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An Analysis on Student- Written Summaries: Automatic Assessment of Summary Writing

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Abstract: Summarization is a process to create a short version of a source text. As identifying summarizing strategies used by students in summary writings is a very time-consuming task, computer-assisted assessment can help teachers to identify summarizing strategies more effectively. The main goal of this investigation is to improve the abilities of students in summary writing and A study of effectiveness of summarizing strategies are used in summary writings which focused on three aspects: 1) analysis the correlation between summarizing strategies and summary performance, 2) the influence of number of summarizing strategies on students' summaries performance and 3) identifying summarizing strategies employed by the students. Results from this study displayed that there is a correlation between summarizing strategies and students 'summaries performance. The summary will improve by using more variety of summarizing strategies. The proposed algorithm is able to identify the summarizing strategies used by students in summarizing. An automatic assessment of summary based on the proposed algorithm has also been developed.

Keywords: Summarizing strategy, summary writing, automatic assessment, summary performance, cognitive operation.

Introduction

Summarization is a process to reduce a source text to its main idea and to recognize what is important and what isn't important in a source text. According to many studies, summarizing strategy is the core of the process to create a short version of a source text. Wino grad [13] has shown that, if students know how to use summarizing strategies, they can create a good summary. If students want to know how to use summarizing strategies, they need instruction and more practice. On the other hand, if teachers want to instruct summarizing strategies and give an appropriate feedback to students, they need to know some information such as what summarizing strategies used by students in summary writing, how is the ability of students in use of summarizing strategies and they used them correctly or not. To get these information teachers should assess student's summary text manually .It is very difficult and time-consuming task. Thus, this work focus on analyzing the summarizing strategies used by students to create summaries that lead to develop an automatic assessment of summary writing as a result which aims to 1) identify the students' strategies and 2) propose an intelligent tool to identify students' summaries strategies in summary writing and provide students with self-learning tool to improve their skills in summarizing. Teachers can use summarization to evaluate their students. It shows the student's ability to create a summarytext. Thus, Teachers can better understand their "students' reading processes and successes or difficulties" [3]. Summary writing is an important part of many English Language Examinations [1]. In school, it helps students to reduce a source text to its main important information. If students have a good ability, they can recognize what is important and is not important in a source text. It also helps them to check understanding [2]. It is useful for students in the ESL / EFL classroom. Since English as a second language uses for instruction in some countries, most of the students have problems in reading and writing in English.

Since summarization can be used as a measure of understanding for a given text, Computer-assisted assessment has attracted interest in recent years. Some techniques such as Latent Semantic Analysis [6-9], word position [10], BLEU [11] and n-gram co-occurrence [12] have proposed to automatic assessment of summary writing. However, most of these systems focused on two criteria, content and style. A few systems have proposed to identify summarizing strategies. The rest of the paper is organized as follows. Section 2 reviews some of proposed systems to evaluate summaries. Section 3 introduces the basic rules in summarization. Section 4 discusses the analysis and presents the results of the analysis. Section 5 presents the development of the proposed system and finally, in Section 6, we summarize the works discussed and the progress of the project.

Summary Evaluation Systems

In this section most of summary assessment systems containing those focused on content and style such as Summary Street [9], LEA [8], Automatic Assessment of Students' free-text Answers [11], Recall-Oriented Understudy [12], Automatic Evaluation of Summaries [21], Summary Assessment System [1] and those focused on identifying

summarizing strategies such as modelling summarization assessment strategies [14] and Summary sentence decomposition algorithm [15] are introduced.

A. Automatic assessment of summary writing: Focused on content and style

Laburpen Ebaluaka Automatikoa (LEA) [8] based on Latent Semantic Analysis (LSA) has been proposed to evaluate the output of the summarizing process which are content. It is designed for both, teachers and students. It allows teachers to examine students-written summary, and allows students to produce a summary text with own words. The summaries are evaluated based on some features such as, cohesion, coherence, the use of language and the adequacy of the summary. Summary Street [9] based on LSA is a computer-based assessment system that used to evaluate the content of summary text. Summary Street ranks student- written summary by comparing the summary text and source text. It creates an environment to give an appropriate feedback to students such as content coverage, length, redundancy and plagiarism. Automatic Assessment of Students' free-text Answers [11] based on BLEU algorithm was developed for grading students' essay. The system compares the student's essay and the model essay to determine how similar they are. Lin [12] proposed an automatic summary assessment system named Recall-Oriented Understudy for Gisting Evaluation. It is used to assess quality of summary text. The current system includes of different automatic evaluation methods such as ROUGE-N, ROUGE-L, ROUGE-W, ROUGE-S and ROUGE-SU. Lin and Hovy [21] proposed a system based on BLEU and N-gram co-occurrence to evaluate summaries. The system aims to measure the closeness of the summary text to the source text. (Yulan et al) [1] Proposed a summary assessment system based on the modified LSA algorithm and n-gram co-occurrence. The system aims to grade students' written summaries.

B. Automatic assessment of summary writing: Focused on identifying summarizing strategies

Modelling summarization assessment strategies [14] based on LSA has proposed to identify summarizing strategies used by student in summary writing. The system is capable of identifying rules such as copy, paraphrase and generalization. Summary sentence decomposition algorithm [15] based on word position has proposed to identify macro rules used by student in summary writing. The system is capable of identifying rules such as Deletion, Sentence Combination, Syntactic Transformation, Sentence Reordering and Copy-paste.

Summarizing Strategies In Summarization

Different researchers used different terminology to describe the summarizing strategies which are fundamentally similar processes. So, we adopt Brown and Day's terminology [4] for the process rules in summary writing (most of them are based on rules that brown has proposed).

- Deletion: It is used to remove unimportant and redundant information from the sentence in the source text.
- Topic Sentence selection: It usually selects a sentence from a paragraph that takes the main idea of the paragraph or it is close to the topic of the document.
- Generalization: In the generalization process, a list of actions or items is replaced by a more general word in the same class.
- Invention: In invention process, the whole paragraph is read, then sentences are produced by own words, which should take the meaning of the whole paragraph.

The analysis of student-written summaries

The analyses of the student-written summaries are split into three main purposes:

- Is there a correlation between summarizing strategies and students'summaries performance?
- Does the number of summarizing strategies affect students' summaries performance?
- The summarizing strategies employed by the students in producing their summaries?

A. The effectiveness of summarizing strategies on students' summaries performance

In this study, 56 samples of student-written summaries have collected from a school. We analysed the correlation between summarizing strategies and the performance of student'summaries. It is done using total scores given by the equation (4,5,6) and the total number of summarizing strategies used by each student to create a summary text. The results of this Analysis are illustrated in a graph as shown in Fig. 1. According to the value of the correlation (R=0. 16), it shows there is a strong interaction between summarizing strategies and students' summaries performance. On the other hand, due to the regression equation (1) , it shows that there is a direct relationship between summarizing strategies and students' summaries performance. It means if students know more summarizing strategies and use more summarizing strategies in summary writing their summary performance will improve.

SSP= 0.6681+ 0.0319 NSS , R^2 = 0.0261, R = 0.16

Students' Summaries Performance=0. 0319 (NO.of Summarizing Strategies) +0.6681 (1)

B. The rules used by the students

Identifying summarizing strategies is very important, since 1) summarization is one of the most effective methods for reading understanding, 2) the students can produce a good summary if they know how to use the summarizing strategies and 3) teachers can give appropriate feedback if they know, How is the ability of students in use of rules to generate the summary text. To analyze the rules used by the students, we follow these steps:

Given a student's summary:

I. Select the summary sentences from the summary text
II. For each summary sentence, determine sentence(s) in the source text which is/are close to the summary sentence
III. Compare the summary sentence and the sentences from the source text and determine the strategies employed to create the summary sentence.

We consider four basic summarization rules which employed by the students to create the summary text, these rules are as follows:

- Deletion
- Generalization
- Paraphrase
- Topic sentence selection

We also identify copy-paste strategy, although it is not a basic rule. Table. 1 displays the result of the analysis. According to the result of an analysis of students' summaries, we can see that, around 90% of students use deletion rule, which removes some useless parts of a sentence. It seems the deletion rule is a usual strategy amongst students. Although copy -paste is not a basic macro rules it displays that copy-paste is also a common strategy among the students. Students by this rule copied the sentences without any change in concept of sentences. The paraphrase is another strategy that students can replace a word from a source sentence with a synonym.39% of students use paraphrase but in comparing with a generalization rule they did not try to replace a list of actions or word with a word so only 7% of student use this rule. The result also shows the topic sentence selection strategy was used by more than 90% of the students.

The results of this analysis show that most of the students don't know how to use the summarizing rules effectively. However, there is a few summarization assessment process which focuses on identifying the students' strategies. Due to that, we proposed an automatic assessment of summary writing that can be used to assess the student's summary by determining the strategies they used in their summaries. The objective of this work is to propose an algorithm for identification the summarizing strategies used by students. Given a student summary and the source text, the system should be able to identify summarizing strategies that have been employed to create a summary sentence.

The Development of the Proposed System

The development of the system can be divided into three main stages as shown in Fig. 2 below and the description of the stages is as follows:

A. Stage 1: finding a set of rules to identify summarizing strategies

Topic sentence selection strategy: is used to select a sentence that presents the main idea of a paragraph [4]. Edmund son [16] Used four methods to extract an important sentence to create a summary text. Topic sentence selection strategy employs these four methods to extract sentences which indicate to the main idea of a source text. These methods are discussed:

- **Location method**:usually the first and the last sentence of a paragraph represent the main idea of the paragraph which includes content that is useful for summarizing the text. Hence, we can say that summary sentence used location method if it was produced from the first or last sentence of a paragraph in the source text.
- **Title method**: it assumes that an important sentence includes words, which appear in the title of a document or in the heading of a paragraph. Thus, a summary sentence uses title method if it includes words from the title or heading. Normally, the words in the title are noun and verbs.
- **Keyword Method**: the most frequent words in the text are the most representative of its content. Thus, sentences which contain these words are considered more relevant that other sentences.
- **Cue Method**:cue words are significant words that increase the importance of a sentence, any sentence that contains cue words such as "conclusion" and "as a result" indicates that it contains important content of the source text.
- **Deletion** : The number of words in summary sentence is less than the number of words in the source sentence. The words of summary sentence are found in source sentence.
- **Sentence combination**: Summary sentence is created by combining two or more sentences from the source text.
- **Paraphrase** : a word in the source sentence is replaced with a synonym in the summary sentence.
- **Copy-paste**: a summary sentence is created from the original sentence without any changes.

B. Stage 2: Finding a technique to design an algorithm to assess the student-written summaries

This stage aims to determine the technique that can be used to design a new algorithm on how to assess the student-written summaries. The algorithm will be based on the rules as shown in Table. 2. The system will be developed based on the linguistic measure method, such as word order similarity between sentences, Semantic Similarity between sentences and semantic similarity between words. The system determines whether the summary sentence is generated from the source text using similarity measure and determines the strategies used by students to produce a summary sentence. This section discusses about three core stages, which constitute the backbone of our algorithm (pre-processing, middle processing, post processing). The proposed algorithm can identify some of summarizing strategies (Deletion. Topic Sentence Selection, Sentence Combination, Copy Paste) which have been employed to create a summary sentence.

- **Pre-processing stage**

This stage aims to perform a basic linguistic analysis on the input source text. Thus, it prepares input source text for further processing. In order to perform this analysis, external tool and resource are used. The pre-processing module provides text pre-processing functions such as sentence segmentation, tokenization, part-of-speech tagging, stemming, stop word removal, keyword extraction, finding sentences location, title word extraction. Word Net [17] is used.

- **Middle processing**

Middle processing is a process to determine whether the summary sentence is generated from the source text using similarity measures. To do so, the similarity between sentences from summary text and the source text is determined using linguistic measures such as word order similarity between sentences, Semantic Similarity between sentences and semantic similarity between words. The existence similarity scores between sentences shows, the summary sentence is from source text; otherwise it is out of source text.

- **Semantic similarity between words**

Semantic word similarity [18,19] plays an important role in this system. It is used to create word order vector and semantic vector. The semantic similarity between words is calculated through some steps:

I. Get synonym of each word using the lexical database (Word Net)
II. Determine number of synonyms of each word
III. Determine least common subsume of two words and its length.
IV. Calculate similarity score

We used the following equations to calculate semantic similarity between words:

$$\text{IC (w)} = 1 - \frac{Log\,(synset\ (w)+1)}{\log(\max\,(wn))} \quad (1)$$

$$Sim\ (w1, w2) = \begin{cases} \frac{2*IC\,(lcs\,(w1,w2))}{IC(w1)+IC(w2)} & w1 \neq w2 \\ 1 & w1 = w2 \end{cases} \quad (2)$$

Where: LCS (least common subsume), Max (w_n): number of concepts in Word Net,Synsets: a set of one or more synonyms of concept (c).

- **Semantic similarity between sentences**

We used semantic-vector approach [20] to measure semantic similarity between sentences. The number of elements in the semantic-vector is equal to the number of distinct words from sentence pair. Each element in the semantic-vector is weighted using semantic similarity between a set of distinct words and the corresponding sentence. The following equation is used to calculate semantic similarity between sentences:

D1= (w1, w2 ,..., wm) , D2= (w1, w2,… ,wm)

$$\text{Sim semantic (S1, S2)} = \frac{\sum_{n=1}^{m}(\text{Wnd 1} * \text{Wnd 2})}{|\sum_{n=1}^{m}(\text{Wnd 1})| * |\sum_{n=1}^{m}(\text{Wnd 2})|} \quad (3)$$

Where wn is the weight of each cell in vectors D1 and D2. D1 and D2 are semantic-vector for sentences (S1) and (S2) respectively.

- **Word order similarity between sentences**

In some case, two sentences have same surface and they share similar words .In this case without syntactic information is not possible to distinguish the meaning of two sentences. Thus, to calculate the sentence similarity, we also used word order similarity measure [20]. The number of elements in the word order vector is equal to the number of distinct words

from the sentence pair but unlike semantic-vector, a unique index is used as a weight for each element of the word order-vector. The unique index can be indexed position of the words in the corresponding sentence. The following equation is used to calculate word order similarity between sentences:

Os1= (d1, d2 …… dm) , Os2= (d2, d2 …… dm)

$$\text{Sim\_wordorder}(S1, S2) = 1 - \frac{||Os1 - Os2||}{||Os1 + Os2||} \quad (4)$$

Where dn is the weight of each cell in vectors (Os1) and (Os2). (Os1) and (Os2) are syntactic-vector of sentence S1 and S2 respectively.

- **Sentence similarity measurement**

Both semantic and syntactic information have an important role in understanding the meaning of a sentence, because of that, we also calculated sentence similarity using the composition of semantic similarity and word order similarity, using the equation 8 as follows:

$$Sim(S1, S2) = \lambda\, Simsem + (\lambda - 1) Simwo \quad , \quad \text{Where : } 0 < \lambda < 1 \quad (6)$$

- **Selecting source text sentences**

This function is used to determine which sentences from the source text have been used to create the summary sentences.

- **Post-processing stage**

This stage applies collected rules, as we can see in Table 2, using various algorithms to identify summarizing strategies used by students in summary writings.

C. Stage 3: Implementing the proposed algorithm and evaluating the performance of the system

This algorithm was developed in C#, which has a user interface; that allows user to perform the following tasks:

- Load source text and summary text
- Display keywords and title words
- Display source sentences that were used to generate summary sentences
- Display methods have used to create each summary sentence
- Display frequency of each method

To evaluate the performance of the proposed algorithm, the system will be evaluated using some samples of real data (the student-written summaries) collected from schools. The proposed system would be able to identify the strategies used by the students to produce the summaries.

Conclusions

Results from this study displayed that there is a correlation between summarizing strategies and students'summaries performance. The summary will improve by using more variety of summarizing strategies. Students can create a good summary and they will understand a source text if they know how to use the summarizing strategies. Teachers can give an appropriate feedback to students if they know what summarizing strategy have been used by students to create a summary and how is the ability of students to use of summarizing strategies. On the other hand, students' summary writing assessment manually is a very time-consuming task. This result has led us to propose an automated summarization assessment system that can be used to identify the strategies used by students in summary writing. It could be an intelligent tool that would help teachers find out the ability of their students in applying the rules and help them improve their students' weaknesses in summarizing.

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Table 1: Number of each summarizing strategy used by students

Strategy	Frequency	Percentage
Deletion	55	98.21%
Generalization	4	7.14%
Paraphrase	22	39.28%
Copy -paste	47	83.92%
Topic sentence selection	*Cue phrase*=47	82.92%
	Location=55	92.21%
	Keyword=55	98.21%
	Title word=55	98.21%

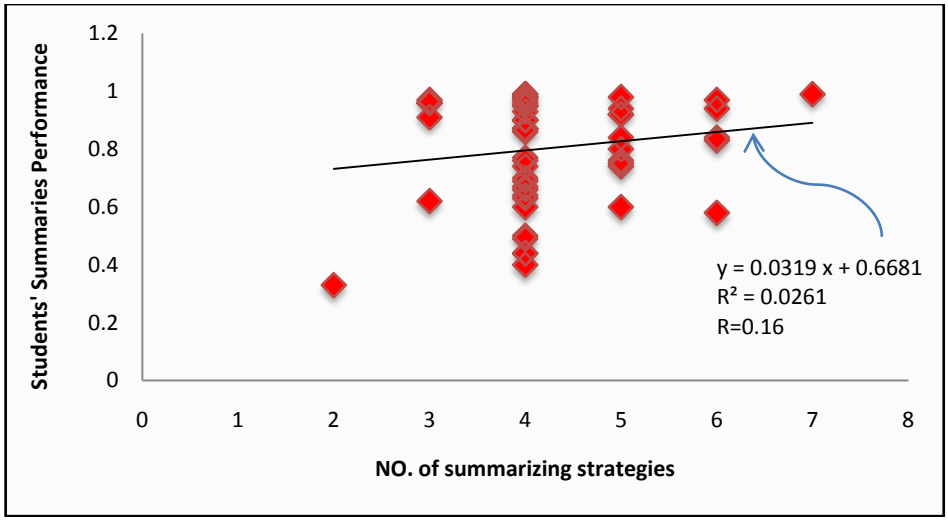

Figure 1: **The correlation between summarizing strategies and summary performance**

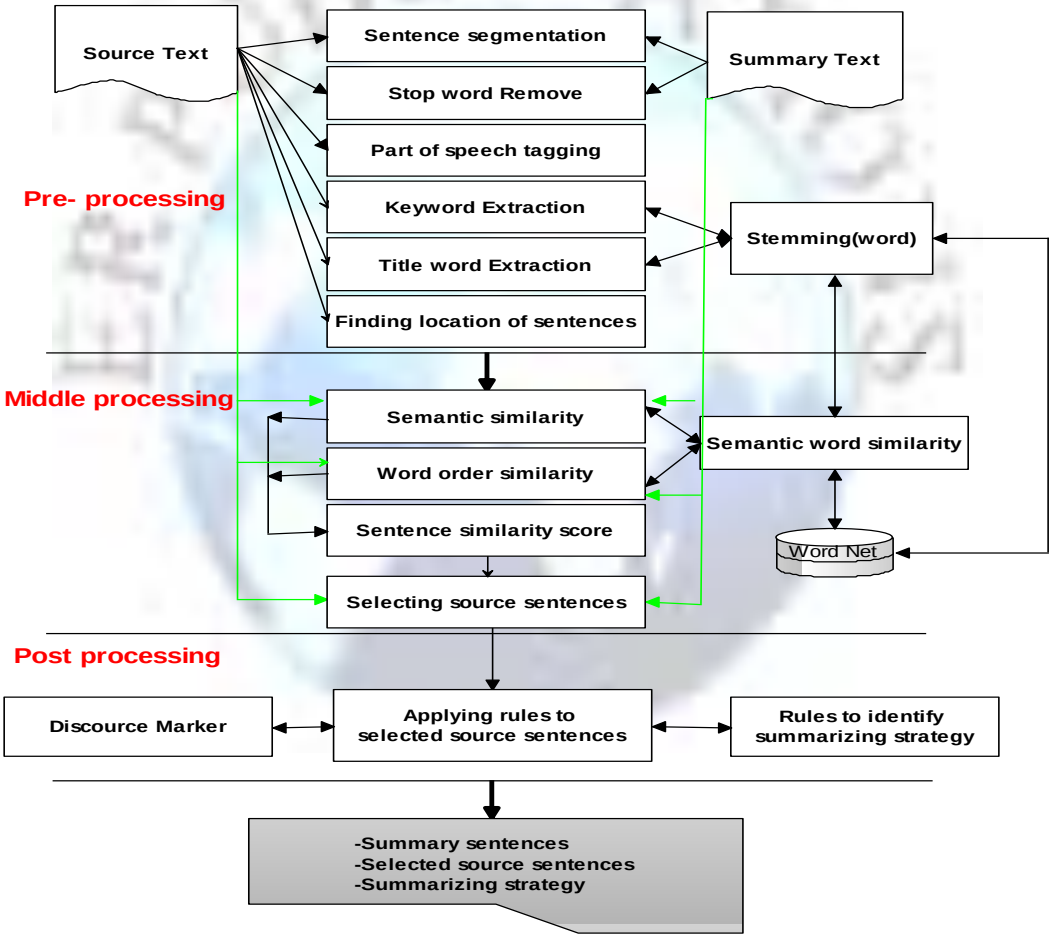

Figure 2: The overview of the system development