Toronto Metropolitan University

2023

SENTIMENT ANALYSIS OF PRODUCTS REVIEW FOR E-COMMERCE PLATFORM

Prepared by:
Sonal Bisla

SUBMITTED TO:
DR. FARID SHIRAZI
DR. CENI BABAOGLU

TABLE OF CONTENTS

1. **Introduction** 3
2. **Data Description** 4
3. **Literature Review** 5
   - 3.1 **Introduction** 5
   - 3.1.1 **Amazon Dataset** 5
   - 3.1.2 **Twitter Dataset** 5
   - 3.1.3 **General E-commerce Platforms** 6
   - 3.1.4 **Review helpfulness and market value** 6
   - 3.1.5 **Data analytics and visualization** 7
   - 3.1.6 **Business analytics and innovation** 8
   - 3.2 **Conclusion** 8
   - 3.3 **Research paper references** 8
4. **EXPLANATORY DATA ANALYSIS (EDA)** 10
   - 4.1 **Introduction** 10
   - 4.1.1 **Data Sources** 10
   - 4.1.2 **Data Cleaning** 10
   - 4.1.3 **Data Exploration** 11
     - **UNIVARIATE ANALYSIS** 11
     - **BIVARIATE ANALYSIS** 11
     - **TEXT ANALYSIS** 11
   - 4.1.4 **INSIGHTS AND VISUALIZATIONS** 11
   - 4.1.5 **CONCLUSION** 11
5. **Methodology & Experiments** 12
   - 5.1 **Data storage and cleaning** 12
   - 5.1.1 **Experimentation with models** 12
   - 5.1.2 **Visualizations** 12
6. **Results** 13
7. **Discussion** 37
   - 7.1.1 **LEARNINGS & FUTURE WORK** 37
   - 7.1.2 **CONCLUSION** 37
8. **GITHUB REPOSITORY / CODE FILES LINK** 38
   - 8.1 **MY REPOSITORY LINK:** 38

1. INTRODUCTION

The ubiquity of e-commerce platforms has revolutionized the way businesses operate and customers shop. With this digital evolution, product reviews and ratings have emerged as powerful indicators of product performance and customer satisfaction. These reviews not only influence consumer purchase decisions but also provide businesses with invaluable insights into their product's market performance. However, the sheer volume of reviews generated on e-commerce platforms makes manual analysis a daunting task. Consequently, there is an increasing need for automated tools capable of analyzing and interpreting this rich source of information.

The proposed project, 'Sentiment Analysis of Product Reviews for E-commerce Platforms,' aims to fill this gap by implementing advanced Natural Language Processing (NLP) and deep learning techniques to automatically analyze and interpret the sentiments inherent in product reviews. The project focuses on datasets from two of the largest e-commerce platforms globally, namely Amazon and Flipkart.

The project's primary objective is to assess a product's market performance by leveraging sentiment analysis to evaluate customer reviews, ratings, and product prices. Such a methodology can provide crucial insights into customer behavior and preferences, enabling businesses to understand their product's strengths and weaknesses more effectively. In turn, this can guide strategic growth decisions, such as adjusting product prices based on consumer sentiment and competitive positioning.

Furthermore, the project addresses the research question: "How can sentiment analysis of product reviews and ratings on e-commerce platforms be used to assess products' performance?" Answering this question will not only enable manufacturers and sellers to gain a comprehensive understanding of customer perceptions but also provide a roadmap for product improvement, informed pricing strategies, and ultimately, business growth.

2. DATA DESCRIPTION

The datasets for this project are sourced from two of the most prominent e-commerce giants globally, Amazon and Flipkart. These platforms have been selected for their broad global reach, extensive product range, and the sheer volume of customer reviews they garner.

Datasets

1. **Flipkart Products Review Dataset**
   https://www.kaggle.com/datasets/mansithummar67/flipkart-product-review-dataset/discussion?select=flipkart_product.csv

   Description
   - ✓ This Dataset contains information of Products Name, Price, Review, Rate, Summary for the Sentiment Analysis Purpose.

2. **Amazon Mobile Phone Reviews Dataset**
   https://data.world/promptcloud/amazon-mobile-phone-reviews

   Description
   - ✓ This Dataset contains information of Product Title, Brand, Price, Rating, Review Text

3. LITERATURE REVIEW

3.1 INTRODUCTION

In the E-commerce platform domain, understanding consumer sentiments through product reviews is essential. Sentiment analysis or opinion mining extracts subjective information like opinions, emotions, and attitudes from text. Major platforms such as Amazon, Flipkart, and eBay rely on customer reviews to gauge product quality, features, and user satisfaction. This literature review categorizes 30 papers into six categories: “Amazon Dataset”, “Twitter Dataset”, “General E-commerce Platforms”, “Review Helpfulness and Market Value” , “Data Analytics and Visualization” , “Business Analytics and Innovation ”.

3.1.1 AMAZON DATASET

Five papers utilizing Amazon datasets for sentiment analysis were reviewed.

In the study "Deep Learning Sentiment Analysis of Amazon.com Reviews and Ratings", a deep learning model achieved 81.82% accuracy in detecting mismatched ratings by combining review and product embeddings. "Product Sentiment Analysis for Amazon Reviews" demonstrated that the BERT model excelled in predicting sentiment polarity of Amazon mobile phone reviews, with an accuracy of 94%. The research titled "Predicting online product sales via online reviews, sentiments, and promotion strategies" underscored the importance of variables such as review volume and sentiment in forecasting product sales. "HOW HELPFUL ARE COMPARATIVE REVIEWS FOR PREDICTING PRODUCT DEMAND?" found that text semantic similarity in comparative reviews held more weight than sentiment in influencing product sales. Lastly, "Model Comparison in Sentiment Analysis: A Case Study of Amazon Product Reviews" introduced the Hybrid Sequential Binary Classification (HSBC) method, outperforming other methods with an accuracy of 64.7%.

3.1.2 TWITTER DATASET

Two papers focused on Twitter sentiment analysis. Both the papers focus on sentiment analysis on Twitter data but employ different methodologies.

The paper "Big data approach for sentiment analysis of twitter data using Hadoop framework and deep learning" employed a Hadoop framework in conjunction with a deep recurrent neural network (RNN) to classify Twitter data into positive or negative sentiments with high accuracy, sensitivity, and specificity. On the other hand, "PROJECT REPORT SENTIMENT ANALYSIS ON TWITTER USING APACHE SPARK" utilized Apache Spark and the Twitter4j library to extract live tweets and perform sentiment analysis through a custom algorithm, effectively classifying tweets into positive, negative, and neutral categories.

Both methodologies present opportunities for adaptation to e-commerce product review sentiment analysis, with the first paper's deep learning approach potentially offering more accurate classification for complex

sentences, and the second paper's real-time data processing being applicable for live customer feedback analysis.

3.1.3 GENERAL E-COMMERCE PLATFORMS

Four papers explored sentiment analysis across various e-commerce platforms.

The paper "Sentiment Analysis on Reviews of E-commerce Sites Using Machine Learning Algorithms" emphasized the importance of tailored algorithms for languages like Bangla and English, with Support Vector Machine achieving high accuracy in sentiment analysis. Meanwhile, "Sentiment analysis of online product reviews based on SenBERT CNN" introduced a novel model, SenBERT CNN, which combined BERT and Convolutional Neural Network for improved performance in analyzing e-commerce reviews, particularly in extracting deeper text features. "Sentiment Analysis of Air Conditioning Users' Comments on e-Commerce Platform Based on NLP Technology" employed Natural Language Processing to analyze user comments on air conditioning products, highlighting the importance of focusing on product performance and after-sales service. Lastly, "Sentiment Analysis in E-Commerce: A Review on The Techniques and Algorithms" provided a comprehensive overview of various sentiment analysis techniques and algorithms used in e-commerce, emphasizing their potential in customer relationship management despite challenges like sarcasm and word sense disambiguation.

3.1.4 REVIEW HELPFULNESS AND MARKET VALUE

This category contains four papers focusing on review helpfulness and market value.

In "Extracting Reliability of the Products through User Reviews," researchers developed automated methods for generating reliable product rating scores through sentiment analysis and feature extraction of user reviews. "Effectiveness of Fine-tuned BERT Model in Classification of Helpful and Unhelpful Online Customer Reviews" showed that fine-tuning BERT can significantly improve the classification of helpfulness in online customer reviews. "Sentiment Analysis over Online Product Reviews: A Survey" provided an extensive overview of the techniques, challenges, and applications of sentiment analysis, emphasizing its importance in extracting insights from user-generated content. Lastly, "Impact of Positive vs. Negative e-Sentiment on Daily Market Value of High-Tech Products" revealed that negative electronic sentiment has a more significant impact on the market prices of high-tech products than positive sentiment, highlighting the importance for managers to pay close attention to negative feedback.

3.1.5 DATA ANALYTICS AND VISUALIZATION

This category contains thirteen papers focusing on different python packages, tableau tips etc for visualizing data.

The "Visualization System For Sentiment Analysis Using Textblob On Twitter" paper focuses on sentiment analysis in Bahasa Indonesia using Tweepy and TextBlob libraries, utilizing visual analytics to explore sentiment distribution geographically and achieving higher accuracies compared to SentiWordNet. Another paper, "Data Filtering and Visualization for Sentiment Analysis of Ecommerce Websites," performs sentiment analysis on customer reviews of Realme 6i, collecting and preprocessing data with UI path and Python, visualizing the results to aid in product improvement. "Visualization Resources: A Survey" provides a categorized collection of visualization resources for students, researchers, practitioners, and developers, offering recommendations as a starting point for exploration. "Sentiment Analysis, Tweet Analysis and Visualization on Big Data Using Apache Spark and Hadoop" conducts sentiment analysis on tweets using Apache Spark and Hadoop, comparing algorithms and visualizing user-related metrics with Power BI. "An Introduction to Data Visualization Tools and Techniques in Various Domains" highlights the importance of data visualization, providing an overview of techniques and practical examples for enhanced data understanding and communication. Lastly, "The State of the Art in Sentiment Visualization" surveys and categorizes sentiment visualization techniques, emphasizing evaluation and perception aspects, supporting researchers and practitioners in sentiment analysis and visualization. These papers contribute valuable insights, methodologies, and recommendations in the fields of sentiment analysis, data visualization, and related areas.

In the realm of Data Analytics & Visualization Methods, the following papers offer valuable contributions. "Exploring the Cultivation of Innovative Talents in the Era of Big Data and Cloud Computing" focuses on fostering innovation and enhancing interdisciplinary abilities through statistical and data analysis education, promoting cross integration between science and engineering. "Information Visualization: Perception for Design" delves into the science of perception and the human visual system, providing design principles to effectively convey information through well-designed visualizations. "E-commerce data analysis and visualization" investigates Pakistan's Largest E-commerce dataset to extract insights about popular categories, customer behavior analysis, and sales condition prediction to enhance business strategies. "The Use of Data Visualization in E-Commerce: A Review" critically examines data visualization in e-commerce, specifically emphasizing Clickstream data. It categorizes existing literature, summarizes visualization techniques, and offers recommendations for designers in this domain. "Survey on Sentimental Analysis and Visualization of Reviews" highlights the significance of sentiment analysis and visualization in the context of food ordering websites, exploring diverse algorithms and techniques while underscoring the importance of visualization tools. "DataSist: A Python-based library for easy data analysis, visualization, and modeling" introduces DataSist, a Python library that simplifies and automates the data analysis process, facilitating high-level functions for analyzing, mining, and visualizing large datasets. "A Study of Big Data Processing for Sentiments Analysis" delves into the tools, techniques, and technologies employed for processing big data, emphasizing sentiment analysis on social media platforms and its applications in streaming data analysis. These papers collectively contribute to the field of data analytics and visualization by providing insights into interdisciplinary education, effective information display, e-commerce analysis, sentiment analysis, and automated data analysis techniques.

3.1.6 BUSINESS ANALYTICS AND INNOVATION

This category contains two papers.

"NNBI: A Neural Network based Business Intelligence Dashboard for a Clothing Store" focuses on developing a Neural Network based Business Intelligence (NNBI) dashboard for a clothing store. It utilizes recurrent neural networks (RNN) to predict sales on a daily, monthly, and weekly basis, with Tableau as the chosen BI tool for interactive analysis and visualization. The NNBI dashboard integrates data from multiple sources, achieving high accuracy in sales forecasting and enabling effective decision-making. "Business and data analytics: New innovations in the management of e-commerce" explores innovative approaches to managing e-commerce through business and data analytics. The research covers various data types, including quantitative, qualitative, and multimedia data, and employs methods such as regression analysis, neural network analysis, and algorithm-based approaches. The studies encompass diverse areas such as customer behavior analysis, personalization systems, decision support tools, and ranking mechanisms, contributing to the understanding of data-driven strategies in e-commerce. These papers collectively contribute to the field of Business Analytics and Innovation by providing insights into predictive modeling, interactive dashboard design, and leveraging data for informed decision-making in the clothing retail industry and e-commerce management.

3.2 CONCLUSION

Sentiment analysis in e-commerce is critical for extracting insights from consumer reviews. Advanced methodologies, including deep learning and NLP techniques, have shown effectiveness in sentiment classification. While positive sentiments are important, negative sentiments significantly influence consumer decisions and market values. Additionally, real-time sentiment analysis and consideration of various languages can be beneficial. The papers reviewed form a solid foundation for further research in sentiment analysis within the e-commerce domain.

3.3 RESEARCH PAPER REFERENCES

Amazon Dataset Category

https://arxiv.org/abs/1904.04096

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3886135

https://core.ac.uk/works/8302737

https://www.researchgate.net/publication/344478746_HOW_HELPFUL_ARE_COMPARATIVE_REVIEWS_FOR_PREDICTING_PRODUCT_DEMAND

https://www.researchgate.net/publication/365491589_Model_Comparison_in_Sentiment_Analysis_A_Case_Study_of_Amazon_Product_Reviews

Twitter Dataset Category

https://www.researchgate.net/publication/340976678_Big_data_approach_for_sentiment_analysis_of_twitter_data_using_Hadoop_framework_and_deep_learning

https://www.researchgate.net/publication/320625064_PROJECT_REPORT_SENTIMENT_ANALYSIS_ON_TWITTER_USING_APACHE_SPARK

General E-commerce Platforms Category

https://www.researchgate.net/publication/360819202_Sentiment_Analysis_on_Reviews_of_E-commerce_Sites_Using_Machine_Learning_Algorithms

https://www.researchgate.net/publication/345681485_Sentiment_analysis_of_online_product_reviews_based_on_SenBERT-CNN

https://www.researchgate.net/publication/366161045_Sentiment_Analysis_of_Air_Conditioning_Users%27_Comments_on_e-Commerce_Platform_Based_on_NLP_Technology

https://www.researchgate.net/publication/339513566_Sentiment_Analysis_in_E-Commerce_A_Review_on_The_Techniques_and_Algorithms

Review Helpfulness and Market Value Category

https://www.researchgate.net/publication/277247969_Extracting_reliability_of_the_products_through_user_reviews

https://europepmc.org/article/PMC/PMC9051848

https://core.ac.uk/works/127220297?source=1&algorithmId=15&similarToDoc=17826331&similarToDocKey=CORE&recSetID=1daf429b-fb31-4b93-863a-d33aca5f77bc&position=4&recommendation_type=same_repo&otherRecs=8302737,17809015,8490770,127220297,19014509

https://www.researchgate.net/publication/267846365_Impact_of_Positive_vs_Negative_e-Sentiment_on_Daily_Market_Value_of_High-Tech_Products

Data Analytics & Visualization Category

https://www.semanticscholar.org/paper/Visualization-System-For-Sentiment-Analysis-Using-Gormantara/83a971cbea2e9699e5470733386fe6dfa84c2cab

https://www.semanticscholar.org/paper/Data-Filtering-and-Visualization-for-Sentiment-of-Keerthana-Prasannakumar/9fa1e9b3ae3481fd2bc79f6ba95a1e51d68c47dd

https://journals.sagepub.com/doi/pdf/10.1177/14738716221126992

https://iopscience.iop.org/article/10.1088/1757-899X/1099/1/012002

https://www.researchgate.net/publication/370593444_An_Introduction_to_Data_Visualization_Tools_and_Techniques_in_Various_Domains

https://www.semanticscholar.org/paper/The-State-of-the-Art-in-Sentiment-Visualization-Kucher-Paradis/2af1587a1f2b0b03e1a17d6a17cc4ef7b1d07c95

https://www.clausiuspress.com/article/5673.html

https://www.semanticscholar.org/paper/Information-Visualization%3A-Perception-for-Design-Ware/b989b192be547648594e5d7f8474f6da99ca4840

https://www.researchgate.net/profile/K-M-Zubair/publication/366020486_E-commerce_Data_Analysis_and_Visualization_using_Random_Forest_Regression_and_Prophet_model/links/638e4f7e095a6a777406cbb7/E-commerce-Data-Analysis-and-Visualization-using-Random-Forest-Regression-and-Prophet-model.pdf

https://www.cs.ubc.ca/~tmm/courses/547-22/projects/yaman/report.pdf

https://www.researchgate.net/profile/Gajanan-Bhole/publication/362517195_Survey_on_Sentimental_Analysis_and_Visualization_of_Reviews/links/62ededc70b37cc344774b211/Survey-on-Sentimental-Analysis-and-Visualization-of-Reviews.pdf

https://arxiv.org/abs/1911.03655

https://www.researchgate.net/profile/Hari-Rawat/publication/348118082_A_Study_of_Big_Data_Processing_for_Sentiments_Analysis/links/614980233c6cb310697fe0db/A-Study-of-Big-Data-Processing-for-Sentiments-Analysis.pdf

Business Analytics and Innovation Category

https://jisrc.szabist.edu.pk/ojs/index.php/jisrc/article/view/10/8

https://ink.library.smu.edu.sg/sis_research/1752/

4. EXPLANATORY DATA ANALYSIS (EDA)

4.1 INTRODUCTION

This EDA aims to conduct a preliminary assessment on datasets of customer reviews and ratings of products from e-commerce platforms. Through sentiment analysis, the performance of products can be gauged by analyzing customer reviews, ratings, and prices. This allows businesses to understand their product's strengths and weaknesses and make strategic decisions for improvement and growth.

4.1.1 DATA SOURCES

1. Flipkart Products Review Dataset
    - Source: Kaggle
    - Features: Product Name, Price, Rating, Review, Summary
      Link to dataset
2. Amazon Mobile Phone Reviews Dataset
    - Source: data. World
    - Features: Product Title, Brand, Price, Rating, Review Text, Review Votes
      Link to dataset

4.1.2 DATA CLEANING

Data cleaning is an essential step to ensure the quality and reliability of the data. During this step:

1. Remove any duplicates and irrelevant data.
2. Handle missing values by imputation or removal.
3. Clean text data by removing punctuations, converting to lowercase, etc.

4.1.3 DATA EXPLORATION

UNIVARIATE ANALYSIS

1. **Distribution of Ratings**: Create pie chart to display the distribution of ratings.
2. **Price Distribution**: Utilize box plots to visualize the distribution of prices for the products.

BIVARIATE ANALYSIS

1. **Ratings vs. Price**: Explore the correlation between product prices and their respective average ratings using scatter plots.
2. **Sentiment vs. Rating**: Perform sentiment analysis on the reviews and explore its relationship with ratings. Use heatmap to represent the proportion of positive, negative, and neutral sentiments for different rating groups.

TEXT ANALYSIS

1. **Word Cloud**: Generate word clouds for positive and negative reviews to identify common words in each category.

4.1.4 INSIGHTS AND VISUALIZATIONS

1. Use Tableau or Python libraries (such as seaborn and matplotlib) for visualizing the patterns and trends in the data.
2. Present the distribution of ratings and how it correlates with price, along with a breakdown by brand. This helps in identifying if more expensive products or certain brands receive higher ratings.
3. Analyze and visualize the sentiments expressed in the review texts, how they relate to the product ratings, and their impact on review votes.
4. Present the results of keyword analysis and topic modeling to summarize the main concerns or praises in the reviews, and how these topics might affect product sentiment.
5. Visualize the aggregated sentiment scores by product and brand and analyze how they can impact market performance.

4.1.5 CONCLUSION

The EDA will provide insights into the customer reviews and ratings for products on e-commerce platforms. These insights will help businesses understand customer perceptions, which is valuable for product enhancement and pricing strategies. This preliminary analysis sets the foundation for further in-depth analysis and modeling.

5.METHODOLOGY & EXPERIMENTS

5.1 DATA STORAGE AND CLEANING

For managing and processing our large datasets, we utilize Apache Hadoop, an open-source software framework that allows for distributed processing of large data sets across clusters of computers. Given the scale of data from Amazon and Flipkart, Hadoop's ability to scale from a single server to thousands of machines, each offering local computation and storage, is crucial.

To assist in the cleaning and pre-processing of our data, we use PySpark, the Python library for Apache Spark. PySpark is a powerful tool for handling large-scale data in a distributed fashion and provides a variety of functionalities for data transformation, making it a suitable tool for preparing our datasets for further analysis.

5.1.1 EXPERIMENTATION WITH MODELS

Python, known for its simplicity, readability, and the availability of powerful data manipulation and machine learning libraries, is our language of choice for model experimentation and prediction tasks.

To accomplish sentiment analysis, we utilize Recurrent Neural Networks (RNNs) and Convolutional Neural Networks (CNNs), both types of deep learning models. RNNs' strength lies in their ability to analyze sequential data, like sentences, making them ideal for our project's sentiment analysis. While CNNs are traditionally used for image processing, their application to text data allows us to capture local semantic features, thus enhancing the performance of our sentiment analysis.

In addition, we leverage Transformer models, like BERT, which have revolutionized natural language processing. Transformer models can capture more complex patterns in text data compared to traditional methods, leading to improved performance in tasks such as sentiment analysis.

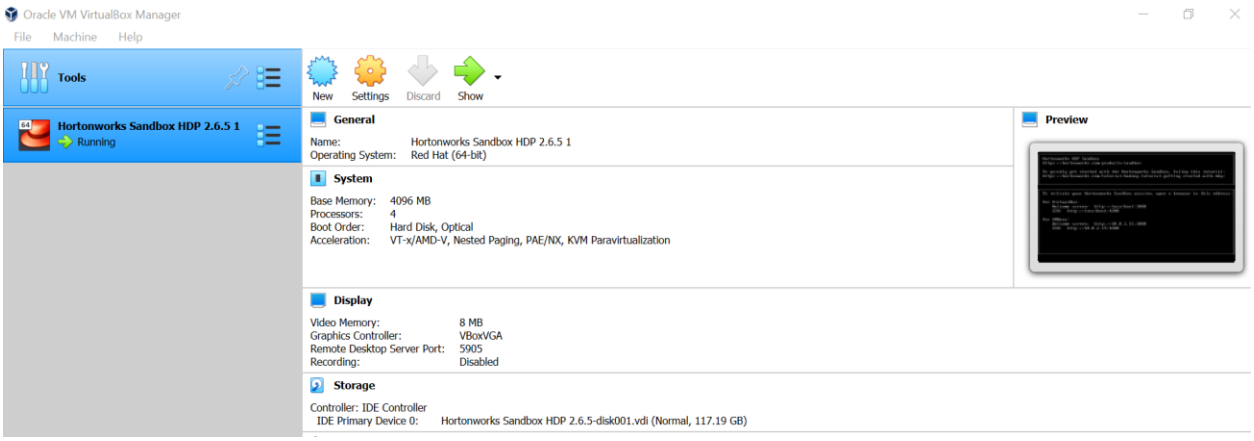
5.1.2 VISUALIZATIONS

We employ Python libraries such as matplotlib, seaborn, and plotly for creating comprehensive data visualizations. These libraries enable us to create histograms, bar plots, scatter plots, etc., helping us visualize the distribution of sentiments and correlations between different variables effectively.

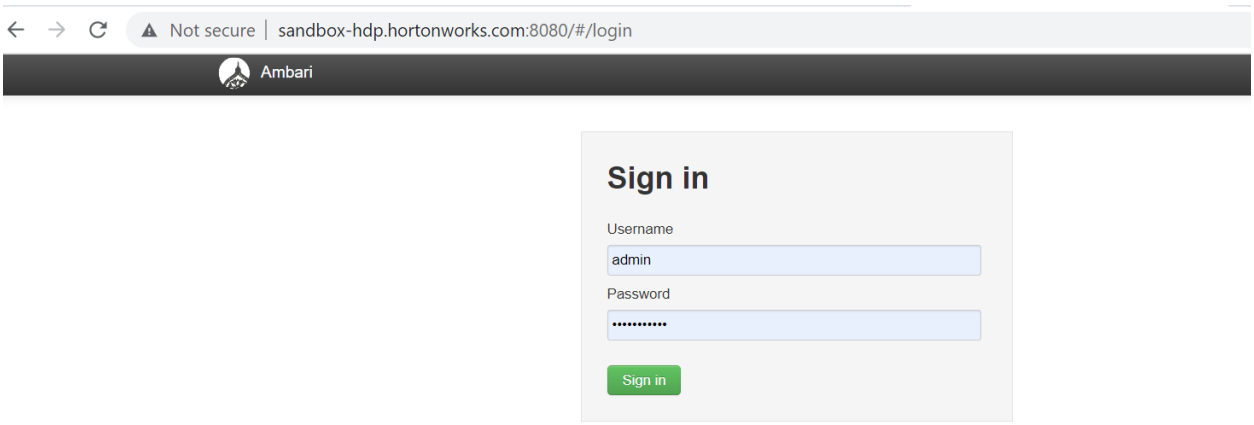
Further, we use Tableau, a robust data visualization tool, to create interactive dashboards and reports. Tableau allows for the visualization of sentiment scores for different products and the observation of trends over time, offering a more interactive and intuitive understanding of our findings.

6. RESULTS

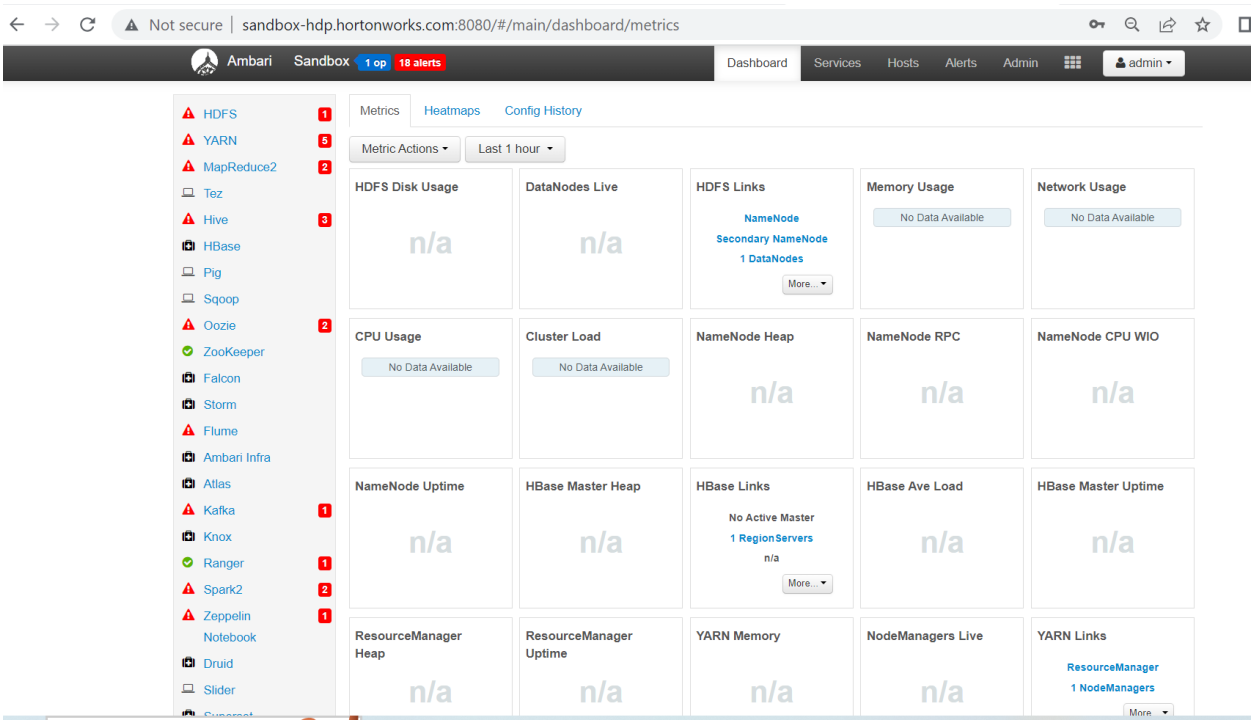
Data cleaning task using Hadoop and PySpark.



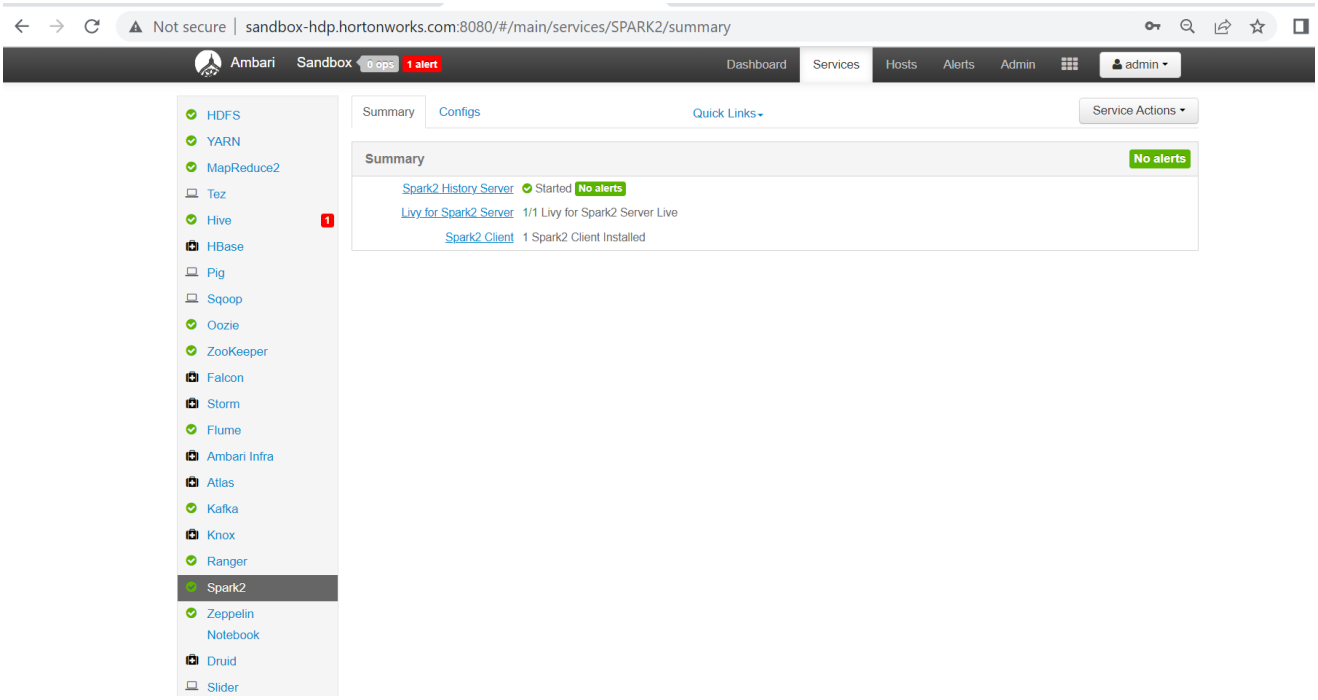
Run the virtual box first. VirtualBox allows you to create isolated, reproducible environments for Hadoop development and testing, and simulate multi-node clusters on a single machine.



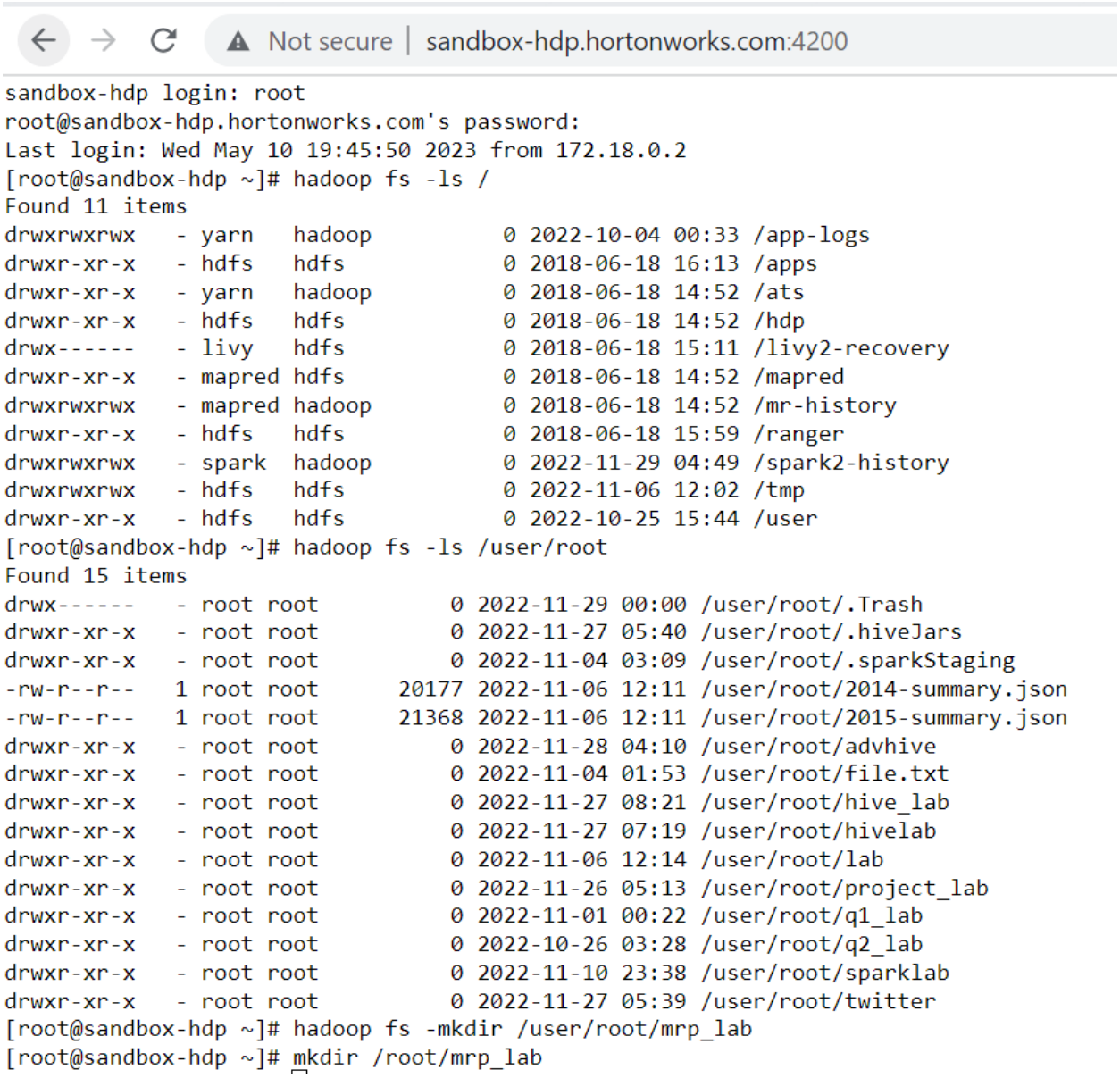
Start the services on Ambari using the browser link http://sandbox-hdp.hortonworks.com:8080/#/login



Services are in red alert, that means not started yet.



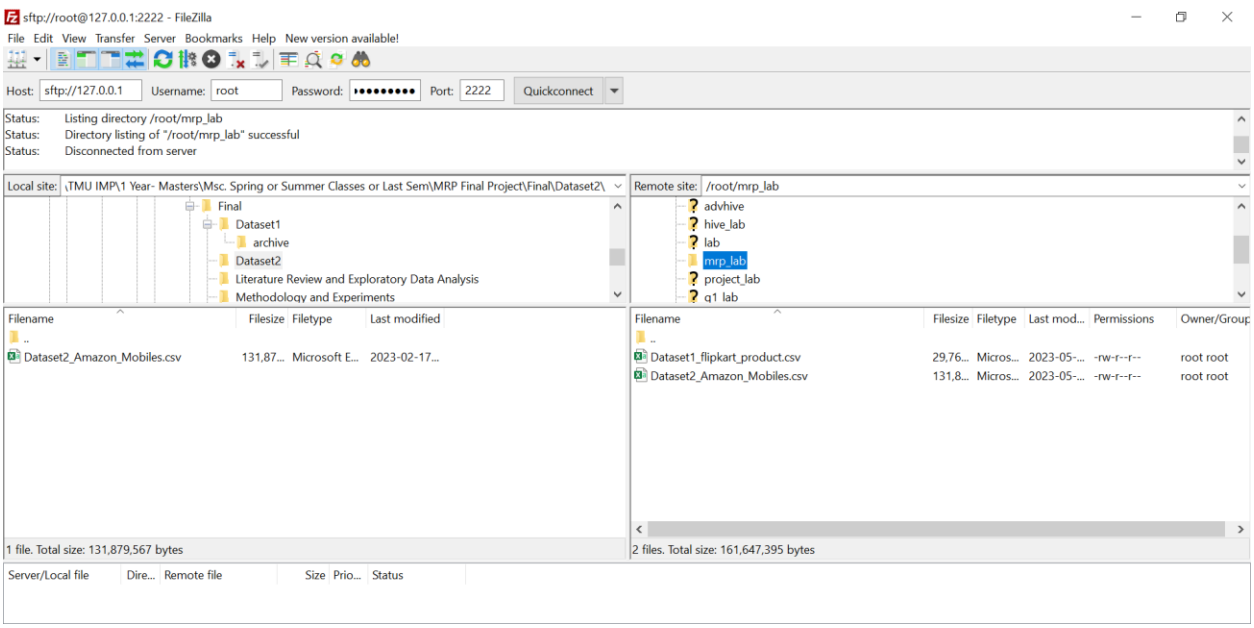
Services on Ambari started successfully.



Login to HDP sandbox using the browser link **http://sandbox-hdp.hortonworks.com:4200/**. I checked the list of all the directories/data that is present at the location /user/root. Then, I made the directory using 'mkdir' on local system and 'Hadoop fs -mkdir' for making directory in hdfs.

```
[root@sandbox-hdp ~]# hadoop fs -ls /user/root
Found 16 items
drwx------   - root root          0 2022-11-29 00:00 /user/root/.Trash
drwxr-xr-x   - root root          0 2022-11-27 05:40 /user/root/.hiveJars
drwxr-xr-x   - root root          0 2022-11-04 03:09 /user/root/.sparkStaging
-rw-r--r--   1 root root      20177 2022-11-06 12:11 /user/root/2014-summary.json
-rw-r--r--   1 root root      21368 2022-11-06 12:11 /user/root/2015-summary.json
drwxr-xr-x   - root root          0 2022-11-28 04:10 /user/root/advhive
drwxr-xr-x   - root root          0 2022-11-04 01:53 /user/root/file.txt
drwxr-xr-x   - root root          0 2022-11-27 08:21 /user/root/hive_lab
drwxr-xr-x   - root root          0 2022-11-27 07:19 /user/root/hivelab
drwxr-xr-x   - root root          0 2022-11-06 12:14 /user/root/lab
drwxr-xr-x   - root root          0 2023-05-10 19:58 /user/root/mrp_lab
drwxr-xr-x   - root root          0 2022-11-26 05:13 /user/root/project_lab
drwxr-xr-x   - root root          0 2022-11-01 00:22 /user/root/q1_lab
drwxr-xr-x   - root root          0 2022-10-26 03:28 /user/root/q2_lab
drwxr-xr-x   - root root          0 2022-11-10 23:38 /user/root/sparklab
drwxr-xr-x   - root root          0 2022-11-27 05:39 /user/root/twitter
```

Directory created successfully with the name /mrp_lab



Login to FileZilla and check if the directory created already. I now transferred/drag and dropped the desired files (Dataset1_flipkart_product.csv, Dataset2_Amazon_Mobiles.csv) into the remote site directory ‘mrp_lab’

Host: sftp://127.0.0.1

Username: root

*Password: *******

Port: 2222

```
[root@sandbox-hdp ~]# cd /root/mrp_lab
[root@sandbox-hdp mrp_lab]# hadoop fs -put Dataset1_flipkart_product.csv /user/root/mrp_lab
[root@sandbox-hdp mrp_lab]# hadoop fs -put Dataset2_Amazon_Mobiles.csv /user/root/mrp_lab
[root@sandbox-hdp mrp_lab]# hadoop fs -ls /user/root/mrp_lab
Found 2 items
-rw-r--r--   1 root root   29767828 2023-05-10 20:18 /user/root/mrp_lab/Dataset1_flipkart_product.csv
-rw-r--r--   1 root root  131879567 2023-05-10 20:20 /user/root/mrp_lab/Dataset2_Amazon_Mobiles.csv
```

Now in this step, I changed the directory so that I can go to mrp_lab folder. Once I enter to that directory/folder. I then copied the files from local system to hdfs using put command while the get command performs the visa-versa operation on the files.

```
[root@sandbox-hdp ~]# pyspark
SPARK_MAJOR_VERSION is set to 2, using Spark2
Python 2.7.5 (default, Apr 11 2018, 07:36:10)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-28)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 2.3.0.2.6.5.0-292
      /_/

Using Python version 2.7.5 (default, Apr 11 2018 07:36:10)
SparkSession available as 'spark'.
```

Here in the above snapshot, we can see that by typing the pyspark, it landed me to the spark session where I can start typing my pyspark commands to get the desired outputs.

```
>>> from pyspark.sql import SparkSession
>>> from pyspark.sql.functions import col
>>> spark=SparkSession.builder \
...     .appName("Sentiment Analysis") \
...     .getOrCreate()
>>> flipkart_df=spark.read \
...      .format("com.databricks.spark.csv") \
...      .option("header","true") \
...      .option("inferSchema","true") \
...      .load("hdfs:///user/root/mrp_lab/Dataset1_flipkart_product.csv")
>>> amazon_df=spark.read \
...     .format("com.databricks.spark.csv") \
...     .option("header","true") \
...     .option("inferSchema","true") \
...     .load("hdfs:///user/root/mrp_lab/Dataset2_Amazon_Mobiles.csv")

>>> flipkart_df.show()
+--------------------+--------+----+--------------------+--------------------+
|         ProductName|   Price|Rate|              Review|             Summary|
+--------------------+--------+----+--------------------+--------------------+
|Candes 12 L Room/...|₹3,999  |   5|               Super!|Great cooler.. ex...|
|Candes 12 L Room/...|₹3,999  |   5|             Awesome|Best budget 2 fit...|
|Candes 12 L Room/...|₹3,999  |   3|                Fair|The quality is go...|
|Candes 12 L Room/...|₹3,999  |   1|     Useless product|Very bad product ...|
|Candes 12 L Room/...|₹3,999  |   3|                Fair|       Ok ok product|
|Candes 12 L Room/...|₹3,999  |   5|             Awesome|The cooler is rea...|
|Candes 12 L Room/...|₹3,999  |   5|  Highly recommended|   Very good product|
|Candes 12 L Room/...|₹3,999  |   3|                Nice|           Very nice|
|Candes 12 L Room/...|₹3,999  |   1|      Unsatisfactory|     Very bad cooler|
|Candes 12 L Room/...|₹3,999  |   4|     Worth the money|           Very good|
|Candes 60 L Room/...|₹8,999  |   5|       Great product|Beautiful product...|
|Candes 60 L Room/...|₹8,999  |   5|Mind-blowing purc...|             Awesome|
|Candes 60 L Room/...|₹8,999  |   5|  Highly recommended|                Good|
|Candes 60 L Room/...|₹8,999  |   5|           Brilliant|Wonderful product...|
|Candes 60 L Room/...|₹8,999  |   5|      Classy product|Nice air cooler, ...|
|Candes 60 L Room/...|₹8,999  |   5|           Must buy!|                Awsm|
|Candes 60 L Room/...|₹8,999  |   5|           Fabulous!|   Nice product ???₹|
|Candes 60 L Room/...|₹8,999  |   5|   Worth every penny|      Great cooler..|
|Candes 60 L Room/...|₹8,999  |   5|              Super!|        Nice product|
|Candes 60 L Room/...|₹8,999  |   5|       Great product|           Good ???₹|
+--------------------+--------+----+--------------------+--------------------+
only showing top 20 rows
```

```
>>> amazon_df.show()
+--------------------+----------+------+------+--------------------+------------+
|        Product Name|Brand Name| Price|Rating|             Reviews|Review Votes|
+--------------------+----------+------+------+--------------------+------------+
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|I feel so LUCKY t...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|nice phone, nice ...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|        Very pleased|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|It works good but...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|Great phone to re...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     1|I already had a p...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     2|The charging port...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     2|Phone looks good ...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|I originally was ...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     3|It's battery life...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     3|My fiance had thi...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|This is a great p...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|These guys are th...|           2|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     1|I'm really disapp...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|Ordered this phon...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     2|Had this phone be...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|I was able to get...|           6|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|I brought this ph...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|I love the phone....|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     3|unfortunately Spr...|           0|
+--------------------+----------+------+------+--------------------+------------+
only showing top 20 rows


>>> flipkart_df=flipkart_df.dropna()
>>> amazon_df=amazon_df.dropna()
>>> from pyspark.sql.functions import regexp_replace
>>> flipkart_df=flipkart_df,withColumn('Review',regexp_replace(col('Review'),'[^a-zA-Z0-9\s]',''))
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'withColumn' is not defined
>>> flipkart_df=flipkart_df.withColumn('Review',regexp_replace(col('Review'),'[^a-zA-Z0-9\s]',''))
>>> amazon_df=amazon_df.withColumn('Reviews',regexp_replace(col('Reviews'),'[^a-zA-Z0-9\s]',''))
>>> flipkart_df=flipkart_df.filter(~col('Review').contains('??'))
>>> amazon_df=amazon_df.filter(~col('Reviews').conatins('??'))
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'Column' object is not callable
>>> amazon_df=amazon_df.filter(~col('Reviews').contains('??'))
>>> from pyspark.sql.functions import lower
>>> flipkart_df=flipkart_df.withColumn('Review',lower(col('Review')))
>>> amazon_df=amazon_df.withColumn('Reviews',lower(col('Reviews')))
>>> from pyspark.sql.functions import regexp_replace,col
>>> for column in flipkart_df.columns:
...     flipkart_df=flipkart_df.withColumn(column,regexp_replace(col(column),'','??'))
...
```

```
>>> flipkart_df.show()
+--------------------+---------+----+--------------------+--------------------+
|         ProductName|    Price|Rate|              Review|             Summary|
+--------------------+---------+----+--------------------+--------------------+
|Candes 12 L Room/...|????3,999|   5|               super|Great cooler.. ex...|
|Candes 12 L Room/...|????3,999|   5|             awesome|Best budget 2 fit...|
|Candes 12 L Room/...|????3,999|   3|                fair|The quality is go...|
|Candes 12 L Room/...|????3,999|   1|     useless product|Very bad product ...|
|Candes 12 L Room/...|????3,999|   3|                fair|       Ok ok product|
|Candes 12 L Room/...|????3,999|   5|             awesome|The cooler is rea...|
|Candes 12 L Room/...|????3,999|   5|  highly recommended|   Very good product|
|Candes 12 L Room/...|????3,999|   3|                nice|           Very nice|
|Candes 12 L Room/...|????3,999|   1|      unsatisfactory|     Very bad cooler|
|Candes 12 L Room/...|????3,999|   4|     worth the money|           Very good|
|Candes 60 L Room/...|????8,999|   5|       great product|Beautiful product...|
|Candes 60 L Room/...|????8,999|   5|mindblowing purchase|             Awesome|
|Candes 60 L Room/...|????8,999|   5|  highly recommended|                Good|
|Candes 60 L Room/...|????8,999|   5|           brilliant|Wonderful product...|
|Candes 60 L Room/...|????8,999|   5|      classy product|Nice air cooler, ...|
|Candes 60 L Room/...|????8,999|   5|            must buy|                Awsm|
|Candes 60 L Room/...|????8,999|   5|            fabulous|  Nice product ?????|
|Candes 60 L Room/...|????8,999|   5|   worth every penny|      Great cooler..|
|Candes 60 L Room/...|????8,999|   5|               super|        Nice product|
|Candes 60 L Room/...|????8,999|   5|       great product|          Good ?????|
+--------------------+---------+----+--------------------+--------------------+
only showing top 20 rows


>>> flipkart_df=flipkart_df.withColumn('Price',regexp_replace(col('Price'),'\?+',''))
>>> flipkart_df=flipkart_df.withColumn('Summary',regexp_replace(col('Summary'),'\x00$',''))

>>> flipkart_df.show()
+--------------------+-----+----+--------------------+--------------------+
|         ProductName|Price|Rate|              Review|             Summary|
+--------------------+-----+----+--------------------+--------------------+
|Candes 12 L Room/...|3,999|   5|               super|Great cooler.. ex...|
|Candes 12 L Room/...|3,999|   5|             awesome|Best budget 2 fit...|
|Candes 12 L Room/...|3,999|   3|                fair|The quality is go...|
|Candes 12 L Room/...|3,999|   1|     useless product|Very bad product ...|
|Candes 12 L Room/...|3,999|   3|                fair|       Ok ok product|
|Candes 12 L Room/...|3,999|   5|             awesome|The cooler is rea...|
|Candes 12 L Room/...|3,999|   5|  highly recommended|   Very good product|
|Candes 12 L Room/...|3,999|   3|                nice|           Very nice|
|Candes 12 L Room/...|3,999|   1|      unsatisfactory|     Very bad cooler|
|Candes 12 L Room/...|3,999|   4|     worth the money|           Very good|
|Candes 60 L Room/...|8,999|   5|       great product|Beautiful product...|
|Candes 60 L Room/...|8,999|   5|mindblowing purchase|             Awesome|
|Candes 60 L Room/...|8,999|   5|  highly recommended|                Good|
|Candes 60 L Room/...|8,999|   5|           brilliant|Wonderful product...|
|Candes 60 L Room/...|8,999|   5|      classy product|Nice air cooler, ...|
|Candes 60 L Room/...|8,999|   5|            must buy|                Awsm|
|Candes 60 L Room/...|8,999|   5|            fabulous|  Nice product ?????|
|Candes 60 L Room/...|8,999|   5|   worth every penny|      Great cooler..|
|Candes 60 L Room/...|8,999|   5|               super|        Nice product|
|Candes 60 L Room/...|8,999|   5|       great product|          Good ?????|
+--------------------+-----+----+--------------------+--------------------+
only showing top 20 rows
```

```
>>> amazon_df.show()
+--------------------+----------+------+------+--------------------+------------+
|        Product Name|Brand Name| Price|Rating|             Reviews|Review Votes|
+--------------------+----------+------+------+--------------------+------------+
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|i feel so lucky t...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|nice phone nice u...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|        very pleased|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|it works good but...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|great phone to re...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     1|i already had a p...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     2|the charging port...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     2|phone looks good ...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|i originally was ...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     3|its battery life ...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     3|my fiance had thi...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|this is a great p...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     1|im really disappo...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|ordered this phon...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     2|had this phone be...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|i was able to get...|           6|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     5|i brought this ph...|           0|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     4|i love the phone ...|           1|
|"""CLEAR CLEAN ES...|   Samsung|199.99|     3|unfortunately spr...|           0|
+--------------------+----------+------+------+--------------------+------------+
only showing top 20 rows

>>> flipkart_df.write.csv('/user/root/mrp_lab/flipkart_data.csv', header=True)
>>> amazon_df.write.csv('/user/root/mrp_lab/amazon_data.csv', header=True)
```

Wrote DataFrame to HDFS

```
[root@sandbox-hdp ~]# hadoop fs -ls /user/root/mrp_lab
Found 4 items
-rw-r--r--   1 root root   29767828 2023-05-10 20:18 /user/root/mrp_lab/Dataset1_flipkart_product.csv
-rw-r--r--   1 root root  131879567 2023-05-10 20:20 /user/root/mrp_lab/Dataset2_Amazon_Mobiles.csv
drwxr-xr-x   - root root          0 2023-05-20 09:38 /user/root/mrp_lab/amazon_data.csv
drwxr-xr-x   - root root          0 2023-05-20 09:37 /user/root/mrp_lab/flipkart_data.csv
[root@sandbox-hdp ~]#
```

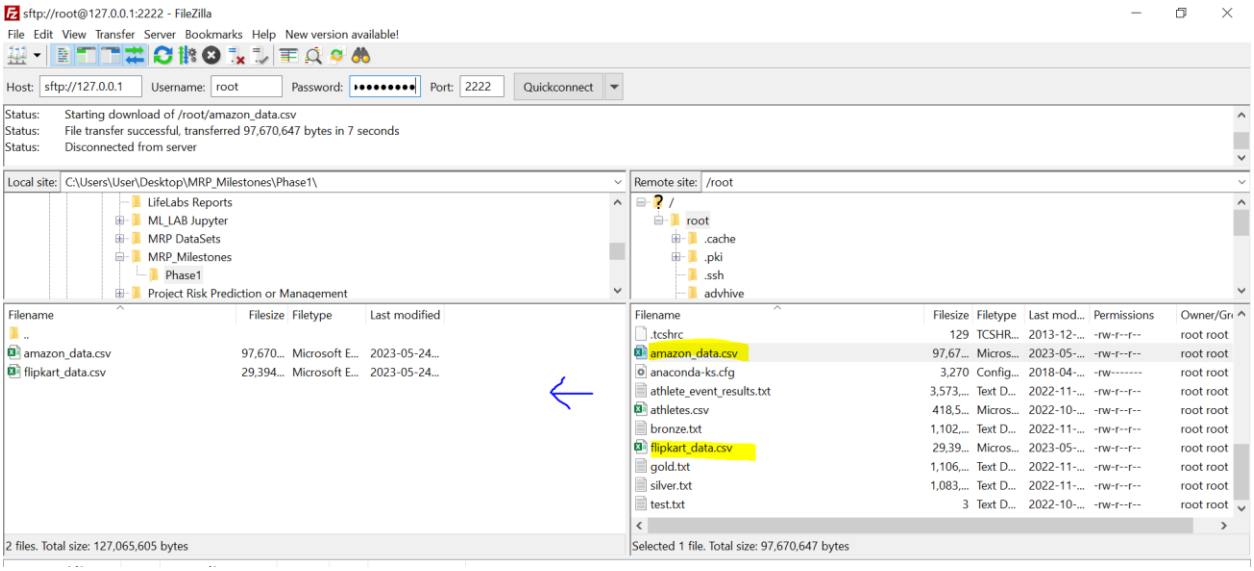
```
[root@sandbox-hdp ~]# hadoop fs -getmerge /user/root/mrp_lab/flipkart_data.csv /C:/Users/User/Desktop/MRP_Milestones/flipkart_data.csv
[root@sandbox-hdp ~]# hadoop fs -getmerge /user/root/mrp_lab/amazon_data.csv /C:/Users/User/Desktop/MRP_Milestones/amazon_data.csv
[root@sandbox-hdp ~]#
```

Then, used the command hadoop fs -getmerge to merge and download the .csv file to my local machine

```
[root@sandbox-hdp ~]#  hadoop fs -getmerge /user/root/mrp_lab/flipkart_data.csv /root/flipkart_data.csv
[root@sandbox-hdp ~]#  hadoop fs -getmerge /user/root/mrp_lab/amazon_data.csv /root/amazon_data.csv

[root@sandbox-hdp ~]# hadoop fs -getmerge /user/root/mrp_lab/flipkart_data.csv /tmp/flipkart_data.csv
[root@sandbox-hdp ~]# hadoop fs -getmerge /user/root/mrp_lab/amazon_data.csv /tmp/amazon_data.csv
```

Downloaded the files to the local file system on the server. The paths are now Unix-style and point to the server's local file system.



Now I have the files on my server's local file system (/tmp/flipkart_data.csv and /tmp/amazon_data.csv). The next step is to get these files to my local Windows machine. For this, I need to use a different tool, because Hadoop's get merge command can't transfer files from the server to my local Windows machine. Hence Used FileZilla tool to transfer the cleaned data files.

Experimentation with Models

RNN_Amazon

```
[8] # Evaluate the model on the test set
    loss, accuracy = model.evaluate(X_test, y_test)
    print(f"Test Loss: {loss}")
    print(f"Test Accuracy: {accuracy}")
```

```
Epoch 1/5
230/230 [==============================] - 23s 91ms/step - loss: 0.6182 - accuracy: 0.7477 - val_loss: 0.4140 - val_accuracy: 0.8468
Epoch 2/5
230/230 [==============================] - 22s 95ms/step - loss: 0.2250 - accuracy: 0.9286 - val_loss: 0.2815 - val_accuracy: 0.9064
Epoch 3/5
230/230 [==============================] - 21s 91ms/step - loss: 0.0926 - accuracy: 0.9735 - val_loss: 0.3165 - val_accuracy: 0.9078
Epoch 4/5
230/230 [==============================] - 22s 96ms/step - loss: 0.0589 - accuracy: 0.9842 - val_loss: 0.3201 - val_accuracy: 0.9119
Epoch 5/5
230/230 [==============================] - 20s 89ms/step - loss: 0.0911 - accuracy: 0.9720 - val_loss: 0.3630 - val_accuracy: 0.9026
115/115 [==============================] - 2s 14ms/step - loss: 0.3630 - accuracy: 0.9026
Test Loss: 0.3629966378211975
Test Accuracy: 0.9026115536689758
```

RNN_Flipkart

```
+ Code + Text                                                    RAM Disk

[5] # Evaluate the model on the test set
    loss, accuracy = model.evaluate(X_test, y_test)
    print(f"Test Loss: {loss}")
    print(f"Test Accuracy: {accuracy}")
```

```
Epoch 1/5
2373/2373 [==============================] - 205s 86ms/step - loss: 0.1576 - accuracy: 0.9512 - val_loss: 0.1155 - val_accuracy: 0.9652
Epoch 2/5
2373/2373 [==============================] - 211s 89ms/step - loss: 0.1087 - accuracy: 0.9673 - val_loss: 0.2258 - val_accuracy: 0.9253
Epoch 3/5
2373/2373 [==============================] - 213s 90ms/step - loss: 0.1083 - accuracy: 0.9674 - val_loss: 0.1138 - val_accuracy: 0.9674
Epoch 4/5
2373/2373 [==============================] - 228s 96ms/step - loss: 0.0939 - accuracy: 0.9710 - val_loss: 0.1095 - val_accuracy: 0.9682
Epoch 5/5
2373/2373 [==============================] - 228s 96ms/step - loss: 0.0746 - accuracy: 0.9769 - val_loss: 0.1098 - val_accuracy: 0.9682
1187/1187 [==============================] - 18s 15ms/step - loss: 0.1098 - accuracy: 0.9682
Test Loss: 0.10982637107372284
Test Accuracy: 0.9681565761566162
```

CNN_Amazon

```
[4] print(f"Test Loss: {loss}")
    print(f"Test Accuracy: {accuracy}")
```

```
[2 2 2 ... 2 2 2]
Epoch 1/5
230/230 [==============================] - 49s 164ms/step - loss: 0.5300 - accuracy: 0.7932 - val_loss: 0.3
Epoch 2/5
230/230 [==============================] - 16s 69ms/step - loss: 0.2229 - accuracy: 0.9287 - val_loss: 0.27
Epoch 3/5
230/230 [==============================] - 8s 33ms/step - loss: 0.1261 - accuracy: 0.9627 - val_loss: 0.253
Epoch 4/5
230/230 [==============================] - 8s 33ms/step - loss: 0.0742 - accuracy: 0.9814 - val_loss: 0.265
Epoch 5/5
230/230 [==============================] - 5s 22ms/step - loss: 0.0495 - accuracy: 0.9874 - val_loss: 0.279
115/115 [==============================] - 0s 3ms/step - loss: 0.2792 - accuracy: 0.9287
Test Loss: 0.27921703457832336
Test Accuracy: 0.928726851940155
```

CNN_Flipkart

```
+ Code + Text                                                    T4
[5] # Evaluate the model on the test set
    loss, accuracy = model.evaluate(X_test, y_test)
    print(f"Test Loss: {loss}")
    print(f"Test Accuracy: {accuracy}")
```

```
[2 2 2 ... 2 2 2]
Epoch 1/5
2373/2373 [==============================] - 84s 30ms/step - loss: 0.1146 - accuracy: 0.9633 - val_loss: 0.0870 - val_accuracy: 0.9718
Epoch 2/5
2373/2373 [==============================] - 20s 9ms/step - loss: 0.0720 - accuracy: 0.9772 - val_loss: 0.0819 - val_accuracy: 0.9742
Epoch 3/5
2373/2373 [==============================] - 22s 9ms/step - loss: 0.0541 - accuracy: 0.9829 - val_loss: 0.0853 - val_accuracy: 0.9734
Epoch 4/5
2373/2373 [==============================] - 19s 8ms/step - loss: 0.0411 - accuracy: 0.9872 - val_loss: 0.0955 - val_accuracy: 0.9726
Epoch 5/5
2373/2373 [==============================] - 19s 8ms/step - loss: 0.0322 - accuracy: 0.9902 - val_loss: 0.1021 - val_accuracy: 0.9723
1187/1187 [==============================] - 5s 4ms/step - loss: 0.1021 - accuracy: 0.9723
Test Loss: 0.10205527395009995
Test Accuracy: 0.9722917079925537
```

BERT_Amazon

+ Code + Text

```
[ ] print(classification_report(y_test, y_pred, target_names=class_names))
```

	precision	recall	f1-score	support
positive	0.93	0.93	0.93	368
negative	0.96	0.95	0.96	249
neutral	0.98	0.98	0.98	1218
accuracy			0.97	1835
macro avg	0.96	0.96	0.96	1835
weighted avg	0.97	0.97	0.97	1835

BERT_Flipkart

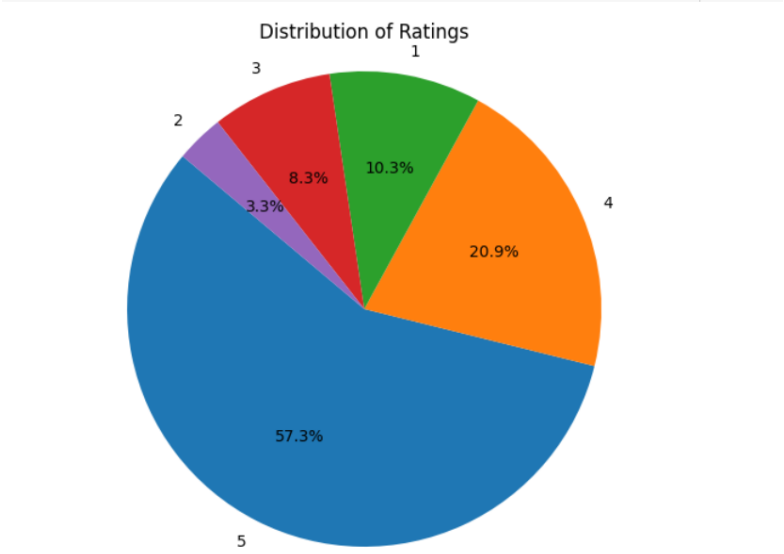
```
[49] print(classification_report(y_test, y_pred, target_names=class_names))
```

	precision	recall	f1-score	support
positive	0.94	0.95	0.94	280
negative	0.80	0.81	0.80	48
neutral	0.99	0.99	0.99	1672
accuracy			0.98	2000
macro avg	0.91	0.92	0.91	2000
weighted avg	0.98	0.98	0.98	2000

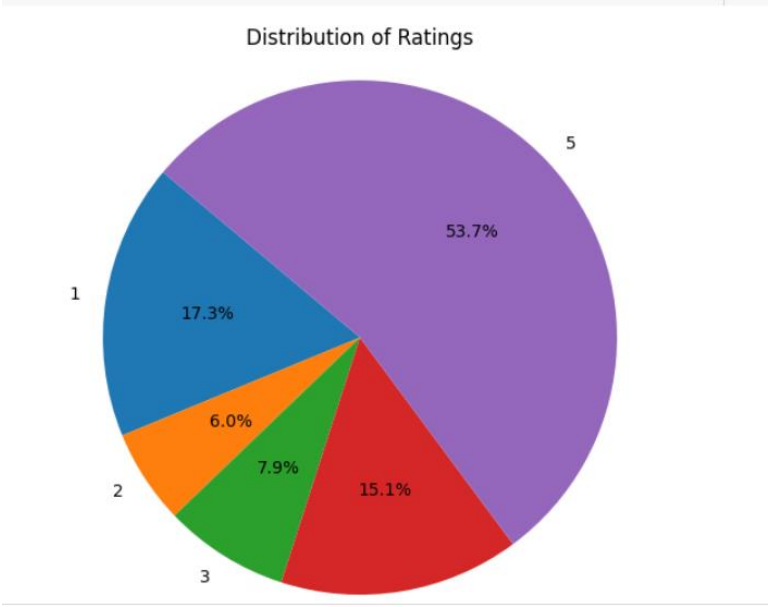
Visualizations:

1) UNIVARIATE ANALYSIS:

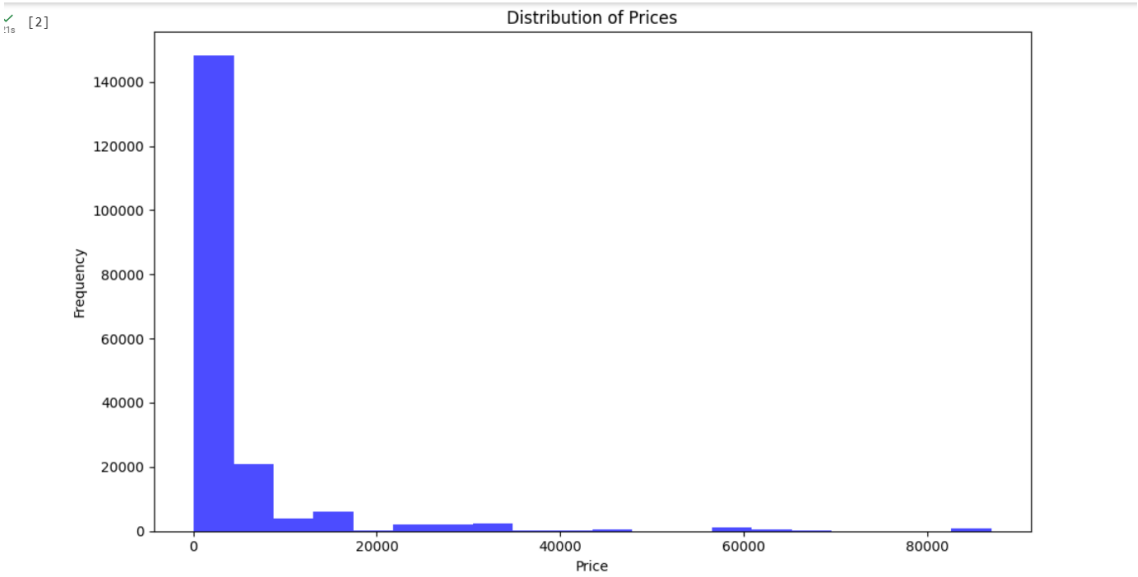
Rating Distribution: Flipkart



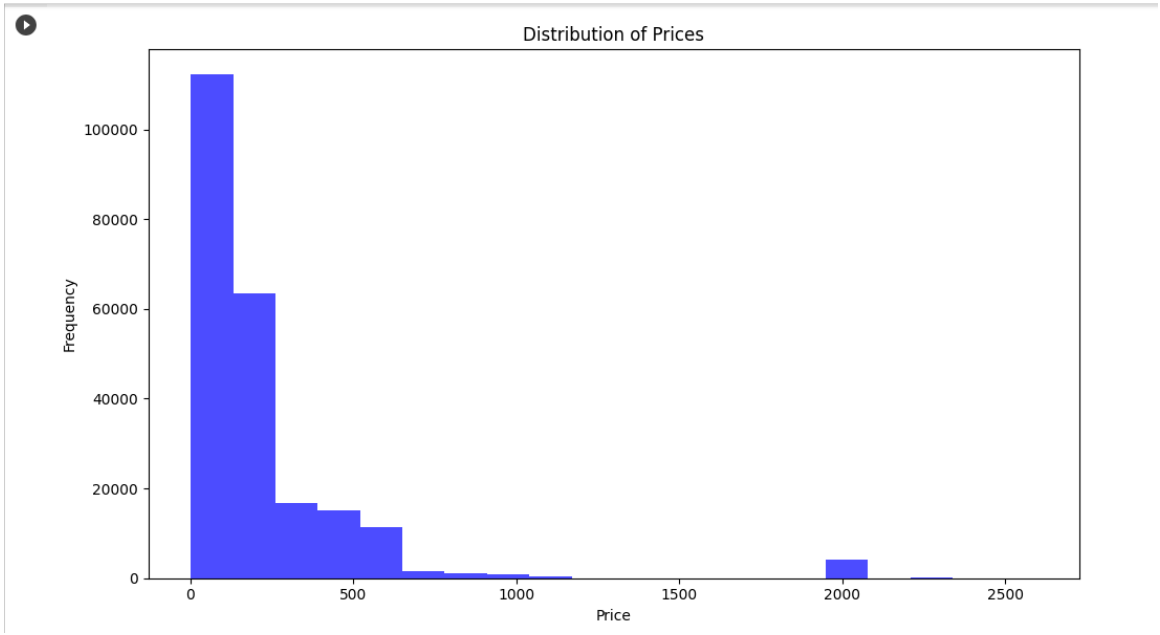
Rating Distribution: Amazon



Price Distribution: Flipkart



Price Distribution: Amazon

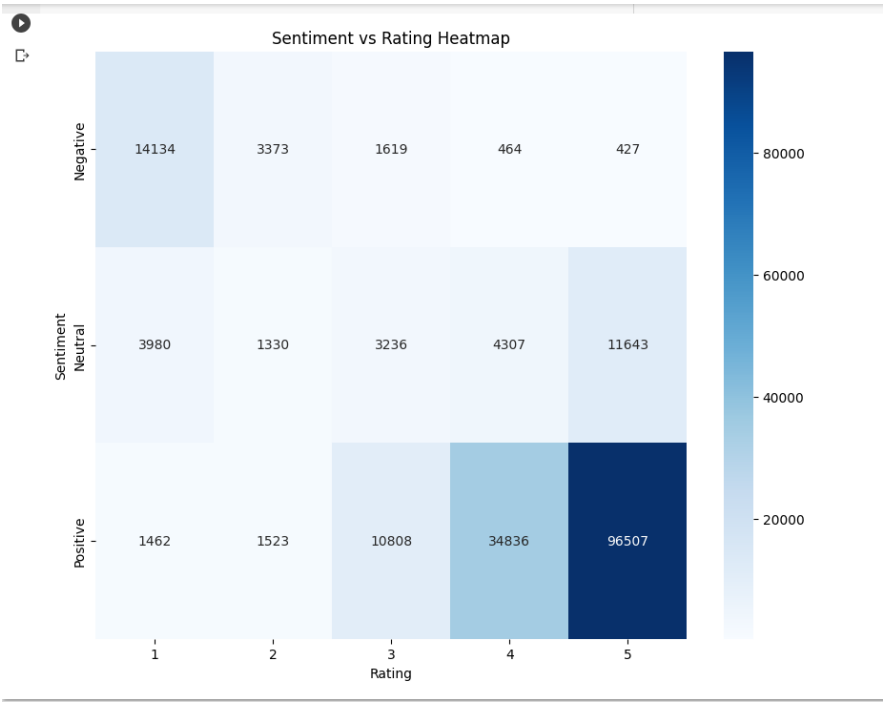


2) BIVARIATE ANALYSIS:

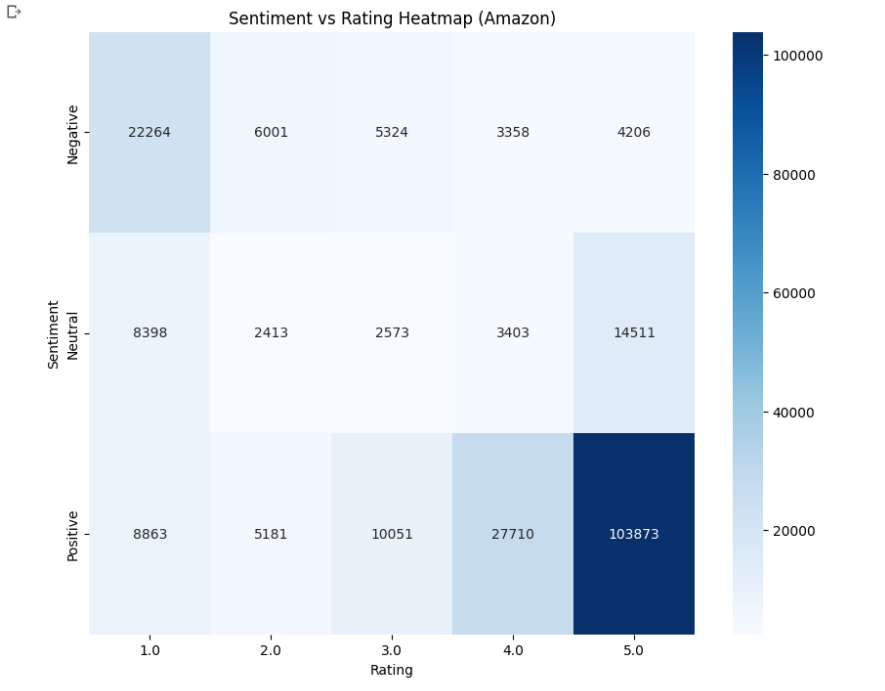
Rating Vs Price: Flipkart

Rating Vs Price: Amazon

Sentiment Vs Rating: Flipkart



Sentiment Vs Rating: Amazon



3) TEXT ANALYSIS:

Word Cloud: Flipkart

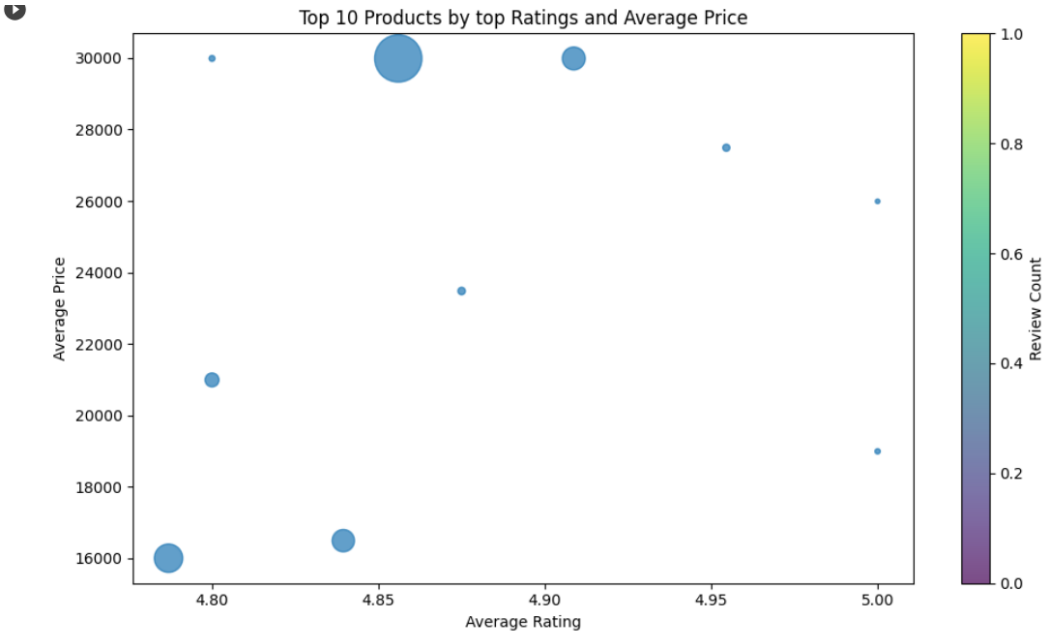
```
Positive Reviews: 145136
Negative Reviews: 20017
Positive Combined Text:
 0    super Great cooler excellent air flow and for ...
1       awesome Best budget 2 fit cooler Nice cooling
2    fair The quality is good but the power of air ...
4                                 fair Ok ok product
5    awesome The cooler is really fantastic and pro...
Name: Review, dtype: object
Negative Combined Text:
 3     useless product Very bad product its a only a fan
8                       unsatisfactory Very bad cooler
32                expected a better product Bad quality
48    waste of money Small wire and moter capacity i...
59    worthless The product doesnt cool as rated by ...
Name: Review, dtype: object
```

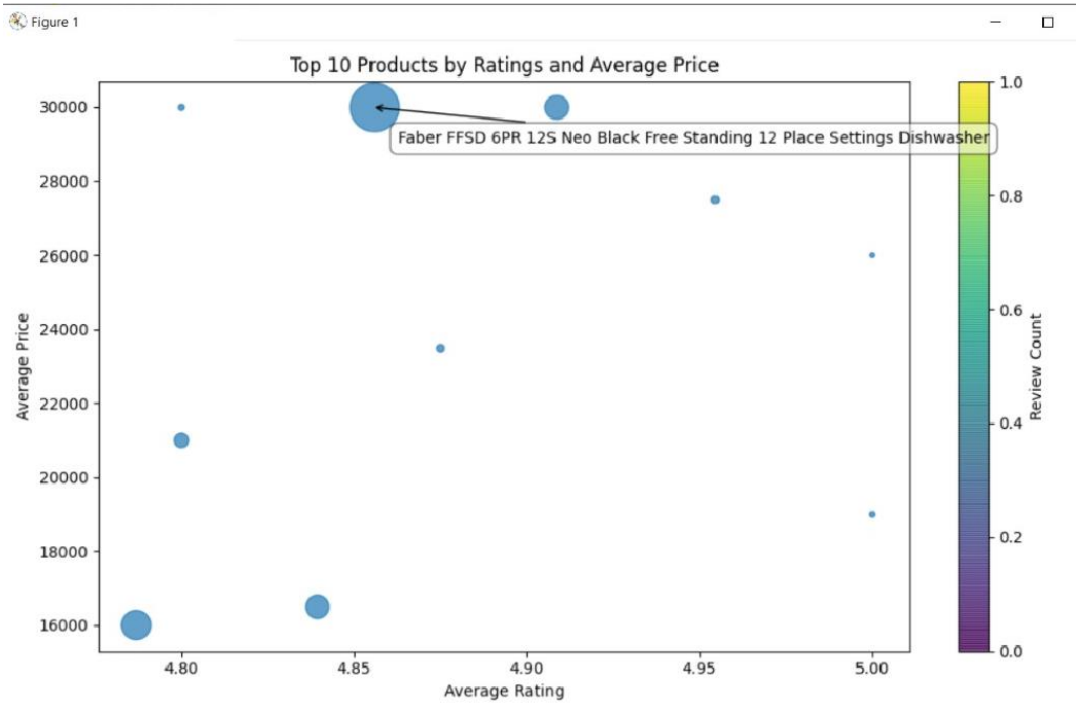
Word Cloud: Amazon

```
Positive Reviews: 155678
Negative Reviews: 41153
Positive Combined Text:
 0    i feel so lucky to have found this used phone ...
1    nice phone nice up grade from my pantach revue...
2                                        very pleased
3    it works good but it goes slow sometimes but i...
4    great phone to replace my lost phone the only ...
Name: Reviews, dtype: object
Negative Combined Text:
 5     i already had a phone with problems i know it ...
6     the charging port was loose i got that soldere...
15    had this phone before and loved it but was not...
20    the battery was old  had been over used becaus...
22    i purchased this phone in december as a christ...
Name: Reviews, dtype: object
```

4) ADDITIONAL CHARTS

Top 10 Products based on the top ratings (4 and 5) and average pricing category: Flipkart.





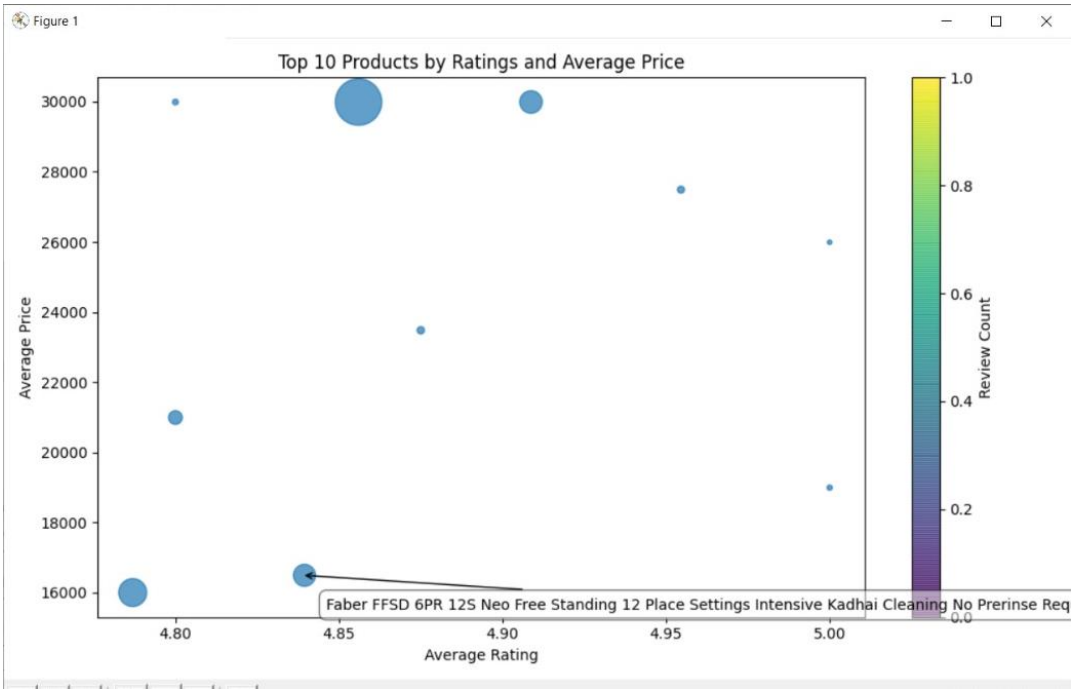


Figure 1
Top 10 Products by Ratings and Average Price
Average Price
Average Rating
Review Count
Faber FFSD 6PR 12S Neo Free Standing 12 Place Settings Intensive Kadhai Cleaning No Prerinse Req

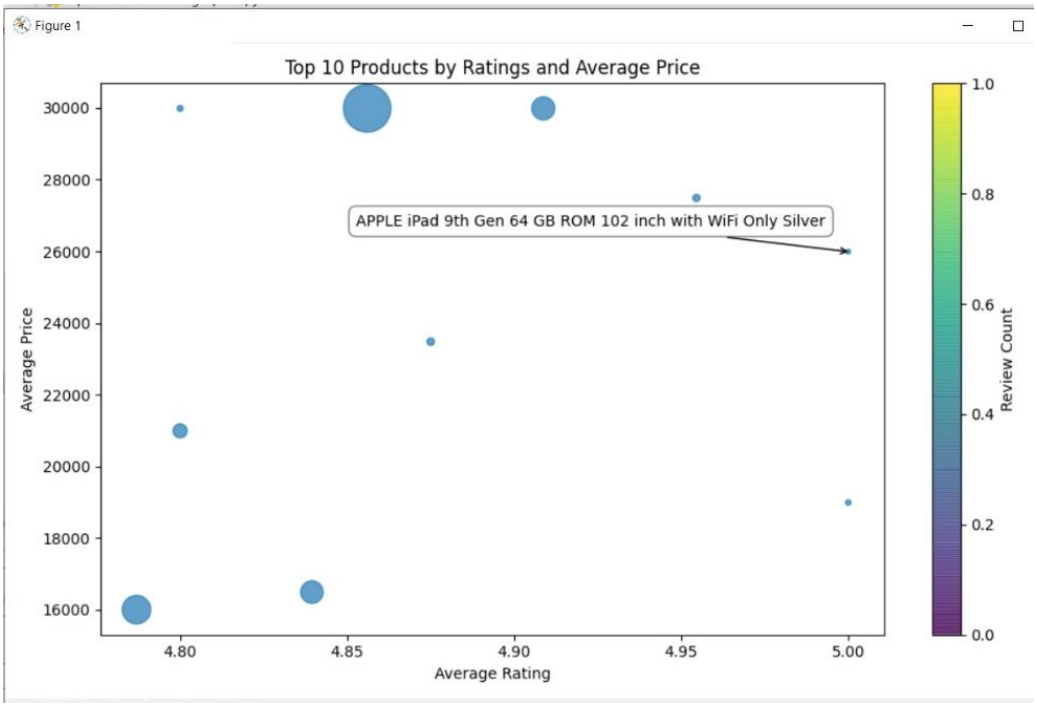
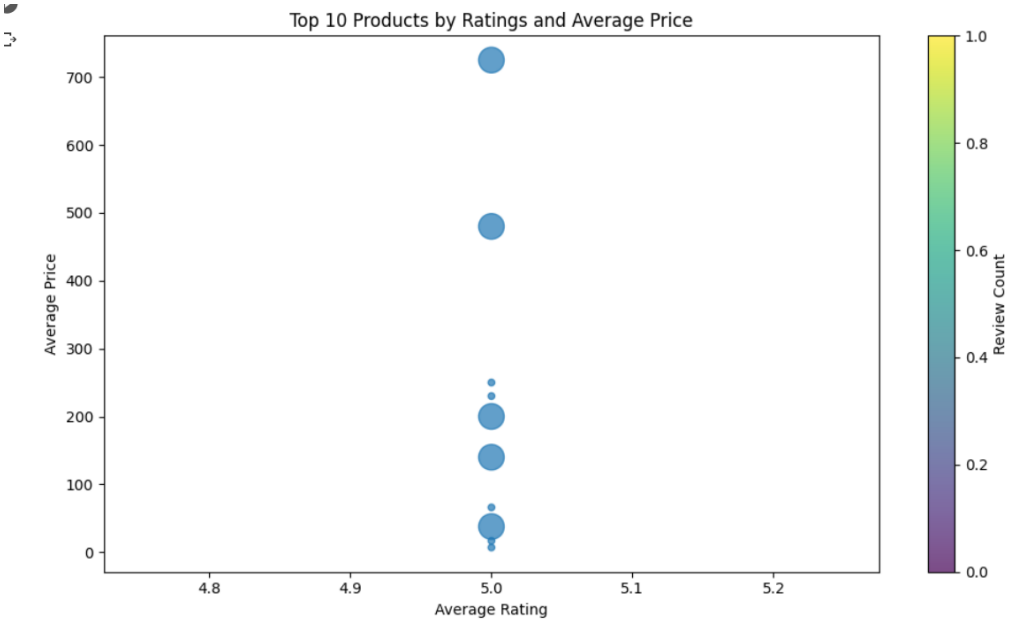
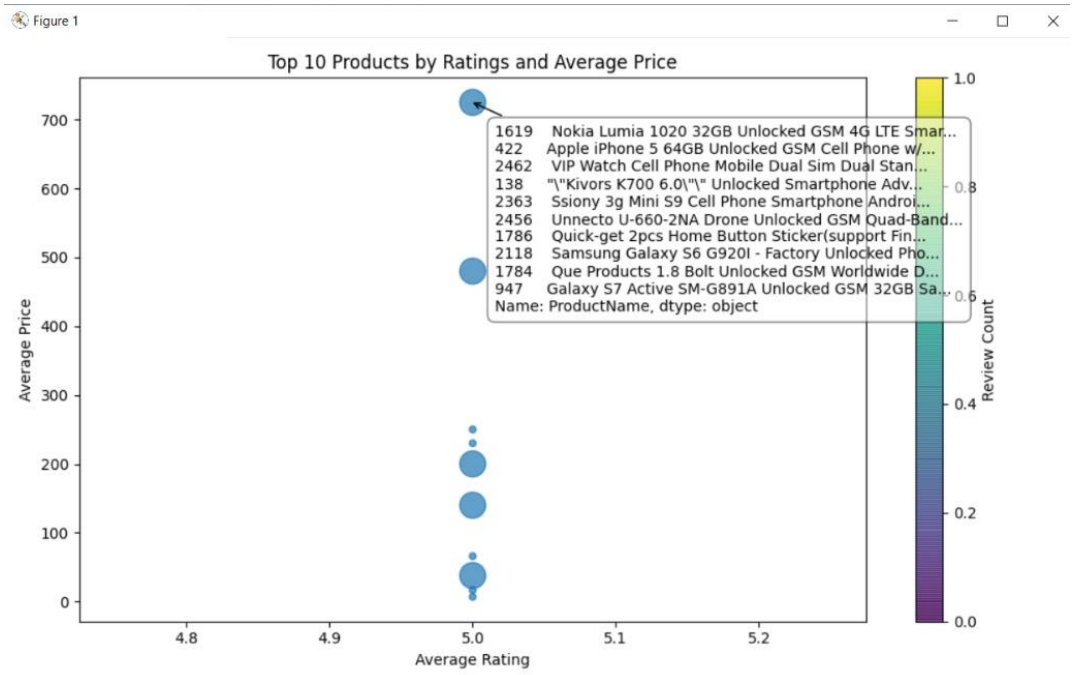


Figure 1
Top 10 Products by Ratings and Average Price
Average Price
Average Rating
Review Count
APPLE iPad 9th Gen 64 GB ROM 102 inch with WiFi Only Silver

Top 10 Products based on the top ratings (4 and 5) and average pricing category: Amazon.





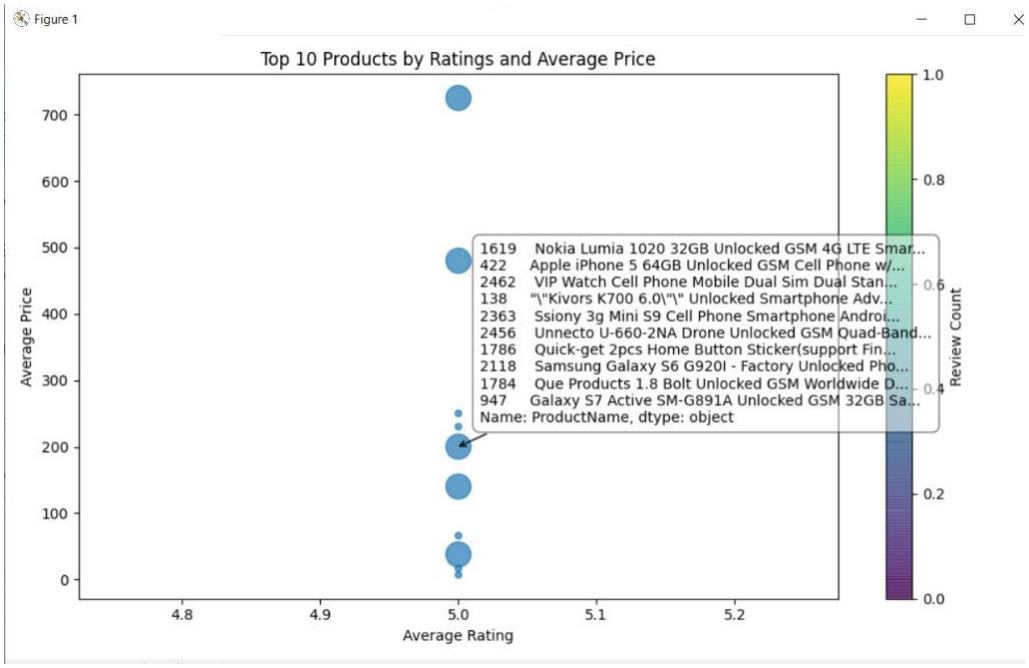


Figure 1
Top 10 Products by Ratings and Average Price
Average Price
Average Rating
Review Count
1619 Nokia Lumia 1020 32GB Unlocked GSM 4G LTE Smar...
422 Apple iPhone 5 64GB Unlocked GSM Cell Phone w/...
2462 VIP Watch Cell Phone Mobile Dual Sim Dual Stan...
138 "\"Kivors K700 6.0\"\" Unlocked Smartphone Adv...
2363 Ssiony 3g Mini S9 Cell Phone Smartphone Androi...
2456 Unnecto U-660-2NA Drone Unlocked GSM Quad-Band...
1786 Quick-get 2pcs Home Button Sticker(support Fin...
2118 Samsung Galaxy S6 G920I - Factory Unlocked Pho...
1784 Que Products 1.8 Bolt Unlocked GSM Worldwide D...
947 Galaxy S7 Active SM-G891A Unlocked GSM 32GB Sa...
Name: ProductName, dtype: object

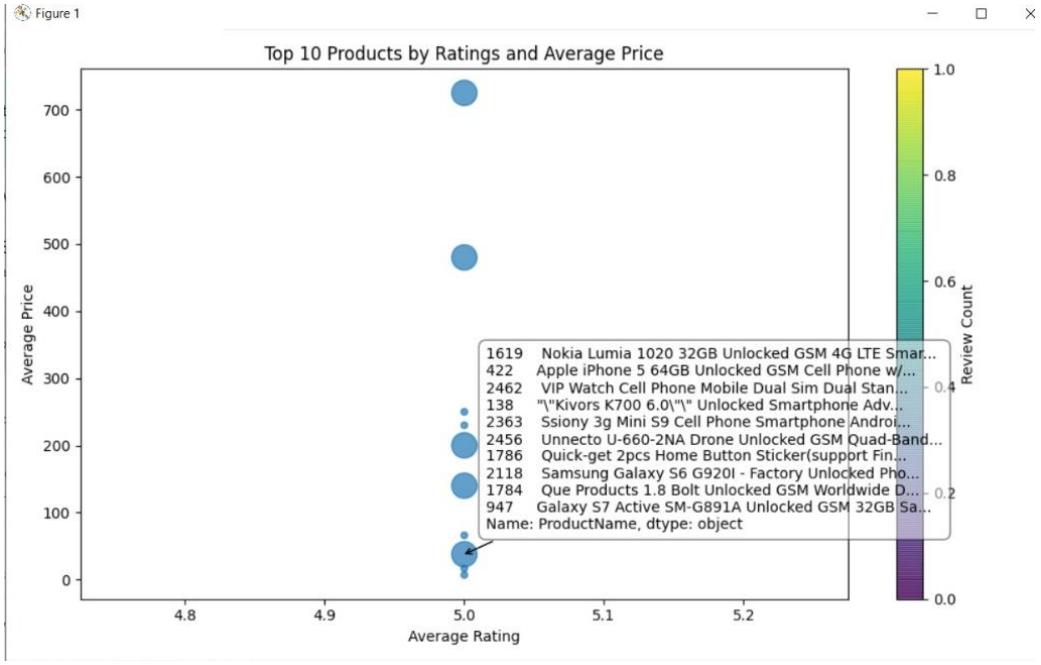


Figure 1
Top 10 Products by Ratings and Average Price
Average Price
Average Rating
Review Count
1619 Nokia Lumia 1020 32GB Unlocked GSM 4G LTE Smar...
422 Apple iPhone 5 64GB Unlocked GSM Cell Phone w/...
2462 VIP Watch Cell Phone Mobile Dual Sim Dual Stan...
138 "\"Kivors K700 6.0\"\" Unlocked Smartphone Adv...
2363 Ssiony 3g Mini S9 Cell Phone Smartphone Androi...
2456 Unnecto U-660-2NA Drone Unlocked GSM Quad-Band...
1786 Quick-get 2pcs Home Button Sticker(support Fin...
2118 Samsung Galaxy S6 G920I - Factory Unlocked Pho...
1784 Que Products 1.8 Bolt Unlocked GSM Worldwide D...
947 Galaxy S7 Active SM-G891A Unlocked GSM 32GB Sa...
Name: ProductName, dtype: object

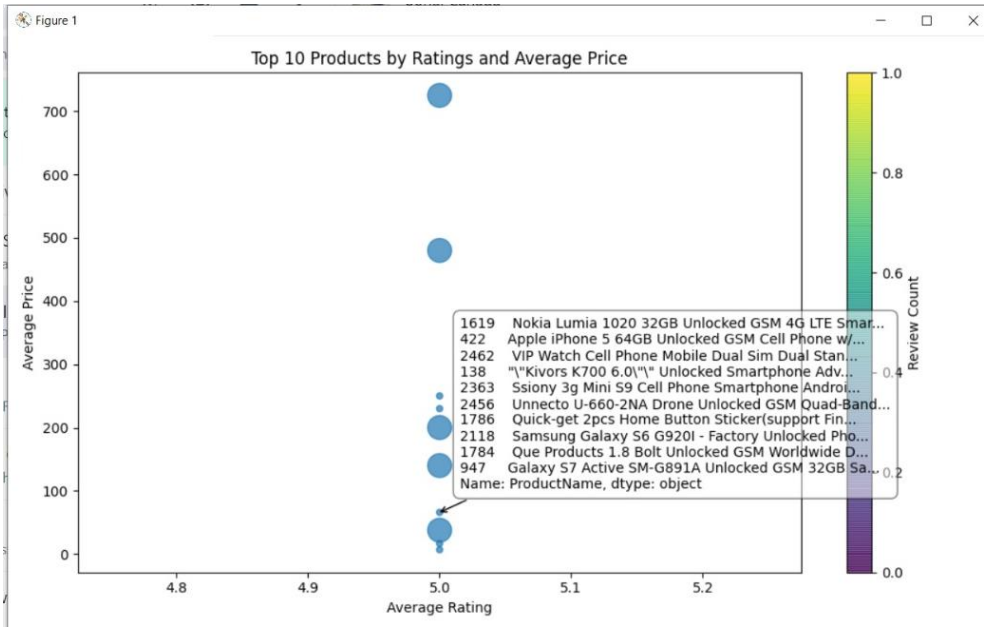


Figure 1
Top 10 Products by Ratings and Average Price
Average Price
Average Rating
Review Count
1619 Nokia Lumia 1020 32GB Unlocked GSM 4G LTE Smar...
422 Apple iPhone 5 64GB Unlocked GSM Cell Phone w/...
2462 VIP Watch Cell Phone Mobile Dual Sim Dual Stan...
138 "\"Kivors K700 6.0\"\" Unlocked Smartphone Adv...
2363 Ssiony 3g Mini S9 Cell Phone Smartphone Androi...
2456 Unnecto U-660-2NA Drone Unlocked GSM Quad-Band...
1786 Quick-get 2pcs Home Button Sticker(support Fin...
2118 Samsung Galaxy S6 G920I - Factory Unlocked Pho...
1784 Que Products 1.8 Bolt Unlocked GSM Worldwide D...
947 Galaxy S7 Active SM-G891A Unlocked GSM 32GB Sa...
Name: ProductName, dtype: object

7. DISCUSSION

7.1.1 LEARNINGS & FUTURE WORK

In this project, BERT emerged as the most accurate model, underscoring its capability in handling the intricacies of text-based sentiment analysis. The insights gleaned from the sentiment analysis proved invaluable for informing pricing strategies and pinpointing areas for product improvement. By utilizing data from multiple e-commerce platforms, the analysis achieved a well-rounded perspective on customer sentiment. This research also marked a shift from traditional intuition-based decision-making to a more empirical, data-driven approach. For future endeavors, the project sets the stage for exploring real-time sentiment tracking and aspect-based sentiment analysis to gain even deeper consumer insights.

7.1.2 CONCLUSION

This project confirmed that sentiment analysis is a vital tool for evaluating product performance on e-commerce platforms. High accuracy achieved via the BERT model emphasizes its utility in capturing consumer sentiment. The insights gathered are pivotal for both current assessment and future strategic decisions. The method proves beneficial in areas from pricing strategy to product enhancement. The approach paves the way for a more data-driven, consumer-centric business model.

8 GITHUB REPOSITORY / CODE FILES LINK

The code for this project is available on GitHub.

8.1 MY REPOSITORY LINK:

https://github.com/BislaSonal/Sentiment-Analysis-of-Products-Review

The repository contains a README file with detailed instructions on how to run the code and reproduce the results.