Analysis of Yelp Business Intelligence Data

We will analyze a subset of Yelp's business, reviews and user data. This dataset comes to us from Kaggle although we have taken steps to pull this data into a publis s3 bucket: `s3://cis9760-yelpdataset/yelp-light/*business.json`

Installation and Initial Setup

Begin by installing the necessary libraries that you may need to conduct your analysis. At the very least, you must install `pandas` and `matplotlib`

```
%%info
```

```
<IPython.core.display.HTML object>
```

```
<IPython.core.display.HTML object>
```

```
sc.install_pypi_package("matplotlib==3.2.1")
sc.install_pypi_package("pandas==1.0.3")
sc.install_pypi_package("scipy==1.7.1")
sc.install_pypi_package("seaborn==0.11.2")
```

```
{"version_major":2,"version_minor":0,"model_id":"8a8bc5f45d7a4ffb97a4d
7219c4c0fcc"}
```

```
Starting Spark application
```

```
<IPython.core.display.HTML object>
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```

```
SparkSession available as 'spark'.
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```

```
Collecting matplotlib==3.2.1
  Downloading
https://files.pythonhosted.org/packages/b2/c2/71fcf957710f3ba1f09088b3
5776a799ba7dd95f7c2b195ec800933b276b/matplotlib-3.2.1-cp37-cp37m-
manylinux1_x86_64.whl (12.4MB)
Collecting python-dateutil>=2.1 (from matplotlib==3.2.1)
  Downloading
https://files.pythonhosted.org/packages/36/7a/87837f39d0296e723bb9b62b
bb257d0355c7f6128853c78955f57342a56d/python_dateutil-2.8.2-py2.py3-
none-any.whl (247kB)
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/d9/41/d9cfb4410589805cd787f8a8
```

```
2cddd13142d9bf7449d12adf2d05a4a7d633/pyparsing-3.0.8-py3-none-any.whl
(98kB)
Collecting cycler>=0.10 (from matplotlib==3.2.1)
  Downloading
https://files.pythonhosted.org/packages/5c/f9/695d6bedebd747e5eb0fe8fa
d57b72fdf25411273a39791cde838d5a8f51/cycler-0.11.0-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/51/50/9a9a94afa26c50fc5d912727
2737806990aa698c7a1c220b8e5075e70304/kiwisolver-1.4.2-cp37-cp37m-
manylinux_2_5_x86_64.manylinux1_x86_64.whl (1.1MB)
Requirement already satisfied: six>=1.5 in
/usr/local/lib/python3.7/site-packages (from python-dateutil>=2.1-
>matplotlib==3.2.1)
Collecting typing-extensions; python_version < "3.8" (from
kiwisolver>=1.0.1->matplotlib==3.2.1)
  Downloading
https://files.pythonhosted.org/packages/75/e1/932e06004039dd670c9d5e1d
f0cd606bf46e29a28e65d5bb28e894ea29c9/typing_extensions-4.2.0-py3-none-
any.whl
Installing collected packages: python-dateutil, pyparsing, cycler,
typing-extensions, kiwisolver, matplotlib
Successfully installed cycler-0.11.0 kiwisolver-1.4.2 matplotlib-3.2.1
pyparsing-3.0.8 python-dateutil-2.8.2 typing-extensions-4.2.0

Collecting pandas==1.0.3
  Downloading
https://files.pythonhosted.org/packages/4a/6a/94b219b8ea0f2d580169e85e
d1edc0163743f55aaeca8a44c2e8fc1e344e/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 (from pandas==1.0.3)
Requirement already satisfied: numpy>=1.13.3 in
/usr/local/lib64/python3.7/site-packages (from pandas==1.0.3)
Requirement already satisfied: python-dateutil>=2.6.1 in
/mnt/tmp/1651366008376-0/lib/python3.7/site-packages (from
pandas==1.0.3)
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: pandas
Successfully installed pandas-1.0.3

Collecting scipy==1.7.1
  Downloading
https://files.pythonhosted.org/packages/b5/6b/8bc0b61ebf824f8c3979a313
68bbe38dd247590049a994ab0ed077cb56dc/scipy-1.7.1-cp37-cp37m-
manylinux_2_5_x86_64.manylinux1_x86_64.whl (28.5MB)
```

```
Requirement already satisfied: numpy<1.23.0,>=1.16.5 in
/usr/local/lib64/python3.7/site-packages (from scipy==1.7.1)
Installing collected packages: scipy
Successfully installed scipy-1.7.1

Collecting seaborn==0.11.2
  Downloading
https://files.pythonhosted.org/packages/10/5b/0479d7d845b5ba410ca702ff
cd7f2cd95a14a4dfff1fde2637802b258b9b/seaborn-0.11.2-py3-none-any.whl
(292kB)
Requirement already satisfied: numpy>=1.15 in
/usr/local/lib64/python3.7/site-packages (from seaborn==0.11.2)
Requirement already satisfied: scipy>=1.0 in /mnt/tmp/1651366008376-
0/lib/python3.7/site-packages (from seaborn==0.11.2)
Requirement already satisfied: matplotlib>=2.2 in
/mnt/tmp/1651366008376-0/lib/python3.7/site-packages (from
seaborn==0.11.2)
Requirement already satisfied: pandas>=0.23 in /mnt/tmp/1651366008376-
0/lib/python3.7/site-packages (from seaborn==0.11.2)
Requirement already satisfied: python-dateutil>=2.1 in
/mnt/tmp/1651366008376-0/lib/python3.7/site-packages (from
matplotlib>=2.2->seaborn==0.11.2)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!
=2.1.6,>=2.0.1 in /mnt/tmp/1651366008376-0/lib/python3.7/site-packages
(from matplotlib>=2.2->seaborn==0.11.2)
Requirement already satisfied: cycler>=0.10 in /mnt/tmp/1651366008376-
0/lib/python3.7/site-packages (from matplotlib>=2.2->seaborn==0.11.2)
Requirement already satisfied: kiwisolver>=1.0.1 in
/mnt/tmp/1651366008376-0/lib/python3.7/site-packages (from
matplotlib>=2.2->seaborn==0.11.2)
Requirement already satisfied: pytz>=2017.2 in
/usr/local/lib/python3.7/site-packages (from pandas>=0.23-
>seaborn==0.11.2)
Requirement already satisfied: six>=1.5 in
/usr/local/lib/python3.7/site-packages (from python-dateutil>=2.1-
>matplotlib>=2.2->seaborn==0.11.2)
Requirement already satisfied: typing-extensions; python_version <
"3.8" in /mnt/tmp/1651366008376-0/lib/python3.7/site-packages (from
kiwisolver>=1.0.1->matplotlib>=2.2->seaborn==0.11.2)
Installing collected packages: seaborn
Successfully installed seaborn-0.11.2
```

Importing

Now, import the installed packages from the previous block below.

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

{"version_major":2,"version_minor":0,"model_id":"2dfc725a9eb04e71955f777e9df7fb07"}

{"version_major":2,"version_minor":0,"model_id":""}

Loading Data

We are finally ready to load data. Using spark load the data from S3 into a dataframe object that we can manipulate further down in our analysis.

```
df =
spark.read.json('s3://cis9760-emr-bucket/yelp_academic_dataset_business.json')
```

{"version_major":2,"version_minor":0,"model_id":"5442b1e4b3fb426badf624f4446c851f"}

{"version_major":2,"version_minor":0,"model_id":""}

```
df.show(5)
```

{"version_major":2,"version_minor":0,"model_id":"d289750b02b6416da77bfdcc209282c7"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+--------------------+--------------------
+--------------------+------------+--------------------+-------
+----------+------------+--------------------+-----------+------------
+-----+-----+
|             address|          attributes|         business_id|
categories|         city|               hours|is_open|  latitude|
longitude|                name|postal_code|review_count|stars|state|
+--------------------+--------------------+--------------------
+--------------------+------------+--------------------+-------
+----------+------------+--------------------+-----------+------------
+-----+-----+
|1616 Chapala St, ...|[,,,,,,,,,,, True...|Pns2l4eNsfO8kk83d...|
Doctors, Traditio...|Santa Barbara|                null|      0|
34.4266787|-119.7111968|Abby Rappoport, L...|     93101|           7|
5.0|   CA|
|87 Grasso Plaza S...|[,,,,,,,,, True,,...|mpf3x-BjTdTEA3yCZ...|
Shipping Centers,...|       Affton|[8:0-18:30, 0:0-0...|      1|
38.551126|  -90.335695|       The UPS Store|     63123|          15|
3.0|   MO|
|5255 E Broadway Blvd|[,,,,,,, True,, T...|tUFrWirKiKi_TAnsV...|
Department Stores...|       Tucson|[8:0-23:0, 8:0-22...|      0|
32.223236| -110.880452|              Target|     85711|          22|
3.5|   AZ|
|         935 Race St|[,, u'none',,,,, ...|MTSW4McQd7CbVtyjq...|
Restaurants, Food...| Philadelphia|[7:0-21:0, 7:0-20...|      1|
39.9555052| -75.1555641|  St Honore Pastries|     19107|          80|
```

```
4.0|   PA|
|       101 Walnut St|[,,,,,,,, True,, T...|mWMc6_wTdE0EUBKIG...|
Brewpubs, Breweri...|   Green Lane|[12:0-22:0,, 12:0...|      1|
40.3381827| -75.4716585|Perkiomen Valley ...|      18054|          13|
4.5|   PA|
+--------------------+--------------------+--------------------
+--------------------+-------------+--------------------+-------
+----------+------------+--------------------+-----------+------------
+-----+-----+
only showing top 5 rows
```

Overview of Data

Display the number of rows and columns in our dataset.

```
print(f"Number of columns in Business table: {len(df.columns)}")
print(f"Number of rows in Business table: {df.count()}")
```


```
{"version_major":2,"version_minor":0,"model_id":"3cfd9f3f17ad45a5b16f9
8e19a038100"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
Number of columns in Business table: 14
Number of rows in Business table: 150346
```

Display the DataFrame schema below.

```
df.printSchema()
```


```
{"version_major":2,"version_minor":0,"model_id":"b4b3e027dd584eea941bd
08a3fa0c7fa"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
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

```
df.select("business_id", "name", "city", "state",
"categories").show(5)
```


```
{"version_major":2,"version_minor":0,"model_id":"11c4da6d0e8242c7ab0d4
4945ec14c71"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+--------------------+------------+-----
+--------------------+
|         business_id|                name|         city|state|
categories|
+--------------------+--------------------+------------+-----
+--------------------+
|Pns2l4eNsfO8kk83d...|Abby Rappoport, L...|Santa Barbara|   CA|
Doctors, Traditio...|
|mpf3x-BjTdTEA3yCZ...|       The UPS Store|       Affton|   MO|
Shipping Centers,...|
|tUFrWirKiKi_TAnsV...|              Target|       Tucson|   AZ|
Department Stores...|
|MTSW4McQd7CbVtyjq...|  St Honore Pastries| Philadelphia|   PA|
Restaurants, Food...|
|mWMc6_wTdE0EUBKIG...|Perkiomen Valley ...|   Green Lane|   PA|
Brewpubs, Breweri...|
+--------------------+--------------------+------------+-----
+--------------------+
only showing top 5 rows
```

Analyzing Categories

Let's now answer this question: **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 questions such as:

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

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
abcd123

We would like to derive something like:

business_id
abcd123
abcd123
abcd123

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.

Implement the code necessary to derive the table described from your original yelp dataframe.

```
# Install the necessary libraries here
from pyspark.sql.functions import explode, split
```

{"version_major":2,"version_minor":0,"model_id":"68d3844a191f4d8ab8a057739edf709d"}

{"version_major":2,"version_minor":0,"model_id":""}

```
df_cat=df.select("business_id", "categories")
df_cat.show(5)
```

{"version_major":2,"version_minor":0,"model_id":"9b71ffd5ca774fa0bed64c90b0e0e96b"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+--------------------+
|         business_id|          categories|
+--------------------+--------------------+
|Pns2l4eNsfO8kk83d...|Doctors, Traditio...|
|mpf3x-BjTdTEA3yCZ...|Shipping Centers,...|
|tUFrWirKiKi_TAnsV...|Department Stores...|
|MTSW4McQd7CbVtyjq...|Restaurants, Food...|
|mWMc6_wTdE0EUBKIG...|Brewpubs, Breweri...|
+--------------------+--------------------+
only showing top 5 rows
```

Display the first 5 rows of your association table below.

```
df_cat_exploded =
df_cat.withColumn('categories',explode(split('categories',", ")))
df_cat_exploded.show(5)
```

{"version_major":2,"version_minor":0,"model_id":"20ec364dc8bd4d3eacdf4b72fb5ce8ec"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+--------------------+
|         business_id|          categories|
+--------------------+--------------------+
|Pns2l4eNsfO8kk83d...|             Doctors|
|Pns2l4eNsfO8kk83d...|Traditional Chine...|
|Pns2l4eNsfO8kk83d...|Naturopathic/Holi...|
|Pns2l4eNsfO8kk83d...|         Acupuncture|
|Pns2l4eNsfO8kk83d...|    Health & Medical|
+--------------------+--------------------+
only showing top 5 rows
```

Total Unique Categories

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

Below, implement the code necessary to calculate this figure.

```
df_cat_exploded.select('categories').distinct().count()
```

{"version_major":2,"version_minor":0,"model_id":"a727d7204142458e98592
a6c207c3b43"}

{"version_major":2,"version_minor":0,"model_id":""}

```
1311
```

Top Categories By Business

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

Counts of Businesses / Category

So now, let's unroll our distinct count a bit and display the per count value of businesses per category.

The expected output should be:

category
a
b
c

Or something to that effect.

```
df_cat_grouped=df_cat_exploded.groupby("categories")
df_cat_grouped.count().show()
```

{"version_major":2,"version_minor":0,"model_id":"4d24a6c213ca482899c695be79c3bbb1"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+-----+
|          categories|count|
+--------------------+-----+
|      Paddleboarding|   98|
|      Dermatologists|  336|
|         Hobby Shops|  552|
|          Bubble Tea|  477|
|             Embassy|    3|
|             Tanning|  667|
|            Handyman|  356|
|      Aerial Fitness|   19|
|             Falafel|  103|
|        Summer Camps|  232|
|       Outlet Stores|  182|
|     Clothing Rental|   37|
|      Sporting Goods| 1662|
|     Cooking Schools|   76|
|  Lactation Services|   27|
|Ski & Snowboard S...|   40|
|             Museums|  413|
|              Doulas|   31|
|                Food|27781|
|         Halotherapy|   23|
+--------------------+-----+
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.

HINT: don't forget about the matplotlib magic!

```
%matplot plt
```

If you want, you can also use seaborn library

```
df_cat_top = df_cat_grouped.count().sort("count", ascending = False)
df_cat_top.show()
```

{"version_major":2,"version_minor":0,"model_id":"f3ec414146804e13a51609f64d21803c"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+-----+
|          categories|count|
+--------------------+-----+
```

```
|         Restaurants|52268|
|                Food|27781|
|            Shopping|24395|
|       Home Services|14356|
|       Beauty & Spas|14292|
|           Nightlife|12281|
|    Health & Medical|11890|
|      Local Services|11198|
|                Bars|11065|
|          Automotive|10773|
|Event Planning & ...| 9895|
|          Sandwiches| 8366|
|American (Traditi...| 8139|
|         Active Life| 7687|
|               Pizza| 7093|
|        Coffee & Tea| 6703|
|           Fast Food| 6472|
|  Breakfast & Brunch| 6239|
|      American (New)| 6097|
|     Hotels & Travel| 5857|
+--------------------+-----+
only showing top 20 rows

bar_df=df_cat_top.toPandas()
bar_df[0:20]
```


```
{"version_major":2,"version_minor":0,"model_id":"a937060b73cc4468b55e4
f9f1b701c6f"}

{"version_major":2,"version_minor":0,"model_id":""}
```


	categories	count
0	Restaurants	52268
1	Food	27781
2	Shopping	24395
3	Home Services	14356
4	Beauty & Spas	14292
5	Nightlife	12281
6	Health & Medical	11890
7	Local Services	11198
8	Bars	11065
9	Automotive	10773
10	Event Planning & Services	9895
11	Sandwiches	8366
12	American (Traditional)	8139
13	Active Life	7687
14	Pizza	7093
15	Coffee & Tea	6703
16	Fast Food	6472
17	Breakfast & Brunch	6239

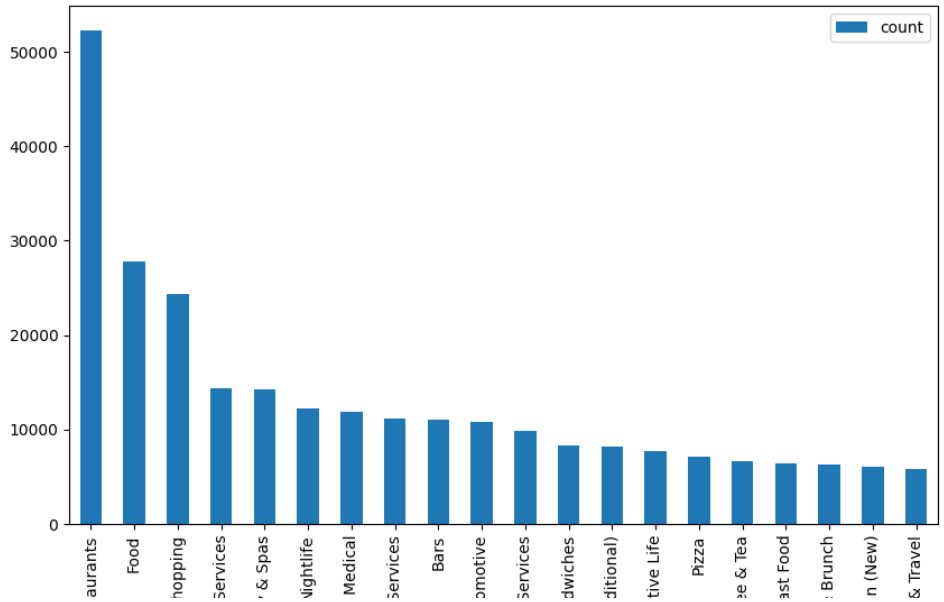
```
18             American (New)   6097
19           Hotels & Travel    5857
```

```
plt.figure(figsize =(10,6))
bar_df[0:20].plot(kind='bar', x='categories', figsize =(10,6))
%matplot plt
```


```
{"version_major":2,"version_minor":0,"model_id":"856b687993044c9b9a8b9
97c560c4a6b"}
```



```
{"version_major":2,"version_minor":0,"model_id":""}
```

Loading User Data

Begin by loading the user data set from S3 and printing schema to determine what data is available. `s3://cis9760-yelpdataset/yelp-light/*review.json`

```
review_df =
spark.read.json('s3://cis9760-emr-bucket/yelp_academic_dataset_review.
json')
```


```
{"version_major":2,"version_minor":0,"model_id":"6b61b5c5297848ac89568
5188a9b5cf3"}
```



```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
review_df.printSchema()
```


```
{"version_major":2,"version_minor":0,"model_id":"062f986953b74d3983efc
42020765c51"}
```



```
{"version_major":2,"version_minor":0,"model_id":""}
```

```
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.

```
review_df.select("business_id", "stars").show(5)
```


```
{"version_major":2,"version_minor":0,"model_id":"2150eab4be3a414fa4258
9e636696c95"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+-----+
|         business_id|stars|
+--------------------+-----+
|XQfwVwDr-v0ZS3_Cb...|  3.0|
|7ATYjTIgM3jUlt4UM...|  5.0|
|YjUWPpI6HXG530lwP...|  3.0|
|kxX2SOes4o-D3ZQBk...|  5.0|
|e4Vwtrqf-wpJfwesg...|  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**.

```
from pyspark.sql.functions import mean
review_avgstar = review_df.select("business_id", "stars") \
    .groupBy("business_id") \
    .agg(mean('stars').alias("avg(stars)"))
review_avgstar.show(5)
```


```
{"version_major":2,"version_minor":0,"model_id":"297121bbe3524b4290be1
c6265348813"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+------------------+
|         business_id|        avg(stars)|
+--------------------+------------------+
|zJErbOQMKX-MwHs_u...|2.9279279279279278|
|RZ-FNTXvqHKngyLGD...|2.8823529411764706|
```

```
|HSzSGdcNaU7heQe0N...|3.3333333333333335|
|skW4boArIApRw9DXK...|2.3947368421052633|
|I0053JmJ5DEFUWSJ8...|2.3956043956043955|
+--------------------+------------------+
only showing top 5 rows
```

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

```
df_bus = df.select("business_id", "name", "city", "state", "stars")
rv_bus = df_bus.join(review_avgstar, df_bus.business_id ==
review_avgstar.business_id)
```


```
{"version_major":2,"version_minor":0,"model_id":"f8fb6689d4c541f68b000
23cd758a277"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```


Let's see a few of these:

```
rv_bus.select("name", "city", "state", "avg(stars)", "stars").show(5)
```


```
{"version_major":2,"version_minor":0,"model_id":"71fdc0f619874985b4730
04f028b3b12"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+------------+-----+------------------+-----+
|                name|        city|state|        avg(stars)|stars|
+--------------------+------------+-----+------------------+-----+
|Philadelphia Marr...|Philadelphia|   PA|2.9279279279279278|  3.0|
|Gaetano's of West...| West Berlin|   NJ|2.8823529411764706|  3.0|
|Gillane's Bar & G...|     Ardmore|   PA|2.3333333333333335|  3.0|
|Champps Penn's La...|Philadelphia|   PA|2.3947368421052633|  2.5|
|Golden Corral Buf...|      Tucson|   AZ|2.3956043956043955|  2.5|
+--------------------+------------+-----+------------------+-----+
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.

```
from pyspark.sql.functions import col
rv_bus=rv_bus.withColumn("skew", (col('avg(stars)')- col('stars')) /
col('stars'))
```

{"version_major":2,"version_minor":0,"model_id":"5ae62a97340e4a60803cb
97370737bbf"}

{"version_major":2,"version_minor":0,"model_id":""}

```
rv_bus.select("name", "city", "state", "avg(stars)", "stars",
"skew").show(5)
```

{"version_major":2,"version_minor":0,"model_id":"20f38848aca740f29a502
7e3913e2582"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+------------+-----+------------------+-----
+--------------------+
|                name|        city|state|        avg(stars)|stars|
skew|
+--------------------+------------+-----+------------------+-----
+--------------------+
|Gillane's Bar & G...|     Ardmore|   PA|3.3333333333333335|  3.0|
0.11111111111111116|
|Champps Penn's La...|Philadelphia|   PA|2.3947368421052633|  2.5|-
0.04210526315789469|
|Philadelphia Marr...|Philadelphia|   PA|2.9279279279279278|  3.0|-
0.02402402402402...|
|Golden Corral Buf...|      Tucson|   AZ|2.3956043956043955|  2.5|-
0.04175824175824179|
|  Swiss Watch Center|       Tampa|   FL| 3.357142857142857|  3.5|-
0.04081632653061223|
+--------------------+------------+-----+------------------+-----
+--------------------+
only showing top 5 rows
```

```
rv_bus_df = rv_bus.toPandas()
```

{"version_major":2,"version_minor":0,"model_id":"adbcccf4966c4c3d8029b
4dfe4d3584f"}

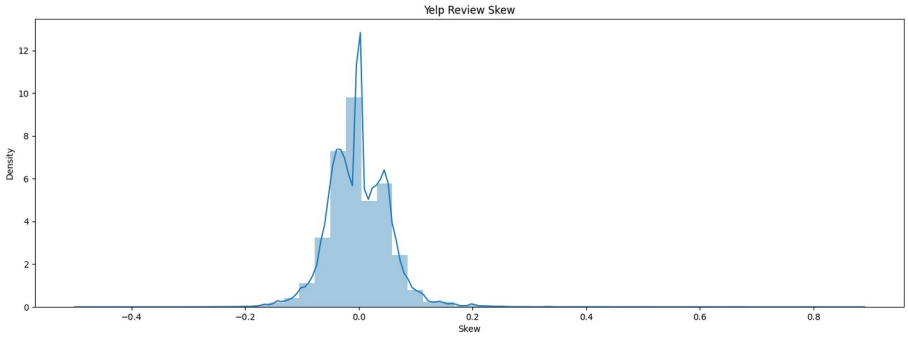
{"version_major":2,"version_minor":0,"model_id":""}

And finally, graph it!

```
plt.figure(figsize =(18,6))
sns.distplot(rv_bus_df["skew"], axlabel = "Skew", kde =
True).set(title = "Yelp Review Skew")
%matplot plt
```

{"version_major":2,"version_minor":0,"model_id":"8dfb0026c2bb4cba868ca
23596e65420"}

{"version_major":2,"version_minor":0,"model_id":""}



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

IMPLICATIONS

Type your answer here: As the graph shows, denisty on the left side is greater than one on the right side, which means that there are more negative Yelp (written) Reviews skews than the positive ones. So at this point, we can interpret that reviewers who left a written response were more dissatisfied than normal.

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? `s3://cis9760-yelpdataset/yelp-light/*user.json`

Feel free to use any and all methodologies at your disposal. You must render one visualization in your analysis and interpret your findings.

```
user_df =
spark.read.json('s3://cis9760-emr-bucket/yelp_academic_dataset_user.json')
```

{"version_major":2,"version_minor":0,"model_id":"b9e2738c9b30429b82b51c3d6eebca0f"}

{"version_major":2,"version_minor":0,"model_id":""}

```
user_df.printSchema()
```

{"version_major":2,"version_minor":0,"model_id":"9970353e6f0d4a70b16a250dee20ef8f"}

{"version_major":2,"version_minor":0,"model_id":""}

```
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_review = user_df.join(review_df, user_df.user_id ==
review_df.user_id)
user_review.columns
```


```
{"version_major":2,"version_minor":0,"model_id":"8d40503b1b5c4a51b1f4a
3d5ed6e6947"}
```



```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
['average_stars', 'compliment_cool', 'compliment_cute',
'compliment_funny', 'compliment_hot', 'compliment_list',
'compliment_more', 'compliment_note', 'compliment_photos',
'compliment_plain', 'compliment_profile', 'compliment_writer', 'cool',
'elite', 'fans', 'friends', 'funny', 'name', 'review_count', 'useful',
'user_id', 'yelping_since', 'business_id', 'cool', 'date', 'funny',
'review_id', 'stars', 'text', 'useful', 'user_id']
```

```
#Average stars for each business_id
from pyspark.sql.functions import mean
busrating = user_review.select("business_id", "stars") \
    .groupBy("business_id") \
    .agg(mean('stars').alias("avg(stars)"))
busrating.show(5)
```


```
{"version_major":2,"version_minor":0,"model_id":"041f097402d4402aac0f3
9eb2e9be731"}
```



```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+------------------+
|         business_id|        avg(stars)|
```

```
+--------------------+------------------+
|C9KvsTqi617Yg_sNj...| 4.510204081632653|
|wopwoiKIllIzcggK7...| 3.205521472392638|
|yqq1Fvt7WtduIO3Gw...|2.9473684210526314|
|3FKIev7ZB_KE6XHL9...|3.8637362637362638|
|nC-dCuPytssHAaMkA...|               3.4|
+--------------------+------------------+
only showing top 5 rows

#Elite users' stars on each business_id
usersrating = user_review.select(user_df.user_id, "stars",
"business_id") \
    .filter(user_review.elite != "")
usersrating.show()

{"version_major":2,"version_minor":0,"model_id":"610e2798085248b9bfb71
5112b25ac60"}

{"version_major":2,"version_minor":0,"model_id":""}

+--------------------+-----+--------------------+
|             user_id|stars|         business_id|
+--------------------+-----+--------------------+
|IeSz60ozr1yAVIH8C...|  4.0|TV81bpCQ6p6o4Hau5...|
|xW2A0MciHB0pLB4RH...|  5.0|W4ZEKkva9HpAdZG88...|
|SSafXe2aUO0cXgQhE...|  5.0|E-4t5Hoon6aVFTWDP...|
|yiYUEExKfZEv_T8CF...|  3.0|_pbx96FZ3eHJw-V_R...|
|A3EiqW7_k00gvaiQi...|  5.0|8uF-bhJFgT4Tn6DTb...|
|Zsucq1c-sjuGxs5jZ...|  4.0|zaC6coZ5Gp8mLjeg7...|
|aX3vDE1UmbdrWeOsg...|  5.0|EqEcDeXqIq1YwnzHg...|
|aHiQYaTXrmQTeG610...|  4.0|3w7NRntdQ9h0KwDsk...|
|g34Qcj06LmCDhKzks...|  5.0|yE1raqkLX7OZsjmX3...|
|yiYUEExKfZEv_T8CF...|  4.0|EP2jFD3aGoSBCWb7i...|
|OTG7-L3N4geWEB_0q...|  4.0|hS6KNGCQVTYUdLb2e...|
|xHU37ocClTtu1rS4L...|  5.0|uW8L6awmCyjovD9Oh...|
|wwoLHw7FX0CaeOmw1...|  4.0|6kAXOzE7fqaBZINQV...|
|Zsucq1c-sjuGxs5jZ...|  5.0|yLIn3po-fKb0T3UIo...|
|417svAEVHreK6c3SK...|  3.0|oQ5CPRt0R3AzFvcjN...|
|qCNZXu0nA1m9_qQDS...|  3.0|psI9u_iVuWFcchWhe...|
|wwoLHw7FX0CaeOmw1...|  5.0|wzE61ThXOdrSegvwS...|
|Zsucq1c-sjuGxs5jZ...|  4.0|z6SVTb9eFIcWVpKXI...|
|Zsucq1c-sjuGxs5jZ...|  5.0|hdVqM-QngiiLRaMOv...|
|Zsucq1c-sjuGxs5jZ...|  4.0|kPG6r0h73sPgXBei0...|
+--------------------+-----+--------------------+
only showing top 20 rows

#Join them
users_bus = usersrating.join(busrating, usersrating.business_id ==
busrating.business_id)
users_bus.show()
```

{"version_major":2,"version_minor":0,"model_id":"0a79bdd528f84dd9b2f3d
bd3b4db93eb"}

{"version_major":2,"version_minor":0,"model_id":""}

```
+--------------------+-----+--------------------+--------------------
+-----------------+
|             user_id|stars|         business_id|         business_id|
avg(stars)|
+--------------------+-----+--------------------+--------------------
+-----------------+
|fen9BWC39ul9SJZfQ...|  4.0|--gJkxbsiSIwsQKbi...|--gJkxbsiSIwsQKbi...|
4.833333333333333|
|7jOaJw3txVFlkHB7Y...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|_VZlDBtCT_Qb3_OOT...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|EO7u_L1_ZgRdawMrb...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|2gyrlO8oOuGf5JMOe...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|mmSvRe11vbz3XTXw5...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|UtpU2qK1p1rmAZpwr...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|Mu5xg6ZESWCp3rnry...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|I06gY9An4o81XpejL...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|x2dkFstjm-FmOOoIU...|  3.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|OA_9Ucc5N-60vtA6i...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|Q4_GklBdHkKaFnRul...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|pOi89mLu4ivFmcoxM...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|xfSiMtuhrlZNszvU2...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|LSHCv3YfKbHWzpWbY...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|ewjyi395faeIo22Ef...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|wqeGcKWbtQLyavwtq...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|eWt6gxEaLt6iH8qS7...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|DdPEm9nl_5zxrzGNa...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
|Z1z2CuqvlgrLkme_8...|  5.0|-02xFuruu85XmDn2x...|-02xFuruu85XmDn2x...|
4.68595041322314|
```

```
+--------------------+-----+--------------------+--------------------
+-----------------+
only showing top 20 rows

#Create a new column (stars_diff)
from pyspark.sql.functions import col
users_bus = users_bus.withColumn("stars_diff", col("stars") -
col("avg(stars)"))
users_bus.sort("stars_diff", ascending = False).show()

{"version_major":2,"version_minor":0,"model_id":"c313fa8a00bf454f9de01
726ce3f63b5"}

{"version_major":2,"version_minor":0,"model_id":""}

+--------------------+-----+--------------------+--------------------
+------------------+------------------+
|             user_id|stars|         business_id|         business_id|
avg(stars)|        stars_diff|
+--------------------+-----+--------------------+--------------------
+------------------+------------------+
|CYsL9QLOpuucO-vJJ...|  5.0|CxmqP1eRI1g4TNnzZ...|CxmqP1eRI1g4TNnzZ...|
1.0597014925373134|3.9402985074626864|
|MmEYowrsA4j3K4gc9...|  5.0|Rmhr3u3Bb5XQReVXl...|Rmhr3u3Bb5XQReVXl...|
1.1|               3.9|
|QJI9OSEn6ujRCtrX0...|  5.0|O_op1voFpnHEHho-2...|O_op1voFpnHEHho-2...|
1.1481481481481481| 3.851851851851852|
|IB2Zyn6ak7wt4YN-j...|  5.0|SodX2x5WpHYetiVEL...|SodX2x5WpHYetiVEL...|
1.1626794258373205|3.8373205741626792|
|Vwslifegl59fQVOe5...|  5.0|LQvZUpDkm07K5UE8K...|LQvZUpDkm07K5UE8K...|
1.1756756756756757|3.8243243243243246|
|jEcSGHkE31zEGt7p_...|  5.0|DuB7UztTWu1eDfEaB...|DuB7UztTWu1eDfEaB...|
1.1851851851851851| 3.814814814814815|
|YcSDGPRj-cmmadlaJ...|  5.0|vQkKg1-VdfQ7bSEak...|vQkKg1-VdfQ7bSEak...|
1.1870503597122302|  3.81294964028777|
|M2NS_aQbMY2apoYjT...|  5.0|fiCL0hm0we0CwrCgq...|fiCL0hm0we0CwrCgq...|
1.1911764705882353|3.8088235294117645|
|hleaFrDFA-KMjJRNC...|  5.0|lvIu-fkVRJqUzVRFz...|lvIu-fkVRJqUzVRFz...|
1.1923076923076923|3.8076923076923075|
|JcV5Lyi9QMwjWET4S...|  5.0|mVsJDGFG34fgI2Ezc...|mVsJDGFG34fgI2Ezc...|
1.1944444444444444|3.8055555555555554|
|ZRTjFsqFT4exHoLc6...|  5.0|SRSHXW5urzw4UYZNY...|SRSHXW5urzw4UYZNY...|
1.2105263157894737|3.7894736842105265|
|5CfE31qFqCQGpfh6i...|  5.0|3UHXD8T80OUFMCzLb...|3UHXD8T80OUFMCzLb...|
1.2240437158469946|3.7759562841530054|
|H2WhI7u2Zc-ozPnKB...|  5.0|3UHXD8T80OUFMCzLb...|3UHXD8T80OUFMCzLb...|
1.2240437158469946|3.7759562841530054|
|j14WgRoU_-2ZE1aw1...|  5.0|toRNyzwkG59NYJP2t...|toRNyzwkG59NYJP2t...|
1.2258064516129032| 3.774193548387097|
|kFV6jUEbhRb_EDjej...|  5.0|N94-orJ8r74MQ2VpL...|N94-orJ8r74MQ2VpL...|
1.2352941176470589| 3.764705882352941|
```

```
|5hHZFMXNdCurTwaQ2...|  5.0|uWLFplSCk3lI9rf84...|uWLFplSCk3lI9rf84...|
1.2365591397849462| 3.763440860215054|
|WeIzmxx0sub0R4KUP...|  5.0|rkqsFfbdeuXevR4Z3...|rkqsFfbdeuXevR4Z3...|
1.2391304347826086|3.7608695652173916|
|VU_iMC9xrM3PvobEA...|  5.0|8FZREDyibPgWsq2C1...|8FZREDyibPgWsq2C1...|
1.2436974789915967|3.7563025210084033|
|UlWDGR0QrBbdFsVY6...|  5.0|oB8E5HS8UEKuPi8JI...|oB8E5HS8UEKuPi8JI...|
1.2592592592592593|3.7407407407407405|
|fylDqbbgPEqZ9J4EB...|  5.0|LpHdRhehNHXQtPevE...|LpHdRhehNHXQtPevE...|
1.26|              3.74|
+--------------------+-----+--------------------+--------------------
+------------------+------------------+
only showing top 20 rows

#Convert the column "stars_diff" to a pandas dataframe
diff_df = users_bus.select("stars_diff").toPandas()
```

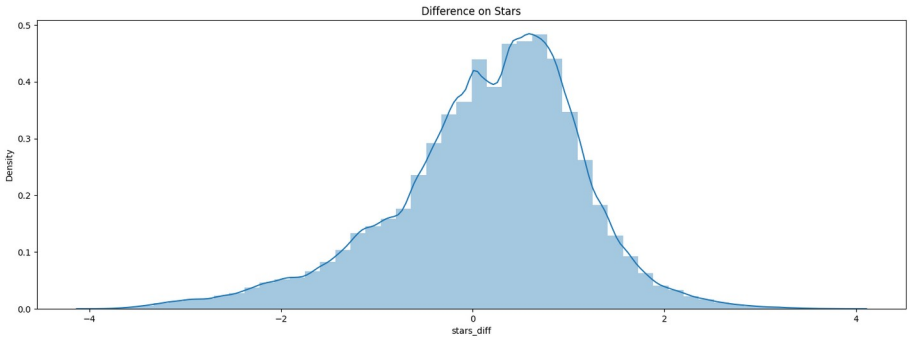

```
{"version_major":2,"version_minor":0,"model_id":"965e55b85ce04aaeb1eff
0252cc2ab25"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
plt.figure(figsize =(18,6))
#from scipy.stats import norm
sns.distplot(diff_df, axlabel = "stars_diff", kde = True).set(title =
"Difference on Stars")
%matplot plt
```


```
{"version_major":2,"version_minor":0,"model_id":"380ebd4a2e5d4dd6a4fd2
68c8c1a617f"}

{"version_major":2,"version_minor":0,"model_id":""}
```

IMPLICATIONS

As the graph shows, differance mainly ranges from -4 from 4, the graph tends to spread out to both sides , which indicate that the difference between elite users' rating and the business average rating is quite large on the whole, they are not close to each other, so at

this point, we can not take an elite user's review as reference to tell if a business is good or not.

Extra Credit (3 points)

Try and analyze some interesting dimension to this data. **Requirements:**

You must use the **Users** dataset and join on either the "**business** or **reviews** dataset.

You must render **one visual**

More Reviewers Means a Higher Star for a Business?

```
#Number of reviewers for each business_id
from pyspark.sql.functions import count
reviewersnum = user_review.select("business_id", user_df.user_id) \
    .groupby("business_id") \
    .agg(count(user_df.user_id).alias("number of reviewers"))
reviewersnum.show()
```


```
{"version_major":2,"version_minor":0,"model_id":"2731032fea0543898a188
459467f0a25"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+--------------------+
|         business_id|number of reviewers|
+--------------------+--------------------+
|yqq1Fvt7WtduIO3Gw...|                  76|
|zJErbOQMKX-MwHs_u...|                 222|
|XH3mYdTg4ZxWV-8W7...|                  18|
|oQ0MQpVVyzGe_JTIL...|                  46|
|ZFaG1Q3voENwwZPQA...|                  14|
|jzsspHqP9kATWji8x...|                 144|
|skW4boArIApRw9DXK...|                  38|
|sbYIQC5k2hVAqagH8...|                  88|
|nGe0BipegbPjll9tG...|                 220|
|DeDszlU-Gg-Hodu_H...|                  11|
|519hm725XtfGaK_7b...|                  30|
|BJOGo_upuBElDT_xO...|                 501|
|dugSltSoiYMwQvttp...|                  46|
|jg02zYvPsUGyHQBlK...|                  33|
|ZamcoxNtToUXvMvwF...|                  31|
|7Y1bCJLDE8surUcI1...|                   8|
|3FKIev7ZB_KE6XHL9...|                 455|
|-JAwNIEJoDXmdE_8s...|                 120|
|WOPAPwhaPqQg0cn4t...|                  26|
|P4E0Lv494T0OvvupB...|                  89|
```

```
+--------------------+------------------+
only showing top 20 rows

#busrating created from Part IV
num_vs_stars = busrating.join(reviewersnum, busrating.business_id ==
reviewersnum.business_id)
num_vs_stars.show()

{"version_major":2,"version_minor":0,"model_id":"1b5a580b9d1449e681b20
3bc18b54820"}

{"version_major":2,"version_minor":0,"model_id":""}

+--------------------+------------------+--------------------
+--------------------+
|         business_id|        avg(stars)|         business_id|number
of reviewers|
+--------------------+------------------+--------------------
+--------------------+
|--gJkxbsiSIwsQKbi...| 4.833333333333333|--gJkxbsiSIwsQKbi...|
6|
|-02xFuruu85XmDn2x...|  4.68595041322314|-02xFuruu85XmDn2x...|
121|
|-0EdehHjIQc0DtYU8...| 3.138888888888889|-0EdehHjIQc0DtYU8...|
36|
|-0dKgi_Hpcis921nO...| 4.678571428571429|-0dKgi_Hpcis921nO...|
28|
|-0iIxySkp97WNlwK6...| 3.721030042918455|-0iIxySkp97WNlwK6...|
233|
|-0qOecqGXEf_6Twai...| 4.238095238095238|-0qOecqGXEf_6Twai...|
42|
|-1ze-oWDnrGAzvAg5...|               5.0|-1ze-oWDnrGAzvAg5...|
12|
|-2j8XqQL68DPqYiaf...|               5.0|-2j8XqQL68DPqYiaf...|
7|
|-2wh7NTLkWEgsrLJv...| 4.416666666666667|-2wh7NTLkWEgsrLJv...|
96|
|-3e3CP3FFc-rvJj_-...|               3.7|-3e3CP3FFc-rvJj_-...|
80|
|-4E0hSCldRJZLI-1c...| 3.230769230769231|-4E0hSCldRJZLI-1c...|
13|
|-63ytt5vkWof-M9ND...|2.3333333333333335|-63ytt5vkWof-M9ND...|
15|
|-6L_z3ftD1iepJb0F...| 4.842592592592593|-6L_z3ftD1iepJb0F...|
108|
|-6qt8a52bBwMogqwZ...| 4.620689655172414|-6qt8a52bBwMogqwZ...|
29|
|-6vtoe3VFedMGouTF...|1.9444444444444444|-6vtoe3VFedMGouTF...|
18|
|-8562lttAp_PuLWpQ...| 4.466666666666667|-8562lttAp_PuLWpQ...|
15|
```

```
|-8VpP01AKfnt4wpT-...| 4.362068965517241|-8VpP01AKfnt4wpT-...|
116|
|-981bIUN3Qt27CVwN...|1.8823529411764706|-981bIUN3Qt27CVwN...|
17|
|-99aS7t1izJrDtgSU...|3.8666666666666667|-99aS7t1izJrDtgSU...|
15|
|-9lL4yFBX_7XVqUr8...|3.6791044776119404|-9lL4yFBX_7XVqUr8...|
134|
+--------------------+------------------+--------------------
+--------------------+
only showing top 20 rows
```

```
from pyspark.sql.types import StringType
num_vs_stars.withColumn("number of reviewers", col("number of
reviewers").cast(StringType()))
num_vs_stars.sort("number of reviewers", ascending = False).show()
```


```
{"version_major":2,"version_minor":0,"model_id":"5f07a6c3e24d43f681a77
358382fb23a"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+------------------+--------------------
+--------------------+
|         business_id|        avg(stars)|         business_id|number
of reviewers|
+--------------------+------------------+--------------------
+--------------------+
|_ab50qdWOk0DdB6XO...| 4.124983709109865|_ab50qdWOk0DdB6XO...|
7673|
|ac1AeYqs8Z4_e2X5M...| 4.146221394358702|ac1AeYqs8Z4_e2X5M...|
7516|
|GXFMD0Z4jEVZBCsbP...|4.4462662337662335|GXFMD0Z4jEVZBCsbP...|
6160|
|ytynqOUb3hjKeJfRj...|  4.60539979231568|ytynqOUb3hjKeJfRj...|
5778|
|oBNrLz4EDhiscSlbO...|4.2912234042553195|oBNrLz4EDhiscSlbO...|
5264|
|iSRTaT9WngzB8JJ2Y...|3.4387133612485723|iSRTaT9WngzB8JJ2Y...|
5254|
|VQcCL9PiNL_wkGf-u...|3.7866303925378935|VQcCL9PiNL_wkGf-u...|
5146|
|_C7QiQQc47AOEv4PE...|  4.29201046488227|_C7QiQQc47AOEv4PE...|
4969|
|GBTPC53ZrG1ZBY3DT...| 4.177429736108131|GBTPC53ZrG1ZBY3DT...|
4661|
|6a4gLLFSgr-Q6CZXD...| 4.186383928571429|6a4gLLFSgr-Q6CZXD...|
4480|
|PP3BBaVxZLcJU54uP...| 3.240158397391102|PP3BBaVxZLcJU54uP...|
4293|
|1b5mnK8bMnnju_cvU...| 4.171179656227926|1b5mnK8bMnnju_cvU...|
```

```
4247|
|I_3LMZ_1m2mzR0oLI...| 4.465184461275348|I_3LMZ_1m2mzR0oLI...|
4093|
|VaO-VW3e1kARkU9bP...| 3.961824491819534|VaO-VW3e1kARkU9bP...|
4034|
|qb28j-FNX1_6xm7u3...| 3.915386552505666|qb28j-FNX1_6xm7u3...|
3971|
|gTC8IQ_i8zXytWSly...| 4.509318355884606|gTC8IQ_i8zXytWSly...|
3917|
|yPSejq3_erxo9zdVY...|  4.48932887631782|yPSejq3_erxo9zdVY...|
3889|
|wz8ZPfySQczcPgSyd...| 2.977435332966428|wz8ZPfySQczcPgSyd...|
3634|
|VVH6k9-ycttH3TV_l...| 4.254610514726122|VVH6k9-ycttH3TV_l...|
3633|
|IkY2ticzHEn4QFn8h...|2.5320886814469077|IkY2ticzHEn4QFn8h...|
3428|
+--------------------+------------------+--------------------
+--------------------+
only showing top 20 rows

scatter_df = num_vs_stars.select("number of reviewers",
"avg(stars)").toPandas()
```

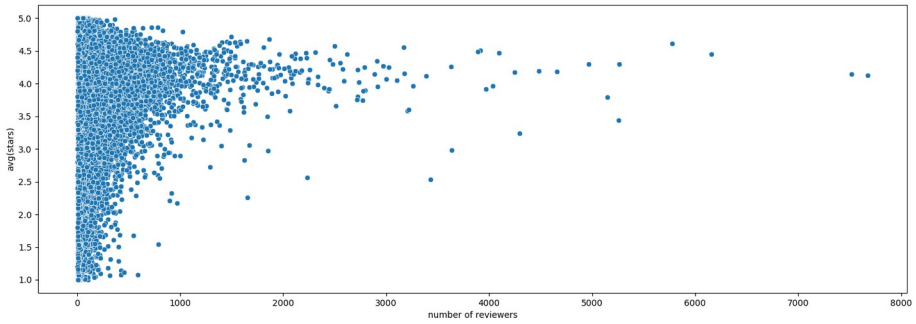

```
{"version_major":2,"version_minor":0,"model_id":"b2b13acec20c44f2a93f6
46b365f6024"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
#Scatter plot
plt.figure(figsize =(18,6))
#from scipy.stats import norm
sns.scatterplot(data=scatter_df, x="number of reviewers",
y="avg(stars)")
%matplot plt
```


```
{"version_major":2,"version_minor":0,"model_id":"cb557a69089b4d02b37f6
1971460b8df"}

{"version_major":2,"version_minor":0,"model_id":""}
```

IMPLICATIONS

The graph does not explicitly indicate the correlation between number of reviewers and stars of a business, however, we still can tell that as the reviewers increase, a business has more possibility to get a higher star.

Top 20 Business Names Having Most Reviews from Elite Users

```
#Join users table and review table
user_review = user_df.join(review_df, user_df.user_id ==
review_df.user_id)
```


```
{"version_major":2,"version_minor":0,"model_id":"6e6bd244ffc74a4981f79
a576a5c3f6f"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
#Get reviews by elite users
elite_rev = user_review.select("business_id", "elite", "stars") \
    .filter(user_review.elite != "")
elite_rev.show()
```


```
{"version_major":2,"version_minor":0,"model_id":"5ce5d370ec624dc592b4e
210c0fbae8b"}

{"version_major":2,"version_minor":0,"model_id":""}
```


```
+--------------------+--------------------+-----+
|         business_id|               elite|stars|
+--------------------+--------------------+-----+
|TV81bpCQ6p6o4Hau5...|2017,2018,2019,20...|  4.0|
|W4ZEKkva9HpAdZG88...|2014,2015,2016,20...|  5.0|
|E-4t5Hoon6aVFTWDP...|2014,2015,2016,20...|  5.0|
|_pbx96FZ3eHJw-V_R...|                2015|  3.0|
|8uF-bhJFgT4Tn6DTb...|          2019,20,20|  5.0|
|zaC6coZ5Gp8mLjeg7...|2011,2012,2013,20...|  4.0|
|EqEcDeXqIq1YwnzHg...|2018,2019,20,20,2021|  5.0|
|3w7NRntdQ9h0KwDsk...|2012,2013,2014,20...|  4.0|
|yE1raqkLX7OZsjmX3...|2017,2018,2019,20,20|  5.0|
|EP2jFD3aGoSBCWb7i...|                2015|  4.0|
|hS6KNGCQVTYUdLb2e...|2018,2019,20,20,2021|  4.0|
|uW8L6awmCyjovD9Oh...|           2014,2015|  5.0|
|6kAXOzE7fqaBZINQV...|           2017,2018|  4.0|
|yLIn3po-fKb0T3UIo...|2011,2012,2013,20...|  5.0|
|oQ5CPRt0R3AzFvcjN...|2018,2019,20,20,2021|  3.0|
|psI9u_iVuWFcchWhe...| 2006,2007,2008,2010|  3.0|
|wzE61ThXOdrSegvwS...|           2017,2018|  5.0|
|z6SVTb9eFIcWVpKXI...|2011,2012,2013,20...|  4.0|
|hdVqM-QngiiLRaMOv...|2011,2012,2013,20...|  5.0|
|kPG6r0h73sPgXBei0...|2011,2012,2013,20...|  4.0|
```

```
+--------------------+--------------------+-----+
only showing top 20 rows

#Group the datafram, get count
elite_rev_grouped = elite_rev.groupby("business_id")
elite_rev_grouped.count().show()

{"version_major":2,"version_minor":0,"model_id":"74a2db4a0bcd460eab5f9
cf3aeccd151"}

{"version_major":2,"version_minor":0,"model_id":""}

+--------------------+-----+
|         business_id|count|
+--------------------+-----+
|zJErbOQMKX-MwHs_u...|   86|
|HSzSGdcNaU7heQe0N...|   11|
|skW4boArIApRw9DXK...|   15|
|I0053JmJ5DEFUWSJ8...|   23|
|kPG6r0h73sPgXBei0...|   31|
|Ety2Z0CImO6FYDV6L...|   29|
|Qbxo9pb5yDsbD3GSu...|   21|
|whUR7TFShhEhPT0X2...|    4|
|Yh_KhyVD6ZBwsIQQ1...|   58|
|H94SJrxs9Fx-WYUSm...|    1|
|64i1xdiU1Wvo1Cuu0...|   28|
|9-uRQkRkXdPQmnU1o...|   33|
|3I3YM0yD2jaXZTK3Y...|    7|
|0YiRkVMR2cg17hk9u...|    5|
|scychO44eMoosS9iE...|    3|
|xR1Wkmrm3yoAJuxPm...|   20|
|EyBlARgBUFBu6ZYS9...|   34|
|gZqFuqTjtN4Bfh-_f...|   65|
|pP4q0Mym-qt20nRqT...|   62|
|lXCFcmhoRsyW-mnzz...|   36|
+--------------------+-----+
only showing top 20 rows

#Sort it
top_bus_eliterev = elite_rev_grouped.count().sort("count", ascending =
False)
top_bus_eliterev.show()

{"version_major":2,"version_minor":0,"model_id":"89e1d25642664413b327b
2199893d2a8"}

{"version_major":2,"version_minor":0,"model_id":""}

+--------------------+-----+
|         business_id|count|
+--------------------+-----+
|_ab50qdWOk0DdB6XO...| 2330|
```

```
|ytynqOUb3hjKeJfRj...| 1955|
|GXFMD0Z4jEVZBCsbP...| 1790|
|_C7QiQQc47AOEv4PE...| 1568|
|PP3BBaVxZLcJU54uP...| 1520|
|iSRTaT9WngzB8JJ2Y...| 1462|
|GBTPC53ZrG1ZBY3DT...| 1402|
|ac1AeYqs8Z4_e2X5M...| 1368|
|6a4gLLFSgr-Q6CZXD...| 1340|
|gTC8IQ_i8zXytWSly...| 1288|
|-QI8Qi8XWH3D8y8et...| 1257|
|VaO-VW3e1kARkU9bP...| 1169|
|Eb1XmmLWyt_way5NN...| 1162|
|VVH6k9-ycttH3TV_l...| 1158|
|1b5mnK8bMnnju_cvU...| 1153|
|I_3LMZ_1m2mzR0oLI...| 1149|
|6Ty-KKWq6hLZYW8DW...| 1138|
|IkY2ticzHEn4QFn8h...| 1131|
|oBNrLz4EDhiscSlbO...| 1110|
|VQcCL9PiNL_wkGf-u...| 1093|
+--------------------+-----+
only showing top 20 rows

#Join the business table, get the name field
bus_name_df = df.select("business_id", "name")
top_bus_eliterev = top_bus_eliterev.join(bus_name_df,
top_bus_eliterev.business_id == bus_name_df.business_id)
top_bus_eliterev.show()

{"version_major":2,"version_minor":0,"model_id":"902ce0809a0a4588b836e
a4f27c05779"}

{"version_major":2,"version_minor":0,"model_id":""}

+--------------------+-----+--------------------+--------------------+
|         business_id|count|         business_id|                name|
+--------------------+-----+--------------------+--------------------+
|_ab50qdWOk0DdB6XO...| 2330|_ab50qdWOk0DdB6XO...|   Acme Oyster House|
|ytynqOUb3hjKeJfRj...| 1955|ytynqOUb3hjKeJfRj...|Reading Terminal ...|
|GXFMD0Z4jEVZBCsbP...| 1790|GXFMD0Z4jEVZBCsbP...|Hattie B’s Hot Ch...|
|_C7QiQQc47AOEv4PE...| 1568|_C7QiQQc47AOEv4PE...|  Commander's Palace|
|PP3BBaVxZLcJU54uP...| 1520|PP3BBaVxZLcJU54uP...|Pat's King of Steaks|
|iSRTaT9WngzB8JJ2Y...| 1462|iSRTaT9WngzB8JJ2Y...| Mother's Restaurant|
|GBTPC53ZrG1ZBY3DT...| 1402|GBTPC53ZrG1ZBY3DT...|                Luke|
|ac1AeYqs8Z4_e2X5M...| 1368|ac1AeYqs8Z4_e2X5M...|        Oceana Grill|
|6a4gLLFSgr-Q6CZXD...| 1340|6a4gLLFSgr-Q6CZXD...|              Cochon|
|gTC8IQ_i8zXytWSly...| 1288|gTC8IQ_i8zXytWSly...|      Cochon Butcher|
|-QI8Qi8XWH3D8y8et...| 1257|-QI8Qi8XWH3D8y8et...|Philadelphia Inte...|
|VaO-VW3e1kARkU9bP...| 1169|VaO-VW3e1kARkU9bP...|Felix's Restauran...|
|Eb1XmmLWyt_way5NN...| 1162|Eb1XmmLWyt_way5NN...|Louis Armstrong N...|
|VVH6k9-ycttH3TV_l...| 1158|VVH6k9-ycttH3TV_l...|Willie Mae's Scot...|
|1b5mnK8bMnnju_cvU...| 1153|1b5mnK8bMnnju_cvU...| Biscuit Love: Gulch|
```

```
|I_3LMZ_1m2mzR0oLI...| 1149|I_3LMZ_1m2mzR0oLI...|  Pappy's Smokehouse|
|6Ty-KKWq6hLZYW8DW...| 1138|6Ty-KKWq6hLZYW8DW...|       Pat O'Brien’s|
|IkY2ticzHEn4QFn8h...| 1131|IkY2ticzHEn4QFn8h...|       Geno's Steaks|
|oBNrLz4EDhiscSlbO...| 1110|oBNrLz4EDhiscSlbO...|Ruby Slipper - Ne...|
|VQcCL9PiNL_wkGf-u...| 1093|VQcCL9PiNL_wkGf-u...|         Royal House|
+--------------------+-----+--------------------+--------------------+
only showing top 20 rows
```

```
#Convert to pandas dataframe
top_bus_eliterev = top_bus_eliterev.toPandas()
```


```
{"version_major":2,"version_minor":0,"model_id":"863beda12bb14748a1946
22b022f65d4"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```


```
#Plot a bar chart
plt.figure(figsize =(10,6))
top_bus_eliterev[0:20].plot(kind='bar', x='name', figsize =(10,6)) \
    .set(title = "Top 20 business Names Having Most Reviews from Elite
Users")
%matplot plt
```


```
{"version_major":2,"version_minor":0,"model_id":"a345e84e6186491ca1f82
0eb6ce21f29"}
```

```
{"version_major":2,"version_minor":0,"model_id":""}
```