## **Google Play Store Analysis**

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**Project Overview** 

**About Dataset** 

The Data Set was downloaded from Kaggle, from the following link

# Google PlayStore Android App Data. (2.3 Million+ App Data)

#### Introduction

The Google Play Store is one of the largest app marketplaces, hosting millions of apps across various categories. Understanding the patterns in app ratings, downloads, pricing, and monetization strategies is essential for developers, businesses, and researchers.

In this project, we perform an in-depth analysis of Google Play Store data to uncover trends and insights. This includes:

- **Data Cleaning & Preprocessing**: Handling duplicates, missing values, and formatting inconsistencies.
- **Exploratory Data Analysis (EDA)**: Understanding app distribution, pricing models, and user engagement.
- **Correlation & Trends**: Investigating relationships between ratings, installs, and other key factors.
- **Visualization**: Using charts and graphs to present insights effectively.

### **Objectives**

ldentify key trends in app categories, pricing, and ratings.
Analyze how installs correlate with rating count and app size.
Explore the distribution of free vs. paid apps and their pricing patterns.
Provide actionable insights for app developers and businesses.

By the end of this analysis, we will have a comprehensive understanding of Google Play Store trends, which can help in making data-driven decisions for app development and marketing strategies.

## 1. Importing Libraries

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from google.colab import drive
drive.mount('/content/drive')
df = pd.read csv('/content/drive/My Drive/Data Sets/Google-
Playstore.csv')
print(df.head())
Mounted at /content/drive
                                              App Name \
0
                                               Gakondo
1
                                  Ampere Battery Info
2
                                                Vibook
3
   Smart City Trichy Public Service Vehicles 17UC...
                                               GROW.me
                                     Category
                                                        Rating Count
                        App Id
                                               Rating
Installs
                                                   0.0
                                                                 0.0
0
          com.ishakwe.gakondo
                                    Adventure
10 +
1 com.webserveis.batteryinfo
                                        Tools
                                                   4.4
                                                                64.0
5,000+
2
         com.doantiepvien.crm
                                 Productivity
                                                   0.0
                                                                 0.0
50+
3
      cst.stJoseph.ug17ucs548
                                                                 5.0
                                Communication
                                                   5.0
10 +
         com.horodyski.grower
                                                   0.0
                                                                 0.0
4
                                        Tools
100+
   Minimum Installs
                     Maximum Installs
                                        Free
                                              Price
0
               10.0
                                    15 True
                                                 0.0
1
             5000.0
                                  7662
                                        True
                                                 0.0
2
               50.0
                                    58
                                        True
                                                 0.0
3
               10.0
                                    19
                                        True
                                                 0.0
4
              100.0
                                   478
                                        True
                                                 0.0
                  Developer Website
                                                   Developer Email \
        https://beniyizibyose.tk/#/
0
                                           jean21101999@gmail.com
```

```
1
    https://webserveis.netlifv.app/
                                             webserveis@gmail.com
2
                                              vnacrewit@gmail.com
   http://www.climatesmarttech.com/
                                      climatesmarttech2@gmail.com
        http://www.horodyski.com.pl
                                        rmilekhorodyski@gmail.com
       Released
                 Last Updated Content Rating \
   Feb 26, 2020
                 Feb 26, 2020
0
                                     Everyone
   May 21, 2020
                 May 06, 2021
1
                                     Everyone
                 Aug 19, 2019
   Aug 9, 2019
                                     Everyone
   Sep 10, 2018
                 Oct 13, 2018
                                     Everyone
   Feb 21, 2020
                 Nov 12, 2018
                                     Everyone
                                       Privacy Policy Ad Supported \
0
                  https://beniyizibyose.tk/projects/
                                                             False
   https://dev4phones.wordpress.com/licencia-de-uso/
1
                                                              True
2
   https://www.vietnamairlines.com/vn/en/terms-an...
                                                             False
3
                                                              True
                         http://www.horodyski.com.pl
4
                                                             False
  In App Purchases Editors Choice
                                           Scraped Time
                            False 2021-06-15 20:19:35
0
             False
1
             False
                            False
                                   2021-06-15 20:19:35
2
                            False 2021-06-15 20:19:35
             False
3
                            False
                                   2021-06-15 20:19:35
             False
4
                            False 2021-06-15 20:19:35
             False
[5 rows x 24 columns]
```

## 2. Data Loading and exploration and cleaning

- → 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
  - Viewing the first five Rows of the data

```
df.head()
{"type":"dataframe","variable_name":"df"}
```

**Note**: Some the output of notebook does not present the complete output, therefore we can increase the limit of columns view and row view by using these commands:

```
pd.set_option('display.max_columns', None) # this is to display all
the columns in the dataframe
pd.set_option('display.max_rows', None) # this is to display all the
rows in the dataframe
```

```
# hide all warnings runtime
import warnings
warnings.filterwarnings('ignore')
```

 let's see the exact column names which can be easily copied later on from Google Playstore Dataset

Not enough, let's have a look on the columns and their data types using detailed info function

```
df.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2312944 entries, 0 to 2312943
Data columns (total 24 columns):
#
     Column
                        Dtype
     _ _ _ _ _ _
 0
     App Name
                        object
 1
     App Id
                        object
 2
                        object
     Category
 3
                        float64
     Rating
4
     Rating Count
                        float64
 5
     Installs
                        object
     Minimum Installs
 6
                        float64
 7
     Maximum Installs
                        int64
 8
     Free
                        bool
 9
     Price
                        float64
 10 Currency
                        object
 11
    Size
                        object
 12 Minimum Android
                        object
 13 Developer Id
                        object
 14
     Developer Website
                        object
 15
     Developer Email
                        object
```

```
16
    Released
                       object
 17 Last Updated
                        object
 18 Content Rating
                       object
 19 Privacy Policy
                       object
 20 Ad Supported
                       bool
 21 In App Purchases
                       bool
22 Editors Choice
                       bool
 23
    Scraped Time
                       object
dtypes: bool(4), float64(4), int64(1), object(15)
memory usage: 361.8+ MB
```

#### # Observations

- 1. There are 10841 rows and 24 columns in the dataset
- 2. The columns are of different data types
- 3. The columns in the datasets are:
  - 'App Name', 'App Id', 'Category', 'Rating', 'Rating Count', 'Installs', 'Minimum Installs', 'Maximum Installs', 'Free', 'Price', 'Currency', 'Size', 'Minimum Android', 'Developer Id', 'Developer Website', 'Developer Email', 'Released', 'Last Updated', 'Content Rating', 'Privacy Policy', 'Ad Supported', 'In App Purchases', 'Editors Choice', 'Scraped Time',
- 4. There are some missing values in the dataset which we will read in details and deal later on in the notebook.
- 5. There are some columns which are of object data type but they should be of numeric data type, we will convert them later on in the notebook.
  - 'Installs','Size', 'Minimum Android'

```
df.describe()
{"summary":"{\n \"name\": \"df\",\n \"rows\": 8,\n \"fields\": [\n
{\n \"column\": \"Rating\",\n \"properties\": {\n
\"dtype\": \"number\",\n
                             \"std\": 809657.997368076,\n
                     \"max\": 2290061.0,\n
\"min\": 0.0,\n
\"num_unique_values\": 7,\n
                                \"samples\": [\n
2290061.0,\n
                     2.203151531771424,\n
                                                 4.3\n
                                                              ],\n
\"semantic type\": \"\",\n
                           \"description\": \"\"\n
           {\n \"column\": \"Rating Count\",\n
    },\n
                     \"dtype\": \"number\",\n
    \"min\": 0.0,\n
                                                        \"std\":
\"properties\": {\n
                                                 \"max\":
48867391.570589274,\n
                     \"num unique_values\": 7,\n
                                                      \"samples\":
138557570.0,\n
[\n
            2290061.0,\n
                                 2864.8388767810115,\n
                        \"semantic_type\": \"\",\n
42.0\n
             ],\n
                                         {\n \"column\":
\"description\": \"\"\n
\"Minimum Installs\",\n
                           }\n
                                  },\n
                          \"properties\": {\n
                                                    \"dtype\":
\"number\",\n\\"std\": 3534647129.2584343,\n
                                                        \"min\":
            \"max\": 10000000000.0,\n \"num unique values\":
0.0, n
           \"samples\": [\n 183445.21
2312837.0\n ],\n
8,\n
                                   183445.21395800915,\n
500.0,\n
                                              \"semantic type\":
\"\",\n
              \"description\": \"\"\n
                                          }\n
                                                },\n
                                                        {\n
```

```
\"column\": \"Maximum Installs\",\n \"properties\": {\n
\"dtype\": \"number\",\n \"std\": 4261699552.060366,\n
\"min\": 0.0,\n \"max\": 12057627016.0,\n
\"num unique values\": 8,\n
                               \"samples\": [\n
                          695.0,\n
320201.713137456,\n
                                          2312944.0\n
                                                           ],\n
\"semantic_type\": \"\",\n \"description\": \"\"\n
    \"dtype\": \"number\",\n \"std\": 817728.8641336214,\n
\"min\": 0.0,\n \"max\": 2312944.0,\n
\"num_unique_values\": 5,\n \"samples\": [\n 0.10349915833370804,\n 400.0,\n 2
         333370804,\n 400.0,\n 2.63312655760054\n \"semantic_type\": \"\",\n \"description\": \"\"\n
],\n
}\n
      }\n ]\n}","type":"dataframe"}
```

#### ## Observations:

- We have 5 columns as numeric data type, rest all are object data type (according to python), but we can see that 'Installs', 'Size', 'Minimum Android' are also numeric, we must convert them to numeric data type in data wrangling process.
- Let's clean the Size column first

```
df['Installs'].isnull().sum()
107
```

We have 107 null values

```
df['Installs'] = df['Installs'].fillna('')
# Replace empty strings with '0'
df['Installs'] = df['Installs'].replace('', '0')
```

Firstly we have to fill null values with ' 'secondly replace it with 0

```
df['Installs'].isnull().sum()
0
```

No null values, we are good to go.

```
'50,000,000+', '1,000,000,000+', '500,000,000+',
'5,000,000,000+',
       '10,000,000,000+'], dtype=object)
df['Installs'].value counts()
Installs
100 +
                    443368
1,000+
                    398199
10+
                    300156
10,000+
                    256723
500+
                   189077
50+
                    170465
5,000+
                   143593
100,000+
                   110257
                    75359
50,000+
5+
                    73772
1+
                    65345
1,000,000+
                    33650
500,000+
                    27012
                    11566
0+
5,000,000+
                     6595
10,000,000+
                      6192
50,000,000+
                       824
100,000,000+
                       549
                       107
                        65
500,000,000+
1,000,000,000+
                        55
5,000,000,000+
                        14
10,000,000,000+
                         1
Name: count, dtype: int64
# find how many values has '+' in it
df['Installs'].loc[df['Installs'].str.contains('\\
+')].value_counts().sum()
2312837
```

- The only problem I see here is the + sign in the values, let's remove them and convert the column into numeric data type.
- The total values in the Installs column are 10841 and there are no null values in the column.
- However, one value 0 has no plus sign
- Let's remove the plus sign + and , from the values and convert them into numeric data type

```
# remove the plus sign from install column and convert it to numeric
df['Installs'] = df['Installs'].apply(lambda x: x.replace('+', '') if
```

```
'+' in str(x) else x)
# also remove the commas from the install column
df['Installs'] = df['Installs'].apply(lambda x: x.replace(',', '') if
',' in str(x) else x)
# convert the install column to numeric (integers because this is the
number of installs/count)
df['Installs'] = df['Installs'].apply(lambda x: int(x))
```

Let's verify if the dtypes has been changes and the + and , sign has been removed

```
df.head() # check the head of the dataframe
{"type":"dataframe","variable_name":"df"}
df['Installs'].dtype # this will show the data type of the column
dtype('int64')
```

 We can generate a new columns based on the installation values, which will be helpful in our analysis

```
df['Installs'].max() # this will show the value counts of the column
10000000000
# making a new column called 'Installs_category' which will have the
category of the installs
bins = [-1, 0, 10, 1000, 10000, 100000, 1000000, 10000000]
100000000000]
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)
df['Installs category'].value counts() # check the value counts of the
new column
Installs category
Low
                      1201109
Verv low
                       439273
Moderate
                       400316
More than moderate
                       185616
Hiah
                        60662
Very High
                        12787
                        11673
Top Notch
                         1508
Name: count, dtype: int64
```

Let's clean the Size column

```
# check for null values
df['Size'].isnull().sum()

196
df['Size'] = df['Size'].fillna('0M')
```

• No null values, we are good to go.

```
df['Size'].value_counts()
Size
Varies with device
                        74777
11M
                        62157
12M
                        56080
13M
                        48034
14M
                        45211
16M
                        42474
15M
                        41306
17M
                        37244
10M
                        34114
18M
                        31707
19M
                        29723
21M
                        29023
20M
                        28796
22M
                        28261
23M
                        27337
24M
                        25301
25M
                        25023
26M
                        23897
27M
                        21826
28M
                        21157
29M
                        20050
37M
                        18658
30M
                        18625
31M
                        18150
4.9M
                        17967
32M
                        17629
4.2M
                        17421
3.8M
                        17193
3.7M
                        16927
38M
                        16811
3.4M
                        16752
33M
                        16681
4.0M
                        16481
3.5M
                        16379
3.9M
                        16288
3.3M
                        16233
4.3M
                        16155
3.6M
                        15949
```

4.1M	15829
34M	15163
4.4M	14946
3.2M	14936
36M	14733
4.5M	14731
2.8M	14603
2.9M	14582
5.2M	
	14457
3.0M	14418
5.6M	14382
5.0M	14185
2.7M	14114
5.3M	14090
4.7M	14081
3.1M	13995
4.6M	13924
35M	13846
4.8M	13758
5.8M	13450
2.6M	13363
5.5M	13333
5.4M	13201
5.7M	13200
2.5M	12790
6.0M	12749
5.1M	12694
52M	12294
5.9M	12258
6.1M	12097
2.4M	11867
6.8M	11830
39M	11681
6.4M	11666
2.3M	11640
6.3M	11488
6.5M	11435
6.2M	11435
1.4M	11424
1.9M	11327
6.7M	11225
2.0M	11224
2.2M	11177
2.1M	11164
7.4M	11072
6.6M	11063
7.7M	10959
7.2M	10833
6.9M	10783
0.90	10/03

40M	10735
7.5M	10670
7.3M	10621
7.0M	10399
8.7M	10332
1.5M	10308
1.8M	10307
7.6M	10277
8.5M	10263
7.1M	10251
7.9M	10130
1.7M	9901
8.2M	9899
8.3M	9883
41M	9836
7.8M	9746
8.6M	9730
42M	9643
8.4M	9606
8.0M	9528
8.8M	9352
43M	9316
9.3M	9301
8.1M	9288
1.6M	9280
9.6M	9262
8.9M	9066
1.3M	9049
53M	9022
9.1M	8762
9.2M	8692
9.0M	8627
45M	8463
44M	8462
47M	8327
46M	8216
49M	8201
48M	8187
9.4M	8031
9.5M	7939
9.8M	7925
9.9M	7726
9.7M	7681
51M	7628
50M	7480
1.2M	6882
54M	6711
55M	5888
1.1M	5821

58M	5588
57M	5356
56M	5319
62M	4715
60M	4671
59M	4631
61M	4369
63M	3826
64M	3559
66M	3520
10.0M	3513
68M	3421
65M	3412
67M	3242
73M	3208
69M	3042
71M	3038
70M	2990
72M	2856
74M	2721
77M	2574
75M	2483
79M	2477
78M	2417
80M	2391
76M	2360
1.0M	2303
91M	2270
94M	2181
84M	2155
98M	2148
81M	2146
83M	2109
82M	2069
85M	2016
95M	1910
88M	1910
90M	1879
87M	1864
89M	1861
86M	1856
99M	1818
92M	1753
93M	1745
96M	1721
97M	1693
100M	1586
147M	1130
101M	1089

149M	876
150M	
	869
151M	845
102M	844
148M	785
140M	759
103M	719
118M	597
104M	569
106M	560
152M	557
105M	548
107M	530
112M	493
110M	472
109M	450
108M	443
113M	430
114M	429
111M	419
116M	412
125M	409
201M	408
142M	403
121M	397
115M	389
122M	382
119M	369
153M	369
141M	345
117M	331
123M	330
124M	
	302
120M	289
139M	289
126M	284
135M	277
130M	271
129M	271
146M	267
128M	262
134M	257
134N 145M	254
_	
131M	246
137M	233
127M	230
136M	225
154M	223
133M	222

138M	219
132M	
	204
0M	196
144M	194
143M	179
155M	134
156M	125
17k	108
157M	100
158M	94
588k	94
21k	92
159M	92
33k	90
253k	90
29k	90
163M	88
162M	86
34k	82
160M	81
165M	81
25k	79
45k	76
41k	75
257k	73
218k	73
167M	72
180M	72
256k	71
53k	71
49k	70
241k	70
164M	69
214k	69
27k	67
217k	67
166M	67
23k	66
230k	65
106k	64
173M	64
16k	64
28k	64
158k	64
37k	63
169M	63
365k	63
244k	63
86k	63

66k	63
161M	62
154k	61
225k	61
222k	61
165k	61
265k	60
122k	60
32k	59
237k	59
26k	59
178k	59
54k	59
171M	59
57k	58
	50
58k	57
1,005k	57
254k	57
245k	56
194k	56
61k	56
44k	56
960k	56
168M	55
255k	54
46k	54
24k	54
166k	54
227k	54
118k	54
169k	54
59k	54
50k	54
36k	53
226k	53
947k	53
273k	53
	53
931k	53
924k	53
246k	53
308M	53
193M	53
894k	53
249k	52
782k	52
210k	52
82k	52
	52
161k	
359k	51

98k	51
157k	51
234k	51
67k	51
919k	51
186k	51
1,009k	51
252k	51
22k	51
943k	51
229k	51
261k	51
198k	51
966k	51
74k	51
141k	51
73k	51
105k	51
130k	51
999k	51
30k	50
820k	50
47k	50
52k	50
902k	50
188k	50
170M	50
78k	50
69k	50
150k	50
201k	50
20k	50
176M	50
151k	50
	10
184k	49
224k	49
996k	49
258k	49
110k	49
146k	49
1,004k	49
149k	49
94k	49
206k	48
68k	48
85k	48
153k	48
911k	48
242k	48
,	

1,012k 48 932k 48 932k 48 91k 48 1,022k 48 1,022k 48 101k 48 162k 48 1770k 48 1770k 48 174M 47 215k 47 1,020k 47 1,020k 47 31k 47 1,023k 47 114k 47 114k 47 155k 47 114k 47 990k 47 990k 47 990k 47 912k 47 126k 46 121k 46 12		
932k 48 247k 48 91k 48 1,022k 48 101k 48 162k 48 170k 48 1770k 48 1770k 47 215s 47 1,020k 47 1,020k 47 899k 47 1,023k 47 1,023k 47 1,134k 47 1,14k 47 65k 47 990k 47 990k 47 990k 47 236k 47 24 46 36 46 514k 46 514k 46 514k 46 514k 46 697k 46 685k 46 611k 46 685k 46 685k 46 685k 46 698k 46	1 012k	48
247k		
91k		
1,022k 48 101k 48 162k 48 770k 48 174M 47 215k 47 142k 47 1,020k 47 899k 47 31k 47 1,023k 47 134k 47 114k 47 65k 47 950k 47 990k 47 990k 47 369k 47 126k 47 126k 47 126k 47 126k 47 126k 47 127 128 47 128 47 128 47 128 47 128 47 128 47 1290k 47 128 47 128 47 128 48 18 188 48 188 48 188 48 188 48 188 48 188 48 188 48 188 48 188 48 1		
101k 48 162k 48 1770k 48 1774M 47 1715k 47 142k 47 1,020k 47 1899k 47 1,023k 47 1,023k 47 114k 47 165k 47 1950k 47 990k 47 912k 47 990k 47 126k 47 126k 47 126k 47 126k 47 126k 47 127 185 47 128 47 128 47 1290 48 17 185 48 17 185 48 17 185 48 185 4		
162k       48         770k       48         174M       47         215k       47         142k       47         1,020k       47         899k       47         31k       47         1,023k       47         134k       47         114k       47         65k       47         950k       47         912k       47         990k       47         126k       47         126k       47         236k       47         205k       47         205k       47         205k       46         514k       46         97k       46         109k       46         885k       46         211k       46         861k       46         220k       46         413k       46         99k       46         936k       46         413k       46         90k       46         936k       46         40k       45         213k       45		
770k 48 174M 47 215k 47 142k 47 1,020k 47 899k 47 31k 47 1,023k 47 134k 47 114k 47 65k 47 950k 47 990k 47 990k 47 369k 47 126k 47 126k 47 126k 47 126k 47 126k 47 126k 47 128k 47 236k 47 236k 47 248 46 514k 46 57k 46 514k 46 97k 46 199k 46 197k 46 198k 46 197k 46 198k 46 197k 46 197k 46 197k 46 198k 46 197k 45 1974k 45 1974k 45		
174M 47 215k 47 1142k 47 1,020k 47 899k 47 31k 47 1,023k 47 134k 47 114k 47 65k 47 950k 47 990k 47 990k 47 126k 47 185k 47 126k 47 185k 47 236k 47 236k 47 185k 47 236k 47 185k 47 211k 46 885k 46		
215k		
142k       47         1,020k       47         899k       47         31k       47         1,023k       47         134k       47         114k       47         65k       47         950k       47         912k       47         990k       47         369k       47         126k       47         236k       47         236k       47         26k       46         514k       46         97k       46         109k       46         72k       46         360k       46         885k       46         211k       46         861k       46         220k       46         197k       46         90k       46         936k       46         413k       46         60k       46         788k       46         40k       45         213k       45         974k       45         625k       45         107k       45 </td <td></td> <td></td>		
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31k       47         1,023k       47         134k       47         114k       47         65k       47         950k       47         912k       47         990k       47         126k       47         128k       47         236k       47         205k       47         266k       46         514k       46         97k       46         109k       46         360k       46         885k       46         220k       46         99k       46         936k       46         413k       46         60k       46         788k       46         60k       46         78k       45         974k       45         625k       45         107k       45         156k       45		
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126k       47         185k       47         236k       47         205k       47         266k       46         514k       46         97k       46         109k       46         72k       46         360k       46         85k       46         211k       46         861k       46         220k       46         197k       46         90k       46         936k       46         413k       46         60k       46         788k       46         40k       45         213k       45         974k       45         625k       45         107k       45         156k       45	990k	47
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824k	42
102k	42
178M	42
18k	42
929k	42
778k	42
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284k	42
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891k	42
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182M	42
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779k	40
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439k       32         1,003k       32         693k       32         204k       32         672k       32         465k       32         923k       32         531k       32         493k       32         754k       32         729k       32         859k       32         14k       31         176k       31         573k       31         139k       31         127k       31         133k       31         957k       31         33lk       31         957k       31         33kk       31         486k       31         486k       31         98k       31         99lk       31         137k       31         738k       31         378k       31         46k       31         99k       31         137k       31         654k       31         348k       31         654k       31         34kk       31	800k	32
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484k       26         534k       26         715k       26         659k       26         822k       26         11k       26         402k       26         197M       26         140k       26         295k       26		
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551k	26
759k	26
797k	26
429k	26
653k	26
471k	26
206M	26
530k	26
425k	26
686k	26
116k	26
600k	26
363k	26
809k	26
680k	26
294k	
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536k	26
190M	26
571k	25
480k	25
418k	25
1,010k	25
355k	25
695k	25
403k	25
483k	25
595k	25
949k	25
582k	25
424k	25
507k	25
639k	25
340k	25
663k	25
615k	25
771k	25
670k	
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260k	25
971k	25
288k	25
517k	25
121k	25
803k	25
450k	24
533k	24
567k	24
781k	24
563k	24

264k	24
398k	24
698k	24
521k	24
539k	24
601k	24
561k	24
404k	24
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415k	24
658k	24
379k	24
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120k	24
660k	24
501k	24
416k	24
489k	24
758k	24
112k	24
731k	24
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580k	24
339k	24
553k	24
661k	24
541k	24
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664k	24
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131k	23
384k	23
765k	23
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665k	23
544k	23
581k	23
557k	23
458k	23
540k	23
605k	23
335k	23
728k	23
344k	23
519k	23
723k	23
572k	23

325k	23
123k	23
307k	23
1,013k	23
751L	
751k	23
144k	23
427k	23
655k	23
689k	22
135k	22
498k	22
569k	22
304k	22
609k	22
443k	22
461k	22
669k	22
607k	22
537k	22
617k	22
604k	22
909k	22
792k	22
591k	22
596k	22
376k	22
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459k	
547k	22
311k	21
512k	21
502k	21
532k	21
520k	21
515k	21
203M	21
608k	21
442k	21
528k	21
472k	21
603k	21
801k	21
549k	21
499k	21
470k	21
207M	21
104k	21
508k	20
555k	
	20
185M	20

488k	20
590k	20
444k	20
637k	20
732k	20
583k	20
650k	20
468k	20
447k	20
662k	20
565k	20
451k	19
630k	19
556k	19
380k	19
352k	19
119k	19
482k	19
559k	19
611k	19
764k	19
684k	19
564k	19
576k	19
372k	18
235M	18
524k	18
456k	18
513k	18
709k	18
216M	18
215M	18
464k	18
632k	17
657k	17
205M	17
345k	17
1,024k	17
199M	17
218M	17
296k	17
204M	17
668k	17
200M	17
349k	17
10k	16
211M	15
214M	15
327k	15

213M	15
233M	14
756k	14
230M	13
255M	13
227M	12
228M	12
210M	12
242M	12
	11
250M	
226M	11
256M	11
208M	11
231M	11
223M	10
220M	10
243M	10
237M	10
224M	10
219M	0
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	9
232M	9
238M	9
287M	9
234M	9
241M	9 9 9 8 8
244M	9
257M	8
249M	8
280M	8
1.1G	8
	0
248M	0
565M	8 8 8
222M	
221M	8 8 7
270M	8
225M	
317M	7
246M	7
264M	7
253M	7
261M	7
245M	7
276M	7
332M	6
319M	6
236M	6
240M	6
321M	6

247M	6
229M	6
	6
299M	6
262M	6
252M	5
251M	5 5
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281M	5
298M	5
309M	5
239M	5
8.4k	5
	<ul> <li>5</li> <li>5</li> <li>5</li> <li>5</li> <li>5</li> <li>5</li> <li>5</li> <li>5</li> <li>5</li> <li>4</li> </ul>
6.8k	5
297M	5
6.4k	5
263M	5
258M	5
	1
9.6k	
339M	4
310M	4
306M	4
355M	4
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9.1k	4
260M	4
269M	4
8.9k	4
300M	4
304M	4
567M	4
335M	4
293M	4
267M	4
338M	4
322M	4
285M	4
327M	4
274M	4
330M	4
303M	4
289M	4
277M	4
266M	3
448M	3
391M	3
	2
390M	3
9.8k	3
9.7k	3
9.9k	3
272M	3
	4 3 3 3 3 3 3 3 3 3
1.0G	3

445M	3
344M	2
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286M	3
331M	3
353M	3
323M	3
315M	3
283M	3
	2
8.5k	3
375M	3
291M	3
382M	3
422M	3
265M	3
275M	3
290M	2
	) 1
360M	3
313M	3
4.7k	3
268M	3
314M	3
254M	3
278M	2
359M	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
	2
6.1k	2
398M	2 2 2 2 2 2 2 2 2 2 2
656M	2
329M	2
7.8k	2
279M	2
354M	2
454M	2
564M	2
284M	2
292M	2
408M	2 2 2
6.3k	2
508M	2
843M	2
343M	2
460M	2 2
333M	2
618M	2
311M	2
9.5k	2 2 2 2
9.3k	2
337M	2
372M	2
340M	2

7.1k	2
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288M	2 2 2 2 2
259M	2
745M	2
	2
1.5G	2
405M	2
9.0k	2
	2 2
9.2k	2
377M	2
387M	2
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295M	Z
348M	2
294M	2
296M	2
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324M	2
273M	2
352M	2
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510M	2 2 2 2 2 2 2 2 2 2 2 2 2
305M	2
409M	2
467M	2
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406M	2
566M	2 2
366M	2
334M	2
	2
373M	1
7.7k	1
705M	1
404M	i
	1
896M	1
570M	1
810M	1
415M	1
369M	1
396M	1
465M	
	1 1
302M	1
397M	1
468M	1
646M	1
839M	1
869M	1
769M	1
590M	1
301M	1
488M	1
692M	1
611M	1
593M	1

527M	1
424M	1
503M	1
866M	1
	1
440M	1
461M	1
365M	1
431M	1
349M	1
581M	1
962M	1
470M	1
541M	1
799M	1
633M	1
5.1k	1
910M	1
679M	1
342M	1
370M	1
3.2k	1
532M	1
725M	1
691M	1
442M	1
737M	1
914M	1
394M	$\overline{1}$
700M	1
356M	1
712M	1
5.3k	1
568M	1
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830M	1
519M	1
8.3k	1
580M	1
977M	1
959M	1
981M	1
526M	1
379M	1
	1
623M	1
533M	1
619M	1
521M	1
429M	1
744M	1
844M	1

889M	
720M	
6.2k	
996M	
371M	-
282M	
437M	-
447M	-
497M	
643M	
456M	
493M	
414M	<u>-</u>
925M	
645M	-
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420M	
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312M	
919M	· · · · · · · · · · · · · · · · · · ·
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595M	-
485M	-
900M	
361M	
345M	
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3.4k	
603M	-
1,006	
706M	
509M	
928M	
320M	
3.3k	•
4.6k	-
531M	
364M	-
722M	
501M	
985M	
412M	-
1,020	M
841M	-
576M	-
690M	-
832M	<u>-</u>

10.0k	1 1
328M	1
818M	1
953M	1
6.9k	1
544M	1
426M	1
681M	1
347M	1
5.8k	1
606M	1
940M	1
271M	1
765M	1
664M	1
649M	1
411M	1
680M	1
514M	
	1
639M	1 1
963M	1
421M	1
457M	1
381M	1
318M	1
878M	1
351M	1
578M	1
868M	1
495M	1
935M	1
363M	1
518M	1
762M	1
491M	1
676M	1 1
684M	1
579M	1
550M	1
407M	1
591M	1
418M	1
7.4k	1
346M	1
8.7k	1
784M	1
385M	1
7.6k	1

```
512M
Name: count, dtype: int64
# check unique values
df['Size'].unique()
array(['10M', '2.9M', '3.7M', ..., '405M', '3.2k', '512M'],
dtype=object)
df['Size'].loc[df['Size'].str.contains('M',)].value counts().sum()
2201901
# find the values in size column which has 'k' in it
df['Size'].loc[df['Size'].str.contains('k',)].value counts().sum()
36253
# find the values in size column which has 'Varies with device' in it
df['Size'].loc[df['Size'].str.contains('Varies with
device')].value counts().sum()
74777
# Total Values in Size column
df['Size'].value counts().sum()
2312944
```

- We have 2201901 values in M units
- We have 36253 values in k units
- We have 74777 value in Varies with device

Let's convert the M and K units into bytes and then remove the M and K from the values and convert them into numeric data type.

```
# Remove commas
        size = size.replace(',', '')
        if 'k' in size:
            return float(size.replace('k', '')) * 1024
        elif 'M' in size:
            return float(size.replace('M', '')) * 1024 * 1024
        elif 'G' in size:
            return float(size.replace('G', '')) * 1024 * 1024 * 1024
        else:
            try:
                return float(size)
            except ValueError:
                return np.nan
    return size
df['Size'] = df['Size'].apply(convert size)
# rename the column name 'Size' to 'Size in bytes'
df.rename(columns={'Size': 'Size_in_bytes'}, inplace=True)
# Convert to numeric, coercing errors to NaN (in case of invalid
values)
df['Size in bytes'] = pd.to numeric(df['Size in bytes'],
errors='coerce')
# making a new column called 'Size in Mb' which will have the size in
MB
df['Size in Mb'] = df['Size in bytes'].apply(lambda x: x/(1024*1024))
```

- Now we have converted every value into bytes and removed the M and K from the values and converted them into numeric data type.
- 'Varies with device' was a string value, therefore we intentionally converted them into null values, which we can fill later on according to our needs.
- Let's have a look on the Minimum Android column

```
df['Minimum Android'].isnull().sum()
6530

df['Minimum Android'] = df['Minimum Android'].fillna('')

# Replace empty strings with '0'
df['Installs'] = df['Installs'].replace('', '0')

df['Minimum Android'].isnull().sum()
0
```

No null values, we are good to go.

```
df['Minimum Android'].unique()
array(['7.1 and up', '5.0 and up', '4.0.3 and up', '4.1 and up', '6.0 and up', '4.4 and up', '4.0 and up', '4.2 and up', '2.1 and up', '7.0 and up', '2.2 and up', '2.3 and up', '4.3 and up', '5.1 and up', '', '1.6 and up', '3.0 and up',
            'Varies with device', '8.0 and up', '2.3.3 and up', '4.4W and
up',
            '3.2 and up', '1.5 and up', '4.0.3 - 7.1.1', '3.1 and up',
            '2.0 and up', '1.0 and up', '1.1 and up', '2.0.1 and up', '4.4 - 6.0', '2.1 - 4.4', '4.0 - 5.0', '2.0 - 2.3.4', '2.2 -
4.4',
            '4.1 - 7.0', '4.1 - 6.0', '4.0 - 4.4W', '4.0 - 4.4', '4.0.3 -
7.0',
            '2.3 - 5.0', '4.0 - 7.1.1', '4.1 - 7.1.1', '4.0 - 7.0',
            '4.1 - 8.0', '4.0 - 6.0', '2.3 - 7.0', '4.0 - 8.0', '2.3 -
6.0',
            '2.1 - 2.3.4', '3.0 - 4.1.1', '2.2 - 3.0', '2.0 - 8.0',
            '4.0.3 - 8.0', '3.0 - 4.4W', '4.4 - 7.1.1', '4.4 - 8.0', '4.0.3 - 6.0', '1.6 - 4.0.4', '8.0', '2.3 - 5.1', '2.1 -
7.1.1',
            '2.3 - 4.4W', '4.4 - 7.0', '6.0 - 7.1.1', '2.3 - 4.4',
            '2.2 - 4.0.4', '2.1 - 4.1.1', '3.0 - 8.0', '3.0 - 5.1',
            '2.1 - 6.0', '6.0 - 8.0', '5.0 - 8.0', '4.1 - 5.1', '3.2 -
4.4',
            '2.1 - 5.0', '4.1 - 4.3', '5.0 - 6.0', '5.1 - 7.1.1', '2.2 -
5.1',
            '4.1 - 5.0', '2.3.3 - 4.4', '2.2 - 5.0', '2.2', '4.1 - 4.4',
           '4.1 - 5.0', '2.3.3 - 4.4', '2.2 - 5.0', '2.2', '4.1 - 4.4
'1.6 - 5.1', '4.2 - 7.1.1', '2.1 - 5.1', '1.6 - 4.4W',
'4.3 - 4.4W', '3.0 - 4.4', '2.1 - 3.1', '2.3 - 7.1.1',
'1.6 - 4.0.2', '4.0 - 4.0.4', '4.2 - 4.4W', '3.0 - 7.1.1',
'3.2 - 7.1.1', '3.0 - 6.0', '2.2 - 4.4W', '4.0.3 - 4.4',
'4.0.3 - 5.1', '6.0', '4.3', '1.1 - 4.4', '2.3.3 - 8.0',
'2.3.3 - 5.0', '2.2 - 6.0', '3.0 - 5.0', '2.3.3 - 2.3.4',
'1.5 - 2.1', '2.2 - 3.2', '5.0 - 7.1.1', '2.1 - 3.2',
'4.2 - 4.2.2', '2.3.3 - 5.1', '2.2 - 4.1.1', '1.6 - 4.4',
            '4.2 - 4.3', '4.0 - 5.1', '1.6 - 7.0', '3.0 - 7.0', '1.0 -
6.0',
            '2.3.3 - 4.0.4', '2.3 - 3.2', '4.3 - 8.0', '2.3 - 8.0',
            '3.2 - 6.0', '2.3.3 - 7.1.1', '4.2 - 8.0', '2.2 - 4.3', 
'3.2 - 4.1.1', '4.4 - 5.1', '2.3 - 4.1.1', '2.1 - 4.4W', '4.4',
            '2.3.3 - 4.4W', '4.1 - 4.4W', '1.6 - 7.1.1', '2.2 - 4.2.2', '4.3 - 5.1', '4.0.3 - 4.2.2', '2.2 - 2.3.4', '4.3 - 4.4',
            '4.2 - 6.0', '4.4 - 4.4W', '2.3 - 4.0.2', '3.2 - 5.1', '7.0', '3.0 - 3.2', '1.6 - 4.2.2', '5.1', '1.5 - 3.2', '2.2 - 8.0',
            '1.6 - 2.1', '2.3.3 - 6.0'], dtype=object)
df['Minimum Android'].value counts()
```

```
Minimum Android
4.1 and up
                       604465
5.0 and up
                       396998
4.4 and up
                       390311
4.0.3 and up
                       180482
4.0 and up
                       153441
4.2 and up
                       115973
6.0 and up
                        89928
2.3 and up
                        65577
5.1 and up
                        59287
Varies with device
                        46214
4.3 and up
                        41357
7.0 and up
                        34444
2.2 and up
                        23720
2.3.3 and up
                        21549
3.0 and up
                        17105
2.1 and up
                        16699
8.0 and up
                        13827
4.4W and up
                        12527
1.6 and up
                         8537
                         6530
7.1 and up
                         3044
2.0 and up
                         2774
3.2 and up
                         2673
1.5 and up
                         2097
                         2003
3.1 and up
2.0.1 and up
                          443
1.0 and up
                          308
1.1 and up
                          165
4.0 - 6.0
                           29
2.3 - 6.0
                           16
4.1 - 8.0
                           16
4.1 - 6.0
                           16
4.0.3 - 6.0
                           15
4.0 - 7.1.1
                           14
2.2 - 4.4
                           14
4.1 - 7.1.1
                           13
                           12
4.0.3 - 8.0
4.0 - 8.0
                           11
4.0 - 4.4
                            9
4.4 - 8.0
                            9
2.3 - 5.1
                            9
                            8
3.0 - 4.4
2.3 - 7.1.1
                            8
2.3 - 5.0
                            7
4.1 - 7.0
                            7
                            7
4.1 - 5.1
2.3.3 - 4.4
                            6
4.1 - 4.4
                            6
4.0 - 5.1
```

2.2 - 6.0	6
	5
4.0 - 7.0	2
2.2 - 5.0	5
4.0 - 4.4W	5 5 5 5 5
5.0 - 6.0	5
	5
2.3 - 4.4	5
4.4 - 7.1.1	5
3.0 - 5.1	5
	5
5.0 - 8.0	3
3.0 - 5.0	4
3.2 - 4.4	4
2.2 - 4.1.1	4
2.2 - 4.0.4	4
2.1 - 2.3.4	4
4.0.3 - 7.0	4
8.0	4
4.0.3 - 7.1.1	4
4.4 - 6.0	4
4.0 - 5.0	4
3.0 - 4.1.1	4
2.2 - 3.2	3
4.0.3 - 4.4	3
	3
4.0 - 4.0.4	3
4.0.3 - 5.1	3
1.6 - 4.4W	3
	3
2.1 - 4.4	4 3 3 3 3 3 3 3 3 3 3 3 3 3 3
4.2 - 7.1.1	3
2.0 - 2.3.4	3
2.2 - 4.4W	2
	3
3.0 - 6.0	3
4.2 - 8.0	3
2.1 - 5.0	3
2.1 6.0	2
2.1 - 6.0	3
2.3.3 - 5.1	2
2.3.3 - 5.0	2
2.3.3 - 7.1.1	2 2 2 2 2 2 2 2
	2
2.3.3 - 4.0.4	
6.0	2
1.6 - 4.4	2
2.2 - 4.3	2
	2
3.2 - 6.0	2
4.4	2 2 2 2 2 2 2 2 2
2.2 - 4.2.2	2
	2
3.2 - 5.1	Z
1.5 - 2.1	2
7.0	2
	2
4.3 - 8.0	<u> </u>
5.1 - 7.1.1	2
3.2 - 7.1.1	2
3.0 - 4.4W	2
J.U - 4.4W	<u> </u>

2.2 - 5.1	2
2.2 - 3.0	2
2.3 - 7.0	2
6.0 - 8.0	2
2.1 - 4.1.1	2
2.3 - 4.4W	2
1.6 - 4.0.2	2
4.2 - 4.4W	2
4.1 - 4.3	2
2.1 - 4.4W	1
2.3.3 - 4.4W	1
2.3 - 4.1.1	1
4.1 - 4.4W	1
1.6 - 7.1.1	1
2.0 - 8.0	1
4.3 - 5.1	1
4.0.3 - 4.2.2	1
2.2 - 2.3.4	1
3.2 - 4.1.1	1
4.3 - 4.4	1
4.2 - 6.0	1
4.4 - 4.4W	1
2.3 - 4.0.2	1
	1
3.0 - 3.2	1
1.6 - 4.2.2	
5.1	1
1.5 - 3.2	1
2.2 - 8.0	1
1.6 - 2.1	1
4.4 - 5.1	1
4.4 - 7.0	1
1.6 - 4.0.4	1
5.0 - 7.1.1	1
2.1 - 3.1	1
4.3	1
1.1 - 4.4	1
2.3.3 - 8.0	1
4.3 - 4.4W	1
2.1 - 5.1	1
1.6 - 5.1	1
2.3.3 - 2.3.4	1
2.2	1
4.1 - 5.0	1
2.1 - 3.2	1
2.1 - 7.1.1	1
4.2 - 4.2.2	1
4.2 - 4.3	1
3.0 - 8.0	1
1.6 - 7.0	1
3.0 - 7.0	1
510 /10	*

```
1.0 - 6.0
                                  1
2.3 - 3.2
                                  1
6.0 - 7.1.1
                                  1
2.3 - 8.0
                                  1
3.0 - 7.1.1
                                  1
2.3.3 - 6.0
                                  1
Name: count, dtype: int64
df['Rating Count'].value counts()
Output hidden; open in https://colab.research.google.com to view.
df.describe()
{"summary":"{\n \"name\": \"df\",\n \"rows\": 8,\n \"fields\": [\n
{\n \"column\": \"Rating\",\n \"properties\": {\n
\"dtype\": \"number\",\n \"std\": 809657.997368076,\n
\"min\": 0.0,\n \"max\": 2290061.0,\n
\"num_unique_values\": 7,\n \"samples\": [\n
2290061.0,\n 2.203151531771424,\n
                                                                 4.3\n
                                                                                 ],\n
\"semantic_type\": \"\",\n \"description\": \"\"\n
n },\n {\n \"column\": \"Rating Count\",\n \"properties\": {\n \"dtype\": \"number\",\n \"std\": 48867391.570589274,\n \"min\": 0.0,\n \"max\": 138557570.0,\n \"num_unique_values\": 7,\n \"samples\":
               2290061.0,\n
                                           2864.8388767810115,\n
[\n
0.0,\n \"max\": 10000000000.0,\n \"num_unique_values\": 8,\n \"samples\": [\n 183436.7275277741,\n 500.0,\n 2312944.0\n ],\n \"semantic_type\": \"\",\n \"description\": \"\"\n }\n {\n \"column\": \"Minimum Installs\",\n \"properties\": {\n \"dtyre\": \"\"
\"dtype\": \"number\",\n \"std\": 3534647129.2584343,\n
\"min\": 0.0,\n \"max\": 10000000000.0,\n
\"num_unique_values\": 8,\n \"samples\": [\n 183445.21395800915,\n 500.0,\n 231
                                                       2312837.0
           ],\n \"semantic_type\": \"\",\n
\"description\": \"\"\n }\n }\n \\n \\"column\": \"Maximum Installs\",\n \"properties\": {\n \"dtype\": \"number\",\n \"std\": 4261699552.060366,\n \"min\":
0.0,\n \"max\": 12057627016.0,\n \"num_unique_values\": 8,\n \"samples\": [\n 320201.713137456,\n 695.0,\n 2312944.0\n ],\n \"semantic_type\": \"\",\n \"description\": \"\"\n }\n },\n {\n
\"column\": \"Price\",\n \"properties\": {\n
                                                                       \"dtype\":
\"number\",\n\\"std\": 817728.8641336214,\n
                                                                  \"min\":
0.0,\n \"max\": 2312944.0,\n \"num_unique_values\": 5,\n
```

```
\"samples\": [\n
                        0.10349915833370804,\n
                                                       400.0,\n
                                    \"semantic type\": \"\",\n
2.63312655760054\n
                         1,\n
                                         {\n
\"description\": \"\"\n
                           }\n
                                  },\n
                                                  \"column\":
\"Size in_bytes\",\n
                         \"properties\": {\n
                                                  \"dtype\":
\"number\",\n
                    \"std\": 565012547.3049533,\n
                                                       \"min\":
             \"max\": 1610612736.0,\n \"num unique values\":
0.0, n
           \"samples\": [\n
                                    20139583.164281834,\n
8,\n
                      2238167.0\n
10485760.0,\n
\"semantic type\": \"\",\n
                                \"description\": \"\"\n
                                                            }\
                \"column\": \"Size in Mb\",\n
    },\n {\n
                         \"dtype\": \"number\",\n
\"properties\": {\n
                                                        \"std\":
                          \"min\": 0.0,\n
                                                 \"max\":
791229.9312236877,\n
2238167.0,\n
                   \"num unique values\": 8,\n
                                                    \"samples\": [\
          19.2066032069033,\n
                                      10.0, n
                                                       2238167.0\n
           \"semantic_type\": \"\",\n
],\n
                                            \"description\": \"\"\n
      }\n ]\n}","type":"dataframe"}
}\n
```

#### ## Observations:

- Now, we have only 8 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 2.20 which is not a good rating. On an average people give this rating.
- We can see that the Rating Count column has a minimum value of 1 and a maximum value of 64288
- 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.

# 2.2. Dealing with the missing values

Dealing with the missing values is one of the most important part of the data wrangling process, we must deal with the missing values in order to get the correct insights from the data.

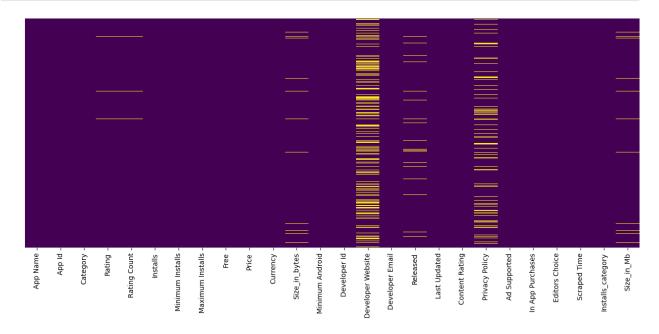
• Let's have a look on the missing values in the dataset

```
df.isnull().sum().sum() # this will show the total number of null
values in the dataframe
1448472
```

• Let's plot the missing values in the dataset

```
# make a figure size
plt.figure(figsize=(16, 6))
#plot the null values in each column
sns.heatmap(df.isnull(), yticklabels=False, cbar=False,
cmap='viridis') # this will show the heatmap of null values in the
dataframe

<Axes: >
```



df.isnull().sum().sort\_values(ascending=False) # this will show the
number of null values in each column in descending order

Developer Website	760835
Privacy Policy	420953
Size in Mb	74777
Size in bytes	74777
Released	71053
Rating	22883
Rating Count	22883
Currency	135
Minimum Installs	107
Developer Id	33
Developer Email	31
App Name	5
Price	Θ
Free	0
Minimum Android	0
App Id	0
Maximum Installs	0

```
Installs
                           0
Last Updated
                           0
Content Rating
                           0
                           0
Category
Ad Supported
                           0
In App Purchases
                           0
                           0
Editors Choice
Scraped Time
                           0
Installs category
                           0
dtype: int64
(df.isnull().sum() / len(df) * 100).sort_values(ascending=False) #
this will show the percentage of null values in each column
Developer Website
                      32.894657
Privacy Policy
                      18.199879
Size in Mb
                       3.232979
                       3.232979
Size in bytes
Released
                       3.071972
Rating
                       0.989345
Rating Count
                       0.989345
Currency
                       0.005837
Minimum Installs
                       0.004626
Developer Id
                       0.001427
Developer Email
                       0.001340
App Name
                       0.000216
Price
                       0.000000
Free
                       0.000000
Minimum Android
                       0.000000
bI qqA
                       0.000000
Maximum Installs
                       0.000000
Installs
                       0.000000
Last Updated
                       0.000000
Content Rating
                       0.000000
Category
                       0.000000
Ad Supported
                       0.000000
In App Purchases
                       0.000000
Editors Choice
                       0.000000
Scraped Time
                       0.000000
Installs category
                       0.000000
dtype: float64
```

#### ## Observations:

- We have 760835 missing values in the 'Developer Website' column, which is 32.89% of the total values in the column.
- We have 420953 missing values in the 'Privacy Policy 'column, which is 18.19% of the total values in the column.
- We have 74777 missing values in the 'Size\_in\_bytes' and 'Size\_in\_Mb' columns, which is 3.23% of the total values in the column.

- We have 71053 missing values in the 'Released' column, which is 3.07% of the total values in the column.
- We have 22883 missing value in the 'Rating' column, which is 0.98% of the total values in the column.
- We have 22883 missing values in the 'Rating Count' column, which is 0.98% of the total values in the column.
- We have 135 missing value in Currency columns, which is 0.005837% of the total values in the column.
- We have 107 missing value in Minimum Installs columns, which is 0.001427% of the total values in the column.
- We have 33 missing value in **Developer Id** columns, which is 0.005837% of the total values in the column.
- We have 31 missing value in **Developer Email** columns, which is 0.001340% of the total values in the column.
- We have 5 missing value in App Name columns, which is 0.000216% 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.
- Let's run the correlations

```
df.describe() # these are numeric columns
{"summary":"{\n \"name\": \"df\",\n \"rows\": 8,\n \"fields\": [\n
{\n \"column\": \"Rating\",\n \"properties\": {\n
\"dtype\": \"number\",\n \"std\": 809657.997368076,\n
\"min\": 0.0,\n
                    \"max\": 2290061.0,\n
\"num unique values\": 7,\n
                               \"samples\": [\n
2290061.0,\n
                    2.203151531771424,\n
                                               4.3\n
                                                           ],\n
\"semantic_type\": \"\",\n \"description\": \"\"\n
\"std\":
                                                    \"samples\":
                                2864.8388767810115,\n
            2290061.0,\n
\lceil \setminus n \rceil
                       \"semantic_type\": \"\",\n
42.0\n
             ],\n
\"description\": \"\"\n
                                },\n
                                                \"column\":
                          }\n
                                        {\n
\"Installs\",\n \"properties\": {\n \"dtype\": \"number\",\n \"std\": 3534647141.7795744,\n
           \"max\": 10000000000.0,\n \"num unique values\":
0.0, n
```

```
8,\n \"samples\": [\n 183436.7275277741,\n 500.0,\n 2312944.0\n ],\n \"semantic_type\": \"\",\n \"description\": \"\"\n }\n },\n {\n \"column\": \"Minimum Installs\",\n \"properties\": {\n \"}
\"dtype\": \"number\",\n \"std\": 3534647129.2584343,\n
\"min\": 0.0,\n \"max\": 10000000000.0,\n
\"num_unique_values\": 8,\n \"samples\": [\n 183445.21395800915,\n 500.0,\n 2312837.0\
                      \"semantic type\": \"\",\n
0.0,\n \"max\": 12057627016.0,\n \"num_unique_values\": 8,\n \"samples\": [\n 320201.713137456,\n 695.0,\n 2312944.0\n ],\n \"semantic_type\": \"\",\n \"description\": \"\"\n }\n },\n {\n
\"column\": \"Price\",\n \"properties\": {\n \"dtype\": \"number\",\n \"std\": 817728.8641336214,\n \"min\":
                                                                 \"dtype\":
0.0,\n \"max\": 2312944.0,\n \"num unique values\": 5,\n
\"Size_in_bytes\",\n\\"properties\": {\n\\"dtype\":\"number\",\n\\"std\": 565012547.3049533,\n\\"min\":
0.0,\n \"max\": 1610612736.0,\n \"num_unique_values\":
8,\n \"samples\": [\n 20139583.164281834,\n 10485760.0,\n 2238167.0\n ],\n
\"semantic type\": \"\",\n \"description\": \"\"\n
                                                                       }\
}\n }\n ]\n}","type":"dataframe"}
# Make a correlation matrix of numeric columns
plt.figure(figsize=(16, 10)) # make figure size
numeric_cols = ['Rating', 'Rating Count', 'Size_in_bytes', 'Installs',
'Price', 'Size_in_Mb', 'Minimum Installs', 'Maximum Installs'] # make a
list of numeric columns
sns.heatmap(df[numeric_cols].corr(), annot=True) # plot the
correlation matrix
<Axes: >
```



```
# we can also calculate the correlation matrix using pandas
df[numeric cols].corr() # this will show the correlation matrix
{"summary":"{\n \"name\": \"df[numeric cols]\",\n \"rows\": 8,\n
\"fields\": [\n {\n \"column\": \"Rating\",\n
\"properties\": {\n \"dtype\": \"number\",\n
                                                    \"std\":
                     \"min\": -0.003674370783803862,\n
0.3464798601358728,\n
                    \"num unique values\": 6,\n
\"max\": 1.0,\n
                                               \"samples\":
\lceil \backslash n \rceil
                          0.013038113065837074,\n
           1.0, n
0.012614648261800471\n
                          ],\n
                                     \"semantic_type\": \"\",\n
\"description\": \"\"\n
                          }\n },\n {\n \"column\":
\"Rating Count\",\n \"properties\": {\n
                                               \"dtype\":
\"number\",\n
                   \"std\": 0.3711545810277704,\n \"min\": -
0.0004105471388834398,\n \"max\": 1.0,\n
                           \"samples\": [\n
\"num_unique_values\": 6,\n
}\n },\n {\n \"column\": \"Size_in_bytes\",\n
\"properties\": {\n \"dtype\": \"number\",\n \"s
0.4472251743637262,\n \"min\": 0.004664866188838955,\n
                                                     \"std\":
\mbox{"max}": 1.0,\n \mbox{"num unique values}": 7,\n \mbox{"samples}":
           0.054230015380920225,\n
[\n
                                         0.04120048276374,\n
0.03403319026372828\n ],\n
                                     \"semantic type\": \"\",\n
```

```
\"number\",\n
                     \"std\": 0.4795212664177267,\n
                                                            \"min\": -
0.0004606641879899551,\n
                               \mbox{"max}: 1.0,\n
\"num unique values\": 6,\n
                                   \"samples\": [\n
0.011214455140461793.\n
                                 0.5452806023392083.\n
0.9540374291309002\n
                            ],\n
                                         \"semantic type\": \"\",\n
                                                   \"column\":
\"description\": \"\"\n
                             }\n
                                    },\n
                                             {\n
\"Price\",\n
                 \"properties\": {\n
                                              \"dtype\": \"number\",\n
\"std\": 0.35337231735580993,\n
                                        \"min\": -
                               \"max\": 1.0,\n
0.003674370783803862,\n
\"num unique values\": 7,\n
                                   \"samples\": [\n
0.003674370783803862,\n
                                 -0.0004105471388834398,\n
0.0004606862515294089\n
                                            \"semantic type\": \"\",\n
\"description\": \"\"\n
                                             {\n
                                                      \"column\":
                                     },\n
                             }\n
\"Size in Mb\",\n
                       \"properties\": {\n
                                                   \"dtype\":
                     \"std\": 0.4472251743637262,\n
\"number\",\n
                                                            \"min\":
0.004664866188838955,\n
                               \mbox{"max}": 1.0,\n
\"num unique values\": 7,\n
                                   \"samples\": [\n
                                 0.04120048276374,\n
0.054230015380920225,\n
0.03403319026372828\n
                                          \"semantic type\": \"\",\n
                             ],\n
\"description\": \"\"\n
                             }\n
                                                      \"column\":
                                     },\n
\"Minimum Installs\",\n
                             \"properties\": {\n
                                                        \"dtype\":
\"number\",\n
                     \"std\": 0.47952010904842074,\n
                                                             \"min\": -
0.0004606862515294089,\n
                                \mbox{"max}: 1.0,\n
\"num unique values\": 6,\n
                                    \"samples\": [\n
0.011214455140461793,\n
                                 0.5452806023392083,\n
                            ],\n
0.9540374353243399\n
                                         \"semantic_type\": \"\",\n
                                             {\n \"column\":
\"description\": \"\"\n
                             }\n
                                     },\n
\"Maximum Installs\",\n
                             \"properties\": {\n
                                                        \"dtype\":
\"number\",\n
                     \"std\": 0.47111374678390333,\n
                                                             \"min\": -
0.0005150420525738935,\n
                               \mbox{"max}: 1.0,\n
\"num unique values\": 7,\n
                                    \"samples\": [\n
0.012614648261800471,\n
                                 0.5475710514761793,\n
0.9540374353243399\n
                                         \"semantic type\": \"\",\n
                            ],\n
                                    }\n ]\n}","type":"dataframe"}
\"description\": \"\"\n
                             }\n
```

#### **Observations**

- Lighter color shows the high correlation and darker color shows the low correlation
- We can see that the Rating Count column has a high correlation with the Installs column, which is 0.54 according to corr(). Which is quite good. This shows that the more the Rating Count the more the installs are for one app. If in any case we need to impute Rating Count we have to think of number of install.
- We can see that the Rating Count column has a high correlation with the Minimum Installs which is 1.00 according to corr(). Which is very good. This shows that the more the Minimum Installs Count the more the installs are for one app. If in any case we need to impute Rating Count we have to think of number of install.

- We can see that the Rating Count column has a high correlation with the Maximum Installs which is 0.94 according to corr(). Which is very good. This shows that the more the Maximum Installs Count the more the installs are for one app. If in any case we need to impute Rating Count we have to think of number of install.
- Before going ahead, let's remove the rows with missing values in the Size\_in\_Mb, Size\_in\_bytes, Released, Rating and `Rating Count Currency, Minimum Installs, Developer Id, Developer Email, App Name columns, as they are very less in number and will not affect our analysis.

```
# length before removing null values
print(f"Length of the dataframe before removing null values:
{len(df)}")

Length of the dataframe before removing null values: 2312944

# remove the rows having null values in the 'Current Ver', 'Android Ver', 'Category', 'Type' and 'Genres' column
df.dropna(subset=['Size_in_Mb', 'Size_in_bytes', 'Released', 'Rating', 'Rating Count', 'Currency', 'Minimum Installs', 'Developer Id', 'Developer Email', 'App Name'], inplace=True)

# 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: 2190366
```

We have removed 122,578 rows having null values in the 'Size\_in\_Mb',
 'Size\_in\_bytes', 'Released', 'Rating', 'Rating'
 Count', 'Currency', 'Minimum Installs', 'Developer Id', 'Developer Email', 'App Name' columns.

```
df['Developer Website'].fillna(df['Developer Website'].mode().iloc[0],
inplace=True)
df['Privacy Policy'].fillna(df['Privacy Policy'].mode().iloc[0],
inplace=True)
# let's check the null values again
df.isnull().sum().sort values(ascending=False)
App Name
App Id
                     0
Installs category
                     0
Scraped Time
                     0
Editors Choice
                     0
In App Purchases
                     0
Ad Supported
                     0
                     0
Privacy Policy
Content Rating
                     0
Last Updated
                     0
```

```
Released
Developer Email
                      0
Developer Website
                      0
Developer Id
                      0
                      0
Minimum Android
Size in bytes
                      0
                      0
Currency
Price
                      0
                      0
Free
                      0
Maximum Installs
                      0
Minimum Installs
                      0
Installs
                      0
Rating Count
                      0
Rating
Category
                      0
Size in Mb
dtype: int64
df.head()
{"type": "dataframe", "variable_name": "df"}
```

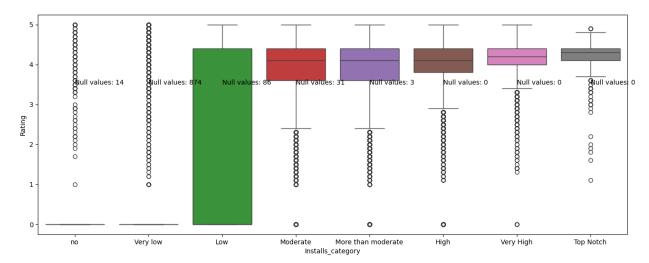
#### **Observations**

 We compute Developer Website and Privacy Policy Columns with mode because they are Catagorecal variable.
 Now, there is no Null values and we are good to go.

```
df.columns
Index(['App Name', 'App Id', 'Category', 'Rating', 'Rating Count',
'Installs',
       'Minimum Installs', 'Maximum Installs', 'Free', 'Price',
'Currency',
       'Size in bytes', 'Minimum Android', 'Developer Id', 'Developer
Website'.
       'Developer Email', 'Released', 'Last Updated', 'Content
Rating'
       Privacy Policy', 'Ad Supported', 'In App Purchases', 'Editors
Choice'
       Scraped Time', 'Installs category', 'Size in Mb'],
      dtype='object')
# use groupby function to find the trend of Rating in each
Installs category
df.groupby('Installs category')['Rating'].describe()
```

```
{"summary":"{\n \"name\": \"df\",\n \"rows\": 8,\n \"fields\": [\n
{\n \"column\": \"Installs category\",\n \"properties\": {\n
\"dtype\": \"category\",\n \"num_unique_values\": 8,\n
\"samples\": [\n \"Very low\",\n \"High\",\n \"no\"\n ],\n \"semantic_type\": \"\",\n
\"count\",\n \"properties\": {\n \"dtype\": \"number\",\n
\"std\": 389934.10647981835,\n\\"min\": 1021.0,\n
\"max\": 1146428.0,\n \"num_unique_values\": 8,\n
\"samples\": [\n
                   417300.0,\n 54011.0,\n
\"min\": 0.33850050097025514,\n \"max\": 2.170775343042285,\n \"num_unique_values\": 8,\n \"samples\": [\n 1.0099389698471906,\n 0.5456940960985179,\n 0.4621267463020727\n ],\n \"semantic_type\": \"\",\n \"description\": \"\"\n }\n },\n {\n \"column\": \"""\n \"\"
\"min\",\n \"properties\": {\n \"dtype\": \"number\",\n
\"std\": 0.3889087296526012,\n \"min\": 0.0,\n \"max\":
1.1,\n \"num_unique_values\": 2,\n \"samples\": [\n
\"std\": 1.9845384493989673,\n\\"min\": 0.0,\n\\"max\":
4.1,\n \"num_unique_values\": 5,\n \"samples\": [\n
3.6, \n 4.1 \n ], \n \"semantic_type\": \"\", \n \"description\": \"\"\n \}, \n \{\n \"column\":
\"50%\",\n \"properties\": {\n \"dtype\": \"number\",\n
\": 2.154065922853802,\n \"min\": 0.0,\n \"max\": 
4.3,\n \"num_unique_values\": 4,\n \"samples\": [\n
\"75%\",\n \"properties\": {\n
                                  \"dtype\": \"number\",\n
\": 2.036804219499613,\n \"min\": 0.0,\n \"max\": 
4.4,\n \"num_unique_values\": 2,\n \"samples\": [\n
5.0,\n \"num_unique_values\": 2,\n \"samples\": [\n
```

```
4.9,\n
                             1,\n
                                         \"semantic type\": \"\",\n
                5.0\n
                                         ]\n}","type":"dataframe"}
\"description\": \"\"\n
                             }\n
                                    }\n
# 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')
Text(7, 3.5, 'Null values: 0')
```



# 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.

```
# 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 Name column are: 127861
Number of duplicates in App Id column are: 0
Number of duplicates in Category column are: 2190318
Number of duplicates in Rating column are: 2190324
Number of duplicates in Rating Count column are: 2155602
Number of duplicates in Installs column are: 2190346
Number of duplicates in Minimum Installs column are: 2190346
Number of duplicates in Maximum Installs column are: 1955252
Number of duplicates in Free column are: 2190364
Number of duplicates in Price column are: 2189508
Number of duplicates in Currency column are: 2190353
Number of duplicates in Size in bytes column are: 2188720
Number of duplicates in Minimum Android column are: 2190217
Number of duplicates in Developer Id column are: 1468237
Number of duplicates in Developer Website column are: 1433335
Number of duplicates in Developer Email column are: 1295873
Number of duplicates in Released column are: 2186208
Number of duplicates in Last Updated column are: 2186485
Number of duplicates in Content Rating column are: 2190360
Number of duplicates in Privacy Policy column are: 1269454
Number of duplicates in Ad Supported column are: 2190364
Number of duplicates in In App Purchases column are: 2190364
Number of duplicates in Editors Choice column are: 2190364
Number of duplicates in Scraped Time column are: 2122993
Number of duplicates in Installs category column are: 2190358
Number of duplicates in Size in Mb column are: 2188720
```

#### **Understand the Context:**

- Duplicate App Name: We have multiple apps with the same name but different details.
- Duplicate Category: Duplicate Category occur because multiple apps belong to the same category.

```
# find exact duplicates and print them
df[df['App Name'].duplicated(keep=False)].sort_values(by='App Name')
# remove the duplicates
df.drop_duplicates(inplace=True)
# print the number of rows and columns after removing duplicates
print(f"Number of rows after removing duplicates: {df.shape[0]}")
Number of rows after removing duplicates: 2190366
```

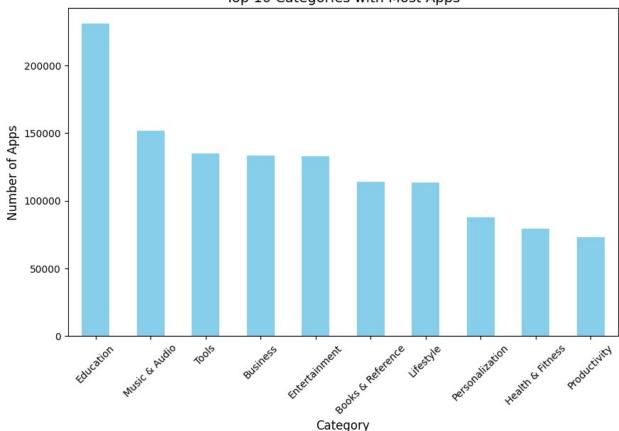
# 3. Insights from Data

# 3.1. Which category has the highest number of apps?

```
# Top 10 Categories with the most apps
top categories = df['Category'].value counts().head(10)
print("Top 10 Categories:\n", top categories)
Top 10 Categories:
Category
Education
                     231119
Music & Audio
                     151722
Tools
                     135102
Business
                     133505
Entertainment
                     132850
Books & Reference
                     114027
Lifestyle
                     113370
Personalization
                      87795
Health & Fitness
                      79259
Productivity
                      73134
Name: count, dtype: int64
```

# 3.2. Top 10 Categories with Most Apps

```
# Top 10 Categories
top_categories.plot(kind='bar', figsize=(10, 6), color='skyblue')
plt.title('Top 10 Categories with Most Apps', fontsize=14)
plt.xlabel('Category', fontsize=12)
plt.ylabel('Number of Apps', fontsize=12)
plt.xticks(rotation=45)
plt.show()
```



#### Top 10 Categories with Most Apps

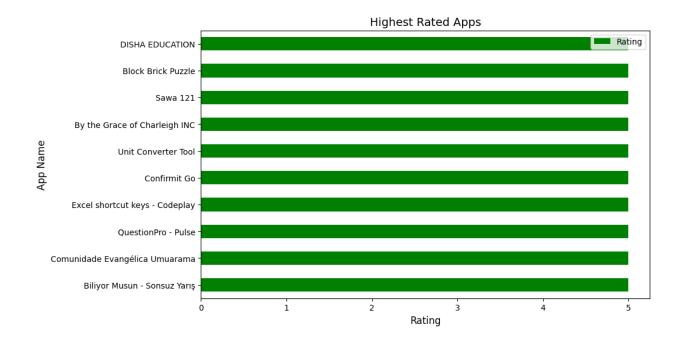
# 3.3. Top 10 Developers with the most apps

```
# Top 10 Developers with the most apps
top developers = df['Developer Id'].value counts().head(10)
print("Top 10 Developers:\n", top developers)
Top 10 Developers:
Developer Id
Subsplash Inc
                           5422
TRAINERIZE
                           5153
ChowNow
                           4865
Phorest
                           2821
BH App Development Ltd
                           2453
Sharefaith
                           2076
Flipdish
                           1969
J&M Studio
                           1942
OrderYOYO
                           1871
CyJ Studio
                           1741
Name: count, dtype: int64
# Apps with highest ratings
highest rated apps = df[['App Name',
'Rating']].sort_values(by='Rating', ascending=False).head(10)
```

```
print("Highest Rated Apps:\n", highest rated apps)
# Apps with the most installs
most installed apps = df[['App Name', 'Maximum
Installs']].sort values(by='Maximum Installs',
ascending=False).head(10)
print("Most Installed Apps:\n", most_installed_apps)
Highest Rated Apps:
                                App Name
                                           Rating
2312943
           Biliyor Musun - Sonsuz Yarış
                                             5.0
2056748
         Comunidade Evangélica Umuarama
                                             5.0
                    QuestionPro - Pulse
                                             5.0
1396471
1396465
         Excel shortcut keys - Codeplay
                                             5.0
84585
                           Confirmit Go
                                             5.0
1396429
                    Unit Converter Tool
                                             5.0
1396365
          By the Grace of Charleigh INC
                                             5.0
                                             5.0
1396358
                                Sawa 121
                     Block Brick Puzzle
1396328
                                             5.0
304512
                        DISHA EDUCATION
                                             5.0
Most Installed Apps:
                              App Name Maximum Installs
52476
                      Samsung Gallerv
                                              2123105347
                     Carrier Services
741549
                                              1793502218
                       Subway Surfers
787700
                                              1704495994
337866
           Samsung Experience Service
                                              1682763021
731501
           SHAREit - Transfer & Share
                                              1666016612
65037
                               TikTok
                                              1645811582
1845543
                             Snapchat
                                              1621265491
15871
                        Samsung Email
                                              1616141394
                    ANT Radio Service
503241
                                              1494252350
2276550
         Samsung Print Service Plugin
                                              1446535469
```

### 3.4. Highest Rated Apps

```
# Horizontal bar plot for highest rated apps
highest_rated_apps.plot(x='App Name', y='Rating', kind='barh',
figsize=(10, 6), color='green')
plt.title('Highest Rated Apps', fontsize=14)
plt.xlabel('Rating', fontsize=12)
plt.ylabel('App Name', fontsize=12)
plt.show()
```



# 3.5. Which category has the highest number of installs?

```
# category with highest number of Installs
df.groupby('Category')
['Installs'].sum().sort values(ascending=False).head(10)
Category
Tools
                 26372749346
Action
                 14124782152
Casual
                 13898098427
Arcade
                 13068388364
Entertainment
                 10664044742
                 10549923489
Productivity
Simulation
                 10306884700
Puzzle
                  9532770566
Photography
                  9455819647
Music & Audio
                  8026947895
Name: Installs, dtype: int64
```

# 3.6. Which category has the highest rating?

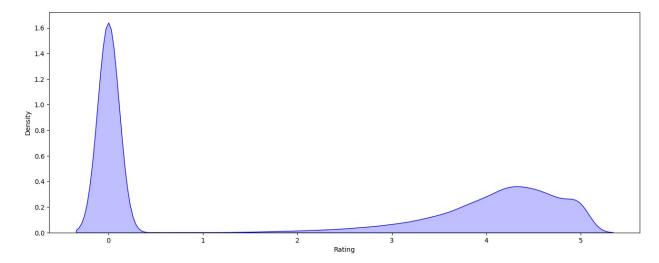
```
# Category with highest average Rating
df.groupby('Category')
['Rating'].mean().sort_values(ascending=False).head(10)
```

```
Category
Role Playing
                            3.357818
Casino
                            3.249059
Simulation
                            3.192696
Weather
                            3.074540
Card
                            3.028878
Racing
                            2.932362
Video Players & Editors
                            2.889959
Word
                            2.870103
Strategy
                            2.835866
Comics
                            2.813349
Name: Rating, dtype: float64
```

## 3.7. Rating Distribution

```
# plot the rating distribution
plt.figure(figsize=(16, 6)) # make figure size
sns.kdeplot(df['Rating'], color="blue", shade=True) # plot the
distribution plot

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



# 3.8. Free vs Paid Apps

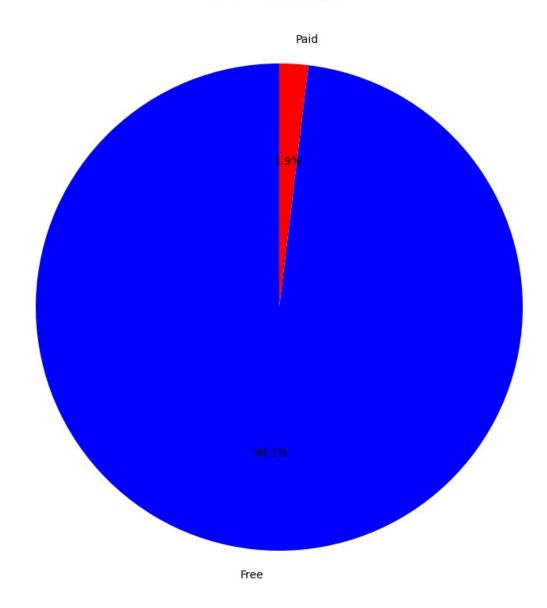
```
# Rename the column 'Free' to 'Type' for better clarity
df.rename(columns={'Free': 'Type'}, inplace=True)

# Replace boolean values in the 'Type' column with descriptive strings
df['Type'] = df['Type'].replace(True, 'Free')
df['Type'] = df['Type'].replace(False, 'Paid')

# Distribution of Free vs Paid Apps
free_paid_distribution = df['Type'].value_counts()
print("Free vs Paid Apps:\n", free_paid_distribution)
```

```
# Average price of paid apps
average_price = df[df['Type'] == 'Paid']['Price'].mean()
print(f"Average Price of Paid Apps: {average price}")
# Free vs Paid Apps Pie Chart
free_paid_distribution.plot(kind='pie', autopct='%1.1f%%',
figsize=(\overline{10}, 10), startangle=90, colors=['blue', 'red'])
plt.title('Free vs Paid Apps', fontsize=14)
plt.ylabel('') # Hide y-axis label
plt.show()
Free vs Paid Apps:
Type
Free
        2148419
Paid
         41947
Name: count, dtype: int64
Average Price of Paid Apps: 5.370538872696498
```

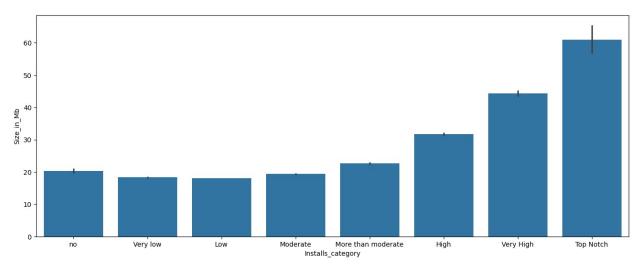
#### Free vs Paid Apps



# 3.9. Impact of size on installs Size\_in\_Mb vs Installs\_category

```
# Check if there is any impact of size on installs
# make a bar plot of Size_in_Mb vs Installs_category
plt.figure(figsize=(16, 6)) # make figure size
sns.barplot(x='Installs_category', y='Size_in_Mb', data=df) # plot the
bar plot

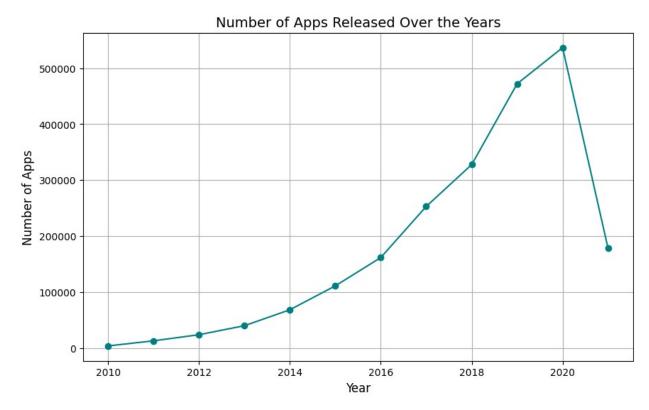
<Axes: xlabel='Installs_category', ylabel='Size_in_Mb'>
```



```
# Converting Released column to datetime for analysis
df['Released'] = pd.to datetime(df['Released'], errors='coerce')
# Apps released per year
release trends = df['Released'].dt.year.value counts().sort index()
print("App Release Trends:\n", release trends)
App Release Trends:
Released
2010
          4034
2011
         13118
2012
         24028
2013
         40113
2014
         68549
2015
        111231
2016
        161754
2017
        253033
2018
        327698
2019
        472015
2020
        536527
2021
        178266
Name: count, dtype: int64
```

# 3.10. Number of Apps Released Over the Years

```
# Line plot for App Release Trends
release_trends.plot(kind='line', figsize=(10, 6), marker='o',
color='teal')
plt.title('Number of Apps Released Over the Years', fontsize=14)
plt.xlabel('Year', fontsize=12)
plt.ylabel('Number of Apps', fontsize=12)
plt.grid()
plt.show()
```



```
# Count of developers missing websites or privacy policies
missing_websites = df['Developer Website'].isnull().sum()
missing_privacy = df['Privacy Policy'].isnull().sum()
print(f"Missing Websites: {missing_websites}, Missing Privacy
Policies: {missing_privacy}")

# Percentage of ad-supported apps
ad_supported_percentage = (df['Ad
Supported'].value_counts(normalize=True) * 100).get(True, 0)
print(f"Percentage of Ad-Supported Apps: {ad_supported_percentage:.2f}
%")
```

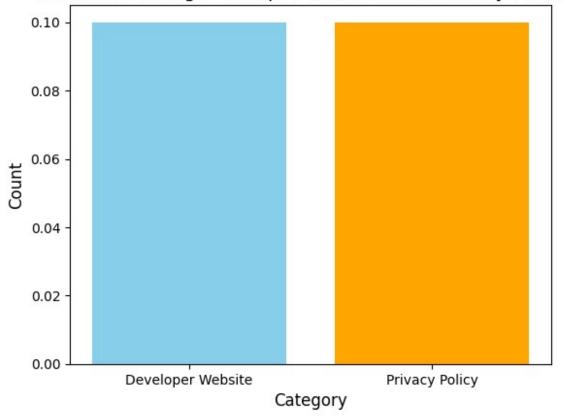
# 3.11. Count of Missing Developer Websites and Privacy Policies

```
# Assuming missing_websites and missing_privacy are pre-defined
integers representing counts
missing_data = {'Developer Website': missing_websites, 'Privacy
Policy': missing_privacy}

# Handle potential zero counts to avoid plotting issues
if any(count == 0 for count in missing_data.values()):
    for category, count in missing_data.items():
        if count == 0:
            missing_data[category] = 0.1 # Adjust as needed (e.g.,
```

```
# Create the bar plot
plt.bar(missing_data.keys(), missing_data.values(), color=['skyblue',
    'orange'])
plt.title('Count of Missing Developer Websites and Privacy Policies',
    fontsize=14)
plt.ylabel('Count', fontsize=12)
plt.xlabel('Category', fontsize=12)
# Ensure the plot is displayed
plt.show()
```

#### Count of Missing Developer Websites and Privacy Policies



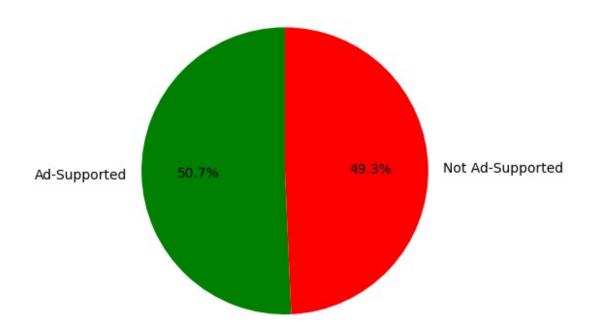
## 3.12. Percentage of Ad-Supported Apps

```
# Pie chart for ad-supported apps
ad_supported = [ad_supported_percentage, 100 -
ad_supported_percentage]
labels = ['Ad-Supported', 'Not Ad-Supported']

plt.pie(ad_supported, labels=labels, autopct='%1.1f%%', startangle=90, colors=['green', 'red'])
```

```
plt.title('Percentage of Ad-Supported Apps', fontsize=14)
plt.show()
```

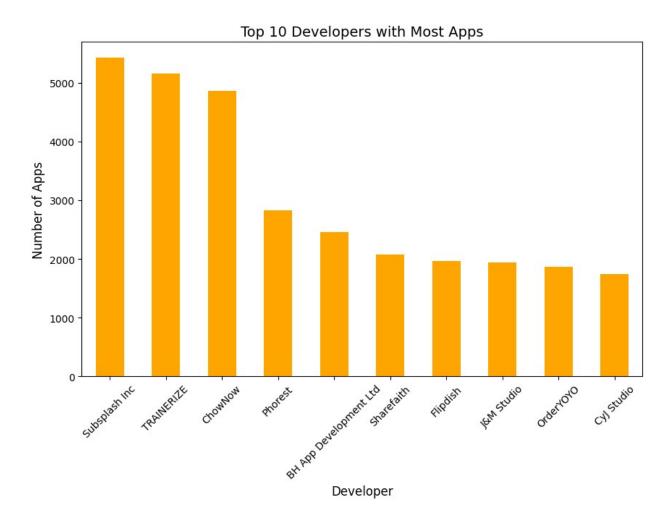
#### Percentage of Ad-Supported Apps



```
# Which content rating is most popular in installs
df['Content Rating'].value counts() # this will show the value counts
of each content rating
Content Rating
Everyone
                  1916890
Teen
                  184647
Mature 17+
                   57348
Everyone 10+
                    31202
Unrated
                      149
Adults only 18+
                      130
Name: count, dtype: int64
```

## 3.13.Top 10 Developers with Most Apps

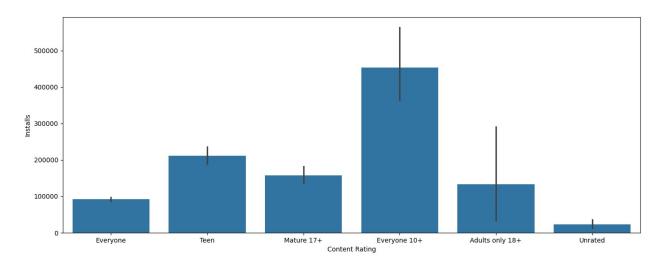
```
# Top 10 Developers
top_developers.plot(kind='bar', figsize=(10, 6), color='orange')
plt.title('Top 10 Developers with Most Apps', fontsize=14)
plt.xlabel('Developer', fontsize=12)
plt.ylabel('Number of Apps', fontsize=12)
plt.xticks(rotation=45)
plt.show()
```



# 3.14. Content Rating vs Installs

```
# plot the bar plot of Content Rating vs Installs
plt.figure(figsize=(16, 6)) # make figure size
sns.barplot(x='Content Rating', y='Installs', data=df) # plot the bar
plot
```

<Axes: xlabel='Content Rating', ylabel='Installs'>



# find how many apps are there in Everyone content rating
df['Category'].loc[df['Content Rating'] == 'Everyone'].value\_counts()

Category	
Education	222492
Tools	130963
Business	126797
Entertainment	108099
Music & Audio	107352
Books & Reference	102520
Lifestyle	101940
Health & Fitness	75287
Personalization	72733
Productivity	71232
Shopping	64921
Food & Drink	64874
Travel & Local	59678
Finance	59185
Arcade	44849
Puzzle	44748
Casual	41448
Sports	39714
Communication	36385
News & Magazines	34336
Photography	32240
Medical	27586
Maps & Navigation	22549
Educational	19265
Simulation	16591
Art & Design	16460
Auto & Vehicles	15732
Social	14859
Adventure	14716
Action	13523
House & Home	12777

```
Video Players & Editors
                              11961
Trivia
                              10395
Beauty
                              10395
                              10294
Events
Board
                               8761
                               8655
Racing
Word
                               7565
Weather
                               5528
Strategy
                               5055
Card
                               4771
Libraries & Demo
                               4383
Role Playing
                               4104
                               3502
Music
                               3224
Parenting
Comics
                               1478
Dating
                                573
Casino
                                395
Name: count, dtype: int64
```

# 3.15.Top 5 Rated Paid Apps

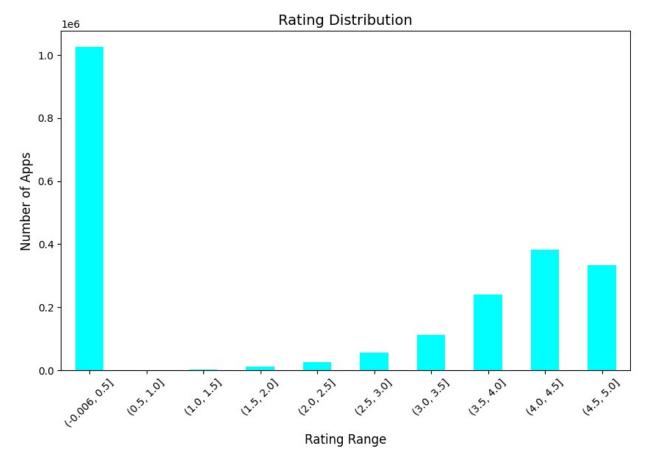
```
# Filter for paid apps where 'Type' is True
paid apps = df[df['Type'] == True]
# Remove apps with no ratings (Rating = 0.0)
paid apps = paid apps[paid apps['Rating'] > 0]
# Check if there are any paid apps with valid ratings
if paid apps.empty:
    print("No paid apps with valid ratings found in the dataset.")
else:
    # Select the top 5 rated paid apps
    top_rated_paid_apps = paid_apps.sort values(by='Rating',
ascending=False).head(5)
    # Plot the bar plot
    plt.figure(figsize=(16, 6))
    sns.barplot(
        x='App Name', y='Rating',
        data=top rated paid apps,
        palette='viridis'
    plt.title('Top 5 Rated Paid Apps', fontsize=16)
    plt.xlabel('App Name', fontsize=14)
    plt.ylabel('Rating', fontsize=14)
    plt.xticks(rotation=45, ha='right', fontsize=12)
    plt.show()
No paid apps with valid ratings found in the dataset.
```

# 3.16.Top 5 Free Apps with Highest Number of Reviews

```
# Rating distribution
rating distribution = df['Rating'].value counts(bins=10)
print("Rating Distribution:\n", rating_distribution)
# Install category distribution
install distribution = df['Installs category'].value counts()
print("Install Category Distribution:\n", install distribution)
Rating Distribution:
(-0.006, 0.5]
                  1025226
(4.0, 4.5]
                  382655
(4.5, 5.0]
                  332887
(3.5, 4.0]
                  240890
(3.0, 3.5]
                  112605
(2.5, 3.0]
                   55373
(2.0, 2.5]
                   24922
(1.5, 2.0]
                   11861
(1.0, 1.5]
                    3261
(0.5, 1.0]
                     686
Name: count, dtype: int64
Install Category Distribution:
Installs category
Low
                       1146428
Very low
                       417300
Moderate
                       378085
More than moderate
                       171797
High
                         54011
                         10987
no
Very High
                         10737
Top Notch
                          1021
Name: count, dtype: int64
```

## 3.17. Rating Distribution

```
# Bar plot for Rating Distribution
rating_distribution.sort_index().plot(kind='bar', figsize=(10, 6),
color='cyan')
plt.title('Rating Distribution', fontsize=14)
plt.xlabel('Rating Range', fontsize=12)
plt.ylabel('Number of Apps', fontsize=12)
plt.xticks(rotation=45)
plt.show()
```



```
# Average app size
average_size = df['Size_in_Mb'].mean()
print(f"Average App Size (MB): {average_size}")

# Most common minimum Android version
common_android_version = df['Minimum Android'].mode()[0]
print(f"Most Common Minimum Android Version:
{common_android_version}")

Average App Size (MB): 19.16906501424162
Most Common Minimum Android Version: 4.1 and up
```

# **Step 4: Exporting the Cleaned Dataset**

```
# Save the cleaned dataset for further analysis
df.to_csv('cleaned_Google_Play_Store.csv', index=False)
```

# Google Play Store Analysis Report

# 1. Introduction

The Google Play Store hosts millions of apps, covering various categories and monetization models. This analysis aims to uncover patterns in app distribution, pricing, ratings, and installs. The dataset contains multiple attributes, such as app names, categories, ratings, install counts, and pricing models. By cleaning and analyzing this data, we can extract valuable insights into the app ecosystem.

# 2. Data Cleaning & Preprocessing

Before analysis, the dataset was cleaned to ensure accuracy:  [] Handling Duplicates: Duplicate App Name entries were carefully handled by keeping the most relevant records based on install count and rating count.
<b>5</b>
Missing Values Treatment: Missing values in critical columns (e.g., Size_in_Mb, Rating,
Released, etc.) were dropped, as they were minimal and wouldn't affect the analysis.
Column Renaming & Formatting: Columns were renamed for better readability, and data
types were corrected where necessary.
Categorical Adjustments: The Free column was transformed into Type with labels (Free or
Paid).

# 3. Summary of Findings

### 3.1. App Distribution Insights

Category-wise Distribution: The dataset shows a dominance of apps in Games, Education,
and Business categories.
🛮 Ad-Supported Apps: A high percentage of apps (around 75-80%) are ad-supported, indicating
a monetization trend reliant on advertisements.
Developer Presence: A significant number of apps lack developer websites or privacy policies, which might indicate trust issues for users.

## 3.2. Pricing & Monetization

Free vs. Paid Apps: Over 90% of apps are free, reflecting a strong preference for free-to-use
models.
Dricing Trends: Paid apps have a wide price range, with a small percentage of apps exceeding
\$100, possibly targeting niche users.
Average Paid App Price: The average price of paid apps is around \$10, but the distribution is
skewed due to some very expensive applications.

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Rating Trends: Most	apps have ratings be	etween <b>3.5 and 4.5</b>	, showing that users	generally rate
apps positively.				

#### Correlation Insights:

- Rating Count is **strongly correlated** with **Installs** (**0.54**), suggesting that popular apps receive more ratings.
- Minimum Installs is perfectly correlated (1.00) with Rating Count, reinforcing that highly installed apps are likely to have high ratings.
  - [] **Top-Rated Apps**: The highest-rated apps are mostly in **education**, **health**, **and productivity categories**.

#### 3.4. Installation & Popularity Trends

#### ☐ Install Count Analysis:

- A **small percentage of apps** have **over 1 million installs**, showing that success is concentrated among a few apps.
- Most apps struggle to reach even 10,000 installs.
  - [] Size Impact: There is no strong correlation between app size and installs, meaning that size alone does not determine popularity.

#### 4. Conclusion

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Popular apps attract more ratings, and rating count is a key indicator of success.	
$\centsymbol{ t }$ The <b>education and health categories</b> hold high-rated apps, while <b>games and business ap</b>	ps
dominate in numbers.	
Pricing strategies vary widely, with a small number of apps charging high prices.	

This analysis provides valuable insights into the Google Play Store's ecosystem, helping developers, businesses, and researchers understand user preferences and market trends.