Yelp Review Dataset Analysis

Spark 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'}`

ID	YARN Application ID	Kind	State	Spark UI	Driver log	Current session?
6	application_1619310664737_0007	pyspark	idle	Link	Link	

In [2]:
```
sc.list_packages()
```

```
Starting Spark application
```

ID	YARN Application ID	Kind	State	Spark UI	Driver log	Current session?
7	application_1619310664737_0008	pyspark	idle	Link	Link	✓

```
SparkSession available as 'spark'.

Package                    Version
-------------------------- -------
beautifulsoup4             4.8.1
boto                       2.49.0
jmespath                   0.9.4
lxml                       4.4.2
mysqlclient                1.4.6
nltk                       3.4.5
nose                       1.3.4
numpy                      1.14.5
pip                        21.1
py-dateutil                2.2
python36-sagemaker-pyspark 1.2.6
pytz                       2019.3
PyYAML                     3.11
setuptools                 56.0.0
six                        1.13.0
soupsieve                  1.9.5
wheel                      0.36.2
windmill                   1.6
```

In [3]:
```
sc.install_pypi_package("pandas==1.0.3")
```

```
Collecting pandas==1.0.3
  Using cached pandas-1.0.3-cp36-cp36m-manylinux1_x86_64.whl (10.0 MB)
Collecting python-dateutil>=2.6.1
  Using cached python_dateutil-2.8.1-py2.py3-none-any.whl (227 kB)
```

```
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib64/python3.6/site-
packages (from pandas==1.0.3) (1.14.5)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.6/site-pac
kages (from pandas==1.0.3) (2019.3)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/site-package
s (from python-dateutil>=2.6.1->pandas==1.0.3) (1.13.0)
Installing collected packages: python-dateutil, pandas
Successfully installed pandas-1.0.3 python-dateutil-2.8.1
```

In [4]:
```
sc.install_pypi_package('matplotlib==3.2.1')
```

```
Collecting matplotlib==3.2.1
  Using cached matplotlib-3.2.1-cp36-cp36m-manylinux1_x86_64.whl (12.4 MB)
Collecting pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1
  Using cached pyparsing-2.4.7-py2.py3-none-any.whl (67 kB)
Requirement already satisfied: numpy>=1.11 in /usr/local/lib64/python3.6/site-pa
ckages (from matplotlib==3.2.1) (1.14.5)
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1619392843364-0/
lib/python3.6/site-packages (from matplotlib==3.2.1) (2.8.1)
Collecting kiwisolver>=1.0.1
  Using cached kiwisolver-1.3.1-cp36-cp36m-manylinux1_x86_64.whl (1.1 MB)
Collecting cycler>=0.10
  Using cached cycler-0.10.0-py2.py3-none-any.whl (6.5 kB)
Requirement already satisfied: six in /usr/local/lib/python3.6/site-packages (fr
om cycler>=0.10->matplotlib==3.2.1) (1.13.0)
Installing collected packages: pyparsing, kiwisolver, cycler, matplotlib
Successfully installed cycler-0.10.0 kiwisolver-1.3.1 matplotlib-3.2.1 pyparsing
-2.4.7
```

In [5]:
```
sc.install_pypi_package('seaborn==0.11.1')
```

```
Collecting seaborn==0.11.1
  Using cached seaborn-0.11.1-py3-none-any.whl (285 kB)
Requirement already satisfied: pandas>=0.23 in /mnt/tmp/1619392843364-0/lib64/py
thon3.6/site-packages (from seaborn==0.11.1) (1.0.3)
Collecting scipy>=1.0
  Using cached scipy-1.5.4-cp36-cp36m-manylinux1_x86_64.whl (25.9 MB)
Requirement already satisfied: matplotlib>=2.2 in /mnt/tmp/1619392843364-0/lib6
4/python3.6/site-packages (from seaborn==0.11.1) (3.2.1)
Collecting numpy>=1.15
  Using cached numpy-1.19.5-cp36-cp36m-manylinux2010_x86_64.whl (14.8 MB)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /mnt/
tmp/1619392843364-0/lib/python3.6/site-packages (from matplotlib>=2.2->seaborn==
0.11.1) (2.4.7)
Requirement already satisfied: python-dateutil>=2.1 in /mnt/tmp/1619392843364-0/
lib/python3.6/site-packages (from matplotlib>=2.2->seaborn==0.11.1) (2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /mnt/tmp/1619392843364-0/lib
64/python3.6/site-packages (from matplotlib>=2.2->seaborn==0.11.1) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /mnt/tmp/1619392843364-0/lib/pyth
on3.6/site-packages (from matplotlib>=2.2->seaborn==0.11.1) (0.10.0)
Requirement already satisfied: six in /usr/local/lib/python3.6/site-packages (fr
om cycler>=0.10->matplotlib>=2.2->seaborn==0.11.1) (1.13.0)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.6/site-pac
kages (from pandas>=0.23->seaborn==0.11.1) (2019.3)
Installing collected packages: numpy, scipy, seaborn
  Attempting uninstall: numpy
    Found existing installation: numpy 1.14.5
    Not uninstalling numpy at /usr/local/lib64/python3.6/site-packages, outside
environment /tmp/1619392843364-0
    Can't uninstall 'numpy'. No files were found to uninstall.
```

```
Successfully installed numpy-1.19.5 scipy-1.5.4 seaborn-0.11.1

ERROR: pip's dependency resolver does not currently take into account all the pa
ckages that are installed. This behaviour is the source of the following depende
ncy conflicts.
python36-sagemaker-pyspark 1.2.6 requires pyspark==2.3.2, which is not installe
d.
```

In [6]:

```
sc.list_packages()
```

```
Package                    Version
-------------------------- -------
beautifulsoup4             4.8.1
boto                       2.49.0
cycler                     0.10.0
jmespath                   0.9.4
kiwisolver                 1.3.1
lxml                       4.4.2
matplotlib                 3.2.1
mysqlclient                1.4.6
nltk                       3.4.5
nose                       1.3.4
numpy                      1.19.5
pandas                     1.0.3
pip                        21.1
py-dateutil                2.2
pyparsing                  2.4.7
python-dateutil            2.8.1
python36-sagemaker-pyspark 1.2.6
pytz                       2019.3
PyYAML                     3.11
scipy                      1.5.4
seaborn                    0.11.1
setuptools                 56.0.0
six                        1.13.0
soupsieve                  1.9.5
wheel                      0.36.2
windmill                   1.6
```

Imports

In [7]:

```
from pyspark.sql.functions import explode, split

import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from pyspark.sql.functions import countDistinct
from pyspark.sql.functions import col, mean
```

Read

In [8]:

```
business = spark.read.json('s3://sta9760yelp/yelp_academic_dataset_business.json
review = spark.read.json('s3://sta9760yelp/yelp_academic_dataset_review.json')
user = spark.read.json('s3://sta9760yelp/yelp_academic_dataset_user.json')
```

Overview of Data

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)
```

In [10]:

```
business.select('business_id','name','city','state','stars','categories').show(5
business.count()
```

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

160585
```

Analyzing Categories

The categories column shows a list of categories the business falls under. We need to break out these categories to further analyze.

original

business_id	categories
RestaurantA	Spicy, Soup, Healthy

new

business_id	categories
RestaurantA	Spicy
RestaurantA	Soup
RestaurantA	Healthy

In [11]:

```
#creating new business df with categories broken out
```

```
business_cat = business.select('business_id','categories')
business_cat_explode =business_cat.withColumn('categories',explode(split('catego
```

In [12]:

```
business_cat_explode.show(15)
business_cat_explode.count()
```

```
+--------------------+--------------------+
|         business_id|          categories|
+--------------------+--------------------+
|6iYb2HFDywm3zjuRg...|          Gastropubs|
|6iYb2HFDywm3zjuRg...|                Food|
|6iYb2HFDywm3zjuRg...|        Beer Gardens|
|6iYb2HFDywm3zjuRg...|         Restaurants|
|6iYb2HFDywm3zjuRg...|                Bars|
|6iYb2HFDywm3zjuRg...| American (Tradit...|
|6iYb2HFDywm3zjuRg...|            Beer Bar|
|6iYb2HFDywm3zjuRg...|           Nightlife|
|6iYb2HFDywm3zjuRg...|           Breweries|
|tCbdrRPZA0oiIYSmH...|               Salad|
|tCbdrRPZA0oiIYSmH...|                Soup|
|tCbdrRPZA0oiIYSmH...|          Sandwiches|
|tCbdrRPZA0oiIYSmH...|               Delis|
|tCbdrRPZA0oiIYSmH...|         Restaurants|
|tCbdrRPZA0oiIYSmH...|               Cafes|
+--------------------+--------------------+
only showing top 15 rows

708968
```

the number of rows increased as expected after breaking out categories

Total Unique Categories

In [13]:

```
business_cat_explode.select(countDistinct('categories')).show()
```

```
+--------------------------+
|count(DISTINCT categories)|
+--------------------------+
|                      2487|
+--------------------------+
```

Top Categories By Business

Purpose is to find the most popular business categories. This will be done by grouping and finding the count of each category.

In [14]:

```
business_group = business_cat_explode.groupby('categories')
business_cat_bar = business_group.count().orderBy('count',ascending=False)
business_cat_bar.show(20)
```

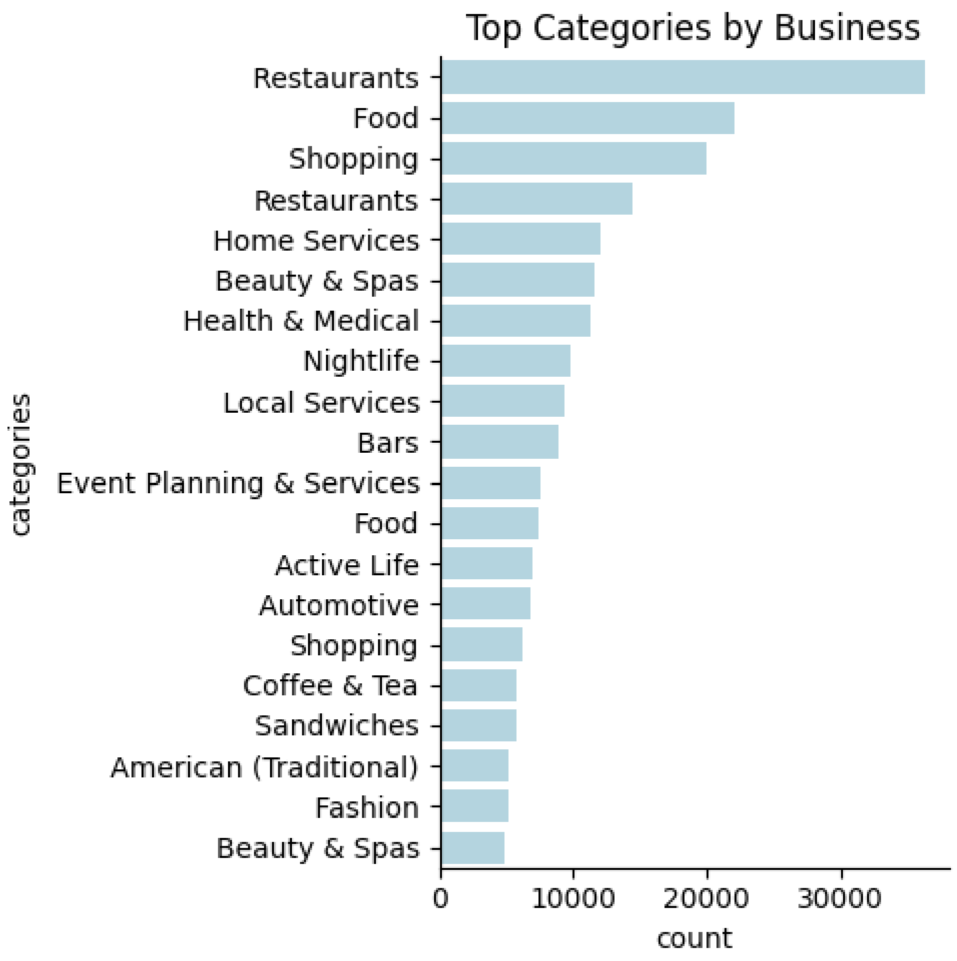
```
+--------------------+-----+
|          categories|count|
+--------------------+-----+
|         Restaurants|36340|
|                Food|22094|
|            Shopping|20056|
|         Restaurants|14423|
|       Home Services|12001|
|       Beauty & Spas|11633|
|    Health & Medical|11390|
|           Nightlife| 9808|
|      Local Services| 9299|
|                Bars| 8914|
| Event Planning &...| 7617|
|                Food| 7375|
|         Active Life| 7039|
|          Automotive| 6785|
|            Shopping| 6149|
|         Coffee & Tea| 5735|
|          Sandwiches| 5697|
| American (Tradit...| 5235|
|             Fashion| 5231|
|       Beauty & Spas| 4941|
+--------------------+-----+
only showing top 20 rows
```

In [15]:

```
bcdf = business_cat_bar.toPandas()
```

In [16]:

```
sns.catplot(y='categories',x='count', data=bcdf[0:20], kind='bar',color='lightbl
plt.title('Top Categories by Business')
plt.tight_layout()
plt.show()
%matplot plt
```



Yelp User Reviews Analysis

In [17]:

```
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 [18]:

```
review.select('business_id','stars').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
```

In [19]:

```
#calculate user review on business grouping by business

rev_avg = review.select('business_id','stars') \
    .withColumn('stars', col('stars').cast('float')) \
    .groupBy('business_id') \
    .agg(mean('stars').alias('avg_stars'))
```

In [20]:

```
rev_avg.show(5)
```

```
+--------------------+------------------+
|         business_id|         avg_stars|
+--------------------+------------------+
|OXcBg_6vgi-J3nZzI...| 3.852272727272727|
|bxy3khT-2R66tcdKj...| 3.986344537815126|
|f3teByaeIKPTYetAa...| 4.329608938547486|
|3KqpiLDAjeeMmZeU-...|2.5555555555555554|
|_hkHeU2cBH9fzthId...| 3.168195718654434|
+--------------------+------------------+
only showing top 5 rows
```

In [21]:

```
#joining business and rev_avg df to compare average user rating to business rati

bus_avg_star = business.join(rev_avg, business.business_id == rev_avg.business_i
```

In [22]:

```
bus_avg_star.select('avg_stars', 'stars', 'name', 'city', 'state').show(5)
```

```
+------------------+-----+--------------------+------------+-----+
|         avg_stars|stars|                name|        city|state|
+------------------+-----+--------------------+------------+-----+
|1.9090909090909092|  2.0|             Safeway|   Vancouver|   WA|
| 2.966292134831461|  3.0|Cracker Barrel Ol...|Pickerington|   OH|
|  2.81981981981982|  3.0|  Peaceful Restaurant|   Vancouver|   BC|
|               5.0|  5.0|      ATX Architects|      Austin|   TX|
| 4.524271844660194|  4.5|     Evergreen Eatery|      Boston|   MA|
+------------------+-----+--------------------+------------+-----+
only showing top 5 rows
```

Calculating Skew Between Business Rating and Average User Rating on said Business

To calculate skewness between user rating and business rating, I will calculate % difference.

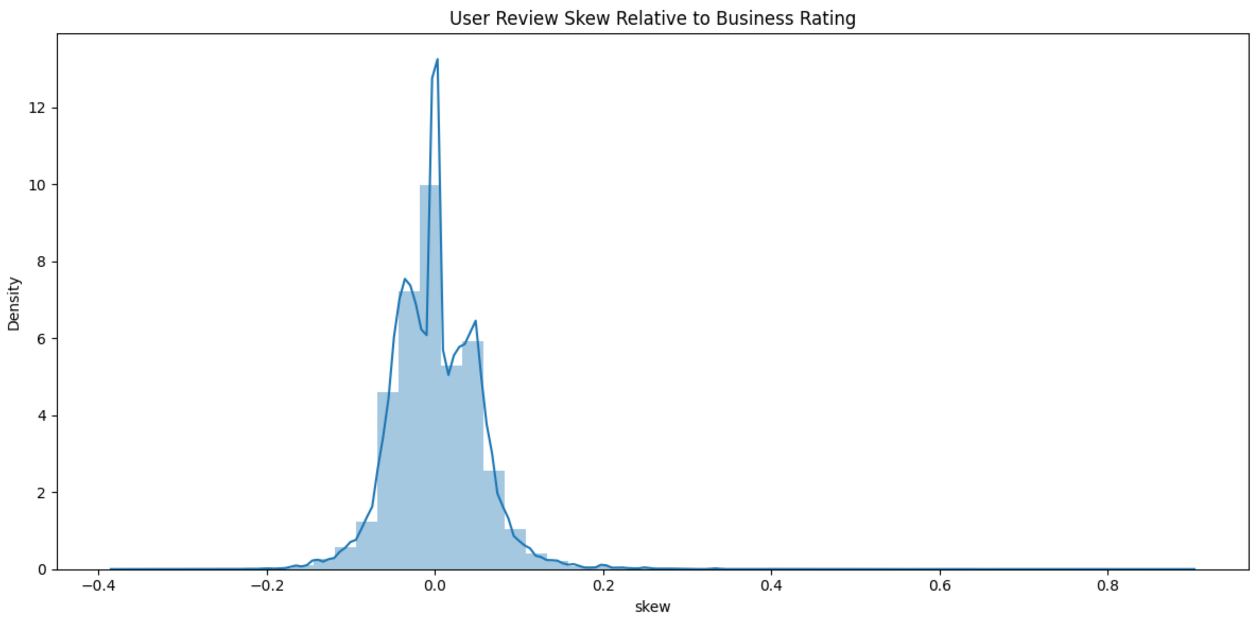
(Average Rating - Business Rating) / Business Rating
Above formula will find the percent change between average user rating and business rating

In [23]:
```
skew = bus_avg_star.withColumn('skew', (col('avg_stars')-col('stars')) / col('st
```

In [24]:
```
skewdf = skew.toPandas()
```

In [25]:
```
plt.clf()
plt.figure(figsize=(12, 6))
sns.distplot(skewdf['skew'])
plt.title('User Review Skew Relative to Business Rating')
plt.tight_layout()

plt.show()
%matplot plt
```



The above histogram shows that the average user rating is typically lower than the business rating due to left skew.

Rating Comparison of Elite vs Normal Users on Same Business

In [26]:
```
#joining review and user df to classify which review is considered elite members

review_user = review.join(user, review.user_id == user.user_id)
```

In [27]:
```
review_user.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)
 |-- 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 [28]:

```
#calculation of elite user average rating on business

norm_avg = review_user.filter(review_user.elite=='').withColumn('stars', col('st
    .groupBy('business_id') \
    .agg(mean('stars').alias('norm_avg'))
```

In [29]:

```
#calculation of normal user average rating on business

elite_avg = review_user.filter(review_user.elite.contains(',')).withColumn('star
    .groupBy('business_id') \
    .agg(mean('stars').alias('elite_avg'))
```

In [30]:

```
#joining both df from above to get ready to calculate skewness

avgjoined = norm_avg.join(elite_avg, norm_avg.business_id == elite_avg.business_
```

In [31]:

```
avgjoined.show(3)
```

```
+--------------------+------------------+--------------------+------------------
+
|        business_id|          norm_avg|         business_id|          elite_avg
|
+--------------------+------------------+--------------------+------------------
+
|-36nnCT71XE0InJXK...| 1.903225806451613|-36nnCT71XE0InJXK...|               2.0
|
|-QOl03c2B22yi_On0...|2.6470588235294117|-QOl03c2B22yi_On0...|               3.4
|
|-VVUUPK0ytYjpJ_S7...| 2.814814814814815|-VVUUPK0ytYjpJ_S7...|2.8333333333333335
|
+--------------------+------------------+--------------------+------------------
+
only showing top 3 rows
```

In [32]:

```python
#calculating % difference between elite and normal reviews

reviewskew = avgjoined.withColumn('reviewskew', (col('elite_avg')-col('norm_avg'
```

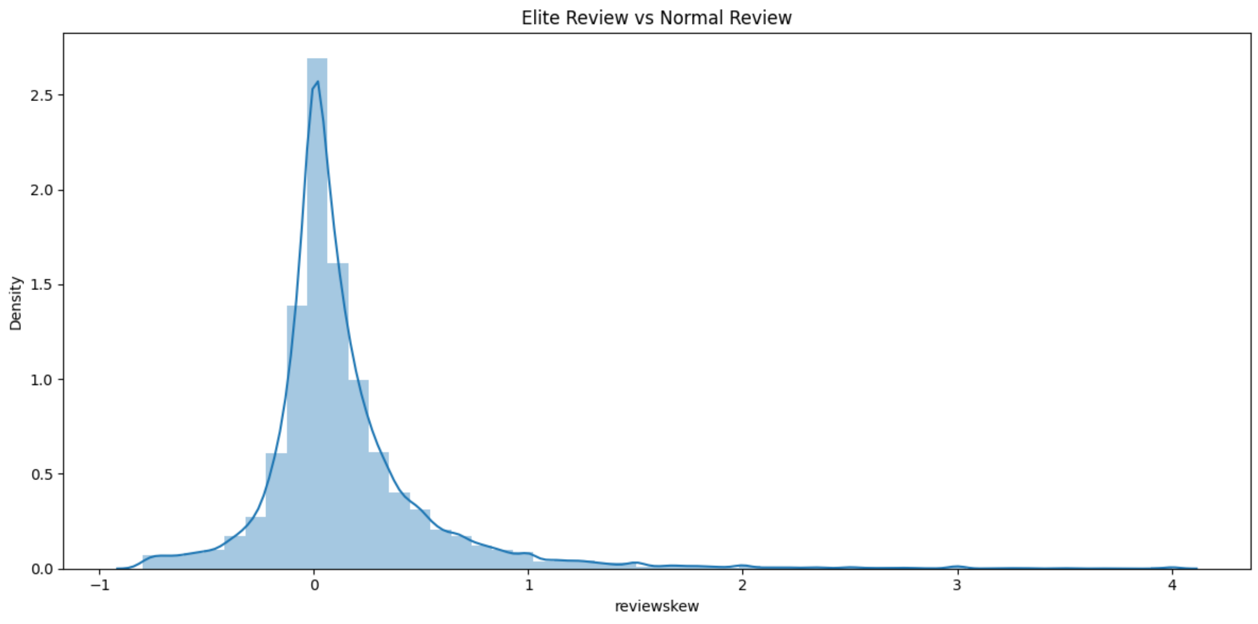
In [33]:

```python
reviewskewdf = reviewskew.toPandas()
```

In [34]:

```python
plt.clf()
plt.figure(figsize=(12, 6))
sns.distplot(reviewskewdf['reviewskew'])
plt.title('Elite Review vs Normal Review')
plt.tight_layout()

plt.show()
%matplot plt
```



Above histogram shows that Elite members typically rate business higher than normal users due to right skew.