FUZZY APPROACH FOR DOCUMENT SUMMARIZATION

[1] MR.S.A.BABAR, [2] MS.P.D.PATIL

Computer Science & Engineering. Sanjeevan Engg & Tech. Institute, Panhala, India
Computer Engineering., Dnyanganga Coleege of Engg. & Research, Narhe,Pune, India

ABSTRACT—*Today, where the great amount of information is available on the internet, it is difficult to extract the correct and meaningful information quickly and efficiently. There are so many text materials available on the internet. We required a good mechanism to extract the most relevant information from it. Automatic Text Summarization mechanism solves this problem. "Text Summarization" is a process of creating a shorter version of original text which contains the important information. Text summarization can be broadly classified into two types: Extraction and Abstraction. This paper focuses on the Fuzzy logic Extraction approach for text summarization.*

Keywords-Text summarization; Fuzzy logic; fuzzy rule,extraction ,text features.

I. INTRODUCTION

Before going to the Text summarization, first we, have to know that what a summary is. A summary is a text that is produced from one or more texts, that conveys important information in the original text, and it is of a shorter form [1]. The goal of automatic text summarization is presenting the source text into a shorter version with semantics [2]. The most important advantage of using a summary is, it reduces the reading time. Text Summarization methods can be classified into extractive and abstractive summarization [1]. An extractive summarization method consists of selecting important sentences, paragraphs etc. from the original document and concatenating them into shorter form. An Abstractive summarization is an understanding of the main concepts in a document and then expresses those concepts in clear natural language.

There are two different groups of text summarization [2]: Indicative and Informative. Inductive summarization only represents the main idea of the text to the user. The typical length of this type of summarization is 5 to 10 percent of the main text. On the other hand, the informative summarization systems gives concise information of the main text .The length of informative summary is 20 to 30 percent of the main text.

The automatic summarization means an automatically summarized output is given when an input is applied. Remember that input is well structured document. For this there are initially preprocesses such as Sentence Segmentation, Tokenization, Removing stop words and Word Stemming. Sentence Segmentation is separating document into sentences. Tokenization means separating sentences into words. Removing stop words means removing frequently occurring words such as a, an, the etc. And word stemming means removing suffixes and prefixes. After preprocessing each sentence is represented by attribute of vector of features. For each sentence there are 8 features and each feature has a value between 0 and 1. The 8 features are: Title features, Sentence length, Term weight, Sentence position, Sentence to sentence similarity, Proper noun, thematic word and Numerical data. Our approach is as follows: After extraction of 8 features the result is passed to fuzzifier then to inference engine and finally to defuzzifier. Rules for Inference engine is supplied from Fuzzy rule base. After this each sentence will have score and the sentence is sorted in the decreasing order of the score. Then 20% of these finally sorted sentences will be the summary of the given document.

II. RELATED WORKS

The first Automatic text summarization was created by Luhn in 1958[1] based on term frequency. Automatic text summarization system in 1969, which, in addition to the standard keyword method (i.e., frequency depending weights), also used the following three methods for determining the sentence weights: a) Cue Method b) Title Method c) Location Method. The Trainable Document Summarizer in 1995 performs sentence extracting task, based on a number of weighting heuristics. Following features were used and evaluated [2]:

1. Sentence Length Cut-O Feature: sentences containing less than a pre-specified number of words are not included in the abstract
2. Fixed-Phrase Feature: sentences containing certain cue words and phrases are included
3. Paragraph Feature: this is basically equivalent to Location Method feature
4. Thematic Word Feature: the most frequent words are defined as thematic words. Sentence scores are functions of the thematic words' frequencies
5. Uppercase Word Feature: upper-case words (with certain obvious exceptions) are treated as thematic words.

In 1990s the machine learning techniques in Natural Language Processing used statistical techniques to produce document summaries. They have used a combination of appropriate features and learning algorithms. Other approaches have used hidden Markov models and log-linear models to improve extractive summarization. Now a day's neural networks are used to generate summary for single documents using extraction. Ladda Suanmali [4] in his work has used sentence weight, a numerical measure assigned to each sentence and then selecting sentences in descending order of their sentence weight for the summary. Recently, neural networks are used to generate summary for single documents using extraction [6].

A lot of work has been done in single document and multi document summarization using statistical methods. A lot of researchers are trying to apply this technology to a variety of new and challenging areas, including multilingual summarization and multimedia news broadcast.

III. Motivation for Text Summarization

Text Summarization is an active field of research in both the IR and NLP communities.

- People keep up with the world affairs by listening to news bites.
- People even go to movies largely on the basis of reviews they've seen.
- People base investment decisions on stock market updates.
- With summaries, People can make effective decisions in less time.
- The motivation here is to build such tool which is computationally efficient and creates summaries automatically.

IV. Approaches To Summarization

Text summarization approach [5] consists of following stages:

A. Preprocessing
B. Feature Extraction
C. Fuzzy logic scoring
D. Sentence selection and Assembly

A. Preprocessing

There are four steps in preprocessing:

1. Segmentation: It is a process of dividing a given document into sentences.
2. Removal of Stop words: Stop words are frequently occurring words such as 'a' an', the' that provides less meaning and contains noise. The Stop words are predefined and stored in an array.
3. Tokenization:
4. Word Stemming: converts every word into its root form by removing its prefix and suffix so that it can be used for comparison with other words.

.Feature Extraction

The text document is represented by set, D= {S1, S2, - - - , Sk} where, Si signifies a sentence contained in the document D. The document is subjected to feature extraction. The important word and sentence features to be used are decided .This work uses features such as Title word, Sentence length, Sentence position, numerical data, Term weight, sentence similarity, existence of Thematic words and proper Nouns .

1. Title word: A high score is given to the sentence if it contains words occurring in the title as the main content of the document is expressed via the title words. This feature is computed as follows:

F1=Nt/Ntotal

2. Sentence Length: Eliminate the sentences which are too short such as datelines or author names. For every sentence the normalized length of sentence is calculated as:

$$F2 = \frac{\textbf{Number of words in the sentence}}{\textbf{Number of words in the longest sentence}}$$

3. Sentence Position: The sentences occurring first in the paragraph have highest score. Suppose a paragraph has n sentences then the score of every sentence for this feature is calculated as follows**:**

$$\mathbf{F3(S_1) = n/n;\quad F3(S_2)=4/5;\quad F3(S_3)=3/5;\quad F3(S_4)=2/5;}\ \text{and so on.}$$

4. Numerical data: The sentences having numerical data can reflect important statistics of the document and may be selected for summary. Its score is calculated as:

$$F4(Si) = \frac{\textbf{Number of numerical data in the sentence Si}}{\textbf{Sentence Length}}$$

5. Thematic words: These are domain specific words with maximum possible relativity. The score for this feature is calculated as the ratio of the number of thematic words that occurs in a sentence over the maximum number of thematic words in a sentence.

$$\mathbf{F5(Si)} = \frac{\textbf{Number of Thematic data in the sentence Si}}{\textbf{Max no of thenatic words}}$$

6. Sentence to Sentence Similarity: For each sentence S, the similarity between S and every other sentence is computed by the method of token matching. The [N][N] matrix is formed where N is the total number of sentence in a document. The diagonal elements of a matrix are set to zero as the sentence should not be compared with itself. The similarity of each sentence pair is calculated as follows:

$$\boldsymbol{F6} = \frac{\sum[\mathrm{Sim}(\mathrm{Si},(\mathrm{Sj})]}{\mathrm{Max}[\mathrm{Sim}(\mathrm{Si},(\mathrm{Sj})]}$$

7. Term weight: The score of this feature is given by the ratio of summation of term frequencies of all terms in a sentence over the maximum of summation values of all sentences in a document. It is calculated by the following equation.

$$F7 = \frac{\sum TF_I}{MAX(\sum TF_I)}$$

Where, i=1 to n, n is the number of terms in a sentence.

8. Proper Nouns: The sentence that contains maximum number of proper nouns is considered to be important.

Its score is given by,

$$\mathbf{F8} = \frac{\textbf{Number of proper nouns in the sentence s}}{\textbf{Sentence length(s)}}$$

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B. Fuzzy Logic Scoring

Thus each sentence is associated with 8 feature vector. Using all the 8 feature scores, the score for each sentence are derived using fuzzy logic method. The fuzzy logic method uses the fuzzy rules and triangular membership function .The fuzzy rules are in the form of IF-THEN .The triangular membership function fuzzifies each score into one of 3 values that is LOW, MEDIUM & HIGH. Then we apply fuzzy rules to determine whether sentence is unimportant, average or important. This is also known as defuzzification.

For example IF (F1is H) and (F2 is M) and (F3 is H) and (F4 is M) and (F5 is M) and (F6 is M) and (F7 is H) and (F8 is H) THEN (sentence is important).

C. Sentence Selection

All the sentences of a document are ranked in a descending order based on their scores. Top n sentences of highest score are extracted as document summary based on compression rate. Finally the sentences in summary are arranged in the order they occur in the original document.

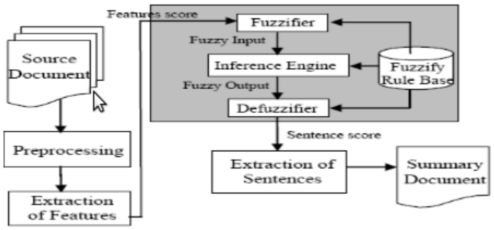

Fig. 1 Text Summarization using Fuzzy Inference System [6].

Thus Summary is improved with our proposed method .Sentences are selected in the summary with the help of sentence scores. Higher scoring (ranked) sentences are added into the summary. Summary from Fuzzy system S1 and summary from LSA S2 are taken into account and common sentences are kept in one set and other sentences from S1 and S2 are chosen by their sentence scores. Sentences with high score are added into the summary.

V. EVALUATION AND RESULTS

We use human generated summary as a gold summary standard for evaluation that has become standards of automatic evaluation of summaries. It compares the summaries generated by our method with the human generated (gold standard) summaries. For comparison, we used accuracy statistics. Our evaluation was done using accuracy percentage which was found to have the highest correlation with human judgments, namely, at a confidence level of 95%. It is claimed that our summary correlates highly with human assessments and has high recall and precision significance test with manual evaluation results. So we choose precision, recall as the measurement of our experiment results. In the table 1, we compare fuzzy summarizer (old Summary) with our proposed and online summarizer with different data sets.

Evaluation Table for Proposed Summary:

Data sets	Precision	Recall	f-measure
1	90.90909091	42.85714286	66.88311688
2	92.30769231	42.85714286	67.58241758
3	94.11764706	49.23076923	71.67420814
4	86.20689655	34.72222222	60.46455939
5	95.23809524	44.44444444	69.84126984
Avrg.	91.75588523	42.82234123	67.28911111

The table shows generated summary with precision average 91.75588523, recall average 42.82234123 and f-measure average 67.82234123. The generated summary is compared with online summary which is the gold standard summary for evaluation.

The results are shown in Table 1; the generated summary reaches precision near to the accuracy with online summarizer. Overall accuracy score from fuzzy based summarizer are better than traditional summary that shown in Figure 1.

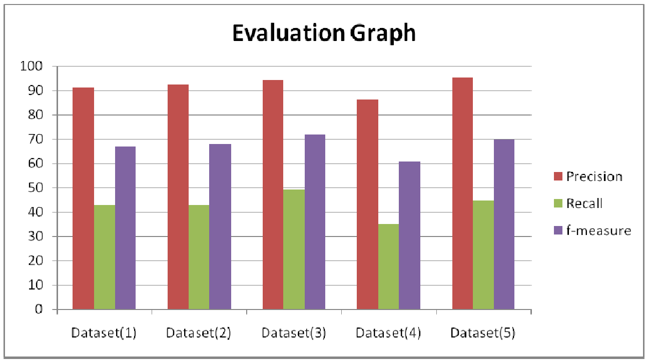

Fig. 5 Precision, recall, f-measure result

VI. CONCLUSION

Automatic summarization is a complex task that consists of several sub-tasks. Each of the sub-tasks directly affects the ability to generate high quality summaries. In extraction based summarization the important part of the process is the identification of important relevant sentences of text. Use of fuzzy logic as a summarization sub-task improved the quality of summary by a great amount. The results are clearly visible in the comparison graphs. Our algorithm shows better results as compared to the output produced by two online summarizers.

Thus our proposed method improves the quality of summary by incorporating the latent semantic analysis into the sentence feature extracted fuzzy logic system to capture the semantic relations between concepts in the text. The focus of this paper is narrow: summarization of documents, but the ideas are more broadly applicable. We conclude that we need to extend the proposed method for multi document summarization with in a large data set.

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