unveiling-the-android-app-market

February 21, 2024

Data collection:

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

[2]:
```
data1 = pd.read_csv('/content/apps.csv')
data1.head()
```

[2]:
```
   Unnamed: 0                                                 App  \
0           0     Photo Editor & Candy Camera & Grid & ScrapBook
1           1                                 Coloring book moana
2           2  U Launcher Lite – FREE Live Cool Themes, Hide …
3           3                               Sketch - Draw & Paint
4           4              Pixel Draw - Number Art Coloring Book

         Category  Rating  Reviews  Size     Installs  Type Price  \
0  ART_AND_DESIGN     4.1      159  19.0      10,000+  Free     0
1  ART_AND_DESIGN     3.9      967  14.0     500,000+  Free     0
2  ART_AND_DESIGN     4.7    87510   8.7   5,000,000+  Free     0
3  ART_AND_DESIGN     4.5   215644  25.0  50,000,000+  Free     0
4  ART_AND_DESIGN     4.3      967   2.8     100,000+  Free     0

  Content Rating                     Genres      Last Updated  \
0       Everyone               Art & Design   January 7, 2018
1       Everyone  Art & Design;Pretend Play  January 15, 2018
2       Everyone               Art & Design    August 1, 2018
3           Teen               Art & Design      June 8, 2018
4       Everyone    Art & Design;Creativity     June 20, 2018

          Current Ver   Android Ver
0               1.0.0  4.0.3 and up
1               2.0.0  4.0.3 and up
2               1.2.4  4.0.3 and up
3  Varies with device    4.2 and up
4                 1.1    4.4 and up
```

```
[3]: data2 = pd.read_csv('/content/user_reviews.csv')
     data2.head()
```

```
[3]:                     App                                    Translated_Review  \
     0  10 Best Foods for You  I like eat delicious food. That's I'm cooking …
     1  10 Best Foods for You    This help eating healthy exercise regular basis
     2  10 Best Foods for You                                                NaN
     3  10 Best Foods for You         Works great especially going grocery store
     4  10 Best Foods for You                                       Best idea us

       Sentiment  Sentiment_Polarity  Sentiment_Subjectivity
     0  Positive                1.00                0.533333
     1  Positive                0.25                0.288462
     2       NaN                 NaN                     NaN
     3  Positive                0.40                0.875000
     4  Positive                1.00                0.300000
```

Data Cleaning:

```
[4]: data1.describe()
```

```
[4]:          Unnamed: 0       Rating       Reviews         Size
     count   9659.000000  8196.000000  9.659000e+03  8432.000000
     mean    5666.172896     4.173243  2.165926e+05    20.395327
     std     3102.362863     0.536625  1.831320e+06    21.827509
     min        0.000000     1.000000  0.000000e+00     0.000000
     25%     3111.500000     4.000000  2.500000e+01     4.600000
     50%     5814.000000     4.300000  9.670000e+02    12.000000
     75%     8327.500000     4.500000  2.940100e+04    28.000000
     max    10840.000000     5.000000  7.815831e+07   100.000000
```

```
[5]: data2.describe()
```

```
[5]:        Sentiment_Polarity  Sentiment_Subjectivity
     count        37432.000000            37432.000000
     mean             0.182146                0.492704
     std              0.351301                0.259949
     min             -1.000000                0.000000
     25%              0.000000                0.357143
     50%              0.150000                0.514286
     75%              0.400000                0.650000
     max              1.000000                1.000000
```

```
[6]: print("\033[1mMissing values in Apps:\033[0m")
     data1.isna().sum()
```

```
Missing values in Apps:
```

```
[6]: Unnamed: 0           0
     App                  0
     Category             0
     Rating            1463
     Reviews              0
     Size              1227
     Installs             0
     Type                 0
     Price                0
     Content Rating       0
     Genres               0
     Last Updated         0
     Current Ver          8
     Android Ver          2
     dtype: int64
```

```
[7]: print("\033[1mMissing values in User Reviews:\033[0m")
     data2.isna().sum()
```

Missing values in User Reviews:

```
[7]: App                           0
     Translated_Review         26868
     Sentiment                 26863
     Sentiment_Polarity        26863
     Sentiment_Subjectivity    26863
     dtype: int64
```

```
[8]: # Fill missing values in the 'Translated_Review' column with an empty string
     data2['Translated_Review'].fillna('', inplace=True)

     # Fill missing values in the 'Sentiment' column with the most frequent value
     most_frequent_sentiment = data2['Sentiment'].mode()[0]
     data2['Sentiment'].fillna(most_frequent_sentiment, inplace=True)

     # Fill missing values in the 'Sentiment_Polarity' column with the mean value
     mean_sentiment_polarity = data2['Sentiment_Polarity'].mean()
     data2['Sentiment_Polarity'].fillna(mean_sentiment_polarity, inplace=True)

     # Fill missing values in the 'Sentiment_Subjectivity' column with the mean value
     mean_sentiment_subjectivity = data2['Sentiment_Subjectivity'].mean()
     data2['Sentiment_Subjectivity'].fillna(mean_sentiment_subjectivity,␣
       ↪inplace=True)
```

```
[9]: print("\033[1mMissing values in User Reviews:\033[0m")
     data2.isna().sum()
```

Missing values in User Reviews:

[9]:

```
App                       0
Translated_Review         0
Sentiment                 0
Sentiment_Polarity        0
Sentiment_Subjectivity    0
dtype: int64
```

[10]:

```
data1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9659 entries, 0 to 9658
Data columns (total 14 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Unnamed: 0      9659 non-null   int64
 1   App             9659 non-null   object
 2   Category        9659 non-null   object
 3   Rating          8196 non-null   float64
 4   Reviews         9659 non-null   int64
 5   Size            8432 non-null   float64
 6   Installs        9659 non-null   object
 7   Type            9659 non-null   object
 8   Price           9659 non-null   object
 9   Content Rating  9659 non-null   object
 10  Genres          9659 non-null   object
 11  Last Updated    9659 non-null   object
 12  Current Ver     9651 non-null   object
 13  Android Ver     9657 non-null   object
dtypes: float64(2), int64(2), object(10)
memory usage: 1.0+ MB
```

[11]:

```
data2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 64295 entries, 0 to 64294
Data columns (total 5 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   App                     64295 non-null  object
 1   Translated_Review       64295 non-null  object
 2   Sentiment               64295 non-null  object
 3   Sentiment_Polarity      64295 non-null  float64
 4   Sentiment_Subjectivity  64295 non-null  float64
dtypes: float64(2), object(3)
memory usage: 2.5+ MB
```

[12]:

```
# Convert 'Last Updated' column to datetime
data1['Last Updated'] = pd.to_datetime(data1['Last Updated'])

# Remove dollar sign ('$') from 'Price' column and convert to float
data1['Price'] = data1['Price'].str.replace('$', '').astype(float)

# Convert 'Installs' column to numeric after removing '+' and ','
data1['Installs'] = data1['Installs'].str.replace('+', '').str.replace(',', '').
  ↪astype(int)

# Display the data types of each column
print(data1.dtypes)
```

```
Unnamed: 0                 int64
App                       object
Category                  object
Rating                   float64
Reviews                    int64
Size                     float64
Installs                   int64
Type                      object
Price                    float64
Content Rating            object
Genres                    object
Last Updated      datetime64[ns]
Current Ver               object
Android Ver               object
dtype: object
```

```
<ipython-input-12-b86c9f68bf1b>:5: FutureWarning: The default value of regex
will change from True to False in a future version. In addition, single
character regular expressions will *not* be treated as literal strings when
regex=True.
  data1['Price'] = data1['Price'].str.replace('$', '').astype(float)
<ipython-input-12-b86c9f68bf1b>:8: FutureWarning: The default value of regex
will change from True to False in a future version. In addition, single
character regular expressions will *not* be treated as literal strings when
regex=True.
  data1['Installs'] = data1['Installs'].str.replace('+', '').str.replace(',',
'').astype(int)
```

[13]:

```
# Convert 'Sentiment_Polarity' and 'Sentiment_Subjectivity' columns to float
data2['Sentiment_Polarity'] = pd.to_numeric(data2['Sentiment_Polarity'],␣
  ↪errors='coerce')
data2['Sentiment_Subjectivity'] = pd.
  ↪to_numeric(data2['Sentiment_Subjectivity'], errors='coerce')
```

```python
# Convert 'App' and 'Sentiment' columns to string (object) type
data2['App'] = data2['App'].astype(str)
data2['Sentiment'] = data2['Sentiment'].astype(str)

# Display the data types of each column
print(data2.dtypes)
```

```
App                        object
Translated_Review          object
Sentiment                  object
Sentiment_Polarity        float64
Sentiment_Subjectivity    float64
dtype: object
```

Category Exploration:

[14]:

```python
# Count the number of apps in each category
category_distribution = data1['Category'].value_counts()

# Display the distribution of apps across categories
print("\033[1mCategories in Apps:\033[0m")
print(category_distribution)
```

```
Categories in Apps:
FAMILY                 1832
GAME                    959
TOOLS                   827
BUSINESS                420
MEDICAL                 395
PERSONALIZATION         376
PRODUCTIVITY            374
LIFESTYLE               369
FINANCE                 345
SPORTS                  325
COMMUNICATION           315
HEALTH_AND_FITNESS      288
PHOTOGRAPHY             281
NEWS_AND_MAGAZINES      254
SOCIAL                  239
BOOKS_AND_REFERENCE     222
TRAVEL_AND_LOCAL        219
SHOPPING                202
DATING                  171
VIDEO_PLAYERS           163
MAPS_AND_NAVIGATION     131
EDUCATION               119
FOOD_AND_DRINK          112
ENTERTAINMENT           102
```

```
AUTO_AND_VEHICLES        85
LIBRARIES_AND_DEMO       84
WEATHER                  79
HOUSE_AND_HOME           74
EVENTS                   64
ART_AND_DESIGN           64
PARENTING                60
COMICS                   56
BEAUTY                   53
Name: Category, dtype: int64
```

[15]:

```
# Extracting categories from the 'App' column
data2['Category'] = data2['App'].str.split(' - ').str[0]

# Count the number of apps in each category
category_distribution = data2['App'].groupby(data2['Category']).count().
 ↪reset_index()
category_distribution.columns = ['Category', 'Number_of_Apps']

# Sort the categories by the number of apps in descending order
category_distribution = category_distribution.sort_values(by='Number_of_Apps',␣
 ↪ascending=False)

# Display the app distribution across inferred categories
print(category_distribution)
```

```
                            Category  Number_of_Apps
362                  Calorie Counter             700
286                       Bowmasters             320
124               Angry Birds Classic            320
329                    CBS Sports App            320
1005                      Helix Jump             300
…                                …              …
632              Easy Healthy Recipes             31
611    Dresses Ideas & Fashions +3000             31
551        Detector de Radares Gratis             31
631            Easy Hair Style Design             30
605     Drawing Clothes Fashion Ideas             30

[1060 rows x 2 columns]
```

Metrics Analysis:

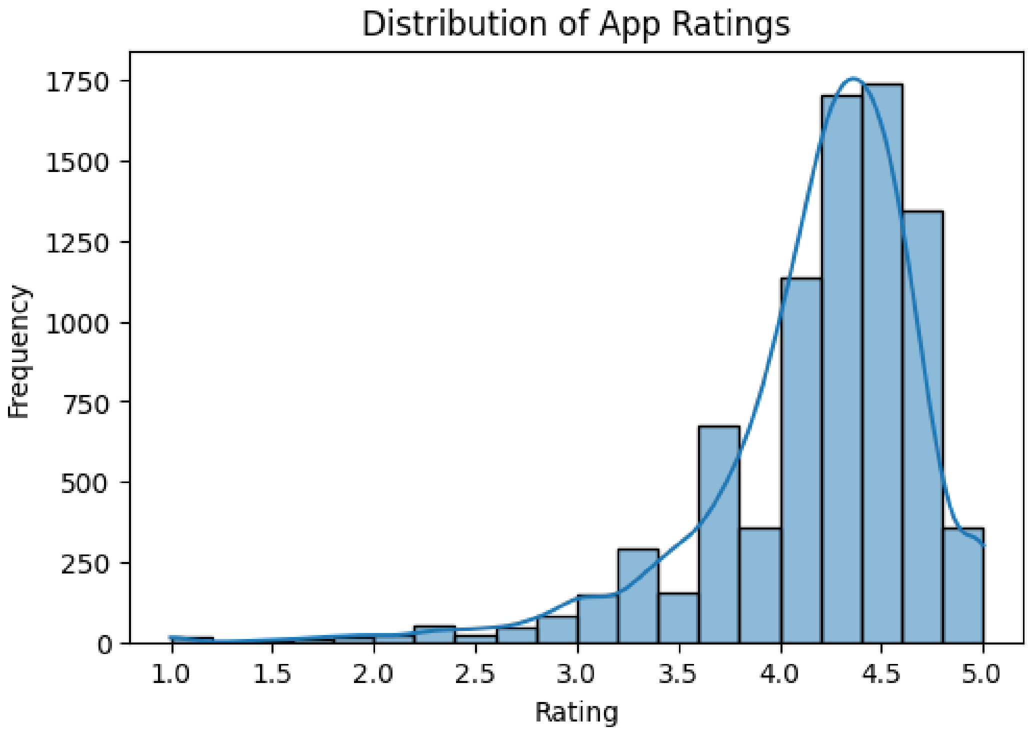
[16]:

```
# App Ratings Analysis
ratings_summary = data1['Rating'].describe()
print("\033[1mApp Ratings Summary:\033[0m")
print(ratings_summary)
```

```
App Ratings Summary:
count    8196.000000
mean        4.173243
std         0.536625
min         1.000000
25%         4.000000
50%         4.300000
75%         4.500000
max         5.000000
Name: Rating, dtype: float64
```

[17]:

```
# Visualize the distribution of ratings
plt.figure(figsize=(6, 4))
sns.histplot(data=data1, x='Rating', bins=20, kde=True)
plt.title('Distribution of App Ratings')
plt.xlabel('Rating')
plt.ylabel('Frequency')
plt.show()
```



[18]:

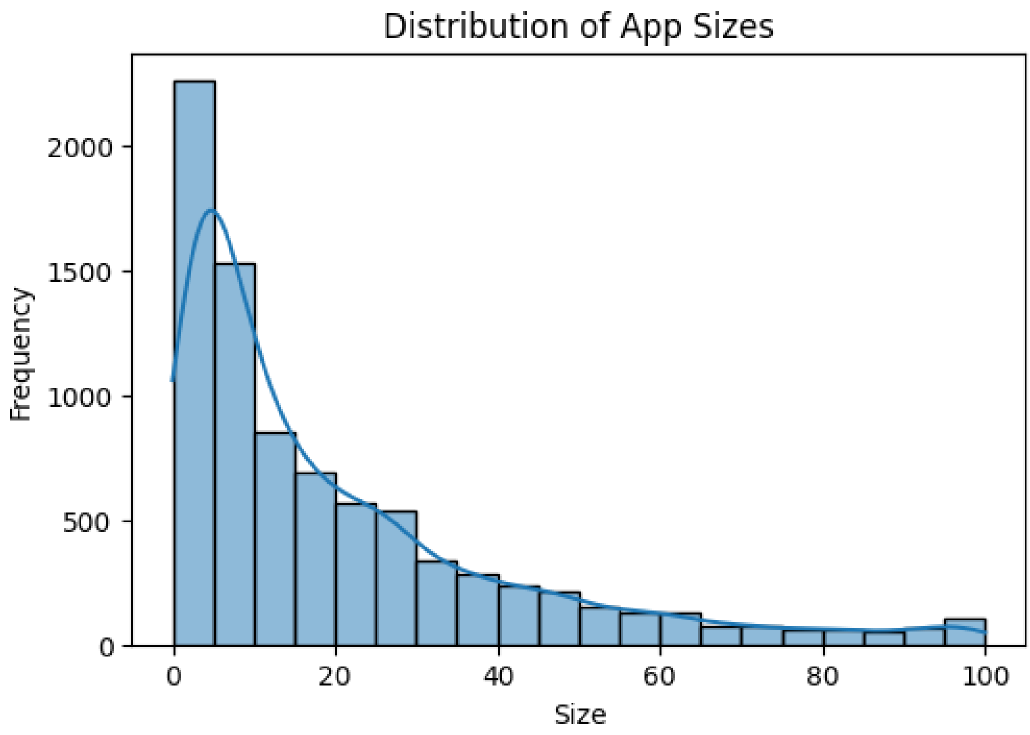
```
# Convert size column to numeric
data1['Size'] = data1['Size'].astype(float)

size_summary = data1['Size'].describe()
```

```python
print("\033[1mApp Size Summary:\033[0m")
print(size_summary)
```

```
App Size Summary:
count    8432.000000
mean       20.395327
std        21.827509
min         0.000000
25%         4.600000
50%        12.000000
75%        28.000000
max       100.000000
Name: Size, dtype: float64
```

[19]:

```python
# Visualize the distribution of app sizes
plt.figure(figsize=(6, 4))
sns.histplot(data=data1, x='Size', bins=20, kde=True)
plt.title('Distribution of App Sizes')
plt.xlabel('Size')
plt.ylabel('Frequency')
plt.show()
```



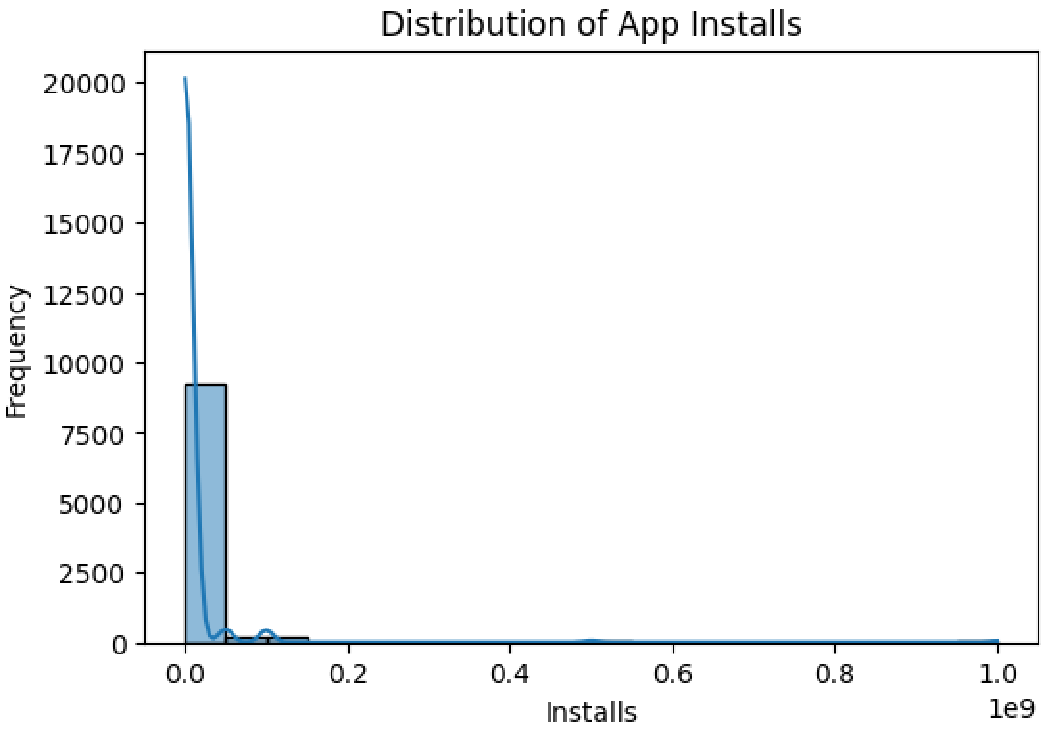
[20]:

```
# Popularity Analysis
popularity_summary = data1['Installs'].describe()
print("\033[1mPopularity Summary:\033[0m")
print(popularity_summary)
```

```
Popularity Summary:
count    9.659000e+03
mean     7.777507e+06
std      5.375828e+07
min      0.000000e+00
25%      1.000000e+03
50%      1.000000e+05
75%      1.000000e+06
max      1.000000e+09
Name: Installs, dtype: float64
```

[21]:

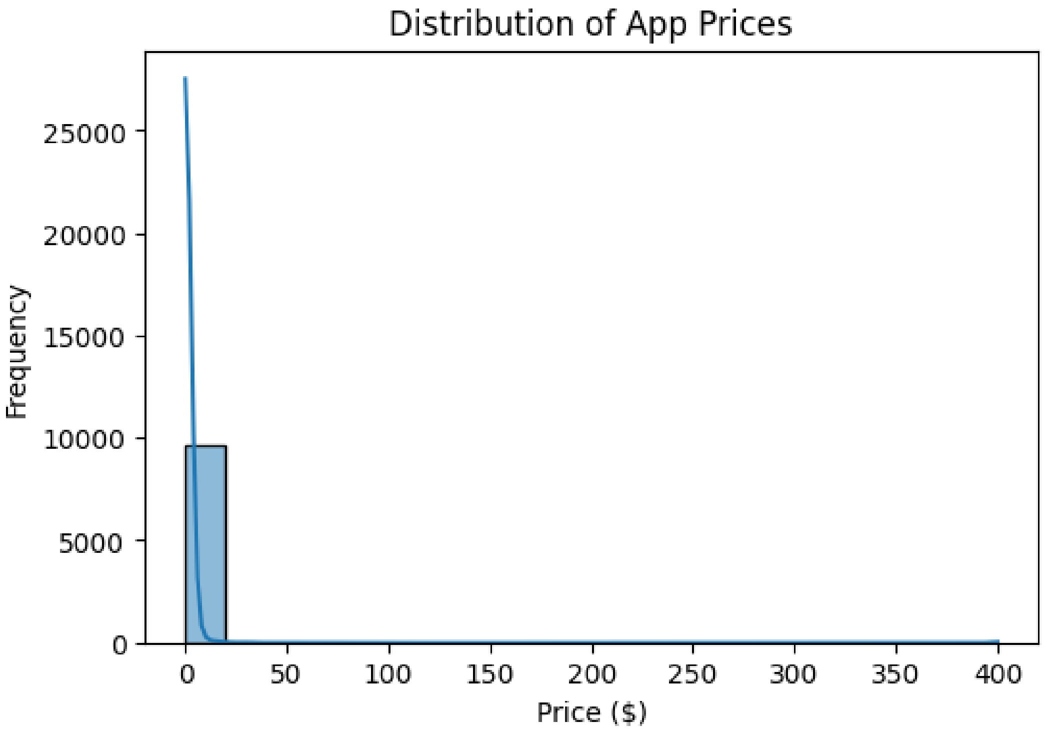
```
# Visualize the distribution of installs
plt.figure(figsize=(6, 4))
sns.histplot(data=data1, x='Installs', bins=20, kde=True)
plt.title('Distribution of App Installs')
plt.xlabel('Installs')
plt.ylabel('Frequency')
plt.show()
```



[22]:
```
# Pricing Analysis
price_summary = data1['Price'].describe()
print("\033[1mPricing Summary:\033[0m")
print(price_summary)
```

```
Pricing Summary:
count    9659.000000
mean        1.099299
std        16.852152
min         0.000000
25%         0.000000
50%         0.000000
75%         0.000000
max       400.000000
Name: Price, dtype: float64
```

[23]:
```
# Visualize the distribution of prices
plt.figure(figsize=(6, 4))
sns.histplot(data=data1, x='Price', bins=20, kde=True)
plt.title('Distribution of App Prices')
plt.xlabel('Price ($)')
plt.ylabel('Frequency')
plt.show()
```

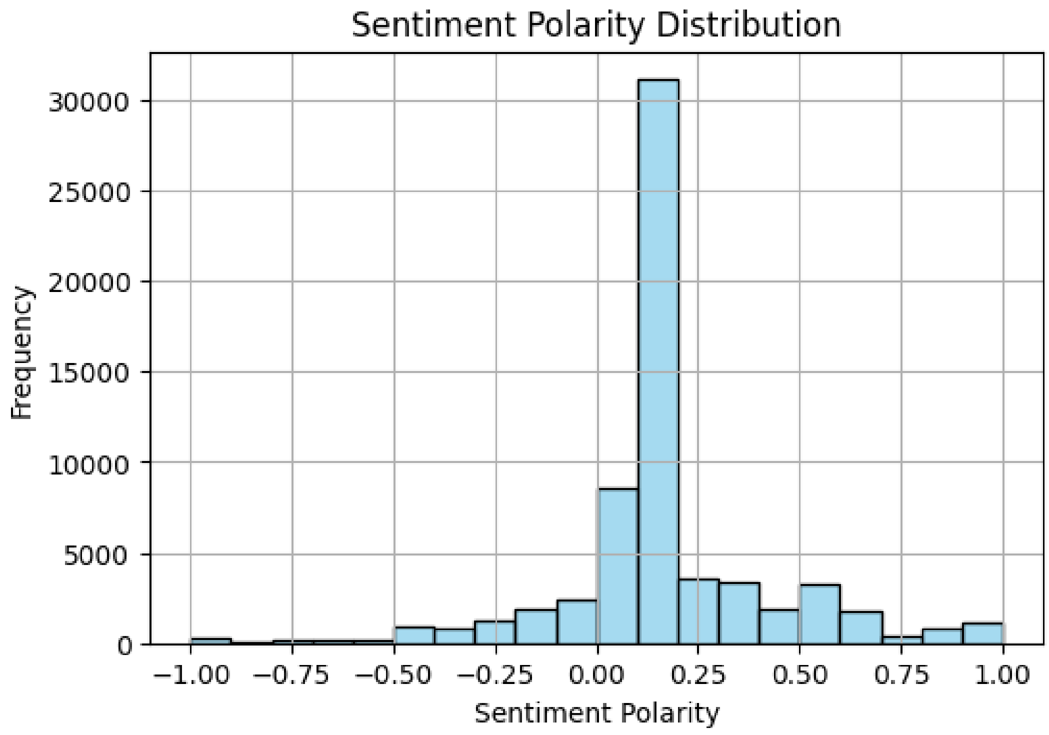


[24]:

```
# 1. App Ratings Analysis
# Drop rows with missing ratings
data2.dropna(subset=['Sentiment_Polarity'], inplace=True)

# Convert 'Sentiment_Polarity' to numeric
data2['Sentiment_Polarity'] = pd.to_numeric(data2['Sentiment_Polarity'],␣
 ↪errors='coerce')

# Calculate descriptive statistics for ratings
rating_stats = data2['Sentiment_Polarity'].describe()
```

[25]:

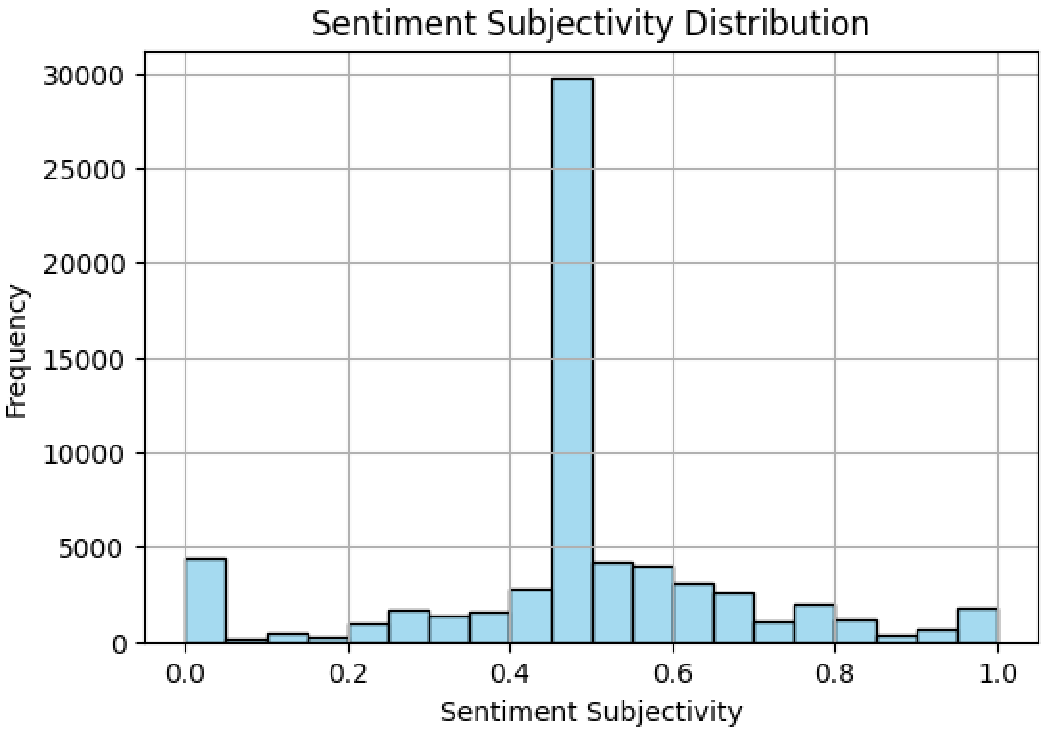
```
# Visualize rating distribution
plt.figure(figsize=(6, 4))
sns.histplot(data2['Sentiment_Polarity'], bins=20, color='skyblue',␣
 ↪edgecolor='black')
plt.xlabel('Sentiment Polarity')
plt.ylabel('Frequency')
plt.title('Sentiment Polarity Distribution')
plt.grid(True)
plt.show()
```



[26]:

```
# 2. Sentiment Subjectivity Analysis (if applicable)
# Drop rows with missing sentiment subjectivity
```

```
data2_cleaned = data2.dropna(subset=['Sentiment_Subjectivity'])

# Convert 'Sentiment_Subjectivity' to numeric
data2_cleaned['Sentiment_Subjectivity'] = pd.
 ↪to_numeric(data2_cleaned['Sentiment_Subjectivity'], errors='coerce')

# Calculate descriptive statistics for sentiment subjectivity
subjectivity_stats = data2_cleaned['Sentiment_Subjectivity'].describe()

# Visualize sentiment subjectivity distribution
plt.figure(figsize=(6, 4))
sns.histplot(data2_cleaned['Sentiment_Subjectivity'], bins=20, color='skyblue',␣
 ↪edgecolor='black')
plt.xlabel('Sentiment Subjectivity')
plt.ylabel('Frequency')
plt.title('Sentiment Subjectivity Distribution')
plt.grid(True)
plt.show()
```



Sentiment Analysis:

[27]:
```
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
```

[28]:

```
# Download the VADER lexicon if not already downloaded
nltk.download('vader_lexicon')

# Initialize the VADER sentiment analyzer
sid = SentimentIntensityAnalyzer()
```

```
[nltk_data] Downloading package vader_lexicon to /root/nltk_data…
[nltk_data]   Package vader_lexicon is already up-to-date!
```

[29]:

```
# Ensure 'Reviews' column is converted to strings
data1['Reviews'] = data1['Reviews'].astype(str)

# Calculate sentiment scores for each review
data1['Review_Sentiment'] = data1['Reviews'].apply(lambda x: sid.
 ↪polarity_scores(x)['compound'])

# Classify sentiment into categories (positive, neutral, negative)
data1['Sentiment_Class'] = data1['Review_Sentiment'].apply(lambda x: 'Positive'␣
 ↪if x > 0 else ('Neutral' if x == 0 else 'Negative'))

# Display the DataFrame with sentiment analysis results
print(data1[['Reviews', 'Review_Sentiment', 'Sentiment_Class']])
```

```
     Reviews  Review_Sentiment Sentiment_Class
0        159               0.0         Neutral
1        967               0.0         Neutral
2      87510               0.0         Neutral
3     215644               0.0         Neutral
4        967               0.0         Neutral
…        …                 …             …
9654      38               0.0         Neutral
9655       4               0.0         Neutral
9656       3               0.0         Neutral
9657     114               0.0         Neutral
9658  398307               0.0         Neutral

[9659 rows x 3 columns]
```

[30]:

```
# Count the number of neutral, positive, and negative sentiments
sentiment_counts = data1['Sentiment_Class'].value_counts()

# Display the counts
print("\033[1mSentiment Counts:\033[0m")
print(sentiment_counts)
```

```
Sentiment Counts:
Neutral     9636
Negative      18
```

```
Positive       5
Name: Sentiment_Class, dtype: int64
```

[31]:

```
# Calculate the percentage of each sentiment
neutral_percentage = (sentiment_counts['Neutral'] / len(data1)) * 100
positive_percentage = (sentiment_counts['Positive'] / len(data1)) * 100
negative_percentage = (sentiment_counts['Negative'] / len(data1)) * 100

# Display the percentages
print("\033[1mSentiment Counts in percentage:\033[0m")
print(f"Neutral: {neutral_percentage:.2f}%")
print(f"Positive: {positive_percentage:.2f}%")
print(f"Negative: {negative_percentage:.2f}%")
```

```
Sentiment Counts in percentage:
Neutral: 99.76%
Positive: 0.05%
Negative: 0.19%
```

[32]:

```
# Apply sentiment analysis to each review
data2['Review_Sentiment'] = data2['Translated_Review'].apply(lambda x: sid.
 ↪polarity_scores(str(x))['compound'])

# Classify sentiment into categories (positive, neutral, negative)
data2['Sentiment_Class'] = data2['Review_Sentiment'].apply(lambda x: 'Positive'␣
 ↪if x > 0 else ('Neutral' if x == 0 else 'Negative'))

# Count the number of reviews in each sentiment category
sentiment_counts = data2['Sentiment_Class'].value_counts()

# Calculate percentage of reviews in each sentiment category
sentiment_percentages = (sentiment_counts / len(data2)) * 100
```

[33]:

```
# Display sentiment analysis results
print("\033[1mSentiment Analysis Results:\033[0m")
print(sentiment_counts)
```

```
Sentiment Analysis Results:
Neutral     30847
Positive    25715
Negative     7733
Name: Sentiment_Class, dtype: int64
```

[34]:

```
# Display sentiment analysis results
print("\033[1mPercentage of Reviews in Each Sentiment Category:\033[0m")
print(sentiment_percentages.apply(lambda x: f"{x:.2f}%"))
```

```
Percentage of Reviews in Each Sentiment Category:
```

```
Neutral     47.98%
Positive    40.00%
Negative    12.03%
Name: Sentiment_Class, dtype: object
```

Interactive Visualization:

[35]:
```
import plotly.express as px
```

[36]:
```
print('\033[1mSentiment Distribution:\033[0m')

# Calculate sentiment counts
sentiment_counts = data1['Sentiment_Class'].value_counts()

# Create a DataFrame for plotting
sentiment_df = pd.DataFrame({'Sentiment': sentiment_counts.index, 'Count':␣
 ↪sentiment_counts.values})

# Calculate percentages
sentiment_df['Percentage'] = (sentiment_df['Count'] / sentiment_df['Count'].
 ↪sum()) * 100

# Plot an interactive pie chart
fig = px.pie(sentiment_df, values='Count', names='Sentiment')

# Update layout to set the size of the plot
fig.update_layout(width=600, height=400)

# Show the plot
fig.show()
```

```
Sentiment Distribution:
```

[37]:
```
print('\033[1mSentiment Distribution:\033[0m')

# Calculate sentiment counts
sentiment_counts = data1['Sentiment_Class'].value_counts()

# Create a DataFrame for plotting
sentiment_df = pd.DataFrame({'Sentiment': sentiment_counts.index, 'Count':␣
 ↪sentiment_counts.values})

# Calculate percentages
sentiment_df['Percentage'] = (sentiment_df['Count'] / sentiment_df['Count'].
 ↪sum()) * 100

# Plot an interactive bar chart
fig = px.bar(sentiment_df, x='Sentiment', y='Count', text='Percentage',
             labels={'Count': 'Count', 'Sentiment': 'Sentiment'})

# Update layout to add annotations and set the size of the plot
fig.update_layout(annotations=[dict(x='Sentiment', y='Count',␣
 ↪text='Percentage', showarrow=False)],
                  width=600, height=400)

# Show the plot
fig.show()
```

Sentiment Distribution:

[38]:

```
print('\033[1mPercentage of Reviews in Each Sentiment Category:\033[0m')

# Calculate sentiment analysis results
sentiment_counts = data2['Sentiment_Class'].value_counts()
sentiment_percentages = (sentiment_counts / len(data2)) * 100

# Create a DataFrame for sentiment analysis results
sentiment_df = pd.DataFrame({
    'Sentiment_Class': sentiment_counts.index,
    'Count': sentiment_counts.values,
    'Percentage': sentiment_percentages.values
})

# Create an interactive pie chart
fig = px.pie(sentiment_df, values='Count', names='Sentiment_Class',
             labels={'Sentiment_Class': 'Sentiment Category'},
             hover_data=['Percentage'],
             hole=0.3)

# Update layout to set the size of the plot
fig.update_layout(width=600, height=400)

# Show the interactive plot
fig.show()
```

Percentage of Reviews in Each Sentiment Category:

Skill Enhancement:

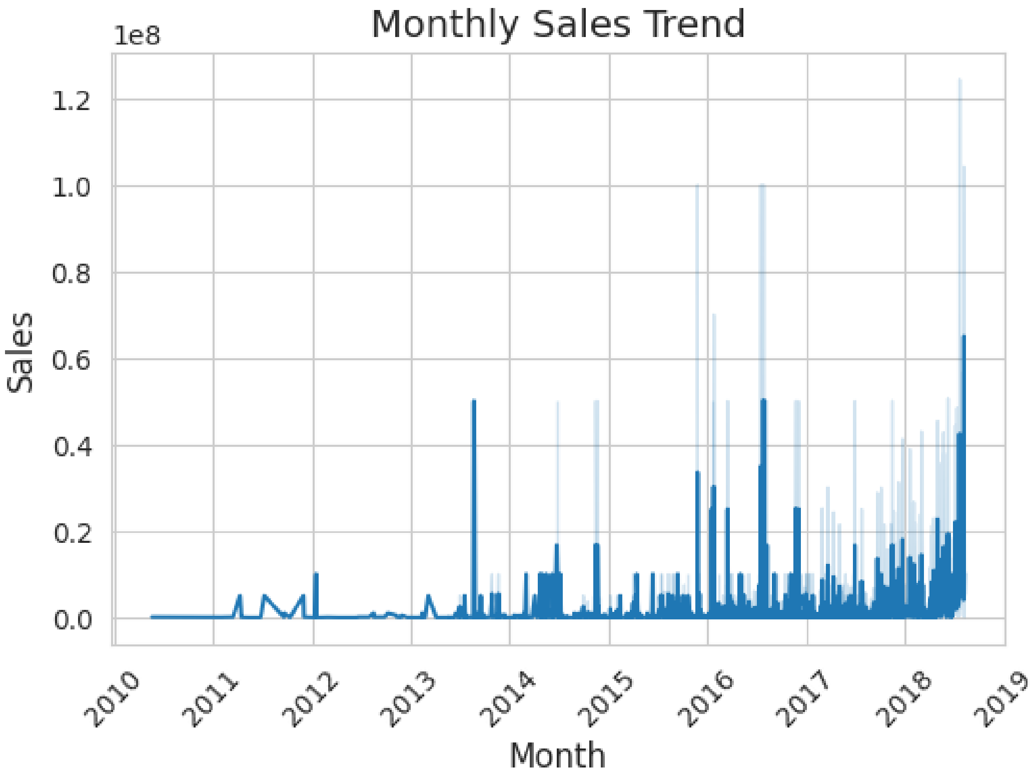
[39]:

```
import plotly.graph_objects as go
```

[40]:

```
# Set the style for the plot
sns.set_style("whitegrid")

# Create a line plot for sales trend over time
plt.figure(figsize=(6, 4))
```

```
sns.lineplot(data=data1, x='Last Updated', y='Installs')

# Label the axes and add a title
plt.xlabel('Month', fontsize=12)
plt.ylabel('Sales', fontsize=12)
plt.title('Monthly Sales Trend', fontsize=14)

# Rotate x-axis labels for better readability
plt.xticks(rotation=45)

# Display the plot
plt.show()
```



[42]:
```
print('\033[1mDistribution of Sentiment Categories for user reviews:\033[0m')

# Calculate sentiment analysis results
sentiment_counts = data2['Sentiment_Class'].value_counts()
sentiment_percentages = (sentiment_counts / len(data2)) * 100

# Create a horizontal bar chart
fig = go.Figure(go.Bar(
    x=sentiment_percentages.values,
    y=sentiment_percentages.index,
    orientation='h',
    marker_color=['lightgreen', 'lightskyblue', 'lightcoral'],  # Colors for␣
 ↪positive, neutral, and negative sentiments
))

# Update layout
fig.update_layout(
    xaxis_title='Percentage (%)',
    yaxis_title='Sentiment Category',
    yaxis=dict(autorange="reversed"),# Reverse the y-axis to show positive␣
 ↪sentiment at the top
    width=600, height=400
)

# Show the interactive plot
fig.show()
```

```
Distribution of Sentiment Categories for user reviews:
```