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://sta9760-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`

In [3]:

```
sc.install_pypi_package("pandas==1.0.3")
sc.install_pypi_package("matplotlib==3.2.1")
```

```
Package already installed for current Spark context!
Traceback (most recent call last):
  File "/usr/lib/spark/python/lib/pyspark.zip/pyspark/context.py", line 1110, in install_pypi_package
    raise ValueError("Package already installed for current Spark context!")
ValueError: Package already installed for current Spark context!
```

In [5]:

```
sc.install_pypi_package("scipy==1.7.0")
sc.install_pypi_package("seaborn==0.11.2")
```

```
Collecting scipy==1.7.0
  Downloading https://files.pythonhosted.org/packages/b2/85/b00f13b52d079b5625e1a12330fc6453c947a482ff667a907c7bc60ed220/
scipy-1.7.0-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==1.7.0)
Installing collected packages: scipy
Successfully installed scipy-1.7.0

Collecting seaborn==0.11.2
  Using cached https://files.pythonhosted.org/packages/10/5b/0479d7d845b5ba410ca702ffcd7f2cd95a14a4dfff1fde2637802b258b9
b/seaborn-0.11.2-py3-none-any.whl
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/1638237931683-0/lib/python3.7/site-packages (from seaborn==0.11.2)
Requirement already satisfied: matplotlib>=2.2 in /mnt/tmp/1638237931683-0/lib/python3.7/site-packages (from seaborn==0.1
1.2)
Requirement already satisfied: pandas>=0.23 in /mnt/tmp/1638237931683-0/lib/python3.7/site-packages (from seaborn==0.11.
2)
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1638237931683-0/lib/python3.7/site-packages (from matplot
lib>=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/1638237931683-0/lib/python3.7/site-pa
ckages (from matplotlib>=2.2->seaborn==0.11.2)
Requirement already satisfied: cycler>=0.10 in /mnt/tmp/1638237931683-0/lib/python3.7/site-packages (from matplotlib>=2.2
->seaborn==0.11.2)
Requirement already satisfied: kiwisolver>=1.0.1 in /mnt/tmp/1638237931683-0/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)
Installing collected packages: seaborn
Successfully installed seaborn-0.11.2
```

Importing

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

In [6]:

```
import matplotlib.pyplot as plt
%matplot inline
%matplot plt
import pyspark.sql.functions as f
from pyspark.sql.functions import avg
from pyspark.sql.functions import lit
from pyspark.sql.functions import collect_set
from pyspark.sql.functions import countDistinct
from pyspark.sql.functions import col, mean
from pyspark.sql.functions import trim
import pandas as pd
import numpy as np
import seaborn as sns
```

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.

In [7]:
```
business = spark.read.json('s3://sta9760f2021-yelp-datasets/yelp_academic_dataset_business.json')
```

Overview of Data

Display the number of rows and columns in our dataset.

In [8]:
```
print(f'Total Columns: {len(business.dtypes)}')
print(f'Total Rows: {business.count():,}')
business.printSchema()
```

```
Total Columns: 14
Total Rows: 160,585
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 DataFrame schema below.

In [9]:
```
business.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 [10]:

```
cols = ['business_id', 'name', 'city', 'state' , 'stars','categories']
business.select(cols).show(5)
```

```
+--------------------+--------------------+-----------+-----+-----+--------------------+
|         business_id|                name|       city|state|stars|          categories|
+--------------------+--------------------+-----------+-----+-----+--------------------+
|6iYb2HFDywm3zjuRg...| Oskar Blues Taproom|    Boulder|   CO|  4.0|Gastropubs, Food,...|
|tCbdrRPZA0oiIYSmH...|Flying Elephants ...|   Portland|   OR|  4.0|Salad, Soup, Sand...|
|bvN78flM8NLprQ1a1...|      The Reclaimory|   Portland|   OR|  4.5|Antiques, Fashion...|
|oaepsyvc0J17qwi8c...|         Great Clips|Orange City|   FL|  3.0|Beauty & Spas, Ha...|
|PE9uqAjdw0E4-8mjG...|    Crossfit Terminus|    Atlanta|   GA|  4.0|Gyms, Active Life...|
+--------------------+--------------------+-----------+-----+-----+--------------------+
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	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.

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

In [11]:

```python
two_cols = ['business_id', 'categories']
business.select(two_cols).show(5)
```

```
+--------------------+--------------------+
|         business_id|          categories|
+--------------------+--------------------+
|6iYb2HFDywm3zjuRg...|Gastropubs, Food,...|
|tCbdrRPZA0oiIYSmH...|Salad, Soup, Sand...|
|bvN78flM8NLprQ1a1...|Antiques, Fashion...|
|oaepsyvc0J17qwi8c...|Beauty & Spas, Ha...|
|PE9uqAjdw0E4-8mjG...|Gyms, Active Life...|
+--------------------+--------------------+
only showing top 5 rows
```

In [12]:
```
from pyspark.sql.functions import explode
from pyspark.sql.functions import split
category_explode = business.select(business.business_id, explode(split(business.categories, ', ')))
category_explode = category_explode.withColumnRenamed('col', 'category')
```

Display the first 5 rows of your association table below.

In [13]:
```
category_explode.show(5)
```

```
+--------------------+------------+
|         business_id|    category|
+--------------------+------------+
|6iYb2HFDywm3zjuRg...|  Gastropubs|
|6iYb2HFDywm3zjuRg...|        Food|
|6iYb2HFDywm3zjuRg...|Beer Gardens|
|6iYb2HFDywm3zjuRg...| Restaurants|
|6iYb2HFDywm3zjuRg...|        Bars|
+--------------------+------------+
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.

In [14]:
```
from pyspark.sql.functions import countDistinct
business_cat = category_explode.select(countDistinct('category'))
business_cat.show(truncate = False)
```

```
+------------------------+
|count(DISTINCT category)|
+------------------------+
|1330                    |
+------------------------+
```

In [15]:

```
category_explode.createOrReplaceTempView('business_category')

count_distinct = spark.sql(
'''
SELECT COUNT(DISTINCT category) as count_distinct_category FROM business_category

'''
)
count_distinct.show()
```

```
+-----------------------+
|count_distinct_category|
+-----------------------+
|                   1330|
+-----------------------+
```

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	count
a	15
b	2
c	45

Or something to that effect.

```
In [16]:
category_explode.createOrReplaceTempView('business_category')

category_count = spark.sql(
'''
SELECT category, COUNT(category) as count_category FROM business_category
GROUP BY category
'''
)
category_count.show()
```

```
+--------------------+--------------+
|            category|count_category|
+--------------------+--------------+
|      Dermatologists|           351|
|      Paddleboarding|            67|
|        Aerial Tours|             8|
|         Hobby Shops|           610|
|          Bubble Tea|           779|
|             Embassy|             9|
|             Tanning|           701|
|            Handyman|           507|
|      Aerial Fitness|            13|
|             Falafel|           141|
|        Summer Camps|           308|
|       Outlet Stores|           184|
|     Clothing Rental|            37|
|      Sporting Goods|          1864|
|     Cooking Schools|           114|
|  College Counseling|            20|
|  Lactation Services|            47|
|Ski & Snowboard S...|            55|
|             Museums|           336|
|              Doulas|            52|
+--------------------+--------------+
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
```

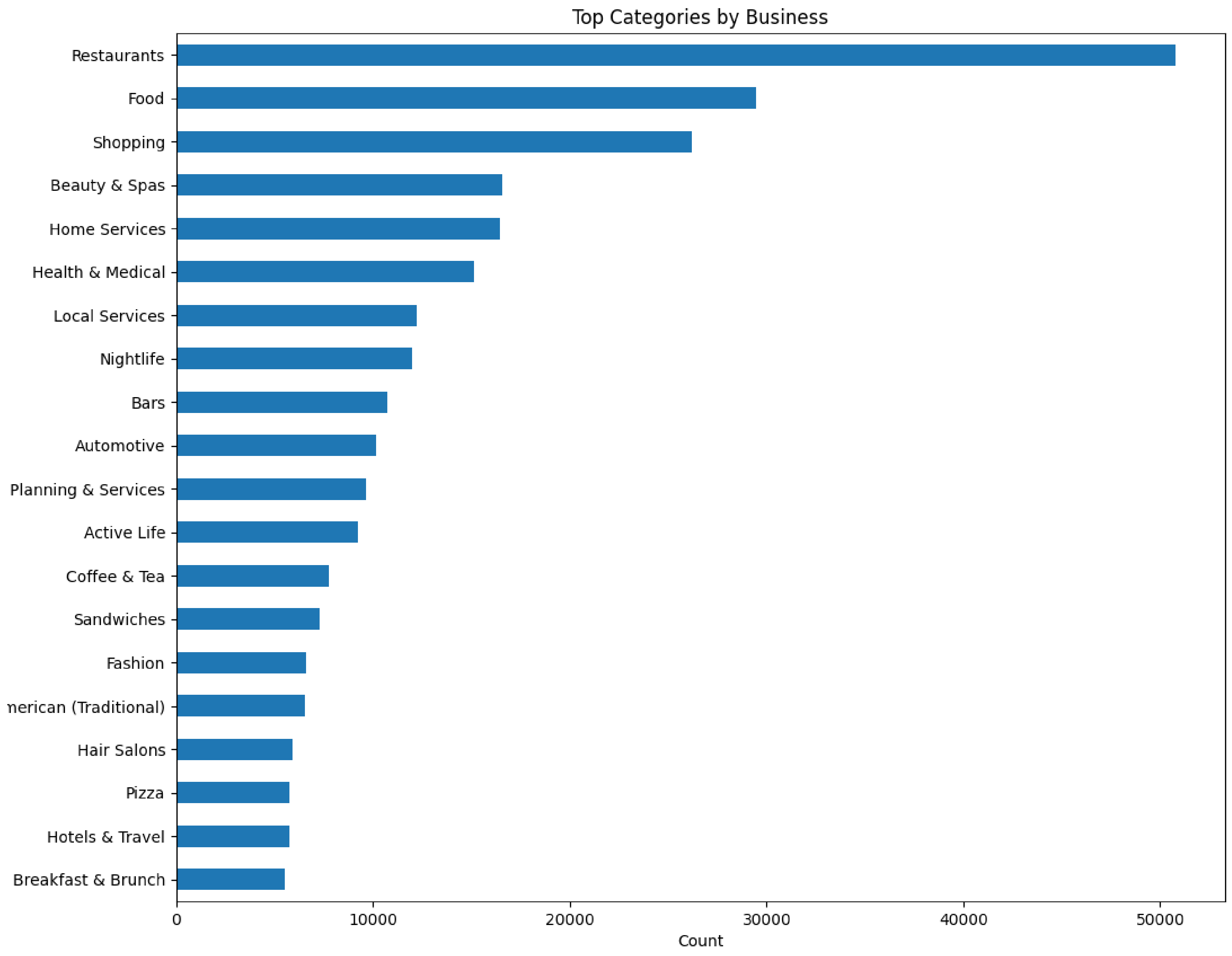
In [17]:

```
top20 = spark.sql(
'''
SELECT category, COUNT(category) as count_category FROM business_category
GROUP BY category
ORDER BY count_category DESC
LIMIT 20
'''
)
top20.show()
```

```
+--------------------+--------------+
|            category|count_category|
+--------------------+--------------+
|         Restaurants|         50763|
|                Food|         29469|
|            Shopping|         26205|
|       Beauty & Spas|         16574|
|       Home Services|         16465|
|    Health & Medical|         15102|
|      Local Services|         12192|
|           Nightlife|         11990|
|                Bars|         10741|
|          Automotive|         10119|
|Event Planning & ...|          9644|
|         Active Life|          9231|
|        Coffee & Tea|          7725|
|          Sandwiches|          7272|
|             Fashion|          6599|
|American (Traditi...|          6541|
|         Hair Salons|          5900|
|               Pizza|          5756|
|     Hotels & Travel|          5703|
|  Breakfast & Brunch|          5505|
+--------------------+--------------+
```

In [43]:

```
business_pan = top20.toPandas()
fig, ax = plt.subplots(figsize = (12,10))
business_pan.sort_values('count_category', ascending = True).plot.barh(y = "count_category", x = 'category',
                                                                      title = 'Top Categories by Business',
                                                                       legend = False, ax = ax)
plt.xlabel('Count')
%matplot plt
```


Top Categories by Business
Restaurants
Food
Shopping
Beauty & Spas
Home Services
Health & Medical
Local Services
Nightlife
Bars
Automotive
Planning & Services
Active Life
Coffee & Tea
Sandwiches
Fashion
nerican (Traditional)
Hair Salons
Pizza
Hotels & Travel
Breakfast & Brunch
0
10000
20000
30000
40000
50000
Count

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.

Loading User Data

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

In [45]:
```
review = spark.read.json('s3://sta9760f2021-yelp-datasets/yelp_academic_dataset_review.json')
review.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 [46]:
```
col = ['business_id','stars']
review_col = review.select(col)
review_col.show(5)
```

```
+--------------------+-----+
|         business_id|stars|
+--------------------+-----+
|buF9druCkbuXLX526...|  4.0|
|RA4V8pr014UyUbDvI...|  4.0|
|_sS2LBIGNT5NQb6PD...|  5.0|
|0AzLzHfOJgL7ROwhd...|  2.0|
|8zehGz9jnxPqXtOc7...|  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 [47]:

```
review_col.createOrReplaceTempView('review_col')
top_review = spark.sql(
'''
SELECT business_id, AVG(stars) FROM review_col
GROUP BY business_id
'''
)
top_review.show(5)
```

```
+--------------------+-----------------+
|         business_id|       avg(stars)|
+--------------------+-----------------+
|yHtuNAlYKtRZniO8O...|4.714285714285714|
|R0IJhEI-zSJpYT1YN...|3.606060606060606|
|uEUweopM30lHcVxjO...|              3.0|
|L3WCfeVozu5etMhz4...|              4.2|
|XzXcpPCb8Y5huklEN...|4.666666666666667|
+--------------------+-----------------+
only showing top 5 rows
```

In [48]:

```
cols = ['business_id', 'name', 'city', 'state' , 'categories','stars']
business_df = business.select(cols)
business_df.show(5)
```

```
+--------------------+--------------------+-----------+-----+--------------------+-----+
|         business_id|                name|       city|state|          categories|stars|
+--------------------+--------------------+-----------+-----+--------------------+-----+
|6iYb2HFDywm3zjuRg...| Oskar Blues Taproom|    Boulder|   CO|Gastropubs, Food,...|  4.0|
|tCbdrRPZA0oiIYSmH...|Flying Elephants ...|   Portland|   OR|Salad, Soup, Sand...|  4.0|
|bvN78flM8NLprQ1a1...|      The Reclaimory|   Portland|   OR|Antiques, Fashion...|  4.5|
|oaepsyvc0J17qwi8c...|         Great Clips|Orange City|   FL|Beauty & Spas, Ha...|  3.0|
|PE9uqAjdw0E4-8mjG...|   Crossfit Terminus|    Atlanta|   GA|Gyms, Active Life...|  4.0|
+--------------------+--------------------+----------+-----+--------------------+-----+
only showing top 5 rows
```

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

In [49]:
```
business_review_df = business_df.join(top_review, business_df.business_id == top_review.business_id)
business_review_df.show(5)
```

```
+--------------------+--------------------+----------+-----+--------------------+-----+--------------------+-------------
-----+
|         business_id|                name|      city|state|          categories|stars|         business_id|        avg(s
tars)|
+--------------------+--------------------+----------+-----+--------------------+-----+--------------------+-------------
-----+
|--JuLhLvq3gyjNnXT...|    CheraBella Salon|   Peabody|   MA|Beauty & Spas, Ha...|  5.0|--JuLhLvq3gyjNnXT...|
5.0|
|--_nBudPOb1lNRgKf...|Mezcal Cantina & ...|  Columbus|   OH|Mexican, Gastropu...|  4.0|--_nBudPOb1lNRgKf...|
3.875|
|--kyOk0waSrCDlbSv...|     Red Table Coffee|    Austin|   TX|Coffee & Tea, Res...|  4.0|--kyOk0waSrCDlbSv...|3.86666666666
66667|
|--z9usx6Fin8P_f0v...|           WonderWell|    Austin|   TX|Education, Presch...|  5.0|--z9usx6Fin8P_f0v...|
5.0|
|-0qeY1293steyCqYh...|         Avalon Oaks|Wilmington|   MA|Real Estate, Home...|  3.5|-0qeY1293steyCqYh...|
3.375|
+--------------------+--------------------+----------+-----+--------------------+-----+--------------------+-------------
-----+
only showing top 5 rows
```

Let's see a few of these:

In [50]:
```
cols = ['avg(stars)', 'stars', 'name' , 'city', 'state']
business_review_df.select(cols).show(5)
```

```
+------------------+-----+--------------------+----------+-----+
|        avg(stars)|stars|                name|      city|state|
+------------------+-----+--------------------+----------+-----+
|               5.0|  5.0|    CheraBella Salon|   Peabody|   MA|
|             3.875|  4.0|Mezcal Cantina & ...|  Columbus|   OH|
|3.8666666666666667|  4.0|    Red Table Coffee|    Austin|   TX|
|               5.0|  5.0|          WonderWell|    Austin|   TX|
|             3.375|  3.5|         Avalon Oaks|Wilmington|   MA|
+------------------+-----+--------------------+----------+-----+
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']
```

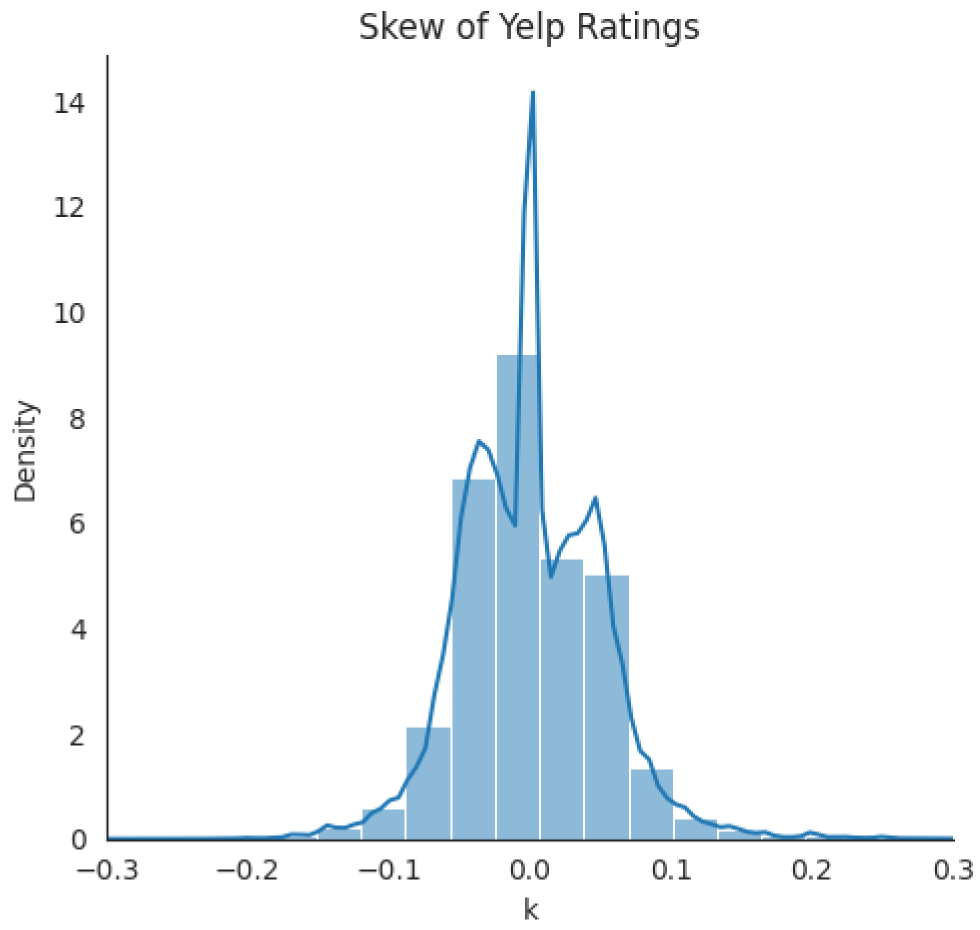
If the **skew** is negative, we can interpret that to be: reviewers who left a written response were more dissatisfied than normal. If **skew** is positive, we can interpret that to be: reviewers who left a written response were more satisfied than normal.

In [88]:
```
business_review_skew = business_review_df.withColumn('skew', (business_review_df['avg(stars)'] -
                                                              business_review_df['stars'] ) / business_review_df['stars']
cols = ['avg(stars)', 'stars', 'name', 'city', 'state', 'skew']
business_skew = business_review_skew.select(cols)
business_skew.show(5)
```

```
+------------------+-----+--------------------+----------+-----+--------------------+
|        avg(stars)|stars|                name|      city|state|                skew|
+------------------+-----+--------------------+----------+-----+--------------------+
|               5.0|  5.0|     CheraBella Salon|   Peabody|   MA|                 0.0|
|             3.875|  4.0|Mezcal Cantina & ...|  Columbus|   OH|            -0.03125|
|3.8666666666666667|  4.0|     Red Table Coffee|    Austin|   TX|-0.03333333333333...|
|               5.0|  5.0|          WonderWell|    Austin|   TX|                 0.0|
|             3.375|  3.5|         Avalon Oaks|Wilmington|   MA|-0.03571428571428571|
+------------------+-----+--------------------+----------+-----+--------------------+
only showing top 5 rows
```

And finally, graph it!

In [91]:
```
#business_skew.toPandas().hist(column = 'Skew', bins = 100)
skew= business_skew.select('skew').toPandas()
sns.set_style("white")
skew_plot=sns.displot(x='skew', data=skew, bins=40, kde=True, stat="density")
plt.xlim(-0.3, 0.3)
plt.title("Skew of Yelp Ratings")
plt.xlabel('k')
plt.tight_layout
plt.subplots_adjust(top=0.9)
%matplot plt
```



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

Should the Elite be Trusted? (Or, some other analysis of your choice)

For the final portion - you have a choice:

- Try and analyze some interesting dimension to this data. The **ONLY** requirement is that you must use the **Users** dataset and join on either the **business* or** reviews** dataset
- Or, you may try and answer the question posed: how accurate or close are the ratings of an "elite" user (check Users table schema) vs the actual business rating.

Feel free to use any and all methodologies at your disposal - only requirement is you must render one visualization in your analysis

In [94]:
```
user = spark.read.json('s3://sta9760f2021-yelp-datasets/yelp_academic_dataset_user.json')
user.printSchema()
```

```
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)
```

In [96]:
```
user_review = user.join(review, on = "user_id", how = 'outer')
user_review.printSchema()
```

```
root
 |-- user_id: string (nullable = true)
 |-- 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)
 |-- yelping_since: string (nullable = true)
 |-- 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)
```

In [97]:

```
user_review1 = user_review.withColumn('difference', (user_review['average_stars'] -
                                                      user_review['stars'] ) / user_review['stars'])
user_review1 = user_review1.select(['average_stars', 'stars', 'difference'])
user_review1.show(5)
```

```
+-------------+-----+----------+
|average_stars|stars|difference|
+-------------+-----+----------+
|         2.62|  5.0|    -0.476|
|         3.67|  5.0|    -0.266|
|         2.73|  2.0|     0.365|
|         2.73|  5.0|    -0.454|
|         2.73|  2.0|     0.365|
+-------------+-----+----------+
only showing top 5 rows
```

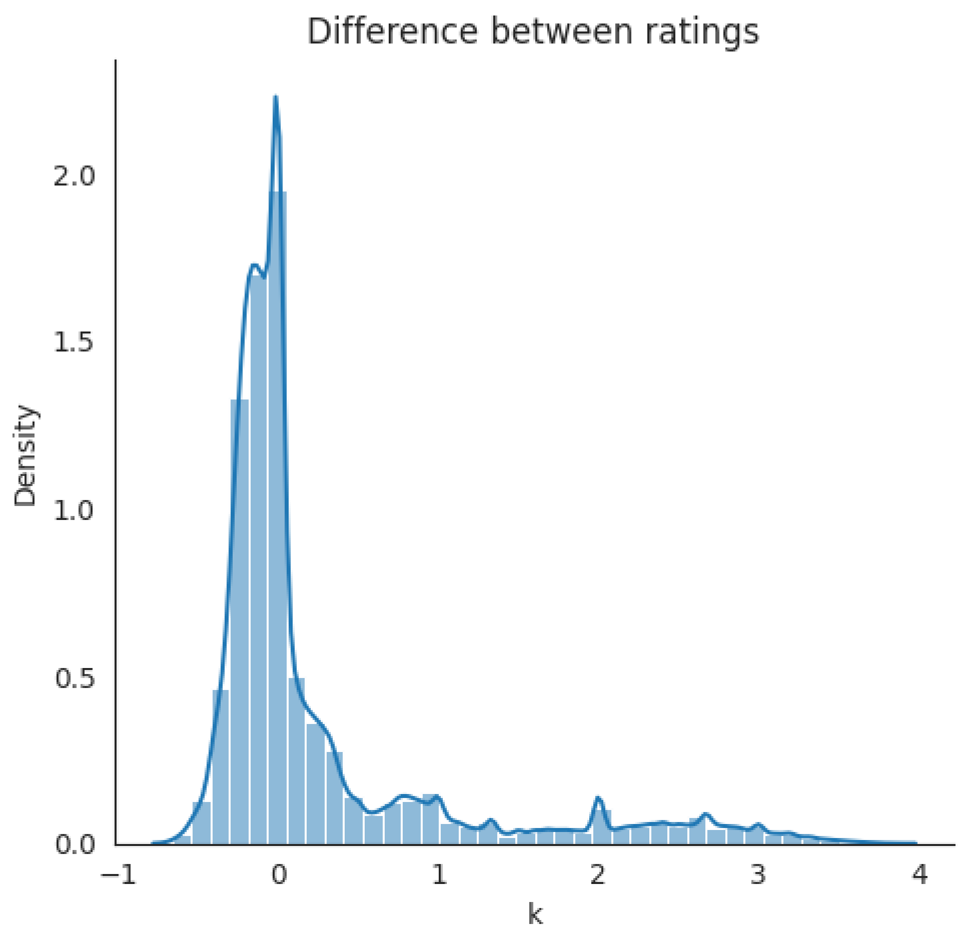
In [101…

```
difference = user_review1.select('difference').toPandas()
sns.set_style("white")
skew_plot=sns.displot(x='difference', data= difference, bins=40, kde=True, stat="density")
#plt.xlim(-0.3, 0.3)
plt.title("Difference between ratings")
plt.xlabel('k')
plt.tight_layout
plt.subplots_adjust(top=0.9)
```

```
/tmp/1638237931683-0/lib/python3.7/site-packages/seaborn/axisgrid.py:409: RuntimeWarning: More than 20 figures have been
opened. Figures created through the pyplot interface (`matplotlib.pyplot.figure`) are retained until explicitly closed an
d may consume too much memory. (To control this warning, see the rcParam `figure.max_open_warning`).
  fig = plt.figure(figsize=figsize)
```

In [102…

```
%matplot plt
```



From this figure, we can see that the distribution of the difference is right skewed. This means that the average stars of the users tend to be higher than the stars of the Elite.

Analysis 2:

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

average stars of an elite user

In [103…

```
user.createOrReplaceTempView('user')
```

```
user_stats = spark.sql(
'''
SELECT mean(average_stars) AS mean, STDDEV(average_stars) AS standard_dev
FROM user

'''
)
user_stats.show()
```

```
+------------------+------------------+
|              mean|      standard_dev|
+------------------+------------------+
|3.6538161105699265|1.1538609330757066|
+------------------+------------------+
```

Average stars of a review

In [104…

```
review.createOrReplaceTempView('review')

review_stats = spark.sql(
'''
SELECT mean(stars) AS mean, STDDEV(stars) AS standard_dev
FROM review

'''
)
review_stats.show()
```

```
+-----------------+-----------------+
|             mean|     standard_dev|
+-----------------+-----------------+
|3.730958705690979|1.456808728407596|
+-----------------+-----------------+
```

Average stars of a business

In [105…

```
business.createOrReplaceTempView('business')

business_stats = spark.sql(
'''
SELECT mean(stars) AS mean, STDDEV(stars) AS standard_dev
FROM business

'''
)
business_stats.show()
```

```
+------------------+------------------+
|              mean|      standard_dev|
+------------------+------------------+
|3.6569542609832797|0.9436044884562207|
+------------------+------------------+
```

We can see that the average ratings and the standard deviation of an "elite" user is about the same as the actual business rating.

In [106…

```
businessUserReview = user_review.join(business, on = 'business_id')
businessUserReview.printSchema()
```

```
root
 |-- business_id: string (nullable = true)
 |-- user_id: string (nullable = true)
 |-- 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)
 |-- yelping_since: 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)
 |-- 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)
 |-- 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)
```

In [107…

```
businessUserReview.select(['friends', 'state', 'categories']).show()
```

```
+--------------------+-----+--------------------+
|             friends|state|          categories|
+--------------------+-----+--------------------+
|ZdKmQ_xpAU90iqior...|   WA|American (Traditi...|
|ZdKmQ_xpAU90iqior...|   OR|Restaurants, Pizz...|
|ZdKmQ_xpAU90iqior...|   OR|  Pizza, Restaurants|
|ZdKmQ_xpAU90iqior...|   WA|Restaurants, Sush...|
|ZdKmQ_xpAU90iqior...|   WA|Bars, Restaurants...|
|ZdKmQ_xpAU90iqior...|   WA|Mediterranean, Mi...|
|maAxvpjUeHqjV_FJp...|   OR|Nightlife, Restau...|
|tcCJzwrzYSrcQqNoJ...|   FL|Food, Desserts, B...|
|tcCJzwrzYSrcQqNoJ...|   FL|Bars, Indian, Res...|
|tcCJzwrzYSrcQqNoJ...|   FL|Bars, Nightlife, ...|
|tcCJzwrzYSrcQqNoJ...|   FL|Mexican, New Mexi...|
|tcCJzwrzYSrcQqNoJ...|   FL|Comfort Food, Wra...|
|tcCJzwrzYSrcQqNoJ...|   FL|Used Car Dealers,...|
|                None|   GA|Sports Bars, Nigh...|
|                None|   GA|Transportation, A...|
|                None|   GA|Transportation, A...|
|                None|   FL|Golf, Golf Lesson...|
|                None|   TX|Nail Technicians,...|
|KNXQLIDnlpoBEmAuB...|   TX|Tacos, Event Plan...|
|KNXQLIDnlpoBEmAuB...|   TX|      Bars, Nightlife|
+--------------------+-----+--------------------+
only showing top 20 rows
```

Analysis 3: This analysis aims to find out which states has the most count of friends from a Yelp business review

In [109…

```
analysis_3 = businessUserReview.select(businessUserReview.friends,
                businessUserReview.state,
                explode(split(businessUserReview.categories, ', ')))
analysis_3.show(5)
```

```
+--------------------+-----+-----------+
|             friends|state|        col|
+--------------------+-----+-----------+
|ZdKmQ_xpAU90iqior...|   OR|Restaurants|
|ZdKmQ_xpAU90iqior...|   OR|      Pizza|
|ZdKmQ_xpAU90iqior...|   OR|  Nightlife|
|ZdKmQ_xpAU90iqior...|   OR|    Italian|
|ZdKmQ_xpAU90iqior...|   OR|      Pizza|
+--------------------+-----+-----------+
only showing top 5 rows
```

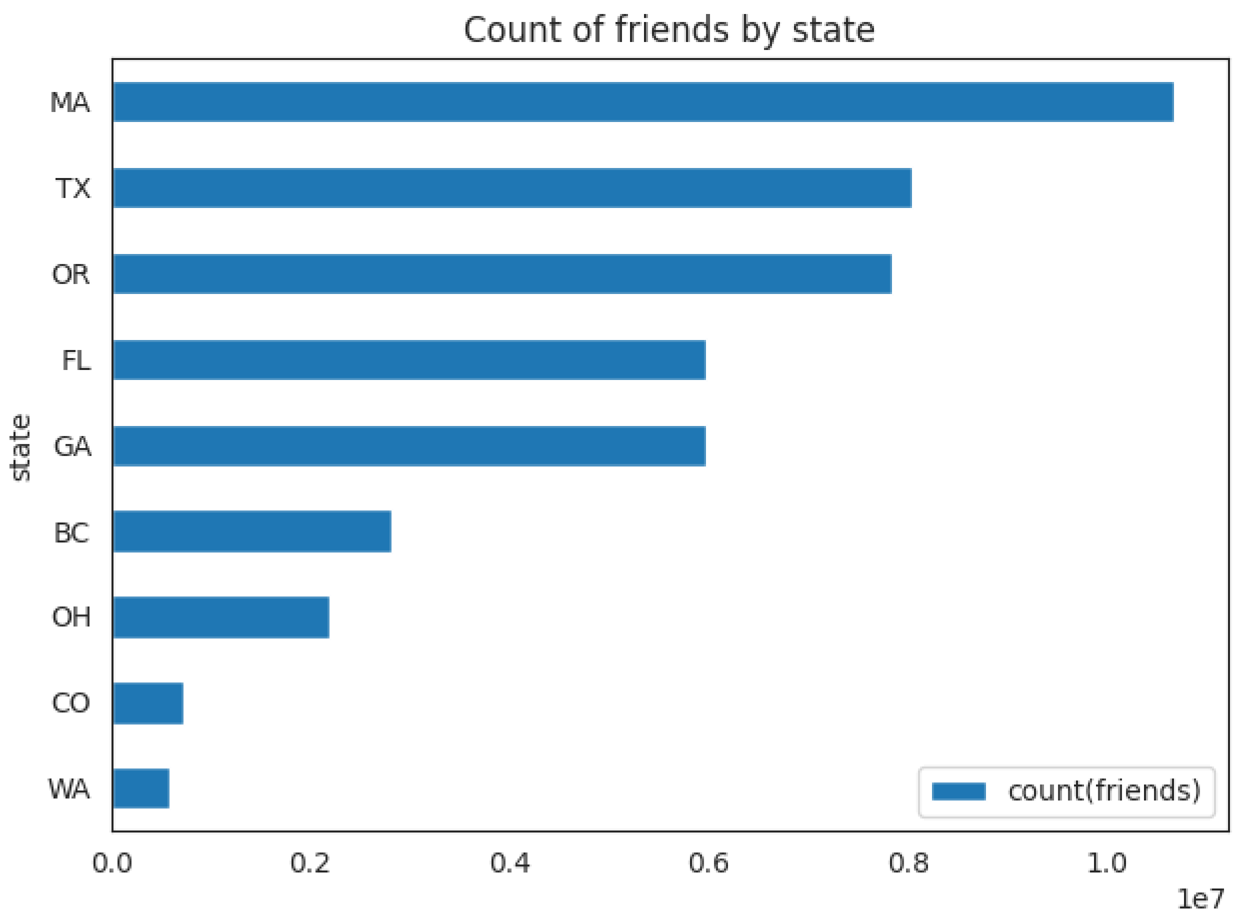
In [110…

```
analysis_3.createOrReplaceTempView('analysis_3')

friendbyStates = spark.sql(
'''
SELECT COUNT(friends), state
FROM analysis_3
GROUP BY state
ORDER BY count(friends) DESC
LIMIT 9
'''
)
friendbyStates.show()
```

```
+--------------+-----+
|count(friends)|state|
+--------------+-----+
|      10689941|   MA|
|       8051285|   TX|
|       7851639|   OR|
|       5975594|   FL|
|       5967913|   GA|
|       2818998|   BC|
|       2203404|   OH|
|        736644|   CO|
|        589754|   WA|
+--------------+-----+
```

In [111…

```
stateFriends = friendbyStates.toPandas()
stateFriends.sort_values('count(friends)', ascending = True).plot.barh(y = "count(friends)", x = 'state',
                                                                       title = 'Count of friends by state',
                                                                        legend = True)

plt.tight_layout()
%matplot plt
```



As we can see, the highest number of friends by state is in MA, TX, OR and FL

```
In [ ]:
```