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Sentiment Analysis Using Machine Learning Techniques: Systematic Study

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Abstract— People have always had an interest in what people think, or what their sentiments and opinion is. Since the inception of the internet, increasing numbers of people are using websites and services to express their opinion and sentiments in the form of tweets. With social media channels such as Facebook, LinkedIn, and Twitter, it is becoming feasible to automate and gauge what public opinion is on a given topic, news story, product, or brand. Sentiments that are mined from such services can be valuable. Datasets that are gathered can be analyzed and presented in such a way that it becomes easy to identify if the online mood is positive, negative, and neutral. In this paper, it is summarized about the essential need for sentiment analysis and its challenges. This also explains the sentiment analysis and the process and challenges involved in the sentiment analysis.

Keywords— Sentiments Analysis, Opinion, Social Media, Reviews, Tweets, Machine Learning

I. INTRODUCTION

The utility of online services has expanded and this makes it too available more and too popular. The sites for user's review and personal blogs are turning into a platform for posting an opinion of users. The pre-eminent area in grouping the information is based on exploring the human thoughts. For analyzing the human thoughts, the area of opinion mining and sentiment analysis is considered as the essential one.

Amazingly, there has been a little confusion between researchers and practitioners regarding the dissimilarity between opinion and sentiment and whether the field must be called Opinion mining or Sentiment analysis. In Merriam-Webster lexicon, sentiment is defined as an idea, outlook, or decision prompted by emotion, whereas opinion is defined as a view, decision formed in the mind about a particular topic. The variation is fairly little, and each contains a few elements of the other. The definitions point out that an opinion is more of a person's vision about something, while a sentiment is more of a feeling. For example, the sentence "I am worried about the present state of the economy" expresses a sentiment, whereas the sentence "I guess the economy is not fine" expresses an opinion [1]. In a discussion, if somebody says the first sentence, we can reply by saying, "I share your sentiment," but for the second sentence, we would usually say, "I agree/disagree with you". Nevertheless, the most important meaning of the two sentences is linked

because the sentiment depicted in the first sentence is likely to be a feeling caused by the opinion in the second sentence. We can also state that the first sentiment sentence entails a negative opinion about the economy, which is what the second sentence is saying. Although in most cases opinions entail positive or negative sentiments [2].

Sentiment analysis and Opinion mining is nearly similar one however there is slight variation between them i.e. opinion mining extracts and analyze people's opinion about an entity whereas Sentiment analysis look for the sentiment words/expression in a text and next analyze it.

Opinion mining is also referred as the sentiment mining that aims to decide the opinion unrevealed a text noted in natural language. This instruction is a cross of information and computing linguistics. This recognizes and selects the instinctive information from the resource materials. Opinions revealed in a group of source documents with reference to an object is extracted with opinion mining [3]. This is done by choosing the attributes of an object from the user statements and decides whether the comments are favourable or unfavourable. For example, the objects salespersons are concentrated more on every user individual comment in online regarding the products and services. These user comments have high importance in moulding the opinions of other purchasers. Institutions and business keep watch on these consumer comments for the purpose of knowing the way of products recognized. Although observing these things are one of the tricky jobs because there are available sources that comprises of commodious data.

II. SENTIMENT ANALYSIS

Sentiments denote the feelings, emotions, views, ideas of individuals for the specific product. Sentiment analysis of opinion mining is very difficult. There are many complications like natural language processing for computerized extracting, categorizing and summarizing opinions which are expressed in online. Sentiment analysis is a study that is accomplished by various organizations for identifying user feedback about the products. This makes the other users for knowing the perfect selection of their favoured product [4].

Sentiment analysis is commonly employed in opinion mining for knowing sentiments, subjectivities moreover sensitive states in online texts. The process was accomplished on product evaluation by organizing the products attributes.

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At the present time, sentiment polarity analysis is utilized in an extensive range of domains like finance. This concentrates on examining the direction-based text that involves text containing statements or opinions [5]. The process of sentiment classification investigates whether the specific text is subjective or objective or if the text constitutes both the feelings of positive or negative. This classification method has many numbers of essential qualities that may include various process, jobs, techniques, attributes and also application domains. There exist many numbers of jobs in the classification of sentiment polarity. There are three major characteristics of classification are a class, level besides assumption with respect to sentiment sources as well as targets. The distinctive two class problem incorporates the categorization of sentiments as positive or negative. Furthermore, changes include organizing messages as subjective / objective [6].

Sentiment analysis concentrates on the specification of user's point of view with respect to specific area. The point of view involves assessment, perception or even emotional stages. The most prime job in sentiment analysis is the categorization of the polarity of specific text at the levels of features, document, sentences etc. After polarities are classified, emotional stages like „happy", „angry" and „sad" are also identified [7].

The classifications of polarities are the main task in opinion mining and it happens at the time of a portion of text stating an opinion on a single issue is categorized as one among the two conflicting sentiments. Few examples for polarity classification are „like" vs. „dislike" or „thumbs up" vs. „thumbs down". This classification also finds the advantages and disadvantages of statements in online reviews and assists in making the assessment of products more reliable. Another form of binary sentiment classification is agreement detection. Agreement detection decides whether two text documents should obtain the similar or dissimilar sentiment associated labels. By identifying the classification of polarity this may allocate positivity degree to the polarity. It may place the opinion on a sequence in between positive and negative. This can also categorize the multimedia resources as stated by emotional or mood contents for intention like troll filtering, emotional human-machine communication and cyber-issue detection. In order to construct an outline of these features, initially, features are found out and the opinions of positive and negative on those features are accumulated [8]. The features of a product may include components, attributes and some other characteristics of a product. The summarization of opinion does not outline the reviews by choosing the subgroup or revises few of the unique statements from the reviews to catch the most important points as the classic text characterization.

III. Sentiment Analysis Process

Sentiment analysis is one of the complex methods that consist of five important steps for examining sentiment data. The sequence of sentiment analysis process is shown in Figure 1. The steps include,

- Data collection,
- Preparation of text,
- Sentiment detection,
- Sentiment classification,
- Displaying output.

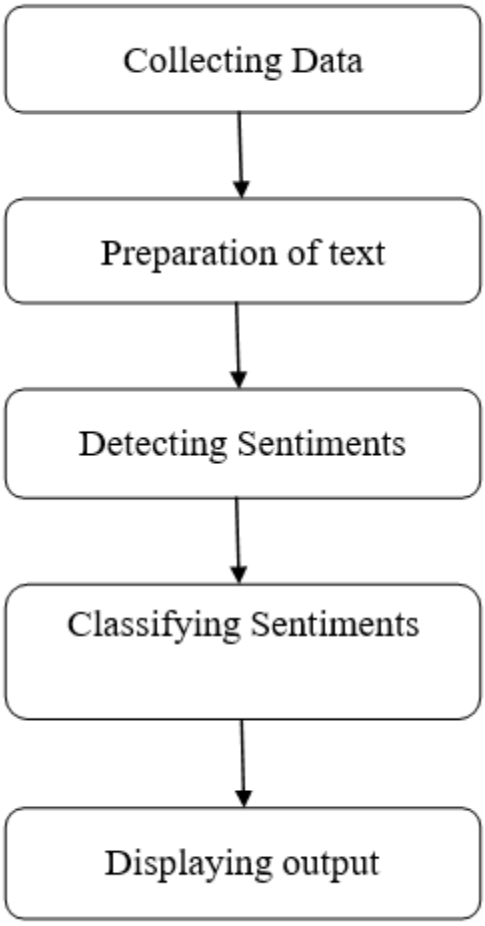

Figure 1: Steps of Sentiment Analysis

A. *Data Collection*

In process of sentiment analysis, data collection is the initial step that constitutes the gathering of data from the content produced by the user which is available on various social networks, blogs and forums. These data are expressed in many different ways with diverse slangs, vocabularies and contexts and are not arranged.

B. *Preparation of Text*

This is next to the data collection. This process involves in cleaning of selected data before the process of data analysis. Non-textual and also the contents that are not applicable are identified and are removed from the data set.

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C. Sentiment Detection

The statements that are selected are investigated and the statements that are with a subjective opinion are preserved whereas the other remaining statements are removed. This task can be carried in various levels either phrases, one term, entire sentence or whole document with generally applied approaches. These techniques include as follows:

- Unigrams
- N-grams
- Lemmas
- Negation
- Opinion words

D. Sentiment Classification

In this task, subjective sentences can be accomplished with the utilization of various points.

E. Displaying Output

The foremost aim of sentiment analysis is the transformation of non-organized data into the valuable information. In the case of investigation is over, then the outcome of text is given as the pictorial representation such as bar chart or pie chart or with line graphs.

IV. Related Work on Sentiment Analysis

The popularity of online reviews has grown substantially over recent years. Online re- views impact more than 93 percent of customers purchasing decisions. User reviews help people determine which products or services to buy, where to travel, and also where to eat. User reviews have gradually become a necessary part of the internet business over time. Various research has been conducted to find out the exact influence of both positive and negative reviews on the popularity, the number of sales, product awareness, rate of transformation and profitability of businesses that sell products or services.

The evolution of customer engagement with Business-to-Business (B2B) and Business-to-Consumer (B2C) business shows that 82% of customers read other user reviews before making a purchase decision, and 60% view user reviews on a weekly basis. Also, the study suggests that two-thirds (68 percent) of consumers are willing to pay up to 15 percent more for the same product or service if they are assured that they will have a better experience.

Research shows that negative reviews are stopping 40% of consumers who want to use a company. In the unfortunate case of these negative reviews popping up on Google searches, companies might lose about 70 percent of their future customers. 91% of 18- 34-year-olds have confidence in online reviews and personal recommendations. To trust reviews, more consumers require multiple reviews. More likely, older consumers will be skeptical about online reviews.

The average local business has 39 user reviews on Google in recent Google Reviews Study. Companies in the top 3 search positions, however, have 47 reviews. The more reviews it becomes easier for consumers and search engines to trust the accuracy of review ratings. Positive reviews increase the probability of 68% of consumers using local businesses. Negative reviews stop 40 percent of consumers wanting to exploit a firm [9].

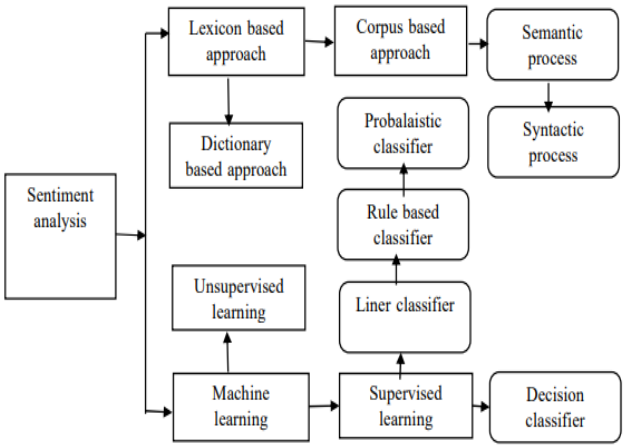

Figure 2: Sentiment Analysis Methods

Sentiment Classification techniques can be roughly divided into the Lexicon-based approach, Machine Learning approach, and hybrid approach. The Machine Learning Approach (ML) applies the famous ML algorithms and uses linguistic features. The Lexicon-based Approach depends on the sentiment lexicon. Lexicon is a collection of known and precompiled sentiment terms. It is again divided into the dictionary-based approach and corpus-based approach which use semantic or statistical methods to find the sentiment polarity of the text. The Hybrid Approach combines both approaches and it is very common with sentiment lexicons playing a key role in the majority of methods [9].

A. Sentiment Analysis in Machine Learning

Information and communication technologies revolutionized the way of learning over a decade. Web 2.0 technologies enhanced the path of teaching and learning. A large amount of unstructured data is generated from the learners by increasing the usage of the internet for learning related activities, discussion forums, etc. In this digital era, comments, reviews, and discussion forums are highly crucial for the instructor. It is difficult to understand the mindset of the learner by the instructor. The size of data to be analyzed is humongous. It can be done through different knowledge mining techniques.

Data and text mining techniques are emphasized to focus on enhancing the learner's ability. Comments, reviews, feedbacks, and discussion forum contents are used to perform the analysis. Sentiment Analysis (SA) otherwise, opinion

mining is a part of education data mining, used by many researchers to express their ideas. Education data mining helps to analyze the state of instructor and learner to provide a better platform.

Natural Language Processing (NLP) empowers sentiment analysis to detect and extract the opinions, attitude, and emotion from the individuals using various text mining methods [10]. This section mainly focuses on performing sentiment analysis on the education field. The ultimate aim of this paper is to represent the current Sentiment Analysis (SA) classification, models, algorithm, and applications and the research articles that are related to sentiment analysis in education domain are discussed. Many researchers adopted different types of sentiment analysis models and algorithms. But Support Vector Machine (SVM) and Naive Bayes (NB) are mostly focused by the researchers for analyzing the sentiment of users [11]. Tools such as Weka and Rapid Miner are primarily used for sentiment analysis.

Computational Linguistics, NLP and Text Analysis are used to extract the emotions from the raw data by SA. It serves as an example where statistics, linguistics, knowledge from engineering and other related disciplines are combined to provide ac- curate analysis. SA grasped the attention of many types of research by showing up its potential for information retrieval, reviews, blogs, and discussion forums by simplifying the process of extracting user opinions from their comments [12].

An important task in sentiment classification is to identify the polarity from the given content in the sentence, viewpoint, or archive level. It should categorize the given record exhibits the nature of the statement as positive, neutral, or negative. The final goal is to anticipate the meaning of the given statement to transform it into valuable insights. The given data can be classified into two categories, such as actualities and conclusions. Articulation of the target substances, properties, and its occasions are the actualities, and the emotional connections belong to conclusions that portray the decision of the individuals, sentiment toward the substances, evaluations and their properties [13].

B. Classification in View of Supervised Learning

Supposition categorization clearly defines managed knowledge issue of three classes, positive, negative, and unbiased. Preparing and testing information utilized in the cur- rent research is, for the most part, item surveys, which isn't amazing because of the above suspicion. Since each audit as of now has a commentator doled out appraisals, preparing and testing information are promptly accessible. For instance, an audit with 4 or 5 stars is viewed as a positive survey, an audit with 1 or 2 stars is considered to be a negative survey, and a survey with 3 stars is considered to be an independent survey.

Any current regulated learning strategies can be connected to supposition categorization, e.g., innocent Bayesian classification, and bolster vector machines (SVM). The way to deal with arrange motion picture surveys into Interrogative or neutral. This demonstrates in utilizing unigrams (a pack of singular words) as highlights categorized with performance on guileless Bayesian or SVM. Ensuing exploration utilized numerous more highlights and methods in learning. Like most machine learning applications, the fundamental undertaken estimated categorization with designing as a successful arrangement of highlights. A portion of the present highlights is recorded underneath.

C. Terms and their Recurrence

The highlight are a singular word or word n-grams and their recurrence tallies. Now and again, word arrangements may likewise be considered. The TF-IDF weighting plan from data recovery might get connected as well. These highlights have been indicated very viable in notion classification.

D. Grammatical Feature

It was found in numerous looks into that descriptive words are essential pointers of conclusions. In this manner, descriptive words have been dealt with as unique high- lights.

E. Assessment Sentences and Expressions

Opinion sentences will be sentences that are normally for interrogative or neutral notions. Instance, lovely, awesome, great, and astonishing is sure feeling Sentences, and awful, bad, and unpleasant are neutral assessment words. Albeit numerous conclusion sentences with descriptors as well with qualifiers, things (e.g., waste, garbage, and poo) and verbs (e.g., despise and like) can likewise demonstrate feelings [14]. Aside from singular words, there are additionally sentiment expressions and figures of speech, e.g., cost somebody dearly. Assessment words and expressions are instrumental to conclusion investigation for clear reasons.

F. Dictionary Based Approach

The straightforward systems in this methodology depend bootstrap-ping utilizing a little arrangement of seed supposition words and an online lexicon. The technique is first to gather a little arrangement of emotional connects physically on introductions, and after that to develop this set via looking in the WordNet or thesaurus for their equivalent words and antonyms. The following emphasis begins. The continuous procedure terminates with not any new items are discovered. After the procedure finishes, manual assessment can be done to evacuate as well as right blunders. The lexicon assessment words gathered have a noteworthy weakness. The methodology can't discover assessment words with space and setting particular introductions, which is very normal. For instance, for a speaker telephone, on the off chance that it is peaceful, it is generally negative.

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Table 1: Summary of Sentiment Analysis in Machine Learning

Sr. No	Authors	Language used	ML Technique	Data Source	Contribution
1	Xing fang, Justin zhan [20]	English	Naïve bayes	Product data collected from Amazon website. Over 5.1 million of product reviews data in 4 major categories: beauty, book, electronic, and home	Extracting subjective content and tackling polarity categorization problem.
2	AysuEzen-Can, Kristy Elizabeth Boyer, Shaun Kellogg, Sherry Booth [21]	English	Bayesian Information Criterion (Bic)	Information gathered inside an 8-week MOOC for Educators (MOOC-Ed) titled Planning for the Digital Learning Transition in K-12 Schools.	An unsupervised discourse act order system with MOOC demonstrating approaches, with the essential objective of picking up bits of knowledge about the structure of discussion posts in a MOOC
4	V. Kagklis, A. Karatrantou, M. Tantoula, C. T. Panagiotakopoulos, and V. S. Verykios [22]	Greek	Dictionary-Based Sentiment Classification	Discussion forum used by 64 users. 12% of ladies and 88% of Men. A sum of 371 messages was posted. 89 out of 371 were beginning posts, while the rest 282 of them were answers. 198 messages were posted by the understudies, and the rest were posted by mentors.	Postgraduate students online course forum used to analyze the Sentiment, text mining, and Social Network Analysis (SNA) techniques from the data. To analyze the course performance and interaction among students. Sentiment analysis is utilized in different levels: sentence level, document level, and corpus level
4	T. Zarra, R. Chiheb, R. Faizi, and A. El Afia [23]	English	Latent Semantic Analysis, Singular Value Decomposition	62505 Stack overflow comments	To identify the students' opinions about educational issues that are problematic.
5	Ho IMK, Cheong KY, Weldon A [24]	English	Multiple Regression and Machine Learning	Conducted the survey on 425 students during 29 of April and 10 of June 2020	Presented study investigated important predictors in determining the satisfaction of undergraduate students (N = 425) from multiple departments in using ERL at a self-funded university in Hong Kong while Moodle and Microsoft Team are the key learning tools. By comparing the predictive accuracy between multiple regression and machine learning models before and after the use of random forest recursive feature elimination, all multiple regression, and machine learning models showed improved accuracy while the most accurate model was the elastic net regression with 65.2% explained variance.
5	Manal Mostafa Ali [25]	Arabic	Naïve Bayes (NB), Multinomial Naïve Bayes (MNB), K Nearest Neighbor (KNN), Logistic Regression (LR), and Support Vector Machine (SVM)	1458 SA-related papers were used	Presented study exploits Natural Language Processing (NLP) and Machine Learning (ML) algorithms to extract subjective information, determine polarity and detect the feeling.
6.	Veni et.al. [26]	English	Naïve Bayes, SVM, Random Forest, KNN and Decision tree	Kaggle data set of 1000 comments of facebook users.	Facebook comments are used for social data analysis based on context adaptive system

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V. Open Challenges and Issues

Increasing accuracy is one of the great challenges in sentiment analysis [18]. Most of the algorithms can be able to classify the dataset but failed in producing the accuracy. This leads to the system unable to recommend further. Here, implementing the ensemble approach made a great challenge in combining the different algorithms. Each and every algorithm have different functionalities and work in their own way. So, combining these algorithms and classifying the data done a lot of work, and also this voting algorithm (Ensemble) must provide higher accuracy than the existing system. The existing system produces lower accuracy, and the proposed approach must provide the accuracy greater than the existing system algorithms.

In the analysis of different sentiment analysis algorithms, the performance of the supervised learning id better than unsupervised learning. However, the unsupervised algorithms are also required as supervised learning depends upon the huge amount of training data that can be sometimes expensive. The failure can occur in the case of supervised learning because of insufficient training. This creates training Twitter as social language is very different from the language.

The polarity of abbreviations, sarcasm may not be determined. At document level Naive Bayes, Support Vector Machines and Maximum Entropy are compared at the different feature like unigrams, bigrams, combining unigrams and position information, taking only adjectives and combining unigrams and bigrams. The results showed that for the small feature set, the performance of the Naive Bayes is better than SVM. But there is an increase in the feature; the performance of SVM increased. Maximum Entropy algorithm also outperforms the Naive Bayes as the feature size is increased. The main advantage of the Naive Bayes algorithm is it is very simple. If there are independent features, Naive Bayes classifier will work faster, and less training data is required. In a real-world scenario, the performance of Naive Bayes classifier is better compared to other algorithms [19].

The Naive Bayes classifier makes string assumption about the independence of feature, which is the first disadvantage of the Naive Bayes classifier. This assumption could lower the performance of the Naive Bayes classifier. SVM can classify the text with very high accuracy and produces robust results even if there are some bugs in the training sample. SVM provides a unique solution. The drawback of this method is that the interpretation of this method relies on graphical visualization. Due to its complex equations, the performance decreases with an increase in the size of input data. The maximum entropy classifiers very much similar to Naive Bayes classifier, except the assumptions of features.

VI. Applications of Sentiment Analysis in the Real World

The following are the application in real-world entities

A. *Product and service reviews*

Reviews of consumer products and services. Many automated websites provide feedback. e.g.: Google product search.

B. *Reputation Monitoring*

Monitoring the reputation of a specific brand. e.g.: Twitter, Facebook.

C. *Result Prediction*

By analyzing sentiments from different sources one can predict the outcome of the event. e.g.: Election. It enables managers to track how voters feel about different issues, and how they relate to the speeches and actions of the candidate.

D. *Decision making*

Sentiment analysis uses various sources to find the articles that discuss the aggregate of the score. e.g.: The Stock Sonar graphically shows the positive and negative sentiment of each stock.

Conclusion

The most recent decade has seen significant advances in the areas of natural language processing and sentiment analysis. Theoretical advances and increased computational power have resulted in applications that detect text and sentiments in comments, communications, automatically classify unstructured data in enterprise settings. This paper reviews the methods applied to various problems in education learning, covid, product reviews etc. and it also portrayed the need for the sentiment analysis in the field of Machin learning. The future work will suggest a comprehensive model and a case study on the impact of various models in real time scenario.

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