Proceedings of the International Conference on Inventive Research in Computing Applications (ICIRCA 2018)
IEEE Xplore Compliant Part Number:CFP18N67-ART; ISBN:978-1-5386-2456-2

Aspect-Level Sentiment Analysis on E-Commerce Data

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***Abstract*—Sentiment Analysis is the most commonly used approach to analyze data which is in the form of text and to identify sentiment content from the text. Opinion Mining is another name for sentiment analysis. A wide range of text data is getting generated in the form of suggestions, feedbacks, tweets and comments. E-Commerce portals are generating a lot of data every day in the form of customer reviews. Analyzing E-Commerce data will help online retailers to understand customer expectations, provide better shopping experience and to increase the sales. Sentiment Analysis can be used to identify positive, negative and neutral information from the customer reviews. Researchers have developed a lot of techniques in Sentiment Analysis. Mostly sentiment Analysis is done using a single machine learning algorithm. This work uses Amazon customer review data and focuses on finding aspect terms from each review, identifying the Parts-of-Speech, applying classification algorithms to find the score of positivity, negativity and neutrality of each review.**

Keywords—Sentiment Analysis, Customer Reviews, Aspect-Level Sentiment Analysis, features

I. INTRODUCTION

Sentiment Analysis is used to analyze data which is stored in text format. Text data can be in the form of customer reviews, complaints, feedback, discussions, tweets in social media etc. There is a lot of data that is being generated every day with the increase in human interaction in social media. Sentiment Analysis is also applicable to news articles, blogs, stock market, political debates, movie reviews etc. People these days tend to purchase products online, book hotels, tickets, cabs online which are generating data in the form of customer reviews. Sentiment Analysis helps to find whether the reviews are Negative, Neutral or Positive. Analyzing this kind of data can help business in understanding customer perspective towards the brand strategies. Sentiment Analysis comes under Natural Language Processing that uses Machine Learning algorithms, Lexicon based algorithms and Hybrid algorithms to classify data.

Analyzing customer reviews plays a crucial role in maintaining product quality and to meet customer expectations. This helps the organization to increase sales. A lot of research till date has been done on sentiment analysis. Researchers introduced lot of techniques, algorithms on sentiment analysis.

Even though there is a lot enhancement done in Sentiment analysis algorithms, there are areas that need improvement like performance, data extraction etc. Sentiment analysis can be done not only on customer review data but can be done on marketing, social media data etc. Some reviews may contain sarcasm and some reviews may be irrelevant to the product that is, the reviews may be regarding to customer services, delivering the product etc., which needs to be taken care of. Sentiment analysis is nothing but the classification of feedbacks into negative, neutral and positive feedbacks and catching the emotion of people.Fig.1. shows the different levels of sentiment analysis.

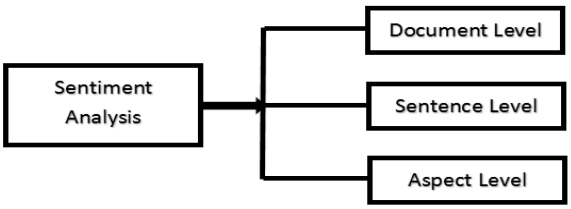

Fig.1.Levels of Sentiment Analysis

Sentiment Analysis basically has three stages:

i) Document-stage
ii) Sentence-stage
iii) Aspect-stage

Document-stage: In document stage sentiment analysis the entire document has to be analyzed at a time. Document level sentiment analysis assumes that the review belongs to a single person. Document level sentiment analysis uses both Supervised and Unsupervised classification algorithms. Document level sentiment analysis gives a primary opinion of a context which is its main advantage. [1]

Sentence-level: In sentence level sentiment analysis, the document has to be broken into sentences. The breaking of document into sentences is termed as subjectivity classification. Each sentence is analyzed at a time. The main concern of this approach is to find the target of the sentence without which the polarity (positivity, negativity, neutrality) of the sentence detected is not useful.[2]

Aspect-level: Feature terms of a product is the main target in this stage of analysis. It depends mainly on the target entity attributes. It is mainly performed on reviews, feedbacks, comments and complaints etc. Its applications include online store reviews, hotels reviews, movie reviews and more. This work mainly concentrates on Aspect level sentiment analysis.[2]

II. PRIOR WORK

Aspect level sentiment analysis can be accomplished in three steps:

i) Identification
ii) Classification
iii) Aggregation

Identification: The identification step is mainly concerned to identify the emotion target pairs in the sentences. [3]

Classification: Identified emotion target pairs classification is the main purpose of this step. Generally the classification is done as positive, negative and neutral contents. [3]

Aggregation: In the final step that is aggregation step, the classified values are aggregated to get an overview. It depends on specific requirements of an application. [3]

Sentiment analysis based on Feature level was proposed in [4]. They considered two kinds of features called implicit features and explicit features. Clear Opinion words and vague opinion words are then classified from the feature words.Clustering features are done from identified implicit features. Structures of features, corresponding opinion words and similarity of features are used for clustering the features in their method [4].

Tweets based on aspect level sentiment analysis was analyzed in [5]. They performed the analysis in three steps, Aspect sentiment extraction, Aspect ranking and selection and Aspect classification.

Aspect Sentiment extraction: An associated emotion and polarity has to be extracted from each tweet and their list of features.

Aspect ranking and selection: A collection of Tweets from a certain domain has to be taken in this step and aspect sentiment extraction algorithm has to be applied.

Aspect Classification: In this step aspects are obtained from a set of important features from the second step. Now, classification can be done based on aspects count that is classified as positive or negative.

A method by phrase level for classification of customer reviews was proposed in [6]. Phrase level is another name for aspect level sentiment analysis. They used supervised algorithm for their proposed method. The supervised algorithm used is Naïve Bayes algorithm. Phrase level sentiment analysis, is used to extract important aspects from reviews. They have implemented frequent item set mining to extract aspects and classified whether they are positive or negative.

Different methods of Sentiment Analysis were categorized in [7]. Fig.2. shows different approaches for Sentiment Analysis. By integrating Lexicon based algorithms and Machine learning algorithms they developed a Hybrid method.

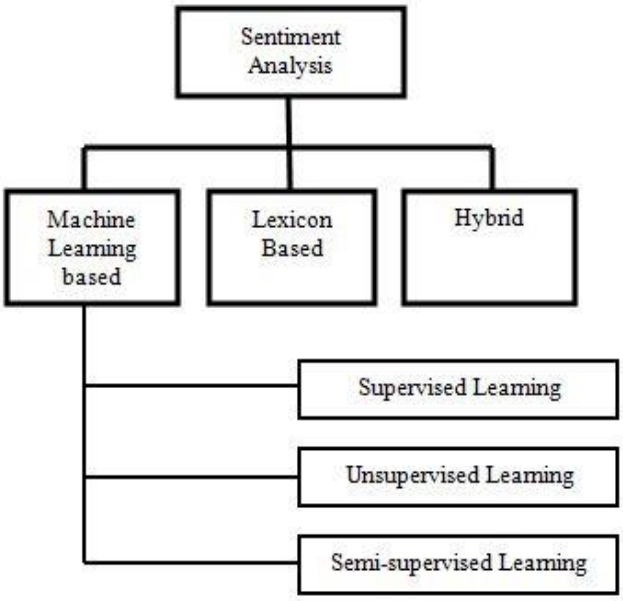

Fig.2. Different Approaches of Sentiment Analysis

Support Vector Machine (SVM) and Naïve Bayes algorithms come under Machine Learning algorithms. Lexicon based techniques uses Parts-of-Speech information and WordNet [7].

A Rule based Hybrid method was proposed in [8]. They proposed Google similarity distance in conjunction with PSO (Particle Swarm Optimization) for grouping synonyms. PSO algorithm is used to find clusters that are optimized with similar aspects. A Lexicon approach on movie reviews is proposed in [9]. To find subjectivity of sentences they used two methods. And to find feature opinion pair they used Rule based system. They have used SentiWordNet to extract opinions. SentiWordNet gives the output as Part-of-Speech tag, positive score and negative score and a unique Id. They used a Lexicon method for the same and then they compared both SentiWordNet and Lexicon method results.

A Hybrid method for sentiment analysis on Twitter data was proposed. They performed binary sentiment classification by using Support Vector Machine and J48 classification algorithms. Tweet specific aspects, unigrams and domain specific lexicons are used for Hybrid method in their paper.

Two supervised learning algorithms Maximum Entropy (ME) and SVM (Support Vector Machine) for Aspect Based Sentiment Analysis were compared in [11]. They compared the performance of the algorithms using the parameters Recall, F-measure, precision and accuracy. An Aspect based sentiment analysis on Restaurant reviews is proposed in [12]. They used POS Tagging, SentiWordNet and dependency parser to extract information.

An enhanced method from Support Vector Machine for classifying the feedbacks was proposed in [13]. Based on the related meaning of the words related to emotions, SentiWordNet gives the sentiment scores. They proposed an enhanced method by modifying these values.

A method to extract specifications like battery, camera, processor etc., for a particular product was proposed in [14]. Important aspects equivalent to technical features of a product are identified and classified it under the specifications. Based on the polarity like negative, positive and neutral reviews a score has been assigned for each specification. By aggregating these scores specific to individual features an overall product rate has been calculated.

III. SYSTEM DESIGN AND IMPLEMENTATION

Sentiment Analysis is a Natural Language Processing technique because it analyses text content. It extracts the emotions out of the text, whether it is a negative, neutral or positive emotion. Since the work deals with text data there is a lot of preprocessing of data need to be done before the actual classification. The preprocessing includes Parts-of-Speech tagging to every word in each sentence, extracting frequently used words, removing stopping or unwanted words and adjective extraction from the sentences.

The proposed work aims to compare two Machine learning algorithms, Naïve Bayes algorithm and Support Vector Machine (SVM) algorithm on Sentiment Analysis by classifying Amazon Customer reviews. In Aspect level sentiment analysis, the analysis mainly targets on aspects terms or features terms of the products. It can be done in the following steps as shown in Fig.3. that shows the proposed system architecture.

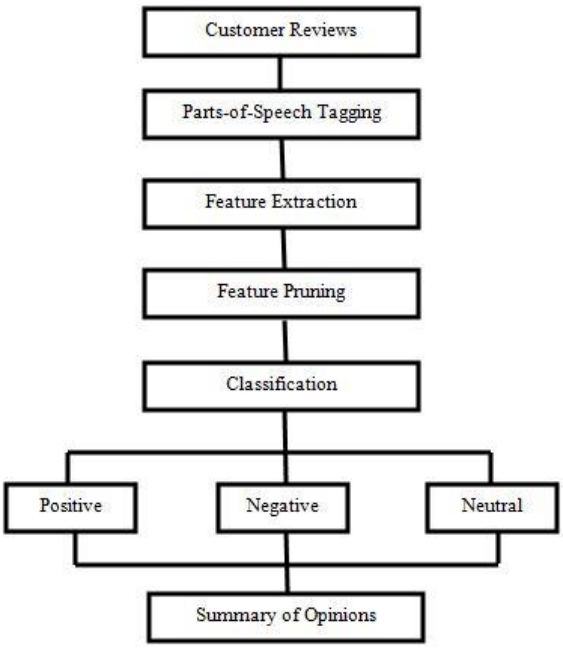

Fig.3. Architecture of Proposed system

Customer Reviews: The input given to the system is Customer Reviews of Amazon products. When a customer buys any product from online shopping portals, they give feedback of the product in the form of Customer Reviews. The reviews may be Positive or Negative or combination of both.

Parts-of-Speech tagging: Customer reviews are in the form of text. Parts-of-Speech tagging is used to assign category of parts of speech to each word of a sentence. This is used to find which part-of-speech the word belongs to. This includes Noun, Pronoun, Verb, Adverb, Adjective, Prepositions etc. For sentiment analysis we use mostly Adjectives and nouns as they tell the emotion of the subject.

Feature Extraction: Based on the noun phrases and nouns, adjectives obtained from Parts-of-Speech tagging, features that are necessary to identify emotions from customer reviews have to be extracted. This is done using Apriori algorithm. Apriori algorithm is a data mining algorithm. It is used to extract frequently used aspects from the dataset. It is based on association rules which are used to determine relations among aspects in databases. While applying Apriori algorithm, two main assumptions has to be taken into account, one is that all the subsets of a frequent itemset should be frequent and the other is for any infrequent itemset its supersets should be frequent. Apriori algorithm is easy to understand and implement. It can also be used for large itemsets.

Feature Pruning: Feature pruning is removing irrelevant features like stopping words from the features.

After Feature Pruning, Opinion words are extracted. Opinion words means set of adjectives those describe the product aspects.

Classification: This step is used to classify if the opinion is negative, neutral or positive. Before classifying SentiWordNet is used to calculate the positivity, negativity, and neutrality score. Then classification is applied using Naïve Bayes (NB) classification and Support Vector Machine (SVM) classification algorithms.

Naïve Bayes algorithm is a machine learning classification algorithm. Naïve Bayes algorithm is a probability based algorithm. Naïve Bayes algorithm calculates probability of each aspect of a text. In sentiment analysis this describes the probability of features. Generally probability can be calculated on numeric data, as this work deals with text data, the text should be converted into numeric data on which we can perform calculations. For this word frequencies should be taken into account. Naïve Bayes algorithm is the simplest algorithm to implement and is fast.

Support Vector Machine is also a machine learning classification algorithm. Support Vector Machine classification is based on finding a hyper plane to divide a dataset into different classes. Support vectors are the data points of the dataset that are nearest to the hyper plane. Hyper plane classifies a set of data. To classify a new data correctly we use hyper which is obtained from a greatest possible margin. Support Vector Machine gives accurate results but works on smaller datasets. This is more efficient.

Summary of Opinions: In this step total number of negative, neutral and positive feedbacks by each classifier Support Vector Machine classification and Naïve Bayes classification are produces as a summary on Opinions.

Finally comparison of the Support Vector Machine classification and Naïve Bayes classification is done. This classification is based on performance of the algorithms. The performance can be calculated using accuracy, precision, recall, F1-measure of each classification algorithm that has been used i.e., Support Vector Machine classification and Naïve Bayes classification. These parameters can be calculated as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1 = \frac{2 * Precision * Recall}{Precision + Recall}$$

Where, TP, FP TN, FN are True Positive instances, False Positive instances, True Negative instances and False Negative instances respectively, which are represented in the Table I.

Table I. Different instances

	Predicted positives	Predicted Negatives
Actual positive samples	# of True Positive samples (TP)	# of False Negative samples (FN)
Actual negative samples	# of False Positive samples (FP)	# of True Negative samples (TN)

IV. RESULTS

Our experimental results provided the Noun, Pronoun, Verb, Adverb, Adjective tags to every word of the reviews. Then the Apriori algorithm provided the frequently used words from the reviews. And then we performed adjective extraction from the reviews finally on which we have performed the classification algorithms. For getting the positive, negative and neutral scores for each word SentiWordNet was used. It is a lexical resource which provides the emotion scores.

To compare the two algorithms, Support Vector Machine classification and Naïve Bayes classification we have calculated recall, f-measure, precision and accuracy. We used False Positive samples, True Positive samples, False Negative samples and True negative samples to calculate the recall, accuracy, F-measure, and precision. Table II. shows the accuracy by both the algorithms.

Table II. Accuracy by SVM and NB classification algorithms

	Naïve Bayes	Support Vector Machine
Accuracy	90.423	83.423
Precision	0.947	0.852
Recall	0.959	0.83
F-Measure	0.952	0.841

Our experimental result shows the accuracy of NB classification is better than the accuracy of Support Vector Machine classification.

The above calculations are done from the True Positive samples (TP), False Positive samples (FP), True Negative samples (TN), False Negative samples (FN) of each classification results. Table III. shows the FP, TP, FN, TN values of Naïve Bayes classification. Table IV shows the FP, TP, FN and TN values of Support Vector Machine classification.

Table III. Instances by Naïve Bayes classification

True Positive	False Positive	True Negative	False Negative
0.947	0.053	0.1	0.04

Table IV. Instances by Support Vector Machine classification

True Positive	False Positive	True Negative	False Negative
0.852	0.148	0.2	0.045

By calculating these parameters we will get the accuracy, precision, recall and F1-measure.

V. CONCLUSION AND FUTURE WORK

In this paper, we have implemented Aspect-level Sentiment Analysis. The classification is done using two machine learning algorithms, SVM classification algorithm and NB classification algorithm and the performance is compared based on Precision, Recall and F1 measure. We obtained more accuracy from Naïve Bayes algorithm than Support Vector Machine algorithm. In future our work will focus on implementing C4.5 algorithm and compare with Naïve Bayes.

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