Project Title	**Google Play Store Apps** (regulatory affairs)
Tools	Python, ML, SQL, Excel
Technologies	Data Analyst & Data scientist
Project Difficulties level	intermediate

Dataset : Dataset is available in the given link. You can download it at your convenience.

Click here to download data set

About Dataset

Context

While many public datasets (on Kaggle and the like) provide Apple App Store data, there are not many counterpart datasets available for Google Play Store apps anywhere on the web. On digging deeper, I found out that the iTunes App Store page deploys a nicely indexed appendix-like structure to allow for simple and easy web scraping. On the other hand, Google Play Store uses sophisticated modern-day techniques (like dynamic page load) using JQuery making scraping more challenging.

Content

Each app (row) has values for catergory, rating, size, and more.

Acknowledgements

This information is scraped from the Google Play Store. This app information would not be available without it.

Inspiration

The Play Store apps data has enormous potential to drive app-making businesses to success. Actionable insights can be drawn for developers to work on and capture the Android market!

NOTE :

1. this project is only for your guidance, not exactly the same you have to create. Here I am trying to show the way or idea of what steps you can follow and how your projects look. Some projects are very advanced (because it will be made with the help of flask, nlp, advance ai, advance DL and some advanced things) which you can not understand .

2. You can make or analyze your project with yourself, with your idea, make it more creative from where we can get some information and understand about our business. make sure what overall things you have created all things you understand very well.

Example

what steps you should have to follow

Here's a beginner-friendly guide to start a data analytics project using the "Google Play Store Apps" dataset with the specified columns. I'll walk you through the key steps, including code snippets and expected outputs.

Project Title:

Exploratory Data Analysis of Google Play Store Apps

1. Objective

The goal of this project is to analyze the characteristics of apps on the Google Play Store, including their ratings, reviews, sizes, installation counts, and more. The analysis will help identify trends, outliers, and patterns in the app market.

2. Steps to Follow

Step 1: Import Libraries

You'll need to import the necessary Python libraries for data manipulation and visualization.

```
import pandas as pd

import matplotlib.pyplot as plt

import seaborn as sns
```

Step 2: Load the Dataset

Assuming your dataset is in a CSV file, you can load it using Pandas.

python

Copy code

```
df = pd.read_csv('google_play_store_apps.csv')
```

Step 3: Basic Data Exploration

Start by exploring the dataset to understand its structure.

```
# Display the first few rows

print(df.head())
```

```
# Get basic information about the dataset
```

```
print(df.info())



# Summary statistics of numerical columns

print(df.describe())
```

Expected Output:

- The first few rows of the dataset will display columns like `App`, `Category`, `Rating`, etc.
- The `info()` method will show the data types and any missing values.
- `describe()` will provide summary statistics for numerical columns like `Rating`, `Reviews`, `Size`, etc.

Step 4: Data Cleaning

You may need to clean the data by handling missing values, converting data types, and removing duplicates.

```
# Check for missing values

print(df.isnull().sum())



# Handle missing values (e.g., filling or dropping)

df['Rating'].fillna(df['Rating'].mean(), inplace=True)
```

```
df.dropna(subset=['App', 'Category'], inplace=True)



# Convert columns to appropriate data types

df['Reviews'] = df['Reviews'].astype(int)

df['Installs']        =        df['Installs'].str.replace(',',
'').str.replace('+', '').astype(int)

df['Price'] = df['Price'].str.replace('$', '').astype(float)
```

Expected Output:

- The output will show the number of missing values in each column.
- The dataset will be cleaned with missing values handled and data types converted as needed.

Step 5: Data Visualization

Visualizing the data helps to understand the distribution and relationships between variables.

```
# Distribution of Ratings

plt.figure(figsize=(10, 6))

sns.histplot(df['Rating'], bins=20, kde=True)
```

```
plt.title('Distribution of App Ratings')

plt.show()



# Count of Apps by Category

plt.figure(figsize=(12, 8))

sns.countplot(y='Category',                                    data=df,
order=df['Category'].value_counts().index)

plt.title('Count of Apps by Category')

plt.show()



# Relationship between Installs and Rating

plt.figure(figsize=(10, 6))

sns.scatterplot(x='Rating',    y='Installs',    hue='Category',
data=df)

plt.title('Relationship between Installs and Ratings')

plt.show()
```

Expected Output:

- A histogram showing the distribution of app ratings.

- A bar chart showing the count of apps by category.
- A scatter plot showing the relationship between the number of installs and app ratings, with colors representing different categories.

Step 6: Analyzing Key Metrics

You can perform further analysis to extract insights.

```
# Average rating by category

avg_rating_by_category                                    =
df.groupby('Category')['Rating'].mean().sort_values(ascending=F
alse)

print(avg_rating_by_category)



# Most popular apps (by installs)

most_installed_apps                  =                df[['App',
'Installs']].sort_values(by='Installs',
ascending=False).head(10)

print(most_installed_apps)



# Top 5 genres

top_genres = df['Genres'].value_counts().head(5)
```

```
print(top_genres)
```

Expected Output:

- A list of average ratings by app category.
- A list of the top 10 most installed apps.
- The top 5 most common genres.

3. Conclusion

Summarize the findings from your analysis, discussing any trends, patterns, or anomalies observed. For example, you might find that certain categories have higher average ratings or that specific genres dominate the market.

4. Next Steps

Consider exploring further:

- Sentiment analysis of user reviews.
- Time series analysis of app updates and their impact on ratings.
- Predictive modeling to forecast app ratings based on features.

This project provides a foundational understanding of exploratory data analysis using real-world data from the Google Play Store.

Sample code

Importing Libraries¶

In [1]:

```
import pandas as pd

import numpy as np

import seaborn as sns

import matplotlib.pyplot as plt

%matplotlib inline
```

```
import warnings

warnings.filterwarnings('ignore')
```

2. Data Loading and exploration and cleaning

c Load the csv file with the pandas

↪ creating the dataframe and understanding the data present in the dataset using pandas

↪ Dealing with the missing data, outliers and the incorrect records

In [2]:

```
df = pd.read_csv('/kaggle/input/google-play-store-apps/googleplaystore.csv')

df.head(4)
```

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

In [3]:

```
df.iloc[10474: 10494]
```

Out[3]:

	App	Category	Rati	Revi	Si	Installs	Ty	Pri	Content Ratin	Genres	Last Update	Current	Android

			ng	ews	ze		pe	ce	g		d	Ver	Ver
10474	Sat-Fi Voice	COMMUNICATION	3.4	37	14M	1,000+	Free	0	Everyone	Communication	November 21, 2014	2.2.1.5	2.2 and up
10475	Wi-Fi Visualizer	TOOLS	3.9	132	2.6M	50,000+	Free	0	Everyone	Tools	May 17, 2017	0.0.9	2.3 and up
10476	Lennox iComfort Wi-Fi	LIFESTYLE	3.0	552	7.6M	50,000+	Free	0	Everyone	Lifestyle	March 22, 2017	2.0.15	2.3.3 and up
10477	Sci-Fi Sounds and Ringtones	PERSONALIZATION	3.6	128	11M	10,000+	Free	0	Everyone	Personalization	September 27, 2017	4.0	4.0 and up
10478	Sci Fi Sounds	FAMILY	3.2	4	8.0M	1,000+	Free	0	Everyone	Entertainment	November 2, 2017	1.0	4.0 and up
10479	Free Wi-fi HotspoT	COMMUNICATION	4.1	382	2.3M	50,000+	Free	0	Everyone	Communication	July 20, 2018	2.5	4.0 and up
10480	FJ 4x4 Cruiser Offroad Driving	FAMILY	4.1	3543	49M	500,000+	Free	0	Everyone	Simulation	January 4, 2017	1.1	2.3 and up

10481	FJ 4x4 Cruiser Snow Driving	FAMILY	4.2	1619	43M	500,000+	Free	0	Everyone	Simulation	June 4, 2018	1.3	4.0 and up
10482	Wallpapers Toyota FJ Cruiser	PERSONALIZATION	4.2	78	10M	10,000+	Free	0	Everyone	Personalization	June 20, 2016	1.0	2.3.3 and up
10483	New Wallpapers Toyota FJ Cruiser Theme	PERSONALIZATION	NaN	1	16M	100+	Free	0	Teen	Personalization	February 23, 2018	1.0	4.1 and up
10484	FJ Final Join , Circles Game	GAME	4.7	32	24M	1,000+	Free	0	Teen	Arcade	July 11, 2018	0.24	4.3 and up
10485	HD Wallpaper - Toyota FJ Cruiser	TOOLS	NaN	2	6.2M	100+	Free	0	Everyone	Tools	November 10, 2017	1.0	4.0 and up
10486	FJ Drive: Mercedes-Benz Lease	AUTO_AND_VEHICLES	4.6	107	27M	10,000+	Free	0	Everyone	Auto & Vehicles	November 6, 2017	2.0.0	4.1 and up

10487	Driving n Parking School 2017	FAMILY	4.5	15	46M	1,000+	Free	0	Everyone	Simulation	May 31, 2017	1.0	2.3 and up
10488	FJ WiFi HDD	TOOLS	NaN	40	2.4M	5,000+	Free	0	Everyone	Tools	October 31, 2017	1.0.5	2.1 and up
10489	Offroad Cruiser	FAMILY	4.3	42432	36M	1,000,000+	Free	0	Everyone	Simulation	July 13, 2016	1.3	2.3.3 and up
10490	HD Themes Toyota Cruiser 70	PERSONALIZATION	4.5	86	17M	10,000+	Free	0	Teen	Personalization	October 2, 2016	1.0	2.3.3 and up
10491	Toyota Cruisers & Trucks Mag	TRAVEL_AND_LOCAL	4.5	10	8.0M	500+	Free	0	Everyone	Travel & Local	March 14, 2018	3.0.0	4.4 and up
10492	4 x4 Offroad SUV 3D Truck Simulator Driving 2017	FAMILY	4.4	32	37M	1,000+	Free	0	Everyone	Simulation	December 6, 2017	1.0	2.3 and up

10493	Cake Shop - Kids Cooking	FAMILY	4.3	30668	33M	5,000,000+	Free	0	Everyone	Casual;Pretend Play	July 16, 2018	2.1.3181	4.0.3 and up

In [4]:

```
df.sample(10)
```

Out[4]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
6781	BT Share It	BUSINESS	4.7	12	13M	500+	Free	0	Everyone	Business	May 16, 2018	3.4.2	4.4 and up
2716	Groupon - Shop Deals, Discounts & Coupons	SHOPPING	4.6	1370749	Varies with device	50,000,000+	Free	0	Teen	Shopping	August 3, 2018	Varies with device	Varies with device
2073	Super School: Educational Kids Games & Rhymes	FAMILY	4.5	1791	56M	500,000+	Free	0	Everyone	Education;Education	June 2, 2018	5.3.11	5.0 and up

7167	CD - Teach me ABC English L1	FAMILY	NaN	2	63M	500+	Free	0	Everyone	Education	June 18, 2017	1.0.0	4.0 and up
3692	OnePlus Gallery	VIDEO_PLAYERS	3.8	5555	64M	1,000,000+	Free	0	Everyone	Video Players & Editors	July 12, 2018	2.6.71	7.1 and up
7649	Krypton by krypt.co	PRODUCTIVITY	4.6	38	13M	1,000+	Free	0	Everyone	Productivity	July 17, 2018	2.4.0	6.0 and up
1517	Lamp detector	LIBRARIES_AND_DEMO	NaN	5	1.8M	1,000+	Free	0	Everyone	Libraries & Demo	April 23, 2018	4.4.2	2.3.3 and up
2865	Cymera Camera-Photo Editor, Filter,Collage,La...	PHOTOGRAPHY	4.4	2418135	Varies with device	100,000,000+	Free	0	Everyone	Photography	July 12, 2018	Varies with device	Varies with device
7067	ePN Cashback AliExpress	SHOPPING	4.4	19212	6.9M	500,000+	Free	0	Everyone	Shopping	August 3, 2018	0.2.9.17	4.1 and up

4796	YouTube Studio	VIDEO_PLAYERS	4.3	436170	Varies with device	10,000,000+	Free	0	Teen	Video Players & Editors	June 28, 2018	Varies with device	Varies with device

Checking the tail of the column

In [5]:

```
df.tail()
```

Out[5]:

	App	Category	Rating	Reviews	Size	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver
10836	Sya9a Maroc - FR	FAMILY	4.5	38	53M	5,000+	Free	0	Everyone	Education	July 25, 2017	1.48	4.1 and up
10837	Fr. Mike Schmitz Audio Teachings	FAMILY	5.0	4	3.6M	100+	Free	0	Everyone	Education	July 6, 2018	1.0	4.1 and up
10838	Parkinson Exercices FR	MEDICAL	NaN	3	9.5M	1,000+	Free	0	Everyone	Medical	January 20, 2017	1.0	2.2 and up

10839	The SCP Foundation DB fr nn5n	BOOKS_AND_REFERENCE	4.5	114	Varies with device	1,000+	Free	0	Mature 17+	Books & Reference	January 19, 2015	Varies with device	Varies with device
10840	iHoroscope - 2018 Daily Horoscope & Astrology	LIFESTYLE	4.5	398307	19M	10,000,000+	Free	0	Everyone	Lifestyle	July 25, 2018	Varies with device	Varies with device

Set the option maximum of rows and column

In [6]:

```
pd.set_option('display.max_columns', None)
```

In [7]:

```
pd.set_option('display.max_rows', None)
```

Checking the shape of the columns

In [8]:

```
print(f'The number of Rows are "{df.shape[0]}", and the number of columns are "{df.shape[1]}"')
```

```
The number of Rows are "10841", and the number of columns are "13"
```

In [9]:

```
print(f'The name of the columns are: {df.columns}')
```

```
The name of the columns are: Index(['App', 'Category', 'Rating', 'Reviews', 'Size',
'Installs', 'Type',
       'Price', 'Content Rating', 'Genres', 'Last Updated', 'Current Ver',
       'Android Ver'],
      dtype='object')
```

Checking the info of the dataset

In [10]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10841 entries, 0 to 10840
Data columns (total 13 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             10841 non-null  object
 1   Category        10841 non-null  object
 2   Rating          9367 non-null   float64
 3   Reviews         10841 non-null  object
```

```
 4   Size            10841 non-null  object
 5   Installs        10841 non-null  object
 6   Type            10840 non-null  object
 7   Price           10841 non-null  object
 8   Content Rating  10840 non-null  object
 9   Genres          10841 non-null  object
 10  Last Updated    10841 non-null  object
 11  Current Ver     10833 non-null  object
 12  Android Ver     10838 non-null  object
dtypes: float64(1), object(12)
memory usage: 1.1+ MB
```

In [11]:

```
df.describe()
```

Out[11]:

	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

Removing this row from the data because this is causing some problem 10472

In [12]:

```
df.drop(10472, axis=0, inplace=True)
```

In [13]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>

Index: 10840 entries, 0 to 10840

Data columns (total 13 columns):
```

```
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   App             10840 non-null  object
 1   Category        10840 non-null  object
 2   Rating          9366 non-null   float64
 3   Reviews         10840 non-null  object
 4   Size            10840 non-null  object
 5   Installs        10840 non-null  object
 6   Type            10839 non-null  object
 7   Price           10840 non-null  object
 8   Content Rating  10840 non-null  object
 9   Genres          10840 non-null  object
 10  Last Updated    10840 non-null  object
 11  Current Ver     10832 non-null  object
 12  Android Ver     10838 non-null  object
dtypes: float64(1), object(12)
memory usage: 1.2+ MB
```

In [14]:

```
df['Reviews'] = df['Reviews'].astype('int')
```

In [15]:

```
df.describe()
```

Out[15]:

	Rating	Reviews
count	9366.000000	1.084000e+04
mean	4.191757	4.441529e+05
std	0.515219	2.927761e+06
min	1.000000	0.000000e+00
25%	4.000000	3.800000e+01
50%	4.300000	2.094000e+03
75%	4.500000	5.477550e+04
max	5.000000	7.815831e+07

Taking size column and make it numeric

In [16]:

```
df['Size'].value_counts()
```

Out[16]:

```
Size

Varies with device    1695

11M                    198

12M                    196

14M                    194

13M                    191

15M                    184

17M                    160

19M                    154

26M                    149

16M                    149

25M                    143

20M                    139

21M                    138

10M                    136


24M                    136
```

```
df['Size'].isnull().sum()
```

Out[17]:

```
0
```

There is no missing values in the size column

Checking the number of values in three different categories in Size

In [18]:

```
print("Number of M in Size Column",
df['Size'].loc[df['Size'].str.contains('M')].value_counts().sum())
print("Number of k in Size Column",
df['Size'].loc[df['Size'].str.contains('k')].value_counts().sum())
print("Number of Varies with device in Size Column",
df['Size'].loc[df['Size'].str.contains('Varies with device')].value_counts().sum())
```

```
Number of M in Size Column 8829
Number of k in Size Column 316
Number of Varies with device in Size Column 1695
```

Convert the whole size of the column into bytes

In [19]:

```
### Defining a Function


def convert_into_bytes(column_name):
    if isinstance(column_name, str):
        if 'k' in column_name:
```

```
            return float(column_name.replace("k", "")) * 1024
        elif 'M' in column_name:
            return float(column_name.replace("M", "")) * 1024 * 1024
        elif 'Varies with device' in column_name:
            return np.nan
    return column_name
```

In [20]:

```
df['Size'] = df['Size'].apply(convert_into_bytes)
```

In [21]:

```
df['Size']
```

Out[21]:

```
0         19922944.0
1         14680064.0
2          9122611.2
3         26214400.0
4          2936012.8
5          5872025.6
6         19922944.0
7         30408704.0
```

```
8         34603008.0

9          3250585.6
```

Observations¶

- Remove + sign
- Remove , from the values
- Convert the column in to integers

In [26]:

```
## Define a function to deal with installs column

def installs(install):
    if isinstance(install, str):
        if '+' in install:
            return install.replace("+", "")
    return int(install)
```

In [27]:

```
df['Installs'] = df['Installs'].apply(installs)
```

In [28]:

```
df['Installs'] = df['Installs'].apply(lambda x: x.replace(',', '') if ',' in str(x)
```

```
else x)
```

In [29]:

```
df['Installs'] = df['Installs'].astype('int')
```

In [30]:

```
df['Installs'].value_counts()
```

Out[30]:

```
Installs
1000000       1579
10000000      1252
100000        1169
10000         1054
1000           907
5000000        752
100            719
500000         539
50000          479
5000           477
100000000      409
10             386
500            330
```

```
50000000       289
50             205
5               82
500000000       72
1               67
1000000000      58
0               15

Name: count, dtype: int64
```

In [31]:

```
# making a new column called 'Installs_category' which will have the category of the
installs
bins = [-1, 0, 10, 1000, 10000, 100000, 1000000, 10000000, 10000000000]
labels=['no', 'Very low', 'Low', 'Moderate', 'More than moderate', 'High', 'Very
High', 'Top Notch']
df['Installs_category'] = pd.cut(df['Installs'], bins=bins, labels=labels)
```

In [32]:

```
df['Installs_category'].value_counts()
```

Out[32]:

```
Installs_category
Low                    2161
High                   2118
Very High              2004
```

```
More than moderate    1648
Moderate              1531
Top Notch              828
Very low               535
no                      15

Name: count, dtype: int64
```

In [33]:

```
df.head(4)
```

Out[33]:

	App	Category	Rating	Reviews	Size_in_bytes	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver	Size_MB	Installs_category
0	Photo Editor & Candy Camera & Grid & Scrap Book	ART_AND_DESIGN	4.1	159	19922944.0	10000	Free	0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up	19.0	Moderate
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14680064.0	500000	Free	0	Everyone	Art & Design; Pretend Play	January 15, 2018	2.0.0	4.0.3 and up	14.0	High

2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	9122611.2	5000000	Free	0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up	8.7	Very High
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	26214400.0	50000000	Free	0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up	25.0	Top Notch

Taking `Price` column

In [34]:

```
df['Price'].unique()
```

Out[34]:

```
array(['0', '$4.99', '$3.99', '$6.99', '$1.49', '$2.99', '$7.99', '$5.99',
       '$3.49', '$1.99', '$9.99', '$7.49', '$0.99', '$9.00', '$5.49',
       '$10.00', '$24.99', '$11.99', '$79.99', '$16.99', '$14.99',
       '$1.00', '$29.99', '$12.99', '$2.49', '$10.99', '$1.50', '$19.99',
       '$15.99', '$33.99', '$74.99', '$39.99', '$3.95', '$4.49', '$1.70',
       '$8.99', '$2.00', '$3.88', '$25.99', '$399.99', '$17.99',
       '$400.00', '$3.02', '$1.76', '$4.84', '$4.77', '$1.61', '$2.50',
       '$1.59', '$6.49', '$1.29', '$5.00', '$13.99', '$299.99', '$379.99',
```

```
       '$37.99', '$18.99', '$389.99', '$19.90', '$8.49', '$1.75',
       '$14.00', '$4.85', '$46.99', '$109.99', '$154.99', '$3.08',
       '$2.59', '$4.80', '$1.96', '$19.40', '$3.90', '$4.59', '$15.46',
       '$3.04', '$4.29', '$2.60', '$3.28', '$4.60', '$28.99', '$2.95',
       '$2.90', '$1.97', '$200.00', '$89.99', '$2.56', '$30.99', '$3.61',
       '$394.99', '$1.26', '$1.20', '$1.04'], dtype=object)
```

In [35]:

```
def adjust_price(price):
    if isinstance(price, str):
        if '$' in price:
            return price.replace("$", "")
    return price
```

In [36]:

```
df['Price'] = df['Price'].apply(adjust_price)
```

In [37]:

```
df['Price'].unique()
```

Out[37]:

```
array(['0', '4.99', '3.99', '6.99', '1.49', '2.99', '7.99', '5.99',
       '3.49', '1.99', '9.99', '7.49', '0.99', '9.00', '5.49', '10.00',
       '24.99', '11.99', '79.99', '16.99', '14.99', '1.00', '29.99',
```

```
       '12.99', '2.49', '10.99', '1.50', '19.99', '15.99', '33.99',
       '74.99', '39.99', '3.95', '4.49', '1.70', '8.99', '2.00', '3.88',
       '25.99', '399.99', '17.99', '400.00', '3.02', '1.76', '4.84',
       '4.77', '1.61', '2.50', '1.59', '6.49', '1.29', '5.00', '13.99',
       '299.99', '379.99', '37.99', '18.99', '389.99', '19.90', '8.49',
       '1.75', '14.00', '4.85', '46.99', '109.99', '154.99', '3.08',
       '2.59', '4.80', '1.96', '19.40', '3.90', '4.59', '15.46', '3.04',
       '4.29', '2.60', '3.28', '4.60', '28.99', '2.95', '2.90', '1.97',
       '200.00', '89.99', '2.56', '30.99', '3.61', '394.99', '1.26',

       '1.20', '1.04'], dtype=object)
```

In [38]:

```
df['Price'].dtype
```

Out[38]:

```
dtype('O')
```

In [39]:

```
df['Price'] = df['Price'].astype('float')
```

In [40]:

```
df.describe()
```

Out[40]:

	Rating	Reviews	Size_in_bytes	Installs	Price	Size_MB
count	9366.000000	1.084000e+04	9.145000e+03	1.084000e+04	10840.000000	9145.000000
mean	4.191757	4.441529e+05	2.256133e+07	1.546434e+07	1.027368	21.516165
std	0.515219	2.927761e+06	2.368637e+07	8.502936e+07	15.949703	22.589084
min	1.000000	0.000000e+00	8.704000e+03	0.000000e+00	0.000000	0.008301
25%	4.000000	3.800000e+01	5.138022e+06	1.000000e+03	0.000000	4.900000
50%	4.300000	2.094000e+03	1.363149e+07	1.000000e+05	0.000000	13.000000
75%	4.500000	5.477550e+04	3.145728e+07	5.000000e+06	0.000000	30.000000
max	5.000000	7.815831e+07	1.048576e+08	1.000000e+09	400.000000	100.000000

Observations:

- Now, we have only 6 columns as numeric data type.

- We can observe their descriptive statistics. and make tons of observations as per our hypotheses.
- We can see that the `Rating` column has a minimum value of `1` and a maximum value of `5`, which is the range of rating, and the mean is `4.19` which is a good rating. On an average people give this rating.
- We can see that the `Reviews` column has a minimum value of `0` and a maximum value of `78,158,306` 78+ Millions, which is the range of reviews, and the mean is `444,111.93` which is a good number of reviews. On an average people give this number of reviews to the apps. But it does not make sense to us, as we have different categories of apps.
- Similarly, we can observe the other columns as well.

Therefore, the most important thing is to classify as app based on the correlation matrix and then observe the descriptive statistics of the app category and number of installs, reviews, ratings, etc.

But even before that we have to think about the missing values in the dataset.

In [41]:

```
df.head()
```

Out[41]:

	App	Category	Rating	Reviews	Size_in_bytes	Installs	Type	Price	Content Rating	Genres	Last Updated	Current Ver	Android Ver	Size_MB	Installs_category
0	Photo Editor & Candy Camera & Grid & Scrap	ART_AND_DESIGN	4.1	159	19922944.0	10000	Free	0.0	Everyone	Art & Design	January 7, 2018	1.0.0	4.0.3 and up	19.0	Moderate

	Book														
1	Coloring book moana	ART_AND_DESIGN	3.9	967	14680064.0	500000	Free	0.0	Everyone	Art & Design;Pretend Play	January 15, 2018	2.0.0	4.0.3 and up	14.0	High
2	U Launcher Lite – FREE Live Cool Themes, Hide ...	ART_AND_DESIGN	4.7	87510	9122611.2	5000000	Free	0.0	Everyone	Art & Design	August 1, 2018	1.2.4	4.0.3 and up	8.7	Very High
3	Sketch - Draw & Paint	ART_AND_DESIGN	4.5	215644	26214400.0	50000000	Free	0.0	Teen	Art & Design	June 8, 2018	Varies with device	4.2 and up	25.0	Top Notch
4	Pixel Draw - Number Art Coloring Book	ART_AND_DESIGN	4.3	967	2936012.8	100000	Free	0.0	Everyone	Art & Design;Creativity	June 20, 2018	1.1	4.4 and up	2.8	More than moderate

Missing Values

In [42]:

```
df.isnull().sum().sort_values(ascending=False)
```

Out[42]:

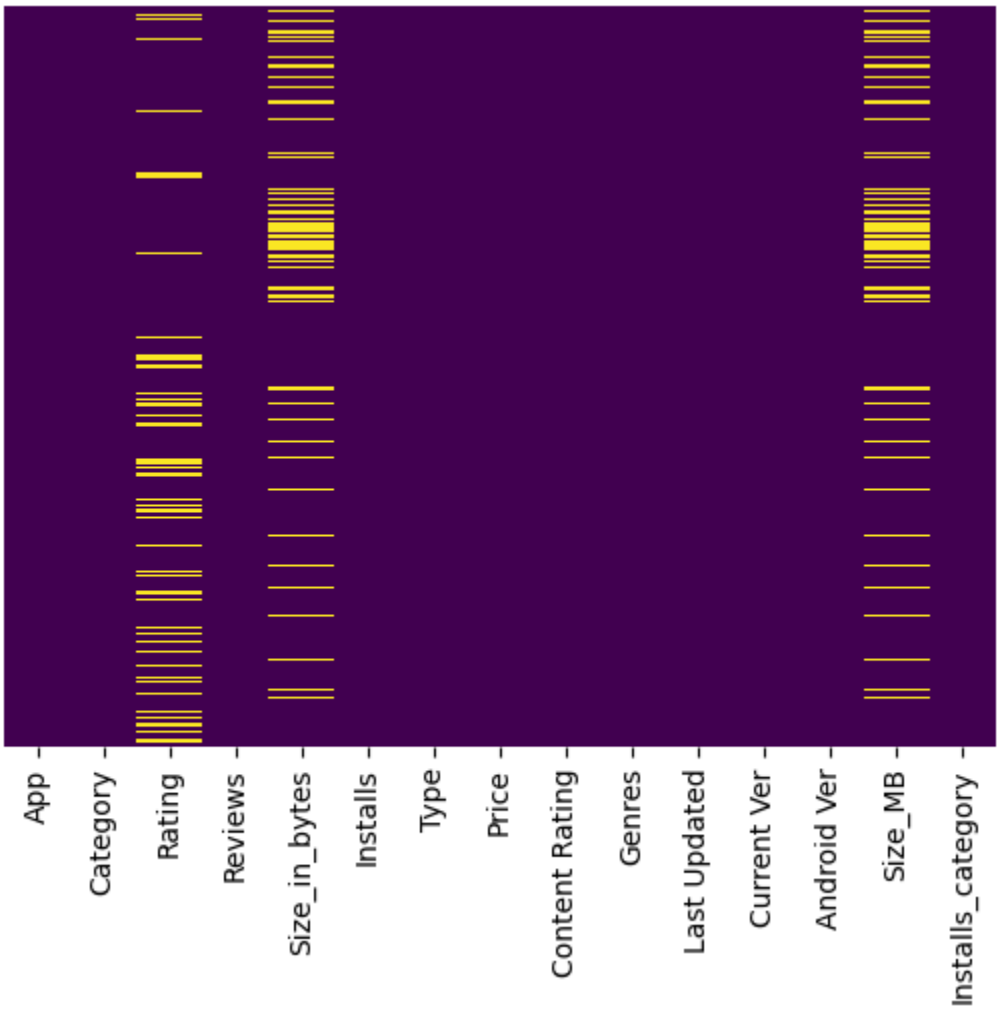
```
Size_in_bytes        1695
Size_MB              1695
Rating               1474
Current Ver             8
Android Ver             2
Type                    1
App                     0
Category                0
Reviews                 0
Installs                0
Price                   0
Content Rating          0
Genres                  0
Last Updated            0
Installs_category       0

dtype: int64
```

In [43]:

```
### Plot Missing Values
sns.heatmap(df.isnull(), yticklabels=False, cbar=False, cmap='viridis')
```

Out[43]:

```
<Axes: >
```



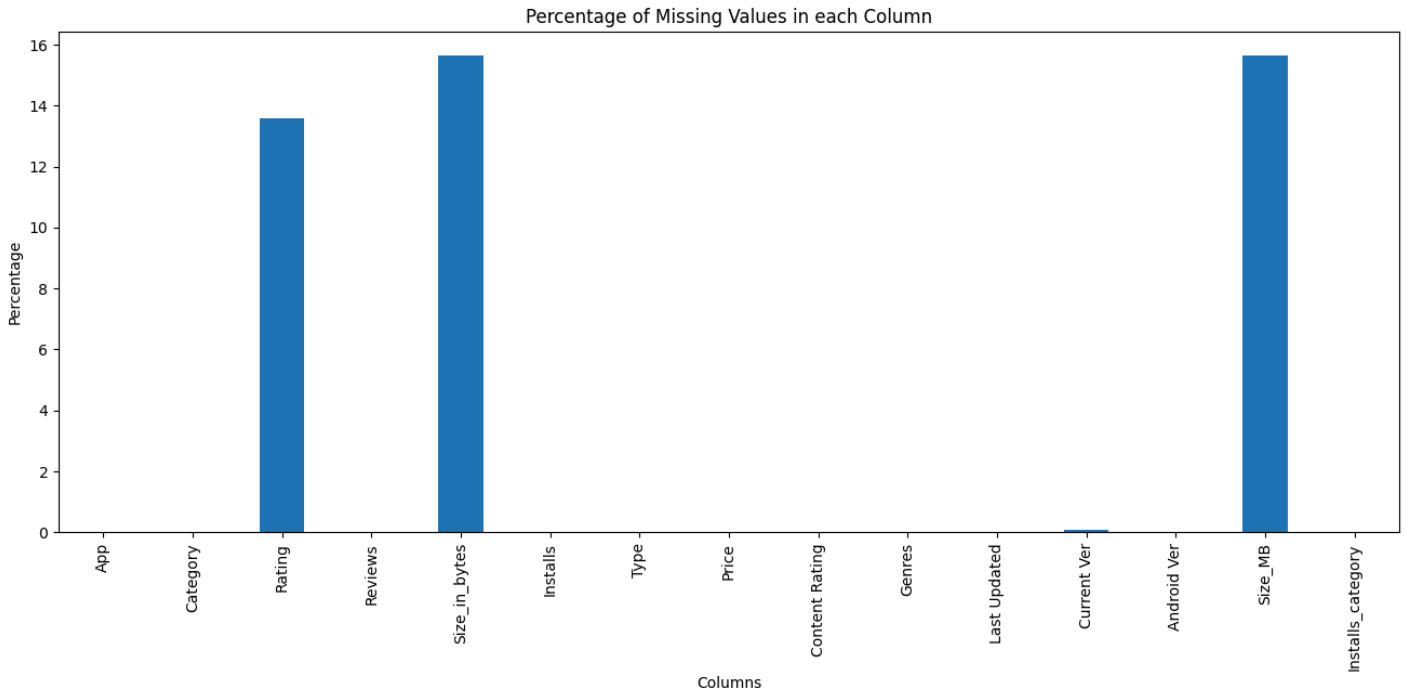
In [44]:

```
# make figure size

plt.figure(figsize=(16, 6))

# plot the null values by their percentage in each column

missing_percentage = df.isnull().sum()/len(df)*100

missing_percentage.plot(kind='bar')

# add the labels

plt.xlabel('Columns')
```

```
plt.ylabel('Percentage')

plt.title('Percentage of Missing Values in each Column')
```

Out[44]:

```
Text(0.5, 1.0, 'Percentage of Missing Values in each Column')
```

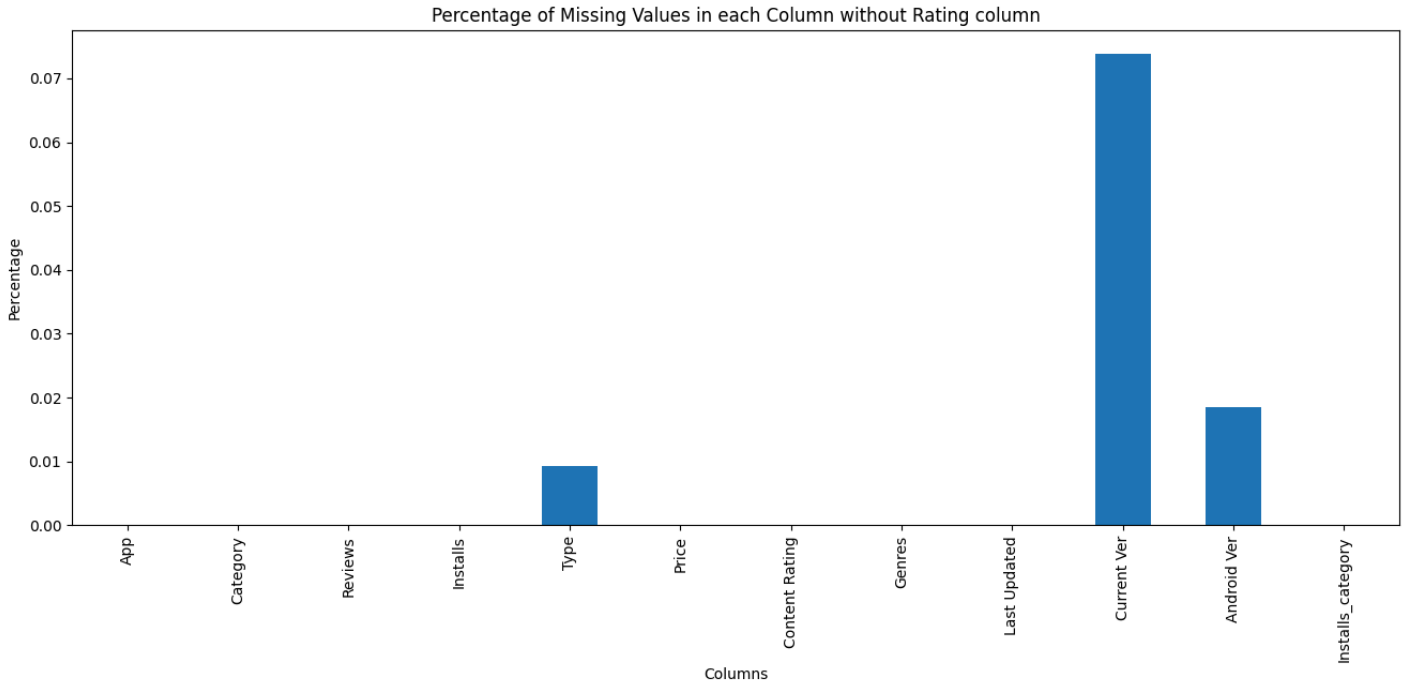


In [45]:

```
plt.figure(figsize=(16, 6)) # make figure size

missing_percentage[missing_percentage < 1].plot(kind='bar') # plot the null values

by their percentage in each column

plt.xlabel('Columns') # add the x-axis labels

plt.ylabel('Percentage') # add the labels for y-axis

plt.title('Percentage of Missing Values in each Column without Rating column')  #

add the title for the plot
```

Out[45]:

```
Text(0.5, 1.0, 'Percentage of Missing Values in each Column without Rating column')
```



Observations:

- We have 1695 missing values in the `'Size_in_bytes'` and `'Size_in_Mb'` columns, which is 15.6% of the total values in the column.
- We have 1474 missing values in the `'Rating'` column, which is 13.6% of the total values in the column.
- We have 8 missing value in the `'Current Ver'` column, which is 0.07% of the total values in the column.
- We have 2 missing values in the `'Android Ver'` column, which is 0.01% of the total values in the column.
- We have only 1 missing value in `Category`, `Type` and `Genres` columns, which is 0.009% of the total

values in the column.

2.3. Dealing with the missing values

- We can not impute the `Rating` column as is is directly linked with the installation column. To test this Hypothesis we need to plot the `Rating` column with the `Installs` and `Size` columns and statistically test it using `pearson correlation test`.

In [46]:

```
df.columns
```

Out[46]:

```
Index(['App', 'Category', 'Rating', 'Reviews', 'Size_in_bytes', 'Installs',
       'Type', 'Price', 'Content Rating', 'Genres', 'Last Updated',
       'Current Ver', 'Android Ver', 'Size_MB', 'Installs_category'],
      dtype='object')
```

In [47]:

```
numeric_cols = [i for i in df.columns if df[i].dtype != 'object' ] # make a list of numeric columns
```

In [48]:

```
numeric_cols.remove("Installs_category")
```

In [49]:

```
numeric_cols
```

Out[49]:

```
['Rating', 'Reviews', 'Size_in_bytes', 'Installs', 'Price', 'Size_MB']
```

In [50]:

```
corr = df[numeric_cols].corr()
```

In [51]:

```
corr
```

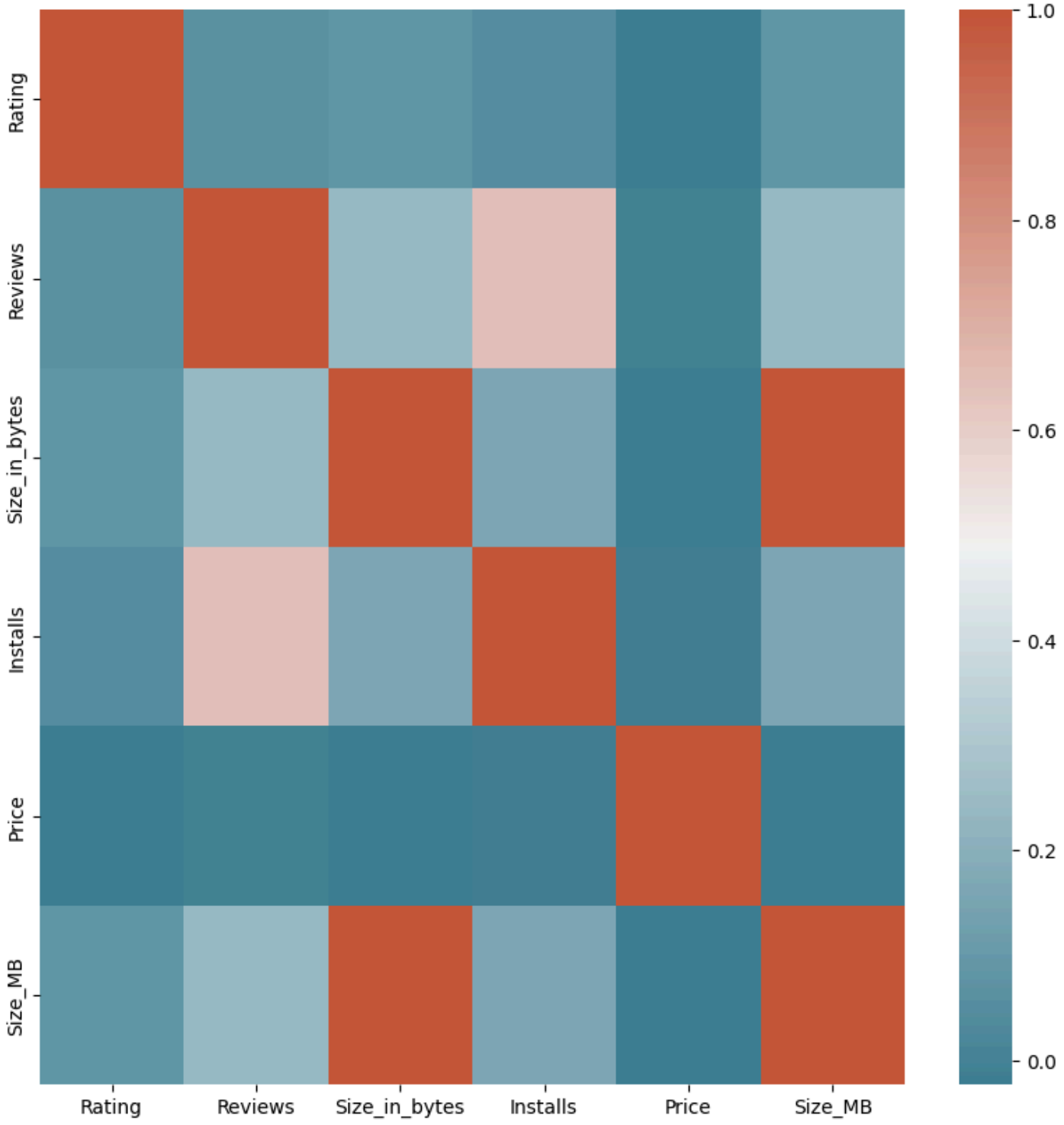
Out[51]:

	Rating	Reviews	Size_in_bytes	Installs	Price	Size_MB
Rating	1.000000	0.068141	0.083737	0.051355	-0.021903	0.083737
Reviews	0.068141	1.000000	0.238214	0.643122	-0.009667	0.238214
Size_in_bytes	0.083737	0.238214	1.000000	0.164787	-0.023007	1.000000
Installs	0.051355	0.643122	0.164787	1.000000	-0.011689	0.164787

Price	-0.021903	-0.009667	-0.023007	-0.011689	1.000000	-0.023007
Size_MB	0.083737	0.238214	1.000000	0.164787	-0.023007	1.000000

In [52]:

```
plt.figure(figsize=(10, 10))

sns.heatmap(corr, cmap=sns.diverging_palette(220, 20, as_cmap=True))

plt.show()
```



In [53]:

```
# we can calculate the pearson correlation coefficient using scipy as well as follows

# this is to install scipy if you have not done it before

# pip install scipy
```

```
from scipy import stats


# remove rows containing NaN or infinite values (Important to calculate Pearson's R)
df_clean = df.dropna()


# calculate Pearson's R between Rating and Installs
pearson_r, _ = stats.pearsonr(df_clean['Reviews'], df_clean['Installs'])
print(f"Pearson's R between Reviews and Installs: {pearson_r:.4f}")
```

```
Pearson's R between Reviews and Installs: 0.6262
```

Observations

- Lighter color shows the high correlation and darker color shows the low correlation
- We can see that the `Reviews` column has a high correlation with the `Installs` column, which is `0.64` according to corr(). Which is quite good.
    - This shows that the more the reviews the more the installs are for one app. If in any case we need to impute reviews we have to think of number of install.
        - If we have an ap with 2 installs and we imputer the reviews with `1000` or via average reviews then it will be wrong.
- Installs is slightly correlated with `Size_in_Mb` or `Size_in_bytes` , which is `0.16`, this also shows us the importance of size and Installs. But we can not depend on it as the Peason correlation is very low.

- Before going ahead, let's remove the rows with missing values in the `Current Ver`, `Android Ver`, `Category`, `Type` and `Genres` columns, as they are very less in number and will not affect our analysis.

In [54]:
```
# remove the rows having null values in the 'Current Ver', 'Android Ver', 'Category', 'Type' and 'Genres' column
df.dropna(subset=['Current Ver', 'Android Ver', 'Category', 'Type', 'Genres'], inplace=True)
```

In [55]:
```
# length after removing null values
print(f"Length of the dataframe after removing null values: {len(df)}")
```

```
Length of the dataframe after removing null values: 10829
```

Observations

- Only `Rating` and `Size_in_bytes` or `Size_in_Mb` columns are left with missing values.
    - We know that we have to be carefull while deadling with `Rating` column, as it is directly linked with the `Installs` column.
    - In Size columns we already know about `Varies with device` values, which we have

converted into null values, we do not need to impute at the moment, as every app has different size and nobody can predict that as nearly as possible.

In [56]:

```
# use groupby function to find the trend of Rating in each Installs_category

df.groupby('Installs_category')['Rating'].describe()
```

Out[56]:

	count	mean	std	min	25%	50%	75%	max
Installs_category								
no	0.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Very low	81.0	4.637037	0.845199	1.0	4.8	5.0	5.0	5.0
Low	1278.0	4.170970	0.825605	1.0	3.8	4.4	4.8	5.0
Moderate	1440.0	4.035417	0.604428	1.4	3.8	4.2	4.5	5.0
More than moderate	1616.0	4.093255	0.505619	1.6	3.9	4.2	4.5	4.9

High	2113.0	4.207525	0.376594	1.8	4.0	4.3	4.5	4.9
Very High	2004.0	4.287076	0.294902	2.0	4.1	4.3	4.5	4.9
Top Notch	828.0	4.374396	0.193726	3.1	4.3	4.4	4.5	4.8

In [57]:

```
df['Rating'].isnull().sum()
```

Out[57]:

```
1469
```

In [58]:

```
# in which Install_category the Rating has NaN values

df['Installs_category'].loc[df['Rating'].isnull()].value_counts()
```

Out[58]:

```
Installs_category
Low                   880
Very low              453
Moderate               88
More than moderate     31
no                     14
```

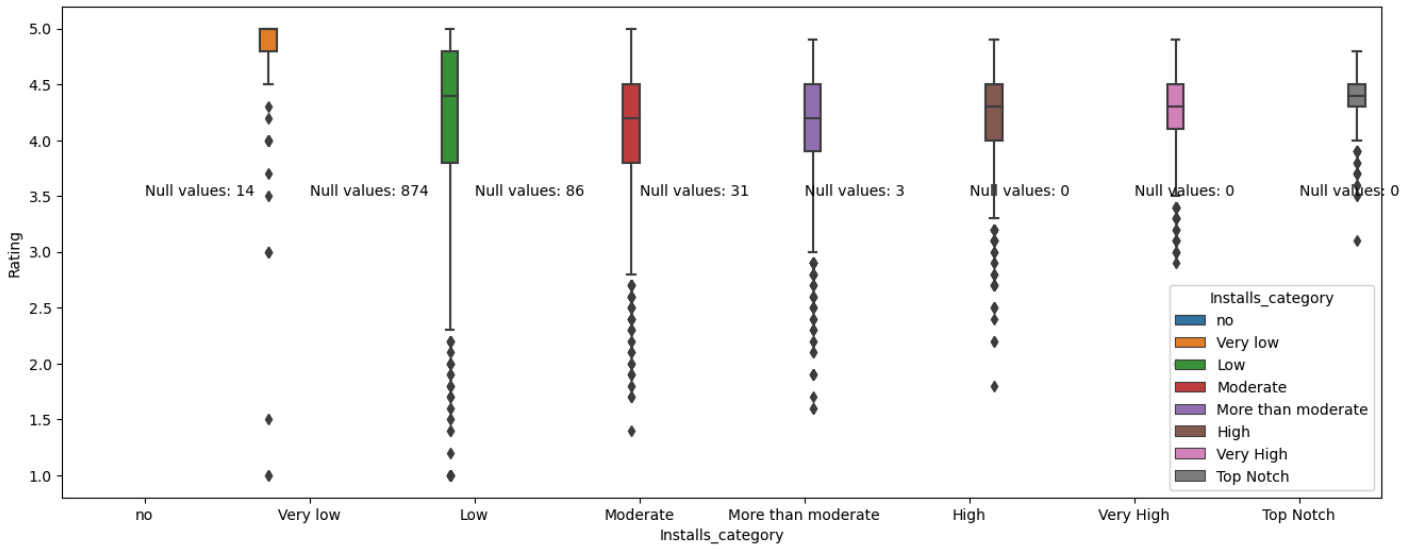
```
High                    3

Very High               0

Top Notch               0


Name: count, dtype: int64
```

In [59]:

```
# plot the boxplot of Rating in each Installs_category

plt.figure(figsize=(16, 6)) # make figure size

sns.boxplot(x='Installs_category', y='Rating', hue='Installs_category', data=df) #

plot the boxplot

# add the text of number of null values in each category

plt.text(0, 3.5, 'Null values: 14')

plt.text(1, 3.5, 'Null values: 874')

plt.text(2, 3.5, 'Null values: 86')

plt.text(3, 3.5, 'Null values: 31')

plt.text(4, 3.5, 'Null values: 3')

plt.text(5, 3.5, 'Null values: 0')

plt.text(6, 3.5, 'Null values: 0')

plt.text(7, 3.5, 'Null values: 0')
```

Out[59]:

```
Text(7, 3.5, 'Null values: 0')
```



In [60]:

```
def fill_missing_ratings(df, category, fill_value):
  """Fills missing rating values in a specified category with a given value.

  Args:
    df: The pandas DataFrame containing the data.
    category: The category to fill missing values for.
    fill_value: The value to fill missing ratings with.

  Returns:
    The modified DataFrame with filled missing values.
  """

  # Filter the DataFrame for rows where the category matches and rating is missing
  filtered_df = df[(df['Installs_category'] == category) & df['Rating'].isnull()]
```

```
  # Fill the missing values with the specified value
  df.loc[filtered_df.index, 'Rating'] = fill_value

  return df
```

In [61]:

```
df = fill_missing_ratings(df, 'Low', 4.170970)
```

In [62]:

```
df = fill_missing_ratings(df, 'Very low', 4.637037)
df = fill_missing_ratings(df, 'Moderate', 4.035417)
df = fill_missing_ratings(df, 'More than moderate', 4.093255)
df = fill_missing_ratings(df, 'High', 4.207525)
```

In [63]:

```
df = fill_missing_ratings(df, 'no', 0)
```

In [64]:

```
# in which Install_category the Rating has NaN values
df['Installs_category'].loc[df['Rating'].isnull()].value_counts()
```

Out[64]:

```
Installs_category
```

```
no                    0
Very low              0
Low                   0
Moderate              0
More than moderate    0
High                  0
Very High             0
Top Notch             0

Name: count, dtype: int64
```

In [65]:

```
df['Rating'].isnull().sum()
```

Out[65]:

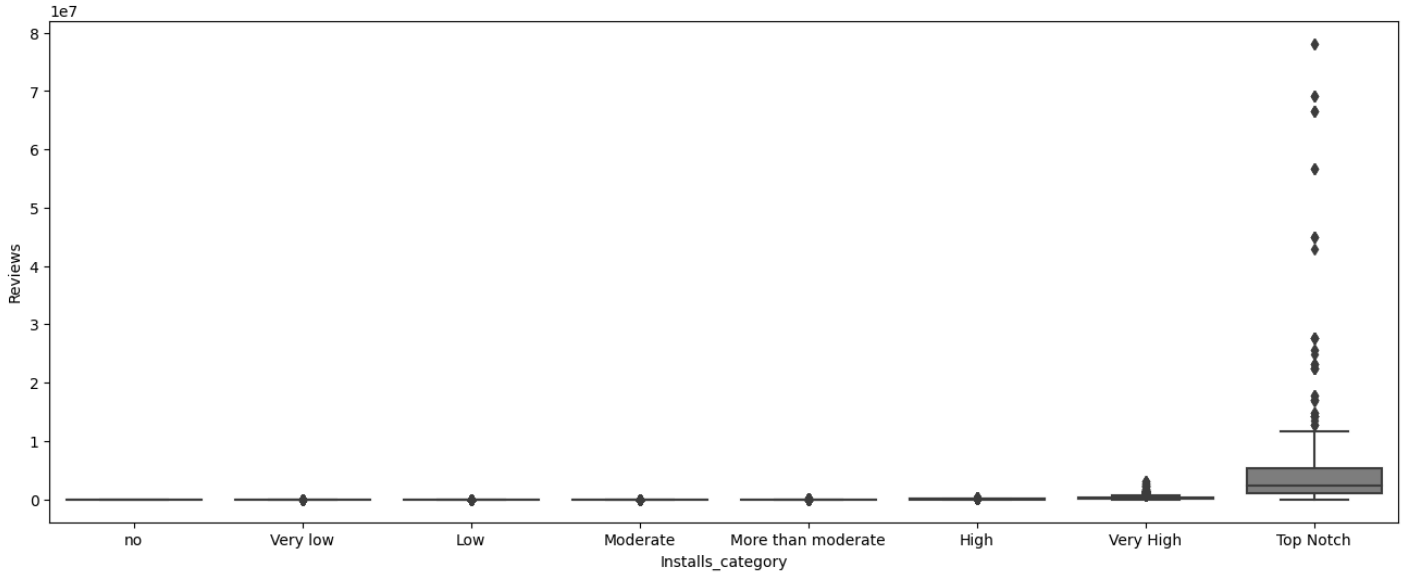
```
0
```

In [66]:

```
# let's plot the same plots for Reviews column as well
plt.figure(figsize=(16, 6)) # make figure size
sns.boxplot(x='Installs_category', y= 'Reviews', data=df) # plot the boxplot
```

Out[66]:

```
<Axes: xlabel='Installs_category', ylabel='Reviews'>
```

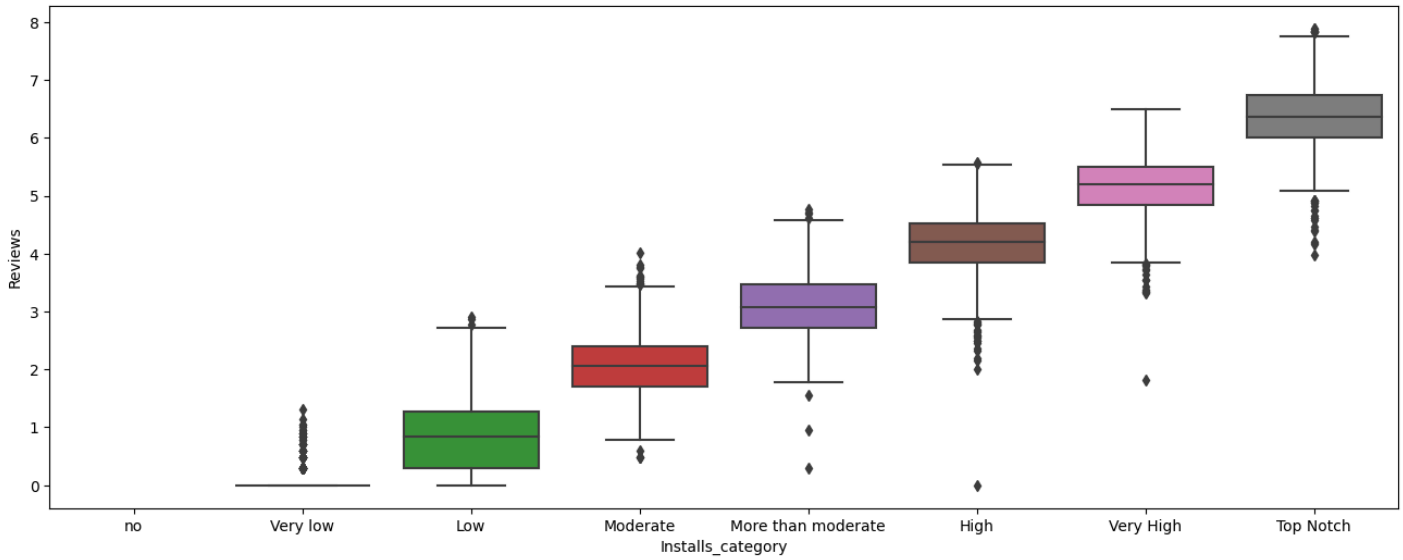


In [67]:

```
# let's plot the same plots for Reviews column as well

plt.figure(figsize=(16, 6)) # make figure size

sns.boxplot(x='Installs_category', y= np.log10(df['Reviews']), data=df) # plot the

boxplot
```

Out[67]:

```
<Axes: xlabel='Installs_category', ylabel='Reviews'>
```



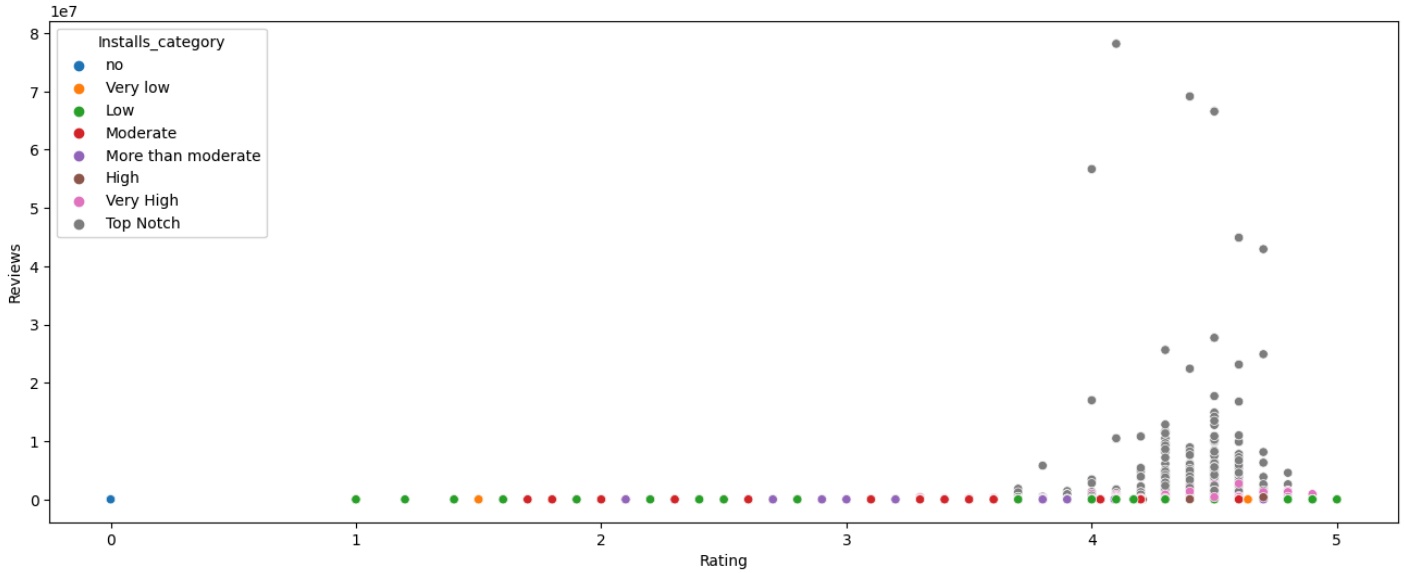
- We also draw the scatter plot of the `Rating` and `Review` columns with the `Installs` column

In [68]:

```
# Draw a scatter plot between Rating, Reviews and Installs

plt.figure(figsize=(16, 6)) # make figure size

sns.scatterplot(x='Rating', y='Reviews', hue='Installs_category', data=df) # plot

the scatter plot
```

Out[68]:

```
<Axes: xlabel='Rating', ylabel='Reviews'>
```



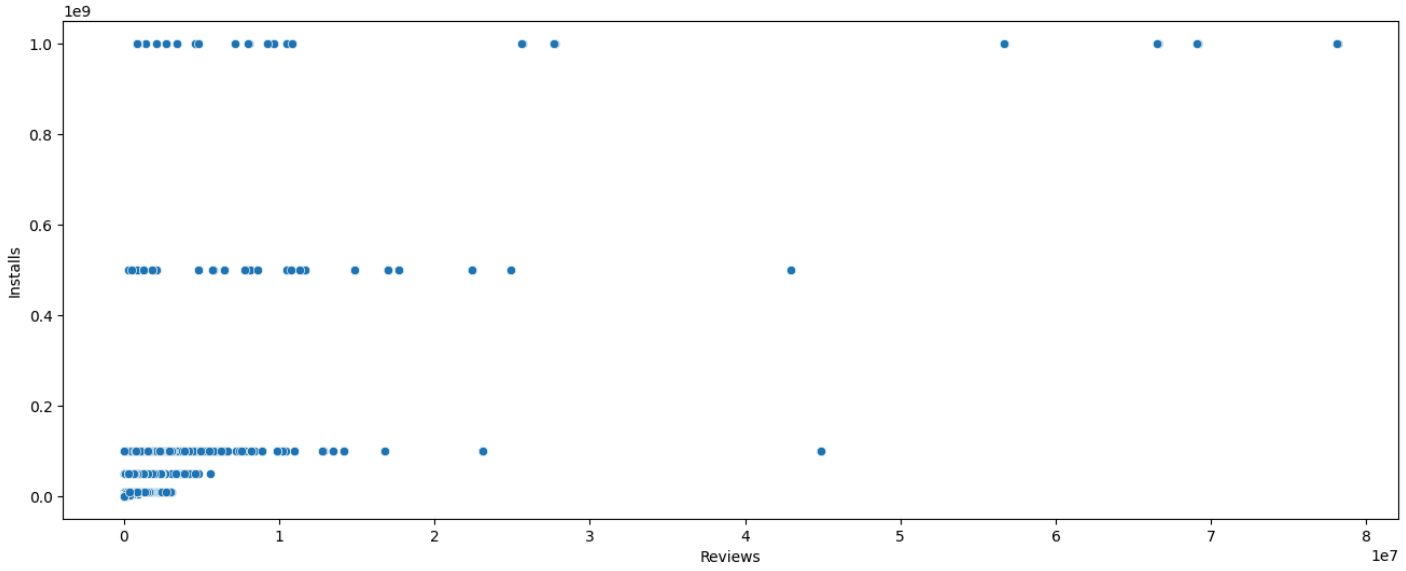
- It doesn't show any trend, because, you should know that Rating is a categorical variable (Ordinal) and Reviews is a continuous variable, therefore, we can not plot them together.
- Let's try with Reviews and Installs

In [69]:

```
# plot reviews and installs in a scatter plot

plt.figure(figsize=(16, 6)) # make figure size

sns.scatterplot(x='Reviews', y='Installs', data=df) # plot the scatter plot
```

Out[69]:

```
<Axes: xlabel='Reviews', ylabel='Installs'>
```



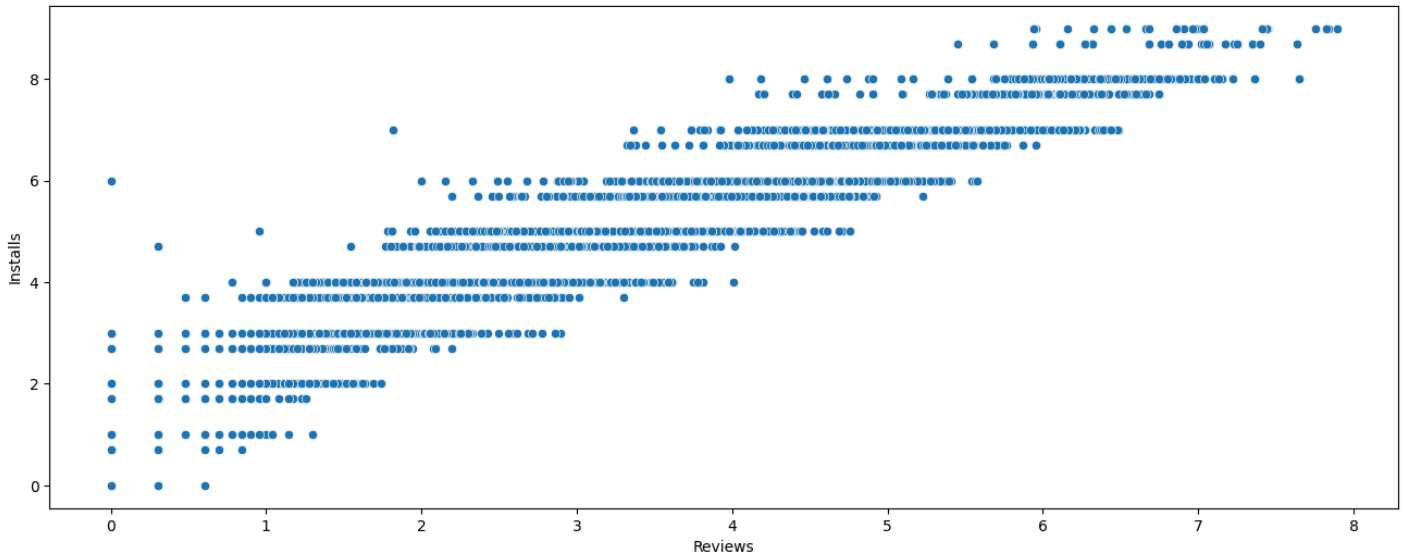
- We did not see any trend and the issue is we need to normalize the data before plotting it, let's try with log transformation

In [70]:

```
# plot reviews and installs in a scatter plot

plt.figure(figsize=(16, 6)) # make figure size

sns.scatterplot(x=np.log10(df['Reviews']),  y=np.log10(df['Installs']),  data=df)  #
plot the scatter plot
```

Out[70]:

```
<Axes: xlabel='Reviews', ylabel='Installs'>
```



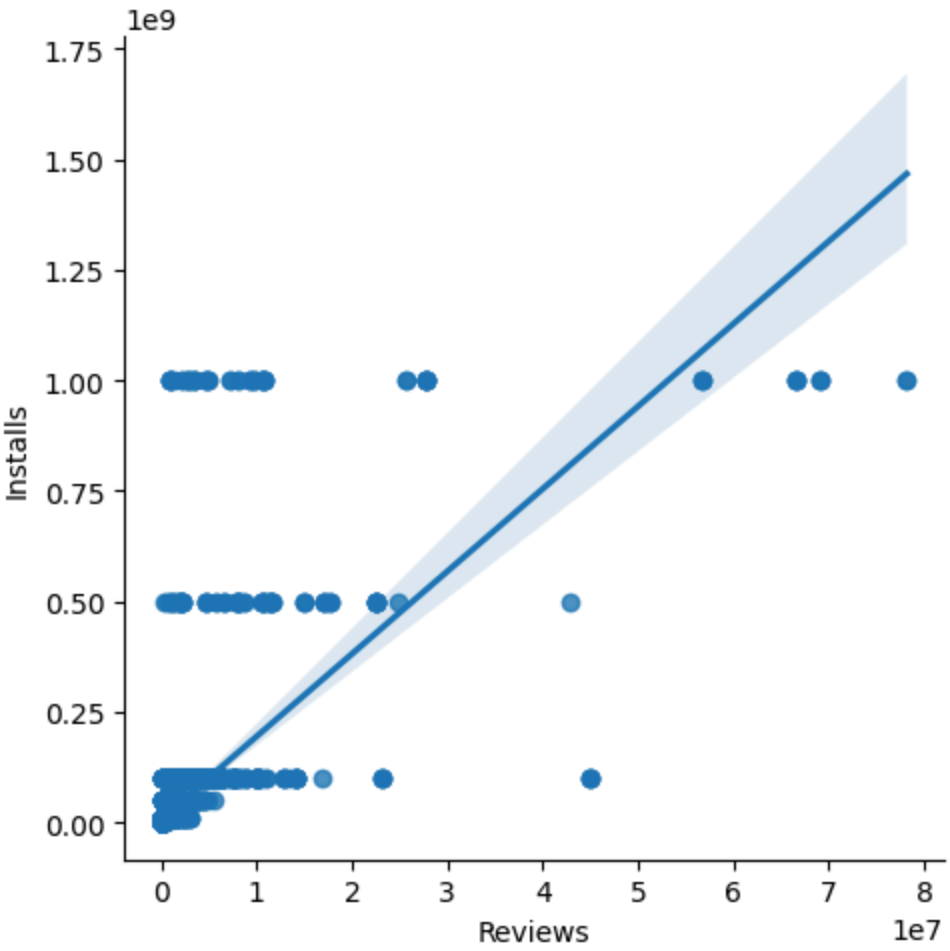
- Now we see a slight trend but still the issue is installs were given in a factorial manner, as 10+, 20+, 1000+ etc, and these are not continuous number but Discreet one, therefore, we can only see a slight trends here. Let's plot a line plot to see the trend.

In [71]:

```
# plot reviews and installs in a scatter plot with trend line

plt.figure(figsize=(16, 6)) # make figure size

sns.lmplot(x='Reviews', y='Installs', data=df) # plot the scatter plot with trend
line
```

Out[71]:

```
<seaborn.axisgrid.FacetGrid at 0x7cfd283b47f0>

<Figure size 1600x600 with 0 Axes>
```



- Here, we can see a nice trend, which shows that number of Reviews increases with the number of Installs, which is quite obvious.

Observation

-We can see that most of the null values from `Rating` column are no - Moderate Installation apps, which make sense that if the app has less installations, it has less Rating and review.

- But wait, we have to check for the duplicates as well, as they can affect our analysis.

2.3. **Duplicates**

- Removing duplicates is one of the most important part of the data wrangling process, we must remove the duplicates in order to get the correct insights from the data.
- If you do not remove duplicates from a dataset, it can lead to incorrect insights and analysis.
- Duplicates can skew statistical measures such as mean, median, and standard deviation, and can also lead to over-representation of certain data points.
- It is important to remove duplicates to ensure the accuracy and reliability of your data analysis.

In [72]:

```
# find duplicate if any

df.duplicated().sum()
```

Out[72]:

```
483
```

In [73]:

```
# let's check for number of duplicates

for col in df.columns:

    print(f"Number of duplicates in {col} column are: {df[col].duplicated().sum()}")
```

```
Number of duplicates in App column are: 1181

Number of duplicates in Category column are: 10796

Number of duplicates in Rating column are: 10784

Number of duplicates in Reviews column are: 4830

Number of duplicates in Size_in_bytes column are: 10373

Number of duplicates in Installs column are: 10809
```

```
Number of duplicates in Type column are: 10827

Number of duplicates in Price column are: 10737

Number of duplicates in Content Rating column are: 10823

Number of duplicates in Genres column are: 10710

Number of duplicates in Last Updated column are: 9453

Number of duplicates in Current Ver column are: 7998

Number of duplicates in Android Ver column are: 10796

Number of duplicates in Size_MB column are: 10373

Number of duplicates in Installs_category column are: 10821
```

In [74]:

```
# print the number of duplicates in df

print(f"Number of duplicates in df are: {df.duplicated().sum()}")
```

```
Number of duplicates in df are: 483
```

In [75]:

```
# remove the duplicates

df.drop_duplicates(inplace=True)
```

- Now we have removed 483 duplicates from the dataset. and have 10346 rows left.

---

3. Insights from Data

3.1. Which category has the highest number of apps?

In [76]:

```
# which category has highest number of apps

df['Category'].value_counts().head(10) # this will show the top 10 categories with
highest number of apps
```

Out[76]:

```
Category

FAMILY             1939

GAME               1121

TOOLS               841

BUSINESS            427

MEDICAL             408

PRODUCTIVITY        407

PERSONALIZATION     386

LIFESTYLE           373

COMMUNICATION       366

FINANCE             360


Name: count, dtype: int64
```

3.2. Which category has the highest number of installs?

In [77]:

```
# category with highest number of Installs
```

```
df.groupby('Category')['Installs'].sum().sort_values(ascending=False).head(10)
```

Out[77]:

```
Category

GAME                   31544024415

COMMUNICATION          24152276251

SOCIAL                 12513867902

PRODUCTIVITY           12463091369

TOOLS                  11452271905

FAMILY                 10041632405

PHOTOGRAPHY             9721247655

TRAVEL_AND_LOCAL        6361887146

VIDEO_PLAYERS           6222002720

NEWS_AND_MAGAZINES      5393217760


Name: Installs, dtype: int64
```

3.3. Which category has the highest number of reviews?

In [78]:

```
# Category with highest number of Reviews

df.groupby('Category')['Reviews'].sum().sort_values(ascending=False).head(10)
```

Out[78]:

```
Category

GAME                1415536650
```

```
COMMUNICATION       601273552

SOCIAL              533576829

FAMILY              396771746

TOOLS               273181033

PHOTOGRAPHY         204297410

VIDEO_PLAYERS       110380188

PRODUCTIVITY        102554498

SHOPPING             94931162

PERSONALIZATION      75192744


Name: Reviews, dtype: int64
```

3.4. Which category has the highest rating?

In [79]:

```
# Category with highest average Rating

df.groupby('Category')['Rating'].mean().sort_values(ascending=False).head(10)
```

Out[79]:

```
Category

EVENTS                4.394346

EDUCATION             4.373794

BOOKS_AND_REFERENCE   4.358435

PERSONALIZATION       4.322099

ART_AND_DESIGN        4.298885

GAME                  4.281926

HEALTH_AND_FITNESS    4.273890
```

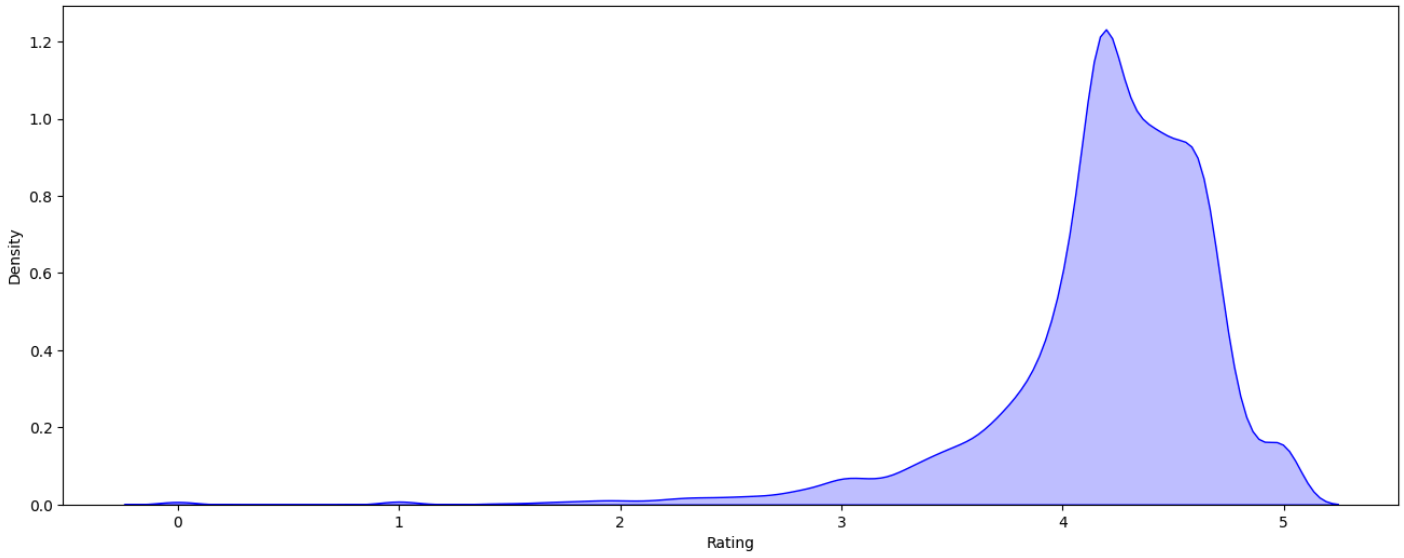
```
PARENTING              4.259759

SHOPPING               4.253376

SPORTS                 4.253041


Name: Rating, dtype: float64
```

In [80]:

```
# plot the rating distribution

plt.figure(figsize=(16, 6)) # make figure size

sns.kdeplot(df['Rating'], color="blue", shade=True) # plot the distribution plot
```

Out[80]:

```
<Axes: xlabel='Rating', ylabel='Density'>
```



In [ ]:

1 Reference link
2 Reference link for ML project