

Research Article

## Aspect Based Sentiment Analysis by Fuzzy Logic

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### Abstract

*Sentiment is something that a person expresses through his actions, speech, expressions, text. Sentiment analysis helps in knowing about people's opinions and emotions towards events and products. These opinions matters as it affects others' opinion and helps in decision making. Up till now we have known the sentiment as few categories: angry, sad, happy, etc. but here the author proposes to throw some light on the intensity part of emotions showing the emotions which doesn't exactly lie in the pre-decided categories. Fuzzy logic is an approach to find the degree of truth rather than fixed 0,1. Here in this paper a system is going to be proposed that uses fuzzy logic to classify opinions in categories as negative, strong negative, positive, strong positive. In this model, a system will be proposed for the imputation of the missing sentiment so as to generate a precise result.*

**Keywords:** Aspect, Sentiment analysis, Fuzzy Logic, Label Propagation, Sentiment summarization.

### 1. Introduction

The advancement in web and technologies like public forums, social networking sites have profoundly transformed the manner in which individuals collaborate with others and explain themselves. Individuals are now able to contribute their sentiments on any and every single thing available online or offline. They share their suppositions, thoughts and interests depending on the reviews that are obtained from the sites. Representatives depend more on these opinions to gather conclusions on their item's advancement for their business enhancement.

Fuzzy logic is the method to give some values or importance to the partial truth which when integrated further leads to higher truth value. It is just the way our brains work Fuzzy logic is important for human like capabilities for Artificial intelligence. People have the liberty to express their emotion and opinions in many ways like through speech, text, motion pictures, facial expression, etc. and it is on these opinions that people set their premise on before making any decision related to it Sentiment analysis is the way to classify those emotions that are posted on web to get an idea on the feelings or liking/disliking of a group of people who posted about some occasion or item.

Although product reviews greatly influence the business development and help in making decisions but gathering them from different sources and analysing each manually is a tedious task and requires

a lot of time. So sentiment Analysis is used to analyse the sentiments of the people and categorise them in different categories and places and wherever the sentiments cannot be categorised precisely there the probability of the sentiments is found out to fall near a particular emotion using the membership function of fuzzy logic. As the data set increases the probability of each emotion in each review is noted and some might be near to the truth, some might dangle or float between two categories giving us the freedom to the accurately tell on the generalized review of a collection of people without any folly. So the graphical representation will be more of continuous nature than of discrete nature and where the data seems to be more clustered is taken as the final result to review or sentiment analysis with the mathematical probability accuracy. This is how fuzzy will help in sentiment analysis.

We will discuss the following

- Background,
- Methodology, and
- Conclusion

### 2. Background

Some authors made a research on product review sentiment analysis and proposed to extract features from the review and categorize them into negatives, positives and neutral category using sentiment analysis and classification method. Before applying the sentiment classification method the pre-processing

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was done by removing noise, extracting features and isolating parallel descriptors. Then it was expanded to comprehend the consequence of fuzzy functions and linguistic obstructs to mimic the outcome of modifiers, dilator sand concentrators as well. This method was tested and the aftermath showed the accuracy of fuzzy logic in SA which was impressive (K. Indhuja, 2014).

Some authors have used the techniques of unsupervised Machine Learning, fuzzy sets, and a sentiment vocabulary which have been used and enhanced by Senti-WordNet. A Hybrid Standard Classification (HSC) was implemented and upgraded to an approach: Hybrid Advanced (O. Appel, 2016). It combined semantic ranking of linguistic polarity which is given by the fuzzy sets. The polarity (classification category) of any sentence that was presented as review was calculated with the help of new opinion mining technique. In this paper, the dataset used is of Movie Review Dataset.

Other authors worked on another method to analyse the reviews of people on social networking sites. The author took to user’s influence on several messages exchanged in social network along with the authorship of those messages. The result obtained was then used to study the reviews on some product and was then employed for the development of the analytics tools (E.E. Luneva, 2016).

Some other authors determined a way to retain decision makers and city planners to spread awareness on issues related to city such as environmental, security and mobility. They used Fuzzy logic and the Cognitive Maps for the accomplishment of the goals. To establish the relationship between the two fuzzy sets, they had taken signatures and different signatures got assembled to mark a field. In addition to this, the authors preferred the factual concept of (FCS) Fuzzy Cognitive Map along with the implementation of if-then analysis (Giuseppe D, 2016). After experimenting the outcomes were found to be persuasive and created a good consciousness on the quality of urban areas which actually created an effect on the issues that are associated to the city.

Some authors proposed different model for fuzzy clustering for scanning posts or reviews that relate to the sentiments of a specific field or brand. They used the actual dataset of containing 12 months data. An analysis via comparison was produced with the process of K-Means clustering and partitioning technique and alongside Expectation Maximization algorithms were used (Suresh Hima, 2016). The execution time, metric precision accuracy was used. The approach built up was tested and was found to give outstanding twitter result of sentiment analysis.

Some authors put forward a method to retrieve the opinions about the product from manufacturers and customers through Naïve Bayesian classifier and presented a more realistic value of opinions obtained through fuzzy method (V. Reshma, 2015). Sentiment classification was performed and Sentiwordnet and fuzzy method were used to calculate the value of

opinion. The method also considered linguistic hedges to be used in the proposed system. In this proposed mechanism, linguistic hedges were also performed along with the opinions identification. Fuzzy rules magnified the effect of opinion describing the imprecise information and its varying degree of value.

Some author also suggesting the step wise approaches to analysis the public sentiments that includes no. of steps like cleaning, identification and classification (B.N. Supriya, 2016).

### 3. Methodology

The main objective of the research is to develop a new method to count on the linguistic hedges, reduce the neural score and impute the missing sentiment using fuzzy logic.

#### A. System Architecture

The high level view of the proposed system is shown below in Figure 1.

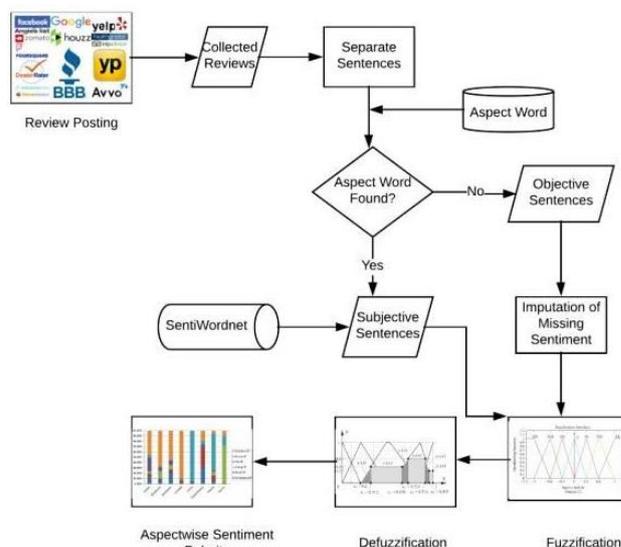


Figure 1 Architecture of the proposed mechanism

The building blocks of the proposed system are

- Collection of Data
- Separation of Sentences
- Label Propagation of Sentences
- Fuzzification Process
- Defuzzification Process
- Summarization (Aspect-wise)

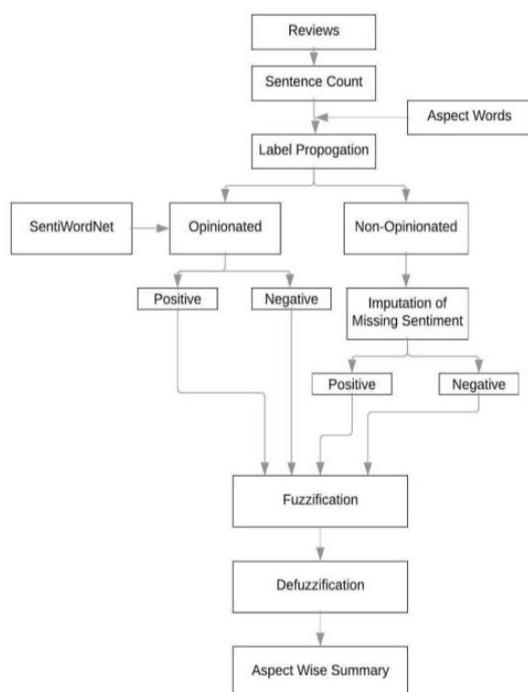
#### B. Approach of the proposed mechanism

The approach for the proposed system is shown by the following steps. These steps will help to explain the architecture of the proposed system in a better and easy way.

- Step 1.** Start  
**Step 2.** Firstly we will collect the reviews  
**Step 3.** Then we will count the Sentence\_Count() method.  
**Step 4.** After Sentence\_Count we will call Label\_Probagation() method  
**Step 5.** Now check label  
**Step 6.** If label is found equal to 'opin' then search in aspect dictionary, obtain the sentiment value with the help of Senti\_WordNet else call for imputation of missing sentiment and end this step.  
**Step 7.** After obtaining the sentiment and its value apply the fuzzification rule  
**Step 8.** Once the fuzzification is applied the result is finally generated by defuzzification  
**Step 9.** Then generate aspect-wise summary  
**Step 10.** End

### C. Workflow

The workflow of the corresponding system architecture showing above is shown in Figure 2.



**Figure 2** Workflow of system architecture

#### 1) Data collection

It is the collection of data from various sources like forums, social networking sites, feedback, comments, tweets, blogs etc. Collection of data can also be done through various surveys. Data collected may be in large number but greatly helps in the process of decision making.

#### 2) Sentence Separation

A sentence comprises of various punctuation that separate one sentence from the other. Sentence

separation means to extract a particular sentence along with a note of the number of sentences counted. Sentence extraction can be made by considering dot, comma, exclamation mark and semi colon. After all the sentences are separated based on these delimiters, for further processing, there is a word array in which each sentence is stored. The procedure is shown as following: Function Sentence\_Count()

#### Step 1. Start

**Step 2.** Read a character till line ends

**Step 3.** If the character is found to be equal to a tab or a space then increase the word count by one

**Step 4.** If the character is found to be equal to '.' or '!' or '?' or '\n' then increase the sentence count by one

**Step 5.** Ask the user to continue more, If 'Y' then goto step 2

**Step 6.** Stop

#### 3) Propagation of Sentence Label

In this process, the sentences are labelled based on propagation of sentence label. It is done through the use of aspect dictionary. The aspect word is searched in the review and the strength of the aspect is noted from the SentiWordNet dictionary. If the review contains the aspect word, it is categorized as 'opinionated' also called subjective as these sentences matter in sentiment analysis and those lacking the aspect value are called 'non opinionated' also called as 'Objective' as those sentences won't matter much in analysis of sentiments. These non-opinionated sentences are the factual sentences and don't participate in sentiment analysis but in case of the missing of the sentiment, imputation of it helps in filling that missing sentiment in the already existing aspect list and strength of the sentiment is noted through the SentiWordNet dictionary. Function Label\_Propagation()

**Step 1.** Look to SentiWordNet

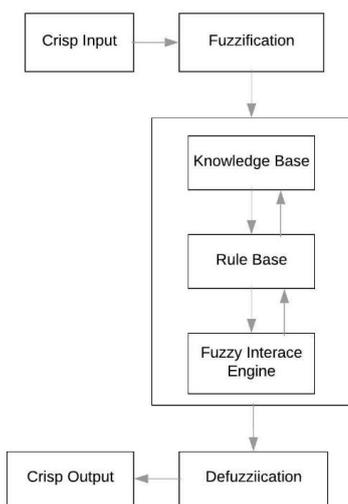
**Step 2.** If the Sentiment Word is found in there label it as 'opin' else label it as 'non-opin'

**Step 3.** Stop

#### 4) Fuzzification

It starts by the identifying the input and output variables. After defining membership function (also known as Fuzzifiers), the rule base design is made to contain IF-THEN rules. Through these function input variables gets transformed into output. Membership function is the heart of fuzzification process and tells "the degree of truth" and can be formed using straight lines. The working mechanism of a process from fuzzification to defuzzification shown below in Figure 3. The simplest is trapezoidal and triangular membership function which takes the advantage of their simplicity. Fuzzification is about using membership function to define the problem graphically.

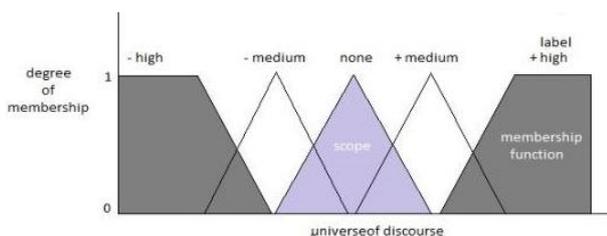
Before taking step ahead in fuzzification one should know about the fuzzy inferencing system. It basically includes three steps like fuzzification, rule evaluation and defuzzification. Now, fuzzification is the first step in an inferencing procedure of fuzzy system in which crisp input values should be converted in to fuzzy input values. Crisp input values are those values taken from the users directly in terms of their recommendations like in movie reviews system one can easily check the review of a movie whether that movie is highly recommended, neutral or less recommended for users. The given figure is showing working mechanism of FIS.



**Figure 3** Working mechanism of Fuzzification and Defuzzification

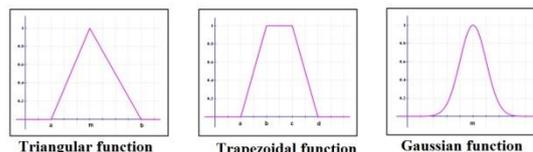
5) *Membership Function*

A membership function was first introduced by Lofti A. Zadeh in his research paper based on “Fuzzy Sets” in 1965. For the given fuzzy values  $x^*$  defined inside any fuzzy set  $X$  and universe of discourse  $U$ , membership function can be used as characterization properties where the values of each fuzzy elements are defined between 0 & 1. It allows us to draw the graphical presentation of fuzzy set along with x-y axis where x-axis represents universe of discourse and y-axis represents degree of membership.



**Figure 4** Membership Function

This can be represented by simple functions like triangular function, trapezoidal function and Gaussian function.



**Figure 5** Membership Function

6) *Rule Evaluation*

The crisp input of the linguistic variable is passed on to the chain: Fuzzification, membership function, defuzzification and then we get the crisp output. Membership function plays the key role in this process (Jorge Roper, 2012). And rule evaluation is all about application of the fuzzy rules.

There exist various types of membership function and it is important to select the most apt membership function for our fuzzy set that best represents the fuzzy modelling. Here in this paper, it is proposed to identify the classification labels to know the potency of the semantic orientation as follows:

- Negative
- Positive
- Weak negative
- Weak positive
- Strong Negative
- Strong Positive

Each sentence in the review if having sentiments as matched from the aspect dictionary is termed as Subjective and sentence having no word of aspect dictionary is termed as Objective. Each subjective sentence exhibits some emotions with some intensity, now this can be positive or negative, and with consideration of intensity part we can categorize each emotion as either positive or negative or strong positive or strong negative as shown below in Figure 4. The membership functions having shapes of triangle or trapezoidal are the best and simplest membership function for this task.

After choosing membership function, we would go for the statement of IF-THEN rule.

Example: For a given variable  $y$  which is supposed to be involved in problem development, so rule can “say” that:

- IF the value of  $y$  is low THEN risk factor of problem is low.
- IF the value  $y$  is normal THEN risk factor of problem is normal.
- IF the value  $y$  is high THEN risk factor of problem is high.

Designing a fuzzy rule to analyse the movie reviews based on the expectation from the movie and story line of the movie:

SP: Strong Positive  
 P: Positive  
 O: Null  
 N: Negative  
 SN: Strong Negative

Storyline	Expectation	SP	P	O	N
SP	SP	SP	SP	SP	P
P	P	P	SP	P	SP
O	O	O	P	O	P
N	N	N	N	N	P
SN	SN	SN	SN	N	N

Figure 6 Rules of Fuzzy controller

6. Defuzzification

Defuzzification is the mechanism of generating a significant outcome in crisp logic if the corresponding fuzzy sets and membership functions are given. While performing this procedure, we are performing the changeover of fuzzified output into crisp output. This process becomes more essential in terms of producing accurate result because we can't get the best outcome only with the help of fuzzification. In real time application, decision has to be taken on crisp values. There are number of modes available for defuzzification like COS, COG/COA, BOS, weighted average method and maxima method etc.

6.1 Mode of Defuzzification

As we mentioned earlier there are various methods available for defuzzification but for a fuzzy reasoning system, the most suited one is maxima method. This method can be further classified in to three categories with various conflict resolution strategies for different maxima like FOM, LOM, and MOM.

6.1.1 First of Maxima Method (FOM)

In the given domain, this method specifies the smallest value with largest membership value. In the given figure, for any given fuzzy set X defuzzified value will be  $x^*=4$ .

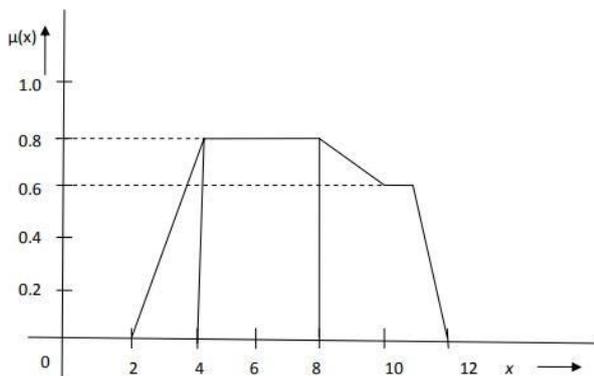


Figure 7 Mode of Defuzzification

6.1.2 Last of Maxima Method (LOM)

In the given domain, this method specifies the largest value with largest membership value. In the given figure, for any given fuzzy set X defuzzified value will be  $x^*=8$ .

6.1.3 Mean of Maxima Method (MOM)

In the given domain, these methods if more than single element of the set X having maximum membership value, the mean value of maxima will be consider. Suppose a fuzzy set X, dataset values x where  $x \in X$  is given then defuzzified value will be defined as:

$$x^* = \frac{\sum_{x_i \in M} x_i}{|M|}$$

And the final defuzzified value will be  $x^*=6$ .

$$x^* = \frac{4+6+8}{3} = \frac{18}{3} = 6.$$

4. Issues in Sentiment analysis

**A. Sarcasm:** Sarcasm is a plain statement that means the opposite to what said an dis difficult to interpret for the automated tracker.

**B. Difference in skills and personal life:** At times, some comments tell about some personal life about a person but it is highly unrelated to the skills of the person that might be the main concern at some particular moment.

**C. Compound Sentiment:** At times the comments say both positive and negative thing in ine statement like: 'Movie was good but animation was bad'. Such statement are difficult to categorise.

**D. Ambiguity in negative or positive words:** At times the context of the review statement needs to be studied thoroughly and then tagged accordingly. Example like: ' His kick was so fierce' actually means amazing.

Conclusion

This paper proposed a novel; 3-Phase system called Aspect based Sentiment Summarization (ASFuL) for aspect based sentiment summarization. It utilizes Fuzzy rationale to order notions from the item surveys. Firstly it demonstrates the design, then it distinguishes approach and the last advance communicates the work process of characterizing the perspectives as related Membership Function. It is appropriate for item audits or occasions which will deliver a high state of precision. It likewise consolidates the non-obstinate sentences utilizing the imputation of sentiment system which assumes a huge job in delivering precise result. This system is likewise valuable to diminish the unbiased score in sentiment polarity.

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