Methodology

In [ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

In [ ]:
```
from google.colab import auth
auth.authenticate_user()
```

In [ ]:
```
from google.cloud import storage

project_id = "sharp-matter-449521-u2"
!gcloud config set project {project_id}
```

```
Updated property [core/project].
```

In [ ]:
```
!wget -P /usr/lib/spark/jars/ https://storage.googleapis.com/hadoop-lib/gcs/gc
```

```
--2025-04-09 22:20:49--  https://storage.googleapis.com/hadoop-lib/gcs/gcs-con
nector-hadoop3-latest.jar
Resolving storage.googleapis.com (storage.googleapis.com)... 172.253.117.207,
142.250.99.207, 142.250.107.207, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|172.253.117.207
|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 40713341 (39M) [application/java-archive]
Saving to: ‘/usr/lib/spark/jars/gcs-connector-hadoop3-latest.jar’

gcs-connector-hadoo 100%[===================>]  38.83M   207MB/s    in 0.2s

2025-04-09 22:20:49 (207 MB/s) - ‘/usr/lib/spark/jars/gcs-connector-hadoop3-la
test.jar’ saved [40713341/40713341]
```

In [ ]:
```
import warnings
warnings.filterwarnings('ignore')
```

In [ ]:
```
from pyspark.sql import SparkSession
```

In [ ]:
```
spark = SparkSession.builder \
    .appName("BigDataProcessing") \
    .config("spark.jars", "/usr/lib/spark/jars/gcs-connector-hadoop3-latest.ja
    .config("spark.hadoop.fs.gs.impl", "com.google.cloud.hadoop.fs.gcs.GoogleH
    .config("spark.hadoop.fs.gs.auth.service.account.enable", "true") \
    .getOrCreate()
```

In [ ]:
```
spark
```

Out[ ]: **SparkSession - in-memory**

SparkContext

Spark UI

Version	`v3.5.5`
Master	`local[*]`
AppName	`BigDataProcessing`

In [ ]:
```
df_reviews = spark.read.parquet('gs://final_dataset_dat490/dat490_final_datase
```

In [ ]:
```
df_reviews.columns
```

Out[ ]:
```
['gmap_id',
 'customer_name',
 'rating',
 'reviews',
 'time',
 'avg_rating',
 'category',
 'latitude',
 'longitude',
 'business_name',
 'num_of_reviews',
 'state',
 'standard_category',
 'Monday',
 'Tuesday',
 'Wednesday',
 'Thursday',
 'Friday',
 'Saturday',
 'Sunday',
 'timestamp',
 'week',
 'month',
 'year',
 'time_seconds']
```

VADER

In [ ]:
```
from pyspark.sql.functions import udf
from pyspark.sql.types import FloatType
from nltk.sentiment.vader import SentimentIntensityAnalyzer
import nltk
nltk.download("vader_lexicon")

# Initializing VADER
sia = SentimentIntensityAnalyzer()

def vader_sentiment(text):
    if text:
        return float(sia.polarity_scores(text)["compound"])
    else:
        return 0.0
```

```
vader_udf = udf(vader_sentiment, FloatType())

df_sentiment = df_reviews.withColumn("sentiment_score", vader_udf("reviews"))
```

```
[nltk_data] Downloading package vader_lexicon to /root/nltk_data...
```

In [ ]:
```
from pyspark.sql.functions import when

df_sentiment = df_sentiment.withColumn(
    "sentiment_label",
    when(df_sentiment["sentiment_score"] > 0.2, "Positive")
    .when(df_sentiment["sentiment_score"] < -0.2, "Negative")
    .otherwise("Neutral")
)
```

In [ ]:
```
from pyspark.sql.functions import approx_count_distinct

df_sentiment.groupBy("sentiment_label").agg(approx_count_distinct("gmap_id").a
```

```
+---------------+------------+
|sentiment_label|approx_count|
+---------------+------------+
|       Positive|     2598785|
|        Neutral|      149531|
|       Negative|      197929|
+---------------+------------+
```

In [ ]:
```
from pyspark.sql.functions import when

df_sentiment = df_sentiment.withColumn(
    "sentiment_label",
    when(df_sentiment["sentiment_score"] > 0.05, "Positive")
    .when(df_sentiment["sentiment_score"] < -0.05, "Negative")
    .otherwise("Neutral")
)
```

In [ ]:
```
df_sentiment.select("reviews", "sentiment_score", "sentiment_label").show(10)
```

```
+--------------------+---------------+---------------+
|             reviews|sentiment_score|sentiment_label|
+--------------------+---------------+---------------+
|The pizza, steak ...|         0.6114|       Positive|
|Great way to get ...|         0.6249|       Positive|
|Went there for a ...|         0.7392|       Positive|
|Friendly and know...|         0.4939|       Positive|
|My personal choic...|         0.8308|       Positive|
|This store has be...|        -0.6324|       Negative|
|I am disappointed...|          0.975|       Positive|
|AUAF oversee a va...|         0.9042|       Positive|
|Great neighborhoo...|         0.6249|       Positive|
|This is place is ...|         0.8807|       Positive|
+--------------------+---------------+---------------+
only showing top 10 rows
```

In [ ]:
```
from pyspark.sql.functions import approx_count_distinct

df_sentiment_counts = df_sentiment.groupBy("sentiment_label").agg(approx_count_
```

In [ ]:
```
from pyspark.sql.functions import approx_count_distinct

df_sentiment.groupBy("sentiment_label").agg(approx_count_distinct("gmap_id").a
```

```
+---------------+------------+
|sentiment_label|approx_count|
+---------------+------------+
|       Positive|     2647752|
|        Neutral|       91804|
|       Negative|      227790|
+---------------+------------+
```

In [ ]:
```
from pyspark.sql.functions import col, round

df_percentages = df_sentiment_counts.withColumn(
    "percentage", round((col("approx_count") / 2884722) * 100, 2)
)
```

TextBlob

In [ ]:
```
from pyspark.sql.functions import col, when, regexp_replace
from textblob import TextBlob
from pyspark.sql.functions import udf
from pyspark.sql.types import StructType, StructField, DoubleType, StringType

def get_textblob_sentiment(text):
    if text is not None and isinstance(text, str):
        blob = TextBlob(text)
        return float(blob.sentiment.polarity), float(blob.sentiment.subjectivi
    else:
        return 0.0, 0.0

schema = StructType([
    StructField("polarity", DoubleType(), True),
    StructField("subjectivity", DoubleType(), True)
])

sentiment_udf = udf(get_textblob_sentiment, schema)

df_reviews = df_reviews.withColumn("sentiment", sentiment_udf("reviews"))
df_reviews = df_reviews.withColumn("polarity", col("sentiment.polarity"))
df_reviews = df_reviews.withColumn("subjectivity", col("sentiment.subjectivity'
```

In [ ]:
```
from pyspark.sql.functions import when

# Putting all the reviews into 3 categories based on their polarity
df_reviews = df_reviews.withColumn(
    "sentiment_label",
    when(col("polarity") <= -0.2, "Negative").
    when(col("polarity") <= 0.2, "Neutral").
    otherwise("Positive")
)
```

In [ ]:
```
df_reviews.select('reviews', 'polarity', 'sentiment_label').show(10, truncate=
+-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
--------------------------------------------+-------------------+------------
--+
|reviews
|polarity           |sentiment_label|
+-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
--------------------------------------------+-------------------+------------
--+
|The pizza, steak street tacos and the portobello truffle fries and were all d
elicious!
|1.0                |Positive       |
|Great way to get around town, and very affordable.
|0.5                |Positive       |
|Went there for a volleyball tournament. The facilities are nice. They have a
lot of bleacher  seating. They offered guest wifi but I didn't connect and the
y have a room with big tables for teams and spectators to sit  during breaks.
There are outlets in that room for those workaholic parents who can be bothere
d to watch their kids play. They have a concessions and offer the usual fare.
Such as hot dogs, nachos, sports drinks etc. I'll attach a menu. They also do
not allow camping chairs, coolers and outside food. Bleacher chairs are okay t
o bring. The facilities is kept well I believe it is one of the top locations
for a volleyball tournament. As for parking. Get there early to get a decent s
pot or you'll end up parking on the  street.|0.18666666666666667 |Neutral
|
|Friendly and knowledgeable. I was able to get a copy of my pets shots.
|0.4375             |Positive       |
|My personal choice for somewhat upscale dining in Woodstock. The burgers are
delicious, but my go to item is the Lobster Cobb Salad. You cannot go wrong wi
th the setting and location. Sit outside on the patio during summer and fall m
onths when musicians play on the square.
|0.125              |Neutral        |
|This store has been featured on the Instagram account of “overpriced bourbo
n”. Tells you all you need to know. Along with the miserable old lady up fron
t, I’m not sure why anyone would shop here. Can’t wait for a binnys to run thi
s store into a reality check.
|-0.38333333333333333|Negative       |
|I am disappointed to see negative reviews for this establishment. I am very f
requent here and always have a pleasant experience. The beds are always clean,
and the bathroom is spotless. The owner is kind and really helps you understan
d what you need,  and what works best for your budget. The pricing is fair and
I have been tanning at different places. The lotions always have great sales a
s well.If you want a good tan with great service and price , come see Julie !!
|0.3984615384615384 |Positive       |
|AUAF oversee a variety  programs. I work as a Home Care Aide through them. As
```

```
an employee of AUAF Home Care program I was treated with respect and dignity a
s a Home Aide.
|0.0                |Neutral        |
|Great neighborhood bar
|0.8                |Positive       |
|This is place is solid. The prices are reasonable and the portions large. How
ever the food is not stellar. Some things are pretty good, others leave someth
ing to be desired in terms of flavorful sauces, etc. I had a frustrating custo
mer service experience with delivery once and the owner was too frustrated/bus
y to resolve the issue so grubhub refunded us. It's a good local spot.
|0.171031746031746  |Neutral        |
+------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
--------------------------------------------+-------------------+-------------
--+
only showing top 10 rows
```

In [ ]:

```
sentiment_label_count = df_reviews.groupby('sentiment_label').count()
```

In [ ]:

```
from pyspark.sql.functions import col, round
df_sentiment_all = df_reviews.withColumn("sentiment_score", vader_udf("reviews'
df_sentiment_all = df_sentiment_all.withColumn("polarity", col("sentiment.pola
df_sentiment_all.columns
```

Out[ ]:

```
['gmap_id',
 'customer_name',
 'rating',
 'reviews',
 'time',
 'avg_rating',
 'category',
 'latitude',
 'longitude',
 'business_name',
 'num_of_reviews',
 'state',
 'standard_category',
 'Monday',
 'Tuesday',
 'Wednesday',
 'Thursday',
 'Friday',
 'Saturday',
 'Sunday',
 'timestamp',
 'week',
 'month',
 'year',
 'time_seconds',
 'sentiment',
 'polarity',
 'subjectivity',
 'sentiment_label',
 'sentiment_score']
```

In [ ]:

```python
from pyspark.sql.functions import when, length, col
from pyspark.sql import functions as F

df_labeled = df_sentiment_all.withColumn(
    "vader_label",
    when(col("sentiment_score") >= 0.05, "Positive")
    .when(col("sentiment_score") <= -0.05, "Negative")
    .otherwise("Neutral")
)
df_labeled = df_labeled.withColumn(
    "textblob_label",
    when(col("polarity") >= 0.05, "Positive")
    .when(col("polarity") <= -0.05, "Negative")
    .otherwise("Neutral")
)
df_labeled = df_labeled.withColumn("review_length", length(col("reviews")))

df_labeled = df_labeled.withColumn(
    "length_bucket",
    when(col("review_length") < 100, "Short")
    .when(col("review_length") <= 300, "Medium")
    .otherwise("Long")
)

top_categories = [row['standard_category'] for row in df_labeled.groupBy("stand
                  .count().orderBy(F.desc("count")).limit(5).collect()]

df_filtered = df_labeled.filter(col("standard_category").isin(top_categories))
```

```
samples = []
for category in top_categories:
    for label in ["Positive", "Negative", "Neutral"]:
        for length_group in ["Short", "Medium", "Long"]:
            subset = (
                df_filtered.filter(
                    (col("standard_category") == category) &
                    (col("vader_label") == label) &
                    (col("length_bucket") == length_group)
                ).orderBy(F.rand()).limit(1)
            )
            samples.append(subset)

df_sample_30 = samples[0]
for i in range(1, len(samples)):
    df_sample_30 = df_sample_30.union(samples[i])

df_final = df_sample_30.select(
    "reviews", "standard_category", "review_length",
    "vader_label", "sentiment", "textblob_label", "polarity"
)

df_final.show(30, truncate=False)
```

In [ ]:
```
df_final_30 = df_final.limit(30)
```

In [ ]:
```
from transformers import pipeline

# Load zero-shot classification model
zero_shot_classifier = pipeline("zero-shot-classification", model="facebook/ba
```

In [ ]:
```
from pyspark.sql.functions import when, length, col

df_bucketed = df_reviews.withColumn("review_length", length(col("reviews")))

df_bucketed = df_bucketed.withColumn(
    "length_bucket",
    when(col("review_length") < 100, "Short")
    .when(col("review_length") <= 300, "Medium")
    .otherwise("Long")
)
```

In [ ]:
```
from pyspark.sql import functions as F

# Group count
group_counts = df_bucketed.groupBy("standard_category", "length_bucket").count

# Total rows
total_count = df_bucketed.count()

# Target sample size
sample_target = 10000

# Compute fraction per group
group_fractions = group_counts.withColumn(
    "fraction", (F.col("count") / total_count) * sample_target
).withColumn(
    "sample_size", F.round("fraction").cast("int")
)
```

In [ ]:
```
sampled_dfs = []

for row in group_fractions.collect():
    cat = row['standard_category']
    bucket = row['length_bucket']
    n = row['sample_size']

    if n > 0:
        subset = (
            df_bucketed.filter(
                (col("standard_category") == cat) &
                (col("length_bucket") == bucket)
            )
            .orderBy(F.rand())
            .limit(n)
        )
        sampled_dfs.append(subset)
```

In [ ]:
```
df_sample_10k = sampled_dfs[0]
for sdf in sampled_dfs[1:]:
    df_sample_10k = df_sample_10k.union(sdf)
```

In [ ]:
```
output_path = "gs://final_dataset_dat490/sample_reviews_stratified_10k.parquet'
```

In [ ]:
```
df_sample_10k.write.mode("overwrite").parquet(output_path)
```

In [ ]:
```
import pandas as pd
df_sample_pandas = pd.read_parquet(output_path)
df_sample_pandas = df_sample_pandas.sort_values(["gmap_id", "timestamp"]).rese
df_sample_pandas.columns
```

Out[ ]:
```
Index(['gmap_id', 'customer_name', 'rating', 'reviews', 'time', 'avg_rating',
       'category', 'latitude', 'longitude', 'business_name', 'num_of_reviews',
       'state', 'standard_category', 'Monday', 'Tuesday', 'Wednesday',
       'Thursday', 'Friday', 'Saturday', 'Sunday', 'timestamp', 'week',
       'month', 'year', 'time_seconds', 'review_length', 'length_bucket'],
      dtype='object')
```

In [ ]:
```
df_sample_pandas[['reviews']]
```

Out[ ]:

	reviews
0	Nice clean place and very friendly staff. Only...
1	This company helped us buy our land 15 years a...
2	Great place for kids and families to do sports...
3	He was able to fit me in at the last minute. A...
4	I have had good experiences here for the past ...
...	...
9996	Store was disorganized and sales representativ...
9997	Treated as a number, not a patient. Rushed by ...
9998	This is such a great place to grab dinner. The...
9999	Dividers and spots clearly marked on floor, pl...
10000	Travelers, this is the cape cod thrift store e...

10001 rows × 1 columns

In [ ]:
```
# pip install pandas transformers openpyxl

# from google.colab import drive
# drive.mount('/content/drive')

# import pandas as pd
# df_reviews_30 = pd.read_excel('/content/drive/MyDrive/Reviews std DAT490.xls
# df_reviews_30.head()

# from transformers import pipeline

# classifier = pipeline("zero-shot-classification", model="facebook/bart-large-
# labels = ["positive", "neutral", "negative"]

# score = []
# for review in df_reviews_30['Reviews']:
#   prediction = classifier(review, candidate_labels=labels)
#   top_label = prediction["labels"][0]
#   score.append(top_label)

# df_reviews_30['Sentiment'] = score
# df_reviews_30

# df_reviews_30.to_excel('/content/drive/MyDrive/Reviews std DAT490 labelled.x
```

In [ ]:
```
!pip install vaderSentiment
```

```
Collecting vaderSentiment
  Downloading vaderSentiment-3.3.2-py2.py3-none-any.whl.metadata (572 bytes)
Requirement already satisfied: requests in /usr/local/lib/python3.11/dist-pack
ages (from vaderSentiment) (2.32.3)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/pyth
on3.11/dist-packages (from requests->vaderSentiment) (3.4.1)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.11/dist-
packages (from requests->vaderSentiment) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.1
1/dist-packages (from requests->vaderSentiment) (2.3.0)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.1
1/dist-packages (from requests->vaderSentiment) (2025.1.31)
Downloading vaderSentiment-3.3.2-py2.py3-none-any.whl (125 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 126.0/126.0 kB 4.0 MB/s eta 0:00:0
0
Installing collected packages: vaderSentiment
Successfully installed vaderSentiment-3.3.2
```

In [ ]:
```
from textblob import TextBlob
from vaderSentiment.vaderSentiment import SentimentIntensityAnalyzer
from tqdm import tqdm

tqdm.pandas()  # Progress bar for apply
```

In [ ]:
```
analyzer = SentimentIntensityAnalyzer()

def get_textblob_polarity(text):
    try:
        return TextBlob(text).sentiment.polarity
    except:
        return None

def get_vader_compound(text):
    try:
        return analyzer.polarity_scores(text)["compound"]
    except:
        return None
```

In [ ]:
```
# Assuming df["reviews"] contains your text
df_sample_pandas["vader_polarity"] = df_sample_pandas["reviews"].progress_apply
df_sample_pandas["textblob_sentiment_score"] = df_sample_pandas["reviews"].prog
```

```
100%|██████████| 10001/10001 [00:03<00:00, 2803.51it/s]
100%|██████████| 10001/10001 [00:03<00:00, 2917.04it/s]
```

In [ ]:
```
def label_textblob(p):
    if p >= 0.05:
        return "Positive"
    elif p <= -0.05:
        return "Negative"
    else:
        return "Neutral"

def label_vader(s):
    if s >= 0.05:
        return "Positive"
    elif s <= -0.05:
        return "Negative"
    else:
        return "Neutral"

# 🔄 Updated column names
df_sample_pandas["textblob_label"] = df_sample_pandas["vader_polarity"].apply(
df_sample_pandas["vader_label"] = df_sample_pandas["textblob_sentiment_score"]
df_sample_pandas.head()
```

Out[ ]:

	gmap_id	customer_name	rating	reviews	tim
0	0x0:0xde4ab363e58baf8	Glen Sikorski	5	Nice clean place and very friendly staff. Only...	161996385647
1	0x145e95d513a77c99:0x7aad3c9a54c17e9f	stephen travers	5	This company helped us buy our land 15 years a...	162198309140
2	0x14e037302ebfe6bd:0x483c80e39ebb0ab7	Shawn Bebej	5	Great place for kids and families to do sports...	157814209377
3	0x14e3db41cf753ebd:0x1d6536e7c20051ef	L C	5	He was able to fit me in at the last minute. A...	161660426447
4	0x1520f8e750be33d7:0xc5e501b57143e755	Lorelei Flaherty	4	I have had good experiences here for the past ...	147707233430

5 rows × 31 columns

In [ ]:

```
from transformers import pipeline
from tqdm import tqdm

# Enable progress bar
tqdm.pandas()

# Load zero-shot classification pipeline with BART
zero_shot_classifier = pipeline("zero-shot-classification", model="facebook/ba
```

```
config.json:   0%|          | 0.00/1.15k [00:00<?, ?B/s]
Xet Storage is enabled for this repo, but the 'hf_xet' package is not installe
d. Falling back to regular HTTP download. For better performance, install the
package with: `pip install huggingface_hub[hf_xet]` or `pip install hf_xet`
WARNING:huggingface_hub.file_download:Xet Storage is enabled for this repo, bu
t the 'hf_xet' package is not installed. Falling back to regular HTTP downloa
d. For better performance, install the package with: `pip install huggingface_
hub[hf_xet]` or `pip install hf_xet`
model.safetensors:   0%|          | 0.00/1.63G [00:00<?, ?B/s]
tokenizer_config.json:   0%|          | 0.00/26.0 [00:00<?, ?B/s]
vocab.json:   0%|          | 0.00/899k [00:00<?, ?B/s]
```

```
merges.txt:   0%|          | 0.00/456k [00:00<?, ?B/s]
tokenizer.json:   0%|          | 0.00/1.36M [00:00<?, ?B/s]
Device set to use cuda:0
```

In [ ]:
```
candidate_labels = ["positive", "neutral", "negative"]

def classify_bart(text):
    try:
        result = zero_shot_classifier(text, candidate_labels)
        return result["labels"][0].capitalize()  # Most likely label
    except:
        return None  # Handle any errors gracefully
```

In [ ]:
```
df_sample_pandas["bart_label"] = df_sample_pandas["reviews"].progress_apply(cla
```

```
  0%|          | 10/10001 [00:02<22:20,  7.45it/s]You seem to be using the pip
elines sequentially on GPU. In order to maximize efficiency please use a datas
et
100%|██████████| 10001/10001 [14:47<00:00, 11.27it/s]
```

In [ ]:
```
df_sample_pandas.head()
```

Out[ ]:

	gmap_id	customer_name	rating	reviews	tim
0	0x0:0xde4ab363e58baf8	Glen Sikorski	5	Nice clean place and very friendly staff. Only...	161996385647
1	0x145e95d513a77c99:0x7aad3c9a54c17e9f	stephen travers	5	This company helped us buy our land 15 years a...	162198309140
2	0x14e037302ebfe6bd:0x483c80e39ebb0ab7	Shawn Bebej	5	Great place for kids and families to do sports...	157814209377
3	0x14e3db41cf753ebd:0x1d6536e7c20051ef	L C	5	He was able to fit me in at the last minute. A...	161660426447
4	0x1520f8e750be33d7:0xc5e501b57143e755	Lorelei Flaherty	4	I have had good experiences here for the past ...	14770723343C

5 rows × 32 columns

In [ ]:
```
import pandas as pd

# Count label frequencies per method
label_counts = pd.DataFrame({
    "TextBlob": df_sample_pandas["textblob_label"].value_counts(),
    "VADER": df_sample_pandas["vader_label"].value_counts(),
    "BART": df_sample_pandas["bart_label"].value_counts()
}).fillna(0).astype(int)

# Reorder rows for consistency
label_counts = label_counts.reindex(["Positive", "Neutral", "Negative"])
```

In [ ]:
```
# Melt into long format
df_melted = label_counts.T.reset_index().melt(
    id_vars="index", var_name="Sentiment", value_name="Count"
)
df_melted.rename(columns={"index": "Method"}, inplace=True)
```

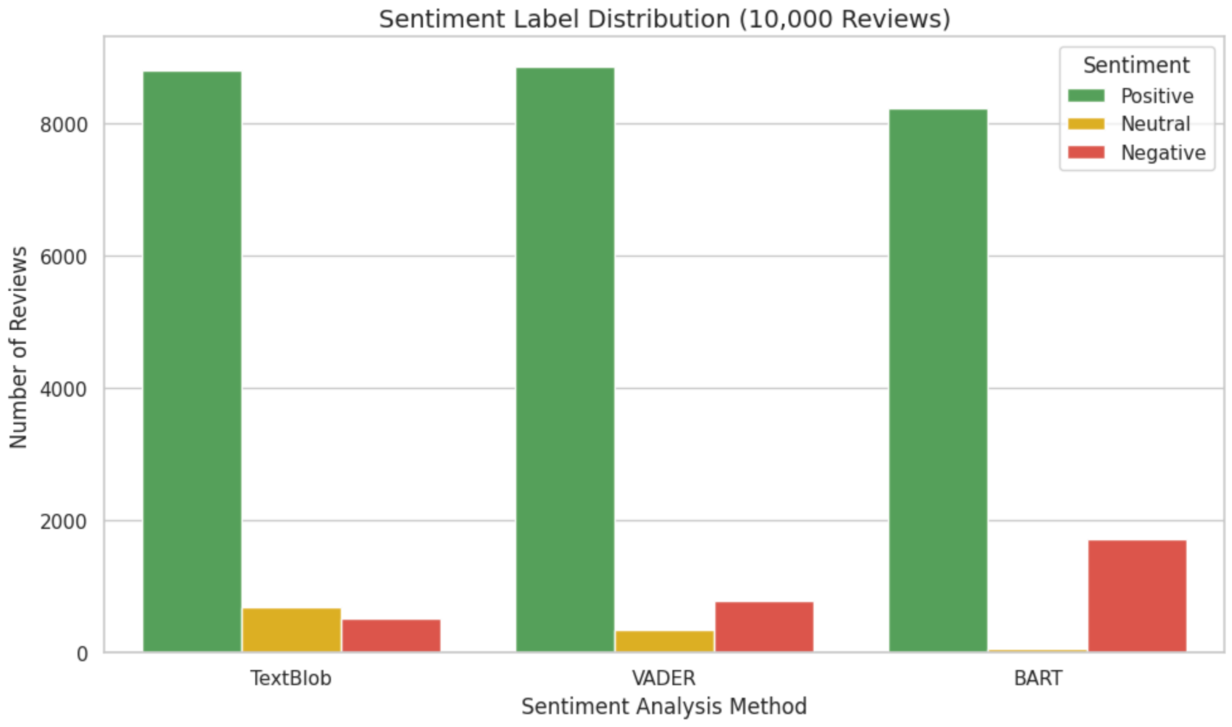
In [ ]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Set seaborn style
sns.set(style="whitegrid")

# Define consistent color palette
palette = {
    "Positive": "#4CAF50",
    "Neutral": "#FFC107",
    "Negative": "#F44336"
}

# Create grouped bar plot
plt.figure(figsize=(10, 6))
sns.barplot(
    data=df_melted,
    x="Method", y="Count", hue="Sentiment",
    palette=palette
)

# Customize the chart
plt.title("Sentiment Label Distribution (10,000 Reviews)", fontsize=14)
plt.xlabel("Sentiment Analysis Method")
plt.ylabel("Number of Reviews")
plt.legend(title="Sentiment")
plt.tight_layout()
plt.show()
```



In [ ]:
```
import json
# Change this to the name of your broken notebook
notebook_filename = "your_notebook_name.ipynb"
# Load the notebook
with open(notebook_filename, 'r', encoding='utf-8') as f:
    notebook_data = json.load(f)
# Fix metadata.widgets if missing 'state'
widgets = notebook_data.get('metadata', {}).get('widgets', {})
if 'application/vnd.jupyter.widget-state+json' in widgets:
    widget_meta = widgets['application/vnd.jupyter.widget-state+json']
    if 'state' not in widget_meta:
        widget_meta['state'] = {}
        widget_meta['version_major'] = 2
        widget_meta['version_minor'] = 0
        print(":white_check_mark: 'state' key added to metadata.widgets.")
else:
    print(":information_source: No widget metadata found or already fixed.")
# Save the fixed notebook (overwrites the original!)
with open(notebook_filename, 'w', encoding='utf-8') as f:
    json.dump(notebook_data, f, indent=2)
print(f":white_check_mark: Notebook '{notebook_filename}' fixed.")
```