SENTENCE EXTRACTION FOR SUMMARIZATION AND NOTETAKING

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ABSTRACT

Notetaking and summarization are important learning skills used by students, even when they are not explicitly instructed to do so. Summarization is the distillation of important information from a source into a shortened form for a particular user or task and Notetaking is to help students acquire and integrate knowledge. Fundamentally, notetaking is closely related to summarizing because it requires students to take information and synthesize it using their own words. In this research, we design both automatic summarization and semi-automatic notetaking system as important tools that can engage students in learning activity and improve their learning, namely comprehending and recalling of the study materials. However, they can be employed by lecturers to evaluate their student’s understanding. Many current systems summarize texts by selecting sentences with important content known as sentence extraction. To deal with the development of a new sentence extraction method, we delve into text analysis at three levels, such as word, sentence and text level analysis. At word level, we consider word similarity and word disambiguation based on WordNet to compute the value for semantic relatedness. This feature is exploited by the proposed method we have made for text similarity. For sentence Level, we analyse for its similarity using vector correlation. For text similarity, a cognitive method is used to identify the most important sentence. Proposed unsupervised sentence extraction method is then used to identify the most salient sentences to produce high quality summarization and notes.
Dedication

To my wife Somayeh and my parent, Sarah and Mohammad for providing context to my thoughts, for brimming with inspiration, and for their extraordinary warmth.
Acknowledgements

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My sincere gratitude goes to Prof. Dr. Chrysanne DiMarco for her graciously providing logistical support and invaluable advice in the process of writing of this research.
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Chapter 1
Introduction

The main objective of this master dissertation is to investigate the role of sentence extraction in automatic summarization and notetaking systems. The proposed methods are all based on unsupervised semantic analysis and take advantage of cognitive approach. In this chapter, I will describe the background and motivation of my research as well as the aims of the dissertation work. In the end, the structure of the word will be introduced.

1.1 Background and motivation

With the growing of electronic text information nowadays, users have to browse a great number of individual documents. To deal with large amount of information, people are expected to explore the important parts. To cope with this task, automatic text summarization is created. It involves condensing a document or a document set to produce a fair summary based. The object is to help users catch the important contents of the original documents. Summarization is useful, as it can be employed alone or combined with other applications like information retrieval. As machine generated summary can not match human written ones at present, it is necessary and meaningful to investigate automatic summarization in the background of information explosion. The previous research on text summarization dates back to Luhn (1958) and Edmundson (1969). Two alternative summarization approaches have been suggested in the literature, called abstraction and extraction. Abstraction typically needs one to comprehensively understand and then paraphrase the salient concepts across documents. Limited by current natural language techniques, it is confined in specific domains. Extractive summarization that use sentence extraction techniques, on the other
hand, select sentences which contain the most significant concepts in documents. Significance of the sentences can be evaluated statistically or empirically. Although the performance of extractive summarization can not satisfy the requirement of human, it is rather effective and applicable.

Extractive summarization extracts part of documents based on some weighting scheme, in which different features are exploited, such as position in document, term frequency, and key phrases. Recently extraction approaches may also employ machine-learning approaches to decide which sentences or phrase should be extracted. According to feature and labels of sentence in training data, sentences in testing data can be decided whether they should be extracted or not based on the input feature values. Some researchers devote their efforts to investigate it and achieve preliminary success in different applications.

Pervious extractive approaches identify the important content mainly based on terms. Bag of words may be not a good representation of meanings, as there is so little useful information associated with these words. Dealing with semantic area of the documents can be a better choice for representation of documents. This tension motivates us to seek a balance between effective implementation and deep understanding.

Recently, researchers (Filatova and Hatzivassiloglou, 2004) define events by action words as well as associated named entities including person names, organization names, locations and times. Given the sentence Yasser Arafat on Tuesday accused the united states of threatening to kill PLO officials, accused, threatening, and kill are identified as an event terms, while Yasser Arafat, United States, PLO and Tuesday are event elements. If semantic specifications
of these words were identified and represented then it would contained more structured information rather than bag of words.

To investigate semantic part of a text, it is required to quantify how semantically related pairs of the words are. More precisely, we wish to measure the relatedness of two word senses, where a word sense is a specific meaning of a particular word. For example, the word ball has several senses, including a round object used in games, a formal dance, and a pitch in baseball that is not a strike. A precise method for quantifying how similar two words senses is called a measure of semantic relatedness. WorldNet is used to measure semantic relatedness between two words and to identify word’s sense. WorldNet is a large lexical database of English, developed under the direction of George A. Miller. Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept. It can be said that WorldNet has been employed significantly in unsupervised approaches of text processing. While similarity measurement between two sentences of a text is considered, for each event in both sentences, the summation of word pair’s similarity is calculated. Correlation method is used to generalize from word level similarity to sentence level similarity. To construct text semantic measurement based on its words, nouns and verbs, is considered as the events happening in the text. For each event, the semantic similarity is measured and the correlation between texts semantic area in calculated as their similarity.

The key point of extractive summarization is not sentence or paragraph selection, but how to select. There are some ideas how human selects important sentences from the text. It is useful to mimic human while selecting important sentences. Kintsch (2002) postulates that the reader would consider as being important those sentences that are highly connected to the
others. By translating connection to similarity, important sentences can be extracted. Automatic Summarization system can be built based on Kintsch’s postulation processing the text semantically.

Notetaking is closely related to summarizing because it requires that students take information and synthesize it using their own words. Notetaking is an important task when learning. Students are expected to acquire a vast amount of knowledge from both lecturers and reading assignments and other learning materials. Most students perceive notetaking as essential for successful management of information load (Palmatier & Bennett, 1974; Meter et al., 1994). Despite the prevalence and demonstrated effectiveness of notetaking as a study strategy among students and the effectiveness of text processing to analyse text, no research has been done to investigate how pre-processed texts influence students learning. These points lead us to investigate if text-processing techniques like sentence extraction can be used to enhance student’s learning skills. There are many systems designed to improve student’s notetaking skill. All attempts up to now concentrate on utilizing technological support tools to enhance student’s notetaking skill. There are four simultaneous problems identified which students should overcome while taking notes. They are listening (paying attention), cognitive load, jotting down notes and reviewing notes. Text processing techniques can be used to identify important sentences and keywords in the text and therefore help students on text distillation. Extracted important keywords can then be highlighted in the text to guide students to find related concepts in the text. Concept-map is a non-linear method for notetaking that can be implemented by students while reading highlighted text. Extracted important keywords can be used instead of concepts in concept-map structure and the links between extracted keywords can be constructed by text events.
1.2 Objectives

In view of the limitation and problems of previous summarization and notetaking systems and approaches, the main aim of this research is to apply cognitive approaches to improve the performance of text summarization semantically and to enhance students' performance while taking notes. The generated summaries should be used reliably to help students catch key points of the text. The focus of this research is on finding effective sentence extraction technique to be used properly in summarization and notetaking systems. To achieve the above aim, investigations are divided into four objectives:

1. **To design and propose a novel sentence extraction and ranking method based on cognitive approach.**

Sentence extraction is one of the most important techniques applied in text processing. We plan to apply cognitive approach to imitate human behaviour while identifying important sentences in a text. We define three levels of analysis such as word, sentence and text to process a text. At the word level, nouns and verbs are considered because they can convey sufficient information from the text. A proper word sense disambiguation and word similarity algorithms are employed. At the sentence level, an algorithm based on correlation concept is designed and implemented to measure similarity among sentences in the text. Finally, a cognitive approach for extracting and ranking sentences is employed for text level analysis. Ultimately, an algorithm based on aforementioned three levels of analysis is designed and implemented to extract important sentences.
2. **To design a cognitive summarization framework to reflect semantic trends of the text.**

We intend to design an automatic summarization system that mimics human behaviour while summarizing a text. A proper cognitive approach is chosen and implemented semantically; the function of the system imitates human behaviour while summarizing a text. In summarization, the degree of compression is an important issue. Therefore, we plan to identify the best compression ratio for the system’s generated summary that is consistent with human generated summary in terms of semantic similarity. The proposed system is then implemented and evaluated.

3. **To design a semi-automatic notetaking system**

Notetaking is an important student’s skill. However we define a new area of research by including text processing in student’s notetaking process. Accordingly, all nouns are extracted from the text as keywords. Those keywords are in the produced summary of the text and can be selected as the most important keywords. Two major types of notetaking method linear and non-linear are investigated. A non-linear method based on concept-map method is introduced. We also investigate the effectiveness of semi-automatic notetaking approach in improvement of students learning output.
1.3 Thesis organization

This dissertation is organized as follows. Chapter 2 gives details of background information and related works. In this chapter different types of notetaking systems are identified based on approaches used. For each approach, one system is chosen for discussion. Different types of sentence extraction techniques used in summarization are discussed. Sentence extraction is the most important technique applied in summarization. Chapter 3 presents analysis of a text in three levels such as word level, sentence level and text level. Essential background including WordNet database and the method employed for word sense disambiguation are presented. The design and algorithms of the sentence similarity and sentence extraction methods are explained. Chapter 4 describes automatic summarization and semi-automatic notetaking frameworks. In this chapter, we show how to design an automatic summarization system and semi-automatic notetaking system exploiting sentence extraction method stated in chapter 3. The structure and modules considered in those two aforementioned systems are illustrated. In chapter 5, we evaluate the two proposed automatic summarization and semi-automatic notetaking frameworks. We show that both frameworks functions effectively. Finally chapter 6 concludes the study.
Chapter 2

An overview on notetaking and summarization

2.1 Notetaking

Notetaking is an important aspect of student attitudes. Studies have shown that as many as 99% of college students take notes in lecture (Palmatier et al., 1975) and 94% of them believe notetaking is an important part of the educational experience (Williams et al., 2002). Notetaking is also a common activity for researchers. It involves extensive reading and writing tasks, or generally in comprehension and reflection activities (Erickson, 1996). However, notetaking is only not used for briefing or recording information, but also used in situations where preserving and transferring of information is crucial, as in academic sources (Armbruster, 2000; Piolat & Boch, 2004; Piolat et al., 2003).

2.1.1 Notetaking as a tool for knowledge acquisition

Educational psychologists report that notetaking consists of two main processes (Beecher, 1988; Bligh, 2000) as follows:

- **Jotting-down notes**

  The process of jotting down notes itself increases learning by enhancing the ability of retention and construct connections of information, as it can be seen in the generation effect, NB. The generation effects refers to the finding that individuals retain materials that they have generated better than materials that have been generated by others and given to them.
Indeed, students not only learn when they review their notes, but also while taking notes. In fact, notes constitute an external memory of caught information that can be used later for studying and related educational tasks (Kiewra, 1985a, 1985b; Benton et al., 1993). In addition, during notetaking, when students comprehend the source comprehensively, they memorize it as well (Williams and Eggert, 2002).

**Reviewing**

The process of reviewing notes is important for memorizing contents of the source. Notetaking concerns both long-term and working memory. Attentional capacity of notetakers decrease according to several factors such as the presumed importance given to the source and to the information delivered (Hartley and Davies, 1978). A study on the role of working memory indicates that quantity and quality of notes are different according to the working memory skill of notetakers (Kiewra, 1988b, 1989). Analysis of the nature of the information that was noted indicates that the attentional capacity of notetakers decreases throughout a course or lecture (Scherbo et al., 1992). In other words, the role of working memory when taking notes causes to decrease the cognitive load during reading (Yeung et al., 1997) or in problem solving (Cary & Carlson, 2001; Cohn, & Bradley, 1995). The notes, as an external memory, thus support retention in working memory of intermediate information or solutions that will be used for comprehension. It can be said that many researchers have neglected to study the critical relation between working memory and notetaking, in which taking notes involves managing between comprehension and production processes under severe time pressure (Piolat et al., 2004). In the academic domain this is our focus, so that in terms of efficiency, the first challenge is to achieve a balance between listening, processing, and Notetaking. In this case efficiency can be technically
defined in terms of the ratio between the number of conceptual points recorded and the number of words in the notes (Piolat et al., 2004).

- **Significance of reviewing notes**
  In addressing the connection between notetaking and academic achievement, both the process and the product of notetaking affect academic achievement and performance (DiVesta and Gray, 1973). In fact, while both notetaking and reviewing contribute to performance, reviewing is the more powerful of the two contributors. Also simply recording notes is not an effective activity unless those notes are reviewed (Kiewra, 1985a, 1985b). An analysis conducted by Henk and Stahl (1985) on notetaking supports this last statement and concluded that just taking notes barely promotes recall of lecture information, but reviewing notes substantially promotes recall. There were also noticeable correlations observed between the amount of notetaking and achievement when the students reviewed notes (Crawford, 1925; Fisher and Harris, 1973; Locke, 1977). Some experimental studies under review indicated that 75% of the notetakers who review their notes perform better than notetakers who do not (Hartley, 1983; Kiewra, 1985b). Although students are more likely to recall noted than non-noted information, having information in one’s notes does not ensure correct responses to exam items related to that information, (Palkovitz and Lore, 1980). This phenomenon can be attributed to inadequate reviewing of one’s notes.

- **Cognitive effort during notetaking**
  It can be said that notetakers should control flow of information when taking notes from lecture or even written documents because transcription is always slower than reading a text or lecturer speech rate (Foulin, 1995). So notetakers should overcome temporal pressure in working memory (Piolat et al, 2004). On the other hand,
cognitive effort can be defined as a part of limited attentional resources that are briefly dedicated to a process (Kahneman, 1973; Ellis et al, 1979). Figure 2.1 shows a comparison of the different tasks associated with the cognitive efforts (Piola et al, 2004):

![Figure 2.1: Cognitive effort (in milliseconds) in different processing information tasks](image)

*IRT* is defined as the degree of *Interference Reaction Time* and is measured in milliseconds (ms). As can be seen, notetaking expends a high degree of cognitive effort, like a chess player selecting a move in the middle stages of a match. Figure 2.2 shows that the degree of cognitive effort for notetaking is different for different languages and considers French as first language and English as second language of Notetakers (English) (Barbier & Piolat, 2004)
2.1.2 Notetaking skills

To obtain a better analysis, it is considered that notetaking involves four major skills (Suritsky & Hughes, 1991). It should be noted that these processes are more likely to be problem rather than skills. However, Notetakers should learn some related skills to find how to overcome these problems more efficiently. The four major skills are presented below.

1. Listening:

There is a subtle difference between Listening and cognitive processing. Listening is highlighted by equating it with paying attention. Therefore, listening can be substituted by paying attention when taking notes from textual resources is considered.

- Cognitive processing:

It can be said that notetaking consists of two stages:

I. Understanding each idea.
II. Connecting that understanding with one’s existing knowledge.

The second stage can be synthesized into two processes:

- Integrating new points with previous points in the lecture (making internal connections)
- Integrating new points with one’s prior knowledge of the topic

- Jotting down notes:

  Notetakers should distinguish between main ideas and superfluous information. Indeed, the most effective notes should accentuate the whole source framework and consider critically specifics to that framework (Williams et al, 2002).

- Reviewing:

  To achieve the benefits of notetaking to recall and address main ideas of a text, reviewing notes plays the most important role. This point is addressed in Section 2.1.1.

2.1.3 An overview on notetaking systems

As more of our educational material moves to the computer, supporting notetaking digitally becomes an increasingly important task. At the same time, technology gives us unprecedented control over the notetaking process (Baue, 2007). This section is a compilation of the results of observations and surveys performed on four systems that endeavour to improve some factors of notetaking skills during their implementation. Thus, the following
systems are analysed based on the four aforementioned skills that construct notetaking skills altogether.

NoteTaker

Ward and Tatsukawa (2003) developed a system named NoteTaker, to enable students taking notes using Laptops. NoteTaker mimics student physical behaviour when taking notes, in other words, it presents some digital devices instead of pen, paper etc.

![Figure 2.3: NoteTaker screenshot](image.png)

Typically, NoteTaker presents the following features and facilities for students:

- A pen for freehand drawing;
- A keyboard for text input;
- A mouse or equivalent for positioning;
- A large inventory of text decorations;
- Support text decoration from the keyboard;
- Optimize text positioning and entry;
• Automate common drawing sequences.

The authors addressed two fundamental problems that a developer may encounter during designation of a notetaking system of any kind:

1. What software and hardware features should be considered for supporting notetaking?  
   Answer: They identified the needs of students taking class notes, and showed how students were not satisfied by existing drawing tools or editors provided by their NoteTaker system.

2. How likely is it, to build a successful notetaking application using hardware available today?  
   Answer: Digitizer quality was the main issue and so with the availability of laptops, this problem is almost solved.

Indeed, NoteTaker is a system, supporting students to apply new digital devices, e.g. using laptops in class to manage digital documents, in a manner analogous to traditional notetaking with pen, paper etc.

In particular, the implementation was not successful in encouraging students to apply graphical objects in their notes. Lastly, the productivity of the system in terms of notetaking skills can be summarizes as follows:

1. **Listening:** NoteTaker can provide a pre-planned and prepared environment, so it decreases the time needed to focus on taking notes. Hence, students pay more attention to their lecturer and in-class instruction.
2. **Cognitive processing:** Notetaker can decrease the student’s cognitive effort, but not by a significant amount. Figure 2.4 shows a comparison between pre-planned (notetaking according to some instructions and methods) versus the usual notetaking.

![Figure 2.4: comparison between pre-planned versus usual notetaking](image)

Although the reduction in cognitive effort is so slight, this can still be helpful to students or readers.

3. **Jotting down notes:** Although the system is designed for assisting students with notetaking, there are not any particular tools to accentuate important points residing in the source. So user’s skill for taking notes can not be promoted by this skill.

4. **Reviewing:** There is no special environment in NoteTaker to make the reviewing of notes easier for example, classification of taken notes based on the subjects.
LiveNotes (M. Kam et al, 2005) functions based on cooperative notetaking for producing augmented notes from lectures. So the basic functionality is the same as NoteTaker in terms of providing students with the facility to take notes digitally for example while using their laptops, but in this case the environment is cooperative.

LiveNotes provides a notetaking environment as a shared whiteboard system. The system uses wireless communication and laptop facilities to support real-time conversations within small groups of students during lectures. Therefore, it enables group members to share their information and interact by taking lecture notes to support each other. The system provides instructor slides in the background to annotate. The most important facility of this system is to provide an environment for students to take notes collaboratively. In a follow up study the
authors reported that in compare to individual notetaking, cooperative notetaking enabled students to collectively compose a more comprehensive set of lecture notes, as well as engage in dialogue. In addition, the resulting set of notes reflected a higher degree of comprehension of the lecture. Lastly, the productivity of the system in terms of notetaking skills can be summarizes as follows:

1. **Listening**: Like NoteTaker, this system can assist the student by increasing the attention time paid to the lecture. In contrast, it may decrease the attention, if students of one group try to analyse each other’s notes during educational time.

2. **Cognitive process**: The system decreases cognitive effort by allowing a student to review other students’ notes and the lecture notes at the same time, but additional effort is required to understand whether a group member’s notes are plausible and if there is any interrelationship.

3. **Jotting down notes**: The system benefits from collaborative notetaking as a tool for finding main ideas and related specifications. As a result, notes produced are more efficient in comparison with individually produced notes. Therefore, by comparing and analysing other classmates’ notes, students can produce more effective notes but this does not help them in coming up with better notes.

4. **Reviewing**: There are no specific tools devised for reviewing notes in LiveNotes.
Palaigeorgiou et al. (2005) developed eVerNotes a system that aims to satisfy students’ study models (figure 2.6). It provides an environment to facilitate verbatim notetaking and to support students in creating association between multiple notes by an intermediate tree structure.

![Figure 2.6: eVerNotes articles area](image)

eVerNotes is intended to improve the efficiency of traditional notetaking models by producing features such as: collecting, connecting, and indexing electronic verbatim notes and sources, and using them for tailoring past notes to the user’s notetaking behaviours. The system provides the facility of creating categories whereby the user can connect each notes to particular category, so that a corresponding linked structure of notes can be produced. Since
categorization is an important cognitive ability (Jacob, 2001), the system allows users to organize knowledge from different perspectives (figure 2.7).

Figure 2.7: eVerNotes Notes area

Lastly, the productivity of the system in terms of notetaking skills can be summarized as follows:

1. **Listening**: eVerNotes does not offer any facilities to increase notetaker’s attention to the source or lectures.

2. **Cognitive process**: By categorization of the documents and notes, eVerNotes decreases the amount of cognitive effort. There are facilities provided by the system, e.g. past taken notes, related articles, to help the
note-taker decide to which category the notes belong. In addition, by looking at related articles users can integrate their own knowledge with new achievements or past knowledge.

3. **Jotting down:** During notetaking, users can access past notes and related article, which helps them to find background and general ideas. This may not be sufficient to produce good notes. In addition, no obvious tool has been devised for the system to support users to produce notes that are more efficient.

4. **Reviewing:** An outstanding feature of eVerNotes is its environment for maintaining notes by categorizing them. With this facility, users can compare articles and their produced notes in the same environment.

➢ **NoteBlogger**

Simon et al. (2008) developed a system, for publically taking notes by using the facilities of a blog to share students’ knowledge (figure 2.8).

With NoteBlogger, students with Laptop take handwritten notes digitally on top of the instructor’s slides, and their notes are instantly reviewable by other students in class by using a web browser. Their approach is very close to LiveNote’s approach but the difference is in using the facilities of blogging that makes it more public.
The productivity of the system in terms of notetaking skills is similar to LiveNote.

None-educational Notetaking systems

There are some other types of notetaking systems are not developed for educational purposes but can be employed by students for managing and relating their information while studying. Some of these types of applications are shown in table 2.1

Table 2.1 General purposes Notetaking systems

<table>
<thead>
<tr>
<th>System No.</th>
<th>Name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BasKet Note Pads</td>
<td>Manage to-do lists, links, pictures, and other types, similar to a scrapbook.</td>
</tr>
<tr>
<td>2</td>
<td>FreeMind</td>
<td>Provide a tool for the user to edit a hierarchical set of ideas around a central concept</td>
</tr>
<tr>
<td>3</td>
<td>Gnote</td>
<td>Filling the need for personal information management</td>
</tr>
<tr>
<td>4</td>
<td>Jaral</td>
<td>A feature for recording pen strokes and playing them back as an animation</td>
</tr>
<tr>
<td>5</td>
<td>SciPlore MindMapping</td>
<td>Focus on combining mind maps with PDF and reference management</td>
</tr>
<tr>
<td>6</td>
<td>TOMBOY</td>
<td>A notepad with a Wiki-like linking system to</td>
</tr>
</tbody>
</table>
connect notes together.

<table>
<thead>
<tr>
<th></th>
<th>System</th>
<th>Listening skill</th>
<th>Cognitive process skill</th>
<th>Jotting down skill</th>
<th>Reviewing skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>WikidPad</td>
<td></td>
<td>WikidPad is for storing thoughts, ideas, to-do lists, contacts, and other notes with Wiki-like linking between pages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>XMind</td>
<td></td>
<td>helps people to capture ideas, organize to various charts, and share them for collaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>xournal</td>
<td></td>
<td>Xournal was designed to be a better-performing program than Jarnal. However, it has no collaboration facilities and is not binary portable to other platforms.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.1: continued

**Discussion:**

Some Notetaking systems have been selected as representative of present running approaches that can be used to tackle Notetaking problems. Presented systems were all more likely to be interfaces, instead of being system and had aim to help note-takers in some aspects of Notetaking skills. However, none of them solve the problem of Listening (pay attention) and deal with it deficiently. For cognitive processing problem, LiveNotes, NoteBlogger, endeavoured to deal with it by providing an environment that users could consult with each other to find main ideas of the source and integrating altogether, on the other hand, eVerNotes provides an environment to compare past taken notes from articles with each other but all of these systems add some new efforts for their users by adding more information to be compared, so they decrease some efforts in one hand while adding new efforts on the other hand. Moreover, all discussed systems do not have any defined function to support users to answer the question: **How they could take the most efficient notes from the source?**

Table 2.2: Notetaking systems comparison

<table>
<thead>
<tr>
<th>System</th>
<th>Listening skill</th>
<th>Cognitive process skill</th>
<th>Jotting down skill</th>
<th>Reviewing skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoteTaker</td>
<td>Enhance</td>
<td>Enhance</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Application</td>
<td>Deteriorate</td>
<td>Deteriorate</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>LiveNotes</td>
<td>Deteriorate</td>
<td>Deteriorate</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>eVerNotes</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
<td>Enhance</td>
</tr>
<tr>
<td>NoteBlogger</td>
<td>Deteriorate</td>
<td>Deteriorate</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>BasKet Note Pads</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>FreeMind</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>Enhance</td>
</tr>
<tr>
<td>Gnote</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>Jaral</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>SciPlore MindMapping</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>TOMBOY</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>WikidPad</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>XMind</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>Enhance</td>
</tr>
<tr>
<td>xournal</td>
<td>NA</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
</tr>
</tbody>
</table>

Table2.2: continued

NA – not applicable.

To review the notes taken, eVerNotes produced a very friendly and straightforward interface, so that users can maintain notes and respective articles with proper categories.

In the following table (Table 2.2), a comparison among the four aforementioned systems based on four notetaking skills is presented. According to the above table, none of the four systems enhanced more than two skills of students in the case that the other two systems (LiveNotes and NoteBlogger) enhance one skill while deteriorate two other skills. For the systems are presented in table 2.1, they are not developed for educational purposes so that there is not any tool devised in them for enhancing both Listening and Cognitive process.
skills. However, they can enhance users’ performance in jotting down and Cognitive process skills. While all of these notetaking systems enhance jotting down skill, because they provide an appropriate interface as input, but only two of them, FreMind and XMind, improve users’ reviewing skill. FreeMind allows user to make hierarchical construction around main concepts therefore, it can help users to recall concepts and respective relations effectively. Similar to FreeMind, XMind provides an area for users to capture ideas and organize them to various charts, and share them for collaboration. To sum up, it can be said that eVerNotes is the best system for educational purposes as it enhance both Cognitive process and reviewing skills. In other words, eVerNotes helps students in learning time by decreasing cognitive load required as well as the time students need to review their taken notes.

2.2 Summarization

Summarization is a difficult skill for students to acquire, one that emerges gradually over years of experience. Brown et al. (1983) found that while summarizing, fifth and seventh grade students relied primarily on the inefficient copy-delete strategy, whereby elements of the original text are simply copied verbatim, with some irrelevant portions deleted, whereas older high school and college students used more sophisticated condensation rules, such as construction and generalization. Additionally, Brown and Smiley (1977) had students rate the importance of story units (ideas) using a four-point scale and found that fifth graders were only able to distinguish the most important units as being more important to the theme than the others. Unlike older students, fifth graders were unable to make distinctions beyond that.
The educational benefits of summarization have been borne out in numerous studies. Not only does summarization training improve the quality of students’ summaries (Brown et al., 1981; Hare and Borchardt, 1984), it has also produced transfer effects on reading comprehension measures (Baumann, 1984; Erickson et al., 1986). Furthermore, summarization training has also been demonstrated to benefit students with learning disabilities (Gajria and Salvia, 1992; Jitendra et al., 1998). In light of these benefits, Rinehart and Thomas (1993) argue that summarization training should begin early in a child’s education and further that summarization helps students move appropriately from an egocentric, what’s-important-to-me viewpoint of text to what is important according to others.

Summarization is also an important method for the acquisition of basic content knowledge in many school settings and instructional methods. For example, Palincsar and Brown (1984), espouse summarization as a strategy for fostering comprehension in their reciprocal teaching model, and Uttero (1988) developed a teaching model based on cooperative learning (Slavin, 1983) in which students use summarization to enhance their understanding of a text after first having paraphrased its essence.

Summarization allows students to develop a deep understanding of complex material and, additionally, to articulate that understanding so that it can be shared with teachers and/or classmates. Teachers have noted marked differences in depth of understanding of topics that have been summarized as opposed to merely being read by students. Additionally, students’ recall of a text is enhanced if they have summarized it as opposed to merely reading it (Taylor, 1982; Taylor and Beach, 1984). In classroom
discussions, they appear to have a deeper understanding of the material, as evidenced by their detailed reasoning and thoughtful contributions.

Furthermore, the task of summarization makes students aware of the need to learn writing strategies beyond simply adding or deleting single words, phrases, or sentences (Brown and Day, 1983; cf. van Dijk and Kintsch, 1983). Summarization can therefore serve as a starting point for the introduction of higher-level writing strategies in the classroom, such as generalization, synthesis, and maintaining coherence. Finally, summarization provides practice in expository writing and requires active meaning construction much more so than choosing the best response from a set of choices, or even than writing short answers to isolated questions. Summarization is therefore a highly effective means for constructing and integrating new knowledge, and provides a more authentic evaluation of student knowledge than do traditional tests of comprehension. Therefore, summarization clearly has a great deal of potential for improving students’ learning and writing, but the amount of work required to review and grade multiple drafts of students’ writing can be overwhelming. Hence, the need for computer-based system such as Summary Street is sensible.

2.2.1 Types of text summarization:

There are many factors involved in text summarization. Texts may be summarized by a human as in news story headlines or movie previews, or automatically as done by search engines such as Google and AltaVista. Below are some of the types of summarizations.
• **Human summarization**

It is currently the most preferred and reliable form of text summarization. News story headlines, movie previews and movie reviews are all examples of human summaries. They are usually considered to be of high quality, coherent and reflective of the source document. However, human summaries are often time consuming and labor intensive to produce.

• **Automatic summarization**

It is machine-generated output that presents the most important content from a source text to a user in a condensed form and in a manner sensitive to the user's or application's needs (Mani et al., 2002). Automatic summaries of text documents are faster and less expensive to generate in comparison to human summaries. However, automatic summaries have not achieved the level of acceptance achieved by human summaries, and it has previously been shown that human summaries provide at least 30% better information than automatic summaries. Various methods for automatic summarization have been proposed, and large scale evaluations such as the Document Understanding Conference (DUC), (Harman and Over, 2004) and SUMMAC (Mani et al., 2002) have been conducted to judge systems and understand issues with summarization.

### 2.2.2 Automatic text summarization approaches

Summarization, as a task performed by humans, includes reading and understanding a document for content, then generating a new document expressing a concise version of respective content. A summary will not contain all the information from the source, but presents only the most important information with some sentences and according to some predefined compression grade. On the other hand notes can be defined as short condensations
of a source material that are generated by writing them down while simultaneously listening, reading, or observing. The function of notetaking is to gather information distributed in a lecture, a book, or in any other situation that needs to be remembered. In other words, notes are external memories whose content is more or less explicit (Hartley, 1976; Kiewra, 1989; Kiewra & Frank, 1988; Kiewra, DuBois, Christensen, Kim, & Lindberg, 1989). Therefore, it can be said that notetaking is a natural example of human summarization and as a result, the outcome of comprehending content. Since notetakers aim to extract the most important ideas that are embedded in the sentences of the source, so sentence extraction can be considered as a fundamental task in notetaking. In a similar strategy, sentence extraction is widely applied in automatic text summarization systems. Statistical heuristics are used to identify the most salient sentences of a text. Applying sentence extraction for text summarization is a low-cost approach compared with knowledge-intensive deeper approaches, which require additional knowledge such as ontologies or linguistic knowledge. Below I classify and discuss some approaches, applied to text summarization based on sentence extraction.

**Surface-based Approaches**

The initial approaches used surface-based cues to realize which parts of a text are important. Hans and Luhn (1958) developed a Preliminary sentence extraction algorithm, which used term frequencies, to measure sentence relevance. The idea was that when writing about a given topic, a writer will repeat certain words as writing the text proceed. Thus, term relevance is considered proportional to its in-document frequency. The term frequencies are used later to score and choose sentences for a corresponding summary. Other good indicators of sentence relevance are the position of a sentence within the document (Baxendale, 1958), the presence of title words or certain cue-words. Edmundson (1969) demonstrated that the
combination of the presence of cue-words, title words, and the position of a sentence produces the most similar extracts to abstracts written by a human.

**Corpus-based Approaches**

It is most likely that documents belonging to the same field share common terms in that field, that do not contain salient information, so their relevance should be reduced. Salton (1988) showed that the relevance of a term in a document is inversely proportional to the number of documents in the corpus including the term. Jones (1972) proposed the normalized formula for the term relevance $t_f_i * i_d_f_i$, where $t_f_i$ is the frequency of term $i$ in the document and $i_d_f_i$ is the inverted document frequency. Sentence weights or scores can then be computed in some ways as the sum of term scores in the sentence. In designing SUMMARIST (Hovy and Lin 1999), new measuring term *concept relevance* was proposed. The authors claim that word counting misses conceptual generalization, for instance, *John bought some vegetables, and fruit, bread, and milk* in comparison with *John bought some groceries*. The word counting method must be extended to recognize that vegetables, fruit, etc. relate to groceries, so they applied WordNet to solve the problem. By using WordNet they obtained the ability to calculate the occurrence of the concept *car* as well as when, for instance, *automobile, vehicle, or machine* were found. Kupiec et al. (1995) implemented Bayesian classifier, which computes the probability that a sentence in a source document should be included in a summary. In order to train the classifier the authors used a corpus of 188 pairs of full documents or summaries sampled from 21 publications in the scientific/technical domain. They used the following features: sentence length, phrase structure, in-paragraph position, word frequency and uppercase words. The most likely sentences to be chosen are computed by the Bayesian formula.
Cohesion-based Approaches

The main deficiency of sentence extraction methods is the failure to capture the relations between concepts in a text. Anaphoric expressions that refer back to events and entities in the text need their antecedents in order to be understood. That would be in case that some sentences from text require to be extracted. For example, for the summary, that can be difficult to understand, if the sentence that contains an anaphoric link is extracted without the previous context. Text cohesion comprises relations between expressions which determine the text connectivity. Cohesive properties of the text have been explored by different summarization approaches.

Barzilay and Elhadad (1997) implemented the first lexical chains algorithm that uses the WordNet database for determining cohesive relations (i.e., repetition, synonymy, antonym, hypernymy, and holonymy) between terms. The chains are then composed semantically. Their scores are determined on the basis of the number and type of relations in the chain. Sentences where the strongest chains are highly concentrated are selected. A similar method where sentences are scored according to the objects they mention was presented by Boguraev and Kennedy (1997). The objects are identified by a co-reference resolution system. Co-reference resolution is the process of linking together multiple expressions of a given entity. The key to solve this problem is to determine the antecedent for each referring expression in a document e.g., sentences where the frequently mentioned objects occur go to the summary.

Rhetoric-based Approaches

Rhetorical Structure Theory (RST) is a descriptive theory of major aspects of the organization of natural text. According to RST, a rhetorical relation typically holds between two contiguous spans, of which one span (the nucleus) is more central to the writer’s
intention that the other (the satellite), whose sole purpose is to increase the reader’s understanding or belief of what is said in the nucleus. Sometimes, two related spans are of equal importance, in which case there is a multinuclear relation between them. The related spans form a new span, which can in turn participate in a relation with another span. The smallest units of discourse are elementary discourse units consists of a number of rhetorical relations that tie together text units. Ono et al. (1994) penalized sentences according to their rhetorical role in the tree. A weight of 1 is given to satellite units and a weight of 0 is given to nuclei units. The final score of a sentence is given by the sum of weights from the root of the tree to the sentence. Marcu (1997) proposed that each parent node identifies its nuclear children as salient. The children are promoted to the parent level. The process is recursive down the tree. The score of a unit is given by the level it obtained after promotion.

**Graph-based Approaches**

Graph-based algorithms, such as HITS introduced by Kleinberg (1999) or Google’s PageRank developed by Brin and Page (1998), have been successfully used in citation analysis, social networks, and in the analysis of the link structure of the Web. In graph-based ranking algorithms, the importance of a vertex within the graph is recursively computed from the entire graph. Mihalcea and Tarau (2004) applied the graph-based model to natural language processing, resulting in Text Rank. Furthermore, the graph-based ranking algorithm was applied to summarization Mihalcea and Tarau (2005). A graph is constructed by adding a vertex for each sentence in the text, while edges between vertices are established using sentence interconnections. These connections are defined using a similarity relation, where similarity is measured as a function of content overlap. The overlap of two sentences can be determined simply as the number of common tokens between lexical representations of two
sentences. After the ranking algorithm is run on the graph, sentences are sorted in the reverse order of their score, and the top ranked sentences are included in the summary.

**Beyond Sentence Extraction**

The most straightforward way of creating abstracts is to identify in a way the most important information in the document(s), appropriately encode it and then feed it to a Natural Language Generation (NLG) system Reiter and Dale (2000) which generates the summary. Two main categories of abstractive techniques are represented as follows:

- In this category the process of identifying and encoding the most important information in the document(s) can be performed using prior knowledge about the structure of this information. This knowledge is represented through cognitive schemas such as frames, scripts, templates. Thus, in such cases, the summary produced is not a generic one, but a rather user-oriented one since the schema can be considered as a sort of user query. Different approaches in this category may be the following:

  - Use of a *script*, i.e. a sort of a simple-structured template with slots identifying common important events over a domain. There is a separate script for each domain. When a document is processed, the corresponding script is activated and its slots filled with information from the document. The activation can be performed through the appearance of certain words, or by the activation of another script. After the script has been activated and filled, the summary can be generated using in most cases simple techniques.

  - Using of domain-specific template, a sort of a relational database, having a more complex structure compared to scripts. The template can be filled from a document
using information extraction techniques. The filled templates can then be processed in order to transform them in an appropriate form for the NLG system. Processing is done using various semantic operators, such as Change of Perspective, Contradiction, Addition/Elaboration, Refinement, Agreement, etc.

- The second category involves techniques that do not use prior knowledge about the structure of the important information to be used in the summary, but instead produce a semantic representation of the documents, which is then fed to the NLG system. The following are the different approaches in this category:

  - The documents are linguistically processed in order to identify noun phrases, verb phrases that can be linked to the concepts, attributes and relations of a domain-specific ontology. Ontology-based annotations can then be used to select the important document regions (sentences, paragraphs). These regions are then converted into some semantic representation using the results of the linguistic processing and the ontology-based annotations. This representation is then fed to a NLG system that produces the abstract.

Finally, it is represented that there are originally two kinds of summarizations methods such as abstractive and extractive. However, abstractive methods are more complicated than the other. In extractive methods, a variety of techniques are employed to extract the most important sentences that contain the gist of the text without doing any paraphrasing even though it is the main issue in abstractive methods. Although the benefits of abstractive methods, which mimic human techniques in summarising a text, are obvious, it is very expensive computationally to be implemented. However, cognitive approaches for sentence extraction can be employed by mimicking human behaviour while choosing important sentences in a text.
In this chapter, we describe a framework to measure semantic similarity between two sentences. WordNet is employed to be referred for counting semantic distances between words. The similarity framework is then used to extract the most salient sentences from text suited for summarization and notetaking tasks. The process of sentence extraction involves three levels of analysis: word; sentence; and text.

3.1 Word level analysis

At word level, we delve into computational semantic relatedness and similarity measurement. Originally, they are to approximate automatically the grade of resemblance embedded in words and documents. There are two main approaches considered for semantic measurement: supervised and unsupervised methods. WordNet is an important tool employing unsupervised method. Thus, this is described below.

3.1.1 WordNet

WordNet is a large, electronically available, lexical database of English Fellbaum (1998). It was created at the Cognitive Science Laboratory at Princeton University. It contains nouns, verbs, adjectives, and adverbs (open-class words) but not pronouns, conjunctions, or prepositions (closed-class words). WordNet classifies sets of synonymous word senses into synonym sets or synsets. It is a semantic network in which each node, called synset, represents a fine-grained concept or word sense that is a particular meaning of a word. For example, the word *study* has several meanings; as a noun, it can refer to a detailed critical inspection or it can refer to a room used for reading, writing, and studying. A synset contains
one or more synonymous word senses. For example, report, study, written report is the synset for the third sense of the noun study (figure 3.1). The synset can be defined as the basic organizational unit in WordNet. Each synset has a gloss associated with it. The gloss for the synset report, study, and written report is a written document describing the findings of some individual or group. Many synsets also have an example in addition to the gloss (figure 3.1).

The sense numbers in WordNet are assigned according to the frequency with which the word sense occurs in the SemCor corpus.

Figure 3.1: The different senses of the word study in WordNet

The first sense of a word is usually more common than the second (figure 3.1). Word senses that do not appear in SemCor are assigned sense numbers in a random order. SemCor corpus consists of about 360,000 words of which about 221,000 are sense-tagged. It consists of texts
selected from the Brown Corpus that was created at Brown University in 1964. Word senses can be represented as strings in a specific format, using the word form, a single letter representing the part of speech, and a sense number, such as study#n#3, which represents the third sense of the noun study (figure 3.1). The part of speech letter ‘n’ stands for nouns, ‘v’ stands for verbs, ‘a’ stands for adjectives, and ‘r’ stands for adverbs. Terms consisting of more than one word are often joined by underscores instead of spaces like orange juice.

WordNet 3.0, the current version as of this research, has more than 117,000 synsets and covers more than 155,000 word-types. It has more than 81,000 noun, 13,000 verb, and 18,000 adjective and 3,000 adverb synsets. It has coverage of more than 117,000 nouns, 11,000 verbs, and 22,000 adjectives and 4,000 adverbs word-types. A relation between synsets can be considered as a semantic relation and a relation between word senses is conceived as a lexical relation. Fundamentally, the distinction between these two kinds of relations is elusive. It can be said that a lexical relation is the relation between members of two synsets in contrast with a semantic relation, which is a relation between two whole synsets. Several kinds of semantic relations are illustrated in the following figures:

<table>
<thead>
<tr>
<th>Relation type</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypernym</td>
<td>From concepts to superordinates</td>
<td>Car ➔ Motor vehicle</td>
</tr>
<tr>
<td>Hyponym</td>
<td>From concepts to subtypes</td>
<td>Meal ➔ Dinner</td>
</tr>
<tr>
<td>Has-Member</td>
<td>From groups to their members</td>
<td>School ➔ Staff</td>
</tr>
<tr>
<td>Member-of</td>
<td>From members to their groups</td>
<td>Professor ➔ Faculty</td>
</tr>
<tr>
<td>Has-part</td>
<td>From wholes to parts</td>
<td>School ➔ Classroom</td>
</tr>
<tr>
<td>Part-Of</td>
<td>From parts to wholes</td>
<td>University ➔ Academia</td>
</tr>
<tr>
<td>Antonym</td>
<td>Opposites</td>
<td>Leader ← ➔ Follower</td>
</tr>
</tbody>
</table>

Figure 3.2: Types of Noun relations in WordNet
<table>
<thead>
<tr>
<th>Relation type</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypernym</td>
<td>From events to superordinates events.</td>
<td>Read → Interpret</td>
</tr>
<tr>
<td>Troponym</td>
<td>From events to their subtypes.</td>
<td>Read → Skim</td>
</tr>
<tr>
<td>Entails</td>
<td>From events to the events they entail.</td>
<td>Study → Read</td>
</tr>
<tr>
<td>Antonym</td>
<td>Opposites</td>
<td>Promote ← → Demote</td>
</tr>
</tbody>
</table>

Figure 3.3: Types of Verb relations in WordNet

<table>
<thead>
<tr>
<th>Relation type</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antonym</td>
<td>Opposite</td>
<td>Beautiful ← → Ugly</td>
</tr>
<tr>
<td>Adverb</td>
<td>Opposite</td>
<td>Wisely ← → Foolishly</td>
</tr>
</tbody>
</table>

Figure 3.4: Adjective and Adverb relations in WordNet.

In this research, WordNet is utilized to provide required information about words. After setting up WordNet, we can now start the analysis at word level.

### 3.1.2 Stop words elimination

There are always some words with high frequency of repetition in the text. They are not informative, like the words *the, a, for*, etc. These are called *stop words*, appear in almost every sentence, and are not considered as important words for differentiating sentences from each other. So they can be deleted from the text. Lingua::StopWords perl module is used to
extract stop words from the text. In the following example, all stopwords are removed from the text.

**Example 4.1:**

Input of Lingua::StopWords:

“Noote taking is closely related to summarizing because it requires that students take information and synthesize it using their own words. The purpose of note taking is to help students acquire and integrate knowledge; it is a way to organize and process information. Because students are extracting new knowledge in a new language, they will need explicit instruction in the art of note taking.”

Output:

“Noote taking closely related summarizing requires students take information synthesize using words. The purpose note taking help students acquire integrate knowledge; way organize process information. Because students extracting new knowledge new language, will need explicit instruction art note taking.”

### 3.1.3 Word sense disambiguation

When WordNet is utilized for word analysis, it presents multiple related senses for a word. Therefore a tool is required to determine the sense of a word from contextual features.

For example, consider the word “school” in the following texts:

- The school was founded in 1900
In above text, the gloss of synset for the word *school* is: an *educational institution* that is related to its first sense. Nevertheless, in the following text:

- A *school* of small glittering fish swam by

The word school is used as its seventh sense that is: *animal group*. Originally, each word in the text that is not stop word should be disambiguated to uncover its sense separately. The sense of each word can be identified by its adjacent words in the text. At each stage of word disambiguation, the word disambiguated is a target word and its surrounding words form the context view. The algorithm employed in this project is based on Michelizzi's (2005) work:

---

**Algorithm 1 for word disambiguation**

1: function disambiguate-all-words
2: for all $W_t$ in input do \{ $W_t$ is known to WordNet and not found in a stop list\}
3: best-sense $\leftarrow$ disambiguate-single-word ($W_t$)
4: display best-sense
5: end for
6: end procedure

7: function disambiguate-single-word ($W_t$) returns sense s
8: for all $S_{ti}$ of target word $W_t$ do \{ $S_{ti}$ is the $i$th sense of the target word $W_t$\}
9: score$_i$ $\leftarrow$ 0
10: for $j = t-cl$ to $t + cr$ do
11: if $j = t$ then
12: next $j$
13: end if
14: for all $s_{jk}$ of $w_j$ do \{ $s_{jk}$ is the $k$th sense of word $w_j$ \}
15: temp-socre$_k$ $\leftarrow$ relatedness ($s_{ti}$; $s_{jk}$)
16: end for
17: best-score $\leftarrow$ max temp-score
18: if best-score $>$ threshold then
19: score$_i$ $\leftarrow$ score$_i$ + best-score
20: end if
21: end for
22: end for
23: return sense$_i$ s.t. score$_i$ $>$ score$_j$ for all $j$, where $j \neq i$
24: end function

---
By assigning a score to each sense of the target word, the algorithm chooses the sense most suited to the context. The score related to each sense of target word is computed by comparing senses of context words with each sense of target words. This comparison was implemented by using a semantic relatedness measure. In this research we apply Extended Gloss Overlaps (Adapted Lesk) for semantic relatedness measure. This method is implemented in a Perl module as: “WordNet::Similarity::lesk” (Pedersen, 2008). The score for each target sense is the sum of the relatedness scores between the target sense and each most related context sense. Once the algorithm finds a score for each sense of the target word, the sense with the greatest score is assigned to the target word. Equation (1) presents the algorithm in a compact mathematical form. For each target word, we have:

$$\text{Best\_suited\_Sense} = \arg \max_i \sum_{j=t-Cl,j\neq t}^{t+Cr} \max_k \text{relatedness}_{(S_{ti}, S_{jk})}$$

(1)

Where $S_{ti}$ is sense $i$ of word $t$ (i.e., the target word), and $S_{jk}$ is sense $k$ of word $j$ (i.e., a context word). This algorithm, is implemented as a set of Perl modules and scripts distributed as: “WordNet::SenseRelate::AllWords” (Michelizzi, 2009) to select the correct sense of a word in given context by considering Example 4.1, the output is:

“Note#n#3 take#v#17 closely#r#1 relate#v#1 summarize#v#1 require#v#1 student#n#2 take#v#17 information#n#1 synthesize#v#2 use#v#1 word#n#1 The #ND purpose#n#1 note#n#3 take#v#17 help#n#2 student#n#2 acquire#v#1 integrate#v#1 knowledge#n#1 way#n#6 organize#v#2 process#n#5 information#n#1 Because #ND student#n#2 extract#v#1 new#a#1 knowledge#n#1 new#a#1 language#n#5 will#n#1 need#n#3 explicit#a#2
Measure semantic relatedness by extended gloss overlaps

As we mentioned before we need to measure semantic relatedness for disambiguation a text. In this project we use WordNet::Similarity::lesk (Pedersen, 2008) that is an adoption of Lesk (1986) measure. For word sense disambiguation, Lesk’s approach proposes overlapped words in glosses to be counted. But in its adaption that is implemented as WordNet::Similarity::lesk. It finds overlaps in WordNet glosses to measure semantic relatedness. There is a significant shortcoming in Lesk’s approach that glosses are presented in the abstract, and even if two words are closely related, it is unlikely there will be a shared word in two glosses. So the implementation uses not only the glosses of the synsets but also the relations between synsets in WordNet to compare the glosses of closely related synsets.

3.1.4 Word Similarity

Semantic similarity can be shown as a measure of likeness between two word senses. In this research, we apply WordNet::Similarity (Pederson, 2008) that is a set of Perl modules, which
implements a number of measures of semantic similarity. As WordNet provides an *is-a* taxonomy, a simple approach to determine the amount of similarity to quantify the path length between two synsets in undirected taxonomy graph. Figure 3.5 depicts an example of WordNet noun hypernyms taxonomy.

![WordNet Noun Hypertention](image)

It can be seen that the synset {Student} is closer to {Creator} than {Agent} so it is considered to be more similar to {Creator} than {Agent}. It is very important to identify the sense of each word. For example in Figure 3.4, the first sense of the word “student” has been employed and will be shown like Student#n#1. Originally, the measures in the WordNet::Similarity package link up all the noun taxonomies and all the verb taxonomies
into one taxonomy for nouns and one for verbs by introducing a unique root node for each part of speech (Michelizzi, 2005). However, this behaviour can be “turned off” so that there is no unique root node for nouns or verbs. When a unique root node is not being used, it is possible for two synsets from the same part of speech to have no common subsumer i.e., a shared parent of two synsets. In this case, the similarity measures cannot give a similarity score. Even when a unique root node is used, the measures cannot give a score for synsets from different parts of speech e.g. nouns and verbs.

Path length distance
In this project, we used WordNet:: Similarity::path within the WordNet:: Similarity package (Pedersen, 2008). It uses path length distance to quantify the similarity of synsets. The similarity is determined by counting nodes situated between two synsets. It is defined as

\[
\text{Similarity}_{PATH} (S1, S2) = \frac{1}{\text{distance} (S1, S2)};
\]

\(\text{distance} (S1, S2)\) the number of nodes between synset S1 and synset S2. In Figure 3.5, the distance between \{Student\} and \{Relaxer\} is six nodes, so the similarity between these two synsets is 0.1667. According to the aforementioned equation, the similarity is between zero and one. The maximum is when an identical node’s similarity is calculated, e.g. student#n#1 and student#n#1 in figure 3.5. There is sometimes more than one hypernym for some synsets in WordNet. Therefore, there can be more than one path between respective synsets. In this case the shortest path is used similarity. In figure 3.5, there are two paths between \{student\} and \{entity\}, and the shorter path is used, i.e. through \{Causal agent, cause, causal agency\} rather than \{organism, being\}.

3.2 Sentence level analysis
A sentence is a grammatical unit of one or more words, bearing minimal syntactic relation to the words that precede or follow it. Typically, sentences can be considered as chunks of texts,
which express independent statements, questions, requests, commands, etc. All latent concepts in a text are spread out in its sentences. Hence, sentence analysis can help us to understand the importance the concept embedded in each of sentences while analysing the whole text.

3.2.1 Sentence semantic vector

There should be at least two sentences in consideration when discussing the term sentence similarity. We present a method to construct two vectors for each of two sentences based on their words similarity. To analyse a sentence, noun and verb parts of speech are considered because the most important concepts are spread out in them.

<table>
<thead>
<tr>
<th>Algorithm 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> The algorithm of constructing semantic vector between two sentences</td>
</tr>
<tr>
<td><strong>Input:</strong> two sentences Sentence1 and Sentence2</td>
</tr>
<tr>
<td><strong>Output:</strong> two vectors, Noun semantic vectors (N_vec) and Verb semantic vectors (V_vec) for sentence1.</td>
</tr>
<tr>
<td>/* disambiguate-all-words algorithm is explained in algorithm1 */</td>
</tr>
</tbody>
</table>

1- \( S1 \leftarrow \text{disambiguate-all-words (Sentence 1)} \)
2- \( S2 \leftarrow \text{disambiguate-all-words (Sentence2)} \)

/* all members of S1 and S2 have the format like word#part of speech#sense number e.g. study#v#3 */

3- foreach item1 \( \in S1 \) do
4- if item1 like (#n#) then
5- Push item1 in N1
6- else if item1 like (#v#) then
7- Push item1 in V1
8-         end if
9-         end if
10-        end foreach
11-        foreach item2 ∈ S2 do
12-         if item2 like (#n#) then
13-            Push item2 in N2
14-         else if item2 like (#v#) then
15-            Push item2 in V2
16-         end if
17-         end if
18-        end foreach
19-        for all items1 in N1 do
20-         for all items2 in N2 do
21-            Similarity_n ← word::similarity::path (item1,item2)
22-            Sum_N += similarity_n
23-         end for
24-        Push Sum_N in N_vec
25-        Sum_N = 0
/* summation of the similarity among one item in N1 and all items in N2 is calculated*/
26-        end for
27-        for all items1 in V1 do
28-         for all items2 in V2 do
29-            Similarity_v ← word::similarity::path (item1,item2)
30-            Sum_V += similarity_v
For example, we consider the following two sentences and analyse them according to the above algorithm.

**Example 3.2**

*Sentence 1:* Note taking is closely related to summarizing because it requires that students take information and synthesize it using their own words.

*Sentence 2:* The purpose of note taking is to help students acquire and integrate knowledge; it is a way to organize and process information.

After disambiguating all the words in the two sentences, the following arrays are created:

S1 = {Note#n#3, take#v#17, closely#r#1, relate#v#1, summarize#v#1, require#v#1, student#n#2, take#v#17, information#n#1, synthesize#v#2, use#v#1, word#n#1}

S2 = {The #ND, purpose#n#1, note#n#3, take#v#17, help#n#2, student#n#2, acquire#v#1, integrate#v#1, knowledge#n#1, way#n#6, organize#v#2, process#n#5, information#n#1}

The following four arrays are created after extracting the noun and verb parts of speech.

N1 = {Note#n#3, student#n#2, information#n#1, word#n#1}

N2 = {purpose#n#1, note#n#3, help#n#2, student#n#2, knowledge#n#1, way#n#6, process#n#5, information#n#1}
V1 = \{ take\#v\#17, relate\#v\#1, summarize\#v\#1, require\#v\#1, take\#v\#17, synthesize\#v\#2, use\#v\#1 \}

V2 = \{ take\#v\#17, acquire\#v\#1, integrate\#v\#1, organize\#v\#2 \}

To build the noun vector for sentence1, we need to add up similarity among each elements of N1 and all elements of N2. To do so the path length distance method is imposed (explained in 3.1.4). Note that the method for building the verb vector is the same as for the noun vector.

The total similarity among Note\#n\#3 and all elements of N2 is calculated as follows:

<table>
<thead>
<tr>
<th>Each elements of N1</th>
<th>All elements of N2</th>
<th>Similarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note#n#3</td>
<td>purpose#n#1</td>
<td>0.083333333333333</td>
</tr>
<tr>
<td></td>
<td>note#n#3</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>help#n#2</td>
<td>0.0769230769230769</td>
</tr>
<tr>
<td></td>
<td>student#n#2</td>
<td>0.0769230769230769</td>
</tr>
<tr>
<td></td>
<td>knowledge#n#1</td>
<td>0.111111111111111</td>
</tr>
<tr>
<td></td>
<td>way#n#6</td>
<td>0.0769230769230769</td>
</tr>
<tr>
<td></td>
<td>process#n#5</td>
<td>0.0769230769230769</td>
</tr>
<tr>
<td></td>
<td>information#n#1</td>
<td>0.125</td>
</tr>
</tbody>
</table>

Sum of similarity among Note\#n\#3 and all elements of N2 (Sum_N) = 1.80747863247863

If the process repeats for other elements of N1, i.e., student\#n\#2, information\#n\#1and word\#n\#1 and for each elements of V1, then we will have two vectors for sentence1 as follows:

For Nouns:

N_vec = \{1.62713675213675, 1.80747863247863, 1.802777777777777, 0.822402597402597\}
For Verbs:
\[ V_{vec} = \{1.7, 0.809523809523809, 0.396464646464646, 1.03333333333333, 1.71, 0.809523809523809, 1.03333333333333\} \]

### 3.2.2 Sentence similarity

One of the most important concepts in sentence analysis is sentence similarity. The employment of sentence similarity has proven to be one of the best techniques in webpage retrieval (E.K. Park et al., 2005), image retrieval from the Web (T.A.S. Coelho et al., 2004), text mining (J. Atkinson-Abutridy et al., 2004), and text categorization (Y. Ko et al., 2004)

#### Distance functions between two vectors

A suitable distance or a similarity function should be chosen that computes the association between a pair of feature vectors. The feature values in the functions such as the Manhattan or Euclidean distance, or similarity functions such as the inner product or cosine function can be used. So, the distance and similarity between two vectors \( V_i \) and \( V_j \) each having \( p \) dimensions can be computed (Bilisoly, 2008).

Manhattan distance: \( Md \)

\[ Md(V_i, V_j) = \sum_{t=1}^{p} |V_{it} - V_{jt}| \quad (3.1) \]

Euclidean distance: \( Ed \)

\[ Ed(V_i, V_j) = \sqrt{\sum_{t=1}^{p} (V_{it} - V_{jt})^2} \quad (3.2) \]
Inner product similarity: Is

\[ Is(V_i, V_j) = \sum_{l=1}^{p} V_{il}V_{jl} \] (3.3)

Cosine similarity: Cs

\[ Cd = \frac{\sum_{l=1}^{p} V_{il}V_{jl}}{\sqrt{\sum_{l=1}^{p} V_{il}^2} \sqrt{\sum_{l=1}^{p} V_{jl}^2}} \] (3.4)

The inner product computes the vector intersection or overlap. In the Boolean case where vectors are zero or one, the inner product can be used to compute the cardinality of the set intersection. The inner product is sensitive to between-vectors and within-vector differences in term of weights. The inner product does not penalize vectors for their representational richness. For instance, a high value in one vector strongly influences the result. The cosine function normalizes the inner product through its division by the Euclidean (Ed) lengths of each of the vectors. The length normalization avoids the influence of a single component and also fixes an upper bound of the range of similarity values (i.e., 1). The cosine function may penalize representational richness and it is insensitive to between-vectors weight relationships.

**Sentence similarity based on cosine value**

We propose a method for sentence similarity that calculates the mean of cosine similarity coefficient between noun semantic vectors and verb semantic vectors.
Algorithm 3

Description: The algorithm of sentence similarity.

1- Input : four semantic vectors : N_vec1, V_vec1, N_vec2, V_vec2

/* since we have two sentences then four semantic vectors created. We call them as N_vec1,V_vec1 for sentence1 and N_vec2,V_vec2 for sentence2 */

Output: Sim[X][Y] /*similarity between sentence [X] and sentence[Y]*/

2- Similarity_N = Cosine-similarity (N_vec1, N_vec2)

3- Similarity_V = Cosine-similarity (V_vec1, V_vec2)

4- Sim[X][Y] = \frac{Similarity_N + Similarity_V}{2}

5- Function Cosine-similarity ( vec1, vec2 )

6- Num1= number of elements in vec1

7- Num2= number of elements in vec2

8- if Num1 > Num2 then

9- Num-iteration = Num1

10- else Num-iteration = Num2

11- end if

12- for ( i=1 to Num-iteration ) do

13- Temp_element1 = extract first element of vec1

14- Temp_element2 = extract first element of vec2

15- sum_scalar += (Temp_element1) * (Temp_element1)

16- end for

17- foreach element ∈ vec1 do

18- sum1 += element^2

19- end foreach

20- foreach element ∈ vec2 do

21- sum2 += element^2

22- end foreach

23- return ( \frac{sum\_scalar}{\sqrt{sum1} \cdot \sqrt{sum2}} )

24- end function

According to algorithm 3, Similarity has been defined as a correlation between semantic vectors of two sentences. To calculate similarity between the following sentences:
Sentence1: Note taking is closely related to summarizing because it requires that students take information and synthesize it using their own words.
Sentence2: The purpose of note taking is to help students acquire and integrate knowledge; it is a way to organize and process information.

We need to calculate semantic vectors for each sentence. By imposing algorithm 2 on above sentences there will be four semantic vectors such as:

- \( V_{vec1} = \{ 1.7, 0.809523809523809, 0.396464646464646, 1.03333333333333, 1.71, 0.809523809523809, 1.03333333333333 \} \)
- \( V_{vec2} = \{ 3.27777777777778, 1.94444444444444, 1.03571428571429, 1.22424242424242 \} \)
- \( N_{vec1} = \{ 1.62713675213675, 1.80747863247863, 1.80277777777778, 0.822402597402597 \} \)
- \( N_{vec2} = \{ 0.377777777777777, 1.29283216783217, 0.467832167832168, 1.26783216783217, 0.531746031746032, 0.392832167832168, 0.378943278943279, 1.35 \} \)

Moreover, similarity is calculated as follows:

\[
\text{Cosine-similarity } (N_{vec1}, N_{vec2}) = 0.627277006986954
\]
\[
\text{Cosine-similarity } (V_{vec1}, V_{vec2}) = 0.695262038407242
\]

\[
\text{Sim}[1][2] = \frac{0.627277006986954 + 0.695262038407242}{2} = 0.66
\]

Thus, similarity is defined as the mean of verb semantic vectors correlation and noun semantic vectors correlation.
3.3 Text level analysis

Text can be described as the writing that forms the main part of a book, magazine etc., rather than the pictures or notes. To process an analysis at text level, at least three sentences are required. The main purpose of text analysis here is to rank sentences according to their importance.

3.3.1 Ranking sentences in a text:

In our proposed method, a cognitive approach is borrowed that originated in psychology to explain important sentences. It defines important sentences such that they are highly connected to other sentences in the text. This idea is borrowed from Kintsch's (2002) notion of sentence typicality, which is the semantic relation between a sentence and all other sentences in its text section. Connectivity here is defined as a similarity measure and furthermore, the importance of a sentence is defined as the mean of the similarity among a sentence and other sentences in the text. In the following example, three sentences are cleared of stop words:

“Note taking closely related summarizing requires students take information synthesize using words. The purpose note taking help students acquire integrate knowledge; way organize process information. Because students extracting new knowledge new language, will need explicit instruction art note taking.”

Sentence1: Note taking closely related summarizing requires students take information synthesize using words.

Sentence2: The purpose note taking help students acquire integrate knowledge; way organize process information.

Sentence3: Because students extracting new knowledge new language, will need explicit instruction art note taking.
Similarities among all sentences of this text are as follows:

Sim \[1][2] = 0.66 \text{ and } \text{Sim} \[1][3] = 0.57

Sim \[2][1] = 0.66 \text{ and } \text{Sim} \[2][3] = 0.84

Sim \[3][1] = 0.57 \text{ and } \text{Sim} \[3][2] = 0.84

So the importance of the sentences is:

Importance of Sentence1 = \( \frac{0.66 + 0.57}{2} = 0.615 \)

Importance of Sentence2 = \( \frac{0.66 + 0.84}{2} = 0.75 \)

Importance of Sentence3 = \( \frac{0.57 + 0.84}{2} = 0.705 \)

Therefore, the most salient sentence in the text is sentence2 with the importance grade of 0.75. Accordingly, the ranking is as follows:

Rank1: Sentence2
Rank2: Sentence3
Rank3: Sentence1

The sentence with the highest rank can be extracted as the most important sentence in the text.

**Algorithm 4**

**Description:** The algorithm of Summarization

**Input:** Text

**Output:** Summarization of the text

/* disambiguate-all-words algorithm is explained in algorithm1 */

1. \( S1 \leftarrow \text{disambiguate-all-words} \text{ (Sentence 1)} \)

2. \( S2 \leftarrow \text{disambiguate-all-words} \text{ (Sentence2)} \)
/* all members of S1 and S2 have the format like word#part of speech#sense number  
e.g. study#v#3 */

3- foreach item1 ∈ S1 do
4-   if item1 like (#n# ) then
5-     Push item1 in N1
6-     else if item1 like (#v#) then
7-       Push item1 in V1
8-       end if
9-     end if

Summary

In this chapter, we propose cognitive sentence ranking that can be applied on sentences in a text. Three levels of analysis on the text are presented. At the word level, the summation of similarity among words in the two sentences is calculated based on path similarity method. At sentence level, the similarity between two sentences is defined as correlation between the two vectors constructed from the summation of similarity measures in word level. At the text level, to rank sentences a cognitive method is employed to mimic human behaviour while identifying the importance of sentences.
Chapter 4
Automatic summarization and notetaking

In both text summarization and notetaking, information is distilled into a concise and synthesized form. Hence, the two tasks are very closely related. However, Text summarization and notetaking are difficult skills for students to acquire. We now carry out an investigation to find a common approach for the two tasks.

4.1 Applying sentence extraction to automatic text Summarization

Sentence extraction is often applied in automatic summarization, but there is still a large gap between summarization extracted by current automatic summarizers and the abstracts written by human professionals. One main reason is that systems cannot always correctly identify the important points (main ideas) of an article; these main ideas are exactly what are needed in notetaking. However, some non-extractive methods are applied to summarization. These methods either compress the sentences or create new sentences from scratch. In this project, we intend to adapt a cognitive approach to find the interconnections within the structure of the source text. It helps to model human abstraction and extraction behaviour when summarizing a text.

4.1.1 Cognitive-based approaches

Cognitive approaches have not been considered by IR (Information Retrieval) researchers very much so far. This could be the main reason of the gap between the capability of present automatic summarization system’s production and human abstraction. We may consider the summarization assessment process performed by a human, whose result is evaluation of a
summary and possibly a global score to estimate which sentences have important ideas. These are the sentences to start processing on first. For cognitive approaches, various models of the way humans assess the importance of sentences in texts can be considered. Below, four models are reviewed which manage differently the cognitive process involved in identifying the most important sentences in a text.

- The first approach considers comparing each sentence to the entire text (Kintsch et al., 2000).
- The second model considers the most important sentences that are highly connected to the others (Kitsch, 2002). In other words, this model considers the semantic relation between a sentence and all other sentences in its text section.
- The third model proposes that the reader is rather aware of coherence gaps between two blocks of sentences (Foltz, Kintsch & Landauer, 1998).
- The last model views the main idea selection as the result of sentence-by-sentence comprehension of the text, by the way of the Construction-Integration model (Kintsch, 1998).

These four computational models were successively presented and compared to human data by Lemaire et al. (2005). They then concluded that the second model is the most fine-grained model. We apply the second model to summarization.

### 4.1.2 Automatic summarization system

As automatic document, summarization is closely related with cognitive psychology, much attention has been paid in psychology to text understanding and representations, e.g., the Construction-Integration Model, explained in section 4.1.1, and the Event-Indexing model (Zwaan, 1998). In order to summarize a document, a reader has to first and foremost understand it. While understanding the documents, the reader has to be able to integrate
information within sentences and to make connections across sentences to form a coherent discourse representation (Rayner, 1994). Considering the importance of sentences to documents, and inspired by the cognitive based sentence extraction model (Knitch, 2002), we designed and developed a new generic system for automatic document summarization based on the analysis of human cognition and intelligence.

4.1.3 Structure of automatic summarization system

After realising the important and basic role of the sentence in document understanding and summarization, we propose a summarization system, which includes the following modules that are implemented in Perl (figure 4.1):

a. **Document to sentences**

   This module takes a plain text, converts it to sentences, and assigns and index number to each of them.

b. **Stop word elimination**

   This module purifies the text and omits all stop words.

c. **Word sense disambiguation**

   This module disambiguates all words in a Text based on semantic similarity and relatedness in WordNet.

d. **Word similarity measurement**

   This module finds the similarity of the words in the sentence by finding the nearest path between the two words in WordNet.
Figure 4.1: The structure of the proposed summarization system.
Sentence similarity measurement
This module applies our proposed sentence similarity method to measure sentence similarity.

Sentence ranking module
This module rank all sentences in the document based on their importance. The importance of a sentence in the text is identified by the degree of connectivity between that sentence and other sentences in the text. Connectivity is translated into similarity and then implemented.

Sentence extraction
This module extracts high ranked sentences in the text and considers them as a member of the summary set.

Size control
This module calculates the length of the summary based on the compression coefficient. In addition, according to the size of each retained sentence and the total size of all retained sentences if an extracted summary does not satisfy the required summary size, e.g., 100 words, the summary will be returned to the module of “sentence extraction”. Once the summary is of required size, it will be delivered to the next module.

Sentence re-arrangement
This module gets all sentences that are qualified sentences as input and rearrange them all according to their index number in the original text. Index number is extracted from document to sentence module.
For more clarification about what happens during each step of the summarization, we choose the text “AP880911-0016” from DUC 2002 corpus to show the process. The Document Understanding Conference will be explained in chapter 5.

Example 4.1 shows the process in detail:

Example 4.1:


“Hurricane Gilbert swept toward the Dominican Republic Sunday, and the Civil Defense alerted its heavily populated south coast to prepare for high winds, heavy rains and high seas. The storm was approaching from the southeast with sustained winds of 75 mph gusting to 92 mph. "There is no need for alarm," Civil Defense Director Eugenio Cabral said in a television alert shortly before midnight Saturday. Cabral said residents of the province of Barahona should closely follow Gilbert's movement. An estimated 100,000 people live in the province, including 70,000 in the city of Barahona, about 125 miles west of Santo Domingo. Tropical Storm Gilbert formed in the eastern Caribbean and strengthened into a hurricane Saturday night. The National Hurricane Center in Miami reported its position at 2 a.m. Sunday at latitude 16.1 north, longitude 67.5 west, about 140 miles south of Ponce, Puerto Rico, and 200 miles southeast of Santo Domingo. The National Weather Service in San Juan, Puerto Rico, said Gilbert was moving westward at 15 mph with a "broad area of cloudiness and heavy weather" rotating around the center of the storm. The weather service issued a flash flood watch for Puerto Rico and the Virgin Islands until at least 6 p.m. Sunday. Strong winds associated with the Gilbert brought coastal flooding, strong southeast winds and up to 12 feet to Puerto Rico's south coast. There were no reports of casualties. San Juan, on the north coast, had heavy rains and gusts Saturday, but they subsided during the night. On Saturday, Hurricane Florence was downgraded to a tropical storm and its remnants pushed inland from the U.S. Gulf Coast. Residents returned home, happy to find little damage from 80 mph winds and sheets of rain.

Florence, the sixth named storm of the 1988 Atlantic storm season, was the second hurricane. The first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month.”

We explained in detail how all sentences in the text are ranked by our proposed ranking method in chapter 3. The sentences that their IDs are first given, are shown better.
The sentences as we ranked by their importance are shown in table 4.1:

<table>
<thead>
<tr>
<th>Sentence priority</th>
<th>Sentences ID</th>
<th>Word count</th>
<th>Importance grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S16</td>
<td>16</td>
<td>0.762666666666667</td>
</tr>
<tr>
<td>2</td>
<td>S10</td>
<td>23</td>
<td>0.748666666666667</td>
</tr>
<tr>
<td>3</td>
<td>S14</td>
<td>16</td>
<td>0.730666666666667</td>
</tr>
</tbody>
</table>
Table 4.1 shows that the last sentence of the text, i.e., “the first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month” (S16), has the highest connection to other sentences in the text and so is identified by the system as the most important sentence and the seventh sentence is identified as the least important. Even though S7 is a rather long sentence with 35 words, i.e. “The National Hurricane Center in Miami reported its position at 2 a.m. Sunday at latitude 16.1 north, longitude 67.5 west, about 140 miles south of Ponce, Puerto Rico, and 200 miles southeast of Santo Domingo.” (S7). After all sentences in the text are ranked, the system picks up sentences sequentially from the highest ranked sentence until it meets the desired length. In summarization, the length is identified by compression ratio. In this example, the compression ratio equals 70% (text length = 321
words and summary length = 91 words), so the following sentences are selected as the most salient sentences:

Sentence_ID=  \{S16, S10, S14, S4, S5\}
Word count = 16 + 23+16+13+ 22 = 90

Apparently, we need to re-arrange the collection of most important sentences to make summary sensible and fluent for readers. At least there are two reasons for tailoring sentences according to their original arrangement:

- **Anaphora resolution problem**
  These are sometimes required to refer to entities were previously introduced into the text. By considering the collection of the most important sentences (Sentence_ID), it is very likely that an entity (anaphora) be introduced in S4 and the writer uses referring expression (anaphoric) in S16 referring to anaphora. Hence, to resolve this problem, we place sentences for summarization, similar to their original sequences. It guarantees at least the right sequences of anaphora and its references i.e., anaphoric.

- **To follow semantic order of the text**
  Indeed the writer uses sentences to present some ideas or explain some facts run-on sentence. All the events (sentences) in a text are related together semantically. To preserve the logical semantic relation between events in produced summary, it needs the text to be in the same order as the original text.
Therefore, we sort the chosen sentences into original order.

Summary_SID = \{S4, S5, S10, S14, S16\}

Finally, the output of the automatic summarization is:

“Cabral said residents of the province of Barahona should closely follow Gilbert's movement. An estimated 100,000 people live in the province, including 70,000 in the city of Barahona, about 125 miles west of Santo Domingo. Strong winds associated with the Gilbert brought coastal flooding, strong southeast winds and up to 12 feet to Puerto Rico's south coast. Residents returned home, happy to find little damage from 80 mph winds and sheets of rain. The first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month.”

### 4.2 Sentence extraction and Notetaking

There are many systems created for supporting students to take notes. As we reviewed in chapter 2, there is not any notetaking system created dealing with text processing yet. Sentence extraction as an important subject in text processing can be used to help students to produce high-qualified notes. We propose to use sentence extraction in notetaking related systems. By using sentence extraction students see the essential keywords at a glance. They do not need to read the full text in order to know what the text contains. Ranking all sentences in the text, facilitates the rapid discovery of ideas, simplifies complex content, inspires creativity, and saves enormous amounts of time and effort. With a simple visual presentation, users can immediately focus on the critical information and make decisions. The proposed sentence extraction method acts as a powerful filter that enables easy exposure of desired information. The Short Summary (<100 words) instantly highlights the most important conclusions saving time and effort by identifying critical findings and eliminating
information overload. It can be said that a convenient notetaking tool should allow students to
effortlessly mine the text to rapidly create their own documents and notes. Sentence
extraction can be used as a handy tool for learning and studying. Most important keywords
can be instantly discovered and presented to student for reviewing and note taking. In
conclusion, by using sentence extraction, large amounts of information are simplified and
reduced to the most essential storyline, which is easy to understand and learn.

4.2.1 Linear notetaking versus Nonlinear Notetaking
There are many notetaking methods devised to help students take more quality notes. These
methods can be described as linear or non-linear methods:

- **Linear notes**
  Taking notes in a linear or sequential fashion is the most common way of
  laying out notes (Greetham, 2001). This is useful for analytical tasks such as
  recording the structure of arguments. The idea is to cluster thoughts and information
  as the mind remembers clear tidy structures, not lists or paragraphs.
  The advantages of using this approach are conventionality, effective organization,
  neat environment and chronological arrangement. Figure 4.2 illustrates a linear
  notetaking.
Non-Linear notes:

In laboratory experiments, researchers measured the average rate of speech as being two-three words per second, while the average handwriting speed as only around 0.2–0.3 words per second. These patterns demonstrate the need and relevance of good temporal information management technique. The problem is exacerbated when one considers that the notetakers need to learn. In contrast to many official reports where shorthand typists need to record verbatim the spoken words, notetakers in general are there to learn the semantic meaning. Thus, notetaking is not an objective by its own right but a tool and an aid for learning. Many studies revealed mixed overall benefits of non-linear notetaking strategies. There are some studies based on non-linear approach that result in devising some non-linear techniques for notetaking.
(Rico, 1983; Turley, 1989; Nast, 2006; Kemp, 2006). There are some other studies that investigate the benefits of non-linear approach in (Boyle & Weishaar, 2001; Hartley, 2002).

For example, when participants in a study were directed to use particular styles of notes (outlining, matrix or traditional), Kiewra et al. (1991) found no difference between the groups in memory tests either immediately after learning or after a short review period. There is supporting evidence that organised and well-structured notes positively correlate with test scores and overall learning benchmarks in students (Titsworth & Kiewra, 1998). Titsworth (2004) argued that organisational cues of lecture notes enhance academic performance because they can help students to reduce their cognitive loads by providing determined note structures. Nevertheless, the outcomes of taking notes in a non-linear format highly depend on the actual technique used and the students’ competence in utilising it. Makany et al. (2008) argued that the non-linear notetakers were significantly better than the linear group both in terms of the quantity and the quality of the learned materials. They also conclude that using cognitively compatible notetaking techniques are very important. Thus, the cognitive mechanisms behind effective notetaking and knowledge representation have been identified. As a result, it can be said that using non-linear techniques enable deeper understanding and more integrated knowledge management. In figure 4.3, an example of one non-linear technique is illustrated. SmartWisdom uses a non-linear approach for taking notes and defines three levels of concept area for interconnecting extracted keywords.
4.2.2 Structure of semi-automatic notetaking system

Piolat et al. (2005) observed that the most fundamental reason behind the development of different notetaking styles and techniques is severe time pressure. While notetaking, students should perform some parallel works simultaneously, e.g., identifying and jotting down important points. Hence, to relieve the pressure students suffer during learning or even reading textual stuffs and to prepare an environment for students to implement non-linear notetaking methods, we propose a semi-automatic notetaking system. In contrast with the aforementioned system for notetaking, a semi-automatic automatic notetaking system deals with text processing system for distilling the text and accentuates the most salient keywords and extracts important points from the text. Students are only requiring connecting keywords together to construct a notemap gradually as they proceed to read the text. The system
produces keywords and highlights the text but the student links up keywords to build a notemap of the text based on what he or she understands from the text or lecture. So the output is made by contribution of both students and the system output, i.e., semi-automatic notetaking. The proposed system comprised the following modules (Figure 4.4)

1. Summarization module

To remove less important information from the text and to extract the gist of the text, in this project, we apply our proposed summarization system that is explained in section 4.1.3.

2. Part-Of- Speech (POS) Tagging module

Part-of-speech tagging is the process of assigning part-of-speech or other lexical class marker to each word in the text. A Perl module Lingua::EN::Tagger (A. Coborn) is used that is a probability-based, corpus-trained tagger and assigns POS tags to English text based on a lookup dictionary and a set of probability values. The tagger applies a bigram (two-word) Hidden Markov Model to guess the appropriate POS tag for a word. That means that the tagger assigns a POS tag based on the known POS tags for a given word and the POS tag assigned to its predecessor. Unknown words are classified according to word morphology or can be set to be treated as nouns or other parts of speech. The tag set is presented in Appendix E.

Below is an example of the part-of-speech tagging module input and output:

**Input**

“Note taking closely related summarizing requires ...”

**Output**

“Note/NN, taking/VBG, closely/RB, related/VBN, summarizing/VBG...”
Figure 4.4: Structure of the proposed notetaking system.
2.2.2 Stop words elimination module

This module eliminates all stop words from the text.

2.2.3 Keywords extractor module

This module extracts all noun and compound noun phrase from the text and then calculates the amount of their iteration in text. Below is the output when the above text is passed through this module.

Noun or noun phrase  ===>  Number of repetitions

knowledge new language  ===>  1
process information  ===>  1
instruction art note  ===>  1
note taking help students  ===>  1
way  ===>  1
extracting new knowledge new language  ===>  1
purpose  ===>  1
instruction  ===>  1
new language  ===>  1
words  ===>  1
explicit instruction art note  ===>  1
new knowledge new language  ===>  1
purpose note taking help students  ===>  1
help  ===>  1
students  ===>  3
language  ===>  1
art  ===>  1
help students  ===>  1
knowledge  ===>  2
information  ===>  2
note  ===>  3
process  ===>  1
art note  ===>  1
taking help students  ===>  1
using words  ===>  1
The system defines the number of repetitions of the most iterated noun, and noun phrase in the text as the benchmark value (BV) for keywords identification.

\[
R = \text{Max (Number of repetitions)}
\]

To identify other keywords we define a coefficient named N such that:

\[
BV = N \times R; \quad BV = \text{Benchmark value}
\]

The term N can be assigned a value based on the length of the text.

Table 4.2: The value of N in different text lengths

<table>
<thead>
<tr>
<th>Text length (Number of words)</th>
<th>&lt;100</th>
<th>100~200</th>
<th>&gt; 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of N value</td>
<td>0.1 ~ 0.5</td>
<td>0.5 ~ 0.75</td>
<td>&gt; 0.75</td>
</tr>
</tbody>
</table>

In this example R= 3 and we define N = 0.5, so BV = 1.5 and the following keywords are identified:

students ===> 3

note ===> 3

knowledge ===> 2

information ===> 2

The value of N can be defined arbitrarily by the user and related to the number of keywords required to be identified.
2.2.4 **Keyword accentuation module**

This module acts on summarised text and highlights the most salient keywords. Summarization of the text contains the most important parts of the text. Accordingly we consider those keywords found in summarized text as the most important keywords. This module takes the keywords from the keyword extractor module and sifts out those are used in the summarized text from other keywords. This module highlights the most important keywords in the original text to be presented to the user. For example, consider the input to the summarization system in example 4.1. The keywords with their iteration numbers in the original text are as follows:

- Hurricane ==> 6
- Storm ==> 6
- Winds ==> 5
- Gilbert ==> 5
- Coast ==> 5
- Saturday ==> 4
- Rico ==> 4
- Puerto rico ==> 4
- Puerto ==> 4
- Weather ==> 3
- Southeast ==> 3
- Miles ==> 3
- Sunday ==> 3
After sifting out these 13 extracted keywords, the following seven keywords are identified as the most important ones.

Important keywords = {hurricane, coast, winds, Gilbert, southeast, Puerto Rico, mph}

As the final output of the system, important keywords are highlighted in the original text and the most important keywords are then presented to the user who wants to take notes from the text. The output of the notetaking system is:

• Most Important Keywords = {hurricane, storm, coast, winds, Gilbert, southeast, Puerto Rico}

• Highlighted text:

  “Hurricane Gilbert swept toward the Dominican Republic Sunday, and the Civil Defense alerted its heavily populated south coast to prepare for high winds, heavy rains and high seas. The storm was approaching from the southeast with sustained winds of 75 mph gusting to 92 mph. "There is no need for alarm," Civil Defense Director Eugenio Cabral said in a television alert shortly before midnight Saturday. Cabral said residents of the province of Barahona should closely follow Gilbert’s movement. An estimated 100,000 people live in the province, including 70,000 in the city of Barahona, about 125 miles west of Santo Domingo. Tropical Storm Gilbert formed in the eastern Caribbean and strengthened into a hurricane Saturday night. The National Hurricane Center in Miami reported its position at 2 a.m. Sunday at latitude 16.1 north, longitude 67.5 west, about 140 miles south of Ponce, Puerto Rico, and 200 miles southeast of Santo Domingo. The National Weather Service in San Juan, Puerto Rico, said Gilbert was moving westward at 15 mph with a "broad area of cloudiness and heavy weather" rotating around the center of the storm. The weather service issued a flash flood watch for Puerto Rico and the Virgin Islands until at least 6 p.m. Sunday. Strong winds associated with the Gilbert brought coastal flooding, strong
southeast winds and up to 12 feet feet to Puerto Rico's south coast. There were no reports of casualties. San Juan, on the north coast, had heavy rains and gusts Saturday, but they subsided during the night. On Saturday, Hurricane Florence was downgraded to a tropical storm and its remnants pushed inland from the U.S. Gulf Coast. Residents returned home, happy to find little damage from 80 mph winds and sheets of rain. Florence, the sixth named storm of the 1988 Atlantic storm season, was the second hurricane. The first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month."

4.2.3 Notes production

The majority of researchers agree that graphs and concept maps can be useful in selecting, encoding, and organising information that leads to better remembering of the studied materials (Robinson, Katayama, DuBois & DeVaney, 1998; Samarawickrema & O’Reilly, 2003). To apply the notetaking system outputs for taking notes, we propose that students use a notemap method that is similar to a concept map method. A concept map is a way of representing relations between ideas, images, or words, in the same way that a sentence diagram represents the grammar of a sentence and a road map represents the locations of highways and towns. In a concept map, each word or phrase is connected to another and linked back to the original idea, word, or phrase. Notemaps can be used as a method to develop logical thinking and study skills, by making connections among important revealed keywords while taking notes and helping students see how individual ideas form a larger whole. We propose cross-linked notemaps (figure 4.5) that uses a descriptive word or phrase and identifies the relationship between the most important keywords with a labelled arrow.
After being presented with the keywords and highlighted text, students need to perform the notetaking process by using a cross-link notemap. Students are required to write down all produced keywords into the ellipses. Students should then concentrate on finding the relations among these keywords and related subjects during the process of reading. Example 4.2 clarifies the student’s task.

**Example 4.2:**

Consider the following text:

“Regular cameras obviously will not function underwater unless specially protected. Though housings are available for waterproofing 35 millimetre (mm) and roll-film cameras, a few special models are amphibious so that they can be used above or below the water. Most of these cameras are snapshot models, but one, Nikon, is a true 35 mm system camera. Though lenses and film must be changed on the surface, the camera will otherwise function normally at depths down to 70 mm. Four lenses are available: two of these, which have focal lengths of 90 mm and 35 mm, will function in air and water; the other two of these, which have focal

![Figure 4.5: The structure of a cross-link notemap](image)
lengths of 90 mm and 35 mm, will function in air and water; the other two, the 28 and 15 mm lenses, work only under water. Lenses are also available from other manufacturers. “

The system output by assigning a summarization compression degree = 50% and N= 0.5 is:

Keywords: mm=>8, Camera=>5, Lenses=>4, models=>2

Students should draw an ellipse for each keyword as below (Figure 4.6).

![Figure 4.6: All produced keywords in the ellipses](image)

The system produces the following text and presents it to students:

“Regular cameras obviously will not function underwater unless specially protected. Though housings are available for waterproofing 35 millimetre (mm) and roll-film cameras, a few special models are amphibious so that they can be used above or below the water. Most of these cameras are snapshot models, but one, a Nikonos, is a true 35 mm system camera. Though lenses and film must be changed on the surface, the camera will otherwise function normally at depths down to 70 mm. Four lenses are available: two of these, which have focal lengths of 90 mm and 35 mm, will function in air and water; the other two of these, which have focal lengths of 90 mm and 35 mm, will function in air and water; the other two, the 28 and 15 mm lenses, work only under water. Lenses are also available from other manufacturers. “
Students construct the notemap’s scaffolding gradually; by paying, more attention to the keywords and all relations linking them within the text.

![Completed notemaps](image)

**Figure 4.7: Completed notemaps**

**Summary**

Notetaking is closely related to summarizing because it requires that students to take information and synthesize it using their own words. In this research, we consider both automatic summarization and a semi-automatic notetaking system as important tools, which can engage students in learning activities and can be used by lecturers to evaluate their understanding. For automatic summarization, after recognising the important role of the
sentences in the text, we propose a cognitive-based approach (Knitch, 2002) to simulate how human identifies the most salient sentences. These sentences are then extracted and ranked to be used in automatic summarization. We then used the output of the summarization system to extract the most important keywords from among a large group of extracted keywords. We assume that the most important keywords are found in the most important parts of the text. Thus, we propose the use of a text processing method such as sentence extraction in notetaking to design a novel notetaking system that may be described as a semi-automatic notetaking system.

Our proposed system is different from those systems discussed in chapter 2 and compared in Table 2.1. It utilizes text processing using cognitive approach to improve students’ notetaking skill: listening, cognitive process, jotting down notes and reviewing. This is done to help the students to

- gain better understanding of important points latent in the text, and
- help them build up appropriate relation among that important text.
Chapter 5

Automatic summarization and semi-automatic notetaking systems evaluation

Both automatic Summarization and semi-automatic notetaking systems have been implemented successfully based on sentence extraction method explained in chapter 3. This chapter presents the evaluation of the automatic summarization and semi-automatic notetaking systems.

5.1 Automatic summarization system evaluation

In this project, we propose and implement an unsupervised automatic summarization system based on cognitive approach and semantic similarity. We use DUC corpus as the required data for evaluation. LSA (Latent Semantic Analysis) is employed as a tool for evaluating semantic similarity. Both applied data and tool are described below.

- Document Understanding Conference (DUC)

  Research in summarization was one of the first efforts to use computers to understand language. Work was done back in the 1950s by many groups, including commercial services, to automatically produce abstracts or lists of relevant keywords for documents. The interest in automatic summarization of text has continued, and currently is enjoying increased emphasis as demonstrated by the numerous summarization workshops held during the last ten years. The DUC summarization evaluations from 2001 to 2007 (http://duc.nist.gov) sponsored by the DARPA TIDES project (Translingual Information Detection, Extraction, and Summarization) are prominent examples. DUC has been guided by a roadmap developed by members of the summarization research community. In our project, the proposed automatic summarization system is adaptive to various documents.
We choose DUC2002 document sets for the evaluation data. It contains 60 sets of 10 documents each. Category definition for each set is:

1. Documents about a single natural disaster event and created within at most a seven-day window.
2. Documents about a single event in any domain and created within at most a seven-day window.
3. Documents about multiple distinct events of a single type (no limit on the time window).
4. Documents that present biographical information mainly about a single individual.

Each document set contains description on specific topic (e.g. Hurricane Gilbert that belongs to first category) and comes with 100-word model summaries created by NIST (National Institute of Standards and Technology) assessors for single document summarization model. The task of our summarization approach is to generate 100-word summary for some clusters of documents.

Figure 5.1: The process of summary creation by NIST assessors
NIST created 3 baselines automatically based roughly on algorithms suggested by Daniel Marcu from earlier work. The Algorithm for Single-document summaries simply takes the first 100 words in the document as the baseline.

- **Latent Semantic Analysis (LSA):**

Latent Semantic Analysis (LSA) is a theory and method for extracting and representing the contextual-usage meaning of words by statistical computations applied to a large corpus of text. The underlying idea is that the totality of information about all the word contexts in which a given word does and does not appear provides a set of mutual constraints that largely determines the similarity of meaning of words and set of words to each other. The adequacy of LSA's reflection of human knowledge has been established in a variety of ways. For example, its scores overlap those of humans on standard vocabulary and subject matter tests, it mimics human word sorting and category judgments, simulates word-word and passage-word lexical priming data and accurately estimates passage coherence, learnability of passages by individual students and the quality and quantity of knowledge contained in an essay (Michael et al, 2003; Kintsch & Bowles, 2002; Quesada et al, 2001; Foltz et al, 1998; Kintsch, et al, 2001). Research reports and applications, available from LSA portal ([http://lsa.colorado.edu](http://lsa.colorado.edu)), exploit a new method for determining and representing the similarity of meaning of words and passages by statistical analysis of large text corpora. After processing a large sample of machine-readable language, Latent Semantic Analysis (LSA) represents the words used in it, and any set of these words such as those contained in a sentence, paragraph, or essay, either taken from the original corpus or new as points in a very high (e.g. 50-1000) dimensional semantic space. Word and discourse meaning representations derived by LSA have been found capable of simulating a variety of human cognitive phenomena, ranging from acquisition of recognition vocabulary to sentence-word
semantic priming and judgments of essay quality (D. Steinhart, 2001). We use LSA to evaluate our semantic based automatic summarization system.

- **Experiment on Automatic summarization system**

In this section, the results of the semantic comparison between past DUC data and proposed automatic summarization system are presented. Figure 5.2 shows the address of the original texts and their human-generated summaries.

![Figure 5.2 Location of articles and their summaries](image)

Docs file contains a set of related documents and Perldoc contains 100-words summaries from the documents which are in Docs file. Summarization performed by NIST experts are representative of human production and are used for assessment of automatic summarization.
systems. We compare the output of automatic summarization system with DUC’s past data semantically. Although there are some famous tools like Rouge (Hovy & Lin, 2004) and Pyramid (Nenkova, 2004) that are still used by DUC to evaluate summaries, their focus is not on semantic similarity. Instead, the most popular method to measure semantic similarity is LSA (Li et al, 2006) that has been used in many researches (Li et al, 2006; Lapata, 2005; Islam and Inkpen, 2008). We use the University of Colorado’s LSA portal to compare similarity. The setting is as follows:

To test if the parameter we set is good enough for our experiments, three documents from two categories of DUC is selected such that two of them are in one category. All DUC documents are categorised based on a particular subject e.g. Storm. Documents that are in the same category are more similar to each other than two documents from different categories because all documents in the same category have the same subject. For example, in the following articles, A1 and A2 are in the same category with the subject “Hurricane Gilbert”. A3 is about the “Hurricane Andrew”, whereas A4 is about “politics”. In this justification experiment, we define three types of similarity based on documents category to show which of “document-to-document or “term-to-term” are more capable to distinguish among different
types of similarity. We expect LSA to show higher similarity between two documents in the same category rather than that of documents in different categories.

1- Similarity type1: Same category
2- Similarity type2: Similar category
3- Similarity type3: Quite different category

Respectively, we found the following four articles from DUC 2002, which are:

a. Article1 and Article2 that are in the same categories and LSA should show highest semantic similarity amongst all types.
b. Article1 and Article3 that are in categories that are closely related. LSA should show that they are less semantically similarity.
c. Article1 and Article4 are in two different categories. LSA should show the lowest semantic similarity compare to the other pairs.

From the values in Table 5.1, the above is clearly illustrated.

The DUC’s articles that are used are (Table 5.1):

Article 1 (A1) -D061j/ AP880911-0016
Article 2 (A2) - D061j/ WSJ880912-0064
Article 3 (A3) - D089d/ AP891116-0191
Article 4(A4) - AP880817-0040
Table 5.1: Similarity level with different comparison type options

<table>
<thead>
<tr>
<th>DUC Articles comparison</th>
<th>Similarity type</th>
<th>Document- to-Documents</th>
<th>Term-to-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 and A2</td>
<td>1</td>
<td>0.85</td>
<td>0.97</td>
</tr>
<tr>
<td>A1 and A3</td>
<td>2</td>
<td>0.60</td>
<td>0.93</td>
</tr>
<tr>
<td>A1 and A4</td>
<td>3</td>
<td>0.21</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Figure 5.4 Similarity measurements with different comparison type options
Figure 5.4 shows quite distinguishable differentiation between three types of similarity by LSA portal on DUC documents. Furthermore, the above figure shows that setting comparison type menu to document-to-document option leads a better result. The following tables show the results of the similarity among baseline, human created summary and the output of proposed automatic summarization system. The selected articles and their summaries generated by our system can be found in appendix A. The following acronyms have been defined:

AT - Article Text
HS - Human summary
SS - System summary
BT - Baseline Text

In the following table, the result of the first test that is conducted on d067f/FT923-5589 is presented. All results of the tests can be found in Appendix F.

Table 5.2: Test result

<table>
<thead>
<tr>
<th>Article Ref. No</th>
<th>D067f/FT923-5589</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Ratio for HS</td>
<td>86%</td>
</tr>
<tr>
<td>Compression Ratio for SS</td>
<td>84%</td>
</tr>
<tr>
<td>Type of Summary</td>
<td>AT</td>
</tr>
<tr>
<td>AT</td>
<td>1</td>
</tr>
<tr>
<td>HS (fi)</td>
<td>0.72</td>
</tr>
<tr>
<td>SS</td>
<td>0.80</td>
</tr>
<tr>
<td>BT</td>
<td>0.64</td>
</tr>
</tbody>
</table>

In above tests (Table 5.2), the length of the summary in both human-created and automatic summarization product is about 100-words but the compression ratio is different for the different cases. We choose five articles with their summary by compression ratio greater than 80% and another five articles by compression ratio lower than 80%. It is clear that texts similarity decreases when the compression ratio increases. However, we start conducting the experiments from high compression ratio to the least compression ratio (Appendix F) to trace any probable
changes in the system’s behaviour. Figure 5.5 illustrates that in each of the 10 tests, the output of our proposed automatic summarization system is more similar semantically to the article that human summary product. In other words, system-generated summary reflects the original text’s semantics better than the human summary. It can be said that the output of the system is more informative and encompasses more concepts of the article rather than human summary (Figure 5.5). The following figure shows that the best compression ratio for the automatic summarization system is between 70% and 80%.

Figure 5.5: Comparison of human summary, system generated and baseline summary

From the above figure is clear that in all tests the value of the similarity measure for our summarization system is greater than the value of baseline summary’s similarity measures. It also shows that when the compression ratio is more than 80%, there is significant improvement in similarity value compared to the baseline summary. However, when
compression ratio decreases the summarization system output follows baseline summary semantically.

- **Automatic summarization system behaviour investigation**

Figure 5.6 comparison similarities among SS, HS, and BS with AT

Figure 5.6 illustrates the comparison between SS with AT, HS with AT and BS with AT. It shows that the best similarity measurement for the system happens when the compression ration is set at 75% or less than 60%. It can be seen that summarization system surpasses human generated summary semantically when the compression ratio increases. Thus, the sentence extraction method that we proposed is confirmed to outperform the human and baseline summaries because sentence extraction is required each time to extract only one sentence. Figure 5.6 highlights a hypothesis that our system tends to follow baseline model rather than following human model in summarization especially when compression ratio decreases. To calculate the correlation among different similarities we use Product-moment
correlation coefficients (Pearson correlation). From table 5.2 and other tables in Appendix F we extract the values as follows:

Similarity HS to AT = (0.72, 0.79, 0.67, 0.66, 0.77, 0.80, 0.84, 0.87, 0.73, 0.85)

Similarity SS to AT = (0.80, 0.80, 0.84, 0.71, 0.78, 0.91, 0.83, 0.86, 0.79, 0.93)

Similarity BS to AT = (0.64, 0.75, 0.79, 0.57, 0.78, 0.84, 0.81, 0.80, 0.79, 0.93)

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation between HS and SS</td>
<td>65.7%</td>
</tr>
<tr>
<td>Correlation between HS and BS</td>
<td>68.9%</td>
</tr>
<tr>
<td>Correlation between SS and BS</td>
<td>85.3%</td>
</tr>
</tbody>
</table>

Table 5.3 illustrates that system summary has a good correlation with baseline method which takes the first 100 words of the article. The correlation values may show that our proposed automatic summarization system tends to choose concepts represented in the primary chunks of the articles. Furthermore, the correlation value between HS and SS, which equals 65.7% and HS and BS, which equals 68.9%, confirms our claim. This finding shows that our system chose the very first sentence in all tests. The system behaviour supports the hypothesis that very first sentences in the text contain the most important concepts in the text.
5.2 Semi-automatic notetaking system evaluation

In this project, we propose and implement a semi-automatic notetaking system as a novel way to contribute to the field of text processing analysis. We also propose to use notemaps (note structure) on a structure akin to concept mapping used in non-linear notetaking.

5.2.1 Method

- Participant

  The Participants are students (N = 20) working on their studies in the main library of University of Malaya. Ten of the students were undergraduate and the other ten were graduate students. The Students’ CGPA were at least 3.00 and all of them had spent at least four semesters in the University. Although the students’ mother tongue is not English, their English competences are reasonable. As such, it is not a problem for them to understand historical content written in English.

- Materials

  The materials used for the evaluation consist of a fiction history text, a multiple-choice test consisting of memory and learning items, produced keywords, and highlighted text.

History Text

The text that is used in our experiment (Appendix B) was developed by Voss and Silfies (1996) in their study on text comprehension. The text presents some of the mounting tensions between two fictional countries, Achad and Boxgrave. A fictitious text was used in order to stop student’s knowledge background affecting the text notetaking. It ensures that the
student’s understanding is solely from the text. The two researchers, Voss and Silfies, produced two versions of the Anchad-Boxgrave text, expanded and unexpanded. We select the expanded 1381-word version containing key events along with additional information about the casual links among the events. In other words, the expanded text provides more detail about the events. The expanded version was used in this project because its style and degree of detail are more typical of college textbooks. The text consists of 12 paragraphs and was assessed to be at a 12th grade reading level. The assessment tool is Microsoft word 2007.

Keywords

The most important keywords were extracted by our proposed notetaking system automatically and highlighted in the text. Students understand how to construct notemaps.

Scoring of Notes and essay test

Participants took notes and completed an essay test on the aforementioned history test. A list of potentially important statements in the text was compiled by Sumowski (2007), resulting in 35 statements (Appendix C). This list was compiled liberally to ensure against omissions of any potentially important statements. Each statement had one point value that means we calculate student’s mark from 35.

Multiple-choice test

The Multiple-choice test used in this study is based on the one developed by Brown (2005). Brown’s test consisted of 18 questions with four possible answers for each questions. Nine questions are on learning and other nine on memory. The memory questions require recall of information stated directly in the text. The learning items require inference generation beyond information directly stated in the text. In this study, we use questions presented by Sumowski
There are two types of questions, one targeted learning, 10 questions, and another type targeted memory, 10 questions, of the students. The multiple choice questions are presented in Appendix D.

Results

We divide 20 students into two groups of 10. Each group consist of 5 undergraduate and 5 graduate students. Students from group 1 are asked to read, and take their notes (they are free to use any kind of techniques they want) about the text and then write an essay about it within 2 hours. After one day, we asked them to only read their taken notes and answer multiple-choice questions within 40 minutes. Students from group 2 are required to present the accentuated text and related important keywords produced by our system from the text. The extracted keywords by our system are as follows: Anchad, Boxgrave, Government, Jones, cagland, Citizens, Country. We asked them to read the text, construct a notemap as their notes of the text, and then write an essay about the text within two hours. After one day, we ask them to answer the developed multiple-choice questions based on the notes they had taken from the text within 40 minutes.

This part of our project is designed to investigate the following questions:

- Does semi-automatic notetaking and proposed notemap construction improves students’ ability in text memory and learning?
- Are the produced keywords important enough to play a main role in notemap construction?

The results of the experiment are shown in table 5.4.
Table 5.4: Essay exam results for group1&group2

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Mean of Marks(group1)</th>
<th>Mean of Marks(group2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essay from 35</td>
<td>19.53</td>
<td>31.47</td>
</tr>
<tr>
<td>Multiple-choice from 20</td>
<td>11.7</td>
<td>16.1</td>
</tr>
<tr>
<td>Memory-questions from 10</td>
<td>7.28</td>
<td>8.47</td>
</tr>
<tr>
<td>Learning-questions from 10</td>
<td>4.39</td>
<td>7.63</td>
</tr>
</tbody>
</table>

Clearly, our system is successful in improving student’s ability in both recall information and in learning from the text. Table 5.4 shows that our system augmented student’s comprehension from the text, a noticeable improvement. Thus, the effectiveness of the produced keywords by the system is justified. In multiple-choice questions, there is 37% improvement in student’s performance. For more clarification, we divide the multiple-choices question into two categories: Memory and Learning. For the memory, there is 16.3% improvement. However, in learning section that needs student’s correct inference to answer the questions, the improvement is 73%. This value shows that our system succeeds in improving student’s learning skills. In conclusion, the results show that the proposed semi-automatic notetaking system is successful in improving student’s comprehension from the text and enhances students’ recalling and learning abilities. The following table compares our proposed system with the four explained systems based on four notetaking skills.

Table 5.5: Notetaking systems comparison

<table>
<thead>
<tr>
<th>System</th>
<th>Listening skill</th>
<th>Cognitive process skill</th>
<th>Jotting down skill</th>
<th>Reviewing skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoteTaker</td>
<td>Enhance</td>
<td>Enhance</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>LiveNotes</td>
<td>Deteriorate</td>
<td>Deteriorate</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>eVerNotes</td>
<td>NA</td>
<td>Enhance</td>
<td>NA</td>
<td>Enhance</td>
</tr>
<tr>
<td>NoteBlogger</td>
<td>Deteriorate</td>
<td>Deteriorate</td>
<td>Enhance</td>
<td>NA</td>
</tr>
<tr>
<td>Semi-automatic Notetaking</td>
<td>Enhance</td>
<td>Enhance</td>
<td>NA</td>
<td>Enhance</td>
</tr>
</tbody>
</table>
As it is shown in table 5.5, our system improves three of four student’s notetaking skills. In terms of listening and cognitive process skills, our system enhances student’s performances by providing the most important keywords in the text. Therefore, students would have some background and ideas about presenting lecture in advance. In this case, they only try to connect every keyword by appropriate links to show their relations. This process let them to concentrate more on important parts of lectures and so their cognitive process skill will enhance that causes comprehension and learning to be improved. There is no tool devised in our system to improve student’s jotting down skill. However, reviewing skill increases. When students construct note-map in lecture time, so that they can find simply relations among keywords that causes their comprehension and memory to be enhanced. To sum up, it can be seen that while other systems shown in table 5.5 increased at most two skills of students, our system improves three skills of students without deteriorating any of their skills.
Chapter 6

Conclusion

6.1 Review

The major objective of this study is to investigate summarization and notetaking techniques with the help of text processing methods like sentence extraction. There are four main problems to be resolved.

- The first one is how to represent contents of documents. We propose to consider documents as collection of its sentences.
- The second one is how to define similarity between sentences. An unsupervised method based on semantic similarity is proposed as a possible approach to be exploited in this procedure.
- The third one is how to identify important sentences and rank them in documents. A cognitive-based approach is selected to simulate human behavior.
- The fourth one is how to extract and arrange important sentences to be used in automatic summarization.
- The fifth one is how to apply text processing and sentence extraction methods in notetaking systems.

Sentence is a natural unit to represent meanings embedded in documents. Summarization approaches based on sentence extraction are investigated. In this study, cognitive approach is considered for sentence extraction that postulates important sentences are highly connected to others. We translate connectivity to semantic similarity. A novel approach for sentence similarity is proposed based on semantic similarity of each noun and verb in two sentences. To infer semantic similarity between two sentences from their noun and verb’s similarity, we
apply cosine value correlation. By using aforementioned cognitive approach, we rank all sentences in the text.

Summarization is to extract the gist of the text. High ranked sentences also contain the most common ideas and concepts in the text. The proposed automatic summarization system picks up the highest ranked sentence in the text and then pick up another sentence with ranking lower than highest but greater that other ranking value. The process continues until the amount of the words collected, meets the condition of summary presumed length. To overcome anaphora resolution problem as much as possible, all selected sentences are arranged based on their original arrangement in the text.

The benefits of notetaking in class and from the text are studied. The problems of students while taking notes are investigated. Four main to-be-solved problems in notetaking research area are identified. There are many systems created to support students while taking notes, some notetaking systems selected as representative of current notetaking systems and discussed. We propose the use text processing in notetaking systems as a novel idea. The proposed approach is named semi-automatic notetaking system. To reinforce students to focus more on the relations between different parts of the text, we use note-map construction based on concept map. Note-map is consists of the most important keywords in the text and the relation among them. The most important keywords are sifting through the general keywords that are literally nouns and noun phrases in the text. To be considered as the most important keywords, they must be found in the generated summary text. User while reading the text constructs the relation between the most important keywords. Note-map
accomplished when reading is over. Semi-automatic notetaking system set out to provide required keywords and accentuated text to be presented to the user.

Latent Semantic Analysis (LSA) is employed in experiments of this study to measure the semantic similarity between system generated summary and human model summary. It is shown that system generated summary is more similar to the to-be-summarized articles rather than human generated summary and baseline summaries, and then it is more informative. We show that the best compression ratio to be set on our system to produce summary very similar to human product is ranged between 70% to 80%. There is a straight relation between system performance and the compression ratio. Therefore, our sentence extraction method is confirmed.

To evaluate the semi-automatic notetaking system, we conduct an experiment to justify the effectiveness of the produced keywords and the method for constructing note-map. It is shown that student’s comprehension, memory and learning increases consecutively 61%, 16% and 81% respectively.

6.2 Contributions:

This study has made four major contributions:

- An unsupervised semantic-based sentence similarity approach is proposed to calculate the connectivity among sentences in a text.
- To identify important sentences of text and ranking them, a sentence extraction method based on cognitive approach is investigated and implemented by translating connectivity to similarity.
• An automatic summarization system proposed and its functions confirmed.
• For notetaking, a novel area of research is investigated by contribution of text processing. A semi-automatic notetaking system is implemented and its functions justified improving student’s comprehension, memory and learning skills.

6.3 Future works

My future work is concerned with notetaking system. However, to prepare the system to be employed in the class by teachers, some functions of the system need to be improved. In the following, some required improvements are explained.

• Text similarity

In this study, we have proposed a system for measuring sentence similarity. However, the main deficiency of the system is that it is time consuming. Although all unsupervised semantic methods that apply WordNet as database are slow, we can design more optimized algorithm, by improving the interface between our program and WordNet, to decrease calculation time.

• Summarization system

The proposed summarization system can be improved by measuring the similarity among selected sentences. However, care has to be taken to avoid including very similar sentences from document. Therefore, before including a sentence in the summary we have to check if there are any sentences whose similarity with the observed one is above a given threshold. Thus, the summarization system can be extended to process multiple documents and therefore generate multi documents.
summarization. The aim is to produce a system that would be able to compete in future DUC competition.

• **Semi-automatic notetaking system**

We have shown that our proposed notetaking method enhances student’s performance in learning; however, we have not compared this performance to a control group of students who work on the same text without the help of the tool using concept maps techniques. Hence, as further work this experiment can also be conducted and comparison of their performance be made. In terms of system evaluation, it is required our proposed system to be compared with one of educational notetaking system. eVerNotes is an specialized notetaking system for educational purposes that can be seen(Table 2.2) to have good performance in improving students Cognitive process and Reviewing skills without deteriorating any other skills. We intend to compare our system’s performance with eVerNotes performance in improving student’s learning skills.

• **Visualization**

We have not included a visualization tool to help the students to present the notes. This can be added to the prototype. Using visualization techniques we can produce highlighted text automatically and connect related accentuated keywords in the text to construct notemap interactively by students. Ultimately, we can improve our proposed notetaking system performance by enhancing the functions of the system such as summarization and text similarity systems. As a friendly interface is an important tool to entice students to
work with the system, therefore we also intend to design a proper and friendly interface for the system.

- **Similarity measures**

We intend to investigate to find if there is feedback relation between two similarity systems e.g., our semantic similarity system and LSA. We make two vectors for each sentence in our similarity measurement approach and apply matrix functions to compute similarity between two sentences,

\[ j = B \cdot i \quad (6.1) \]

where \( B \) represents our semantic similarity system matrix function and \( i \) represents input vectors in our similarity system (\( N_{vec} \) and \( V_{vec} \)). In this case, \( j \) is output vector from our similarity system (\( Sum_N \) and \( Sum_V \)). These vectors are explained in pages 45 and 46. On the other hand, while computing semantic similarity by LSA, it uses again matrix function to find semantic similarity that is shown below,

\[ k = A \cdot j \quad (6.2) \]

\[ = A \cdot B \cdot i \]

\[ = C \cdot i \]

where \( A \) represents the LSA matrix function, and:

\[ C = A \cdot B \quad (6.3) \]

We intend to clarify whether these two consecutive matrix functions \((A, B)\) have conflicts, correlation or other types of relationships.
References


Knight K., Marcu D.. 2000,’ Statistics-Based Summarization —Step One: Sentence Compression’, In Proceeding of The 17th National Conference of the American Association for Artificial Intelligence, pp. 703–710, Austin, USA.


Appendix A

Articles and their system generated summaries

Article ID: D067f-FT923-5589

WHILE Hurricane Andrew was wreaking havoc across large parts of southern Florida and Louisiana this week, a grade two dollar crisis (on a one-to-four scale, four being most severe) was blowing itself out at the end of a tumultuous few days for US and world financial markets. On Wall Street, most of the damage from the currency storm was inflicted a week ago Friday and on the following Monday, when bond yields jumped sharply and the Dow Jones industrial average plunged by more than 75 points. The flimsy walls erected hastily by the Federal Reserve and other big central banks to protect the vulnerable dollar from a tidal wave of selling on foreign exchange markets failed to hold; and as the sellers poured through the breached barricades, the currency dropped to DM1.40. This was it’s lowest-ever point against the D-mark. The conditions necessary for a dollar crisis had been building up in currency markets for some time. Interest rate differentials between US and Germany widened over the summer as the Fed eased, and the Bundesbank tightened, their respective monetary policies. The failure of the US economy to climb out of recession with any vigour was also making overseas investors increasingly unhappy about holding the dollar. So, too, was the political hole President Bush had dug for himself in a re-election battle that only a year ago was supposed to be a shoo-in for the incumbent. Moreover, the fact that almost every central bank worth its salt was in the markets trying to prop up the dollar served only to convince foreign exchange dealers that the currency was heading in one direction - down. While there were plenty of reasons for the dealers to sell the dollar, the logic for such a strongly negative reaction from bond and stock markets was less obviously compelling. There are two standard explanations why a weak dollar prompts bond prices to fall. The first is that it raises import prices and, as a result, adds to inflationary pressures. The second is that it makes it hard for the Fed to engineer another cut in interest rates to stimulate the flagging recovery, and raises the possibility that rates may actually have to go up to protect the currency. The first explanation is not particularly convincing - imports account for not much more than 10 per cent of US gross domestic product, so higher import prices do not greatly effect the overall price level, which is now around 3 per cent and heading lower. The second explanation carries more weight. Although there is not much chance, given the present economic and political climate, that the Fed will raise rates to help the dollar, there is little doubt that the currency's weakness makes it extremely difficult for the Fed to ease monetary policy again. The fear that the Fed may be done with interest rate cuts for the present economic cycle was also behind the selling in equity markets. But investors in stocks were equally, if not more, troubled by the rise in bond yields. Just over a week ago, the yield on the benchmark 30-year bond, which has remained stubbornly high all year despite the poor state of the economy, looked as if it might drop below 7.3 per cent. The dollar put paid to those hopes and, by the middle of this week, it was approaching 7.45 per cent, putting an upward pressure on the all-
important mortgage rate for home-buyers. The dollar was not the only story in financial markets this week, and the devastating effect of Hurricane Andrew produced a typically hard-eyed, although nonetheless logical, reaction from Wall Street. The stocks of those insurance companies with the greatest exposure in southern Florida, the area hit worst by the hurricane, all took a tumble. But the relatively modest losses in Geico, Travelers and Progressive suggested that the market believed the insurers were reserved or reinsured adequately enough to cover hurricane-related claims. The flip side of the hurricanes coin was a strong showing from the stocks of home construction companies expected to benefit from demand for rebuilding damaged or destroyed homes. Since there are an estimated 250,000 people left homeless by the storm, there is a lot of work to be done. The biggest gains among construction stocks this week were posted by Lennar, Oakwood Homes, Engle Homes and Fleetwood, the largest maker of pre-manufactured homes in the US.

System generated summary

Interest rate differentials US Germany widened summer Fed eased, Bundesbank tightened, respective monetary policies. So, too, political hole President Bush dug re-election battle year ago supposed shoo-in incumbent. Moreover, fact central bank worth salt markets prop dollar served convince foreign exchange dealers currency heading direction - down. The fear Fed interest rate cuts present economic cycle selling equity markets. Just week ago, yield benchmark 30-year bond, remained stubbornly high year poor state economy, looked drop 7.3 cent. The dollar story financial markets week, devastating effect Hurricane Andrew produced typically hard-eyed, nonetheless logical, reaction Wall Street. But modest losses Geico, Travelers Progressive suggested market believed insurers reserved reinsured adequately cover hurricane-related claims.

Article ID: D075b-AP881115-0113

The expensive practice of using balloon catheters to force open heart arteries immediately after heart attacks, now routinely done at many large hospitals, is unnecessary and should be abandoned, according to a major study released Tuesday. The study found that if heart attack victims quickly receive clot-dissolving drugs, they usually dont need the extra step of the common balloon procedure, known as angioplasty. Some experts said the results are good news, because they mean that most heart attack patients can be treated in community hospitals, where angioplasty is not available. The study also has an important financial message. Its authors estimated that if angioplasty was widely adopted after heart attacks, it could raise the nations annual medical bills by $704 million. This trial has settled one of the most important questions in modern-day cardiology, commented Dr JWard Kennedy of the University of Washington, Seattle. The study is phase 2 of the Thrombolysis in Miocardial Infarction Trial, or TIMI-II, directed by Dr Eugene Braunwald of Brigham and Womens Hospital in Boston. The first phase of the study showed that giving people a clot-dissolving
drug called tissue plasminogen activator, or TPA, immediately after heart attacks dramatically improved their chances of survival. The latest study, presented at the annual meeting of the American Heart Association, was intended to see whether people did better still if doctors tried to clear away any remaining blockages after giving TPA. At 50 hospitals across the United States, doctors randomly assigned 1,636 patients to get angioplasty within two days of their heart attacks if tests showed there was any chance they might benefit. Sixty percent of them actually underwent the procedure, which temporarily inflates balloons in dangerously narrowed heart arteries to squeeze them open. A comparison group of 1,626 also got TPA. But they were not considered for angioplasty unless they had lingering heart pain or abnormal exercise tests during their recovery. After 42 days, 11 percent of those in the angioplasty group had died or suffered further heart attacks, as did 10 percent of those in the comparison group. A year after the treatment, there was no difference in survival. About 93 percent of both groups were still alive. There does not appear to be any additional benefit from angioplasty, Braunwald said. Dr Thomas J Ryan of Boston University Medical Center commented, We have the answer in this trial to a very important question of health care delivery. While small hospitals can give clot-dissolving drugs to heart attack patients, most of them do not have the sophisticated labs where angioplasty is performed. If the study had found that immediate angioplasty improves survival, it would have meant that many more angioplasty labs would need to be established and more doctors trained to give the procedure. The watch word is watchful waiting to see if patients need angioplasty. This ultimately makes it possible for patients to be treated in community hospitals and be transferred to tertiary care centers if angioplasty is needed, said Dr Howard Morgan, immediate past president of the heart association. Heart attacks occur when a clot blocks an artery that feeds the heart muscle. The purpose of TPA and similar drugs is to dissolve these clots before the muscle dies. To be effective, the drugs must be given within about four hours of the start of heart attack symptoms. Experts say that only about 20 percent of heart attack victims are considered to be candidates for the drugs. Many people delay going to the hospital until permanent damage occurs. In others, the treatment may be considered too dangerous because of recent surgery or a history of strokes. Balloon angioplasty is also widely used to treat people with clogged heart arteries who have not suffered heart attacks. The latest study did not question the usefulness of this kind of angioplasty.

System generated summary

The study found heart attack victims quickly receive clot-dissolving drugs, dont extra step common balloon procedure, angioplasty. The latest study, presented annual meeting American Heart Association, intended people doctors clear remaining blockages giving TPA.A comparison group 1,626 TPA. But considered angioplasty lingering heart pain abnormal exercise tests recovery. After 42 days, 11 percent angioplasty group died suffered heart attacks, 10 percent comparison group. A year treatment, difference survival. If study found angioplasty improves survival, meant angioplasty labs established doctors trained give procedure. To effective, drugs hours start heart attack symptoms. The latest study question usefulness kind angioplasty.
Already they’re saying its the biggest happening in astronomy since Galileo put his eye to a telescope. So, step right up folks, and discover the wonders of the universe. See how big it is. Learn its age. Look at light created 14 billion years ago and arriving at your eye only this instant. Ride along to the beginning of everything, almost, to the Big Bang of 10 or 20 thousand million years ago. See stars born and see them die. Watch galaxies form. Follow the flow of gas into the Milky Ways halo. Peer deep into the universe, past so many stars in our own galaxy that it would take a person more than a lifetime to count, to a hundred billion other galaxies each with about 200 billion stars. For scientists, and then the rest of us, all that becomes possible now that the space shuttle Discovery has carried the Hubble Space Telescope into the sky to see what no one has seen before. The telescope, a silvery tube as long as a tanker truck, has an unmatched ability to detect and capture the faintest light. Light, speeding along at 186,000 miles a second, is the messenger of creation. Tracking the trail of light from today to the first moments contains all the information we will ever have about the creation of the universe. The Hubble promises to give science an open window perhaps to the first echoes of creation. This is a world-class event, even if astronomy is not your thing. Superlatives In the history of optical astronomy there have been two great leaps in the resolution of the universe: Galileos telescope in the autumn of 1609, and the Hubble Space Telescope in April 1990. Eric JChaisson, a senior scientist at the Space Telescope Science Institute in Baltimore. One more? No one ever made anything that good, James Westphal, California Institute of Technology. Another DrLennard Fisk, NASAs chief scientist, predicts that the Hubble telescope will literally be the dawn of a new era in astronomy. Eras rarely can be proclaimed in advance. But the HST, named after Edwin Powell Hubble, holds that kind of promise. Hubble was an astronomer in the first half of the century who concluded not only that distant galaxies are moving away from Earth but that the farther away they are, the faster they move. The theory of an expanding universe supported the belief that the universe originated in a cosmic explosion and that all matter is still rushing from the site of that so-called Big Bang. Astronomers think the Big Bang occurred 12 billion to 20 billion years ago and sent the entire universe flying out at incredible speed and heat. Eventually matter cooled and condensed into galaxies, stars and planets. There are bigger telescopes than the Hubble, but they are all on Earth and all subject to a major limitation the atmosphere which is fine for breathing but lousy for seeing through. The problem of skywatching through layers of air has been likened to birdwatching from the bottom of a swimming pool. The Voyager spacecraft, which sent back astonishing views of Earths sister planets, had to travel 12 years to get close enough for pictures as they whizzed past. With the Hubble, says scientist Edward Weiler, such pictures are possible any time we want. The telescope is 42.5 by 14 feet and consists of a 94.5-inch primary mirror that gathers incoming light. On a clear, dark night you can see a flashlight from two miles away, says Weiler, chief NASA scientist on the Hubble project. With a 28-power telescope you can see it on the moon 250,000 miles away. With the HST you could see a firefly in Australia from Washington.
Eventually matter cooled condensed galaxies, stars planets. For scientists, rest us, space shuttle Discovery carried Hubble Space Telescope sky before. The telescope, silvery tube long tanker truck, unmatched ability detect capture faintest light. Tracking trail light today moments information creation universe. The Hubble promises give science open window echoes creation. One more? The theory expanding universe supported belief universe originated cosmic explosion matter rushing site so-called Big Bang. Eventually matter cooled condensed galaxies, stars planets. The problem skywatching layers air likened birdwatching bottom swimming pool. The Voyager spacecraft, back astonishing views Earth's sister planets, travel 12 years close pictures whizzed past. With Hubble, scientist Edward Weiler, pictures time want.

**Article ID: D103g/LA062390-0001**

Shortly after 2 p.m Wednesday, San Diego resident Mohammad Nyakoui got a call from his wife, who is spending the summer in the Caspian Sea coastal city of Rasht, Iran, with her family. I asked her what she was doing, and she said she was watching the World Cup, Nyakoui recalls. About 15 minutes after she hung up, Rasht and other cities in Iran's northern region were rocked by an earthquake that killed thousands. Back home in San Diego, it was several hours before Nyakoui even heard news of the quake. When he did, some quick time-zone arithmetic showed that he had talked to his wife just minutes before the quake happened. I was very worried, Nyakoui said. I tried through the Red Cross to call Iran, but they told us they couldnt do anything before 48 hours passed. One of about 25,000 San Diego Iranians in the same anxious state, Nyakoui was luckier than most: His wife managed to call him a second time that day, about eight hours after the quake, to tell him she and their two children were safe. Phone lines remained jammed Friday, other Iranian-Americans in San Diego said. There is a sense of panic. Its just impossible to get through, said Houshang Ghashghai, who teaches political science at San Diego State University. Already though, some of the worried immigrants were turning their fear into action by mobilizing relief efforts for Iran. Hamid Biglari, a theoretical physicist at UC San Diego, was among those who organized a local group to gather contributions for the United Nations Fund for the Iran Earthquake. The group has set up two offices and phone lines. They are collecting medicine, food and a variety of living supplies, including blankets, light clothing and flashlights. The supplies will be transported by the United Nations, Biglari said. Another group gathering medical supplies is Southwest Medical Teams, an organization whose last major international effort was sending volunteers and medical supplies to Armenia after the 1988 quake there. Southwest Medical Teams wont be sending any volunteers this time, said director Barry La Forgia. Thats at the advice of the State Department. They couldnt ensure our safety over there, and we dont want to endanger any of our volunteers, La Forgia said. **WHERE TO SEND AID** Donations for Iranian earthquake relief are being taken in San Diego by two
groups. United Nations Fund for the Iran Earthquake (467-1120 or 456-4000) -- Collecting antibiotic and analgesic drugs, collapsible plastic water containers, plastic sheeting, 220-volt portable generators of less than 10 kilowatts, tents, blankets, dry food, light clothing, flashlights and lighting equipment. Bring items or mail checks to 4540 Kearny Villa Road, Suite 214, San Diego 92123; or to 7509 Girard Ave., Suite A, La Jolla 92037. Checks should be made out to the U.N.. Fund for the Iran Earthquake. Southwest Medical Teams (284-7979) -- Through Thursday, collecting sutures, surgical gloves, antibiotics, analgesics (including aspirin), vitamins, ophthalmic solutions and empty blood collection bags. Shipment will be sent July 2. Cash donations will be used to pay to fly the supplies to Iran. Mail checks to 3547 Camino del Rio South, Suite C, San Diego 92108, noting that donation is for Iranian Earthquake Relief Fund. Other agencies accepting donations for Iranian earthquake victims.

System generated summary

I asked doing, said watching World Cup, Nyakoui recalls. About 15 minutes hung up, Rasht cities Iran's northern region rocked earthquake killed thousands. Phone lines remained jammed Friday, Iranian-Americans San Diego said. It's just impossible get through, said Houshang Ghashghai, teaches political science San Diego State University. They collecting medicine, food variety living supplies, including blankets, light clothing flashlights. Southwest Medical Teams sending volunteers time, said director Barry La Forgia. They ensure safety there, want endanger volunteers, La Forgia said WHERE TO SEND AID Donations Iranian earthquake relief taken San Diego two groups.

Article ID: D089d-AP891116-0184

A powerful storm system brought strong winds and heavy thunderstorms to the Northeast on Thursday, causing flooding and widespread property damage. Seven children died when a wall collapsed in a school cafeteria near Newburgh, N.Y.. Tornadoes were reported in New Jersey, Delaware, Virginia and New York, although the National Weather Service was unable to confirm them. The same storm system caused tornadoes in seven states in the South and Midwest on Wednesday, and was blamed for 17 deaths in Huntsville, Ala.. The storm was particularly violent because it occurred along a line of extreme variations in temperature. High temperature records fell in advance of the storm and sharply colder weather lurked behind it. Record highs were recorded in Binghamton, N.Y where it was 61 degrees, Bridgeport, Conn (66), and Burlington, Vt (69). A record was also set in Miami, where it was 89. Thunderstorms continued across the Ohio Valley overnight and during the morning. Storms that might have been tornados damaged a residence and a store near Richmond, Va and uprooted about 600 feet of trees near Wilmington, Del.. Other storms that might have been tornados were reported near Peekskill, N.Y and Piscataway, N.J during the afternoon. Strong thunderstorms caused a concrete-and-glass wall to blow in on a cafeteria during lunchtime at the East Coldenham Elementary School near Newburgh. Seven children were
killed and 18 injured. There were reports of damage from strong thunderstorms and gusty winds in eastern Virginia, Maryland, Delaware, New Jersey, eastern Pennsylvania and eastern New York state. Winds gusted to 65 mph in Baltimore, 76 mph in Lancaster, Pa and 100 mph at Great Valley, Pa. A tornado watch was posted for northeast New York state, much of Vermont and much of New Hampshire. Thunderstorms also produced locally heavy rain and flooding. A flood warning was posted over portions of upstate New York. Nearly two inches of rain fell east of Utica, N.Y at the Little Falls Reservoir, which overflowed and caused flooding. Water was eroding the Lyons Pond Dam near Dolgeville, N.Y causing flooding there. Snow was falling west of the cold front. A winter storm warning was posted for northwest Wisconsin, in the snowbelt near Lake Superior. Winter storm warnings were posted for much of lower Michigan, northwestern upper Michigan and north central Indiana. Winds gusted to 63 mph at Whitefish Point, Mi. and near blizzard conditions extended over eastern upper Michigan. Overnight snowfall across upper Michigan included 12 inches at Van Riper State Park and 10 inches near Neguance. Heavier snowfall during the 6 hours ending at 1 p.m EST included 4 inches at Houghton Lake, Mich 3 inches at Marquette, Pellston, Saginaw and Sault Ste.. Marie, all in Michigan, and 2 inches at South Bend, Ind.. Heavy snow warnings were posted for the northwest and northern mountain portions of Pennsylvania. A snow squall warning was posted for northeast Ohio.. Cold weather was expected to invade the Southeast, with warnings of freezing overnight temperatures posted for Friday morning in Georgia, Alabama, northwest Florida, most of Mississippi and all but extreme southeast Louisiana. The low temperature for the nation Thursday morning was 8 degrees below zero at Bismarck, N.D.. Temperatures around the nation at 3 p.m EST ranged from 7 degrees at Fergus Falls, Minn to 88 degrees at Miami, Fla ..

System generated summary

A powerful storm system brought strong winds heavy thunderstorms Northeast Thursday, causing flooding widespread property damage. Seven children died wall collapsed school cafeteria Newburgh, N.Y.. The storm system caused tornadoes states South Midwest Wednesday, blamed 17deaths Huntsville, Ala. High temperature records fell advance storm sharply colder weather lurked it. Record highs recorded Binghamton, N.Y 61 degrees, Bridgeport, Conn (66), Burlington, Vt (69). Storms tornadoes damaged residence store Richmond, Va uprooted 600 feet trees Wilmington, Del.. Seven children killed 18 injured. Winter storm warnings posted lower Michigan, northwestern upper Michigan north central Indiana. The low temperature nation Thursday morning 8 degrees Bismarck, N.D..

Article ID: D109h/FBIS4-26392

BFN [Text] Beijing, 21 Jun (XINHUA) According to the State Flood Control and Drought Relief Headquarters, after the largest or the second largest flood peaks since the liberation of China occurred a few days ago in the Xi Jiang, Bei Jiang, Xiang Jiang, and Gan Jiang rivers,
water levels in these rivers are dropping slowly; however, high water levels will remain in these rivers for the next few days. Due to interaction of the Bei Jiang and Xi Jiang, the Zhujiang Delta will face a high water-level test. Heavy rainfall over a wide area since mid-June resulted in the largest flood waters since liberation of the country in the Xi Jiang, Bei Jiang, and Xiang Jiang rivers. The flood water in Guangdong's Xi Jiang crested in Gaoyao County on 20 June; the water level in Gaoyao's Xi Jiang dropped to 13.37 meters at 0600 today. A flood peak occurred in Bei Jiang in Guangdong's Sanshui at 0400 on 20 June, raising the water level to 10.39 meters, the largest flood level ever recorded. The water level dropped to 10.16 meters at 0600 today. Drops in water levels in Guangdong's Bei Jiang and Xi Jiang do not mean that Guangdong's flooding situations have eased, because flood waters in the Xi Jiang and Bei Jiang will remain at high levels for quite a long period and will enter the sea after the two flood waters jointly flow through the low-lying Zhujiang Delta. In particular, the sea tide may add to the flood waters on 25 June. With these factors combined, the Zhujiang Delta, which has a developed economy and a forest of factories, will face the most rigorous flood water test since the liberation of the country. The situation in the Xiang Jiang is also not an easy one. The flood peak passed Changsha on 19 June, but the water level at the Changsha Station was still at 25 meters at 0200 today [1800 GMT 20 June]. Because the water level has remained high for a long period, several dangerous situations have occurred along the river's dikes. Dike reinforcing work needs to be stepped up. The flood peak in Gan Jiang entered Boyang Lake on 20 June. However, due to continued rains over the last few days, the water level in the upper reaches west of Ganzhou has begun to rise again. At 0800 today, the water level at the Ganzhou Station was 100.95 meters, 3.45 meters above the warning level.

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Due interaction Bei Jiang, Xi Jiang, Zhujiang Delta will face high water-level test. A flood peak occurred Bei Jiang Guangdong's Sanshui 0400 20 June, raising water level 10.39 meters largest flood level ever recorded. With factors combined, Zhujiang Delta, developed economy forest factories, will face rigorous flood water test since liberation country. Because water level remained high long period, several dangerous situations occurred along river's dikes. The flood peak Gan Jiang entered Boyang Lake 20 June. However, due continued rains last days, water level upper reaches west Ganzhou begun rise again. At 0800 today, water level Ganzhou Station 100.95 meters, 3.45 meters above the warning level.

Article ID: D081a/FBIS4-42027

BFN [Text] Donetsk Oblast [no date as received] As UNIAN reported, miners at the Ordzhonikidzevuhillya coal production association and the Yenakiyevo and Poltava pits went on strike in Yenakiyevo on 27 June, demanding payment of wage arrears. The strike continued at these mines on 28 June. Some of the miners at the Karl Marx, Chernovonyy
Zhovten, Chervonyy Profinter, and Yunkom pits joined the strike. A total of 1,200 of the associations 2,248 workers are on strike. A rally consisting of 350 miners was held on 28 June near the town council building where demands were made to pay the wages and dismiss the director general of the Ordzhonikidzevuhillya production association. A strike committee consisting of 12 persons was elected (one of the members is a former Komsomol leader and former USSR peoples deputy Viktor Honcharov) and it was decided to continue the strike until the demands that had been raised have been completely fulfilled. On 28 June, 118 of 258 workers on the second shift at the PivdennoDonbass mine of the Donetskvuhillya production association in the town of Ugledar refused to start work for the same reasons delay in paying wages. After a meeting with the mines director, who promised to pay the arrears, the miners on the third shift returned to work. On 27 June, all miners on the fourth shift at the Karbomid and Pervomaysk mines in Pervomaysk, Lugansk oblast, refused to start work (142 and 157 miners respectively). In the opinion of the mines representatives, who wished not to be identified, the strike has a clear political hue to attempt to compromise the existing authorities and, particularly, President Leonid Kravchuk before the second round of presidential elections. According to some reports, among the leaders of the striking pits there are members of the Kuchma-Hrynyov Interregional Bloc of Reforms. As Kostyantyn Fesenko, chairman of the coal industry workers trade union, informed a UNIAN correspondent, Viktor Yushchenko, the chairman of the National Bank of Ukraine, in a telephone conversation on 29 June, gave assurances that the money for the miners wages as well as subsidies for the following month would be found and forwarded in the next few days.

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A rally consisting 350 miners held 28 June town council building demands made pay wages dismiss director general Ordzhonikidzevuhillya production association. On 28 June, 118 258 workers shift PivdennoDonbass mine Donetskvuhillya production association town Ugledar refused start work reasons delay paying wages. After meeting mines director, promised pay arrears, miners shift returned work. On 27 June, miners fourth shift Karbomid Pervomaysk mines Pervomaysk, Lugansk oblast, refused start work (142 157 miners respectively). In opinion mines representatives, wished identified, strike clear political hue attempt compromise existing authorities and, particularly, President Leonid Kravchuk round presidential elections.

Article ID: D061j-AP880911-0016

Hurricane Gilbert swept toward the Dominican Republic Sunday, and the Civil Defense alerted its heavily populated south coast to prepare for high winds, heavy rains and high seas. The storm was approaching from the southeast with sustained winds of 75 mph gusting to 92 mph. "There is no need for alarm," Civil Defense Director Eugenio Cabral said in a television alert shortly before midnight Saturday. Cabral said residents of the province of
Barahona should closely follow Gilbert's movement. An estimated 100,000 people live in the province, including 70,000 in the city of Barahona, about 125 miles west of Santo Domingo. Tropical Storm Gilbert formed in the eastern Caribbean and strengthened into a hurricane Saturday night. The National Hurricane Center in Miami reported its position at 2 a.m. Sunday at latitude 16.1 north, longitude 67.5 west, about 140 miles south of Ponce, Puerto Rico, and 200 miles southeast of Santo Domingo. The National Weather Service in San Juan, Puerto Rico, said Gilbert was moving westward at 15 mph with a "broad area of cloudiness and heavy weather" rotating around the center of the storm. The weather service issued a flash flood watch for Puerto Rico and the Virgin Islands until at least 6 p.m. Sunday. Strong winds associated with the Gilbert brought coastal flooding, strong southeast winds and up to 12 feet to Puerto Rico's south coast. There were no reports of casualties. San Juan, on the north coast, had heavy rains and gusts Saturday, but they subsided during the night. On Saturday, Hurricane Florence was downgraded to a tropical storm and its remnants pushed inland from the U.S. Gulf Coast. Residents returned home, happy to find little damage from 80 mph winds and sheets of rain. Florence, the sixth named storm of the 1988 Atlantic storm season, was the second hurricane. The first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month.

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Cabral said residents of the province of Barahona should closely follow Gilbert's movement. An estimated 100,000 people live in the province, including 70,000 in the city of Barahona, about 125 miles west of Santo Domingo. Strong winds associated with the Gilbert brought coastal flooding, strong southeast winds and up to 12 feet to Puerto Rico's south coast. Residents returned home, happy to find little damage from 80 mph winds and sheets of rain. The first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month.

Article ID: D093c/SJMN91-06064099

First accounts of the accident were reported Sunday in Kenyan newspapers. Two English-language dailies said the accident occurred one mile off the coast, but a third said it was six miles away. Police, navy divers, tourists and local residents had recovered about 130 bodies by Saturday afternoon, but 50 victims were believed still trapped in the sunken vessel, according to the newspapers. Confirmation from local authorities of the accounts was not immediately available. The boat with the refugees had set sail from the Somali town of Kismayo, 250 miles north of Malindi, on Feb 26. It was one of a stream of vessels that brought thousands of Somalis seeking refuge to Kenya since rebels overthrew Somalian President Mohamed Siad Barre in late January. The victory followed a month of heavy fighting in Mogadishu, capital of the East African nation. The fighting appears largely to have stopped since the rebel United Somali Congress established an interim government, but refugees continue to arrive in Kenya. Abdi Mohammed Ali, a survivor, was quoted as telling the Standard newspaper that most of those who drowned were on the ships lower deck. First word of the accident came when two survivors staggered into the Jambo Club tourist hotel, manager Barney Ngare was quoted as saying by the Sunday Nation. The hotel sent a small boat to help save those still on the sinking vessel, but rescue workers had to cut the lifeline when too many people grabbed hold, according to Ngare. Another boat sent by the hotel
ferried 15 people at a time to shore, said the Nation. Eleven Somalis drowned when a boat capsized off Kenya near Lamu, north of Malindi, on Feb1.

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Article ID: D116i/LA042290-0160

Countdown clocks resumed ticking Saturday for the shuttle Discovery's delayed launch Tuesday to boost the $1.5-billion Hubble Space Telescope into orbit. Engineers also readied the shuttle Columbia for rollout to its launch pad today for a May flight. Discovery's carefully scripted countdown began on time at 3 p.m. The ship's five-member crew is set to blast off at 5:31 am PDT Tuesday, 14 days after the flight was grounded just four minutes before takeoff by a faulty hydraulic power steering unit. We are off and running, NASA spokesman George Diller said. We're still 80% go for launch weather-wise. With Discovery's launch processing on track, engineers worked to ready Columbia for its May 16 Spacelab astronomy mission. The National Aeronautics and Space Administration has not had two shuttles on the launch pad since Columbia took off Jan12, 1986, with Challenger poised on a pad 1.7 miles away. Columbia's 3.5-mile trip to the firing stand was set to begin at 8 a.m. today. Five hours later, Discovery's five-member crew was scheduled to fly in from the Johnson Space Center in Houston to make final preparations for launch. Commander Loren JShriver, 45; co-pilot Charles FBolden, 43; Steven AHawley, 38; Bruce McCandless, 52, and Kathryn DSullivan, 38, plan to launch the telescope Wednesday. Discovery's replacement auxiliary power unit was successfully test fired Wednesday and the battery charging for the telescope was completed Thursday, one day ahead of schedule.

System generated summary

Countdown clocks resumed ticking Saturday shuttle Discovery's delayed launch Tuesday boost $1.5-billion Hubble Space Telescope orbit. Engineers also readied shuttle Columbia rollout launch pad today May flight. With Discovery's launch processing track, engineers worked ready Columbia May 16 Spacelab astronomy mission. The National Aeronautics Space Administration two shuttles launch pad since Columbia took Jan12, 1986, Challenger poised pad 1.7 miles away. Columbia's 3.5-mile trip firing stand set begin 8 a.m. today. Five hours later, Discovery's five-member crew was scheduled fly in from the Johnson Space Center Houston to make final preparations for launch. Discovery's replacement auxiliary power unit successfully test fired Wednesday battery charging telescope completed Thursday, one day ahead schedule.
Dan Quayle's sister believes the Indiana senator won't let his candidacy for vice president hurt the family life he and his wife, Marilyn, enjoy. "I don't think it will be tough on the family," said Martha Saddler, Quayle's sister, who lives in Huntington, Ind. "Since he's been in politics, we all kind of shake our heads at his hectic schedule and wonder how he does it. But he does it and loves it." The Quayle family and friends were celebrating Tuesday afternoon after George Bush announced he wants the 41-year-old Indiana senator to be the Republican nominee for vice president. Those who have known the Quayles for years said the senator and his wife have remained relatively unchanged by their years in public life. Dan and Marilyn Quayle met as law students in Indianapolis, married while they were still in school and remain close to many of their friends from that period. "One of the greatest things about him is the job of being a senator has not changed him a bit," said Indianapolis attorney William R. Neale, treasurer of Quayle's 1986 re-election campaign. "He's the same nice guy he was in law school." Neale, who grew up with Marilyn Tucker Quayle in Indianapolis, introduced Dan Quayle to his future wife at a student gathering at the Indiana University law school in the early 1970s. Dan Quayle, who grew up in Huntington, graduated from DePauw University, a small liberal arts college in Greencastle, Ind., before going to work in the Indiana attorney general's office in 1970. Daniel F. Evans, also a law school classmate of Dan Quayle, said he doesn't expect Quayle's national candidacy to change him. "I think his strength is he'll remember who his friends are even after this," said Evans, who was chairman of Quayle's 1986 campaign. Friends said the Quayles are devoted to their three children and prefer quiet nights at home to nights out on the town in Washington. "His family looks like the family both parties are trying to appeal to," said Mitch Daniels, former political chief in the White House and now president of the Hudson Institute. "It's a beautiful family. I think they'll be a real asset." The couple, who married in 1972, have a 14-year-old son, Tucker; a 12-year-old son, Benjamin; and a 9-year-old daughter, Corinne. When they campaign in Indiana, the Quayles often tour in two groups _ the boys riding in parades with Marilyn Quayle and Corinne and her father visiting county fairs. "The kids are nonchalant, normal kids," said Mrs. Saddler. "They take it in stride and play." In an interview with Indiana reporters Monday, the Quayles said they had worried during the vice presidential speculation about the family's loss of privacy during a national campaign. "The total lack of privacy is going to be the biggest minus," said Mrs. Quayle, 39. Quayle said he had questioned each of his children about whether he should accept the vice presidential spot if Bush offered it. Tucker was fascinated by the idea, Quayle said. Benjamin was ambiguous but he thought Secret Service agents might be able to help him on tests at school, Mrs. Quayle said. Corinne didn't like the prospect of having her father spend more time away from home, Quayle said. "She told me, 'Daddy, I really hope George Bush picks Bob Dole,'" said Quayle.
Appendix B

Fictional history Text

Precursors of Anchad-Boxgrave conflict

In 1895, Cagland invaded one of its neighboring countries and divided it into two separate entities, Anchad and Boxgrave. [Since Boxgrave was primarily an agricultural region, it was of little value to the Caglanders, whose own agricultural area was prosperous.] Cagland [therefore] withdrew its occupation of Boxgrave in 1901 but remained in Anchad [for economic reasons, specifically its vast wealth of mineral resources and its strategic port position. After several decades, Cagland's President Morris Roscovitch argued successfully that the cost of maintaining the occupation of Anchad had become much higher than the economic benefits originally gained from the invasion. Therefore,] in 1948, Cagland also withdrew its occupation of Anchad, but Anchad and Boxgrave have remained separate countries.

Cultural changes in Anchad occurred as a result of the invasion by Cagland. One notable change was in the country's language. [The Anchadians were forced to adopt the Caglandian language,] and with the passage of time a distinct regional dialect, a mixture of the two languages, developed in Anchad. Another noticeable change as a result of the invasion was in terms of religion. The country which was split into Boxgrave and Anchad had been primarily of the Catholic faith. The Caglanders, however, were mainly of the Protestant faith, and over the years the majority of the Anchadians converted to these beliefs.

Immediately after Cagland withdrew from Boxgrave, the highest ranking military leader, Admiral White, took control and set up a dictatorial government. [His first priority was to build up a massive military force to ensure Boxgrave's safety from a future invasion.] In 1970, Admiral White's successor, General Howe, passed the leadership on to General Jones, whom he had groomed to take over the government. [Jones had very strong ethnic leanings, and his life-long dream of reuniting Anchad and Boxgrave remained a closely guarded secret, shared only with those who he felt he could trust completely. Jones was quite aware of the great disparity between the two nations, but felt very strongly that a reunion would be beneficial to everyone involved.] During recent years, General Jones steadily increased the country's military strength. [He initiated mandatory military service by all Boxgravian males, doubled the size of the country's standing army, and also negotiated a major weapons purchase from Doxland. The General informed the Boxgravian citizens that this build-up was necessary to defend against possible invasion by expansionistic governments. Some of Jones' advisors, however, thought that he felt threatened by the "radicals" within his own country, and was afraid that they might unknowingly disrupt his efforts to negotiate a friendly merger with Anchad.]

Next to General Jones, the highest-ranking official in Boxgrave was General Wolt. [By doing "dirty work" for others,] Wolt had been rapidly promoted through the military ranks [and felt confident that he would be the next leader of Boxgrave. Although Wolt himself had never specifically stated it, many felt that he sought power and probably wanted to extend Boxgrave's territory into prosperous Anchad.]

Throughout the years, Boxgrave has remained primarily agricultural and is much poorer than Anchad. The citizens have low levels of education, with the majority of the children never
reaching high school [because they are needed at home to help their families work the crops. Recent drought conditions and the subsequent failure of most of the crops have combined with the huge military expenditures to result in] extremely poor economic conditions and a very low standard of living. The citizens are becoming increasingly dissatisfied with their government, but cannot openly condemn it [for fear of being "detained" by the military.] An "underground" network has developed, led by individuals who want to overthrow the dictator and change Boxgrave's government to a democ- racy, and this movement has gained a great deal of momentum during the last few years.

Anchad, on the other hand, has prospered since the invasion. [During its occupation, Cagland made major improvements in Anchad. Vast mining opera- tions were put into place, and the development of the port allowed the Anchadians to export their mineral resources to countries all over the world.] After Cagland's withdrawal, a democratic form of government was put into place, [with a new president and a parliament representing the nation's three political parties being elected every five years.] The Anchadian citizens have been encouraged to voice their opinions and to be actively involved in the workings of their government.

[The Anchadians were able to maintain their global trading after they gained their independence, and with their mineral resources in even greater demand,] Anchad's economy has flourished. [This economic success allowed] the Anchadian government to develop a wide range of programs aimed at raising the standard of living of its citizens. [A great deal of time and energy were spent developing Anchad's educational system, which has received a great deal of praise from educators around the world.] The vast majority of the Anchadian citizens have completed a high school education, and many have gone on to college. The government also encouraged cultural development and provided funding for a wide range of endeavors, from the ballet to the national zoo.

Anchad's current President, Joseph Mann, is now serving the third year of his term in office. [Because of his popularity with the Anchadian people and the country's position in world-wide trade,] President Mann has a great deal of power as well as the respect of other leaders. Recently, though, negative opinions about the president have been growing. [Last month, Mann rejected a bill developed by members of the Unified political party, which holds the majority of the seats in the legislature. The bill called for a tax increase in order to fund a build-up of the military, and many Anchadians are very upset and angry about Mann's refusal to sign the bill.] Currently, service in Anchad's military is voluntary, and it functions more as a reserve unit than a standing military threat. The citizens are concerned with recent reports indicating huge weapons purchases by Boxgrave. Reliable sources have also confirmed several unsuccessful attempts by high-ranking Boxgravian officials to negotiate the purchase of nuclear weap- ons, and this frightens the Anchadian people.

General Jones arranged a meeting with Anchad's President Mann and presented him with the proposal that Anchad and Boxgrave reunite. Mann's immediate response was that [under no circumstances would Anchad bear the burden of "bailing out" the depressed Boxgravian economy, and that, regardless of ethnic ties,] a merger was completely out of the question. News of the meeting spread quickly through Anchad, and many citizens were appalled that Mann would so quickly dismiss the idea of a reunification. [After all, the Boxgravians were in a desperate state and the Anchadians felt that, in light of their own prosperity, they should help theirformer countrymen.] Massive demonstrations against the position of the Anchadian government broke out rapidly all across the country.
Upon returning to Boxgrave, Jones was devastated, [his life-long dream of reunification brutally shattered.] Wolt convinced Jones that the only way to realize his dream was to organize a group of individuals whose purpose would be to infiltrate Anchad's government and place supporters of a merger in power. Mann, however, found out about the plot and was furious. [In preparation for a possible take-over attempt by Boxgrave, Mann activated Anchad's military units to defend the border between the two countries, and reiterated his position regarding Boxgrave, saying that Anchad would not tolerate any type of interference by the Boxgrarians.]

Four months later, General Jones was suddenly assassinated by an unknown assailant, and Wolt immediately took over the command of Boxgrave. Wolt publicly accused the Anchadian leaders of plotting the assassination, [saying that even the "extremists" in Boxgrave would not do such a thing.] The Anchadian leaders firmly denied these accusations, [claiming that Wolt was upset by Anchad's refusal to reunify and was just trying to stir up trouble.]

Last week, the Anchadian press reported that a Boxgravian patrol unit crossed over the border into Anchad, where they were warned to return to their own land. Instead, they opened fire on the Anchadian soldiers. The Boxgravian press, however, published a completely different version of the incident, saying that the Anchadian soldiers fired over the border at the Boxgravians and were clearly preparing to cross the border into Boxgrave. After the incident, each side mobilized its forces, and only yesterday a Boxgravian plane dropped bombs on Anchad's capitol.
Appendix C

The following is a list of the 35 statements scored in notes and essay

1. Cagland invaded neighbouring country
2. Divided into two separate entities/ Divided into Anchad and Boxgrave
3. Boxgrave of little value to Cagland
4. Cagland withdrew from Boxgrave
5. Cagland remained in Anchad
6. Cagland withdrew from Anchad
7. Anchad and Boxgrave remained separate countries
8. A dictatorial government was established in Boxgrave
9. A massive military force was established in Boxgrave
10. General Jones took over Boxgrave government
11. Gen Jones had strong ethnic leanings / had life-long dream of reuniting Anchad and Boxgrave
12. General Jones increased Boxgrave’s military strength
13. General Wolt was the next highest-ranking official in Boxgrave
14. People believe General Wolt wants to extend Boxgrave’s territory into Anchad
15. Poor economic conditions and low standard of living in Boxgrave
16. Boxgravian citizens becoming increasingly dissatisfied with government
17. Underground network developed to overthrow dictator / change the government to a democracy
18. Cagland made: major improvements in Anchad / vast mining operation / development of port
19. Anchad economy flourished
20. High standard of living for Anchadian citizens
21. Anchad is a democracy
22. Joseph Mann is president of Anchad
23. Recent reports indicate huge weapons purchases by Boxgrave (maybe nuclear)
24. Unified political party in Anchad proposed bill calling for a tax increase to built up military
25. President Mann rejected the bill
26. Gen Jones proposed to Pres. Mann that the 2 counties unite / Jones and Mann discuss unification
27. Mann rejected proposal
28. Mann did not want Anchad to bear the burden of “bailing out” the depressed Boxgrave
29. Wolt convinced Jones to infiltrate Anchad’s government and place supporters of merger in power
30. Mann found out / was furious
31. Mann activated Anchad’s military units to defend the border
32. Jones was assassinated
33. Wolt took command of Boxgrave
34. Boxgrave and Anchad accuse each other for the assassination
35. Boxgravian military forces mobilized and bombs dropped on Anchad’s capital / War begins
Appendix D

Multiple-Choice Test: Memory and Learning Items

(Bolded Lines : Memory targeted questions)

1. What was Admiral White’s first priority when he took control of Boxgrave?
   a. Build up a military force to ensure against invasion
   b. Build up a military force to pressure Anchad into reuniting
   c. Establish a democratic government
   d. Increase the standard of living in Boxgrave

2. The Anchadian and Boxgravian press organizations reported conflicting stories about a skirmish between the two countries. Which of the following is most likely true?
   a. The Anchadian press report was completely accurate
   b. The Boxgravian press report was completely accurate
   c. Both reports contained inaccuracies
   d. Both reports were completely inaccurate

3. General Jones increased Boxgrave’s military strength by which of the following ways?
   a. Tax increase to provide greater military funding
   b. Making military service mandatory
   c. Offering incentives to the families of recruits
   d. Trading natural resources for weapons

4. In addition to the distinct economic differences between Anchad and Boxgrave after the invasion, what other differences would have made it difficult for a successful reunification?
   a. Different views about the importance of education
   b. Differences in religious beliefs and practices
   c. Differences in ideas about the roles of men and women in society
   d. Different views about how Cagland should be punished

5. Why have Anchadian opinions about President Mann become increasingly negative?
   a. His interest in improving his people’s standard of living has wanted over time
   b. He will not build the military resources necessary to defend Anchad
   c. He wants to initiate mandatory military services by all defend Anchad
   d. His interest in reuniting with Boxgrave increased

6. How does the standard of living in Anchad compare with that of other countries in the world?
a. Below average
b. Average
c. Above average
d. It’s impossible to tell

7. If Boxgrave wins the war, how will President Mann most likely be portrayed in the country’s history books?
   a. As a vicious leader who killed to accomplish his agenda
   b. As a weak leader who tried to avoid military conflict
   c. As a greedy leader who rejected his cultural roots
   d. As a promoter of high living standards for his people

8. Which of the following is Anchad’s primary export?
   a. Technology
   b. Mineral Resource
   c. Agriculture
   d. Anchad is not actively involved in trade

9. Why did Anchad’s President Mann immediately reject General Jones’ reunification plan?
   a. He refused to be intimidated by Boxgrave’s military force
   b. He knew that a reunification with Boxgrave would be unpopular with his citizens
   c. He did not want Anchad to accept the problem of Boxgrave’s failing economy
   d. He believe that Boxgrave would destroy Anchad’s culture

10. When did Anchad begin to prosper?
    a. Before Calgland’s invasion
    b. After Calgland’s withdrawal
    c. Since Cagland’s invasion
    d. After their leader was assassinated

11. What kind of response did many Anchadians have to President Mann’s immediate refusal to reunite with Boxgrave?
    a. A natural response
    b. A negative response
    c. A positive response
    d. No response – most Anchadians were unaware of Boxgrave’s request for reunification
12. Why do some Boxgravians want to overthrow General Jones?
   a. They want to replace him with General Wolt
   b. He treats the Boxgravians unfairly
   c. He is squandering their limited resources on military expenditures
   d. He is too focused on his dream of uniting with Anchad

13. Which of the following is an example of a major cultural change that occurred while Cagland governed Anchad?
   a. Improvement of Anchad’s educational system
   b. The traditional dress changed
   c. The language changed
   d. Females were not granted educations

14. Which of the following military branches is likely to be least powerful in Boxgrave?
   a. Army
   b. Navy
   c. Air Force
   d. Impossible to tell

15. If Anchad had Boxgrave’s leaders assassinated, why do you think Anchad might have done that?
   a. Boxgrave threatened to assassinate Anchad’s leader
   b. It was part of a plot to take over Boxgrave
   c. To protect its government
   d. Because Boxgrave’s leader was a dictator

16. Which of the following is a goal of the “underground network” in Boxgrave?
   a. To secure nuclear weapons in order to prevent future invasions
   b. To overthrow the dictator and create a democratic government
   c. To sneak scholars out of the country to countries with better education
   d. To infiltrate Anchad’s government and place supporters of a merger between the two countries in power

17. If Boxgrave wants to damage Anchad’s economy, which of the following would be the best target?
   a. Airports
   b. Seaports
   c. Railroads
   d. Factories
18. Whose idea was it to infiltrate Anchad’s government and place supporters of a merger in power?
   a. General Jones
   b. President Mann
   c. General Howe
   d. General Wolt

19. What did General Wolt accuse the Anchadian leaders of doing?
   a. Making a major weapons purchase from Doxland
   b. Plotting the assassination of General Jones
   c. Firing weapons over the border at Boxgravian soldiers
   d. Convincing Boxgravian soldiers to commit treason

20. Compared to Boxgrave’s current military, what was the military like under General Howe’s leadership?
   a. Larger but poorly trained
   b. One of the most powerful in the world
   c. Smaller and weaker
   d. Larger and more powerful
# Appendix E

The set of POS tags used in this project

<table>
<thead>
<tr>
<th>Tag</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td>Conjunction, coordinating</td>
<td>and, or</td>
</tr>
<tr>
<td>CD</td>
<td>Adjective, cardinal number</td>
<td>3, fifteen</td>
</tr>
<tr>
<td>DET</td>
<td>Determiner</td>
<td>this, each, some</td>
</tr>
<tr>
<td>EX</td>
<td>Pronoun, existential</td>
<td>there</td>
</tr>
<tr>
<td>FW</td>
<td>Foreign words</td>
<td></td>
</tr>
<tr>
<td>IN</td>
<td>Preposition / Conjunction</td>
<td>for, of, although, that</td>
</tr>
<tr>
<td>JJ</td>
<td>Adjective</td>
<td>happy, bad</td>
</tr>
<tr>
<td>JJR</td>
<td>Adjective, comparative</td>
<td>happier, worse</td>
</tr>
<tr>
<td>JJS</td>
<td>Adjective, superlative</td>
<td>happiest, worst</td>
</tr>
<tr>
<td>LS</td>
<td>Symbol, list item</td>
<td>A, A.</td>
</tr>
<tr>
<td>MD</td>
<td>Verb, modal</td>
<td>can, could</td>
</tr>
<tr>
<td>NN</td>
<td>Noun</td>
<td>aircraft, data</td>
</tr>
<tr>
<td>NNP</td>
<td>Noun, proper</td>
<td>London, Michael</td>
</tr>
<tr>
<td>NNPS</td>
<td>Noun, proper, plural</td>
<td>Australians, Methodists</td>
</tr>
<tr>
<td>NNS</td>
<td>Noun, plural</td>
<td>women, books</td>
</tr>
<tr>
<td>PDT</td>
<td>Determiner, prequalifier</td>
<td>quite, all, half</td>
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<tr>
<td>POS</td>
<td>Possessive</td>
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</tr>
<tr>
<td>PRP</td>
<td>Determiner, possessive second</td>
<td>mine, yours</td>
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<tr>
<td>PRPS</td>
<td>Determiner, possessive</td>
<td>their, your</td>
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<td>RB</td>
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<tr>
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<td>Adverb, comparative</td>
<td>faster</td>
</tr>
<tr>
<td>RBS</td>
<td>Adverb, superlative</td>
<td>fastest</td>
</tr>
<tr>
<td>RP</td>
<td>Adverb, particle</td>
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<tr>
<td>SYM</td>
<td>Symbol</td>
<td>*</td>
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<tr>
<td>TO</td>
<td>Preposition</td>
<td>to</td>
</tr>
<tr>
<td>UH</td>
<td>Interjection</td>
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<td>VB</td>
<td>Verb, infinitive</td>
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<tr>
<td>VBD</td>
<td>Verb, past tense</td>
<td>took, lived</td>
</tr>
<tr>
<td>VBG</td>
<td>Verb, gerund</td>
<td>taking, living</td>
</tr>
<tr>
<td>VBN</td>
<td>Verb, past/passive participle</td>
<td>taken, lived</td>
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<tr>
<td>VBP</td>
<td>Verb, base present form</td>
<td>takes, live</td>
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<tr>
<td>VBZ</td>
<td>Verb, present 3SG -s form</td>
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</tr>
<tr>
<td>WP</td>
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<tr>
<td>WPS</td>
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<td>WRB</td>
<td>Adverb, question</td>
<td>when, how, however</td>
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<td>PP</td>
<td>Punctuation, sentence ender</td>
<td>., !, ?</td>
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<td>PPC</td>
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<tr>
<td>PPD</td>
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</tr>
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<td>PPR</td>
<td>Punctuation, quotation mark right</td>
<td>&quot;</td>
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<tr>
<td>PPS</td>
<td>Punctuation, colon, semicolon, ellipsis</td>
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<tr>
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<td>(, {, [</td>
</tr>
<tr>
<td>RRB</td>
<td>Punctuation, right bracket</td>
<td>), }, ]</td>
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</table>
Appendix F

The results of text summarization system evaluation

The following acronyms have been defined:

AT - Article Text
HS - Human summary
SS - System summary
BT - Baseline Text

**Result 1**

<table>
<thead>
<tr>
<th>Article Ref.No:</th>
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<tbody>
<tr>
<td>Compression Ratio for HS:</td>
<td>86%</td>
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<tr>
<td>Compression Ratio for SS:</td>
<td>84%</td>
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<tr>
<td>Similarity between HS (fi) and AT</td>
<td>0.72</td>
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<tr>
<td>Similarity between SS and AT</td>
<td>0.80</td>
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<tr>
<td>Similarity between BT and AT</td>
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<td>Similarity between SS and HS (fi)</td>
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<td>Compression Ratio for SS:</td>
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<tr>
<td>Similarity between SS and AT</td>
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<td>Similarity between BT and AT</td>
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<tr>
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<td>Similarity between HS (ga) and AT</td>
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<tr>
<td>Similarity between SS and AT</td>
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<td>Similarity between BT and AT</td>
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<tr>
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<td>Similarity between SS and AT</td>
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<tr>
<td>Similarity between BT and AT</td>
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<tr>
<td>Similarity between SS and HS (ad)</td>
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<tr>
<td>Similarity between SS and BT</td>
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<td>Compression Ratio for SS:</td>
<td>71%</td>
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<td>Similarity between SS and AT</td>
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<td>0.80</td>
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<tr>
<td>Similarity between SS and BT</td>
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<td>Compression Ratio for SS:</td>
<td>55%</td>
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<td>Similarity between BT and AT</td>
<td>0.93</td>
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<tr>
<td>Similarity between SS and HS (ib)</td>
<td>0.83</td>
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<tr>
<td>Similarity between SS and BT</td>
<td>0.81</td>
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