# Analysis of Yelp Dataset

I will analyze Yelp dataset. This dataset is downloaded from Kaggle and uploaded to my S3 bucket.

## Part I: Installation and Initial Setup

In [1]:

```
%%info
```

Current session configs: {'conf': {'spark.pyspark.python': 'python3', 'spark.pyspark.virtualenv.enabled': 'true', 'spark.pyspark.virtualenv.type': 'native', 'spark.pyspark.virtualenv.bin.path': '/usr/bin/virtualenv'}, 'kind': 'pyspark'}

No active sessions.

In [2]:

```
# check currently installed packages
sc.list_packages()
```

```
Starting Spark application
```

| ID | YARN Application ID | Kind | State | Spark UI | Driver log | Current session? |
|---|---|---|---|---|---|---|
| 11 | application_1606143194499_0012 | pyspark | idle | Link | Link | ✓ |

```
SparkSession available as 'spark'.

Package                    Version
-------------------------- ---------
beautifulsoup4             4.9.1
boto                       2.49.0
click                      7.1.2
jmespath                   0.10.0
joblib                     0.16.0
lxml                       4.5.2
mysqlclient                1.4.2
nltk                       3.5
nose                       1.3.4
numpy                      1.16.5
pip                        9.0.1
py-dateutil                2.2
python37-sagemaker-pyspark 1.4.0
pytz                       2020.1
PyYAML                     5.3.1
regex                      2020.7.14
```

```
setuptools                    28.8.0
six                           1.13.0
soupsieve                     1.9.5
tqdm                          4.48.2
wheel                         0.29.0
windmill                      1.6
```

In [3]:

```
# install and update necessary dependencies (pandas, matplotlib, searborn, and numpy)
sc.install_pypi_package("pandas==1.0.3")
sc.install_pypi_package("matplotlib==3.2.1")
sc.install_pypi_package("seaborn==0.10.0")
```

```
Collecting pandas==1.0.3
  Using cached https://files.pythonhosted.org/packages/4a/6a/94b219b8ea0f2d580169e85ed1edc0163743f55aaeca8a44c2
e8fc1e344e/pandas-1.0.3-cp37-cp37m-manylinux1_x86_64.whl
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)
  Using cached https://files.pythonhosted.org/packages/d4/70/d60450c3dd48ef87586924207ae8907090de0b306af2bce5d1
34d78615cb/python_dateutil-2.8.1-py2.py3-none-any.whl
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from python-dateutil>=2.6.1-
>pandas==1.0.3)
Installing collected packages: python-dateutil, pandas
Successfully installed pandas-1.0.3 python-dateutil-2.8.1

Collecting matplotlib==3.2.1
  Using cached https://files.pythonhosted.org/packages/b2/c2/71fcf957710f3ba1f09088b35776a799ba7dd95f7c2b195ec8
00933b276b/matplotlib-3.2.1-cp37-cp37m-manylinux1_x86_64.whl
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1606254383641-0/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)
  Using cached https://files.pythonhosted.org/packages/8a/bb/488841f56197b13700afd5658fc279a2025a39e22449b7cf29
864669b15d/pyparsing-2.4.7-py2.py3-none-any.whl
Collecting cycler>=0.10 (from matplotlib==3.2.1)
  Using cached https://files.pythonhosted.org/packages/f7/d2/e07d3ebb2bd7af696440ce7e754c59dd546ffe1bbe732c8ab6
8b9c834e61/cycler-0.10.0-py2.py3-none-any.whl
Requirement already satisfied: numpy>=1.11 in /usr/local/lib64/python3.7/site-packages (from matplotlib==3.2.1)
Collecting kiwisolver>=1.0.1 (from matplotlib==3.2.1)
  Using cached https://files.pythonhosted.org/packages/d2/46/231de802ade4225b76b96cffe419cf3ce52bbe92e3b092cf12
db7d11c207/kiwisolver-1.3.1-cp37-cp37m-manylinux1_x86_64.whl
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from python-dateutil>=2.1->m
atplotlib==3.2.1)
Installing collected packages: pyparsing, cycler, kiwisolver, matplotlib
Successfully installed cycler-0.10.0 kiwisolver-1.3.1 matplotlib-3.2.1 pyparsing-2.4.7

Collecting seaborn==0.10.0
  Downloading https://files.pythonhosted.org/packages/70/bd/5e6bf595fe6ee0f257ae49336dd180768c1ed3d7c7155b2fdf8
```

```
94c1c808a/seaborn-0.10.0-py3-none-any.whl (215kB)
Requirement already satisfied: pandas>=0.22.0 in /mnt/tmp/1606254383641-0/lib/python3.7/site-packages (from sea
born==0.10.0)
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib64/python3.7/site-packages (from seaborn==0.10.0)
Collecting scipy>=1.0.1 (from seaborn==0.10.0)
  Using cached https://files.pythonhosted.org/packages/dc/7e/8f6a79b102ca1ea928bae8998b05bf5dc24a90571db13cd119
f275ba6252/scipy-1.5.4-cp37-cp37m-manylinux1_x86_64.whl
Requirement already satisfied: matplotlib>=2.1.2 in /mnt/tmp/1606254383641-0/lib/python3.7/site-packages (from
seaborn==0.10.0)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/site-packages (from pandas>=0.22.0->sea
born==0.10.0)
Requirement already satisfied: python-dateutil>=2.6.1 in /mnt/tmp/1606254383641-0/lib/python3.7/site-packages
(from pandas>=0.22.0->seaborn==0.10.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /mnt/tmp/1606254383641-0/lib/python
3.7/site-packages (from matplotlib>=2.1.2->seaborn==0.10.0)
Requirement already satisfied: cycler>=0.10 in /mnt/tmp/1606254383641-0/lib/python3.7/site-packages (from matpl
otlib>=2.1.2->seaborn==0.10.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /mnt/tmp/1606254383641-0/lib/python3.7/site-packages (from
matplotlib>=2.1.2->seaborn==0.10.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from python-dateutil>=2.6.1-
>pandas>=0.22.0->seaborn==0.10.0)
Installing collected packages: scipy, seaborn
Successfully installed scipy-1.5.4 seaborn-0.10.0
```

## Importing Packages

In [4]:

```
import pandas as pd
from pandas import DataFrame
import numpy as np
import matplotlib.pyplot as plt
import matplotlib
```

## Loadning Business Data

In [5]:

```
business = spark.read.json('s3://sta9760f2020spark-taejun/yelp_academic_dataset_business.json')
```

In [6]:

```
print('Data frame type: ' + str(type(business)))
```

```
Data frame type: <class 'pyspark.sql.dataframe.DataFrame'>
```

## Overview of Data

In [7]:

```
print(f'Total Columns: {len(business.dtypes)}')
print(f'Total Rows: {business.count():,}')
```

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

In [8]:

```
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)
```

In [9]:

```
print('Columns overview')
pd.DataFrame(business.dtypes, columns = ['Column Name','Data type'])
```

```
Columns overview
     Column Name                                         Data type
0        address                                            string
1     attributes  struct<AcceptsInsurance:string,AgesAllowed:str...
2    business_id                                            string
3     categories                                            string
4           city                                            string
5          hours  struct<Friday:string,Monday:string,Saturday:st...
6        is_open                                            bigint
7       latitude                                            double
8      longitude                                            double
9           name                                            string
10   postal_code                                            string
11  review_count                                            bigint
12         stars                                            double
13         state                                            string
```

In [10]:

```
#Display the first 5 rows with the following columns: business_id, name, city, state, categories
business.select('business_id','name','city','state','categories').show(5)
```

```
+--------------------+--------------------+---------------+-----+--------------------+
|         business_id|                name|           city|state|          categories|
+--------------------+--------------------+---------------+-----+--------------------+
|f9NumwFMBDn751xgF...|The Range At Lake...|      Cornelius|   NC|Active Life, Gun/...|
|Yzvjg0SayhoZgCljU...|   Carlos Santo, NMD|     Scottsdale|   AZ|Health & Medical,...|
|XNoUzKckATkOD1hP6...|             Felinus|       Montreal|   QC|Pets, Pet Service...|
|6OAZjbxqM5ol29BuH...|Nevada House of Hose|North Las Vegas|   NV|Hardware Stores, ...|
|51M2Kk903DFYI6gnB...|USE MY GUY SERVIC...|           Mesa|   AZ|Home Services, Pl...|
+--------------------+--------------------+---------------+-----+--------------------+
only showing top 5 rows
```

## Part II: Analyzing Categories

In [11]:

```
# The table described from my original yelp dataframe
business.select('business_id','categories').show(5)
```

```
+--------------------+--------------------+
|         business_id|          categories|
+--------------------+--------------------+
|f9NumwFMBDn751xgF...|Active Life, Gun/...|
|Yzvjg0SayhoZgCljU...|Health & Medical,...|
|XNoUzKckATkOD1hP6...|Pets, Pet Service...|
|6OAZjbxqM5ol29BuH...|Hardware Stores, ...|
|51M2Kk903DFYI6gnB...|Home Services, Pl...|
+--------------------+--------------------+
only showing top 5 rows
```

In [12]:

```
# Split categories to each distinct category
from pyspark.sql.functions import explode, split

business_id_categories = business.withColumn("categories", explode(split('categories', ", ")))
```

In [13]:

```
# Display the first 5 rows of the association table
business_id_categories.select('business_id', "categories").show(5)
```

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

## Total Unique Categories

In [14]:
```
unique_categories = business_id_categories.select('business_id', "categories")
unique_categories.select("categories").distinct().count()
```

```
1336
```

## Top Categories by Business

In [15]:
```
business_id_categories.groupby("categories").count().show(20)
```

```
+--------------------+-----+
|          categories|count|
+--------------------+-----+
|      Dermatologists|  341|
|      Paddleboarding|   36|
|        Aerial Tours|   28|
|         Hobby Shops|  828|
|          Bubble Tea|  720|
|             Embassy|   13|
|            Handyman|  682|
|             Tanning|  938|
|      Aerial Fitness|   29|
|             Tempura|    1|
|             Falafel|  159|
|       Outlet Stores|  399|
|        Summer Camps|  318|
|     Clothing Rental|   55|
|      Sporting Goods| 2311|
|      Cooking Schools|  118|
|   College Counseling|   15|
|  Lactation Services|   50|
|Ski & Snowboard S...|   50|
|             Museums|  359|
+--------------------+-----+
only showing top 20 rows
```

## Bar Chart of Top Categories

In [16]:

```
top_categories = business_id_categories.groupby("categories").count().orderBy('count', ascending=False).limit(2
top_categories = top_categories.set_index('categories','count')
top_categories = top_categories.sort_values(by='count', ascending=True)
```

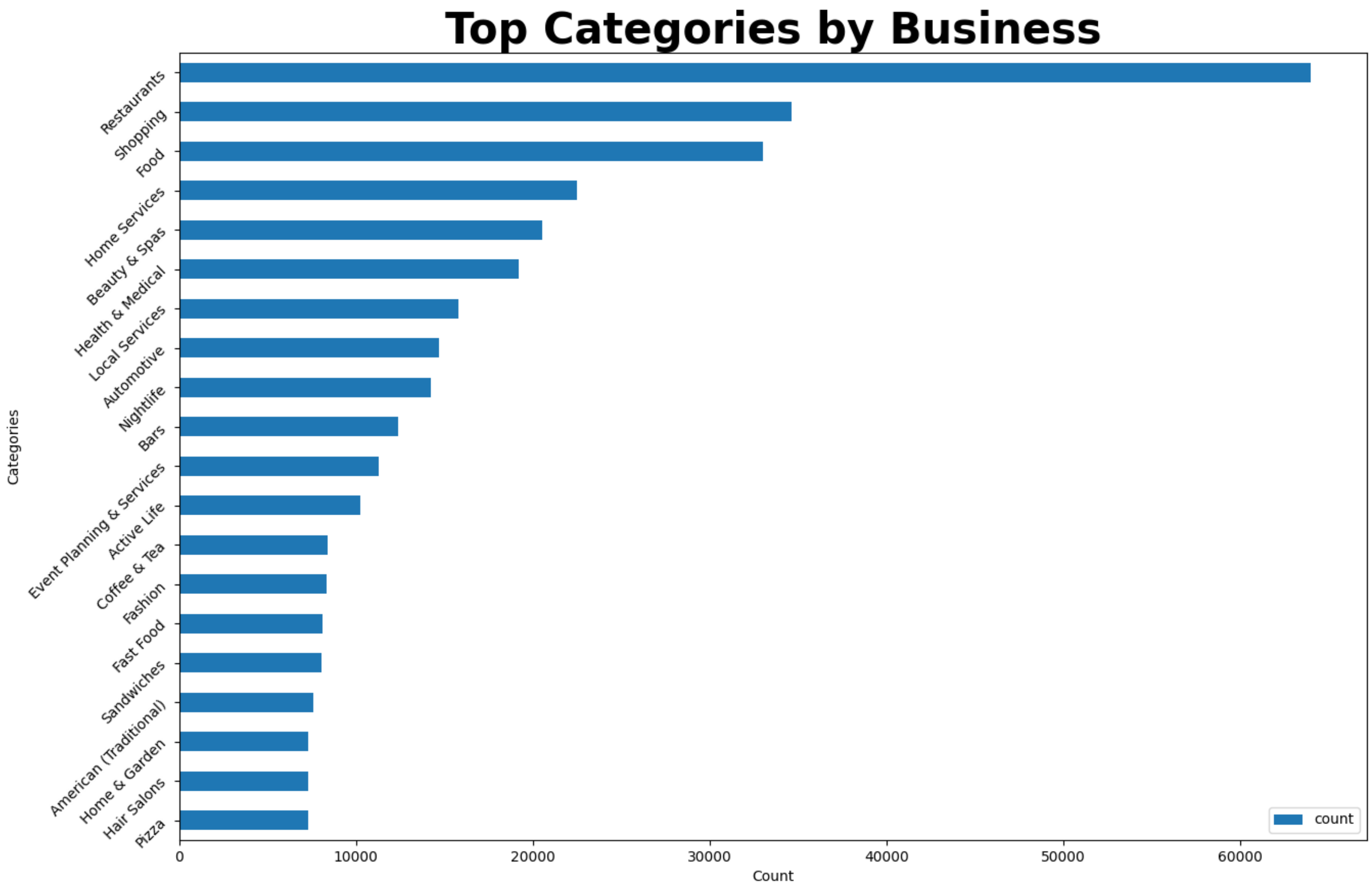
In [17]:

```
top_categories.plot.barh(figsize=(15,10), rot=45)
plt.xlabel('Count')
plt.ylabel('Categories')
plt.title('Top Categories by Business', fontsize=30, fontweight='bold')
```

```
Text(0.5, 1.0, 'Top Categories by Business')
```

In [18]:

```
%matplot plt
```



# Part III: Do Yelp Reviews Skew Negative?

## Loading Review Data

In [19]:
```
review= spark.read.json('s3://sta9760f2020spark-taejun/yelp_academic_dataset_review.json')
```

In [20]:

```
print('Data frame type: ' + str(type(review)))
```

```
Data frame type: <class 'pyspark.sql.dataframe.DataFrame'>
```

In [21]:

```
print(f'Total Columns: {len(review.dtypes)}')
print(f'Total Rows: {review.count():,}')
```

```
Total Columns: 9
Total Rows: 8,021,122
```

In [22]:

```
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)
```

In [23]:

```
# business and stars data
business_id_stars = review.select('business_id', "stars")
business_id_stars.show(5)
```

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

In [24]:

```
from pyspark.sql.functions import avg
business_id_avg_stars = review.groupby("business_id").avg("stars")
```

In [25]:

```
business_id_avg_stars.show(5)
```

```
+--------------------+------------------+
|         business_id|        avg(stars)|
+--------------------+------------------+
|VHsNB3pdGVcRgs6C3...| 3.411764705882353|
|RMjCnixEY5i12Ciqn...|3.5316455696202533|
|ipFreSFhjClfNETuM...|               2.6|
|dLDMU8bOLnkDTmPUr...| 4.942857142857143|
|Qm2datcYBPXrPATVG...| 4.352941176470588|
+--------------------+------------------+
only showing top 5 rows
```

In [26]:

```
# Join two dataframes by busienss_id
df1 = business_id_avg_stars.select('business_id','avg(stars)')
df2 = business.select('business_id','stars','name','city','state')
joined_df = df1.join(df2, df1.business_id == df2.business_id)
```

In [27]:

```
# Display 5 first rows
joined_df = joined_df.select('avg(stars)','stars','name','city','state')
joined_df.show(5)
```

```
+----------------+-----+--------------------+---------+-----+
|      avg(stars)|stars|                name|     city|state|
+----------------+-----+--------------------+---------+-----+
|4.11784140969163|  4.0|Delmonico Steakhouse|Las Vegas|   NV|
|             4.5|  4.5|Mr. Pancho Mexica...|     Mesa|   AZ|
|            3.75|  4.0|Maricopa County D...|  Phoenix|   AZ|
|             4.0|  4.0|Double Play Sport...|Las Vegas|   NV|
|          2.6875|  2.5|  Impressions Dental| Chandler|   AZ|
+----------------+-----+--------------------+---------+-----+
only showing top 5 rows
```

In [28]:

```
# Dataframe to Pandas dataframe
skew_df = joined_df.select('avg(stars)','stars').toPandas()
```

In [29]:

```
skew_df["skew"] = (skew_df['avg(stars)'] - skew_df['stars']) / skew_df['stars']
skew_df
```

```
        avg(stars)  stars      skew
0         3.411765    3.5 -0.025210
1         3.531646    3.5  0.009042
2         2.600000    2.5  0.040000
3         4.942857    5.0 -0.011429
4         4.352941    4.5 -0.032680
...            ...    ...       ...
209388    4.000000    4.0  0.000000
209389    3.000000    3.0  0.000000
209390    5.000000    5.0  0.000000
209391    1.666667    1.5  0.111111
209392    3.250000    3.0  0.083333

[209393 rows x 3 columns]
```

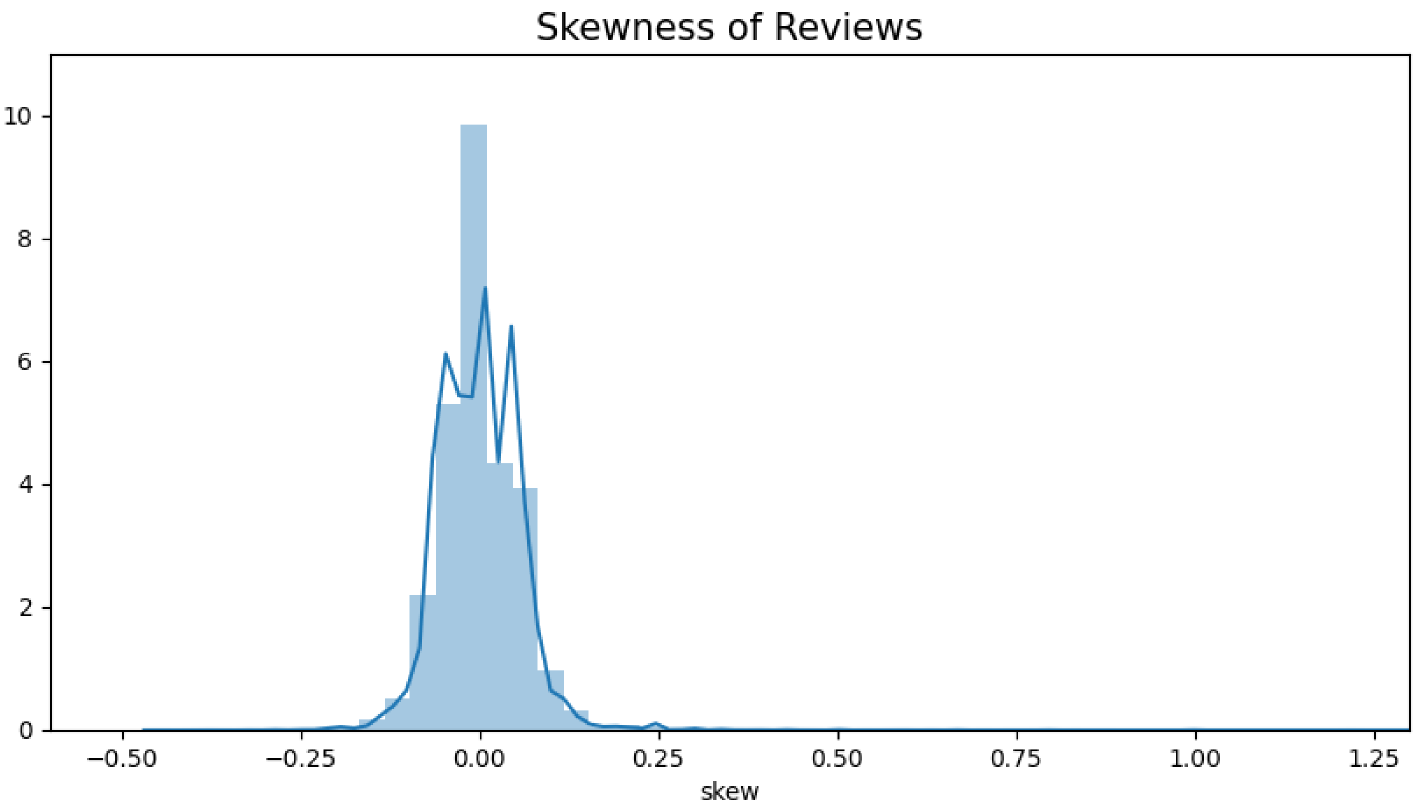
## Skewed Distribution of Reviews

In [30]:

```
import seaborn as sns

plt.figure(figsize=(10,5))
sns.distplot(skew_df["skew"], kde=True)
plt.title('Skewness of Reviews', size = 15)
plt.axis((-0.6, 1.30, 0, 11))

%matplot plt
```



## Calculating Skewness

In [31]:

```
# Calcuate Pearson's coefficient of skewness with mean, median, and standard deviation
# round up values to calaute values easily

mean = skew_df['skew'].mean().round(5)
median = skew_df['skew'].median().round(5)
std_dev = skew_df['skew'].std().round(5)
skewness = (3 * (mean-median) / std_dev).round(5)

print('Mean: ', mean)
print('Median: ', median)
print('Standard Deviation: ', std_dev)
print('Skewness: ', skewness)
```

```
Mean:  0.00124
```

```
Median:  0.0
Standard Deviation:  0.05524
Skewness:  0.06734
```

### IMPLICATIONS

Once I looked at the above graph, I could not decide whether skewness of Yelp reviews is positive or negative. So, I calculated Paerson's coefficient of skewness with mean, median, and standard deviation.

- The formula to calculate skewness is 3 * (Mean - Median) / Standard Deviation
- Mean is 0.00124
- Median is 0.0
- Standard Deviation is 0.05524

By the formula and values, I could get skewness of 0.06734. It is greater than 0 so I can say skewness is positive. It shows that users who wrote reviews were more satisfied than normal. However, it has not a strong positive value and is close to 0, so I would like to say that it is slightly more satisfied than normal.

# Part IV: Should the Elite be Trusted?

## Loading user data

In [32]:

```
user= spark.read.json('s3://sta9760f2020spark-taejun/yelp_academic_dataset_user.json')
```

In [33]:

```
print('Data frame type: ' + str(type(user)))
```

```
Data frame type: <class 'pyspark.sql.dataframe.DataFrame'>
```

In [34]:

```
print(f'Total Columns: {len(user.dtypes)}')
print(f'Total Rows: {user.count():,}')
```

```
Total Columns: 22
Total Rows: 1,968,703
```

In [35]:

```
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 [36]:

```
# See necessary columns
user.select('user_id','elite', 'average_stars').show(10)
```

```
+--------------------+--------------------+-------------+
|             user_id|               elite|average_stars|
+--------------------+--------------------+-------------+
|ntlvfPzc8eglqvk92...|                    |         3.57|
|FOBRPlBHa3WPHFB5q...|2008,2009,2010,20...|         3.84|
|zZUnPeh2hEp0WydbA...|                2010|         3.44|
|QaELAmRcDc5TfJEyl...|                2009|         3.08|
|xvu8G900tezTzbbfq...|2009,2010,2011,20...|         4.37|
|z5_82komKV3mI4ASG...|                2007|         2.88|
|ttumcu6hWshk_EJVW...|                    |          4.0|
|f4_MRNHvN-yRn7EA8...|2011,2012,2013,20...|         3.63|
|UYACF30806j2mfbB5...|                    |         3.75|
|QG13XBbgHWydzThRB...|           2008,2009|          4.1|
+--------------------+--------------------+-------------+
only showing top 10 rows
```

In [37]:

```
# Select only elite users by filter empty value out
elite = user.filter(user['elite'] != '').select('user_id', 'elite', 'average_stars')

# Select columns from Review dataset
```

```
review_info = review.select('business_id', 'stars', 'user_id')

# Join two dataframes to get the elite's reviews
elite_review = elite.join(review_info, elite.user_id == review_info.user_id).drop(review['user_id'])
elite_review.show(5)
```

```
+--------------------+-------------------+-------------+--------------------+-----+
|             user_id|              elite|average_stars|         business_id|stars|
+--------------------+-------------------+-------------+--------------------+-----+
|1Dul59QEe-Q-7OQHT...|               2017|         3.75|-8F04F54iDT6VgWPC...|  4.0|
|3pMczoCBOSKBcqMhV...|               2017|         4.24|p2OOk46G_AOO0nCWl...|  5.0|
|jO44Apni7iJZVVK4H...|2010,2011,2012,2013|         3.75|jyFoxS8MofdpkAAK6...|  1.0|
|RO78oDy7vbEcOJU8a...|          2017,2018|         3.98|ewty6EB70nwPJsUkA...|  4.0|
|TFxeEvpjMNQ3AWL49...|          2017,2018|         3.89|0M3KCmdY-_xlIu5vE...|  5.0|
+--------------------+-------------------+-------------+--------------------+-----+
only showing top 5 rows
```

In [38]:

```
# Get the average starts per each business from Part III
business_id_avg_stars.show(5)
```

```
+--------------------+------------------+
|         business_id|        avg(stars)|
+--------------------+------------------+
|VHsNB3pdGVcRgs6C3...| 3.411764705882353|
|RMjCnixEY5i12Ciqn...|3.5316455696202533|
|ipFreSFhjClfNETuM...|               2.6|
|dLDMU8bOLnkDTmPUr...| 4.942857142857143|
|Qm2datcYBPXrPATVG...| 4.352941176470588|
+--------------------+------------------+
only showing top 5 rows
```

In [39]:

```
# Join Elite review and Business average stars dataframes
elite_review_skew = elite_review.join(business_id_avg_stars, business_id_avg_stars.business_id == elite_review.
elite_review_skew.show(5)
```

```
+--------------------+--------------------+-------------+-----+--------------------+----------------+
|             user_id|               elite|average_stars|stars|         business_id|      avg(stars)|
+--------------------+--------------------+-------------+-----+--------------------+----------------+
|PMz5Pp3g19MjVmUdT...|           2017,2018|         3.79|  5.0|--9e1ONYQuAa-CB_R...|4.11784140969163|
|y22jM83qCgsNGryv9...|2012,2013,2014,20...|         3.67|  5.0|--9e1ONYQuAa-CB_R...|4.11784140969163|
|jOLdczkaKqfaFb_a_...|           2017,2018|         4.66|  5.0|--9e1ONYQuAa-CB_R...|4.11784140969163|
|le3Xn9Mheb1hNxWur...|2010,2011,2012,20...|         3.86|  5.0|--9e1ONYQuAa-CB_R...|4.11784140969163|
|ERb2hZxyCN9Wz999z...|           2017,2018|         4.24|  4.0|--9e1ONYQuAa-CB_R...|4.11784140969163|
+--------------------+--------------------+-------------+-----+--------------------+----------------+
only showing top 5 rows
```

In [40]:

```
# Calcualte skew value
elite_review_skew = elite_review_skew.toPandas()
elite_review_skew['skew'] = (elite_review_skew['stars'] - elite_review_skew['avg(stars)']) / elite_review_skew[
elite_review_skew
```

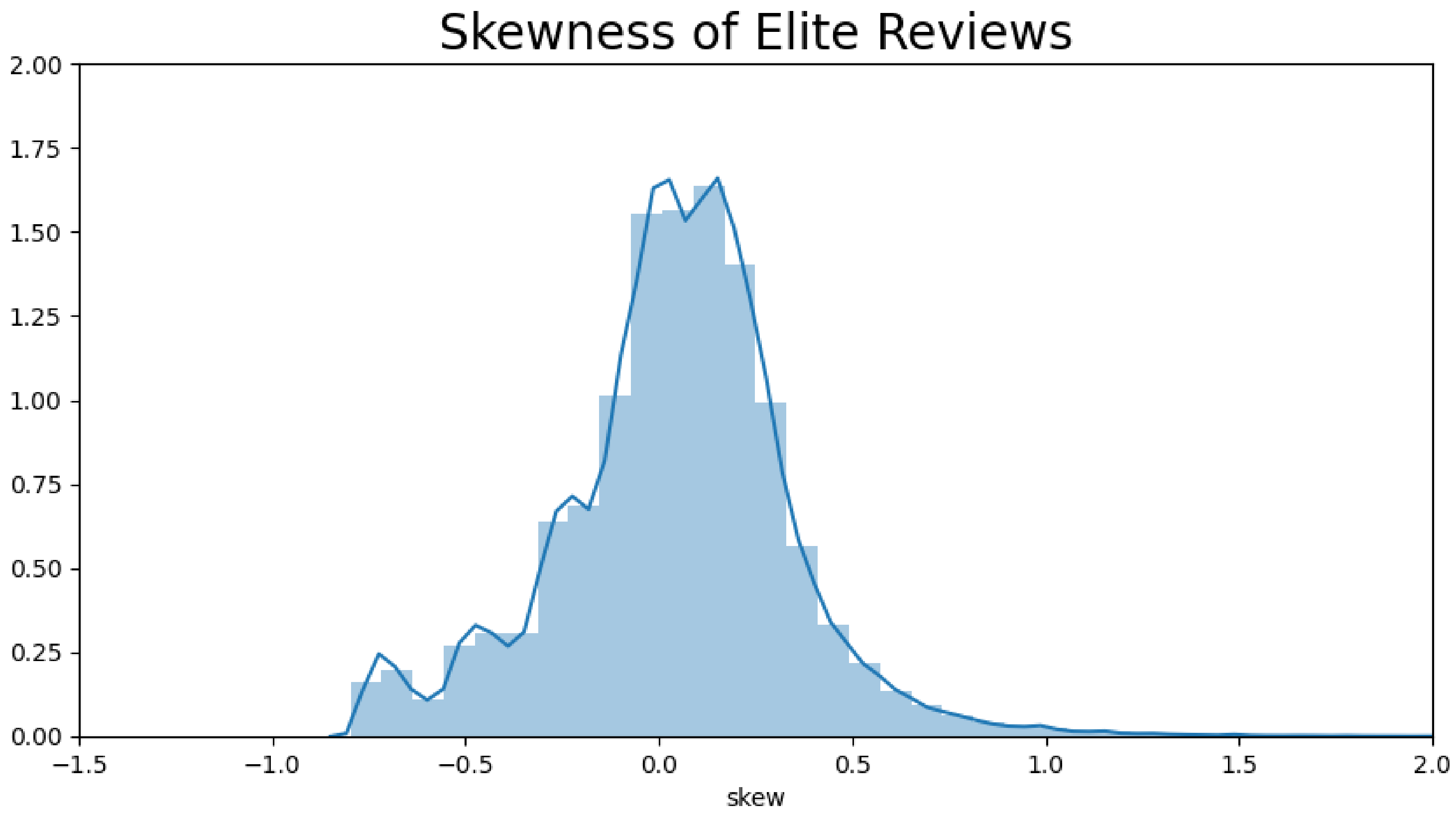
```
                       user_id  ...      skew
0        PMz5Pp3g19MjVmUdT6JTew  ...  0.214228
1        y22jM83qCgsNGryv9328gQ  ...  0.214228
2        jOLdczkaKqfaFb_a_0A6CA  ...  0.214228
3        le3Xn9Mheb1hNxWurF7RSw  ...  0.214228
4        ERb2hZxyCN9Wz999z4a7Cg  ... -0.028617
...                        ...  ...       ...
1756322  EtxsD-Jbyxh7TsaWHtGCew  ...  0.250000
1756323  _BQMCYEIfsn_Ldb4W3TjUg  ... -0.642857
1756324  MMf0LhEk5tGa1LvN7zcDnA  ...  0.071429
1756325  r_B6CZ-gZNKeW1bOzSAXPw  ... -0.785714
1756326  pUjccQauq08ICVR480S-Lg  ... -0.700000

[1756327 rows x 7 columns]
```

## Skewed Distribution of Elite Reviews

In [41]:

```
plt.figure(figsize=(10,5))
sns.distplot(elite_review_skew['skew'], kde = True)
plt.title('Skewness of Elite Reviews', size = 20)
plt.axis((-1.5, 2, 0, 2))
%matplot plt
```



## Calculating Skewness

In [42]:

```
# Calcuate Pearson's coefficient of skewness with mean, median, and standard deviation
# round up values to calaute values easily

mean = elite_review_skew['skew'].mean().round(5)
median = elite_review_skew['skew'].median().round(5)
std_dev = elite_review_skew['skew'].std().round(5)
skewness = (3 * (mean-median) / std_dev).round(5)

print('Mean: ', mean)
print('Median: ', median)
print('Standard Deviation: ', std_dev)
print('Skewness: ', skewness)
```

```
Mean:  0.04378
```

```
Median:  0.05655
Standard Deviation:  0.30707
Skewness:  -0.12476
```

## IMPLICATIONS

A "Skewness of Elite Reviews" graph did not clearly show if skewness is postivie or negative. I calculated Pearson's coefficient of skewness with mean, median, and standard deviation.

- The formula to calculate skewness is 3 * (Mean - Median) / Standard Deviation
- mean is 0.04378
- median is 0.05655
- standard deviation is 0.30707

As a result, I could get skewness of -0.12476. It is less than 0, so I can say skewness is negative. It shows that Elite users were less satisfied than normal business reviews. They might tend to write critic reviews due to the title of the Elite. It would result in leaving more negative reviews than normal business reviews. Skewness is not a strong negative value and is close to 0. It looks like Elite users do not intentionally leave negative reviews.

Elite users would be trusted. However, we don't need to stronlgy trust them or consider only their reviews rather than normal users who left reviews.