Analysis of Yelp Business Intelligence Data

In this project, I analyzed a subset of the Yelp's business, reviews and user data.

The dataset originally comes from Kaggle and it has been uploaded into an S3 bucket:

s3://yelpreviewdataset/yelp_academic_dataset_business.json\
s3://yelpreviewdataset/yelp_academic_dataset_review.json\
s3://yelpreviewdataset/yelp_academic_dataset_user.json

Part I: Installation and Initial Setup

1. Install Packages

In [1]:

```
from pyspark.sql import SparkSession
spark = SparkSession \
.builder \
.appName("Analysis of Yelp Business") \
.config("spark.some.config.option", "some-value") \
.getOrCreate()
sc.install_pypi_package("pandas==1.0.3")
sc.install_pypi_package("matplotlib==3.2.1")
sc.install_pypi_package("seaborn==0.10.0")
sc.list_packages()
```

```
Starting Spark application
```

ID	YARN Application ID	Kind	State	Spark UI	Driver log	Current session?
0	application_1606187319027_0001	pyspark	idle	Link	Link	✓

```
SparkSession available as 'spark'.

Collecting pandas==1.0.3
  Downloading https://files.pythonhosted.org/packages/4a/6a/94b219b8ea0f2d580169e85ed1ed
c0163743f55aaeca8a44c2e8fc1e344e/pandas-1.0.3-cp37-cp37m-manylinux1_x86_64.whl (10.0MB)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/site-packages (f
rom pandas==1.0.3)
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib64/python3.7/site-packages
(from pandas==1.0.3)
Collecting python-dateutil>=2.6.1 (from pandas==1.0.3)
  Downloading https://files.pythonhosted.org/packages/d4/70/d60450c3dd48ef87586924207ae8
907090de0b306af2bce5d134d78615cb/python_dateutil-2.8.1-py2.py3-none-any.whl (227kB)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from
python-dateutil>=2.6.1->pandas==1.0.3)
Installing collected packages: python-dateutil, pandas
Successfully installed pandas-1.0.3 python-dateutil-2.8.1

Collecting matplotlib==3.2.1
  Downloading https://files.pythonhosted.org/packages/b2/c2/71fcf957710f3ba1f09088b35776
a799ba7dd95f7c2b195ec800933b276b/matplotlib-3.2.1-cp37-cp37m-manylinux1_x86_64.whl (12.4
MB)
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1606188495504-0/lib/pyth
on3.7/site-packages (from matplotlib==3.2.1)
Collecting pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 (from matplotlib==3.2.1)
  Downloading https://files.pythonhosted.org/packages/8a/bb/488841f56197b13700afd5658fc2
79a2025a39e22449b7cf29864669b15d/pyparsing-2.4.7-py2.py3-none-any.whl (67kB)
```

```
Collecting cycler>=0.10 (from matplotlib==3.2.1)
  Downloading https://files.pythonhosted.org/packages/f7/d2/e07d3ebb2bd7af696440ce7e754c
59dd546ffe1bbe732c8ab68b9c834e61/cycler-0.10.0-py2.py3-none-any.whl
Requirement already satisfied: numpy>=1.11 in /usr/local/lib64/python3.7/site-packages
(from matplotlib==3.2.1)
Collecting kiwisolver>=1.0.1 (from matplotlib==3.2.1)
  Downloading https://files.pythonhosted.org/packages/d2/46/231de802ade4225b76b96cffe419
cf3ce52bbe92e3b092cf12db7d11c207/kiwisolver-1.3.1-cp37-cp37m-manylinux1_x86_64.whl (1.1M
B)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from
python-dateutil>=2.1->matplotlib==3.2.1)
Installing collected packages: pyparsing, cycler, kiwisolver, matplotlib
Successfully installed cycler-0.10.0 kiwisolver-1.3.1 matplotlib-3.2.1 pyparsing-2.4.7

Collecting seaborn==0.10.0
  Downloading https://files.pythonhosted.org/packages/70/bd/5e6bf595fe6ee0f257ae49336dd1
80768c1ed3d7c7155b2fdf894c1c808a/seaborn-0.10.0-py3-none-any.whl (215kB)
Requirement already satisfied: pandas>=0.22.0 in /mnt/tmp/1606188495504-0/lib/python3.7/
site-packages (from seaborn==0.10.0)
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib64/python3.7/site-packages
(from seaborn==0.10.0)
Collecting scipy>=1.0.1 (from seaborn==0.10.0)
  Downloading https://files.pythonhosted.org/packages/dc/7e/8f6a79b102ca1ea928bae8998b05
bf5dc24a90571db13cd119f275ba6252/scipy-1.5.4-cp37-cp37m-manylinux1_x86_64.whl (25.9MB)
Requirement already satisfied: matplotlib>=2.1.2 in /mnt/tmp/1606188495504-0/lib/python
3.7/site-packages (from seaborn==0.10.0)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/site-packages (f
rom pandas>=0.22.0->seaborn==0.10.0)
Requirement already satisfied: python-dateutil>=2.6.1 in /mnt/tmp/1606188495504-0/lib/py
thon3.7/site-packages (from pandas>=0.22.0->seaborn==0.10.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /mnt/tmp/1606
188495504-0/lib/python3.7/site-packages (from matplotlib>=2.1.2->seaborn==0.10.0)
Requirement already satisfied: cycler>=0.10 in /mnt/tmp/1606188495504-0/lib/python3.7/si
te-packages (from matplotlib>=2.1.2->seaborn==0.10.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /mnt/tmp/1606188495504-0/lib/python
3.7/site-packages (from matplotlib>=2.1.2->seaborn==0.10.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from
python-dateutil>=2.6.1->pandas>=0.22.0->seaborn==0.10.0)
Installing collected packages: scipy, seaborn
Successfully installed scipy-1.5.4 seaborn-0.10.0

Package                    Version
-------------------------- ---------
beautifulsoup4             4.9.1
boto                       2.49.0
click                      7.1.2
cycler                     0.10.0
jmespath                   0.10.0
joblib                     0.16.0
kiwisolver                 1.3.1
lxml                       4.5.2
matplotlib                 3.2.1
mysqlclient                1.4.2
nltk                       3.5
nose                       1.3.4
numpy                      1.16.5
pandas                     1.0.3
pip                        9.0.1
py-dateutil                2.2
pyparsing                  2.4.7
python-dateutil            2.8.1
python37-sagemaker-pyspark 1.4.0
pytz                       2020.1
PyYAML                     5.3.1
regex                      2020.7.14
```

```
scipy                      1.5.4
seaborn                    0.10.0
setuptools                 28.8.0
six                        1.13.0
soupsieve                  1.9.5
tqdm                       4.48.2
wheel                      0.29.0
windmill                   1.6
```

2. Importing

In [2]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import pyspark.sql.functions as F
from scipy import stats
from scipy.stats import norm, skew
from pyspark.sql.functions import explode, split, desc, col, avg, udf, when
from pyspark.sql.types import IntegerType, StringType, DoubleType
```

3. Loading Data

In [3]:

```
business_df = spark.read.json('s3://yelpreviewdataset/yelp_academic_dataset_business.js
```

4. Overview of Data

In [4]:

```
print(f'Columns: {len(business_df.columns)} | Rows: {business_df.count():,}')
```

```
Columns: 14 | Rows: 209,393
```

In [5]:

```
business_df.printSchema()
```

```
root
 |-- address: string (nullable = true)
 |-- attributes: struct (nullable = true)
 |    |-- AcceptsInsurance: string (nullable = true)
 |    |-- AgesAllowed: string (nullable = true)
 |    |-- Alcohol: string (nullable = true)
 |    |-- Ambience: string (nullable = true)
 |    |-- BYOB: string (nullable = true)
 |    |-- BYOBCorkage: string (nullable = true)
 |    |-- BestNights: string (nullable = true)
 |    |-- BikeParking: string (nullable = true)
 |    |-- BusinessAcceptsBitcoin: string (nullable = true)
 |    |-- BusinessAcceptsCreditCards: string (nullable = true)
 |    |-- BusinessParking: string (nullable = true)
 |    |-- ByAppointmentOnly: string (nullable = true)
 |    |-- Caters: string (nullable = true)
 |    |-- CoatCheck: string (nullable = true)
 |    |-- Corkage: string (nullable = true)
 |    |-- DietaryRestrictions: string (nullable = true)
 |    |-- DogsAllowed: string (nullable = true)
 |    |-- DriveThru: string (nullable = true)
 |    |-- GoodForDancing: string (nullable = true)
 |    |-- GoodForKids: string (nullable = true)
 |    |-- GoodForMeal: string (nullable = true)
 |    |-- HairSpecializesIn: string (nullable = true)
 |    |-- HappyHour: string (nullable = true)
 |    |-- HasTV: string (nullable = true)
 |    |-- Music: string (nullable = true)
 |    |-- NoiseLevel: string (nullable = true)
 |    |-- Open24Hours: string (nullable = true)
 |    |-- OutdoorSeating: string (nullable = true)
 |    |-- RestaurantsAttire: string (nullable = true)
 |    |-- RestaurantsCounterService: string (nullable = true)
 |    |-- RestaurantsDelivery: string (nullable = true)
 |    |-- RestaurantsGoodForGroups: string (nullable = true)
 |    |-- RestaurantsPriceRange2: string (nullable = true)
 |    |-- RestaurantsReservations: string (nullable = true)
 |    |-- RestaurantsTableService: string (nullable = true)
 |    |-- RestaurantsTakeOut: string (nullable = true)
 |    |-- Smoking: string (nullable = true)
 |    |-- WheelchairAccessible: string (nullable = true)
 |    |-- WiFi: string (nullable = true)
 |-- business_id: string (nullable = true)
 |-- categories: string (nullable = true)
 |-- city: string (nullable = true)
 |-- hours: struct (nullable = true)
 |    |-- Friday: string (nullable = true)
 |    |-- Monday: string (nullable = true)
 |    |-- Saturday: string (nullable = true)
 |    |-- Sunday: string (nullable = true)
 |    |-- Thursday: string (nullable = true)
 |    |-- Tuesday: string (nullable = true)
 |    |-- Wednesday: string (nullable = true)
 |-- is_open: long (nullable = true)
 |-- latitude: double (nullable = true)
 |-- longitude: double (nullable = true)
 |-- name: string (nullable = true)
 |-- postal_code: string (nullable = true)
 |-- review_count: long (nullable = true)
 |-- stars: double (nullable = true)
 |-- state: string (nullable = true)
```

Display the first 5 rows with the following columns:

- business_id
- name
- city
- state
- categories

In [6]:

```
busi_df = business_df.select('business_id', 'name', 'city', 'state', 'stars', 'categori
busi_df.show(5)
```

```
+--------------------+--------------------+--------------+-----+-----+-----------------
---+
|         business_id|                name|          city|state|stars|          categor
ies|
+--------------------+--------------------+--------------+-----+-----+-----------------
---+
|f9NumwFMBDn751xgF...|The Range At Lake...|     Cornelius|   NC|  3.5|Active Life, Gu
n/...|
|Yzvjg0SayhoZgCljU...|   Carlos Santo, NMD|    Scottsdale|   AZ|  5.0|Health & Medica
```

```
l,...|
|XNoUzKckATkOD1hP6...|             Felinus|       Montreal|   QC|  5.0|Pets, Pet Servic
e...|
|6OAZjbxqM5ol29BuH...|Nevada House of Hose|North Las Vegas|   NV|  2.5|Hardware Stores,
...|
|51M2Kk903DFYI6gnB...|USE MY GUY SERVIC...|           Mesa|   AZ|  4.5|Home Services, P
l...|
+--------------------+--------------------+---------------+-----+-----+-----------------
---+
only showing top 5 rows
```

Part II: Analyzing Categories

Let's now answer: **How many unique categories are represented in this dataset?**

Essentially, we have the categories per business as a list - this is useful to quickly see what each business might be represented as but it is difficult to easily answer the following questions such as:

- How many businesses are categorized as Active Life?
- What are the top 20 most popular categories available?

1. Association Table

We need to "break out" these categories from the business ids? One common approach to take is to build an association table mapping a single business id multiple times to each distinct category.

For instance, given the following:

business_id	categories
abcd123	a,b,c

We would like to derive something like:

business_id	category
abcd123	a
abcd123	b
abcd123	c

What this does is allow us to then perform a myriad of rollups and other analysis on this association table which can aid us in answering the questions asked above.

Display the first 5 rows of the association table below

In [7]:
```
associ_table_one = business_df.select('business_id', explode(split(business_df.categori
associ_table_one.show(5)
```

```
+--------------------+----------------+
|         business_id|        category|
+--------------------+----------------+
|f9NumwFMBDn751xgF...|     Active Life|
|f9NumwFMBDn751xgF...|Gun/Rifle Ranges|
|f9NumwFMBDn751xgF...|     Guns & Ammo|
|f9NumwFMBDn751xgF...|        Shopping|
|Yzvjg0SayhoZgCljU...|Health & Medical|
+--------------------+----------------+
only showing top 5 rows
```

2. Total Unique Categories

Finally, we are ready to answer the question: **what is the total number of unique categories available?**

In [8]:

```
associ_table_one.select('category').distinct().count()
```

```
1336
```

3. Top Categories By Business

Now let's find the top categories in this dataset by rolling up categories.

Counts of Businesses / Category

In [9]:

```
category_count = associ_table_one.select('category').groupby(associ_table_one.category)
category_count.show()
```

```
+--------------------+-----+
|            category|count|
+--------------------+-----+
|      Paddleboarding|   36|
|      Dermatologists|  341|
|        Aerial Tours|   28|
|         Hobby Shops|  828|
|          Bubble Tea|  720|
|             Embassy|   13|
|             Tanning|  938|
|            Handyman|  682|
|      Aerial Fitness|   29|
|             Falafel|  159|
|       Outlet Stores|  399|
|        Summer Camps|  318|
|     Clothing Rental|   55|
|      Sporting Goods| 2311|
|     Cooking Schools|  118|
|  College Counseling|   15|
|  Lactation Services|   50|
|Ski & Snowboard S...|   50|
|             Museums|  359|
|              Doulas|   45|
+--------------------+-----+
only showing top 20 rows
```

Bar Chart of Top Categories

With this data available, let us now build a barchart of the top 20 categories

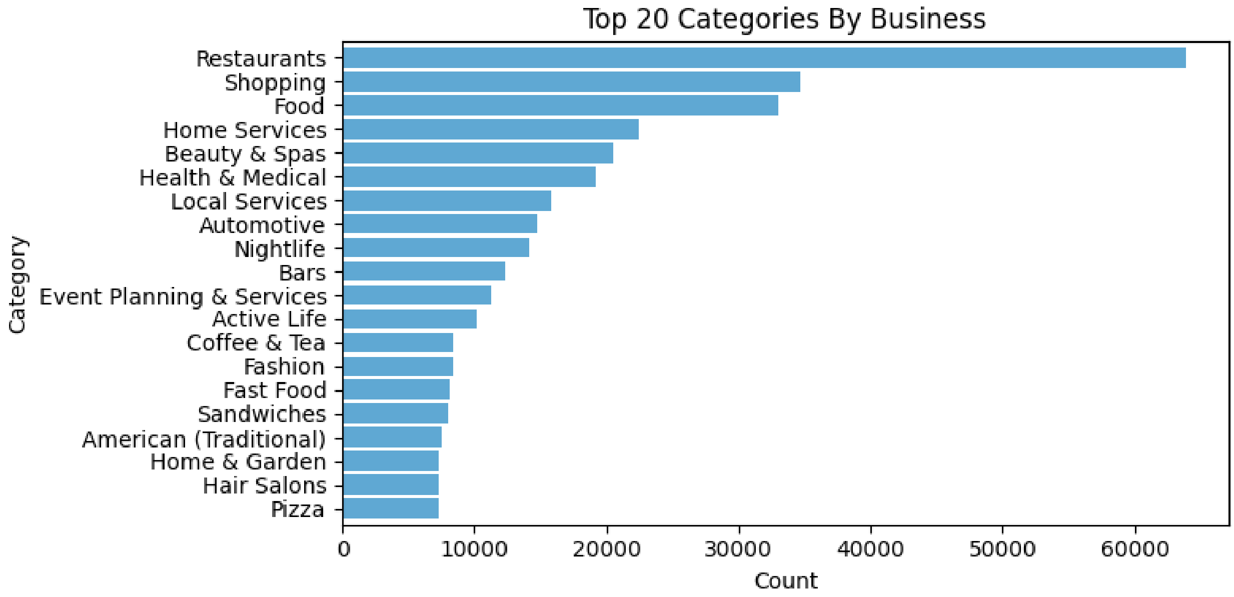
In [52]:

```
top_20 = category_count.sort(desc('count')).limit(20).toPandas()

ax = top_20.plot(kind='barh', x='category', y='count',
            figsize=(8, 4), color='#5fa8d3', zorder=2, width=0.85)
```

```
ax.invert_yaxis()
ax.set_xlabel("Count")
ax.set_ylabel("Category")
ax.set_title("Top 20 Categories By Business")
ax.get_legend().remove()

plt.tight_layout()
%matplot plt
```



Part III. Do Yelp Reviews Skew Negative?

Oftentimes, it is said that the only people who write a written review are those who are extremely dissatisfied or extremely satisfied with the service received.

How true is this really? Let's try and answer this question.

1. Loading Review Data

Begin by loading the review data set from S3 and printing schema to determine what data is available

In [11]:

```
review_df = spark.read.json('s3://yelpreviewdataset/yelp_academic_dataset_review.json')
review_df.printSchema()
```

```
root
 |-- business_id: string (nullable = true)
 |-- cool: long (nullable = true)
 |-- date: string (nullable = true)
 |-- funny: long (nullable = true)
 |-- review_id: string (nullable = true)
 |-- stars: double (nullable = true)
 |-- text: string (nullable = true)
 |-- useful: long (nullable = true)
 |-- user_id: string (nullable = true)
```

Let's begin by listing the business_id and stars columns together for the user reviews data

In [12]:

```
business_stars = review_df.select('business_id', 'stars')
business_stars.show(5)
```

```
+--------------------+-----+
|         business_id|stars|
+--------------------+-----+
|-MhfebM0QIsKt87iD...|  2.0|
|lbrU8StCq3yDfr-QM...|  1.0|
|HQl28KMwrEKHqhFrr...|  5.0|
|5JxlZaqCnk1MnbgRi...|  1.0|
|IS4cv902ykd8wj1TR...|  4.0|
+--------------------+-----+
only showing top 5 rows
```

Now, let's aggregate along the stars column to get a resultant dataframe that displays average stars per business as accumulated by users who **took the time to submit a written review**

In [13]:

```
written_review = review_df.where(col("text").isNotNull()).groupby(review_df.business_id
written_review.show(5)
```

```
+--------------------+------------------+
|         business_id|        avg(stars)|
+--------------------+------------------+
|RMjCnixEY5i12Ciqn...|3.5316455696202533|
|VHsNB3pdGVcRgs6C3...| 3.411764705882353|
|kpbhERZoj1eTDRnMV...| 2.033333333333333|
|ipFreSFhjClfNETuM...|               2.6|
|9A_mB7Ez3RIh26EN5...|               2.6|
+--------------------+------------------+
only showing top 5 rows
```

Now the fun part - let's join our two dataframes (reviews and business data) by business_id

In [14]:

```
user_review = review_df.groupby(review_df.business_id).agg(avg(col("stars")))
new_df1 = business_df.join(written_review, on=['business_id'])
new_df2= business_df.join(user_review,on=['business_id'])
new_df1.select("""avg(stars)""","stars","name","city","state").sort(desc("""avg(stars)"
```

```
+----------+-----+--------------------+----------+-----+
|avg(stars)|stars|                name|      city|state|
+----------+-----+--------------------+----------+-----+
|       5.0|  5.0|  Larry Fafalak, LMT| Las Vegas|   NV|
|       5.0|  5.0|   Rentech Solutions|Willoughby|   OH|
|       5.0|  5.0|Everest Curry and...|   Calgary|   AB|
|       5.0|  5.0|Krown Rust Contro...|   Markham|   ON|
|       5.0|  5.0|     EVO Swim School|      Mesa|   AZ|
+----------+-----+--------------------+----------+-----+
only showing top 5 rows
```

Compute a new dataframe that calculates what we will call the skew (for lack of a better word) between the avg stars accumulated from written reviews and the actual star rating of a business (ie: the average of stars given by reviewers who wrote an actual review and reviewers who just provided a star rating).

The formula you can use is something like:

(row['avg(stars)'] - row['stars']) / row['stars']

If the **skew** is negative, we can interpret that to be: reviewers who left a written response were more dissatisfied than normal. If **skew** is positive, we can interpret that to be: reviewers who left a written response were more satisfied than normal.

In [15]:

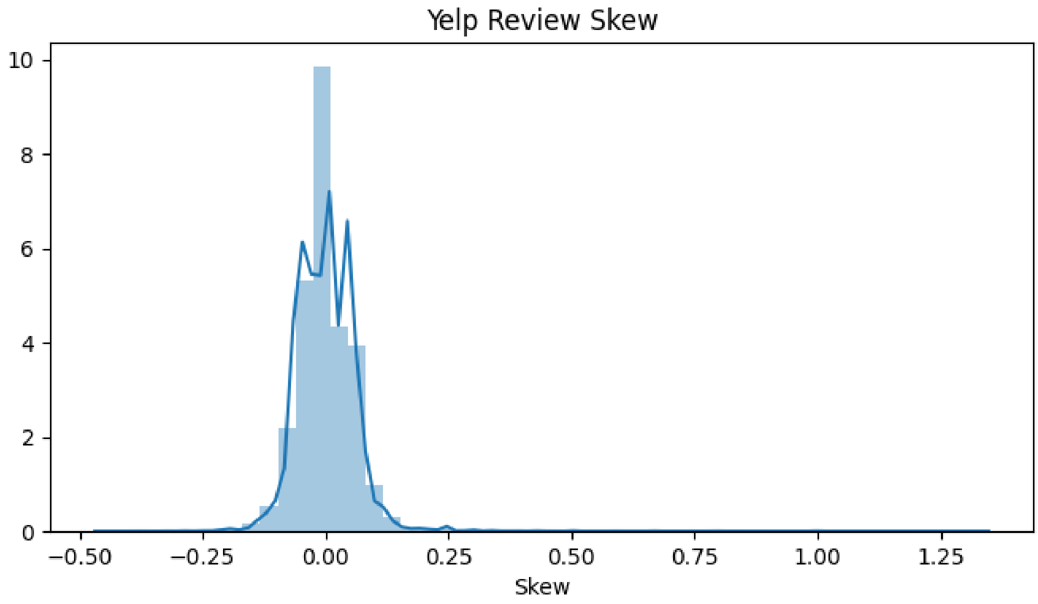
```
fv_df1 = new_df1.select("avg(stars)","stars","name","city","state").sort("""avg(stars)"
fv_df2 =   new_df2.select("avg(stars)","stars","name","city","state").sort("""avg(stars
fv_df = fv_df1.withColumn("skew", ((fv_df1["""avg(stars)"""]-fv_df2["stars"])/fv_df1["s
```

And finally, graph it!

In [50]:

```
plt.figure(figsize=(8,4))
ax = sns.distplot(fv_df["skew"])
ax.set_xlabel('Skew')
plt.title("Yelp Review Skew")

%matplot plt
```



So, do Yelp (written) Reviews skew negative? Does this analysis actually prove anything? Expound on implications / interpretations of this graph.

The distribution of skew appears to be normal, but skewed a little bit to the right. The implications of the above graph are that the satisfaction level of reviewers who left positively skewed reviews is greater than the dissatisfaction level of reviewers who left negatively skewed reviews.

Part IV. Should the Elite be Trusted?

How accurate or close are the ratings of an "elite" user (check Users table schema) vs the actual business rating

It takes a special Yelper to become an Elite. Frequent, quality reviews and photos are important in the application of the elite status on Yelp. Elite candidates need to meet the criteria below for the consideration.

To become Elite, Yelpers agree that they

- Are using their real name on Yelp.
- Have a clear photo of themself on their profile page.
- Are of legal drinking age where they live.

They also agree that they are NOT

- A business owner.
- Closely affiliated with a business owner.
- Managing a Yelp Business Account.
- Working for one of Yelp's competitors.

It's important to know that accepting compensation or freebies in exchange for reviews or leveraging the Elite Squad for personal or commercial gain will result in Elite status being revoked or account closure.

1. Loading User Data

In [17]:

```
user_df = spark.read.json('s3://yelpreviewdataset/yelp_academic_dataset_user.json')
```

2. Overview of Data

In [18]:

```
user_df.printSchema()
print(f'User Dataset Columns: {len(user_df.columns)} | Rows: {user_df.count():,}')
review_df.printSchema()
print(f'Review Dataset Columns: {len(review_df.columns)} | Rows: {review_df.count():,}'
```

```
root
 |-- average_stars: double (nullable = true)
 |-- compliment_cool: long (nullable = true)
 |-- compliment_cute: long (nullable = true)
 |-- compliment_funny: long (nullable = true)
 |-- compliment_hot: long (nullable = true)
 |-- compliment_list: long (nullable = true)
 |-- compliment_more: long (nullable = true)
 |-- compliment_note: long (nullable = true)
 |-- compliment_photos: long (nullable = true)
 |-- compliment_plain: long (nullable = true)
 |-- compliment_profile: long (nullable = true)
 |-- compliment_writer: long (nullable = true)
 |-- cool: long (nullable = true)
 |-- elite: string (nullable = true)
 |-- fans: long (nullable = true)
 |-- friends: string (nullable = true)
 |-- funny: long (nullable = true)
 |-- name: string (nullable = true)
 |-- review_count: long (nullable = true)
 |-- useful: long (nullable = true)
 |-- user_id: string (nullable = true)
 |-- yelping_since: string (nullable = true)

User Dataset Columns: 22 | Rows: 1,968,703
root
 |-- business_id: string (nullable = true)
 |-- cool: long (nullable = true)
 |-- date: string (nullable = true)
 |-- funny: long (nullable = true)
 |-- review_id: string (nullable = true)
 |-- stars: double (nullable = true)
 |-- text: string (nullable = true)
 |-- useful: long (nullable = true)
 |-- user_id: string (nullable = true)

Review Dataset Columns: 9 | Rows: 8,021,122
```

In [19]:

```
user_df.select('user_id','elite').show(5)
```

```
+--------------------+--------------------+
|             user_id|               elite|
+--------------------+--------------------+
|ntlvfPzc8eglqvk92...|                    |
|FOBRPlBHa3WPHFB5q...|2008,2009,2010,20...|
|zZUnPeh2hEp0WydbA...|                2010|
|QaELAmRcDc5TfJEyl...|                2009|
|xvu8G900tezTzbbfq...|2009,2010,2011,20...|
+--------------------+--------------------+
only showing top 5 rows
```

3. Split Elite column

In [20]:

```
user_elite_split = user_df.select('user_id', explode(split(user_df.elite, ',')).alias('
user_elite_split = user_elite_split.withColumn('elite', user_elite_split.elite.cast(Int
user_elite_split.show(5)
print(f'User Elite Split Dataset Columns: {len(user_elite_split.columns)} | Rows: {user
```

```
+--------------------+-----+
|             user_id|elite|
+--------------------+-----+
|ntlvfPzc8eglqvk92...| null|
|FOBRPlBHa3WPHFB5q...| 2008|
|FOBRPlBHa3WPHFB5q...| 2009|
|FOBRPlBHa3WPHFB5q...| 2010|
|FOBRPlBHa3WPHFB5q...| 2011|
+--------------------+-----+
only showing top 5 rows

User Elite Split Dataset Columns: 2 | Rows: 2,125,315
```

In [21]:

```
user_elite_split.select("elite").distinct().sort('elite', ascending=False).show()
```

```
+-----+
|elite|
+-----+
| 2018|
| 2017|
| 2016|
| 2015|
| 2014|
| 2013|
| 2012|
| 2011|
| 2010|
| 2009|
| 2008|
| 2007|
| 2006|
| null|
+-----+
```

In [22]:

```
Elite_or_Not = user_elite_split.select('user_id',
           when( user_elite_split.elite.isNull(), "Not Elite").otherwise("Elite").alias
Elite_or_Not.show()
```

```
+--------------------+------------+
|             user_id|Elite or Not|
+--------------------+------------+
|ntlvfPzc8eglqvk92...|   Not Elite|
|FOBRPlBHa3WPHFB5q...|       Elite|
|FOBRPlBHa3WPHFB5q...|       Elite|
|FOBRPlBHa3WPHFB5q...|       Elite|
|FOBRPlBHa3WPHFB5q...|       Elite|
|FOBRPlBHa3WPHFB5q...|       Elite|
|FOBRPlBHa3WPHFB5q...|       Elite|
|zZUnPeh2hEp0WydbA...|       Elite|
|QaELAmRcDc5TfJEyl...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|xvu8G900tezTzbbfq...|       Elite|
|z5_82komKV3mI4ASG...|       Elite|
|ttumcu6hWshk_EJVW...|   Not Elite|
+--------------------+------------+
only showing top 20 rows
```

In [23]:

```
unique_user_df = Elite_or_Not.dropDuplicates(['user_id'])
unique_user_df.show()
```

```
+--------------------+------------+
|             user_id|Elite or Not|
+--------------------+------------+
|---RfKzBwQ8t3wu-L...|   Not Elite|
|--1UpCuUDJQbqiuFX...|   Not Elite|
|--AGAPpP1pgp1afbq...|   Not Elite|
|--C-42rr7hPSsUROJ...|   Not Elite|
|--ChzqcPs4YFWlw1j...|   Not Elite|
|--ET3paBtrThD95dk...|   Not Elite|
|--GLTFzU93A40YB56...|   Not Elite|
|--I4wRDhmM2J2VLzK...|   Not Elite|
|--RquisWmBzcezXZr...|   Not Elite|
|--UizzbnQlZg7bEv2...|   Not Elite|
|--cd_gA-9Q8gM9P2c...|   Not Elite|
|--dhSVoOFDBiMCCwD...|   Not Elite|
|--fpTdHQOGWGbAjk9...|   Not Elite|
|--ju6XpRd0dY1Swmf...|   Not Elite|
|--oVdTxVd7QVr8Y0U...|   Not Elite|
|--pWqE-KOwDWo5ADG...|   Not Elite|
|--t6W1JHbStaCp5RO...|   Not Elite|
|--tmwndDOZJwfRvvt...|   Not Elite|
|--yrdC1dIR6VYsW6k...|   Not Elite|
|-06viLTmtlRTHxxDg...|   Not Elite|
+--------------------+------------+
only showing top 20 rows
```

4. Join "Unique User" Dataset with Review Dataset

In [24]:
```
user_join_review = review_df.join(unique_user_df, on = "user_id", how='left')
print(f'User Join Review Dataset Columns: {len(user_join_review.columns)} | Rows: {user
```

```
User Join Review Dataset Columns: 10 | Rows: 8,021,122
```

5. Clean Data

Combined Dateset which includes elite and non-elite

In [25]:
```
combine_df = user_join_review.select('review_id','business_id','stars','user_id','Elite
combine_df.show()
```

```
+--------------------+--------------------+-----+--------------------+------------+
|           review_id|         business_id|stars|             user_id|Elite or Not|
+--------------------+--------------------+-----+--------------------+------------+
|rv2EaVEP_cs0Yzc-z...|Z3ZSar8IVAR2qIupq...|  5.0|---RfKzBwQ8t3wu-L...|   Not Elite|
|HVR4EWzZMlyPrdbzE...|kJhQq1BFz7lOYLve7...|  1.0|--1UpCuUDJQbqiuFX...|   Not Elite|
|uy83M2YEnInksqsKX...|EpPOZAG0u7qHP-jv5...|  5.0|--1UpCuUDJQbqiuFX...|   Not Elite|
|EHsBHPADGfllO2Zm5...|OLmcIJ7VBCxaYhZSN...|  5.0|--AGAPpP1pgp1afbq...|   Not Elite|
|xtHcnwOx-27sunclu...|WoiOpMEcbAfOqNYXq...|  5.0|--AGAPpP1pgp1afbq...|   Not Elite|
|pFq8ijDeB-Gz1HXsS...|L-_-9JNAb6UDyq7wa...|  4.0|--C-42rr7hPSsUROJ...|   Not Elite|
|SI_ONkbwzN_i38Gvg...|4KmrrhtfnngTVFa2d...|  4.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|fHqAyF58eC6vC4_BP...|AMTNJbYbu0OMMAkx4...|  4.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|bQkvjkpLZmtFYaYdO...|KVsv8wRGnLX8QWoNZ...|  3.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|V4nVpftxljW4sFOgO...|6pG7n8Rx_7ZXeQQk6...|  2.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|YSW-S2XUyCKR3jUtW...|F9CcIFltPDXiOkCCF...|  4.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|mfqVYzvoeiZREW8bs...|QZV9hW3WP9o9SmmV2...|  5.0|--ET3paBtrThD95dk...|   Not Elite|
|99Vpr7r8dGR0txvL3...|pT6baSMzC6rZfwhp_...|  5.0|--GLTFzU93A40YB56...|   Not Elite|
|YQN6mfSAX12LFsn6r...|JmI9nslLD7KZqRr__...|  2.0|--I4wRDhmM2J2VLzK...|   Not Elite|
|X2sbxAYTM9KYjyP0e...|HW7JPZBImm3tyEpDg...|  5.0|--RquisWmBzcezXZr...|   Not Elite|
|cqrmoHebDTzgc5hjO...|XNFA-aJFX8IQjol8D...|  4.0|--RquisWmBzcezXZr...|   Not Elite|
|ubpg7b5NJUih_A_2d...|W2Vis19kUa7kP6GkS...|  5.0|--RquisWmBzcezXZr...|   Not Elite|
|Bz_KEvFEyKL1QtbFe...|hDD6-yk1yuuRIvfdt...|  2.0|--UizzbnQlZg7bEv2...|   Not Elite|
|sZR9FQeM1cO7UKhTD...|eNFubUPJR7yIQah-N...|  4.0|--cd_gA-9Q8gM9P2c...|   Not Elite|
|yhgRUG0ctQ0aEaaIi...|uPa5hrWmHm0n1l4MS...|  4.0|--cd_gA-9Q8gM9P2c...|   Not Elite|
+--------------------+--------------------+-----+--------------------+------------+
only showing top 20 rows
```

Combined (Elite and Non-Elite) Average Ratings Grouped by Business ID

In [26]:
```
combine_stars_df = combine_df.groupBy("business_id").agg(F.mean('stars').alias('Stars')
combine_stars_df.show()
```

```
+--------------------+------------------+
|         business_id|             Stars|
+--------------------+------------------+
|--9e1ONYQuAa-CB_R...|  4.11784140969163|
|RtUvSWO_UZ8V3Wpj0...| 4.133498145859085|
|kpbhERZoj1eTDRnMV...| 2.033333333333333|
|eKznX8VTfcQrjCqXp...|4.3584905660377355|
|umwULmdsxx8aTsoRQ...| 2.388888888888889|
|ru_WUOAmx9xPBxcJu...|               5.0|
|VHsNB3pdGVcRgs6C3...| 3.411764705882353|
|rtwojGcYuhbLbQ9D1...|3.4545454545454546|
|SjgeuBlgKER9yegpo...| 3.973643410852713|
|VmSrPPO2WXmOKjUW7...| 3.227906976744186|
|0FWYa5RT_gQOwW3CR...|3.4545454545454546|
|RMjCnixEY5i12Ciqn...|3.5316455696202533|
|llCxryWr8j1S39tus...|  4.43839541547278|
|35X1ZV9tSEqB__yJE...|3.0316742081447963|
|X6jKCn5FoRiJ1t7y4...|1.8444444444444446|
|DgCAM01n2Qo5DsoKj...|3.3448275862068964|
|xusE_x84QOEDaRZ8r...|3.7096774193548385|
|cz5vz-893D3LNH3TM...| 3.803514376996805|
|jfdUtdkXogP2kjK5K...|3.6323529411764706|
|uC3qwaxsOkdJzpOc0...| 3.368948247078464|
+--------------------+------------------+
only showing top 20 rows
```

Elite Only Dataset

```
In [27]: elite_df = combine_df.filter(col("Elite or Not") == "Elite")
         elite_df.show()
```

```
+--------------------+--------------------+-----+--------------------+------------+
|           review_id|         business_id|stars|             user_id|Elite or Not|
+--------------------+--------------------+-----+--------------------+------------+
|EIKPUavToyh-dz2eE...|WYw3Uf56DT5IwpaLN...|  5.0|-1_RJoRLeoDK3h_gN...|       Elite|
|ygfb-2RWSKtI3jVC3...|0gXYLVPNWz0WT8wXQ...|  4.0|-1_RJoRLeoDK3h_gN...|       Elite|
|84GE9SrQCw-Yv-qpM...|W2CzAePJakvARgoQu...|  3.0|-1_RJoRLeoDK3h_gN...|       Elite|
|tyTkxTaNh1sL8t9XK...|iCQpiavjjPzJ5_3gP...|  4.0|-1_RJoRLeoDK3h_gN...|       Elite|
|TJDpUewi8F1E9eUgi...|qalkZ4AQDWzYrFvQV...|  5.0|-1_RJoRLeoDK3h_gN...|       Elite|
|bAd_-cPcZNsVfhFgN...|_w5hBpkjHs5_Hv3pL...|  4.0|-1_RJoRLeoDK3h_gN...|       Elite|
|kKuzCM7kpGqCUe3iD...|Yl05MqCs9xRzrJFkG...|  5.0|-1_RJoRLeoDK3h_gN...|       Elite|
|ITIUKGvnRE3u6RLns...|7FvDsYqtij_BbaGVt...|  3.0|-1_RJoRLeoDK3h_gN...|       Elite|
|W4FCaD23_CzAoC28j...|A4zLP5AyKEEHQr_dW...|  4.0|-1_RJoRLeoDK3h_gN...|       Elite|
|6aNCF2uoLILz27pWS...|90bL34o2KEes9pUnC...|  4.0|-1_RJoRLeoDK3h_gN...|       Elite|
|3QvS6Ued-M__5Wjln...|fE9SP84G6TZrv36FL...|  3.0|-1_RJoRLeoDK3h_gN...|       Elite|
|yUWEX8m3DnwI3YnNW...|MBekdd_f7S1ezEzZb...|  5.0|-1xh43lAhmrByuMzc...|       Elite|
|23fDyVgPz7-gHvNvx...|deL9fV4Jw3XhS0WqG...|  4.0|-1xh43lAhmrByuMzc...|       Elite|
|my4UdVCrQ9dITsWRO...|mz9ltimeAIy2c2qf5...|  5.0|-1xh43lAhmrByuMzc...|       Elite|
|0fWB1f-2BK9fMgYTA...|M4vh_kzppP1nsxo7h...|  3.0|-1xh43lAhmrByuMzc...|       Elite|
|wF-_nw2kG_vQOO79N...|deL9fV4Jw3XhS0WqG...|  4.0|-1xh43lAhmrByuMzc...|       Elite|
|gJeVSSm1CQ6XOLh0v...|KdQM64AQ5_ppgs6Ro...|  4.0|-1xh43lAhmrByuMzc...|       Elite|
|X_JpVPD3EoPF8YRpb...|LYNKKnl4jAiU1-U-9...|  4.0|-1xh43lAhmrByuMzc...|       Elite|
|PkTOJZZvFpKaKmitR...|Bkkwt8E9MHvgCHn4l...|  5.0|-1xh43lAhmrByuMzc...|       Elite|
|qIhEdr18_bLGuaiRL...|TqUVH7Ox_3qEkCxCC...|  4.0|-1xh43lAhmrByuMzc...|       Elite|
+--------------------+--------------------+-----+--------------------+------------+
only showing top 20 rows
```

Elite Average Rating Grouped by Business ID

```
In [28]: elite_stars_df = elite_df.groupBy("business_id").agg(F.mean('stars').alias('Stars rated
         elite_stars_df.show()
```

```
+--------------------+--------------------+
|         business_id|Stars rated by elite|
+--------------------+--------------------+
|eKznX8VTfcQrjCqXp...|   4.268817204301075|
|RtUvSWO_UZ8V3Wpj0...|   4.156193895870736|
|rtwojGcYuhbLbQ9D1...|  3.3636363636363638|
|--9e1ONYQuAa-CB_R...|  4.1916058394160585|
|X6jKCn5FoRiJ1t7y4...|                 4.5|
|SjgeuBlgKER9yegpo...|  3.8938775510204082|
|jfdUtdkXogP2kjK5K...|  3.3846153846153846|
|uC3qwaxsOkdJzpOc0...|  3.6745562130177514|
|yJGr28OXuMk2bCKYl...|               3.125|
|f4mh1Y0rnvbJRfQ3j...|               3.875|
|cz5vz-893D3LNH3TM...|  3.8587570621468927|
|MEoDTsA3Af6TLzB7Z...|  3.2142857142857144|
|qtsrM6Xxh1LqxG0X6...|                 4.5|
|OjuzFQpprqmuapKh6...|                 3.6|
|VmSrPPO2WXmOKjUW7...|   3.423076923076923|
|Rxb7oKtKyDUwuFNc2...|  3.4285714285714284|
|4iY_gyKX2ogbem7ra...|   4.444444444444445|
|mx0Pjm0erpv1CqsRI...|                 3.8|
|VHsNB3pdGVcRgs6C3...|                 4.0|
|LCRdP3m826-Df52-x...|                 1.0|
+--------------------+--------------------+
only showing top 20 rows
```

Non-Elite Dataset

In [29]:

```
non_elite_df = combine_df.filter(col("Elite or Not") == "Not Elite")
non_elite_df.show()
```

```
+--------------------+--------------------+-----+--------------------+------------+
|           review_id|         business_id|stars|             user_id|Elite or Not|
+--------------------+--------------------+-----+--------------------+------------+
|rv2EaVEP_cs0Yzc-z...|Z3ZSar8IVAR2qIupq...|  5.0|---RfKzBwQ8t3wu-L...|   Not Elite|
|HVR4EWzZMlyPrdbzE...|kJhQq1BFz7lOYLve7...|  1.0|--1UpCuUDJQbqiuFX...|   Not Elite|
|uy83M2YEnInksqsKX...|EpPOZAG0u7qHP-jv5...|  5.0|--1UpCuUDJQbqiuFX...|   Not Elite|
|EHsBHPADGfllO2Zm5...|OLmcIJ7VBCxaYhZSN...|  5.0|--AGAPpP1pgp1afbq...|   Not Elite|
|xtHcnwOx-27sunclu...|WoiOpMEcbAfOqNYXq...|  5.0|--AGAPpP1pgp1afbq...|   Not Elite|
|pFq8ijDeB-Gz1HXsS...|L-_-9JNAb6UDyq7wa...|  4.0|--C-42rr7hPSsUROJ...|   Not Elite|
|V4nVpftxljW4sFOgO...|6pG7n8Rx_7ZXeQQk6...|  2.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|fHqAyF58eC6vC4_BP...|AMTNJbYbu0OMMAkx4...|  4.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|YSW-S2XUyCKR3jUtW...|F9CcIFltPDXiOkCCF...|  4.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|SI_ONkbwzN_i38Gvg...|4KmrrhtfnngTVFa2d...|  4.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|bQkvjkpLZmtFYaYdO...|KVsv8wRGnLX8QWoNZ...|  3.0|--ChzqcPs4YFWlw1j...|   Not Elite|
|mfqVYzvoeiZREW8bs...|QZV9hW3WP9o9SmmV2...|  5.0|--ET3paBtrThD95dk...|   Not Elite|
|99Vpr7r8dGR0txvL3...|pT6baSMzC6rZfwhp_...|  5.0|--GLTFzU93A40YB56...|   Not Elite|
|YQN6mfSAX12LFsn6r...|JmI9nslLD7KZqRr__...|  2.0|--I4wRDhmM2J2VLzK...|   Not Elite|
|X2sbxAYTM9KYjyP0e...|HW7JPZBImm3tyEpDg...|  5.0|--RquisWmBzcezXZr...|   Not Elite|
|cqrmoHebDTzgc5hjO...|XNFA-aJFX8IQjol8D...|  4.0|--RquisWmBzcezXZr...|   Not Elite|
|ubpg7b5NJUih_A_2d...|W2Vis19kUa7kP6GkS...|  5.0|--RquisWmBzcezXZr...|   Not Elite|
|Bz_KEvFEyKL1QtbFe...|hDD6-yk1yuuRIvfdt...|  2.0|--UizzbnQlZg7bEv2...|   Not Elite|
|PR0lxlQOsrxmQ8TIu...|9Eghhu_LzEJgDKNgi...|  4.0|--cd_gA-9Q8gM9P2c...|   Not Elite|
|CtO3r0f40jz05T1jm...|fQwB9Z98YEhkJit7c...|  3.0|--cd_gA-9Q8gM9P2c...|   Not Elite|
+--------------------+--------------------+-----+--------------------+------------+
only showing top 20 rows
```

Non-Elite Average Rating Grouped by Business ID

In [30]:

```
non_elite_stars_df = non_elite_df.groupBy("business_id").agg(F.mean('stars').alias('Sta
non_elite_stars_df.show()
```

```
+--------------------+------------------------+
|         business_id|Stars rated by non elite|
+--------------------+------------------------+
|--9e1ONYQuAa-CB_R...|        4.08596214511041|
|RtUvSWO_UZ8V3Wpj0...|       4.121583411875589|
|kpbhERZoj1eTDRnMV...|      1.9642857142857142|
|umwULmdsxx8aTsoRQ...|                    2.25|
|ru_WUOAmx9xPBxcJu...|                     5.0|
|VHsNB3pdGVcRgs6C3...|       3.279279279279279|
|eKznX8VTfcQrjCqXp...|       4.406976744186046|
|SjgeuBlgKER9yegpo...|                  4.0225|
|VmSrPPO2WXmOKjUW7...|       3.201058201058201|
|0FWYa5RT_gQOwW3CR...|                     3.4|
|RMjCnixEY5i12Ciqn...|      3.6226415094339623|
|llCxryWr8j1S39tus...|      4.4627831715210355|
|35X1ZV9tSEqB__yJE...|      3.0080645161290325|
|X6jKCn5FoRiJ1t7y4...|      1.7209302325581395|
|DgCAM01n2Qo5DsoKj...|      3.1739130434782608|
|xusE_x84QOEDaRZ8r...|      3.7142857142857144|
|cz5vz-893D3LNH3TM...|      3.7817371937639197|
|uC3qwaxsOkdJzpOc0...|      3.2488372093023257|
|rtwojGcYuhbLbQ9D1...|      3.6363636363636362|
|D-CykxLr_NJe1fI4e...|      1.8235294117647058|
+--------------------+------------------------+
only showing top 20 rows
```

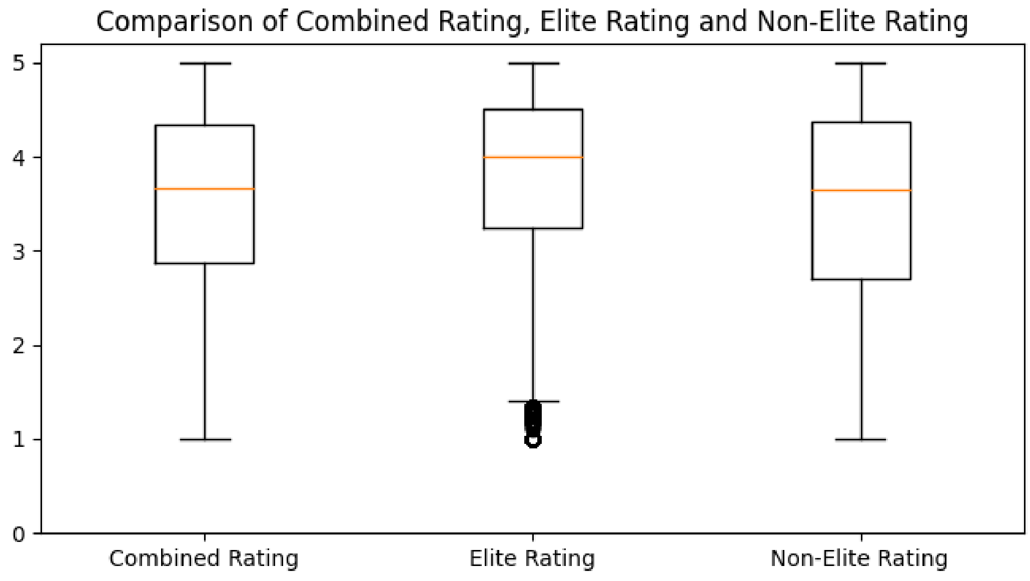
Prepare data for plotting

In [31]:

```python
combined_data = combine_stars_df.toPandas()["Stars"].values.tolist()
elite_data = elite_stars_df.toPandas()["Stars rated by elite"].values.tolist()
non_elite_data = non_elite_stars_df.toPandas()["Stars rated by non elite"].values.tolis
data = [combined_data, elite_data, non_elite_data]
```

In [49]:

```python
fig = plt.figure(figsize =(8, 4))
plt.boxplot(data)
plt.xticks([1, 2, 3], ['Combined Rating', 'Elite Rating', 'Non-Elite Rating'])
plt.title("Comparison of Combined Rating, Elite Rating and Non-Elite Rating")
y_ticks = np.arange(0, 6, 1)
plt.yticks(y_ticks)
plt.show()
%matplot plt
```



As we can see from the above boxplot, elite data has more outliers. Additionally, the first, third quantiles and the median of the elite ratings are also higher than the non-elites' ratings. From my point of view, I would say elite should not be trusted.