

# Sentiment Classification of Reviews using Combination of Flower Pollination Algorithm and ANN

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**Abstract**—With the availability of many social media sites, the reviews and comments by the customers are freely available for analysis. As reviews are in text, the amount of words needs to be processed for any analysis work is very large in amount. So, approaches need to be adopted for minimizing count of words without affecting the result. Thus, Flower Pollination Algorithm is used in present paper to select the fit reviews by using a fitness function. These fit reviews are then given input to Artificial Neural Network (ANN) for further classification. The classification result is evaluated with the help of confusion matrix and various other performance evaluation parameters obtained from the confusion matrix. Finally, the result is compared with the result of existing papers to validate the result. The accuracy value obtained is 97.7%, which is found out to be comparably better than recent manuscripts in the same area.

**Index Terms**—Sentiment analysis, Flower pollination algorithm, Artificial Neural Network, Fitness function, Confusion matrix, Performance evaluation parameter

## I. INTRODUCTION

Everyone feels free to express their feelings and thoughts on social media these days by leaving comments or providing criticism. These reviews are valuable in determining how consumers feel about the product and may also assist new users in selecting reviews for later usage. Because these remarks are textual in nature, they must be analyzed in order to extract any relevant data. The words that are used in a document are what matter most when it comes to analysis. However, it is noted that the dataset's word list is rather lengthy and requires additional analysis to condense without compromising the research's conclusion. Therefore, gathering evaluations from a trustworthy source, processing these reviews, and then extracting relevant data for further analysis and subsequent work is the definition of sentiment analysis [1].

Each reviewer has a different writing style, so some prefer to write their reviews in a document, some write them in just

one or two sentences, some compare the product to others rather than making direct comments about it, and some offer feedback on a specific feature, such as a mobile camera. Feldman has examined the extent of sentiment analysis in relation to the standards of review authoring and, ultimately, review processing [2]. A basic overview of Feldman's suggested degree of sentiment analysis is shown in Figure 1.

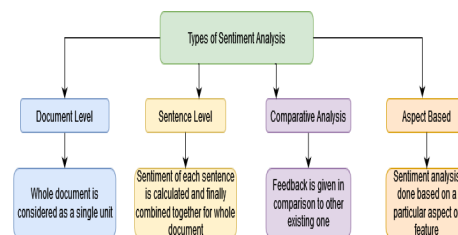


Fig. 1. Sentiment Analysis types

For this proposed work, the whole reviews are considered as a single unit for the analysis purpose i.e., document level approach is adopted. This is because, when the other methods are used for processing the flow of the analysis is get disturbed by partitioning the reviews to sentence level.

Whatever the activities happen in the natural world, it is always a learning for us. In each and every field of life, these learning are used. Similarly, the motion of birds, the food searching of other animals are taken into consideration for the implementation of machine learning techniques. Yang has studied many such activities and tried to transform them into a form, that can be used in machine learning analysis [3]. Among the many nature inspired algorithms few are mentioned below:

- **Genetic Algorithm (GA):** This method suggest how the

genetic evolution has happened in the nature. According to Darwin theory, only the fit elements are allowed to go through the process of next generation. Thus, the GA approach proposed by J.H.Holland in 1975 suggested that only the best or fit elements can only go through the process and unfit are neglected. But, later research suggested method like mutation and cross over to transform the unfit one to fit once.

- **Ant Colony optimization (ACO):** Ant, a social animal, always in search of the food to make their colony stronger. They always communicate with other through their pheromone, to suggest their colony member where is source of food or where the enemy lies. This concept is transformed to machine learning approach by Marco Dorigo in 1992 during his Ph.D. work.
- **Particle Swarm Optimization (PSO):** Particles like birds, honey bee and others always moves in the group or swarm for searching food and other resources needed for their survival and future. As they move along different paths, they might found out different solutions but among them they choose the best one and move together to active the success. This concept of particles are observed by James Kennedy and Russel C. Eberhart in 1995 and proposed the PSO method.
- **Flower Pollination Algorithm (FPA):** Xin-She Yang had proposed FPA in 2012 [4]. This algorithm is based on the principle of flower pollination i.e., the agents like birds, butterfly and others first search for the male flower. Then collect pollen from their and then search for the female flower. The pollen collected from male flower stick to the stigma of female plant and the breeding happens. This process is proposed in this algorithm.

The present paper proposed the use of supervised ML technique but in a hybrid manner i.e., two different ML techniques are combined together to obtain a better result. First, flower pollination algorithm is used, which select the best features from the set of all features by using the fitness function. These fit features are than given input to ANN for further classification purpose.

#### Motivation for proposed approach

The motivation to perform the current research work is mentioned as below:

- 1) Part of speech (POS) tag is considered by many others for sentiment analysis. But, for a particular word the POS is not fixed. The word having POS, adjective and adverbs are mainly considered for analysis of sentiment but as the POS of word is not fixed, in some case the output is not considered. In present paper, instead of using POS as a criteria for sentiment analysis, the sentiment value of each word is considered, which eventually affect the whole document.
- 2) Many authors prefer to use only one machine learning technique to process the reviews. But, it is observed that the bias or shortcoming of the ML techniques plays a role in final output. In order to solve this issue, a combination

of two ML techniques namely Ant Colony optimization and ANN are used for analysis are proposed.

- 3) **Choice of Flower Pollination Algorithm (FPA):** Flower Pollination Algorithm is an optimization technique. In present paper, it is used for feature selection. In feature selection technique, a set of best features are chosen from the dataset, which act as the representative of the whole dataset. The reason for selection of optimization technique is that it not only select the best features but also try to make the unfit ones to fit by changing some parameters of the reviews. Thus, a good number of representative of the dataset is obtained. Any of the optimization algorithm can be taken for analysis, there is no such reason for selecting FPA in present paper.

The current paper can be organized as follows: information about the recent existing papers in the area of sentiment analysis is mentioned in Section II. The methods used for processing the reviews, their source, types and the ML techniques used in the current paper is depicted in Section III. The way the mentioned methodologies are used to achieve the classification result described in Section III is explained in Section IV. A comparison of the obtained result need to be done with existing results, which is mentioned in Section V. Eventually, the paper is concluded with a concluding remark and the future aspects that can be carried out for deeper analysis in Section VI.

## II. RELATED WORK

Document level Sentiment analysis based research work using hybrid machine learning techniques has been performed by many authors. Some of the recent work are mentioned below briefly.

Kaur and Sharma [5] have used hybrid feature selection approach and then use the ML technique for processing of reviews. They proposed approach consist of features related to reviews (RRF), which include the TF-IDF value, polarity of emotions, and n-gram. The other feature selection technique is related to aspect (ARF). Finally, both approach are combined together to form Hybrid Feature Vector (HFV). The HFV is given input to LSTM for classification. They have considered multiple dataset like STS-Gold dataset, Sentiment140, and SemEval-2014 restaurant review dataset. The highest accuracy achieved by their suggested approach is found out to be 92.7% for Sentiment140 dataset using LSTM and HFV.

For processing the reviews Tripathy *et al.* [6] have suggested an hybrid approach, which is combination of ANN and GA. Their analysis is carried out on the polarity movie review dataset. They have used GA for the feature selection stage of the study. ANN performs further processing on the finest characteristics that GA has yielded. They use changeable hidden nodes to do analysis since, in an ANN, the input and output nodes are relatively fixed. The greatest accuracy of 96.6% is finally attained for 600 hidden nodes.

Gite *et al.* [7] have proposed ACO for feature selection for hate speech classification problem. They have conducted their research on two different dataset i.e., variation of Twitter reviews. They have used ACO for feature selection and the

selected features are than given input to KNN, Logistic Regression, Random Forest and Stochastic Gradient Descent [8]. The highest accuracy achieved by their suggested approach is found out to be 80% using combination of ACO and Random Forest.

Zitnik *et al.* [9] have used Senticconf 1.0 dataset for sentiment analysis. They have used Entity document model, where the TF-IDF and Word2Vec methods are used. Further, they used dependency model to find out relation between the words considered for analysis. Finally, Deep Neural Network is used to classify the reviews and The highest accuracy achieved by their suggested approach is found out to be 77%.

Tripathy *et al.* [10] have perform the sentiment analysis in document level using SVM and ANN. For the purpose of feature selection, they have selected SVM among other ML techniques . Using SVM, the sentiment values of each features / words are obtained. For selection of features sentiment value of the words more than 0.009 in both positive and negative scale are selected for further analysis. While executing the ANN, they have keep on changing the hidden nodes to check flow of the result. For IMDB dataset, the peak accuracy is obtained at 600 hidden nodes is 95%, for Polarity dataset, the peak accuracy obtained at 500 hidden node is 96.4%.

Sunitha *et al.* [11] have used Tweeter tweets for analysis. They have collected 3100 tweets consisting of 2000 European and 1100 Indian tweet during lock down of COVID-19 related to lock down, Corona virus. Then, used topic modeling using LDA techniques to model the tweets based on a particular technique. Finally, the obtained results are processed using a combination of CapsNet and GRU model. The highest accuracy achieved by their suggested approach is found out to be 96.65% on European tweets with 10 fold cross validation technique.

From the literature survey, it is observed that many authors prefer to use the hybrid approach i.e., combination of multiple machine learning techniques to obtain a better result. The traditional machine learning technique selected the features only once and after that the unfit features are neglected. But, when a optimization technique is used, it select the features and again process the unfit ones to make them fit by using different operators or functions. Thus, FPA technique is adopted to select all the features that met the criteria and with the help of these features, the reviews are classified by ANN.

### III. METHODOLOGY USED

#### A. Kinds of sentiment analysis

Like all other system of processing, Sentiment analysis also have different levels. These levels are mainly used on the final classification result. Tang *et al.* [13] have proposed a method of categorization of the result after sentiment classification process, which is shown in Figure 2

In this research work, the reviews are categorized into either positive or negative class, i.e., binary classification concept is adopted.

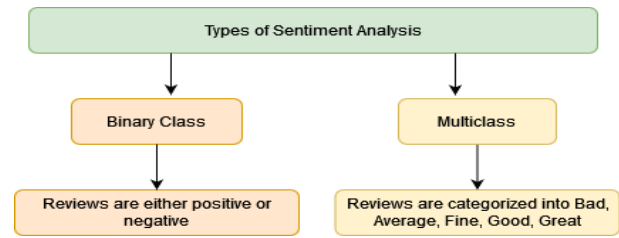


Fig. 2. Types of Sentiment Analysis

#### B. Transformation of reviews

Most of the machine learning techniques prefer into in the matrix format i.e., of integer or float value. But, when the case of sentiment analysis comes, the inputs are text reviews. Thus, a proper transformation need to be done, so that, the reviews can be processed by machine learning technique. Garetta and Moncecchi [14] have suggested different techniques to transform the text reviews to machine learning technique suitable form, i.e., Count Vectorizer and TF-IDF. The details of these approaches can be informed in the Figure 3.

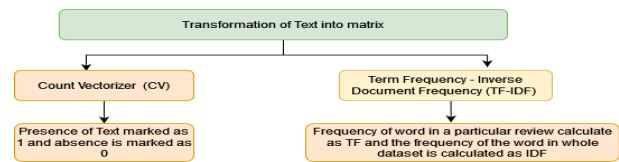


Fig. 3. Transformation of text into matrix

The present research work suggested the use of TF-IDF method the transform the reviews as it not only work on the occurrence of the word but also the frequency of the occurrence of the words.

#### C. Dataset for analysis

The approach of analysis or the process need to be verified on a set of dataset to check that whether the process adopted is correct or wrong. Thus, collecting the reviews (in case of sentiment analysis) from a reliable source, which is used by different authors previously in their research work along with that the amount of reviews contained in the dataset should be enough for a proper research work is a important as well as difficult task. aclIMDB dataset is proposed by Mass *et.al.* [15], which ticked all the requirement for a good dataset. The information about the dataset is mentioned below:

**aclIMDB dataset:** The researchers always prefer the dataset, which is freely available because that dataset is used by different authors for their work like aclIMDB. Again, the dataset must contain the reviews of different categories so that it will be useful for different types of analysis. In this dataset, both labeled and unlabeled reviews are present for analysis. The labeled reviews are again divided into testing and testing dataset. For both testing and training purpose, 12500 positive and same number of negative reviews are there, which is

labeled. For unlabeled dataset, 50000 reviews are there without any label.

#### D. Machine learning technique adopted

The Section I informs that two machine leaning techniques are used in present paper. Firstly, Flower Pollination algorithm is used, which does the work of feature selection through the process of optimization and then, the selected features are given as input to ANN for further analysis. The details of the techniques are discussed as follows:

1) **Flower Pollination Algorithm (FPA)** The FPA was proposed by Xin-She Yang in 2012, inspired by flower pollination process of flowering plants [4]. Later, the algorithm is extended to multi-objective optimization problem. The different rules for FPA is as follows:

- Biotic or cross-pollination can be considered as the global pollination process.
- For abiotic or self-pollination is considered as local pollination process.
- Pollinators such as inserts, birds, animals develop flower consistency, which is proportional to similarity between two flowers.

In present paper, FPA is used for feature selection. The algorithm adopted to perform FPA is explained in Algorithm 1.

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#### Algorithm 1 Flower Pollination algorithm

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**Basic Input** A set of search space or data items for the analysis.

The set of constraints  $\alpha$  need to checked on the data items.

The objective function  $fun$  to obtain the best fit data items

**Outcome:** The best fit data items for further processing.

Population is initialized. Random initialization of population is done for N flowers, where, N = flower size.

Fitness function evaluate performance for each agent for initial population.

Checking stopping criteria.

**while** iteration < max\_iteration **do**

**for** 1:N **do**

        Calculate step using Levy Distribution

        Evaluate solution

**if** The new result is better than older one **then**

            Update result

**end if**

**end for**

**end while**

Output the feature subset

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In present work, the FPA is used for classification of the reviews.

- In FPA, the Pollinators search for the male flower. They collect the pollen from the male power and then stick it to the stigma of female flower. But, when the classification of the sentiment is carried out, there is no concept of pollen or male / female flower and

thus, the words present in the text and its sentiment value plays the role of male / female flower. For example, as the supervised sentiment classification is carried out, the label or the polarity of the reviews are known earlier i.e., if the number of positive words are more in compared to that of negative words than the review is classified as positive or else it is classified as negative. Thus, the sentiment value of the words act as male / female flower. The positive labeled reviews can be considered as the male flower, similarly the negative labeled reviews are considered as female flower. The male flower identified by pollen, similarly the positive labeled reviews contains the words having positive polarity. The female flowers identified by stigma in it, similarly, the negative labeled reviews contains the words having positive polarity

- Finally, like the FPA algorithm, an objective function is set to check whether the reviews pass through the test and marked as fit ones. In present work, K-Nearest Neighbor (KNN) algorithm is used as the objective function. The 'k' value is set to be two as binary classification is carried out. All the reviews go though KNN to check the result. If the predicted polarity of the reviews matched with the actual ones that are marked as fit reviews.

2) **Artificial Neural Network (ANN):** The process of Neural Network classification represented using the following mapping function:

$$F : N^d \rightarrow N^m$$

The Figure 4 informs the basic composition of a neural network. The 'd' represent the submitted input dimension to the network, 'm' represents the classification output obtained by the network. The input layer contains 'd' number of independent signal, the number of hidden layer and the neurons in the hidden layer is finalize by the user, the output layer contains 'm' number of dependent neurons. In the present work, one hidden layer and two output neurons are considered for analysis purpose.

Selected Features ( $n_1$ ) Hidden layer ( $n_2$ ) Classification results ( $n_3$ )

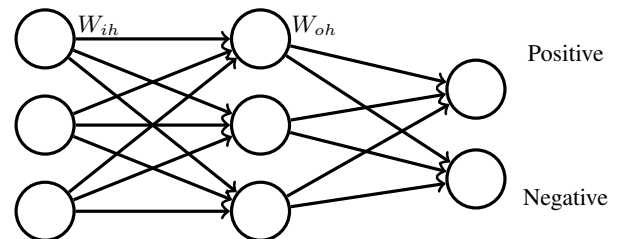


Fig. 4. A basic composition of Neural Network

#### E. Performance Evaluation Parameters

After the analysis of the reviews are performed, the performance must be evaluated using some parameters. As su-

pervised technique has the labeled reviews, which help to compare the predicted label with the actual label and thus, performance is evaluated [10]. Confusion matrix is mostly used in case of supervised approach for evaluation of performance. The confusion matrix is informed in Figure 5.

		Predicted Values	
		Positive	Negative
Actual Values	Positive	TP	FP
	Negative	FN	TN

Fig. 5. Confusion Matrix

Confusion matrix only can not evaluate the performance. So, other parameters generated using the using it. The parameters generated using confusion matrix are shown in the Figure 6, which also help to compare the result with the recent research work.

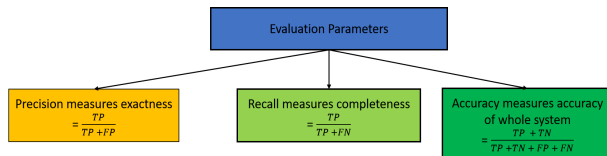


Fig. 6. Performance Evaluation parameters using confusion matrix

#### IV. PROPOSED APPROACH

The current research work is based on document level sentiment analysis using combination of two machine learning techniques namely, FPA and ANN. For classification purpose, the aclIMDB dataset is considered with the labeled reviews only. These reviews are in textual in nature and thus, pre-processing is needed to removed unwanted information. Then, the reviews are transformed into matrix format. The transformed matrix is given input to FPA for feature selection, the selected feature are then given to ANN for final classification. The classification results obtained using confusion matrix and corresponding performance evaluation parameters. Proposed approach can be represented using the Figure 7.

The proposed approach can be described as follows:

- Step 1. For clustering purpose, aclIMDB dataset is considered. This dataset contains both labeled and unlabeled reviews. For the present analysis work the labeled reviews are considered for analysis.
- Step 2. Sentiment analysis is performed on comments and as those are in textual manner. The reviews may contain unwanted information, thus need to be removed [10].
  - **Stop words:** These are the words that are used frequently in the text but do not have any effect

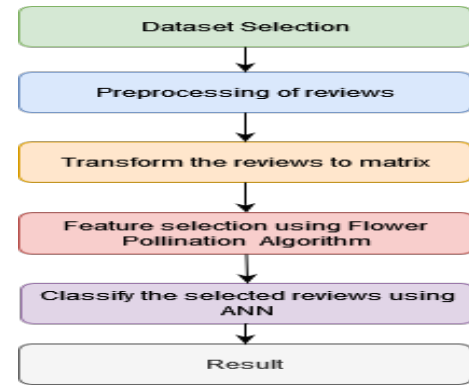


Fig. 7. Flowchart based proposed approach representation

on the sentiment of the reviews and thus, need to be eliminated during the pre-processing phase. Again, these words increase the word count during the analysis, which eventually increase the time of processing.

- **Stemming:** Words mainly the verb can have different forms in the text. But, when the analysis is carried out, only one version is considered for analysis i.e., the root word. During the process of stemming the root words for the verbs are find out and replaced.

- Step 3. The transformation of the reviews into matrix format is started after the completion of the pre-processing phase. The matrix is then given input to the machine learning algorithm for further analysis. In present paper, TF-IDF is used to transform the text as it considers both the presence and frequency of the word during matrix transformation.
- Step 4. The transformed matrix of reviews are given input to FPA for the feature selection process. The objective function is set and the reviews satisfy the criteria are considered as fit reviews. After the implementation of FPA, the fit reviews obtained are 13879 out of 25000 reviews. Among these 13889 reviews, 6861 are positive labeled reviews and 7018 are negative labeled reviews.
- Step 5. The fit reviews obtained after the feature selection using FPA is given input to ANN for final classification. The proposed ANN contains 13879 neurons in input layer, one hidden layer and two output layers. The number of neurons in the hidden layers are kept on changing during the analysis process. Initially, it starts from 200 nodes and then, 400, 600, 800 and 1000 hidden nodes are considered in hidden layers. Afterwards, again the analysis is carried out by adding 500 nodes like 1500, 2000, 2500, 3000 nodes. The accuracy obtained using the varied nodes are initially observed to be in increasing mode and decrease. The highest accuracy obtained is shown in this Table I.
- Step 6. The confusion matrix obtained after processing the



13879 reviews is presented in Figure 8.

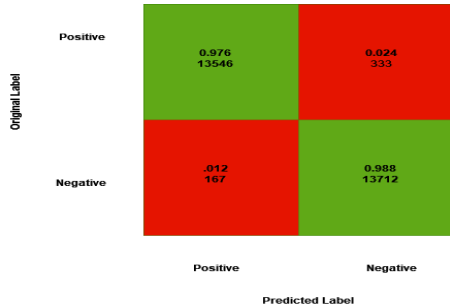


Fig. 8. Confusion matrix obtained after analysis

The parameters generated using confusion matrix is informed in the Table I.

TABLE I  
CONFUSION MATRIX GENERATED EVALUATION PARAMETERS

	Evaluation Parameters		
	Precision	Recall	Accuracy
Positive	0.976	0.97	0.977
Negative	0.979	0.975	

## V. RESULT ANALYSIS

In the recent time, the sentiment analysis is an important research area for researchers. Different authors have done the research in the area of using hybrid machine learning technique in the field of sentiment analysis. The following Table II provides a comparative analysis of the obtained result with the result of other papers.

TABLE II  
RESULT COMPARISON BETWEEN PRESENT AND RECENT PAPER

Authors	Dataset Used	Technique Used	Highest Accuracy achieved
Kaur and Sharma [5]	Sentiment 140	HFV + LSTM	92.7
Tripathy <i>et al.</i> [6]	Polarity dataset	GA + ANN	96.6
Zitnik <i>et al.</i> [9]	Senticnf 1.0	Entity document + DNN	77
Tripathy <i>et al.</i> [10]	IMDb and Polarity	SVM + ANN	96.4
<b>Proposed Approach</b>	<b>IMDb</b>	<b>FPA + ANN</b>	<b>97.7</b>

The Table II shows the comparison between the result obtained by different authors. It is observed that most of them use different approach for feature selection or preprocessing, then, the obtained result is classified using Neural Network or its different versions. The present approach has shown a better result as the preprocessing is done in much better way, then the conversion of the reviews to matrix format is done using TF-IDF. Afterwards, FPA is used for feature selection and finally, ANN is used for classification to obtain the best result.

## VI. CONCLUSION AND FUTURE WORK

In present paper, the document level sentiment analysis is carried out using hybrid machine learning approach. The reviews, which are considered for analysis, is textual in nature

and thus, words play a role in finding out the sentiment of the text. But, it is observed that after the initial preprocessing steps, the number of words obtain is huge in number and thus, need feature selection. This feature selection is the process of selecting the features that act as representative of the whole dataset without affecting the final result. In present paper, FPA is considered for feature selection and then the selected features are analyzed using ANN. The obtained result is analyzed using confusion matrix and evaluation parameters provide the quality of obtained result. In order to perform this implementation work, python programming language is used with the help of scikit learn package, which contains program related to ML. The proposed approach work on word but now the writing style has significantly changed, i.e., emojis and words like “fineee”, “okkkk” and similar types of words used in reviews. The emojis and the deformed words are not processed in present work. As emojis are images, it needs other type of processing and for deformed words, the root words need to be found out. Thus, these tasks are considered for the future work, which need more analysis and attention.

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