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://yelp-dataset-cis9760/yelp_academic_dataset_business.json`

`s3://yelp-dataset-cis9760/yelp_academic_dataset_checkin.json`

`s3://yelp-dataset-cis9760/yelp_academic_dataset_review.json`

`s3://yelp-dataset-cis9760/yelp_academic_dataset_tip.json`

`s3://yelp-dataset-cis9760/yelp_academic_dataset_user.json`

Part I - 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 [1]:

```
sc.install_pypi_package("pandas==1.0.3")
sc.install_pypi_package("matplotlib==3.2.1")
sc.install_pypi_package("scipy==1.7.1")
sc.install_pypi_package("seaborn==0.11.1")
```

```
VBox()
Starting Spark application
```

ID	YARN Application ID	Kind	State	Spark UI	Driver log	Current session?
0	application_1651348033111_0001	pyspark	idle	Link	Link	✓

```
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
SparkSession available as 'spark'.
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
Collecting pandas==1.0.3
  Downloading https://files.pythonhosted.org/packages/4a/6a/94b219b8ea0f2d580169e85ed1edc0163743f55aaeca8a44c2e
8fc1e344e/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)
Collecting python-dateutil>=2.6.1 (from pandas==1.0.3)
  Downloading https://files.pythonhosted.org/packages/36/7a/87837f39d0296e723bb9b62bbb257d0355c7f6128853c78955f
57342a56d/python_dateutil-2.8.2-py2.py3-none-any.whl (247kB)
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-2.8.2

Collecting matplotlib==3.2.1
  Downloading https://files.pythonhosted.org/packages/b2/c2/71fcf957710f3ba1f09088b35776a799ba7dd95f7c2b195ec80
0933b276b/matplotlib-3.2.1-cp37-cp37m-manylinux1_x86_64.whl (12.4MB)
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (fr
om 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/d9/41/d9cfb4410589805cd787f8a82cddd13142d9bf7449d12adf2d0
5a4a7d633/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/f9/695d6bedebd747e5eb0fe8fad57b72fdf25411273a39791cde8
38d5a8f51/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/51/50/9a9a94afa26c50fc5d9127272737806990aa698c7a1c220b8e5
075e70304/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->m
atplotlib==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/e1/932e06004039dd670c9d5e1df0cd606bf46e29a28e65d5bb28e
894ea29c9/typing_extensions-4.2.0-py3-none-any.whl
Installing collected packages: pyparsing, cycler, typing-extensions, kiwisolver, matplotlib
Successfully installed cycler-0.11.0 kiwisolver-1.4.2 matplotlib-3.2.1 pyparsing-3.0.8 typing-extensions-4.2.0

Collecting scipy==1.7.1
  Downloading https://files.pythonhosted.org/packages/b5/6b/8bc0b61ebf824f8c3979a31368bbe38dd247590049a994ab0ed
077cb56dc/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==0.11.1
  Downloading https://files.pythonhosted.org/packages/68/ad/6c2406ae175f59ec616714e408979b674fe27b9587f79d59a52
8ddfbcd5b/seaborn-0.11.1-py3-none-any.whl (285kB)
Requirement already satisfied: numpy>=1.15 in /usr/local/lib64/python3.7/site-packages (from seaborn==0.11.1)
Requirement already satisfied: scipy>=1.0 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (from seaborn
==0.11.1)
Requirement already satisfied: matplotlib>=2.2 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (from se
aborn==0.11.1)
Requirement already satisfied: pandas>=0.23 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (from seabo
rn==0.11.1)
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (fr
om matplotlib>=2.2->seaborn==0.11.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /mnt/tmp/1651349555731-0/lib/python
3.7/site-packages (from matplotlib>=2.2->seaborn==0.11.1)
Requirement already satisfied: cycler>=0.10 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (from matpl
otlib>=2.2->seaborn==0.11.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /mnt/tmp/1651349555731-0/lib/python3.7/site-packages (from
matplotlib>=2.2->seaborn==0.11.1)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/site-packages (from pandas>=0.23->seabo
rn==0.11.1)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from python-dateutil>=2.1->m
atplotlib>=2.2->seaborn==0.11.1)
Requirement already satisfied: typing-extensions; python_version < "3.8" in /mnt/tmp/1651349555731-0/lib/python
3.7/site-packages (from kiwisolver>=1.0.1->matplotlib>=2.2->seaborn==0.11.1)
Installing collected packages: seaborn
Successfully installed seaborn-0.11.1
```

In [2]:

```
sc.list_packages()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
Package                    Version
-------------------------- ---------
beautifulsoup4             4.9.1
boto                       2.49.0
click                      7.1.2
cycler                     0.11.0
jmespath                   0.10.0
joblib                     0.16.0
kiwisolver                 1.4.2
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                  3.0.8
```

```
python-dateutil            2.8.2
python37-sagemaker-pyspark 1.4.0
pytz                       2020.1
PyYAML                     5.3.1
regex                      2020.7.14
scipy                      1.7.1
seaborn                    0.11.1
setuptools                 28.8.0
six                        1.13.0
soupsieve                  1.9.5
tqdm                       4.48.2
typing-extensions          4.2.0
wheel                      0.29.0
windmill                   1.6
```

Importing

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

In [3]:

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

import re
import nltk
from nltk.tokenize import RegexpTokenizer
from nltk.stem.porter import PorterStemmer
from nltk import FreqDist

from scipy import stats
from scipy.stats import skew
from pyspark.sql.types import StructType,StructField, StringType, IntegerType
from pyspark.sql.functions import mean, stddev, col, abs, split, explode, avg
from pyspark.sql import functions as F
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

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 [4]:

```
business = spark.read.json('s3://yelp-dataset-cis9760/yelp_academic_dataset_business.json')
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [5]:

```
business.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+--------------------+--------------------+--------------------+-------------+------------
--------+-------+----------+------------+--------------------+-----------+------------+-----+-----+
|             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.

In [6]:

```
print(f'Number of columns in Business table: {len(business.dtypes)}')
print(f'Number of rows in Business table: {business.count():,}')
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
Number of columns in Business table: 14
Number of rows in Business table: 150,346
```

In [7]:
```
business.printSchema()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
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 [8]:

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

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+--------------------+-------------+-----+--------------------+
|         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
```

Part II - 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 [9]:

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

```
VBox()
```

```
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [10]:

```
business_categories=business.select("business_id", explode(split("categories" , ", ")).alias("category"))
business_categories.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+--------------------+
|         business_id|            category|
+--------------------+--------------------+
|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.

In [11]:

```
unique_cat = business_categories.select("category").distinct()
unique_cat.count()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
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	count
a	15
b	2
c	45

Or something to that effect.

In [12]:

```
top_cat = business_categories.groupby("category").count()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

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

In [13]:

```
top_cat_sorted = top_cat.sort(col("count").desc())
top_cat_sorted.show()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+-----+
|            category|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
```

In [14]:

```
tcs = top_cat_sorted.limit(20).toPandas()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

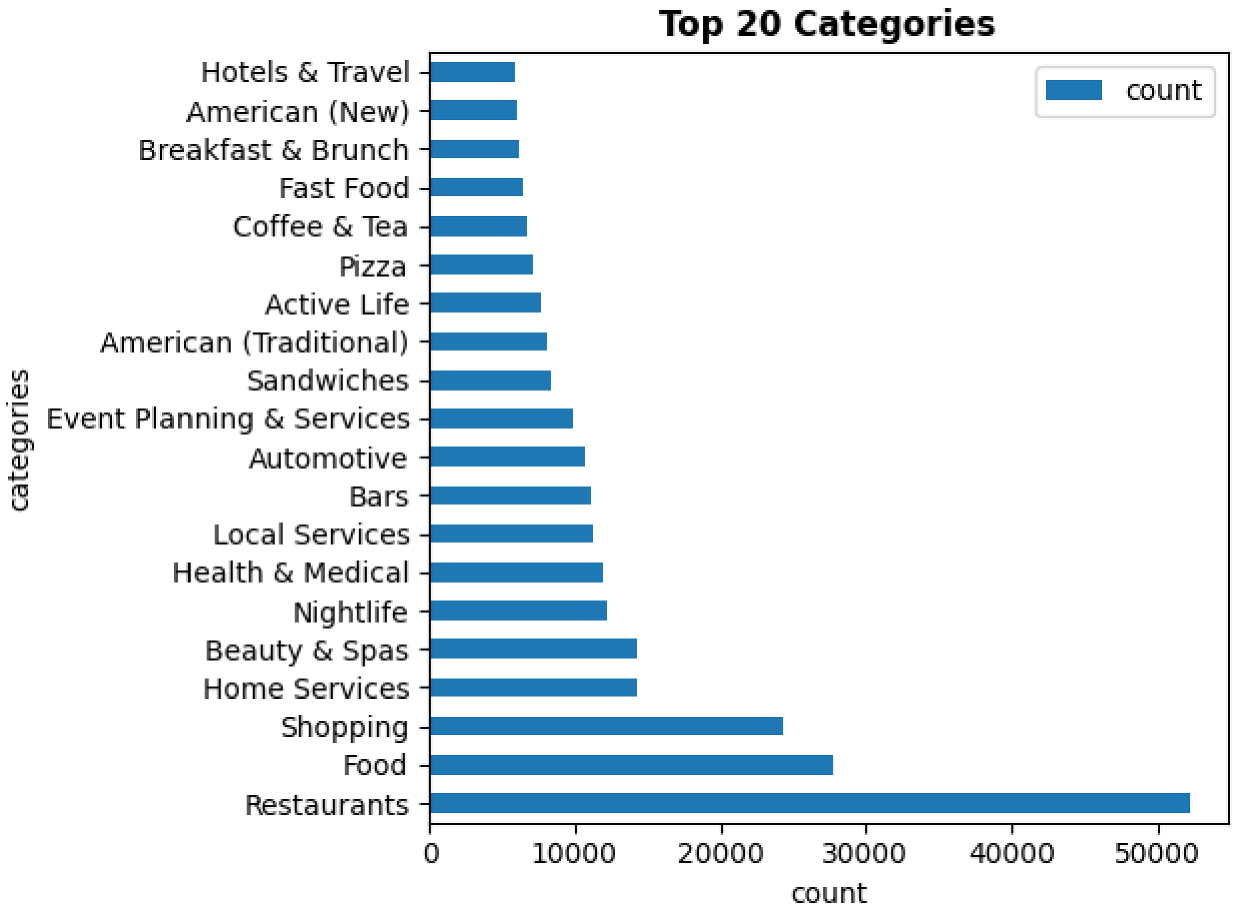
In [15]:

```
fig, ax = plt.subplots(figsize=(12,8))
tcs.plot(kind="barh", x="category")

plt.yticks(size = 10)
plt.xticks(size = 10)
plt.title("Top 20 Categories", fontfamily = "Times New Roman", size = 12, weight='bold')
plt.xlabel("count", fontfamily = "Times New Roman", size = 10)
plt.ylabel("categories", fontfamily = "Times New Roman", size = 10)

plt.tight_layout()
%matplot plt
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```



Part III - Do Yelp Reviews Skew Negative?

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`

In [16]:
```
review = spark.read.json('s3://yelp-dataset-cis9760/yelp_academic_dataset_review.json')
```

```
VBox()
```

```
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [17]:

```
print(f'Number of columns in Business table: {len(review.dtypes)}')
print(f'Number of rows in Business table: {review.count():,}')
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
Number of columns in Business table: 9
Number of rows in Business table: 6,990,280
```

In [18]:

```
review.printSchema()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
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 [19]:

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

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+-----+
|         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**.

In [20]:

```
avg_stars = review.filter(review["text"] != '').groupby("business_id").avg("stars")
avg_stars.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+------------------+
|         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` .

In [21]:

```
bus_stars = business.select("business_id", "name", "city", "state", "stars")
bus_avg_stars = bus_stars.join(avg_stars, avg_stars.business_id == business.business_id) \
                .drop(business.business_id)
bus_avg_stars.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+------------+-----+-----+--------------------+------------------+
|                name|        city|state|stars|         business_id|        avg(stars)|
+--------------------+------------+-----+-----+--------------------+------------------+
|Gillane's Bar & G...|     Ardmore|   PA|  3.0|HSzSGdcNaU7heQe0N...|3.3333333333333335|
|Champps Penn's La...|Philadelphia|   PA|  2.5|skW4boArIApRw9DXK...|2.3947368421052633|
|Philadelphia Marr...|Philadelphia|   PA|  3.0|zJErbOQMKX-MwHs_u...|2.9279279279279278|
|Golden Corral Buf...|      Tucson|   AZ|  2.5|I0053JmJ5DEFUWSJ8...|2.3956043956043955|
|  Swiss Watch Center|       Tampa|   FL|  3.5|wS-SWAa_yaJAw6fJm...| 3.357142857142857|
+--------------------+------------+-----+-----+--------------------+------------------+
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 [22]:

```
df_skew = bus_avg_stars.toPandas()
df_skew["skew"] = (df_skew['avg(stars)'] - df_skew['stars']) / df_skew['stars']
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [23]:

```
print(df_skew.head(5))
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
                             name         city  ... avg(stars)      skew
0  Philadelphia Marriott Old City  Philadelphia  ...   2.927928 -0.024024
1        Gaetano's of West Berlin   West Berlin  ...   2.882353 -0.039216
2          Gillane's Bar & Grille       Ardmore  ...   3.333333  0.111111
3          Champps Penn's Landing  Philadelphia  ...   2.394737 -0.042105
4    Golden Corral Buffet & Grill        Tucson  ...   2.395604 -0.041758

[5 rows x 7 columns]
```

In [24]:

```
skewness = df_skew["skew"].skew()
print(skewness)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
0.8492120525021551
```

The skewness for Yelp reviews are 0.8, meaning that the distribution will come out slightly right skewed.

And finally, graph it!

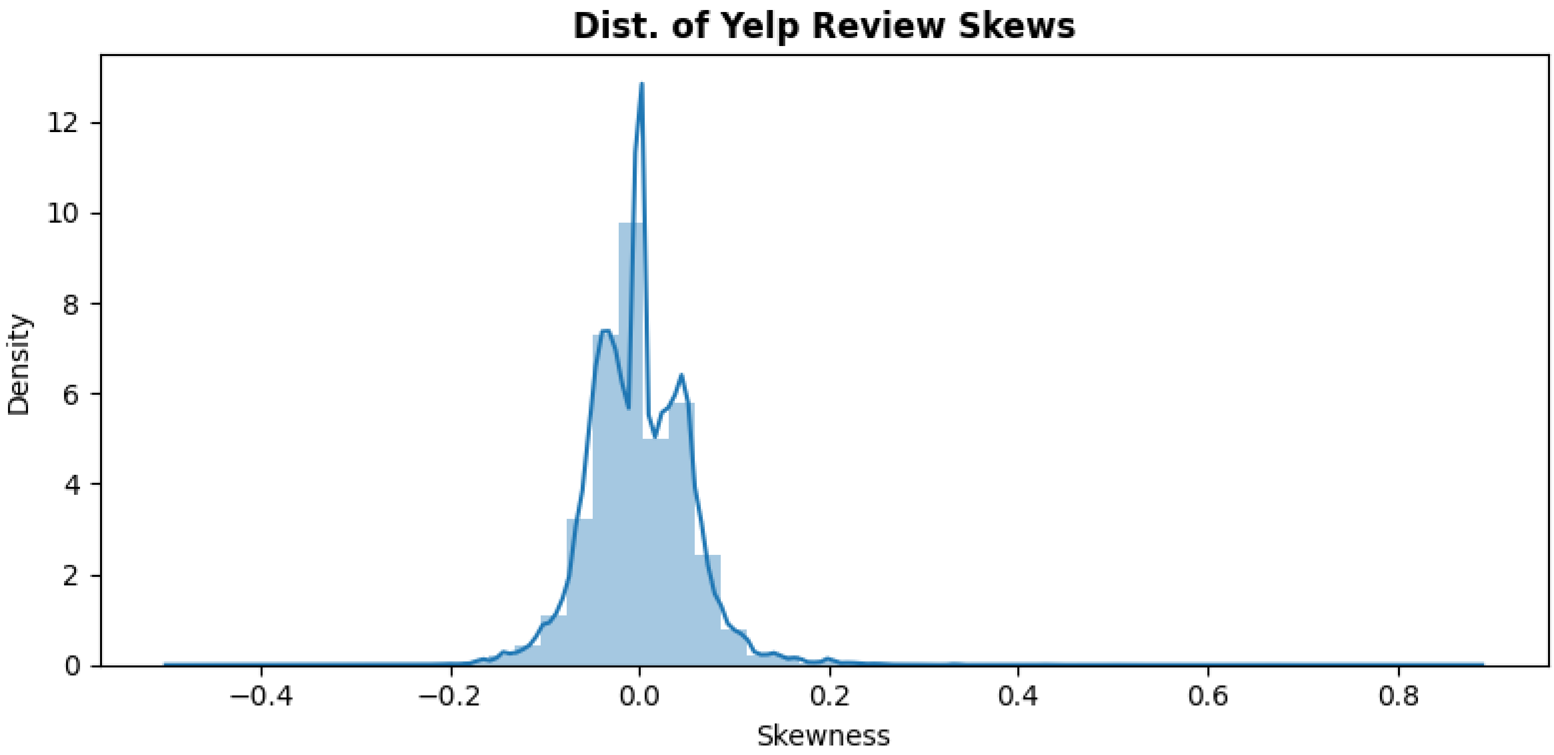
In [25]:

```
plt.figure(figsize=(8,4))
ax = sns.distplot(df_skew["skew"])
ax.set_xlabel('Skewness')

plt.yticks(size = 10)
plt.xticks(size = 10)
plt.title("Dist. of Yelp Review Skews", fontfamily = "Times New Roman", size = 12, weight='bold')
plt.tight_layout()

%matplot plt
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```



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

As seen from the graph above, the distribution is ever so slightly right skewed, yet overall it is normally distributed. It can also be inferred that the users who wrote those reviews were more satisfied than the normal.

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 \ `s3://yelp-dataset-cis9760/yelp_academic_dataset_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.

In [26]:

```
user = spark.read.json('s3://yelp-dataset-cis9760/yelp_academic_dataset_user.json')
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [27]:

```
print(f'Number of columns in Business table: {len(user.dtypes)}')
print(f'Number of rows in Business table: {user.count():,}')
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
Number of columns in Business table: 22
Number of rows in Business table: 1,987,897
```

In [28]:

```
user.printSchema()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
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)
```

We will start our analysis by choosing only the elite users from our users table, and the display the results. \ But first, let's take a look at the elite column.

In [29]:

```
user.select("user_id", "elite").show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+--------------------+
|             user_id|               elite|
+--------------------+--------------------+
|qVc8ODYU5SZjKXVBg...|                2007|
|j14WgRoU_-2ZE1aw1...|2009,2010,2011,20...|
|2WnXYQFK0hXEoTxPt...|2009,2010,2011,20...|
|SZDeASXq7o05mMNLs...|      2009,2010,2011|
|hA5lMy-EnncsH4JoR...|                    |
+--------------------+--------------------+
only showing top 5 rows
```

As seen from above, elite users are those with year values entered on the elite column. Those without any values on the elite column are considered non-elite users. \ We will filter our results by users whose elite column is **not blank.**

In [30]:

```
elite_users = user.select("user_id", "elite") \
                .filter(user["elite"] != '')
elite_users.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+--------------------+
|             user_id|               elite|
+--------------------+--------------------+
|qVc8ODYU5SZjKXVBg...|                2007|
|j14WgRoU_-2ZE1aw1...|2009,2010,2011,20...|
|2WnXYQFK0hXEoTxPt...|2009,2010,2011,20...|
|SZDeASXq7o05mMNLs...|      2009,2010,2011|
|q_QQ5kBBwlCcbL1s4...|2006,2007,2008,20...|
+--------------------+--------------------+
only showing top 5 rows
```

Next, we will extract the reviews information from reviews table, and match it to the each elite users by inner joining them with the elite_users table.\ Here, we also give an alias to stars column as *review_stars* to tell it apart from the *stars* column from the business table.

In [31]:
```
reviews = review.select("business_id", "user_id", col("stars").alias("review_stars") )
elite_reviews = elite_users.join(reviews, reviews.user_id == elite_users.user_id).drop(reviews.user_id)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [32]:
```
elite_review_stars = elite_reviews.join(business, "business_id")\
              .select(elite_reviews.user_id, elite_reviews.business_id, elite_reviews.review_stars, business.star
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [33]:
```
elite_review_stars.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+--------------------+------------+-----+
|             user_id|         business_id|review_stars|stars|
+--------------------+--------------------+------------+-----+
|IeSz60ozr1yAVIH8C...|TV81bpCQ6p6o4Hau5...|         4.0|  4.5|
|xW2A0MciHB0pLB4RH...|W4ZEKkva9HpAdZG88...|         5.0|  4.0|
|SSafXe2aUO0cXgQhE...|E-4t5Hoon6aVFTWDP...|         5.0|  4.0|
|yiYUEExKfZEv_T8CF...|_pbx96FZ3eHJw-V_R...|         3.0|  2.5|
|A3EiqW7_k00gvaiQi...|8uF-bhJFgT4Tn6DTb...|         5.0|  4.5|
+--------------------+--------------------+------------+-----+
only showing top 5 rows
```

Now we will need to calculate the avg review stars for each business given by an elite user, and join it with elite_review_stars table.

In [34]:
```
##second we calculate the avg business star by elite review stars
elite_avg_stars = elite_review_stars.groupby("business_id").avg("review_stars")
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [35]:
```
elite_avg_stars.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+------------------+
|         business_id| avg(review_stars)|
+--------------------+------------------+
|vQ5Qa6kvlXiUHT60G...| 4.184210526315789|
|I0053JmJ5DEFUWSJ8...| 2.391304347826087|
|zJErbOQMKX-MwHs_u...|3.0697674418604652|
|KBvdN8Apn4DIxuNW3...|               4.0|
|RZ-FNTXvqHKngyLGD...|               3.8|
+--------------------+------------------+
only showing top 5 rows
```

In [36]:

```
##and finally we join elite_avg_stars to our elite_review_stars table
elrevstr = elite_review_stars.join(elite_avg_stars, "business_id") \
            .select(elite_reviews.business_id,
                   elite_reviews.review_stars,
                   business.stars,
                   col("avg(review_stars)").alias("avg_elite_review_stars"))
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [37]:

```
elrevstr.show(5)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
+--------------------+------------+-----+----------------------+
|         business_id|review_stars|stars|avg_elite_review_stars|
+--------------------+------------+-----+----------------------+
|--gJkxbsiSIwsQKbi...|         4.0|  5.0|                   4.0|
|-02xFuruu85XmDn2x...|         5.0|  4.5|     4.863636363636363|
|-02xFuruu85XmDn2x...|         5.0|  4.5|     4.863636363636363|
|-02xFuruu85XmDn2x...|         5.0|  4.5|     4.863636363636363|
|-02xFuruu85XmDn2x...|         5.0|  4.5|     4.863636363636363|
+--------------------+------------+-----+----------------------+
only showing top 5 rows
```

Finally, we have all the data we need to calculate the skew of difference between the actual avg business stars vs the avg review stars given by the elite users.

After converting our RDD into pandas Dataframe, we will calculate the skew, the same way as we did in Part III:

```
(row['avg_elite_review_stars'] - row['stars']) / row['stars']
```

In [38]:

```
##we convert it to pandas df
```

```
elrevstr_df = elrevstr.toPandas()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [39]:

```
##add a new column called skew to measure the dif between the actual business stars vs. the avg elite review st
elrevstr_df["skew"] = (elrevstr_df['avg_elite_review_stars'] - elrevstr_df['stars']) / elrevstr_df['stars']
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [40]:

```
print(elrevstr_df.head(5))
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
              business_id  review_stars  ...  avg_elite_review_stars      skew
0  --gJkxbsiSIwsQKbiwm_Ng           4.0  ...                4.000000 -0.200000
1  -02xFuruu85XmDn2xiynJw           5.0  ...                4.863636  0.080808
2  -02xFuruu85XmDn2xiynJw           5.0  ...                4.863636  0.080808
3  -02xFuruu85XmDn2xiynJw           5.0  ...                4.863636  0.080808
4  -02xFuruu85XmDn2xiynJw           5.0  ...                4.863636  0.080808

[5 rows x 5 columns]
```

In [41]:

```
elrev_skewness = elrevstr_df["skew"].skew()
print(elrev_skewness)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
3.016210545517221
```

The skewness came out 3.0, therefore we expect our distribution to be right skewed.

In [42]:

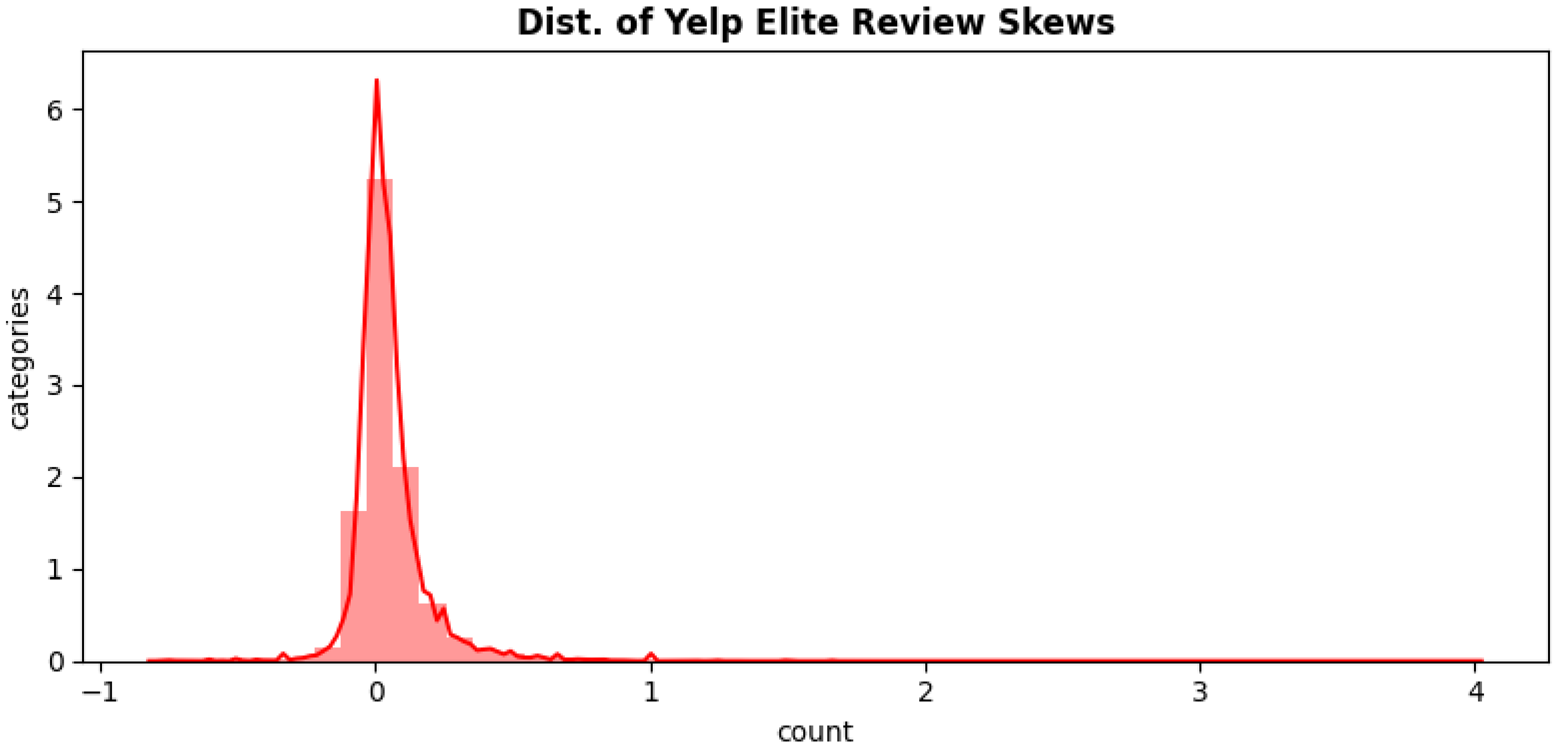
```
plt.figure(figsize=(8,4))
sns.distplot(elrevstr_df["skew"], color="red" )

plt.yticks(size = 10)
plt.xticks(size = 10)
plt.title("Dist. of Yelp Elite Review Skews", fontfamily = "Times New Roman", size = 12, weight='bold')
plt.xlabel("count", fontfamily = "Times New Roman", size = 10)
plt.ylabel("categories", fontfamily = "Times New Roman", size = 10)

plt.tight_layout()
```

```
%matplot plt
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```



In [43]:

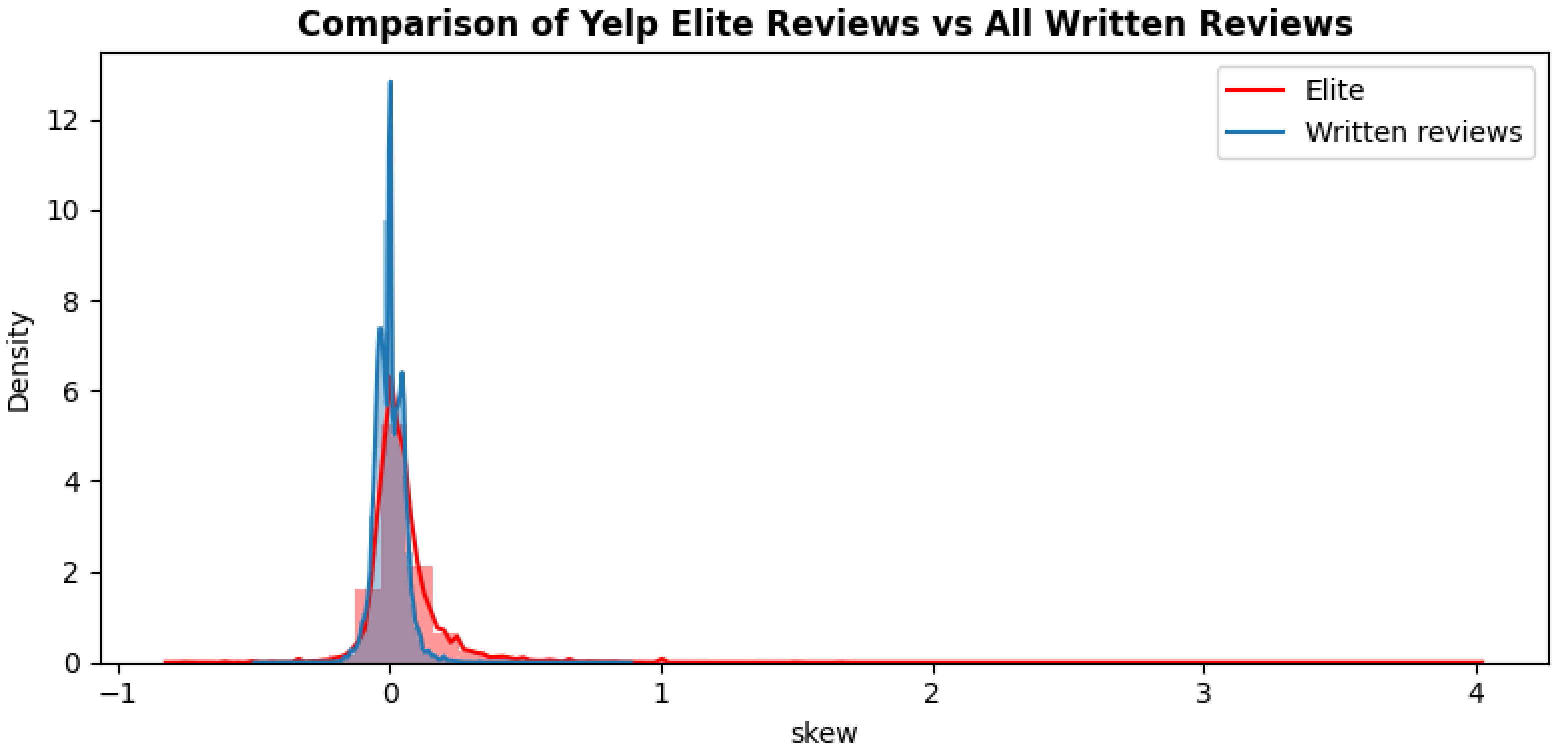
```
plt.figure(figsize=(8,4))
sns.distplot(elrevstr_df["skew"], color="red" )
sns.distplot(df_skew["skew"])
ax.set_xlabel('Skewness')

plt.yticks(size = 10)
plt.xticks(size = 10)
plt.title("Comparison of Yelp Elite Reviews vs All Written Reviews", fontfamily = "Times New Roman", size = 12,
plt.legend(["Elite", "Written reviews"])

plt.tight_layout()

%matplot plt
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```



As seen from above graphs, there is quite a difference between the distribution of All Written Reviews and the Elite Reviews. Elite reviews have more outliers on both ends of the graph. And the distribution is right skewed. Therefore, I suggest that Elite Reviews should not be trusted as Elite Users tend to give higher review stars than the actual business ratings.

Part V -What are the Most Common Unigrams and Bigrams in Hotels & Travel Reviews?

Loading the Data

Since we have some text data included in our dataset, I wanted to analyze the most common unigrams (one-word-sequence), and bigrams (two-word_sequence) in Hotels & Travel Reviews. \

First, we extract the text and business_id columns from the review dataset. And filter the rows to make sure the text column is not empty.

In [44]:

```
review_text = review.select("business_id", "text")\
                .filter(review["text"] != '')
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

Second, we identify all businesses who falls in "Hotels & Travel Category", and then join them on business_id with review_text table we created previously.

In [45]:

```
hotels_travel = business_categories.select("business_id", "category")\
                .filter(business_categories["category"]=="Hotels & Travel")
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [46]:

```
ht_reviews = review_text.join(hotels_travel, "business_id").select(review.text)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

Before we start our text analysis, we convert our RDD table into pandas dataframe. Because we want to take advantage of python's nltk package for the analysis.

In [47]:

```
df = ht_reviews.toPandas()
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [48]:

```
print(df.head(5))
print(len(df))
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
                                                text
0  Loved this tour! I grabbed a groupon and the p...
1  We checked in around 2:30 pm.  Check-in was qu...
2  Comfortable bed, good breakfast, fast internet...
3  The TV shows are $4.99 and they have commercia...
```

```
4  The kayaking tour at the Santa Cruz Island was...
329658
```

Pre-processing our Text

Text Preprocessing is an important aspect for natural langauge processing. In order to use any kind of text data for analysis, we first need to change it into a digestible format such as by removing nonrelevant characters, stopwords, urls, and then apply lemmatization and tokenization techniques to turn the text into group of words.

Below, we have defined a function *clean_text* to preprocess our text and assign it into a new column. I added comments for each regex expression as well.

Another thing is that we manually insert stopwords (commonly-used words) such as "a", "am", "is "into a list array so that we can skip those words for our analysis.

NLTK package allready has a stopwords corpus, but for this project I chose to manually insert them into an array.

In [49]:

```
stopwords = ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're", "you've", "you'll",
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [50]:

```
def clean_text(text):

    # lowercase all letters
    text = text.lower()

    # remove emojis
    text = text.encode('ascii','ignore')
    text = text.decode()

    # replacing handlers with empty string
    text = re.sub('@[^\s]+',"",text)

    # remove punctuations and numbers
    text = re.sub('[^a-zA-Z]', ' ', text)

    # replacing URLs with empty string
    text = re.sub(r"http\S+", "",text)

    # remove all the special characters
    text = ' '.join(re.findall(r'\w+', text))

    # replacing single characters with empty string
    text = re.sub(r'\s+[a-zA-Z]\s+', ' ', text)

    # substituting multiple spaces with single space
    text = re.sub(r'\s+', ' ', text, flags=re.I)

    # remove stopwords
    text = ' '.join([word for word in text.split() if not word in set(stopwords)])

    # words to singular forms
    stemmer = PorterStemmer()
    text = stemmer.stem(text)

    return text
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [51]:

```
df["prep_text"] = df["text"].apply(lambda x : clean_text(x))
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

In [52]:

```
print(df.head(10))
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
                                                text                                          prep_text
0  Loved this tour! I grabbed a groupon and the p...  loved tour grabbed groupon price great perfect...
1  We checked in around 2:30 pm.  Check-in was qu...  checked around pm check quick easy complimenta...
2  Comfortable bed, good breakfast, fast internet...  comfortable bed good breakfast fast internet g...
3  The TV shows are $4.99 and they have commercia...  tv shows commercials cheesy way make money sig...
4  The kayaking tour at the Santa Cruz Island was...  kayaking tour santa cruz island great husband ...
5  I have been to a number of dog friendly hotels...  number dog friendly hotels city know expect us...
6  My parents and I took the Oak Alley and Laura ...  parents took oak alley laura plantation tour s...
7  Great customer service! We were a little out o...  great customer service little pick area accomm...
8  I had numerous things happen during my move an...  numerous things happen move required additiona...
9  We stayed at The Saint last year for a girl's ...  stayed saint last year girl trip lobby lovely ...
```

After preprocessing is done, you can see how much it looks different from the original text above.

Next we introduce "regexptokenizer" to tokenize each sentence into a word tokens. In order to run the tokenizer, we first insert the preprocessed text into a list, and apply regexptokenizer.

```
In [53]:
tokenizer = RegexpTokenizer("[\w']+")

text = list(df['prep_text'])
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

```
In [54]:
words = [tokenizer.tokenize(t) for t in text]
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

After the tokenization is completed we append each tokenized word into a list and calculate the frequency distribution.

```
In [55]:
word = [w for word in words for w in word]
fdist = nltk.FreqDist(w for w in word)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

```
In [56]:
unigrams = [item[0] for item in fdist.most_common(20)]
frquni = [item[1] for item in fdist.most_common(20)]
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

```
In [57]:
fdist=nltk.FreqDist((x,y) for (x,y) in nltk.bigrams(word))
most_common=fdist.most_common(20)
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

```
In [58]:
top_words=[word for (word, freq) in most_common]
frqbi = [freq for (word, freq) in most_common]
bigrams = [' '.join(i) for i in top_words]
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```

And finally we graph the most common unigrams and bigrams as below.

In [59]:

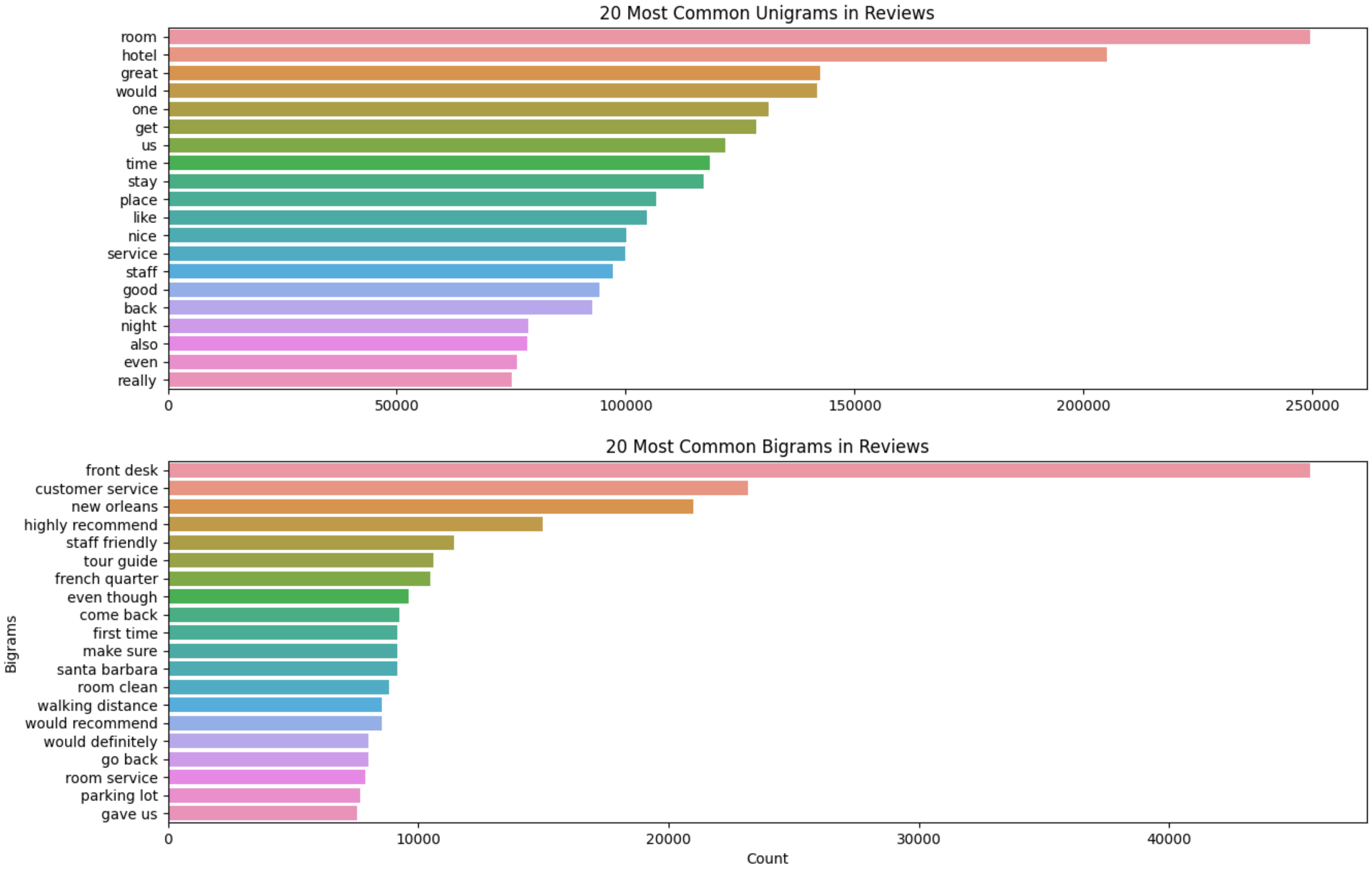
```
fig, axes = plt.subplots(2,1, figsize=(15,10))

sns.barplot(y=unigrams, x=frquni, ax=axes[0]).set(title='20 Most Common Unigrams in Reviews')
plt.xlabel("Count")
plt.ylabel("Unigrams")

sns.barplot(y=bigrams, x=frqbi, ax=axes[1]).set(title='20 Most Common Bigrams in Reviews')
plt.xlabel("Count")
plt.ylabel("Bigrams")

%matplot plt
```

```
VBox()
FloatProgress(value=0.0, bar_style='info', description='Progress:', layout=Layout(height='25px', width='50%'),…
```


20 Most Common Unigrams in Reviews
room
hotel
great
would
one
get
us
time
stay
place
like
nice
service
staff
good
back
night
also
even
really
0
50000
100000
150000
200000
250000
20 Most Common Bigrams in Reviews
Bigrams
front desk
customer service
new orleans
highly recommend
staff friendly
tour guide
french quarter
even though
come back
first time
make sure
santa barbara
room clean
walking distance
would recommend
would definitely
go back
room service
parking lot
gave us
0
10000
20000
30000
40000
Count