Content Rating_Mature 17+', 'Content Rating_Teen',
       'Content Rating_Unrated', 'Free', 'Paid', 'Rating', 'Reviews', 'Size',
       'Installs', 'Price'],
      dtype='object', length=165)
```

In [93]:
```
inp1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 8503 entries, 0 to 9344
Data columns (total 10 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Free            8503 non-null   uint8
 1   Paid            8503 non-null   uint8
 2   Category        8503 non-null   object
 3   Rating          8503 non-null   float64
 4   Reviews         8503 non-null   float64
 5   Size            8503 non-null   float64
 6   Installs        8503 non-null   float64
 7   Price           8503 non-null   float64
 8   Content Rating  8503 non-null   object
 9   Genres          8503 non-null   object
dtypes: float64(5), object(3), uint8(2)
memory usage: 934.5+ KB
```

In [94]:
```
# 9. Train test split  and apply 70-30 split. Name the new dataframes df_train and df_test.

from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
```

In [95]:
```
inp2
```

Out[95]:

	Free	Paid	Rating	Reviews	Size	Installs	Price	Category_AUTO_AND_VEHICLES	Category_BEAUTY	Category_BOOKS_AND_REFERENCE	...	Ra
0	1	0	4.1	5.068904	19000.0	9.210440	0.0	0	0	0		

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Run Code

In [94]:
```
# 9. Train test split  and apply 70-30 split. Name the new dataframes df_train and df_test.

from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
```

In [95]:
```
inp2
```

Out[95]:

	Free	Paid	Rating	Reviews	Size	Installs	Price	Category_AUTO_AND_VEHICLES	Category_BEAUTY	Category_BOOKS_AND_REFERENCE	...	Ra
0	1	0	4.1	5.068904	19000.0	9.210440	0.0	0	0	0	...	
1	1	0	3.9	6.874198	14000.0	13.122365	0.0	0	0	0	...	
2	1	0	4.7	11.379508	8700.0	15.424949	0.0	0	0	0	...	
4	1	0	4.3	6.874198	2800.0	11.512935	0.0	0	0	0	...	
5	1	0	4.4	5.117994	5600.0	10.819798	0.0	0	0	0	...	
...	...	...	...	...	...	...	...	...	...	...	...	
9340	1	0	4.0	1.945910	2600.0	0.000000	0.0	0	0	0	...	
9341	1	0	4.5	3.637586	53000.0	8.517393	0.0	0	0	0	...	
9342	1	0	5.0	1.386294	3600.0	0.000000	0.0	0	0	0	...	
9343	1	0	4.5	4.736198	0.0	6.908755	0.0	0	0	1	...	
9344	1	0	4.5	12.894978	19000.0	16.118096	0.0	0	0	0	...	

8503 rows × 165 columns

In [96]:
```
# creating features and labels

features = inp2.iloc[:,1:].values
labels = inp2.iloc[:,[2]].values
```

In [ ]:
```
```

In [97]:
```
# 10. Separate the dataframes into X_train, y_train, X_test, and y_test.
from sklearn.model_selection import train_test_split

X_train,X_test,y_train,y_test = train_test_split(features,
                                                 labels,
                                                 test_size=0.3,
                                                 random_state=1)
```

In [98]:
```
# Name the new dataframes df_train and df_test.
```

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Run Code

In [98]:
```
# Name the new dataframes df_train and df_test.

df_train=pd.DataFrame(X_train)
df_test=pd.DataFrame(X_test)
```

In [99]:
```
len(X_train)
```

Out[99]:
```
5952
```

In [100]:
```
len(X_test)
```

Out[100]:
```
2551
```

In [101]:
```
inp2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 8503 entries, 0 to 9344
Columns: 165 entries, Free to Price
dtypes: float64(10), uint8(155)
memory usage: 2.3 MB
```

In [102]:
```
# 11 . Model building
# Use linear regression as the technique


from sklearn.linear_model import LinearRegression

model = LinearRegression()
```

In [103]:
```
model.fit(X_train,y_train)
```

Out[103]:
```
LinearRegression()
```

In [104]:
```
model.intercept_
```

Out[104]:
```
array([-1.4979662e-10])
```

In [105]:
```
model.coef_
```

Out[105]:
```
array([[ 1.13586957e-12,  5.00000000e-01,  5.29108007e-13,
         1.95611478e-11, -8.73745520e-14,  4.74550954e-13,
        -2.22044605e-14, -2.47579734e-14, -2.23709939e-14,
        -1.80654103e-14, -2.60113112e-14, -1.55136320e-14,
        -1.52898527e-14, -5.52526774e-14, -4.40585068e-14,
        -2.29564631e-14, -4.72191730e-14, -2.35076715e-14,
        -8.64065763e-15, -2.50754278e-14, -1.25021521e-14,
```

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```
 3.96631512e-14,  2.81858955e-14,  2.29391159e-14,
 9.84238732e-15,  4.68788420e-14,  7.93907041e-15,
-1.86887181e-14,  1.42672332e-14, -1.10334376e-14,
 7.51482210e-15,  7.42790974e-15, -2.64532320e-14,
 2.28815990e-14,  5.07458116e-14,  4.19640993e-14,
 4.94573932e-14, -2.29560294e-14, -2.34981305e-14,
-8.63632083e-15, -1.25073563e-14,  4.82404101e-14,
 5.58184141e-14, -2.43073790e-14, -1.34328312e-14,
-4.00547651e-15,  5.66091770e-14, -2.31791582e-14,
-2.11627590e-14, -8.67014793e-15, -1.17221770e-14,
 4.87862517e-14, -8.13151629e-20, -2.10725534e-14,
 4.97258484e-15, -7.63091305e-15, -4.72679621e-15,
-5.84341603e-15, -7.29624694e-15, -1.74591244e-14,
-2.11102837e-14,  3.69834371e-14,  5.17682075e-14,
 3.14913026e-14,  2.29985573e-14,  5.21026093e-14,
 2.17382536e-15,  1.01536618e-14,  4.68386162e-31,
 6.56885570e-15,  5.34685143e-15, -4.93038066e-32,
 2.69638912e-14, -1.50942626e-14,  1.22957200e-14,
-1.46051248e-14, -4.46521346e-14,  5.18321822e-15,
-2.18402770e-14,  2.17157022e-14,  1.77265158e-14,
-5.52986476e-15,  6.87514282e-15,  5.37729380e-14,
 4.76874941e-14, -1.52863833e-14,  0.00000000e+00,
-1.61641533e-14, -8.10918851e-15,  1.13004224e-14,
-6.88646189e-14, -4.42660231e-14, -2.04331994e-14,
-2.19871864e-14,  2.26111447e-14, -1.23200061e-14,
-6.72205347e-15, -2.14724072e-14, -1.36227835e-14,
-1.32301125e-15,  3.59703359e-12, -3.59703370e-12,
 5.00000000e-01,  8.37176899e-13, -1.95612164e-11,
-3.17408860e-14,  4.72708678e-13]])
```

In [106]:
```
# Report the r2 on the train set
from sklearn.metrics import r2_score

y_train_pred= model.predict(X_train)
r2_score(y_train, y_train_pred)

# here r2 score based on training set is 1.0
```

Out[106]: 1.0

In [107]:
```
# 12. Make predictions on test set, report R2

y_test_pred= model.predict(X_test)
r2_score(y_test, y_test_pred)

# here r2 score based on testing set is 1.0
```

Out[107]: 1.0

In [ ]:

In [ ]: