# 1. Google Play Store apps and reviews

Mobile apps are everywhere. They are easy to create and can be lucrative. Because of these two factors, more and more apps are being developed. In this notebook, we will do a comprehensive analysis of the Android app market by comparing over ten thousand apps in Google Play across different categories. We'll look for insights in the data to devise strategies to drive growth and retention.


Let's take a look at the data, which consists of two files:

- `apps.csv`: contains all the details of the applications on Google Play. There are 13 features that describe a given app.
- `user_reviews.csv`: contains 100 reviews for each app, most helpful first (https://www.androidpolice.com/2019/01/21/google-play-stores-redesigned-ratings-and-reviews-section-lets-you-easily-filter-by-star-rating/). The text in each review has been pre-processed and attributed with three new features: Sentiment (Positive, Negative or Neutral), Sentiment Polarity and Sentiment Subjectivity.

In [ ]:
```
# Read in dataset
import pandas as pd
apps_with_duplicates = pd.read_csv("datasets/apps.csv")

# Drop duplicates from apps_with_duplicates
apps = apps_with_duplicates.drop_duplicates()

# Print the total number of apps
print('Total number of apps in the dataset = ', apps)

# Have a look at a random sample of 5 rows
print(apps[0:5])
```

```
Total number of apps in the dataset =        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
5              5                          Paper flowers instructions
6              6            Smoke Effect Photo Maker - Smoke Editor
7              7                                 Infinite Painter
8              8                               Garden Coloring Book
9              9                        Kids Paint Free - Drawing Fun
10            10                             Text on Photo - Fonteee
11            11            Name Art Photo Editor - Focus n Filters
12            12                     Tattoo Name On My Photo Editor
13            13                               Mandala Coloring Book
14            14    3D Color Pixel by Number - Sandbox Art Coloring
15            15                    Learn To Draw Kawaii Characters
16            16       Photo Designer - Write your name with shapes
17            17                            350 Diy Room Decor Ideas
18            18                      FlipaClip - Cartoon animation
19            19                                        ibis Paint X
20            20                          Logo Maker - Small Business
21            21          Boys Photo Editor - Six Pack & Men's Suit
22            22            Superheroes Wallpapers | 4K Backgrounds
23            23                               Mcqueen Coloring pages
24            24                           HD Mickey Minnie Wallpapers
25            25                            Harley Quinn wallpapers HD
26            26                       Colorfit - Drawing & Coloring
27            27                               Animated Photo Editor
28            28                               Pencil Sketch Drawing
29            29                     Easy Realistic Drawing Tutorial
...          ...                                                 ...
9629       10811                                       FR Plus 1.6
9630       10812                                     Fr Agnel Pune
9631       10813                                    DICT.fr Mobile
9632       10814                                FR: My Secret Pets!
9633       10815                          Golden Dictionary (FR-AR)
9634       10816                                 FieldBi FR Offline
9635       10817                               HTC Sense Input - FR
9636       10818                               Gold Quote - Gold.fr
9637       10819                                         Fanfic-FR
9638       10820                                Fr. Daoud Lamei
9639       10821                                           Poop FR
9640       10822                                         PLMGSS FR
9641       10823                                    List iptv FR
9642       10824                                       Cardio-FR
9643       10825                                 Naruto & Boruto FR
9644       10826          Frim: get new friends on local chat rooms
9645       10827                                 Fr Agnel Ambarnath
9646       10828                              Manga-FR - Anime Vostfr
9647       10829                       Bulgarian French Dictionary Fr
9648       10830                                 News Minecraft.fr
9649       10831                       payermonstationnement.fr
9650       10832                                         FR Tides
9651       10833                                      Chemin (fr)
9652       10834                                    FR Calculator
```

```
9653       10835                                        FR Forms
9654       10836                                Sya9a Maroc - FR
9655       10837                Fr. Mike Schmitz Audio Teachings
9656       10838                         Parkinson Exercices FR
9657       10839                    The SCP Foundation DB fr nn5n
9658       10840      iHoroscope - 2018 Daily Horoscope & Astrology

                    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
5           ART_AND_DESIGN     4.4      167   5.6      50,000+  Free     0
6           ART_AND_DESIGN     3.8      178  19.0      50,000+  Free     0
7           ART_AND_DESIGN     4.1    36815  29.0   1,000,000+  Free     0
8           ART_AND_DESIGN     4.4    13791  33.0   1,000,000+  Free     0
9           ART_AND_DESIGN     4.7      121   3.1      10,000+  Free     0
10          ART_AND_DESIGN     4.4    13880  28.0   1,000,000+  Free     0
11          ART_AND_DESIGN     4.4     8788  12.0   1,000,000+  Free     0
12          ART_AND_DESIGN     4.2    44829  20.0  10,000,000+  Free     0
13          ART_AND_DESIGN     4.6     4326  21.0     100,000+  Free     0
14          ART_AND_DESIGN     4.4     1518  37.0     100,000+  Free     0
15          ART_AND_DESIGN     3.2       55   2.7       5,000+  Free     0
16          ART_AND_DESIGN     4.7     3632   5.5     500,000+  Free     0
17          ART_AND_DESIGN     4.5       27  17.0      10,000+  Free     0
18          ART_AND_DESIGN     4.3   194216  39.0   5,000,000+  Free     0
19          ART_AND_DESIGN     4.6   224399  31.0  10,000,000+  Free     0
20          ART_AND_DESIGN     4.0      450  14.0     100,000+  Free     0
21          ART_AND_DESIGN     4.1      654  12.0     100,000+  Free     0
22          ART_AND_DESIGN     4.7     7699   4.2     500,000+  Free     0
23          ART_AND_DESIGN     NaN       61   7.0     100,000+  Free     0
24          ART_AND_DESIGN     4.7      118  23.0      50,000+  Free     0
25          ART_AND_DESIGN     4.8      192   6.0      10,000+  Free     0
26          ART_AND_DESIGN     4.7    20260  25.0     500,000+  Free     0
27          ART_AND_DESIGN     4.1      203   6.1     100,000+  Free     0
28          ART_AND_DESIGN     3.9      136   4.6      10,000+  Free     0
29          ART_AND_DESIGN     4.1      223   4.2     100,000+  Free     0
...                    ...     ...      ...   ...          ...   ...   ...
9629    AUTO_AND_VEHICLES      NaN        4   3.9         100+  Free     0
9630               FAMILY     4.1       80  13.0       1,000+  Free     0
9631             BUSINESS     NaN       20   2.7      10,000+  Free     0
9632               FAMILY     4.0      785  31.0      50,000+  Free     0
9633  BOOKS_AND_REFERENCE     4.2     5775   4.9     500,000+  Free     0
9634             BUSINESS     NaN        2   6.8         100+  Free     0
9635                TOOLS     4.0      885   8.0     100,000+  Free     0
9636              FINANCE     NaN       96   1.5      10,000+  Free     0
9637  BOOKS_AND_REFERENCE     3.3       52   3.6       5,000+  Free     0
9638               FAMILY     5.0       22   8.6       1,000+  Free     0
9639               FAMILY     NaN        6   2.5          50+  Free     0
9640        PRODUCTIVITY      NaN        0   3.1          10+  Free     0
9641       VIDEO_PLAYERS     NaN        1   2.9         100+  Free     0
9642             MEDICAL     NaN       67  82.0      10,000+  Free     0
9643              SOCIAL     NaN        7   7.7         100+  Free     0
9644              SOCIAL     4.0    88486   NaN   5,000,000+  Free     0
9645               FAMILY     4.2      117  13.0       5,000+  Free     0
9646              COMICS      3.4      291  13.0      10,000+  Free     0
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9647 | BOOKS_AND_REFERENCE | 4.6 | 603 | 7.4 | 10,000+ | Free | 0 |
| 9648 | NEWS_AND_MAGAZINES | 3.8 | 881 | 2.3 | 100,000+ | Free | 0 |
| 9649 | MAPS_AND_NAVIGATION | NaN | 38 | 9.8 | 5,000+ | Free | 0 |
| 9650 | WEATHER | 3.8 | 1195 | 0.6 | 100,000+ | Free | 0 |
| 9651 | BOOKS_AND_REFERENCE | 4.8 | 44 | 0.6 | 1,000+ | Free | 0 |
| 9652 | FAMILY | 4.0 | 7 | 2.6 | 500+ | Free | 0 |
| 9653 | BUSINESS | NaN | 0 | 9.6 | 10+ | Free | 0 |
| 9654 | FAMILY | 4.5 | 38 | 53.0 | 5,000+ | Free | 0 |
| 9655 | FAMILY | 5.0 | 4 | 3.6 | 100+ | Free | 0 |
| 9656 | MEDICAL | NaN | 3 | 9.5 | 1,000+ | Free | 0 |
| 9657 | BOOKS_AND_REFERENCE | 4.5 | 114 | NaN | 1,000+ | Free | 0 |
| 9658 | LIFESTYLE | 4.5 | 398307 | 19.0 | 10,000,000+ | 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 | |
| 5 | Everyone | Art & Design | March 26, 2017 | |
| 6 | Everyone | Art & Design | April 26, 2018 | |
| 7 | Everyone | Art & Design | June 14, 2018 | |
| 8 | Everyone | Art & Design | September 20, 2017 | |
| 9 | Everyone | Art & Design;Creativity | July 3, 2018 | |
| 10 | Everyone | Art & Design | October 27, 2017 | |
| 11 | Everyone | Art & Design | July 31, 2018 | |
| 12 | Teen | Art & Design | April 2, 2018 | |
| 13 | Everyone | Art & Design | June 26, 2018 | |
| 14 | Everyone | Art & Design | August 3, 2018 | |
| 15 | Everyone | Art & Design | June 6, 2018 | |
| 16 | Everyone | Art & Design | July 31, 2018 | |
| 17 | Everyone | Art & Design | November 7, 2017 | |
| 18 | Everyone | Art & Design | August 3, 2018 | |
| 19 | Everyone | Art & Design | July 30, 2018 | |
| 20 | Everyone | Art & Design | April 20, 2018 | |
| 21 | Everyone | Art & Design | March 20, 2018 | |
| 22 | Everyone 10+ | Art & Design | July 12, 2018 | |
| 23 | Everyone | Art & Design;Action & Adventure | March 7, 2018 | |
| 24 | Everyone | Art & Design | July 7, 2018 | |
| 25 | Everyone | Art & Design | April 25, 2018 | |
| 26 | Everyone | Art & Design;Creativity | October 11, 2017 | |
| 27 | Everyone | Art & Design | March 21, 2018 | |
| 28 | Everyone | Art & Design | July 12, 2018 | |
| 29 | Everyone | Art & Design | August 22, 2017 | |
| ... | ... | ... | ... | |
| 9629 | Everyone | Auto & Vehicles | July 24, 2018 | |
| 9630 | Everyone | Education | June 13, 2018 | |
| 9631 | Everyone | Business | July 17, 2018 | |
| 9632 | Teen | Entertainment | June 3, 2015 | |
| 9633 | Everyone | Books & Reference | July 19, 2018 | |
| 9634 | Everyone | Business | August 6, 2018 | |
| 9635 | Everyone | Tools | October 30, 2015 | |
| 9636 | Everyone | Finance | May 19, 2016 | |
| 9637 | Teen | Books & Reference | August 5, 2017 | |
| 9638 | Teen | Education | June 27, 2018 | |
| 9639 | Everyone | Entertainment | May 29, 2018 | |
| 9640 | Everyone | Productivity | December 1, 2017 | |

| | | | |
|---|---|---|---|
| 9641 | Everyone | Video Players & Editors | April 22, 2018 |
| 9642 | Everyone | Medical | July 31, 2018 |
| 9643 | Teen | Social | February 2, 2018 |
| 9644 | Mature 17+ | Social | March 23, 2018 |
| 9645 | Everyone | Education | June 13, 2018 |
| 9646 | Everyone | Comics | May 15, 2017 |
| 9647 | Everyone | Books & Reference | June 19, 2016 |
| 9648 | Everyone | News & Magazines | January 20, 2014 |
| 9649 | Everyone | Maps & Navigation | June 13, 2018 |
| 9650 | Everyone | Weather | February 16, 2014 |
| 9651 | Everyone | Books & Reference | March 23, 2014 |
| 9652 | Everyone | Education | June 18, 2017 |
| 9653 | Everyone | Business | September 29, 2016 |
| 9654 | Everyone | Education | July 25, 2017 |
| 9655 | Everyone | Education | July 6, 2018 |
| 9656 | Everyone | Medical | January 20, 2017 |
| 9657 | Mature 17+ | Books & Reference | January 19, 2015 |
| 9658 | Everyone | Lifestyle | July 25, 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 |
| 5 | 1 | 2.3 and up |
| 6 | 1.1 | 4.0.3 and up |
| 7 | 6.1.61.1 | 4.2 and up |
| 8 | 2.9.2 | 3.0 and up |
| 9 | 2.8 | 4.0.3 and up |
| 10 | 1.0.4 | 4.1 and up |
| 11 | 1.0.15 | 4.0 and up |
| 12 | 3.8 | 4.1 and up |
| 13 | 1.0.4 | 4.4 and up |
| 14 | 1.2.3 | 2.3 and up |
| 15 | NaN | 4.2 and up |
| 16 | 3.1 | 4.1 and up |
| 17 | 1 | 2.3 and up |
| 18 | 2.2.5 | 4.0.3 and up |
| 19 | 5.5.4 | 4.1 and up |
| 20 | 4 | 4.1 and up |
| 21 | 1.1 | 4.0.3 and up |
| 22 | 2.2.6.2 | 4.0.3 and up |
| 23 | 1.0.0 | 4.1 and up |
| 24 | 1.1.3 | 4.1 and up |
| 25 | 1.5 | 3.0 and up |
| 26 | 1.0.8 | 4.0.3 and up |
| 27 | 1.03 | 4.0.3 and up |
| 28 | 6 | 2.3 and up |
| 29 | 1 | 2.3 and up |
| ... | ... | ... |
| 9629 | 1.3.6 | 4.4W and up |
| 9630 | 2.0.20 | 4.0.3 and up |
| 9631 | 2.1.10 | 4.1 and up |
| 9632 | 1.3.1 | 3.0 and up |
| 9633 | 7.0.4.6 | 4.2 and up |
| 9634 | 2.1.8 | 4.1 and up |

```
9635          1.0.612928          5.0 and up
9636                 2.3          2.2 and up
9637               0.3.4          4.1 and up
9638               3.8.0          4.1 and up
9639                   1        4.0.3 and up
9640                   1          4.4 and up
9641                   1        4.0.3 and up
9642               2.2.2          4.4 and up
9643                   1          4.0 and up
9644  Varies with device  Varies with device
9645              2.0.20        4.0.3 and up
9646               2.0.1          4.0 and up
9647                2.96          4.1 and up
9648                 1.5          1.6 and up
9649           2.0.148.0          4.0 and up
9650                   6          2.1 and up
9651                 0.8          2.2 and up
9652               1.0.0          4.1 and up
9653               1.1.5          4.0 and up
9654                1.48          4.1 and up
9655                   1          4.1 and up
9656                   1          2.2 and up
9657  Varies with device  Varies with device
9658  Varies with device  Varies with device

[9659 rows x 14 columns]
   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
```

# 2. Data cleaning

Data cleaning is one of the most essential subtask any data science project. Although it can be a very tedious process, it's worth should never be undermined.

By looking at a random sample of the dataset rows (from the above task), we observe that some entries in the columns like `Installs` and `Price` have a few special characters (`+` , `$`) due to the way the numbers have been represented. This prevents the columns from being purely numeric, making it difficult to use them in subsequent future mathematical calculations. Ideally, as their names suggest, we would want these columns to contain only digits from [0-9].

Hence, we now proceed to clean our data. Specifically, the special characters `,` and `+` present in `Installs` column and `$` present in `Price` column need to be removed.

It is also always a good practice to print a summary of your dataframe after completing data cleaning. We will use the `info()` method to acheive this.

In [ ]:
```
# List of characters to remove
chars_to_remove = ['+', ',', '$']
# List of column names to clean
cols_to_clean = ["Installs", "Price"]

# Loop for each column in cols_to_clean
for col in cols_to_clean:
    # Loop for each char in chars_to_remove
    for char in chars_to_remove:
        # Replace the character with an empty string
        apps[col] = apps[col].apply(lambda x: x.replace(char, ''))

# Print a summary of the apps dataframe
print(apps.info())
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9659 entries, 0 to 9658
Data columns (total 14 columns):
Unnamed: 0        9659 non-null int64
App               9659 non-null object
Category          9659 non-null object
Rating            8196 non-null float64
Reviews           9659 non-null int64
Size              8432 non-null float64
Installs          9659 non-null object
Type              9659 non-null object
Price             9659 non-null object
Content Rating    9659 non-null object
Genres            9659 non-null object
Last Updated      9659 non-null object
Current Ver       9651 non-null object
Android Ver       9657 non-null object
dtypes: float64(2), int64(2), object(10)
memory usage: 1.1+ MB
None
```

# 3. Correcting data types

From the previous task we noticed that `Installs` and `Price` were categorized as `object` data type (and not `int` or `float`) as we would like. This is because these two columns originally had mixed input types: digits and special characters. To know more about Pandas data types, read this (https://datacarpentry.org/python-ecology-lesson/04-data-types-and-format/).

The four features that we will be working with most frequently henceforth are `Installs`, `Size`, `Rating` and `Price`. While `Size` and `Rating` are both `float` (i.e. purely numerical data types), we still need to work on `Installs` and `Price` to make them numeric.

In [ ]:
```
import numpy as np

# Convert Installs to float data type
apps["Installs"] = apps["Installs"].astype(float)

# Convert Price to float data type
apps["Price"] = apps["Price"].astype(float)

# Checking dtypes of the apps dataframe
print(apps.dtypes)
```

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

# 4. Exploring app categories

With more than 1 billion active users in 190 countries around the world, Google Play continues to be an important distribution platform to build a global audience. For businesses to get their apps in front of users, it's important to make them more quickly and easily discoverable on Google Play. To improve the overall search experience, Google has introduced the concept of grouping apps into categories.

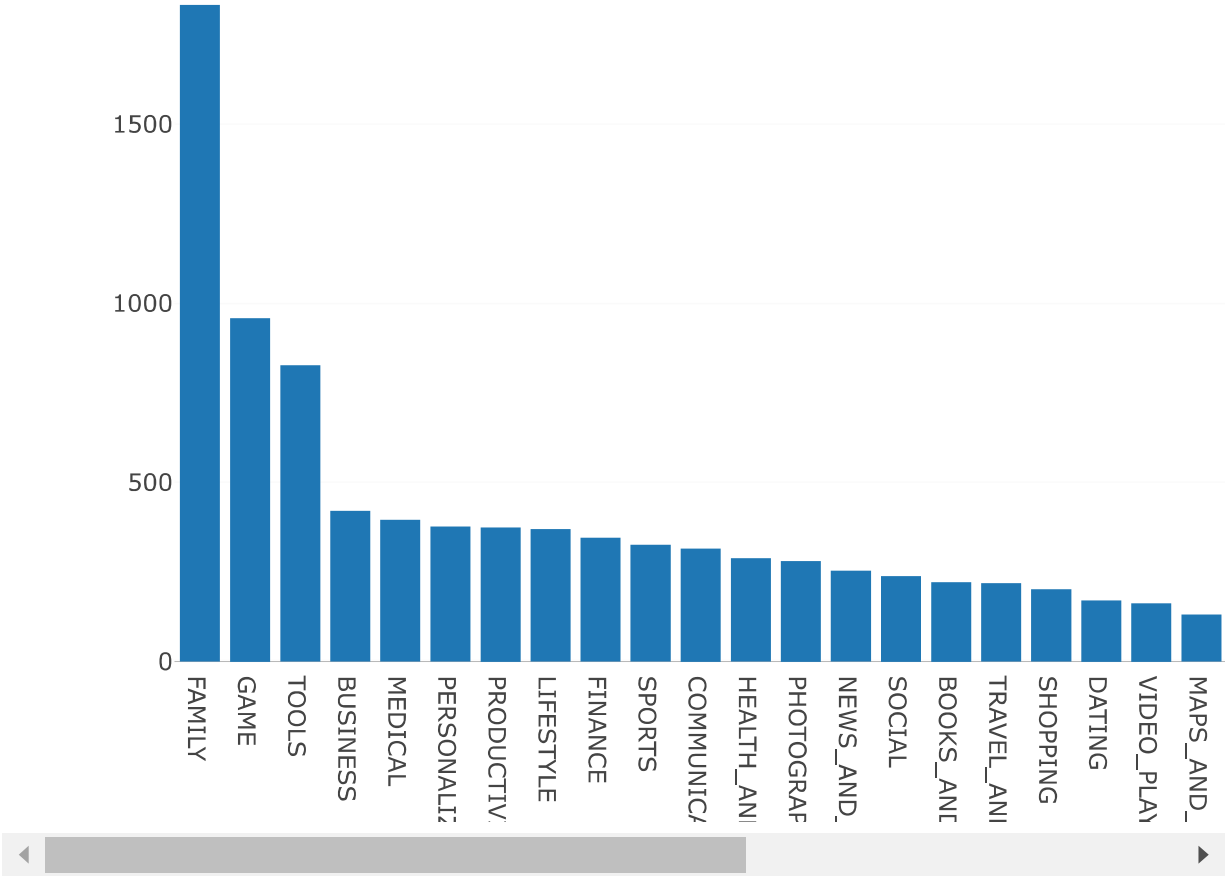
This brings us to the following questions:

- Which category has the highest share of (active) apps in the market?
- Is any specific category dominating the market?
- Which categories have the fewest number of apps?

We will see that there are `33` unique app categories present in our dataset. *Family* and *Game* apps have the highest market prevalence. Interestingly, *Tools*, *Business* and *Medical* apps are also at the top.

In [ ]:
```
import plotly
plotly.offline.init_notebook_mode(connected=True)
import plotly.graph_objs as go

# Print the total number of unique categories
num_categories = len(apps['Category'].unique())
print('Number of categories = ', num_categories)

# Count the number of apps in each 'Category'.
num_apps_in_category = apps['Category'].value_counts()

# Sort num_apps_in_category in descending order based on the count of apps in
 each category
sorted_num_apps_in_category = num_apps_in_category.sort_values(ascending = Fal
se)

data = [go.Bar(
        x = num_apps_in_category.index, # index = category name
        y = num_apps_in_category.values, # value = count
)]

plotly.offline.iplot(data)
```

```
Number of categories =  33
```



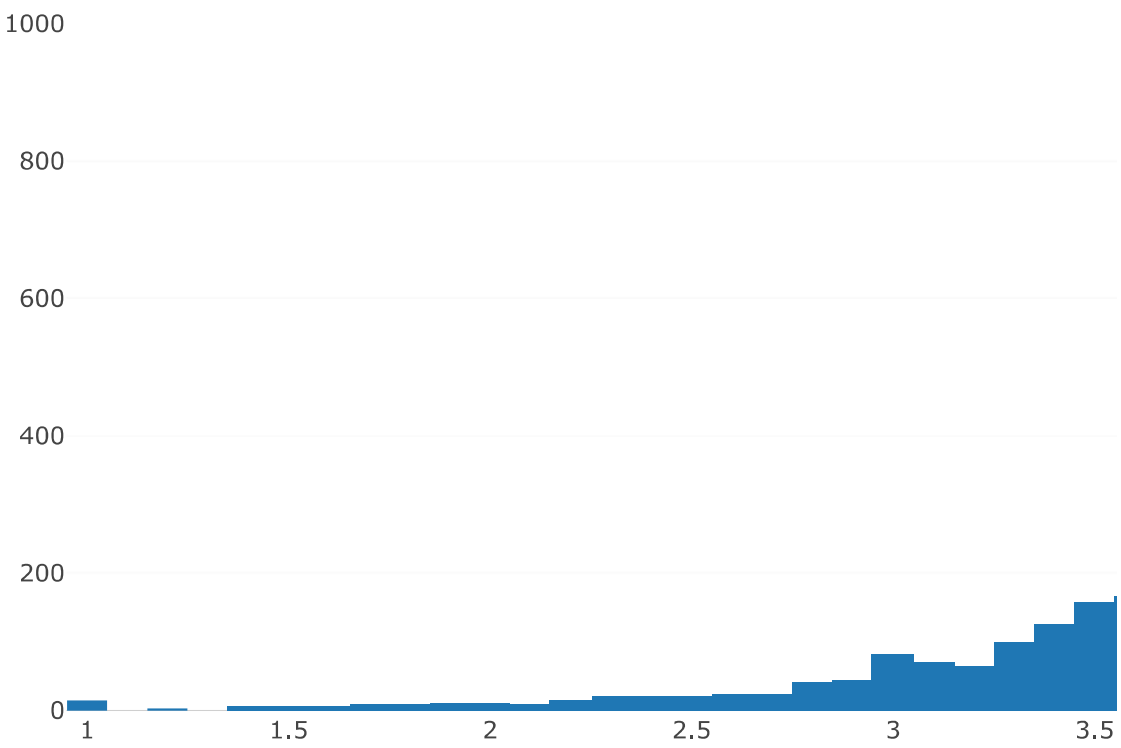

## 5. Distribution of app ratings

After having witnessed the market share for each category of apps, let's see how all these apps perform on an average. App ratings (on a scale of 1 to 5) impact the discoverability, conversion of apps as well as the company's overall brand image. Ratings are a key performance indicator of an app.

From our research, we found that the average volume of ratings across all app categories is `4.17`. The histogram plot is skewed to the left indicating that the majority of the apps are highly rated with only a few exceptions in the low-rated apps.

In [ ]:
```
# Average rating of apps
avg_app_rating = apps['Rating'].mean()
print('Average app rating = ', avg_app_rating)

# Distribution of apps according to their ratings
data = [go.Histogram(
        x = apps['Rating']
)]

# Vertical dashed line to indicate the average app rating
layout = {'shapes': [{
              'type' :'line',
              'x0': avg_app_rating,
              'y0': 0,
              'x1': avg_app_rating,
              'y1': 1000,
              'line': { 'dash': 'dashdot'}
          }]
          }

plotly.offline.iplot({'data': data, 'layout': layout})
```

```
Average app rating =  4.173243045387994
```



# 6. Size and price of an app

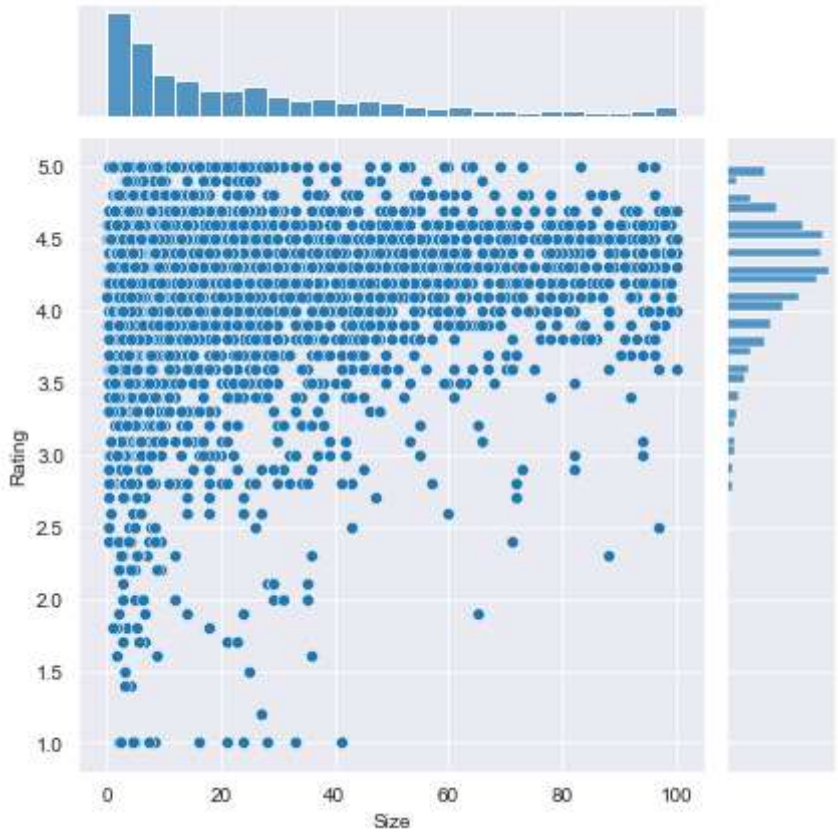
Let's now examine app size and app price. For size, if the mobile app is too large, it may be difficult and/or expensive for users to download. Lengthy download times could turn users off before they even experience your mobile app. Plus, each user's device has a finite amount of disk space. For price, some users expect their apps to be free or inexpensive. These problems compound if the developing world is part of your target market; especially due to internet speeds, earning power and exchange rates.

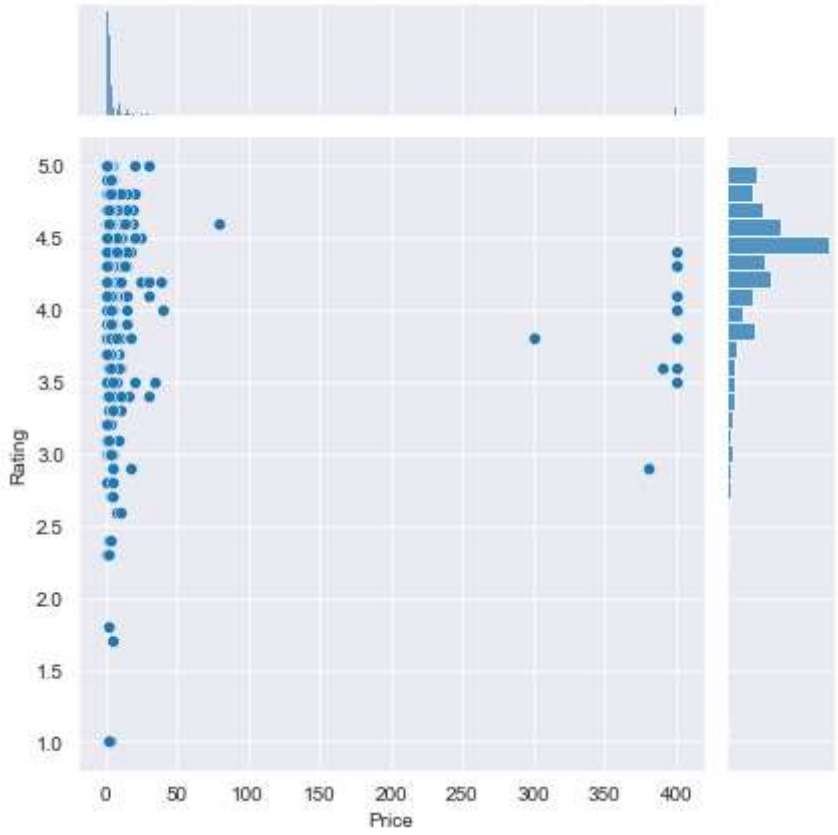
How can we effectively come up with strategies to size and price our app?

- Does the size of an app affect its rating?
- Do users really care about system-heavy apps or do they prefer light-weighted apps?
- Does the price of an app affect its rating?
- Do users always prefer free apps over paid apps?

We find that the majority of top rated apps (rating over 4) range from 2 MB to 20 MB. We also find that the vast majority of apps price themselves under $10.

In [ ]:
```
%matplotlib inline
import seaborn as sns
sns.set_style("darkgrid")
import warnings
warnings.filterwarnings("ignore")

# Select rows where both 'Rating' and 'Size' values are present (ie. the two v
alues are not null)
apps_with_size_and_rating_present = apps[(~apps['Rating'].isnull()) & (~apps[
'Size'].isnull())]

# Subset for categories with at least 250 apps
large_categories = apps_with_size_and_rating_present.groupby(['Category']).fil
ter(lambda x: len(x) >= 250)

# Plot size vs. rating
plt1 = sns.jointplot(x = large_categories['Size'], y = large_categories['Ratin
g'])

# Select apps whose 'Type' is 'Paid'
paid_apps = apps_with_size_and_rating_present[apps_with_size_and_rating_presen
t['Type']=='Paid']

# Plot price vs. rating
plt2 = sns.jointplot(x = paid_apps['Price'], y = paid_apps['Rating'])
```


Rating
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
20
40
60
80
100
Size


Rating
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
50
100
150
200
250
300
350
400
Price

# 7. Relation between app category and app price

So now comes the hard part. How are companies and developers supposed to make ends meet? What monetization strategies can companies use to maximize profit? The costs of apps are largely based on features, complexity, and platform.

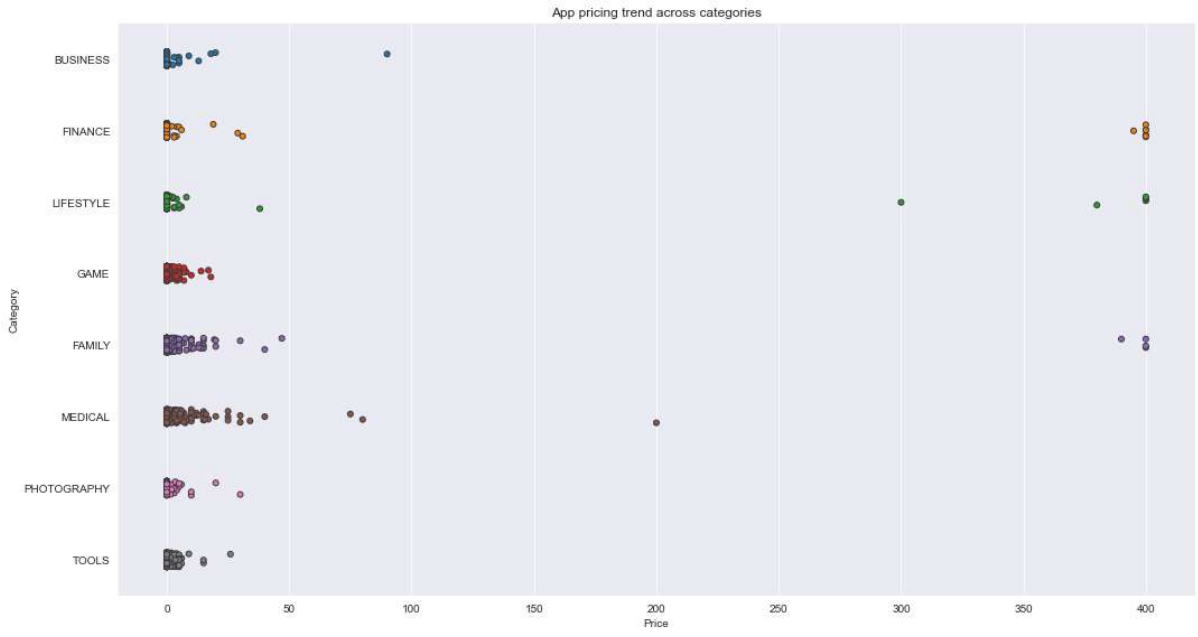
There are many factors to consider when selecting the right pricing strategy for your mobile app. It is important to consider the willingness of your customer to pay for your app. A wrong price could break the deal before the download even happens. Potential customers could be turned off by what they perceive to be a shocking cost, or they might delete an app they've downloaded after receiving too many ads or simply not getting their money's worth.

Different categories demand different price ranges. Some apps that are simple and used daily, like the calculator app, should probably be kept free. However, it would make sense to charge for a highly-specialized medical app that diagnoses diabetic patients. Below, we see that *Medical and Family* apps are the most expensive. Some medical apps extend even up to $80! All game apps are reasonably priced below $20.

In [ ]:
```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
fig.set_size_inches(15, 8)

# Select a few popular app categories
popular_app_cats = apps[apps.Category.isin(['GAME', 'FAMILY', 'PHOTOGRAPHY',
                                            'MEDICAL', 'TOOLS', 'FINANCE',
                                            'LIFESTYLE','BUSINESS'])]

# Examine the price trend by plotting Price vs Category
ax = sns.stripplot(x = popular_app_cats['Price'], y = popular_app_cats['Catego
ry'], jitter=True, linewidth=1)
ax.set_title('App pricing trend across categories')

# Apps whose Price is greater than 200
apps_above_200 = popular_app_cats[popular_app_cats['Price'] >200 ]
apps_above_200[['Category', 'App', 'Price']]
```

Out[ ]:

| | Category | App | Price |
|---|---|---|---|
| **3327** | FAMILY | most expensive app (H) | 399.99 |
| **3465** | LIFESTYLE | 💎 I'm rich | 399.99 |
| **3469** | LIFESTYLE | I'm Rich - Trump Edition | 400.00 |
| **4396** | LIFESTYLE | I am rich | 399.99 |
| **4398** | FAMILY | I am Rich Plus | 399.99 |
| **4399** | LIFESTYLE | I am rich VIP | 299.99 |
| **4400** | FINANCE | I Am Rich Premium | 399.99 |
| **4401** | LIFESTYLE | I am extremely Rich | 379.99 |
| **4402** | FINANCE | I am Rich! | 399.99 |
| **4403** | FINANCE | I am rich(premium) | 399.99 |
| **4406** | FAMILY | I Am Rich Pro | 399.99 |
| **4408** | FINANCE | I am rich (Most expensive app) | 399.99 |
| **4410** | FAMILY | I Am Rich | 389.99 |
| **4413** | FINANCE | I am Rich | 399.99 |
| **4417** | FINANCE | I AM RICH PRO PLUS | 399.99 |
| **8763** | FINANCE | Eu Sou Rico | 394.99 |
| **8780** | LIFESTYLE | I'm Rich/Eu sou Rico/أنا غني/我很有錢 | 399.99 |



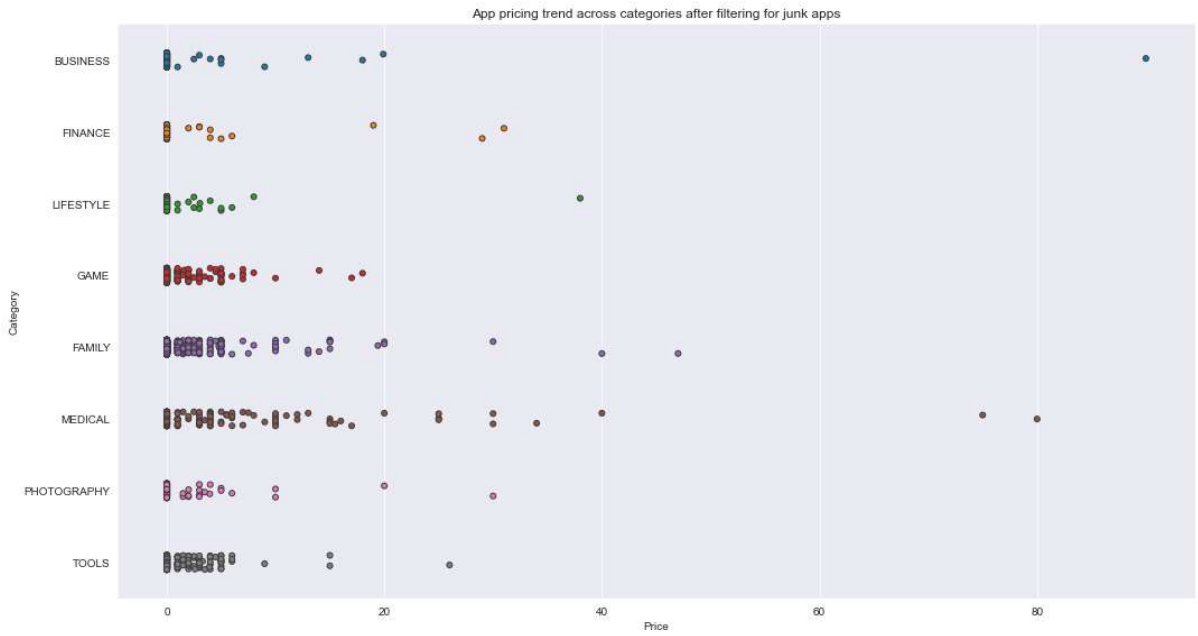
# 8. Filter out "junk" apps

It looks like a bunch of the really expensive apps are "junk" apps. That is, apps that don't really have a purpose. Some app developer may create an app called *I Am Rich Premium* or *most expensive app (H)* just for a joke or to test their app development skills. Some developers even do this with malicious intent and try to make money by hoping people accidentally click purchase on their app in the store.

Let's filter out these junk apps and re-do our visualization.

In [ ]:
```
# Select apps priced below $100
apps_under_100 = popular_app_cats[popular_app_cats['Price'] < 100]

fig, ax = plt.subplots()
fig.set_size_inches(15, 8)

# Examine price vs category with the authentic apps (apps_under_100)
ax = sns.stripplot(x = 'Price', y = 'Category', data = apps_under_100, jitter
= True, linewidth = 1)
ax.set_title('App pricing trend across categories after filtering for junk app
s')
```

Out[ ]:
```
Text(0.5, 1.0, 'App pricing trend across categories after filtering for junk
apps')
```



# 9. Popularity of paid apps vs free apps

For apps in the Play Store today, there are five types of pricing strategies: free, freemium, paid, paymium, and subscription. Let's focus on free and paid apps only. Some characteristics of free apps are:

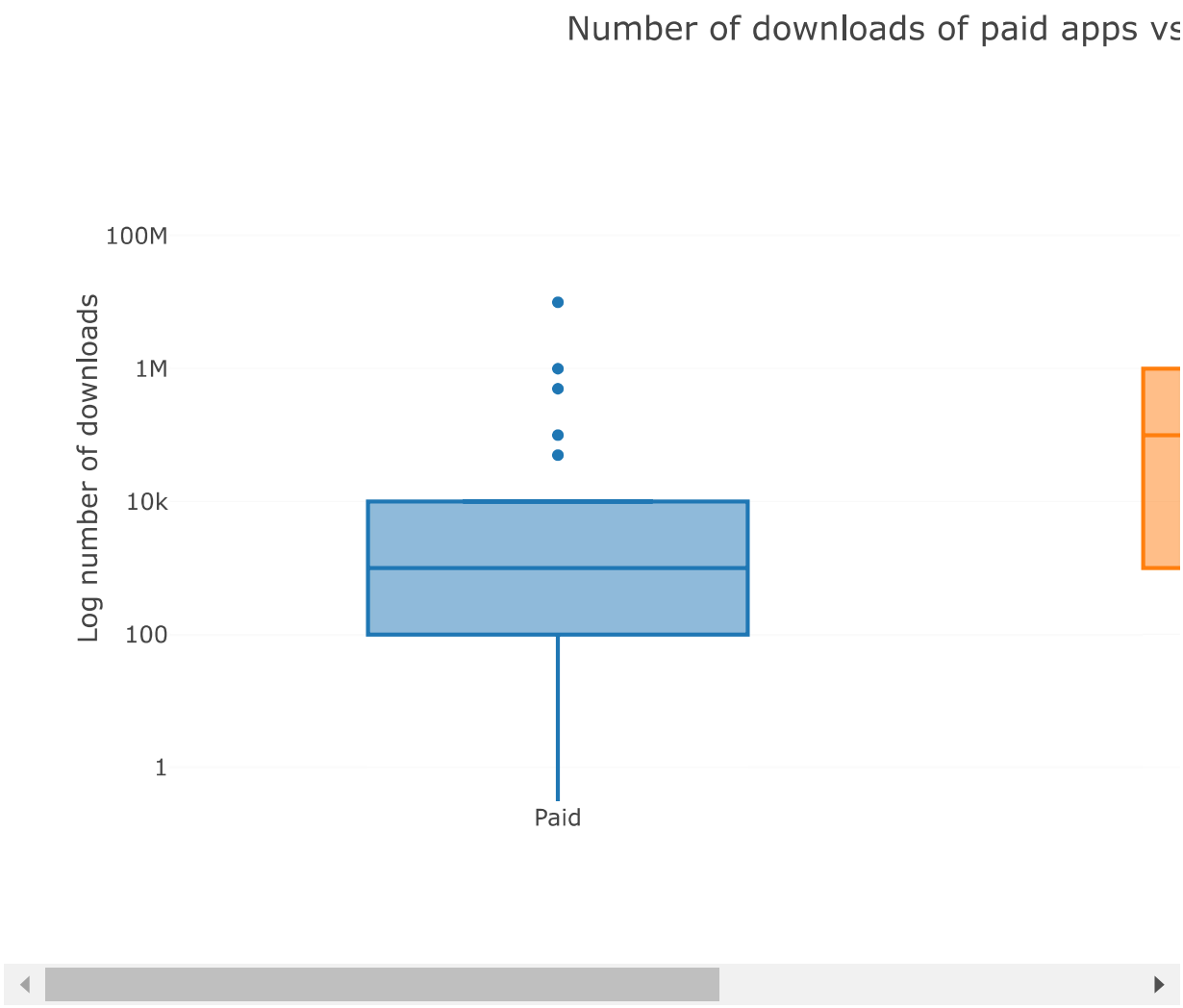
- Free to download.
- Main source of income often comes from advertisements.
- Often created by companies that have other products and the app serves as an extension of those products.
- Can serve as a tool for customer retention, communication, and customer service.

Some characteristics of paid apps are:

- Users are asked to pay once for the app to download and use it.
- The user can't really get a feel for the app before buying it.

Are paid apps installed as much as free apps? It turns out that paid apps have a relatively lower number of installs than free apps, though the difference is not as stark as I would have expected!

In [ ]:
```
trace0 = go.Box(
    # Data for paid apps
    y = apps[apps['Type'] == 'Paid']['Installs'],
    name = 'Paid'
)

trace1 = go.Box(
    # Data for free apps
    y = apps[apps['Type'] == 'Free']['Installs'],
    name = 'Free'
)

layout = go.Layout(
    title = "Number of downloads of paid apps vs. free apps",
    yaxis = dict(title = "Log number of downloads",
                 type = 'log',
                 autorange = True)
)

# Add trace0 and trace1 to a list for plotting
data = [trace0, trace1]
plotly.offline.iplot({'data': data, 'layout': layout})
```



# 10. Sentiment analysis of user reviews

Mining user review data to determine how people feel about your product, brand, or service can be done using a technique called sentiment analysis. User reviews for apps can be analyzed to identify if the mood is positive, negative or neutral about that app. For example, positive words in an app review might include words such as 'amazing', 'friendly', 'good', 'great', and 'love'. Negative words might be words like 'malware', 'hate', 'problem', 'refund', and 'incompetent'.

By plotting sentiment polarity scores of user reviews for paid and free apps, we observe that free apps receive a lot of harsh comments, as indicated by the outliers on the negative y-axis. Reviews for paid apps appear never to be extremely negative. This may indicate something about app quality, i.e., paid apps being of higher quality than free apps on average. The median polarity score for paid apps is a little higher than free apps, thereby syncing with our previous observation.

In this notebook, we analyzed over ten thousand apps from the Google Play Store. We can use our findings to inform our decisions should we ever wish to create an app ourselves.

In [ ]:
```
# Load user_reviews.csv
reviews_df = pd.read_csv('datasets/user_reviews.csv')

# Join the two dataframes
merged_df = pd.merge(apps, reviews_df, on= 'App')

# Drop NA values from Sentiment and Review columns
merged_df = merged_df.dropna(subset = ['Sentiment', 'Review'])

sns.set_style('ticks')
fig, ax = plt.subplots()
fig.set_size_inches(11, 8)

# User review sentiment polarity for paid vs. free apps
ax = sns.boxplot(x = 'Type', y = 'Sentiment_Polarity' , data =merged_df )
ax.set_title('Sentiment Polarity Distribution')
```

Out[ ]: Text(0.5, 1.0, 'Sentiment Polarity Distribution')