A Survey on Sentiment Analysis Algorithms and Techniques For Arabic Textual Data

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Abstract

The concept Sentiment means the feeling, behavior, belief or attitude towards something that almost being embedded. sentiment analysis is the process of analyzing, extracting, studying and classifying the various reviews, opinions given by people and human's emictions into positive, negative, neutral. It is considered one of the most significant scientific branches that aims to determine the behavior of speaker, the attitude of writer according to some topic or the overall emotional reacting to website, document, event, interaction, products or services. many users can share every day various opinions on different topics that may be detected or embedded by using micro-blogging which considered a rich resource for sentiment analysis and belief mining such as Facebook, Twitter, forums and Blogs. recently a huge number of posted comments, tweets and reviews of different social media websites include rich information in addition to most of the on-line shopping sites provide the opportunity to customers to write reviews about products in order to enhance the sales of those products and to improve both of product quality and customer satisfaction. manual analysis of these large reviews is practically impossible thus it is needed to discover an automated approach to solve such hard process. In the Middle East and particularly in the Arab world, social media websites continue to be the top visited websites especially with the current social and political changes in this part of the world. the main objective of that research is to differentiate between various algorithms and techniques of sentiment analysis and classification dependent on Arabic language as little number of researches discusses that point relevant to Arabic language. Different algorithms and techniques of data mining such as Support Vector Machine (SVM), Naïve Bayes (NB), Bayesian Network (BN), Decision tree (DT), k-nearest neighbor (KNN), Maximum Entropy (ME), and Neural Network (NN) in addition to many other alternative techniques which are used for analyzing and classifying textual data. For the reasons of difficulties in analyzing and mining large number of linguistic words for their Those techniques are estimated based on Arabic language due to its richness and diversity. The comparison between data mining techniques showed that the most accurate technique is support vector machine (SVM) algorithm. every successful sentiment depends on two essential analysis tools are language and culture.

Keywords: Sentiment Analysis, Arabic Sentiment Analysis, Arabic sentiment classification, Sentiment Structure Review, Arabic Dialects, Dialectical Lexicons, Sentiment Classification Model.

1.Introduction

Sentiment Analysis is also called (Opinion Mining) that points to (NLP) Natural Language Processing and machine learning approach where machines analyze and classify the human's sentiments, emotions, opinions about some topic which are expressed in the form of either text or speech [1]. Sentiment Analysis has become one of the essential research domains which appears in different fields such as tourism, health, commerce, politics, manufacturing and education [2].

Nowadays process of classification doesn't be manually it becomes automatically for different algorithms of sentiment analysis such as attitude summarization, online recommendations, business marketing and different websites [1]. Must take on consideration Some important factors which effect on algorithms of sentiment analysis, one of these challenges is short length of irregular data whereas the content may be one of three types of sentiment review structure: Structured Sentiments, Semi-Structured Sentiments, Unstructured Sentiments. The Structured Sentiment mostly expresses facts and scientific things, it is showed in formal sentiment reviews like researches and books. The Unstructured Sentiments is showed in free texts, irregular formats and informal sentiment reviews as there is no constrains of sentence's content. it includes two types: one of them is Explicit Feature when feature X is founded in sentence of review. Another one is Implicit Feature when feature x is not found in sentence review. The Semi-Structured Sentiments is showed in the form between formal sentences of Structured Sentiment reviews and informal sentences of Unstructured Sentiment reviews, it also depends on short phrases that written separately [3].

Most number of the micro-blogging users such what we daily use to express our opinions in comments of Facebook, tweets of Twitter, previews of Blogs and texts of Forums, these opinions may be noticed or embedded, all those sites of social media and online web sites are precious and rich source of sentiments, attitudes and beliefs to be extracted by specific algorithms to be analyzed and classified [4]. Scientific experiments proved that correctness and accuracy of sentiment results are affected by the strong interconnection between both sentiment challenges and sentiment review structure. there are some drawbacks and challenges in the evaluation of sentiment analysis to aid getting right polarity and accurate meaning content of opinion. One of the most significant factors which assist scientists on selecting the most influential challenge in sentiment analysis and classification techniques is sentiment review structure [3]. Sentiment Analysis (SA) has been discussed well on the English language and close examination of the enormous volume of reviews, comments and tweets posted on related micro blogging and social media channels that will be a rich source of information and reveal that dialectical language is presented in all these written comments [5]. One of key contributions of any research is developing a model that aims to classify sentiments into one of three scores regardless the type or amount of used dataset. we deal with document opinions and algorithms of both the Arabic language and the English language where it is considered the most usable and common language in the world. On our work we will concentrate on the Arabic language. The Arabic language is also is one of the most useable language which comes in rank after The English language but it is more difficult, wider and deeper than the English one. The deficulties of the Arabic language is due to the more steps of pre-processing dataset as we need to make best of data preparation after gathering it also the wide linguistics words and morphological terms which makes users have to deal with deifferent Arabic dialect lexicons for improving accuracies of results. Scientists categories Arabic language into three varieties: First, Modern Standard Arabic (MSA) that used in formal events second, Traditional Arabic that is called (classical Arabic) which found in religious scripts third, Dialectical Arabic that is also called (colloquial Arabic or slang Arabic) which is typically spoken not written and is region dependent [5].

That survey paper has a target of presenting an overall evaluation for most usable algorithms and techniques of sentiment analysis also aims to compare between several papers and review the major studies that have been conducted on Sentiment Analysis in Arabic Language. The rest of this survey is organized as follows. Section 2 gives background information about Sentiment Analysis and classification. Section 3 reviews number of main characteristics and some advantages of the most useable algorithms of sentiment analysis which collected from most significant research studies. Section 4 presents the most significant experimentation results of many researches for Arabic sentiment analysis and classification. Section 5 displays comparison of the most usable Arabic techniques and algorithms used in sentiment analysis and classification in a table format. The final section is Section 6 which briefly presents conclusions.

2. Sentiment Analysis and Classification

Sentiment analysis becomes a great area in decision making as 90% of online websites customers take on their consideration those sentiment comments, tweets and reviews which help the owner of those websites to enhance their financial profits and keep on their reputation by improving the quality of online products and usually develop them for what be suitable as possible to customer's opinions in reviews and proposals [6]. There are three types of Sentiment Analysis: positive sentiment, negative sentiment and neutral sentiment. Also, sentiment analysis is divided into a three main levels: document level SA, sentence level SA and word level SA, the first level is used to classify the attitude of document by determining its type whether if positive sentiment or negative sentiment, the second one is used to classify the attitude of the sentence that must not be subjective in general but it may be one of them subjective or objective, the last one is used to distinguish between opinions and attitudes according to different entities [3].

As we will say later sentiment classification is an important phase of several phases of sentiment analysis so we can present these phases of sentiment analysis as the following structure.

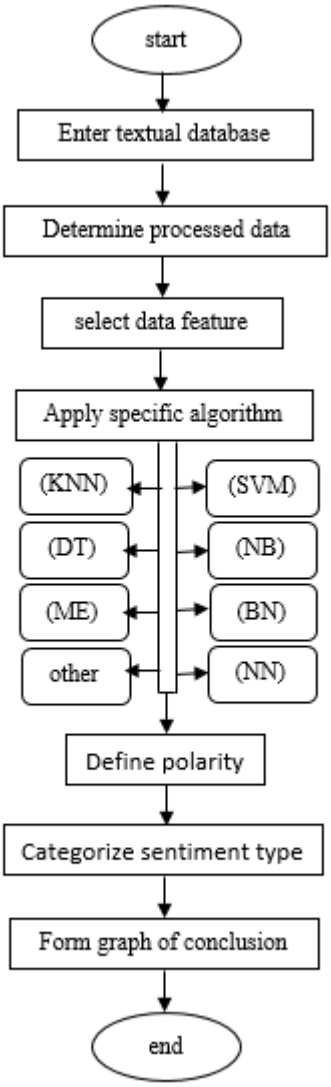

Figure 1. schematic serial steps of sentiment analysis.

Figure 1. in that designed form we can declare detailed overview of a schematic serial steps of the sentiment analysis and the opinion mining which begins from entering the collected data input as we said before there are many different sources of them for example: comments of Facebook, tweets of Twitter, previews of Blogs and texts of Forums and opinion reviews of several online purchasing websites. Some of methods that already used for collecting data input are the search Application Programming Interface (API) and the streaming Application Programming Interface (API) and also many other different methods which used for that purpose [7]. Those two different ways are mostly used in Twitter to collect tweets with a special way to be used and some limitations are founded. The step of browsing collected data is the first step which is followed by step of determining preprocessing textual data according to some effective techniques such as: text tokenization, word streaming, letter replacement, dialectical replacement, punctuation removal, stop words removal and many other preprocessing techniques. After at least one or more preprocessing techniques are executed on to be ready to use for a step of extracting features of those collected preprocessed data such as: POS features, semantic features, syntactic features, stylistic features, N-Grams, word embeddings and others [8]. The next step is considered the most significant step of the analyzing process which is done by applying specific Machine Learning Approaches (ML) or lexicon-based-Approach. in that paper those classification algorithms will be discussed later in details. That step is a key role of defining polarity of sentiment whether if it is one of these types positive, negative or neutral. after that it is so easy to classify sentiments and then drawing results in graph.

The operation of mining attitudes and extracting opinions of Arabic textual data whether it is founded in comments, tweets and reviews and other data websites by implementing number of serializations to classify its polarity whether it is positive sentiment, negative sentiment or neutral sentiment is called analysis of Arabic sentiment. Nowadays Most scientists of data mining trying to solve problems and significant challenges which already faces sentiment analysis in their experiments to achieve more accurate result than the last one. There is few numbers of papers and researches which discuses Arabic Sentiment Analysis and explains it's lexicons, challenges and resources like newspaper.

One of the main problems in Sentiment Analysis for Arabic language is the absence of Arabic parser which complicates the process of understanding the structure of document, sentence or word in addition to overcoming the lack of creating Dialectical Lexicons that is considered a data driven approach [9].

Dialectical Lexicons or (Colloquial Lexicons) looks like a dictionary that each one has two subdivides where they have two different words for the same meaning as the first subdivide includes word of dialectical Arabic language (slang word) which pointed to the most suitable associated corresponding word of Modern Standard Arabic in the second subdivide, also they have emotions and their annotator words in the Arabic language with their polarity weights. most dialectical lexicons are constructed with weight value of the Arabic slang term whether it is positive, negative, or neutral. The most closely definition for the word polarity is a degree of sentiment subjectivity whither if the attitude of three main levels document, sentence and word are positive, negative or neutral. it can aid in analyzing and classifying sentiment by getting accurate, correct and reasonable result at most [10]. Whatever the length of the word, comment or document, there are more polarity concepts used for the effective result of the lexicon. The most known general classification of the polarity weight is 7-weight, 5-weight, and 3-weight. First weight is "3-weight" which includes three values that discreet from 1 to -1 as the following (1=Positive, 0=Neutral, and -1=Negative). second weight is "5-weight" which includes five values that discreet from 2 to -2 as the following (2=Positive, 1=Nearly Positive, 0=Neutral, -1=Nearly Negative, and -2=Negative). Third weight is "7-weight" which includes seven values that discreet from 3 to -3 as the following (3=High Positive, 2=Positive, 1=Nearly Positive, 0=Neutral, -1=Nearly Negative, -2=Negative, and -3=High Negative) [11].

We can conclude that sentiment analysis includes four main branches according to its classification as the following: the first one sentiment analysis can be divided according the classification level into: word level, sentence level and document level. the second one sentiment analysis can be divided according the predicted class of text into: subjective or objective. the third one sentiment analysis can be divided according the applied approach into: supervised learning approach or unsupervised learning approach. the fourth one sentiment analysis can be divided according the polarity weights into: positive sentiment, negative sentiment and neutral sentiment [10].

In most details we can discuss the variation between objective class and subjective class, firstly anyone can find one or both of them in many tweets, reviews, Facebook comments, newspaper articles and many other information sources. Subjective class includes all terms of human attitudes that have polarity weights (positive, negative or neutral). Objective class means there isn't polarity weights that mentions to certain fact [9].

3. Characteristics of Sentiment classification Algorithms

As we discus previously there is a relation between Sentiment Analysis and Sentiment Classification. where Sentiment Analysis is also known as Opinion Mining or Sentiment Extraction, that concept appears recently in the last ten years because of the huge amount of data content. it means attitudes, thoughts and opinion of the speaker or writer in different levels may be in oral speech or textual such as documents, sentences and words. Sentiment analysis is used in various scopes such as social, industrial and commercial systems [12].

Many researches nowadays use sentiment analysis to increase the efficiency of sentiment classification which widely used in most research studies to extract emotions from online available information with their annotated words which located in lexicons and corpus, also it is used to link between those different corpus in different languages, it is used to decrease repeated data that is collected manually and then is processed by using techniques of Machine Learning to increase the performance and accuracy of results [13]. Any model which present or use both corpus or lexicons of sentiment analysis and semantic models which have different terms with the same meaning is called Sentiment Classification Model [14].

Figure 2. shows in details what we would conclude from various articles where many authors could differentiate clearly between the most important approaches of sentiment classification techniques by using the Machine Learning approach that includes three main branches are: the supervised learning approach, the unsupervised learning approach and the sim-supervised learning approach. Firstly, the supervised learning approach which mainly relays on labeled training expressions. That type of machine learning approach is based on classification in most details that approach is used in machine learning technique for comment's classification of such products on the online shopping sites and also to distinguish between large number of marketing products reviews to train model. Secondly, the unsupervised learning approach which based on lexicons and is applied if it is hard to apply the supervised learning approach and could not obtain labeled training. The last one is the sim-supervised learning approach is a combination between the supervised learning approach and the unsupervised learning approach and it is rarely to be used in reality [15].

the most used Sentiment Analysis approaches of classification techniques is the supervised learning approach that is because of including most of several used algorithms. The supervised learning approach is classified into five branches the first on is the probabilistic classifiers, the second one is the linear classifiers, the third one is the Decision Tree classifier, the fourth one is the Key-Nearest-Neighbors classifier and the fifth and last one is the Rule-Based-classifier. both of classifiers of Linear and Probabilistic includes many various techniques of machine learning which widely used in recent time to facilitate extracting embedded opinions and to overcome many various challenges automatically that may face users when using to solve problems manually, also those developed techniques are trying to obtain the efficient result and best conclusion.

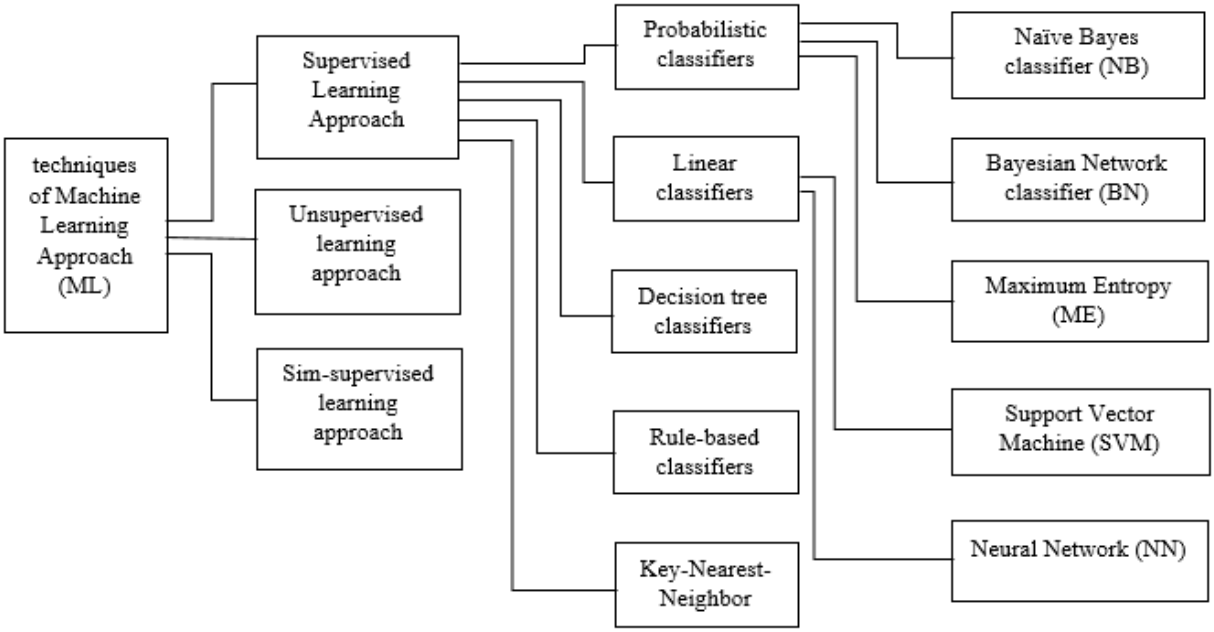

Figure 2. Sentiment Analysis approach of classification techniques.

machine learning approach which is used to overcome the problem of feature selection in sentiment classification and it is the first partition of three main partitions of sentiment classification techniques, the second partition is Lexicon based approach and the third partition hybrid approach. there are three divisions of approaches for machine learning techniques as the following: the first divide is supervised learning approach; the second divide is unsupervised learning approach and the third divide is sim-supervised learning approach. supervised learning approach which is divided into many divisions such as: Probabilistic classifiers, Linear classifiers, Decision Tree classifiers, Rule-based classifiers and K-Nearest Neighbor. the first divide is the Probabilistic Classifier is one of the supervised Learning Approach which almost depends on probabilities and it needs to achieve its purpose of sentiment classification wherefore it relies on the supposition whereas every single element of the combination includes class. Also, that classifier is designated as (generative classifier) for the reason of sampling probability of the generative model. that type of classifier includes number of important techniques such as: Naive Bayes classifier, Bayesian Network classifier and Maximum Entropy. the second divide is the Linear Classifier is also one of the supervised Learning Approach which is considered the simplest kind of classifiers and it is the most popular and regulated one. That classifier is searching for the best linear break between groups. We can describe the equation which is presented as p=$\bar{A}.\bar{X}$+b where $\bar{X}=\{x_1, x_2,\ldots, x_{n-1}, x_n\}$ that means the document word is variable. Also the description of linear vector that has the identical feature measures can be given as $\bar{A}=\{a_1, a_2,\ldots, a_{n-1}, a_n\}$ and the last identifier is the scalar of symbol b. that classifier includes some techniques such as: Support Vector Machine classifier and Neural Network classifier [16].

also, there are additional Machine Learning Approaches which are mostly used in classifying polarity of sentiments into positive and negative such as Artificial Neural Networks (ANN) and Logistic Regression (LR) where some special features are used with these classifiers among them Part-Of-Speech (POS) tags is the first theoretical type as it is the highest technique usage, the second one is Bag-of-words (BOW), the third one is N-gram technique which also used mostly that's why that technique relays on expressions, phrases and sentences and the last one is social media-driven features. On the other hand, deep learning techniques play an important role in sentiment classification such as Deep Neural Network (DNN), Recurrent Neural Network (RNN) and Convolutional Neural Network (CNN) and many other techniques [17].

On the other hand, the second partition of sentiment classification techniques is Lexicon-based approach which is deeply related with lexicons of opinions and attitudes. Lexicon-based approach also includes two partitions are used to determine if sentiment of the object is one of those categories: positive, negative and neutral. one of these

partitions is the corpus-based approach which needs to depend on one of the two effective factors are statistical methodology or semantic methodology and the other one is the dictionary-based approach [18]. There is a special and widespread mixture between the both reminded approaches the corpus-based approach and the dictionary-based approach is called the Hybrid-Approach all that is shown down in Figure 3.

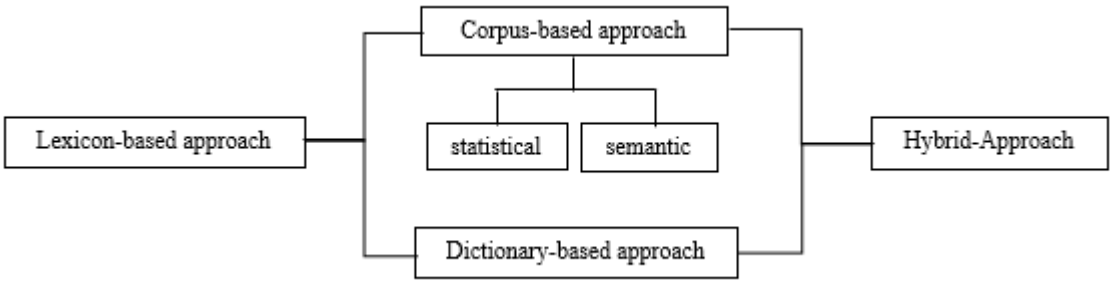

Figure 3. Lexicon-based approach and Hybrid Approach.

That means we could analyze any documented data and texture source by means of the Lexicon-based approach which greatly relies on lexicons of opinions and attitudes. As we said before that the dictionary-based approach and the corpus-based approach are two categories of the Lexicon-based approach. the first category is the dictionary-based approach which searches for the kernel terms of sentiment and also searches for the term's alternative expressions that is called (synonyms) and antonyms of the same particular term. the second category is the corpus-based approach which searches for the sentiment kernel list of that particular term to be able to search about particular sentiment terms in a huge corpus that step would be obtained by applying one of the two specific methodologies either statistical methodology or semantic methodology to be leaded at least to the same terms of sentiment. In that section we can discuss each algorithm and technique and present most of their effective information to be aware of many of their advantages and disadvantages. That would assist to determine the most efficient technique and which of them is executed rapidly with the most accurate and correct result of classifying which type of sentiment polarity.

On the other hand, one of the supervised Learning Approach of Machine Learning is Key-Nearest-Neighbor classifier (KNN) which is considered the most common and widespread technique that relies on effective factor of nearness of specific labels of unidentified training set. Each class of multidimensional sample space includes numbers of some appropriated labels so when we need to execute the classifier of Key-Nearest-Neighbor on a new test data to determine the range of the closeness among these classes. a key role of that algorithm is a significant measure which is called "Euclidean distance low measure" which lead us to a proposed value that algorithm relies on mostly.

There are a lot of advantages of Key-Nearest-Neighbor algorithm, one of these advantages is the facility of applying that algorithm for classifying different models effectively and with most correct and accurate result. another advantage is the special property of applying that type of classifier with any object of n-class labels and with n-class model classes. Another one is that algorithm implements elastic and low-priced model with a great solution in all situations even if most huge and extremely noisy test data. at least that classifier can be used to simulate many realistic systems and develop applications in some various fields such as engineering, medical, financial and many other fields. With all these characteristics we cannot remined any noticeable effected defects during dealing and applying it [19].

Another supervised classifier of Machine Learning Approach is Diction Tree classifier (DT) which aims to extract the most beneficial attribute to be classified and checked for every node. it includes several levels where each level in the order root, internal nodes and leaves that are connected by directed edges which outcomes from one node and incomes to other node. The root of decision tree is the only main root in each tree which has only outcoming directed edges but other internal nodes have both incoming and outcoming directed edges that are called test nodes where each one is divided into n-sub divides. The node which has only incoming directed edges is called leaves, the final leaf node is considered class of instance and usually ends any sub divide of the diction tree and that refers to successful steps.
Diction Tree algorithm has some advantages, one of them is the facility on explaining and translating its steps. The

characteristic of non-parametric that enables use data without limitations of linearly separable data and plurality of outliers. On the other hand, the way and steps of Diction Tree algorithm comparing with boosted trees or random forests SVMs we found that random forests are very popular, most scalable in parameters and very fast in classifying lots of problems on reverse of applying Diction Tree and with random forests we will not be worry about the facility of overfitting such what found in random forests and also about tuning parameter's bunch such what always happened with SVMs.

The most accurate algorithm of supervised machine learning approaches which was viewed and presented to us by Boser, Guyon and Vapnik is Support Vector Machine classifier (SVM) where its principal purpose is to be used in sentiment classification, pattern recognition and regression and its purpose is related to training data to differentiate between members of two classes as well as it goals to find the best function that used in classification. The hyper plans which is popular in using for classification problems as the best one of them is chosen for pattern classification to enhance hyper plane margin. The correct steps of SVM leads to high efficiency because of its margin's maximization. That means margins size of SVM patterns effects on improving classification accuracy. We can state some of Support Vector Machine advantages, one of these advantages is the highest performance of generalization of much knowledge. SVM technique plays important role in sentiment classification if it is applied in various real time applications and most problems where the output result is considered the most accurate and highly effective performance in sentiment analysis process if it is compared with other techniques. Most of using technique of SVM gets correct and successful results as that due to many reasons like the linearity separable of large number of textual problems, if a sample spare set is founded then they are robust in high spaces of dimensions and relevant feature has great learning ability. If spaces of high-dimensional are used in classification then SVM will gain great benefits of quick evaluation. At least we can execute SVM in many realistic applications such as text classification and image categorization.

The Naïve Bayes classifier (NB) which is called simple Bayes because of its facility in using, also it is called "idiot's Bayes" and "independence Bayes" because all its steps are individuals where any problem has given objects while each class has only one of these objects that has vector of variables. The principal purpose of using NB is to determine which class of already exacting classes will include every entered object in the future with awareness of variables vectors of future objects. Naïve Bayes classifier is considered one of techniques that specialized in most problems of supervised machine learning with popular improving in its way of applying and its way of understanding because of the ease of interpretation for several various users. Some of its advantages is the fast and facility of Appling it in most problems that may be very enormous that's why user only do group of counts without requiring parameters of iterative which may be difficult and complex. NB will be always ready for less practicing and training When assumption of it is without holding in such logistic regression.

All types of machine learning Approaches which may be supervised and un supervised such as Rule-based classifiers, Bayesian Network classifier, Neural Network classifier, Maximum Entropy and many others where each of them has several distinguished characteristics and advantages or may disadvantages to be discussed in that current work or later in most details.

4. Arabic Sentiment experimentations

Experimentations of these research studies includes many descriptions, comparisons and evaluations for most of usable algorithms for both Arabic sentiment analysis and Arabi sentiment classification. As we remind latter a definition of Arabic sentiment analysis, we can also define Arabic sentiment analysis in details as it is a general operation which includes number of sequential steps that begins from step of detecting opinion from the Arabic data input that may be founded in reviews of blogs and forums, comments of Facebook, tweets of twitter and online websites, then another serial step is extracting features data input, then that step is followed by another serial one is applying specific algorithm or technique of machine learning approach that is executed to be able to move another step of detecting sentiment polarity whether it is positive, negative or neutral, then at least we reach to the last step witch can clearly classify sentiment of the Arabic text.

As well as we need to differentiate between the two concepts of the Arabic sentiment analysis and the Arabic sentiment classification, so we can also define Arabic sentiment classification as it is a significant step of some

sequential steps of the Arabic sentiment analysis which responsible for determining the polarity of sentiment whether it is positive, negative or neutral [20].

One of Sentiment Classification for Arabic tweets where the author of that paper aims to create lexica of data for the Arabic language by using three classifiers of machine learning algorithms and deep learning techniques are Support Vector Machine, Logistic Regression (LR) and Recurrent Neural Network (RNN). Experiments tries to obtain the best results with the optimal solution which gets high accuracy and performance. Results of that experiments is presented as the following: SVM = 81.52%, LR = 83.73% and RNN = 81.62% so that means the best result is for the classifier of LR = 83.73%, then RNN and then SVM [21]. But In that research study [22] another methodology would be applied for the opinion mining of Arabic language on several tweets such as: Naive Bayes, Support Vector Machines, Maximum Entropy, Adaptive Boosting (AdaBoost) and Support edge Regression (RR) with best result of accuracy RR = 99.90%.

Another Arabic sentiment analysis and classification is used in [23] where Support Vector Machine classifier, Random Sub Space algorithms (RSS) and the Genetic Algorithms (GA) which applied on data that were collected to be tested from Arabic newspaper about 1000 of Arabic reviews. the hybrid approach is linked with Random Sub Space algorithms (RSS) for classification enhancement results.

Rahab, H., Zitouni, A., Djoudi, M. in the research study [24] which use number of comments about 92 Arabic comments from different Websites of newspaper to create ARAACOM that is Corpus of ARAbic Algerian. Support Vector Machine classifier and Naïve Bayes classifier are applied on the data set but the best result is for bi-gram word model which is obtained after trying two various methods are used to be tested on that collected data by using uni-gram word model and bi-gram word model.

As showed in research study [25] the data is used for the opinion mining is the Arabic of the Saudi dialect on Twitter whereas authors evaluated its selected features which were collected from the AraSenTi lexicon to advance some techniques for sentiment analysis and classification are: the first one is called as the two ways (positive and negative), the second one is also called the three ways (positive, negative and neutral), and at least the third one is called the four ways (positive, negative, neutral, and mixed).

This research study is done by both Authors Mohcine Maghfour and Abdeljalil Elouardighi whereas they aim to improve performance and accuracy of two applied classifiers are Support Vector Machine and Naïve Bayes for the classification of Arabic sentiment are used for some collected Facebook comments that were written in both Moroccan dialectical Arabic and Modern Standard Arabic. the results of accuracy for those classifiers as the following NB = 81.83% and SVM = 78.94% they test all benefits of the Arabic corpus classification whether if it is Modern Standard Arabic or dialectical [26].

Another methodology of an Arabic opinion mining is showed in research study [27] which applies two of most important machine learning classifiers are Support Vector Machine and Naïve Bayes also on both Jordanian dialectical and Modern Standard Arabic. Examinations would select two features are Term Frequency–Inverse Document Frequency TF–IDF weighting scheme through bigrams and n-grams considered the best combination and outs the highest performance of Naïve Bayes classifier.

In research study [28] uses a combination of several classifiers as the following: Support Vector Machine, Naïve Bayes, Maximum Entropy, Decision Tree, Artificial Neural Networks (ANN), BOOSTING, RF, AGGING. Authors use a hybrid approach by having aids from the corpus-based approach like lexicon-based approach by obtaining terms with the same meaning in lexicon. the highest performance by using RF classifier that gets an accuracy RF = 96.34%.

Also, in [29] which analyzing some collected Arabic tweets from twitter website that based on Modern Standard Arabic (MSA). The Arabic sentiment classification methodology is applied by using supervised machine learning approach Naïve Bayes classifier with an accuracy NB = 64.85%. In addition to the research study [30] which is prepared by Mustafa Hammad, Mouhammd Al-awadi is used to classify Arabic sentiments by applying Support Vector Machine classifier, Naïve Bayes classifier, and Decision Tree on some reviews of social media data with the highest accuracy of DT = 96%.

One of recent works by Hamed Al-Rubaiee, Renxi Qiu and Dayou Li [31] which analyzed Arabic tweets of twitter social media data by applying two of Machine Learning approaches are Support Vector Machine classifier and

Naïve Bayes classifier where the accuracy of them SVM = 89.68% and NB = 82.7%. as well as [32] presents some techniques which based on the Modern Standard Arabic to classify Arabic sentiments from different newspaper and movie reviews. That work selected several features to be ready for applying classifiers of Machine Learning such as Opinion, stylistic, discourse, morphological and domain features. three main classifiers are used: Support Vector Machine, Maximum Entropy and Artificial Neural Networks (ANN). The highest classifier accuracy of ANN = 85.6%.

Another research study [33] which applied one of supervised technique is Support Vector Machine (SVM) for classifying sentiments on some of Twitter's Arabic tweets and microblogs that used Standard and linguistic features with the accuracy of SVM = 95%. Also, in the work of [34] by using the existing corpora to create a lexica and techniques of pre-processing and selected features then the result presents the highest accuracy of SVM = 96.1% after applying classifier of Support Vector Machine and other classifiers such as both of Naïve Bayes and Key-Nearest-Neighbor on Arabic sentiment Tweets Dataset (ASTD).

Classifying an Arabic Sentiments for different OCA corpus Books reviews by using techniques of supervised machine learning approach are Support Vector Machine and other classifiers such as Naïve Bayes to get the highest performance and accuracy of NB classifier [35]. Also, in that research study [36] which used for classifying several collected Arabic comments of Facebook and the optimal result is for classifier of Support Vector Machine from different applied techniques Decision Tree, Key-Nearest- Neighbor, Support Vector Machine, Naïve Bayes. The two same used techniques Support Vector Machine and Naïve Bayes. which are also applied to several web sites. comments of Facebook and bolos to classify Arabic sentiments that is showed in [37].

A sentiment classification for some Arabic reviews on different websites of Yahoo Maktoob showed in a research [38] by using Support Vector Machine and Naïve Bayes with many features' extraction and pre-processing techniques. Comparing with Naïve Bayes results, the best result of Support Vector Machine. In another research study [39] which extracting features of word n-grams and characters n-grams and then using some techniques of preparation step known as pre-processing such as Stemming and light stemming applying these three techniques of Key-Nearest-Neighbor, Support Vector Machine and Naïve Bayes that produces the highest accuracy of NB = 96.6%. in that work [40].

5. Comparisons of Arabic sentiments

Table 1, presents a typical comparison of various algorithms of Arabic Sentiment Analysis (SA) and Arabic Sentiment Classification (SC) which taken from several research studies. That table will provide us a deep look of some utilizations in opinion mining, evaluations, characteristics and analysis of each algorithm for sentiment analysis and sentiment classification based in the Arabic Language on number of categories while each attribute of the table refers to specific category. First table attribute is reference number of each research study is used, second one is the authors of them, third one the publication year of those used research studies, fourth is sentiment domain oriented during analysis phase and classification phase if the value is yes or no. Fifth attribute determines the type of polarity of sentiment that may be (pos / neg) if data is used for classification or may be (G) that means the used data is general, attribute number six identifies the type of sentiment which includes six types are (SA), (CS), (FS), (BR), (ED) and (TL) where (SA) refers to Sentiment Analysis, (CS) refers to research studies that use Sentiment Classification as a solution, (FS) Feature Selection that refers to process of mining Feature of Sentiment from research studies, (BR) Building Resource that refers to a three classifications lexica, corpora or dictionaries and both (ED) Emotion Detection and (TL) Transfer Learning are used to show research studies that use (SA) Sentiment Analysis. Seventh attribute is to determine the field of chosen data set, attribute number eight is for the source of data, nineth one is the kinds of used algorithms of both Arabic sentiment analysis and Arabic sentiment classification, the tenth attribute table is for the optimal algorithm is used.

Table 1. Comparison of Sentiment Analysis and Sentiment Classification in Arabic Language.

Ref.no	Author Name	Year	Domain oriented	SA Polarity	SA Types	Field of Data	Source of Data	Algorithm Used	Optimal Algorithm
[21]	Kariman Elshakankery, Mona F. Ahmed.	2019	No	Pos/Neg	BR	Arabic Tweets	Twitter	Support Vector Machine (SVM), Recurrent Neural Network (RNN), Logistic Regression (LR)	Support Vector Machine (SVM)
[22]	Gamal, D., Alfonse, M., Salem, A.M.	2019	No	Pos/Neg	SA	Arabic Tweets	Twitter	Naïve Bayes (NB), Support Vector Machine (SVM), Maximum Entropy (ME), RR, AdaBoost	Support edge Regression (RR)
[23]	Ziani, A., Zenakhra, D., Cheriguene, S., Aldwairi, M.	2019	No	G	SC	Social Media Data	Arabic newspaper reviews	Support Vector Machine (SVM), Random Sub Space (RSS), Genetic Algorithms (GA)	Support Vector Machine (SVM)
[24]	Rahab, H., Zitouni, A., Djoudi, M.	2018	No	Pos/Neg	SA	Social Media Data	Arabic newspaper website	Support Vector Machine (SVM), Naïve Bayes (NB), uni-gram word model, bi-gram word model	bi-gram word model
[25]	Nora Al-Twairesh, Hend Al-Khalifa, AbdulMalik Alsalman, Yousef Al-Ohali.	2018	No	Pos/Neg	SA	Arabic Tweets	Twitter	Support Vector Machine (SVM)	Support Vector Machine (SVM)
[26]	Mohcine Maghfour, Abdeljalil Elouardighi,	2018	No	Pos/Neg	SC	Facebook comments	Facebook	Support Vector Machine (SVM), Naïve Bayes (NB)	Naïve Bayes (NB)
[27]	Khaled Mohammad Alomari, Hatem M. ElSherif, Khaled Shaalan.	2017	No	Pos/Neg	SA	Arabic Tweets	Twitter	Naïve Bayes (NB), Support Vector Machine (SVM)	Naïve Bayes (NB)
[28]	Mariam Biltawi, Ghazi Al-Naymat, Sara Tedmori.	2017	No	Pos/Neg	SA	Arabic tweets	Twitter and DCA	Support Vector Machine (SVM), Naïve Bayes (NB), Maximum Entropy (ME),	RF

								Decision Tree (DT), Artificial Neural Networks (ANN), RF BOOSTING, AGGING	
[29]	Lamia Al-Horaibi, Muhammad Badruddin Khan.	2016	No	Pos/Neg	SA	Arabic tweets	Twitter	Naïve Bayes (NB)	Naïve Bayes (NB)
[30]	Mustafa Hammad, Mouhammd Al-awadi.	2016	No	Pos/Neg	SC	Social Media Data	Arabic reviews	Support Vector Machine (SVM), Naïve Bayes (NB), Decision Tree (DT)	Decision Tree (DT)
[31]	Hamed Al-Rubaiee, Renxi Qiu, Dayou Li.	2016	No	Pos/Neg	SC	Arabic tweets	Twitter	Support Vector Machine (SVM), Naïve Bayes (NB)	Support Vector Machine (SVM)
[32]	Amine Bayoudhi, Hatem Ghorbel, Lamia Hadrich Belguith	2015	No	Pos/Neg	SA	Newspaper and movie reviews	Arabic reviews	Support Vector Machine (SVM), Maximum Entropy (ME), Artificial Neural Networks (ANN).	Artificial Neural Networks (ANN)
[33]	Hossam S. Ibrahim, Sherif M. Abdou, Mervat Gheith.	2015	No	G	SA	Arabic tweets and microblogs	Twitter and websites	Support Vector Machine (SVM)	Support Vector Machine (SVM)
[34]	Mahmoud Nabil, Mohamed A. Aly, Amir F. Atiya.	2015	No	Pos/Neg	BR	Arabic tweets	Twitter	Key-Nearest-Neighbor (KNN), Support Vector Machine (SVM), Naïve Bayes (NB)	Support Vector Machine (SVM)
[35]	Mahyoub, F., Siddiqui, M., and Dahab, M.	2014	No	Pos/Neg	SC	Movie reviews	OCA corpus Book reviews	Support Vector Machine (SVM), Naïve Bayes (NB)	Naïve Bayes (NB)
[36]	Faqeeh, M., Abdulla, N., Al-Ayyoub, Y., and Quwaider, M	2014	No	G	SC	Facebook comments	Facebook	Decision Tree (DT), Key-Nearest- Neighbor (KNN), Support Vector Machine (SVM), Naïve Bayes (NB)	Support Vector Machine (SVM)
[37]	Akaichi, J	2014	No	G	SC	Arabic comments	Facebook and Blogs	Support Vector Machine (SVM), Naïve Bayes (NB)	Support Vector Machine (SVM)

[38]	Nawaf A. Abdulla, Mahmoud Al-Ayyoub, Mohammed Naji Al-Kabi,	2014	No	Pos/Neg	SA	Arabic reviews	Yahoo maktob web site	Support Vector Machine (SVM), Naïve Bayes (NB)	Support Vector Machine (SVM)
[39]	Rehab Duwairi, Mahmoud El-Orfali.	2014	No	Pos/Neg	SA	Arabic newspaper	movie datasets	Support Vector Machine (SVM), Naïve Bayes (NB), Key-Nearest- Neighbor (KNN)	Naïve Bayes (NB)
[40]	Muhammad Abdul-Mageed, Mona Diab, Sandra Kübler.	2014	No	Pos/Neg	SA	Arabic tweets and social media data	Twitter, forums and chats	Support Vector Machine (SVM)	Support Vector Machine (SVM)

6. Conclusions

Analysis and classification of textual data in Arabic language is considered one of the most significant scope that widely relates and services several scopes such as medicine, finance, manufacture, agriculture and online businesses where it plays a great role in increasing online users satisfaction by improving products that is also by analyzing and classifying different textual opinions and attitudes founded in different textual sources such reviews, comments, tweets and others. That research study could define roles of sentiment analysis and classification and their kinds of polarity, types, levels and classes. It presents some characteristics of the most effective categorization for techniques and algorithms of machine learning approaches and compare between them in addition to their using to evaluate textual Arabic sentiments. The future work, by widely discovering and exploring many research studies of opinion mining we can improve techniques and algorithms of the Arabic sentiment analysis to be examined, evaluated and compared among them. also, we will arrange to enhancing a special schema for differentiating between both types of Arabic language, Arabic dialects and modern slandered Arabic.

Funding: "This research received no external funding"

Conflicts of Interest: "The authors declare no conflict of interest."

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