

**IMPLEMENTATION OF CREATIVE-PAD:
A NEW CREATIVITY SUPPORT TOOL**

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Abstract

To achieve success, one has to be able to think creatively. Henceforth, many methods for creative thinking have been developed. Many organizations seek creative support tools to assist them to be productive and innovative. There is now a strong and urgent need to develop such tools.

This research describes the implementation of a new creativity support tool, codenamed Creative-Pad, a tool for brainstorming of ideas. Creative-Pad was first thought of by my supervisor at the Auckland University of Technology, New Zealand. The task in this research is to implement the idea so that the program is ready for experimentation.

Creative-Pad is designed initially as a tool to help creative directors in an advertising agency to come up with new ideas to create an advertisement for their clients. These directors are often given a one-line brief describing a client product or service. For example, the sentence, “A car with more family space”, would describe a client’s new product which is a car targeted for family. The creative directors would have to design an advertisement suitable for promoting this product. They will need lots of ideas.

Creative-Pad works by tapping into the internet as a rich source of information about all things. It takes in one or more keywords from the initial sentence and automatically searches the internet to retrieve any related information. It then processes the search results to extract interesting words and sentences. These words and sentences are then “beamed” in front of the creative directors to stimulate their thoughts for the new advertisement. An interface was specially designed to encourage creative thinking. Creative Pad is implemented using Java and is a stand-alone application.

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Chapter 1

Introduction

Creativity support tools are computer software developed to assist people in their search for a creative solution to a problem. These tools provide either support for an individual to work creatively or stimulus to assist one's creative thinking. The former would include support for the simultaneous development of alternative solutions (for example Terry *et al.*, 2004) and support for visualizing related information (for example, Sugimoto *et al.*, 1998). The latter would include programs that help find related ideas for a brainstorming session (for example, Nishimoto *et al.*, 1996). Creativity support tools play a significant role in today's science and business. The value of producing new ideas has been given increased importance in literally every field from science to business. Shneiderman (2006), a guru in developing creative tools, noted "*Creativity, innovation, discovery and exploration are potent concepts in academic communities and leading companies*". Companies can enhance their efficiency by using creative tools to help them remain innovative. Thus, there is a strong need to develop such tools.

However, and as noted in Shibata and Hori (2002), most of the creativity support tools developed to date have not become popular. There are two main problems associated with these systems in general. Firstly, these systems are highly complex and are not easy to use. One might even argue that using these systems could interfere with one's thought processes because of the need to follow complex commands. Secondly, the source of stimulus material that they use to invoke idea generation is often limited. These systems usually make use of a fix database as a repository of ideas, clues, words, graphics and others to assist the ideation process. A fixed database, however large, is

still somewhat limited as a source for creative ideas. Furthermore, if used repeatedly, one could possibly be getting the same ideas out of these systems. Human's intellect and knowledge appear to be infinite and this quality is important for creative thinking.

This research is to implement a new creative support tool which will be used to generate ideas for the users to assist them in their creative thinking. In particular, it generates ideas to assist the users to develop ideas for a new advertisement or a new slogan. The theoretical underpinning of this work has been modeled by Professor Albert Yeap and his doctoral student, Mr. Tommi Opas, in New Zealand. They observed that, in advertising, a client product or service can often be described succinctly in one sentence. For example, "A car with more family space" is a sentence that could describe a new car targeted towards families. From this brief, the creative directors are required to develop an advertisement for this product. How do they do it? How do they come up with some creative ideas that will lead to the development of such an advertisement? What ideas they have seen or known that have inspired them to come up with a particular advertisement?

Although creative thinking such as the one described above is still very much a mysterious process, developing a tool to assist such thinking is not. The tool could generate ideas to trigger new ideas in the mind of the creative directors. Such a creative method is commonly known as brainstorming.

Brainstorming is a well known method for supporting the divergent thinking process in obtaining diverse information (Osborn, 1963; Toubia, 2000). Nowadays, more than 40 years after Osborn's brainstorming method, the most important difference between now and then is the emergence of new sources for ideas other than the human's brain and the internet is one such source. It is literally possible to find anything about

anything in the Internet. However, information retrieved from the internet is not in a form suitable for presentation to the users for a brainstorming session.

Significant research for the development of Creative-Pad was done to study various aspects before producing a creativity support tool which will be used to assist users such as a creative director in an advertising agency. In this research, a new creativity support tool Creative-Pad is developed based upon two key observations:

1. The internet is both a rich and a dynamic source of information. Thus it will be good to tap into that resources for ideas to assist one's creative thinking;
2. The creative process is still little understood. Therefore, for now, creating a tool to support users in their creative process should best focus on generating ideas for the users and let the users do their creative bit.

Thus in the design of Creative-Pad, one focuses on:

1. Developing a module to access the internet for ideas; and
2. Developing an interface to present the ideas to the users for brainstorming of new ideas.

Creative-Pad, however, was not implemented and the task given for this project is to implement Creative-Pad. As noted above, one major problem with existing designs of creative tools is that they are too complicated. Hence, one guiding principle used in the implementation of Creative-Pad in this project would be simplicity. The system developed must be simple and easy to use.

The result of this research is the successful implementation and testing of Creative-Pad. Creative-Pad is implemented using Java and is a stand-alone application. All the concepts and paradigms of Object-Oriented Programming are taken into consideration while developing this system. Although the initial intended user of this application is an advertiser who seeks ideas to come up with an idea for a new advertisement, the system is found to be useful for any other user who shares common interests and needs a tool to help in a brainstorming session.

1.1 Background Notes on Creativity and Importance of Its Study

Much research has been done on creativity in the field of cognitive psychology to understand how the human brain functions and to develop techniques and methods that may aid people to be more creative both as individuals and as team members.

1.1.1 Creativity

Since creativity is an interdisciplinary issue, there are different definitions from different point of views. A common definition from Webster's Dictionary states that – *‘Creativity is marked by the ability or power to create, to bring into existence, to invest with a new form, to produce through imaginative skill, to make or bring into existence something new.’*

According to Boden (2004), creativity is: *‘The ability to produce ideas/artifacts that are novel, surprising, and valuable.’*

There are some other interesting definitions of creativity such as :

‘A "new" idea is a combination of old elements. Being able to devise new combinations depend on your ability to discern relationships between seemingly disparate items’(Young , 2003).

‘Creativity is the juxtaposition of ideas which were previously thought to be unrelated.’ It is your ability to combine ideas in a unique way or to make useful associations among ideas’ (Kotelnikov, 2008). Figure 1.1 depicts creativity from the Kotelnikov’s point of view. Taking resources along with enough motivation and thinking skills together, will result in the creation of new ideas.

Among many definition of creativity, it is commonly agreed that creativity is the ability to produce work that is innovative, implying both novelty and usefulness (Mayer, 1999). While novelty refers to originality and usefulness implies relevance.

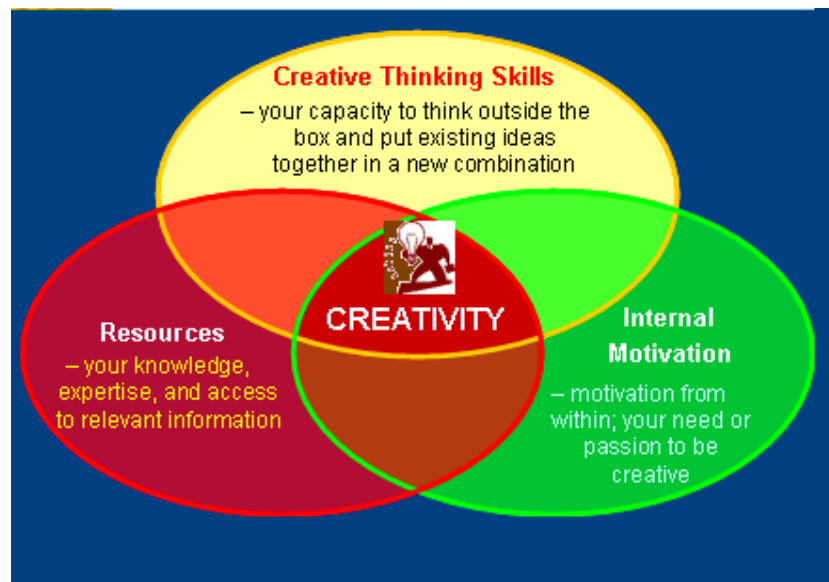


Figure 1.1 Creativity (Kotelnikov, 2008)

1.1.2 Types of creativity

There are different categories in the academia regarding the types of creativity. Based on a minimalist yet well-put categorization (Hijazi *et al.*, 2004), there are two types of creativity:

- Problem solving creativity
- Artistic creativity

The first type of creativity solves a problem in a unique and appropriate manner. This kind of applied creativity is pointed in the direction of problem solving, where the problem is known in advance.

The second type does not really solve a physical problem but rather creates something genuine and out of nothing which is novel and appealing from an aesthetic point of view. This kind of pure creativity is free-roaming, and typically introduces materials we are aware of but have not brought into consciousness often in response to some deep-seated concern or issue that has been "in the back of our mind" for some time.

1.1.3 Creative thinking techniques

Based on the psychological observations of the human nature, we are creatures of habit and once we adopt a particular pattern in regard to something, we tend to keep it unless a deliberate and conscious attempt is done to break it away and change or replace it with a new one. Creative thinking techniques can be described as a range of techniques used to help people to see problems and issues in different ways. An

alternated point of view assists a person to synthesize existing ideas to form a new one or apply an idea from one domain to another.

Regardless of the different views on definition of creativity and its mechanisms, there is a consensus that the final product of the stimulation of the human's creativity is an idea which manifests itself in different ways and forms.

There is a wide range of methods which facilitate the process of creative thinking such as Mind Map, brainstorming and Alternative words (Goel and Singh, 1998). There are some other techniques such as random association techniques, starting a process at a different point like beginning at the end and working from there to the beginning, and using metaphors.

1.1.3.1 Mind Map

A dominant role is played by association in nearly every mental function. Every single idea has numerous links attaching it to other ideas and concepts. Mind map, developed by Tony Buzan, is an effective method of notes taking and is useful in the generation of ideas by associations (Buzan, 1991).

Mind mapping remains a novel strategy to organize ideas, support creativity and to reflect the mental image that a person has at any moment. Figure 1.2 depicts an interesting example of how mind mapping technique can be used for population and the planet.

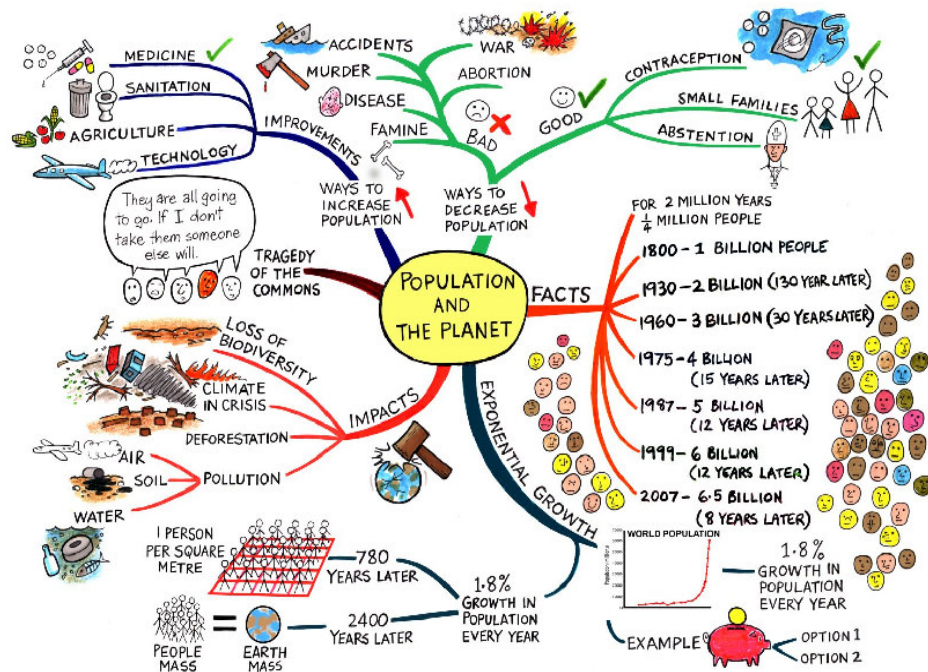


Figure1.2 Mind Map (Genovese, 2007)

1.1.3.2 Brainstorming

Since brainstorming is essential to the development of the Creative-Pad, it will be elaborated more than the other approaches mentioned in this chapter. This technique is one of the most famous and well known idea generation methods (Osborn, 1963). It is a creative problem-solving strategy introduced in 1963 by Alex Osborn. He developed this technique when he was in charge of an advertising company. He used it to help his employees to come up with many new ideas for the advertising business. Because of his great success in use of brainstorming, it began to be used in many different kinds of situations where ideas were needed to help solve problems. Osborn's support for the technique of brainstorming helped it to spread and he is a key reason that brainstorming is as widely used and known as it is today.

Before diving more into the depth of brainstorming, it is good to explain two significant stages in creative process which are divergent thinking and convergent thinking (Imai *et al.*, 1984). In addition, free wheel is another key term for better brainstorming.

- Divergent thinking: Generating a number of possible ideas or options in response to an open question or situation even if their relevance to the problem is not immediately clear.
- Convergent thinking: Choosing among many options to reach a conclusion.
- Free wheel: To welcome and be open to all ideas, even those which may seem irrelevant, and even silly.

The basic idea of brainstorming is generating ideas in a group situation for supporting the divergent thinking process based on the principle of suspending judgment. The generation phase is separate from the judgment phase of thinking. There are four principles in brainstorming. Figure 1.3 shows an instance of a brainstorming session.

Focus on quantity: This rule is a means of enhancing divergent production, aiming to facilitate problem solving through the maximum quantity breeds quality. The greater the number of ideas generated, the greater the chance of producing a radical and effective solution.

Criticism is forbidden: In a group, it is often emphasized in brainstorming sessions that you should put criticism 'on hold'. When suspending judgment, you create a supportive atmosphere where participants feel free to generate unusual ideas.

Unusual ideas are welcome: By looking from another perspective, or by setting aside assumptions, some unusual ideas can be generated. These ideas will open new ways of working or thinking. It is easier to tame down an idea than to think up an idea.

Combine and improve ideas: The approach of combining and improving ideas will lead to better and more complete ideas than solely generation of new ideas and will cause a chain reaction of idea generation by using the power of association.



Figure 1.3 Brainstorming Session (*Nothing clever*, 2006)

Brainstorming is a supplement for:

- Creative thinking: improve creative ability in groups and individuals in order to solve problem.
- Individual ideation: generate a maximum number of potentially practical ideas in a minimum time.

- Business conference: stimulate creative thinking in a free atmosphere.

Nowadays, brainstorming is widely used for advertising, business planning, team building, new product development, problem solving, project management, new product development and process management.

It is wrong to assume that the sole advantage that brainstorming offers is the generation of new ideas but equally important, it helps to create them with a minimum amount of effort.

It is also worth mentioning that traditional and electronic brainstorming are usually differentiated. The main difference lies in the use of computer software in electronic (advanced) brainstorming that promotes group brainstorming or makes individual brain storming possible. Moreover, most of the problems associated with traditional brainstorming such as finding a group to participate is eliminated in the electronic brainstorming.

1.1.4 Creativity support tools

Creativity support tools are computer software for enhancing human creativity and assist people to generate ideas. Former mentioned methods are called traditional when they do not employ computers and software in the process of idea generation. However, today you can find some of these methods which take advantage of the abilities that software systems provide to promote themselves.

The main difference between traditional idea generation method and creativity support tool is the application of various softwares to facilitate the process of idea generation. We will elaborate more about creativity support tools in chapter 2.

1.2 Motivation

The motivation for this project is the challenge to implement a new creative support tool. Furthermore, in this study initial survey into the nature of such tools shows that good tools in this area are lacking and yet demand for them is high. According to Shneiderman (2007), the topic is also a relatively new one in computer science and information science and the challenge of creativity support tools stems from vague requirement for discovery and innovation. The latest Creativity and Cognition Conference in 2007 highly supports the aforementioned claim:

‘Creativity support tools are set an especially difficult task when they are applied to art/science collaboration. Not because of any fundamental incompatibility between the disciplines, but because creativity support tools are rarely supple enough to manage dramatically shifting requirements at various stages of design or handle the diversity of artifacts that might be generated’ (Adamczyk et al., 2007).

Such a challenge is very interesting and it is motivating to plunge into the sea of the challenge to undertake research in developing Creative-Pad.

1.3 Research Objectives

The main objectives of this research are:

- To design a good creative-support environment for Creative-Pad. This includes investigating how to extract related ideas from internet search and how to present them to the users in an environment that inspire creative thinking;
- To implement and test the performance of Creative-Pad.

The overall goal is to develop an effective and easy to use creative-support tool which is thought-provoking and helps advertisers to generate new ideas in order to create an advertisement. A thorough research on the nature of creativity needs to be carried out to realize the objective and goal. In addition, existing creativity support tools are needed to be studied.

1.4 Scope and Limitations

Project scope is considered in successfully producing a viable creativity support tool which include:

- A review of relevant literature in the area of creative research;
- Successfully implementing a working prototype for Creative-Pad;
- Creative-Pad will be used by a single user only for brainstorming of ideas; and
- Input to Creative-Pad would be restricted to keywords only and ideas produced by Creative-Pad would be in terms of words only. In particular, no pictorial output is used to express an idea. The focus is on visualization based on words and sentences in a motivating environment.

A prototype -Creative-Pad- was developed within academic time constraint to produce a feasible creativity support tool. This paves the way for future research. The time constraint imposes some limitations on the research and the implementation of Creative-Pad which are listed below:

- The system would be implemented to accessing one search engine only and a future work can test the changes in functionality with different search engines; the selected search engine is AltaVista. This search engine allows a query

formed within a program be sent to it as a URL and sends the results back to the application. Google could not be used because it does not allow queries be sent directly from a Java program. Moreover you need to use a library provided by Google named SOAP search API. Unfortunately, Google does not issue any more registration keys for this library since December 5th 2006 (*Google code*, 2006).

- The system would allow one brainstorming session per use;
- The system would allow one user per session.

1.5 Research Methodology

The research methodology employed in this research is an incremental system development with a cycle of:

Design → Implementation → Test → Evaluation

During the design phase, the problem is studied carefully and answers to various design questions such as the choice of data structure, programming language, and others will be answered. Implementation of the ideas will be done in stages, debugged and testing done in an incremental fashion based on five significant tasks, namely searching, visualizing, thinking, composing and reviewing from Shneiderman's framework for developing a creativity support tool. The prototype will be evaluated in terms of its efficient use to generate ideas for the users. Any problems found will bring us back to the start of the cycle. The cycle repeats until the final production of a creative prototype system which can assist users to generate ideas in a thought provoking environment.

1.6 Requirements

1.6.1 System Requirements

Minimum hardware requirements for this system:

- CPU: Intel Core Duo
- 1 GB of RAM
- 16-, 24-, or 32-bit OpenGL capable graphics adapter

Minimum software requirements:

- Operating system: Microsoft Windows Vista, XP Professional, Microsoft Windows 2000 or Linux
- Web browser: Microsoft Internet Explorer 5.5, 6 or 7, Firefox 1.0, 1.5 or 2, Mozilla 1.7, Netscape 7.1 or 8.0

1.6.2 Development tools requirements

- Java Development Kit (JDK1.6)
- NetBeans or any Integrated Development Environment (IDE) for Java

1.7 Dissertation Organization

Chapter 1 (Introduction) comprises an introduction to the research area and how it will be carried out.

Chapter 2 (Literature Review on Creativity Support Tool) provides an overview of creativity criteria and computer support for creativity with an emphasis on idea generation support. Also in this chapter, some of the famous programs for creativity support tools are studied.

Chapter 3 (System Design) explains in detail the system architecture and design from an Object Oriented point of view. It contains UML diagrams which depict the system's functional requirements and design.

In chapter 4 (Development of Creative-Pad), the architectural components of system are analyzed. The functionality of each component and the relation between components are clarified.

In chapter 5 (Performance and Results), the results of several experiments and the performance of the system in idea generation process are studied.

Finally, Chapter 6 (Conclusion and Future Work) concludes this work and suggests areas for further research.

Chapter 2

Literature Review on Creativity Support Tool

This chapter provides a review of some existing creativity support tools. Note that there are many different creative problem solving methodologies and for each, a very different kind of tool is needed. Creative-Pad is aimed as a tool for assisting a brainstorming session with the users. Therefore, this chapter will review other creativity support tools developed for brainstorming for ideas. However, as Shneiderman (2002, p.116) noted: *‘These exemplars are helpful, but to make more rapid progress creativity support tool designers could benefit from a clearer set of requirements’*. In short, we need a suitable framework guiding the development and evaluation of such tools. Thus, prior to discussing relevant work, this chapter will first discuss Shneiderman’s framework of activities for creative work.

2.1 Shneiderman’s Creativity Framework

Prior to discussing his creativity framework, Shneiderman (2002) mentioned Couger’s (1996) review of 22 “creative problem solving methodologies” using a framework consisting of four simple steps: Preparation, Incubation, Illumination and Verification. After Couger’s review of those work, Couger himself offered his own framework consisting of five steps:

1. Opportunity, delineation, problem definition
2. Compiling relevant information
3. Generating ideas
4. Evaluating, prioritizing ideas

5. Developing an implementation plan

Note that earlier frameworks such as the above and used to evaluate creative problem solving methodologies are designed for reviewing *any* creative problem solving methodologies. However, not all these methodologies can be computerized. Consequently, Shneiderman influenced by Csikszentmihalyi's analysis (Csikszentmihalyi, 1996), proposed a new framework called "GENEX" which is developed for problem solving methodologies which could be implemented using computer software. Furthermore, Shneiderman wanted a framework which also places a greater emphasis on the social nature of creativity, a point strongly emphasized in Csikszentmihalyi's (1996) famous analysis of the creative process. Hence the "GENEX" framework is discussed in detail here.

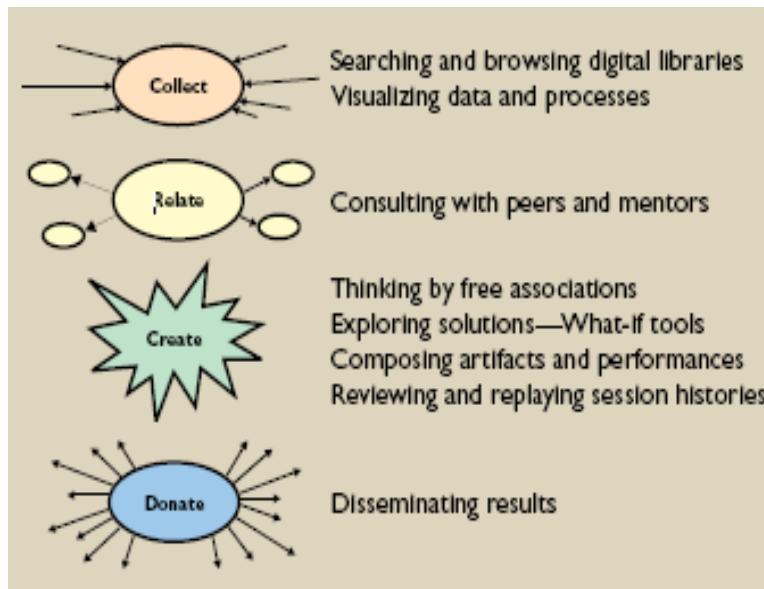


Figure 2.1 Primary relationships of four activities and eight tasks (Shneiderman, 2002)

The GENEX framework consists of four activities to assist designers in providing effective tools for users (Figure 2.1):

1. **Collect** – learn from previous works stored in libraries, the Web, and other sources;
2. **Relate** – consults with peers and mentors at early, middle, and late stages;
3. **Create** – explore, compose and evaluate possible solutions;
4. **Donate** – disseminate the results and contribute to libraries, the Web, and other sources.

As can be seen above, the framework proposed indeed placed a lot of emphasis on the social nature of creativity. Both activities 2 and 4, and to a certain extent activity 1, relate strongly to the social interactions that promote creative thinking.

In creating a tool such as Creative-Pad, whereby the users are given ideas to help them in their creative thinking, one is in danger of cutting out the social interaction part of the creative process which is much emphasized in Shneiderman's framework (1999). The development of Creative-Pad would generally consider the first two activities however not the last two. Furthermore, for the second activity (Relate), it is not about consulting with peers and mentors but about providing a process to *automatically* relate the material collected so that the program can assist the user in the creative process of generating new ideas.

The last two activities 'Create' and 'Donate' are usually relevant after research completion. In this research study, it is not necessary to explore, compose and evaluate possible solution in providing solution for particular practical problems. Similarly deployment of final product to other sources is beyond the scope of this research.

However, Shneiderman (2002) also proposed eight specific tasks to help people to increase their creativity more often (Figure 2.2). These eight specific tasks help people to be more creative. Although these eight tasks might not be complete but he suggested them as a checklist for designers and developers of creativity support tools. Activities of “Collecting”, “Relating”, “Creating” and “Donating” can be achieved by the iterative applications of the eight tasks. There are existing general purpose software tools which can help users to support these tasks, but specially custom made and tailored software products in each work domain will be more effective.

(1) Searching and browsing digital libraries, the Web, and other resources
(2) Visualizing data and processes to understand and discover relationships
(3) Consulting with peers and mentors for intellectual and emotional support
(4) Thinking by free associations to make new combinations of ideas
(5) Exploring solutions—What-if tools and simulation models
(6) Composing artifacts and performances step-by-step
(7) Reviewing and replaying session histories to support reflection
(8) Disseminating results to gain recognition and add to the searchable resources

Figure 2.2 Eight tasks to support creativity (Shneiderman, 2002)

These tasks which are elaborated in the following sections, are used as guidelines in evaluating Creative-Pad and other creativity support tools observed and evaluated in this research.

- 1. Searching:** Searching libraries, the Web or other resources accelerates the collection of information about previous work done on the area that new ideas are needed for.

2. **Visualizing:** *'Drawing mental or concept maps of current knowledge helps users organize their knowledge, see relationships, and possibly spot what is missing' (Shneiderman, 2002).*
3. **Consulting:** Specialized forms of exchange, more sophisticated than usual instant messaging or email, are needed that makes communication possible between participants or while ensuring credit for and protecting new ideas.
4. **Thinking:** Usually creativity support tools are implemented to support one of the following thinking techniques. The most common is thinking by free association, sometimes called brainstorming. Another popular approach, is lateral thinking coined by Edward De Bono. He defines it as *'exploring multiple possibilities and approaches instead of pursuing a single approach'* (De Bono, 1973).

Many creative people value tools that support their free association that helps to break free from their current mind set. Some software tools have attempted to do this by providing related concepts textually as in the IdeaFisher that provides capabilities that go beyond the usual thesaurus.

5. **Exploring:** *'Another important task during creative exploration is to conduct thought experiments about the implications of decisions. ... Simulations open users minds to possibilities, allow them to explore safely, and enable them to see complex relationships'* (Shneiderman, 2002).

6. **Composing:** In line with Terry and Mynatt (2002), graphics composition tools show the enormous power of software to enable more people to be more creative. For example, slide presentations tools such as Microsoft PowerPoint are now widely used, even by elementary school children, and photo editing tools such as Adobe Photoshop have enabled many people to crop, retouch, enhance, and combine their photos.
7. **Reviewing:** One of the features to be added to creativity support tools is the capacity to record activities, review them, and save them for future use. This history lets users return to previous steps, much like the back button on the Web browser. *‘There is growing evidence that such tools help users and learners in many ways’ (Shneiderman, 2002).*
8. **Disseminating:** Finally, when users have created something they like, they need to disseminate it. This can be achieved via sending emails to putting up a web site and so on.

These tasks can help as a checklist for designers of software tools. The four activities - Collect, Relate, Create, Donate - can be accomplished by repeated applications of the eight tasks. Users can apply existing general-purpose software tools to support these eight tasks, but specially tailored products in each domain of work will be more effective. In developing Creative-Pad, the important tasks would be: Searching, visualizing, thinking, composing and reviewing. Other tasks (consulting with peers, explore solutions and disseminating results) are out of the scope of this research as mentioned in section 2.1.

2.2 Creativity Support Tools

As mentioned in chapter 1, a creativity support tool, is a tool or system to support people working in an area of creative endeavor (Nichol, 2005). ‘*The integration of computer systems with creativity has only been a recent focus*’ (Candy and Hori, 2003; Paradice *et al.*, 2002; Shneiderman, 2002). The most common method used for ideation is brainstorming. There are tools and software available for making brainstorming process more efficient. Four such creativity support tools, namely Axon Idea Processor, Idea Fisher, Maxthink and IdeaCue, are reviewed in this section. Since Creative-Pad emphasizes on finding brilliant related ideas to trigger the creative thinking of its users, the review here will focus on the techniques used by these systems to stimulate creativity and idea generation process. Some of these tools have a much broader domain of functionality but since these features are irrelevant to creativity support, they will not be described.

2.2.1 Axon Idea Processor

The Axon Idea Processor is a windows-based application developed in Visual Prolog which commenced development in 1990 and since then it has been revised yearly (Bok, 2000). Axon includes internal resources such as question database but it has no support for searching and retrieving from external resources such as Internet or digital libraries. Based on Herbjornsen (2003), it provides a flexible and multi-dimensional environment that supports and empowers the thinking processes. The main feature of the system is a 3D workspace where ideas can be represented as graphical objects, and the relationships between different ideas are shown as links (Figure 2.3). These visual cues facilitate recall, association and discovery of ideas or in other words

promote the users' thinking process. Axon implements brainstorming and associative thinking as its ideation methods. History is limited to the saving of the simulations for reviewing purposes.

Axon has other features that allow the user to focus his/her attention on fewer areas, and at a higher level of abstraction. For example, the Sequencer tool can be used to sequence ideas at a later stage, thus freeing the mind from sequencing tasks during the initial idea generation stage. The free writer feature of Axon is based on the free-writing technique which claims to help users in the process of brainstorming. The user is allowed to write but at the same time prohibited from any kind of editing, formatting or the performing of any grammar or spell checking operations for a set amount of time. This enables the user to free his/her mind from the editing details and focus solely on the representation of ideas in a textual form without any interruption to the profusion of ideas and thoughts. Although it offers advanced features but the interface is complex and the program is difficult to use (Herbjornsen, 2003).

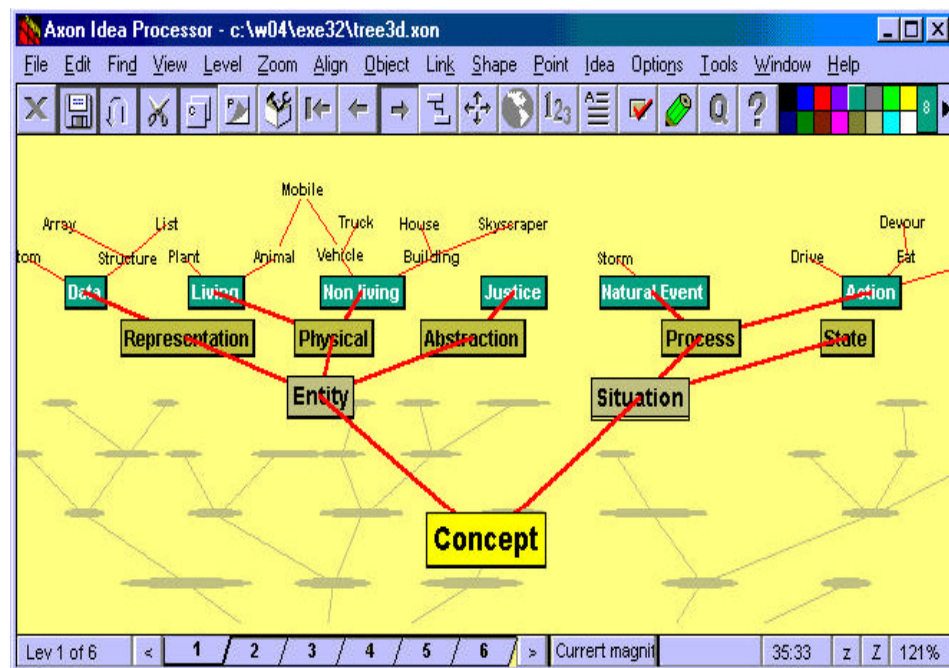


Figure 2.3 Axon Idea Processor (Herbjornsen, 2003)

2.2.2 Idea Fisher

Idea Fisher is a famous and well-known idea generation and creativity support tool which works based on the association and relationship between two or more concepts. The main claim of Idea Fisher is that it takes advantage of idea generation mechanisms which are quite similar to the way that human brain functions. Any new idea, and in general creativity, is the outcome of the associations and linkage that human mind creates between concepts. A thought like food leads to associations such as orange, cooking, tea, washing the dishes and so on. The birth of a new idea is the result of making associations between concepts in the way that does not exist before.

Figure 2.4 shows associate thinking in relation to 'beach' as an example.

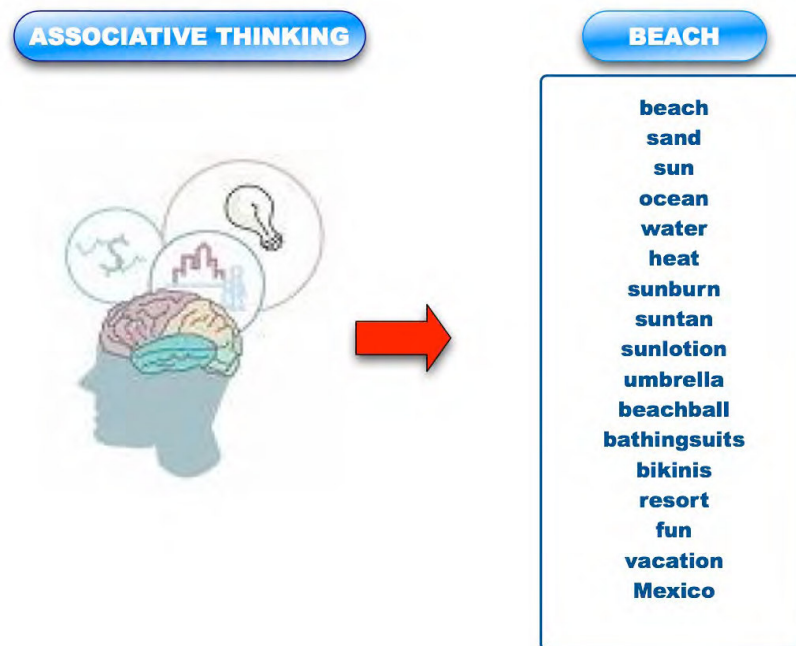


Figure 2.4 Associative thinking (*Introduction to thoughtoffice*, 2006)

The heart of Idea Fisher is a database of associations named IdeaBank. The IdeaBank is an organized storehouse of more than 65,000 idea words, phrases, and concepts familiar to modern society. It is used to look up related ideas and concepts. The software cross-referencing power creates more than 775,000 direct associations (*Creativity on demand*, 2005). The IdeaBank is searched for concepts and relationships every time the user selects a word from an alphabetically indexed list of words to show the associated topical categories. Like Axon, it does not search from any external resources such as the Internet or digital libraries. Marsh Fisher, developer of the software, spent more than 10 years to improve and develop the software and sorting thousands of words organized in hundreds of boxes whereby each box has “associative categories”.

2.2.3 Maxthink

Maxthink (Figure 2.5) is another outliner available for processing ideas, which is a stand-alone DOS program, also called knowledge management tool. It is designed for provoking creative thinking, organizing masses of written material, and for structuring complex writing projects. The developer of Maxthink argues that the human mind is better at high-level thinking (new ideas) than low-level thinking (school and work) and consequently, Maxthink is developed to assist in organizing and structuring ideas (Herbjornsen, 2003).

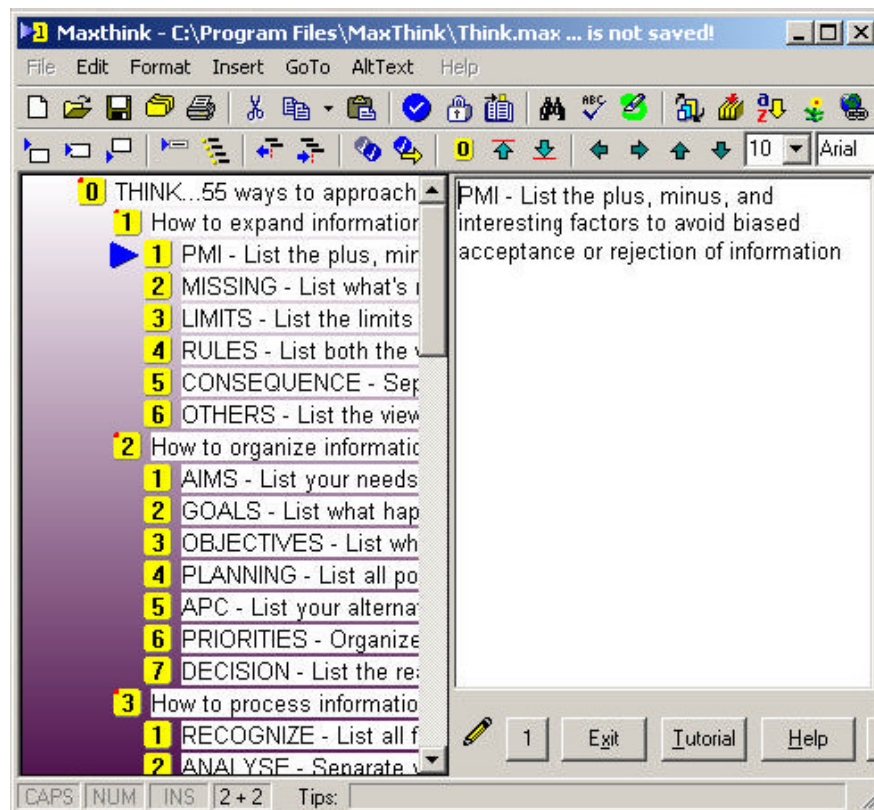


Figure 2.5 Maxthink (Herbjornsen, 2003)

The module of interest in Maxthink is the idea generator module. This module helps the user in the early stages of idea generation and thinking by providing

mechanisms for list processing such as finding, sorting, joining, collecting and segmenting ideas.

2.2.4 IdeaCue

IdeaCue (Figure 2.6) is a brainstorming software intended to help managers, product developers, engineers and entrepreneurs create new ideas with prompting creative thought. It can be used either by group or individuals. It contains two different brainstorming exercises (Idea Engine and Concept Scrambler) and one idea evaluation tool (Concept Analysis). Both Idea Engine and Concept Scrambler have customized database with a variety of typical product or services to help user's brainstorm (*IdeaCue*, 2003).

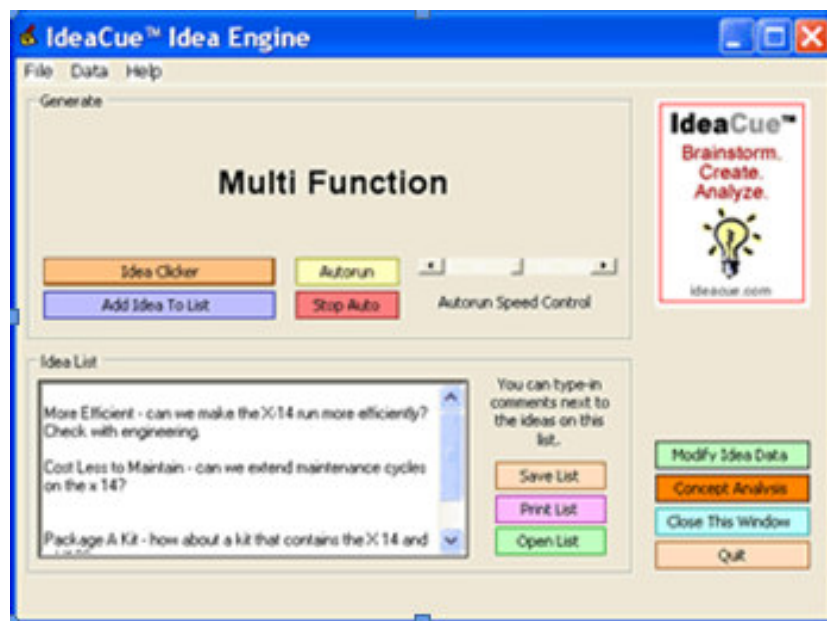


Figure 2.6 IdeaCue (*IdeaCue*, 2003)

The basic idea of IdeaCue resembles the "flash card framework" which is a technique used for brainstorming sessions and works by displaying stimulating concepts

and ideas on a random basis. The program's database can be easily customized to meet the needs of nearly any type of organization, profession or industry. The Idea Engine presents single concepts or phrases on the screen, one at a time, to stimulate creative ideas. User can save words or concepts, add comments and ideas for further use. In concept, scrambler phase groups of three random words are shown to inspire the user's mind with combination of these words (Frey, 2003).

2.3 Conclusion

A review of Shneiderman's framework highlighted the importance of the social nature of creativity and an important phase where the individual or a group explore, compose and evaluate possible solutions (see Create – the third activity). However, the implementation of a tool such as Creative-Pad focuses on the 'Collect' and 'Relate' phases in creative thinking. Like the developer of Maxthink, we believe that the human mind is best in coming up with the creative ideas and the machine is best at supplying "triggers" to help them to think. However, unlike Maxthink, Creative-Pad is meant to provide an environment for "free thinking" rather than an environment with instructions to guide how one should go about doing creative thinking. Thus, Creative-Pad does not have rules on how to think, only ideas that might trigger the mind of the user to come up with a fantastic advertisement. It also differs from the other systems in that it accesses the Internet for ideas. Since the Internet is growing every second, one could claim the Creative-Pad has an infinite source of information for creative thinking.

Chapter 3

System Design

3.1 System Architecture

Creative-Pad is implemented using a pipe and filter system architecture. Pipe and filter is a very simple, yet powerful architecture which is also very robust. It consists of any number of components (filters) that transform or filter data, before passing it on via connectors (pipes) to other components.

This architecture is selected because it impeccably corresponds to the nature of the Creative-Pad's flow of data. Creative-Pad consists of a series of modules which retrieve, process and filter data and then pass it to the next component. It should be mentioned that unlike typical applications implemented by using pipe and filter architecture, every filter in the Creative-Pad, that is every component that data goes through, has a graphical user interface. This is to enable users to perform the filtering of the words and lines in respective stages by selecting the words or lines they find useful. Figure 3.1 depicts the system's structure with respect to pipe and filter architecture.

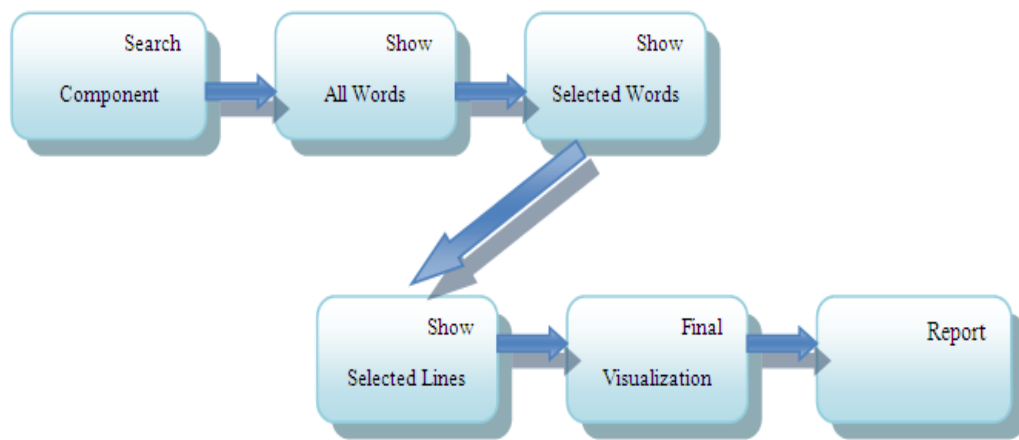


Figure 3.1 System Architecture

3.2 System Design

This section of chapter 3 contains the different UML diagrams of the system. UML is a formal language that enables system developers to specify, visualize, and document models in a manner that supports scalability, security, and robust execution (Pender, 2003).

3.2.1 Use Case Diagram

The first diagram is the Use Case diagram which shows the system's requirements from the users' perspective. Creative-Pad's intended user is an advertiser who needs the system to facilitate the creative process of generating a new advertisement for a product. Figure 3.2 illustrates the systems' use cases.

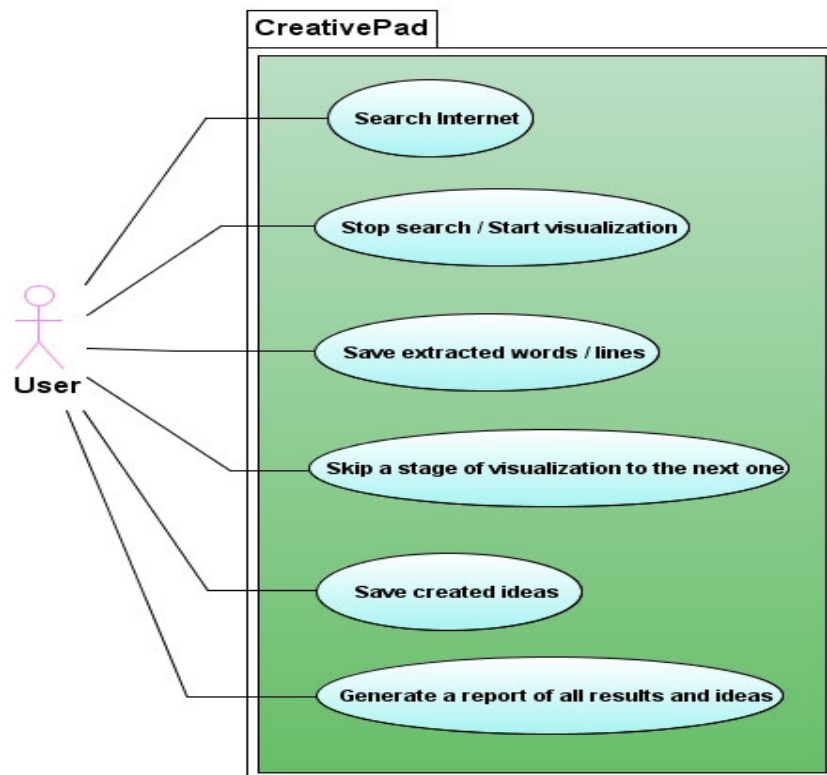


Figure 3.2 Use Case Diagram

Each use case is described individually using a Use Case Description table. This table contains elaborated information about each use case.

3.2.1.1 Search the Internet Use Case description

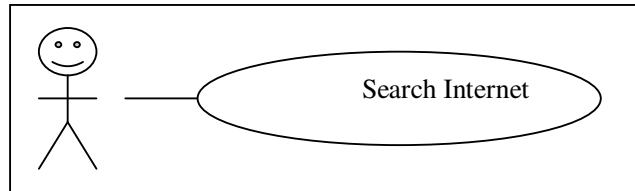


Table 3.1 Search Internet Use Case description

Use Case Name:	Search Internet
Summary:	Advertiser searches the Internet for related information
Dependency:	None
Actor:	Advertiser
Description	<ul style="list-style-type: none">• User enters the search keywords and clicks the Search button on the user interface to start the search• System sends request to AltaVista search engine
Alternatives:	None
Pre-Condition:	System should be connected to the Internet

3.2.1.2 Stop Search / Start Visualization Use Case description

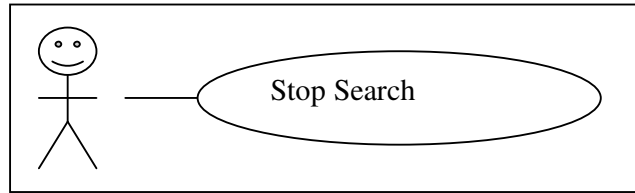


Table 3.2 Stop Search / Start Visualization Use Case description

Use Case Name:	Stop Search / Start Visualization
Summary:	Advertiser stops the search process and system will automatically start visualization of retrieved words
Dependency:	None
Actor:	Advertiser
Description	<ul style="list-style-type: none">• User clicks the stop button on the interface• System starts detagging the retrieved HTML files• Adjectives and verbs will be extracted from the retrieved textual content• Visualization of all the selected words starts
Alternatives:	None
Pre-Condition:	Search should be in progress

3.2.1.3 Save Extracted Words / Lines Use Case description

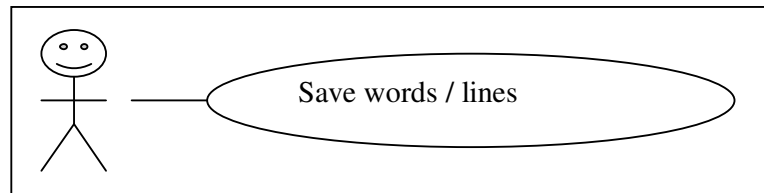


Table 3.3 Save Extracted Words / Lines Use Case description

Use Case Name:	Save words / lines
Summary:	Advertiser can save words or lines which he finds interesting and stimulating
Dependency:	None
Actor:	Advertiser
Description	<ul style="list-style-type: none">• Advertiser clicks the save button on the screen to save• The current word in visualization which is moving on the screen is shown in a textbox in the bottom of the page to make it easier for the user to know which word / line he selects• System will add the selected word to the report object
Alternatives:	None
Pre-Condition:	Visualization of all words or selected words or lines should be in progress

3.2.1.4 Skip a Visualization Stage

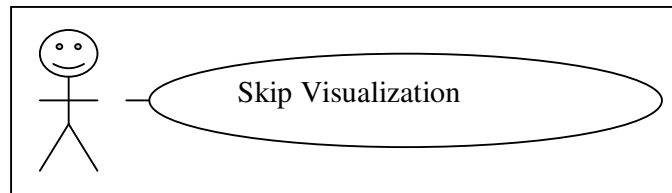


Table 3.4 Skip Visualization Use Case description

Use Case Name:	Skip a visualization stage Use Case
Summary:	Advertiser can skip from on visualization stage to the next one
Dependency:	None
Actor:	Advertiser
Description	<ul style="list-style-type: none">• Advertiser clicks the save continue/next button on the screen• The current visualization will be terminated and the next stage of the visualization starts. If user skips the ShowAllWords stage, the ShowSelectedWords stage will be started. If user skips the ShowSelectedWords stage, ShowLines stage will be started. Finally, if the user chooses to end ShowLines stage, the FinalVisualization stage starts.• System will add the selected words to the report object
Alternatives:	None
Pre-Condition:	Visualization of all words or selected words or lines should be in progress

3.2.1.5 Save Ideas Use Case description

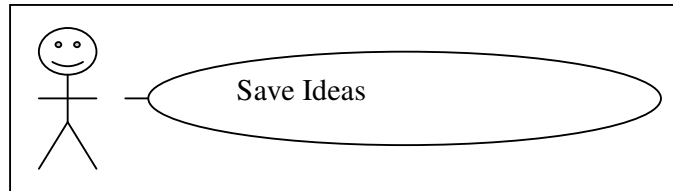


Table 3.5 Save Ideas Use Case description

Use Case Name:	Save Ideas Use Case
Summary:	Advertiser can generate a report of all the saved words, lines and ideas
Dependency:	None
Actor:	Advertiser
Description	<ul style="list-style-type: none">• Advertiser can create a report containing all the saved words, lines and ideas by clicking the negate report button on the main user interface.
Alternatives:	None
Pre-Condition:	All the visualization stages should be finished or escaped before generating a report

3.2.1.6 Generate Report Use Case description

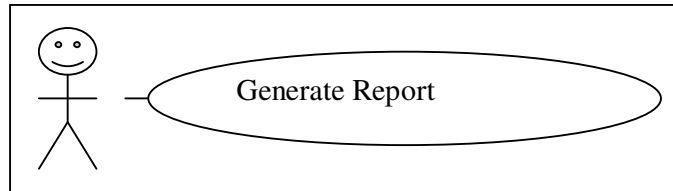


Table 3.6 Generate Report Use Case description

Use Case Name:	Generate report Use Case
Summary:	Advertiser save ideas
Dependency:	None
Actor:	Advertiser
Description	<ul style="list-style-type: none">• User can save the ideas that form in his mind as the result of the stimulations caused by retrieved words or lines• The saving of the ideas can be done during three visualization stages.• First in ShowSelectedWords stage, second in the ShowLines stage and finally the FinalVisualization stage.• There is a textbox at the bottom of each user interface that allows user to enter and save ideas• Ideas will be saved in the report object
Alternatives:	None
Pre-Condition:	Visualization of all selected words or lines or final should be in progress

The aforementioned Use Cases along with their descriptions show the system functional requirements from the user's point of view. There are other non-functional requirements for this system which are listed below:

- **Performance:** It is necessary to select suitable search, extraction and storage algorithms and data structures to provide the user with the best performance and minimum processing time.
- **Availability:** Since the process of idea generation is very delicate and its results are different every time, therefore it is vital to have a system that crashes as minimum as possible because every system crash and loss of idea might be irreplaceable.
- **Usability:** Creative-Pad should cover all of its complicatedness under the hood and avoid engaging user in the selections of menus, pressing of the buttons and entering the commands as much as possible because the ideation process needs the person to be fully immersed in it. A simple and easy to use user interface can ensure a major part of the system's usability.

3.2.2 Class Diagrams

The Class diagram is probably the most widely used diagram of the UML. The Class diagram is at the heart of the object modeling process. It models the definitions of resources essential to the proper operation of the system. This section of chapter 3 includes the class diagrams of the three main packages that form the Creative-Pad. These packages are:

- InterfaceAndSearch
- Parser
- Visualization

3.2.2.1 InterfaceAndSearch package

The first package is the InterfaceAndSearch that comprises of the classes which perform the searching, detagging of the HTML files, generating the main user interface, help file and extraction of the words. Figure 3.3 shows the classes inheritance hierarchy from the Java Standard Library JDK1.6.0.

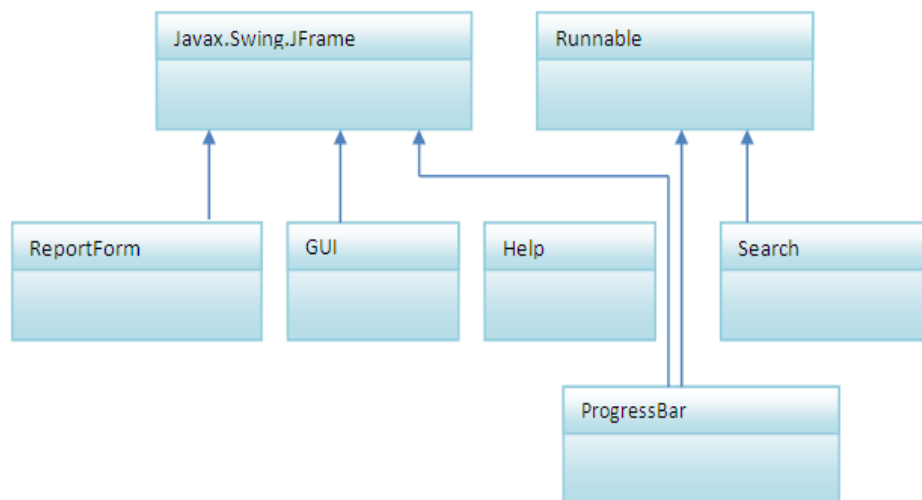


Figure 3.3 InterfaceAndSearch Package inheritance hierarchy

As it can be viewed in Figure 3.3, most of these classes extend the JFrame class which is in the Java's Swing package. Figure 3.4 illustrates the relationships between the classes in this package. Each straight line from one class to the other shows a 'composition' association between the two classes.



Figure 3.4 Classes and their relationships in InterfaceAndSearch package

3.2.2.2 Parser package

This package consists of two classes. The first class is FastTag that contains operations which can determine a word's part of speech and the second class is Tokenizer which has operations able to return words forming a sentence. Figure 3.5 shows these two classes. Class Tokenizer has a 'composition' relationship with the FastTag class.

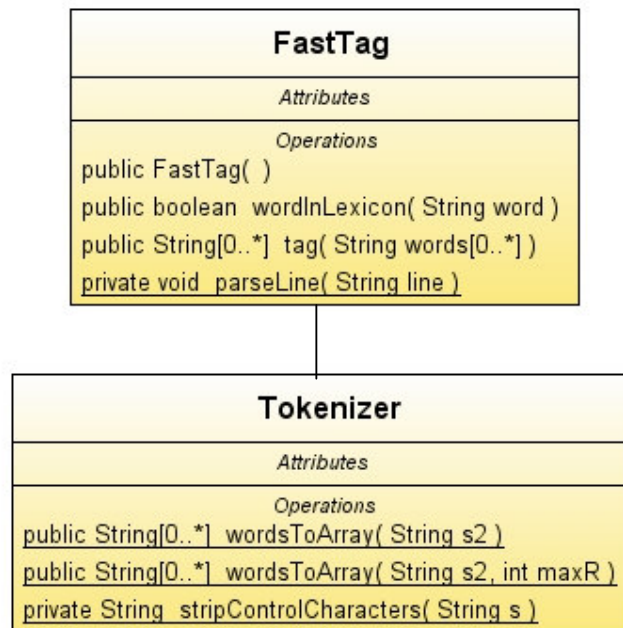


Figure 3.5 Parser package class diagram

3.2.2.3 Visualization package

The Visualization package contains classes that their instances are in charge of creating different stages of the visualization of the extracted and filtered materials. Figure 3.6 shows their inheritance hierarchy from the Java standard library JDK1.6.0

and Figure 3.7 demonstrates the associations between the classes in this package. All the associations are of the type 'composition' and are illustrated as a straight line between classes.

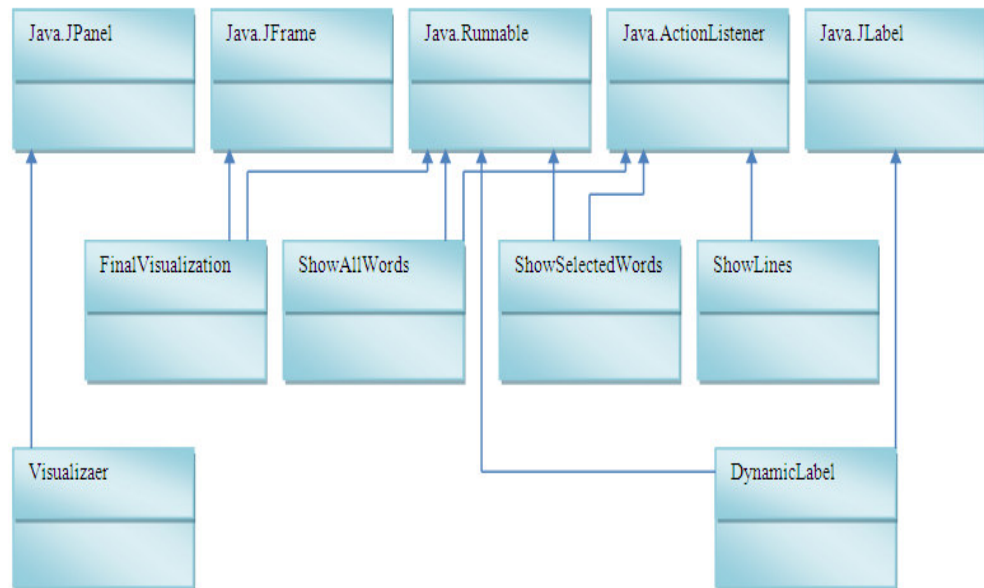


Figure 3.6 Visualization package classes inheritance hierarchy

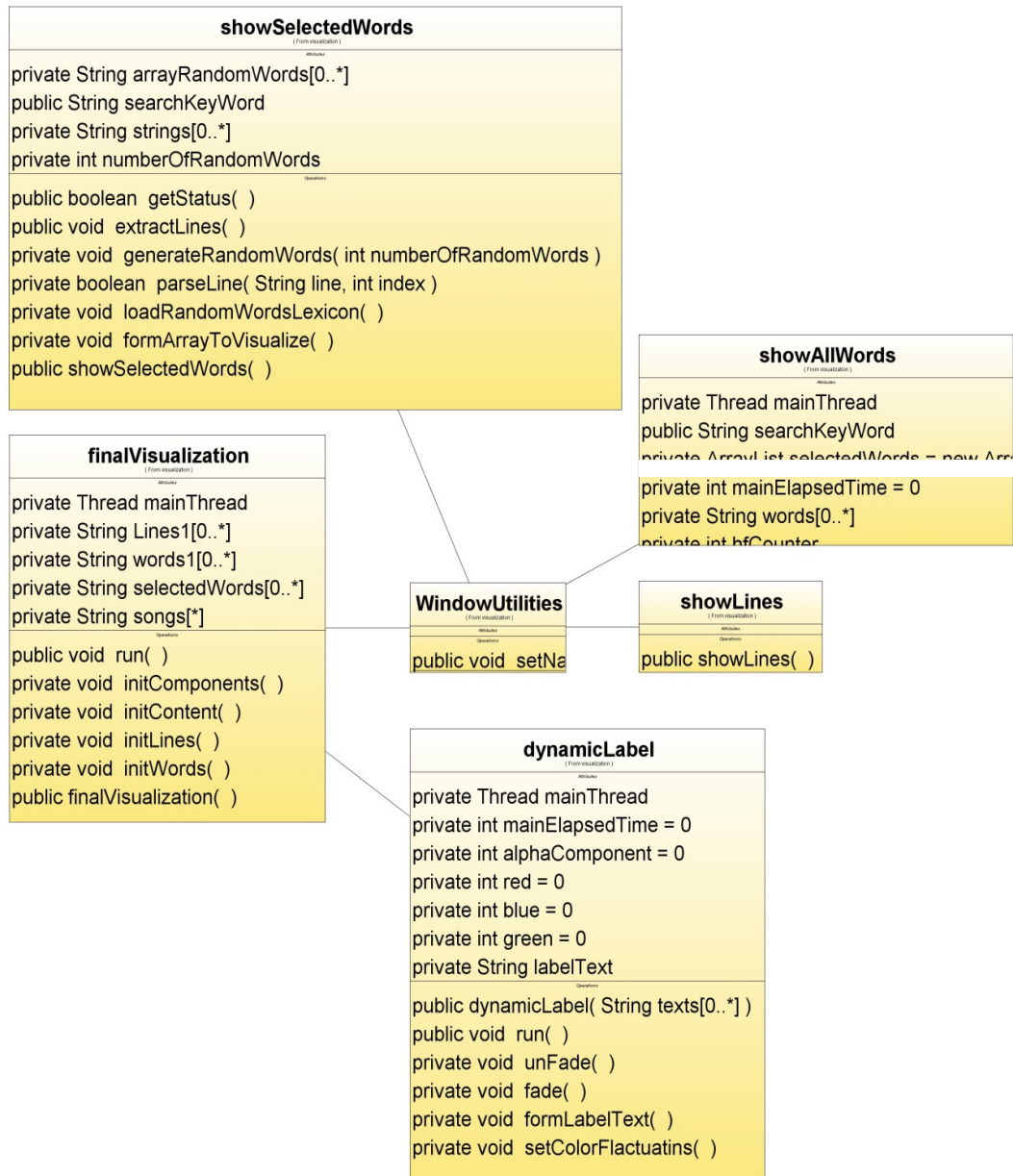


Figure 3.7 Visualization package classes associations

Multimedia presentation (representation of extracted words, initial ideas generated, presentation of sentences and main idea generation) is based on the classes in Figure 3.7.

3.2.3 Sequence Diagrams

This section contains the sequence diagrams of the aforementioned Use Cases. Each sequence diagram shows the objects involved in carrying out each task as well as the messages which are passed between those objects.

3.2.3.1 Search sequence diagram

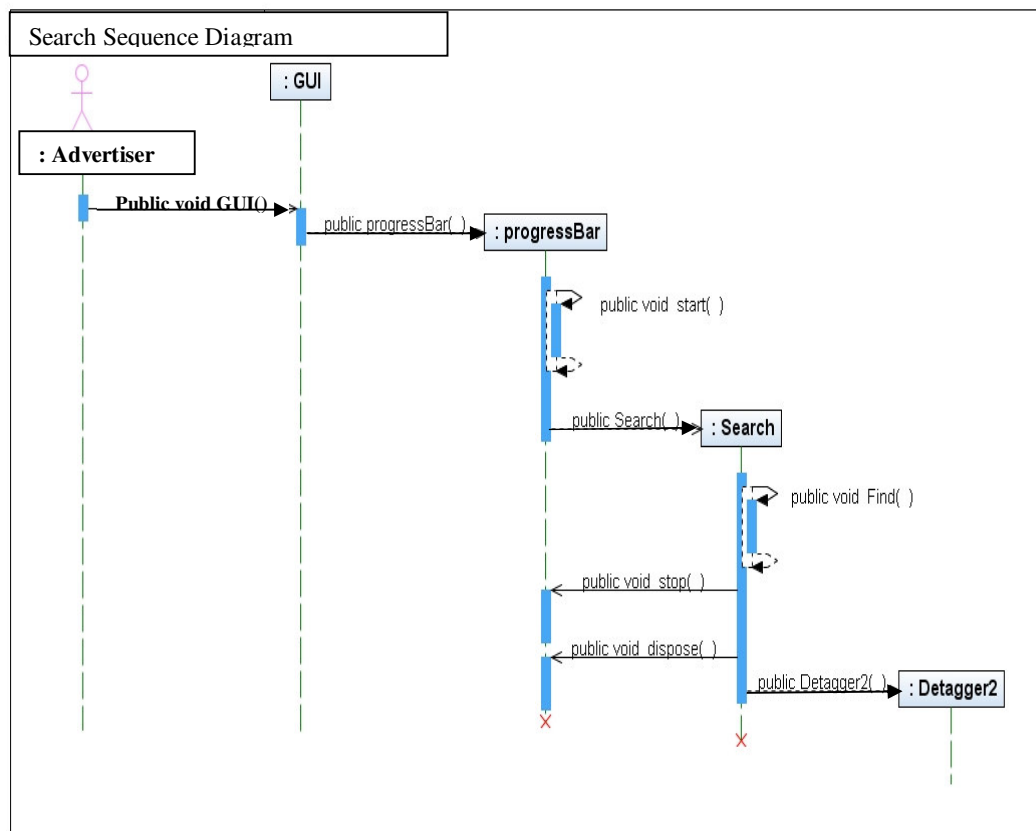


Figure 3.8 Search sequence diagram

3.2.3.2 Stop search sequence diagram

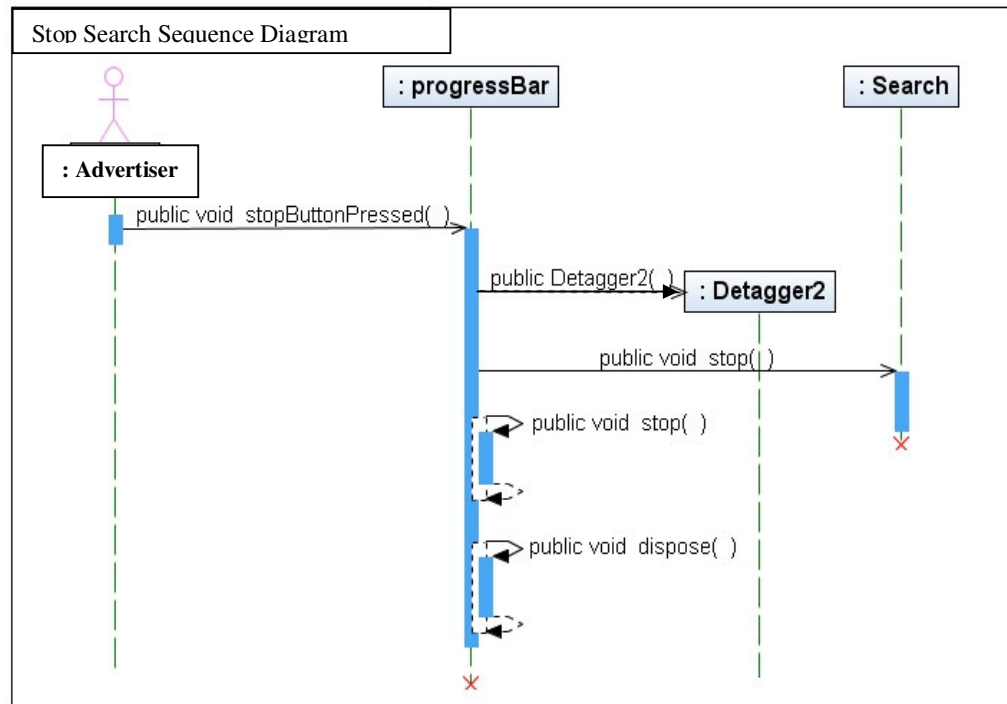


Figure 3.9 Stop search sequence diagram

3.2.3.3 Save words sequence diagrams

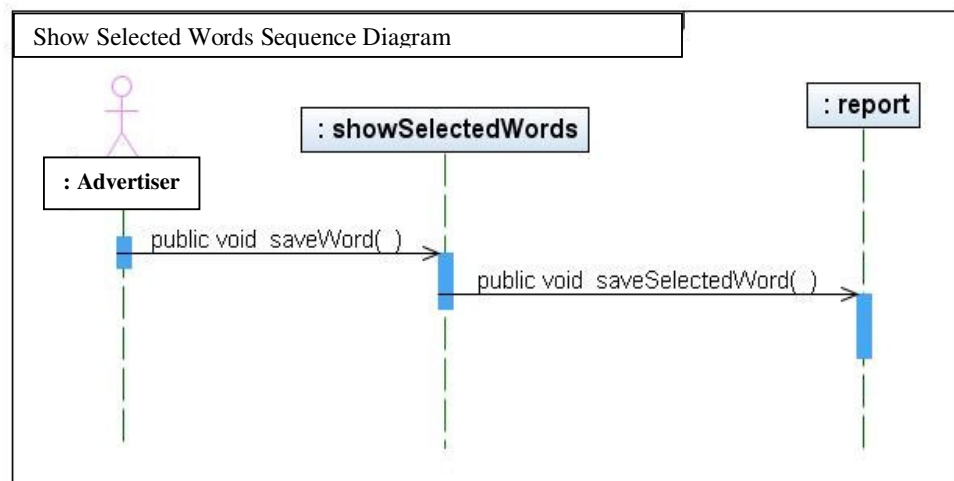
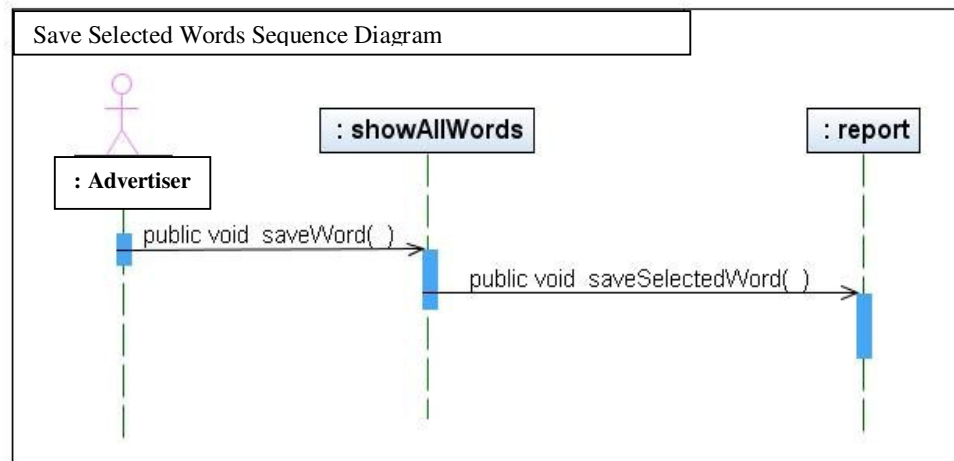


Figure 3.10 Save words sequence diagrams

3.2.3.4 Save lines sequence diagram

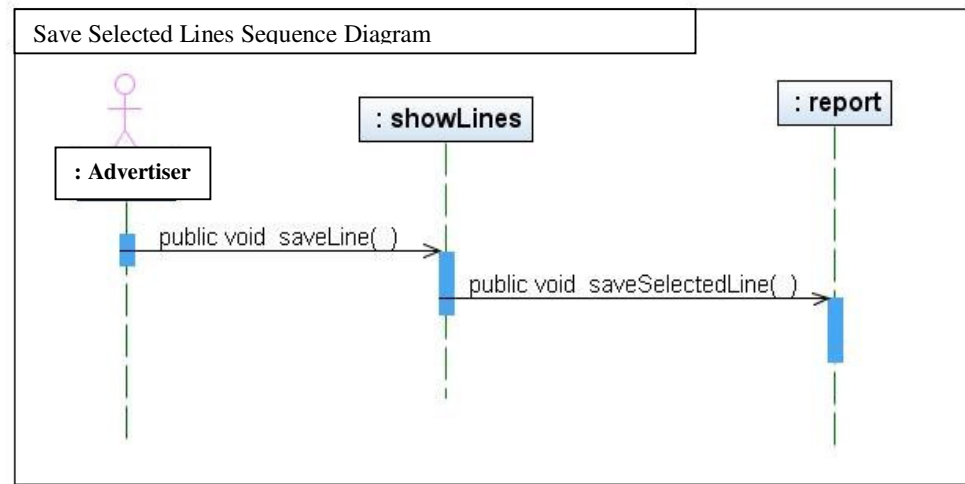


Figure 3.11 Save lines sequence diagram

3.2.3.5 Skip visualization stage sequence diagrams

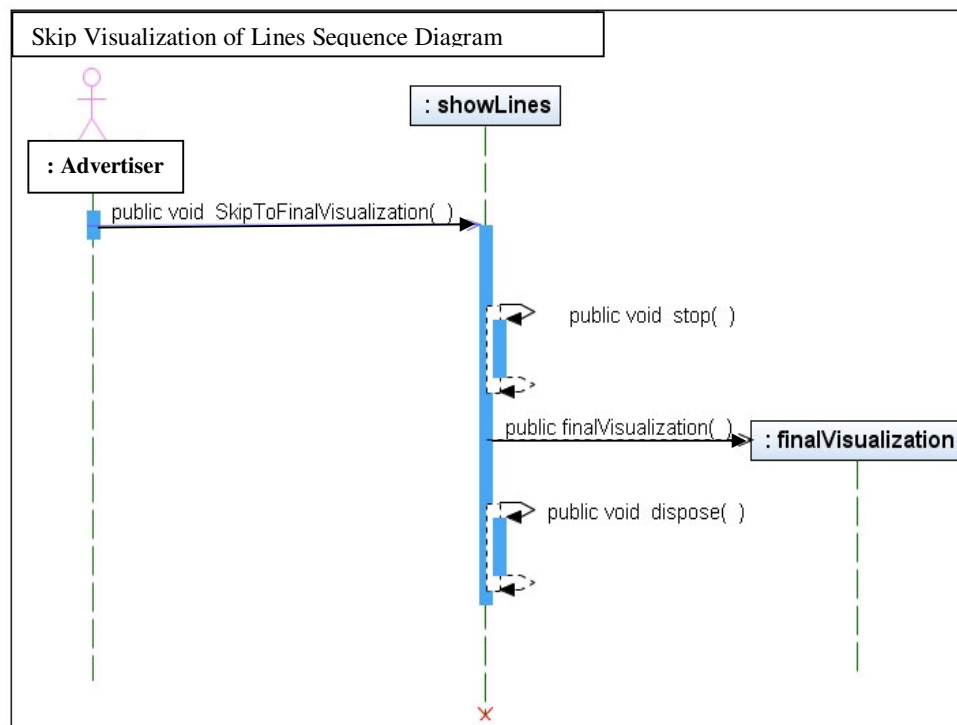
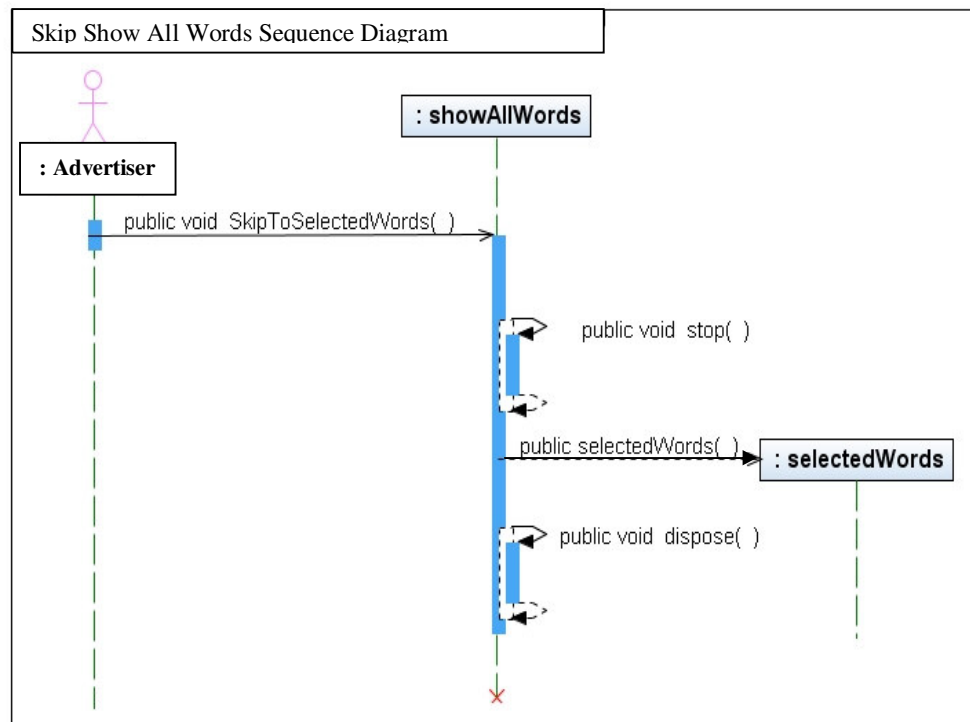


Figure 3.12 Skip a visualization stage sequence diagrams

3.2.3.6 Save ideas sequence diagram

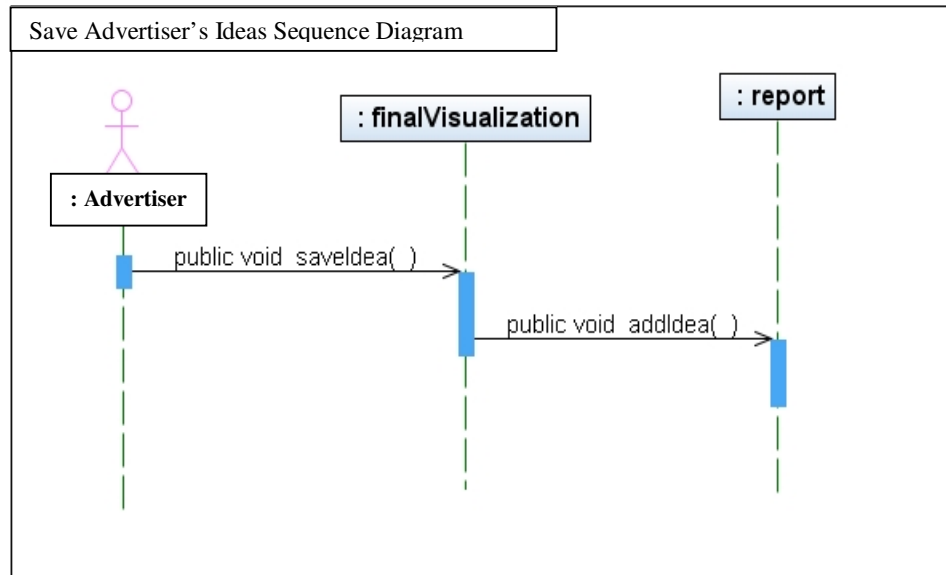


Figure 3.13 Save ideas sequence diagram

3.2.3.7 Generate report sequence diagram

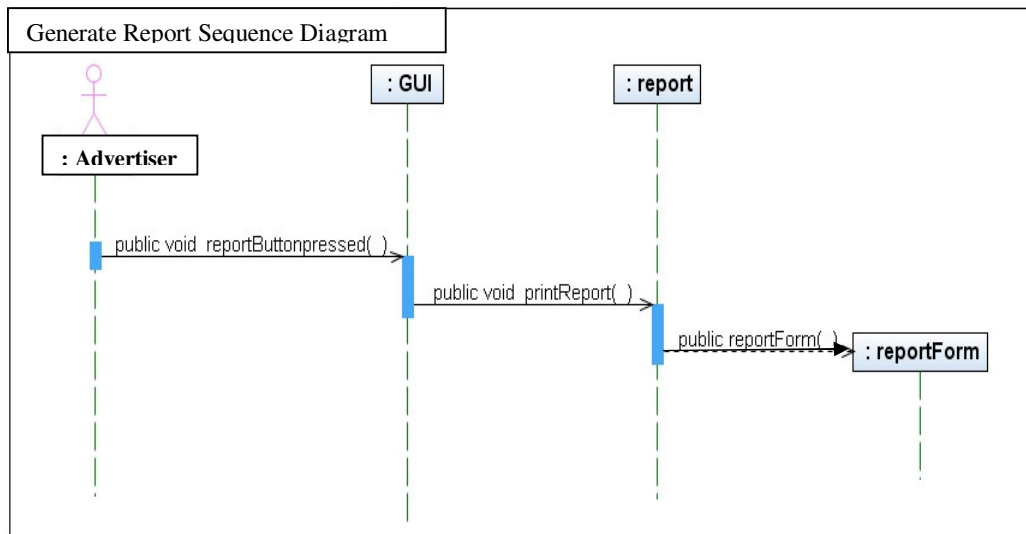


Figure 3.14 Generate report sequence diagram

3.3 Summary

Analysis and design in developing Creative-Pad takes into consideration the principals of the Object-Oriented programming such as inheritance, encapsulation and polymorphism. This chapter includes a comprehensive documentation of the system analysis and design comprising the Use Cases and their descriptions which indicate the functional requirements of the user and UML diagrams such as class diagram and sequence diagrams containing the system design.

This documentation was used as a reference while implementing the Creative-Pad.

Chapter 4

Development of Creative-Pad

Fundamentally, Creative-Pad is a creativity support tool which, given the keywords related to the problem faced by the user, searches the Internet for ideas and returns with related ideas which will hopefully trigger the mind of the user to come up with a solution to his/her problem. For example, consider a creative director wanting to design a new advertisement for a new small car which is about to be launched into the market. According to the manufacturer of the new car, the advertisement should highlight the fact that although the car is small, it still has plenty of space for the whole family.

The principle underlying how Creative-Pad works is as follows. It searches the Internet for *any* information related to, say, “A small car with plenty of space” and the search usually returns lots of information which is somehow related to the ideas “A small car with plenty of space”. Creative-Pad then extracts interesting ideas from the search results and then presents it to the user in a thought provoking manner. Since these ideas are related to the topic “A small car with plenty of space”, it is hoped that they, and the way in which they are presented, will inspire the user to come up with a creative advertisement.

An incremental software development approach was undertaken to implement Creative-Pad. First, a prototype of the system was created and evaluated. Later on, this prototype evolved by adding features into the final version of the program. At the end of each development and before moving to the next development phase, the system was

tested by users. Feedback from the users was taken into consideration and implemented into the system in later versions of the system.

The system is implemented using Java because of many advantages that Java offers as a fully object-oriented programming (OOP) language. One of the most important features of Java that is undertaken while developing Creative-Pad is the availability of multi-threading in Java. This allows application to deliver its multimedia features like playing sound and animation simultaneously. Reuse, which is another pillar of OOP, is also used widely here. For example, the common class for extracting lines from text is re-used.

The final design and implemented version of Creative-Pad consists of two main phases, namely:

1. Ideas extraction from the Internet, and
2. Multi-media presentation of ideas to the user.

Each of the above phases will be described in detail in sections 4.1 and 4.2 respectively.

Figure 4.1 depicts the overall flow of the program.

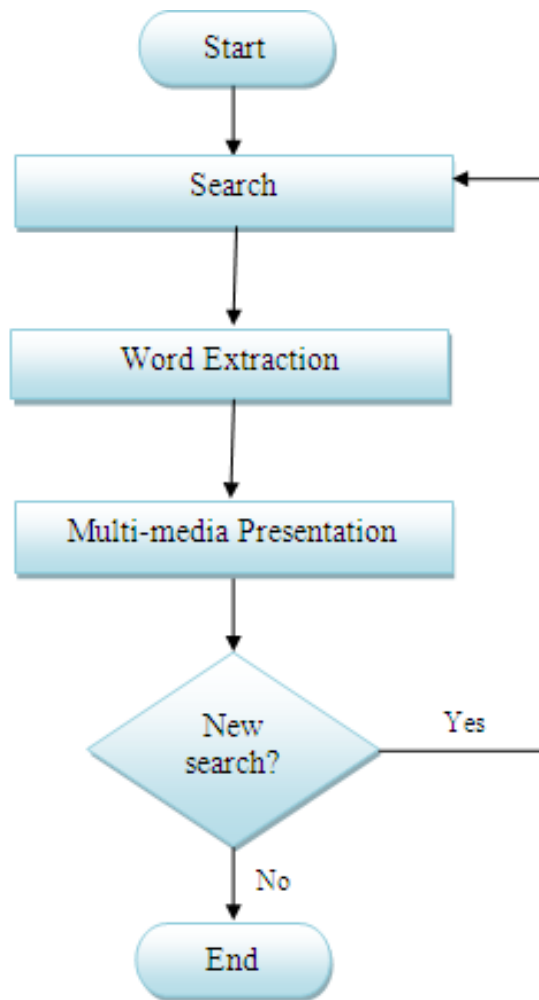


Figure 4.1 Overall flow of the program

4.1. Ideas Extraction Phase

The aim of this phase is to search the Internet for *any* ideas related to the one on hand. The ideas collection phase thus consists of the following steps and each will be described in their respective sub-sections:

4.1.1. Search

4.1.2. Convert HTML to text

4.1.3. Retrieve sentences

4.1.4. Extracting adjectives and verbs from sentences

4.1.1. Search

After a user enters his/her prominent keyword(s) and presses the search button in the main page of application (Figure 4.2), the search phase starts. Figure 4.3 shows a flow diagram of the search process. Creative-Pad will read in the request and send it to a search engine. The user's query is similar to the common practice of doing a search using the search engine itself. If the search term is a single keyword, then that term is entered on its own. If the search term is a combination of words and if the user wants the result to contain either of them, then he/she enters the words separated by a white space. If the search results must contain both keywords, then the user enters a search term separated by a '+' character. Examples of all the three possibilities are shown below:

- 1- Single keyword: chocolate
- 2- Multi keyword, either required: chocolate health
- 3- Multi keywords, both required: chocolate + health

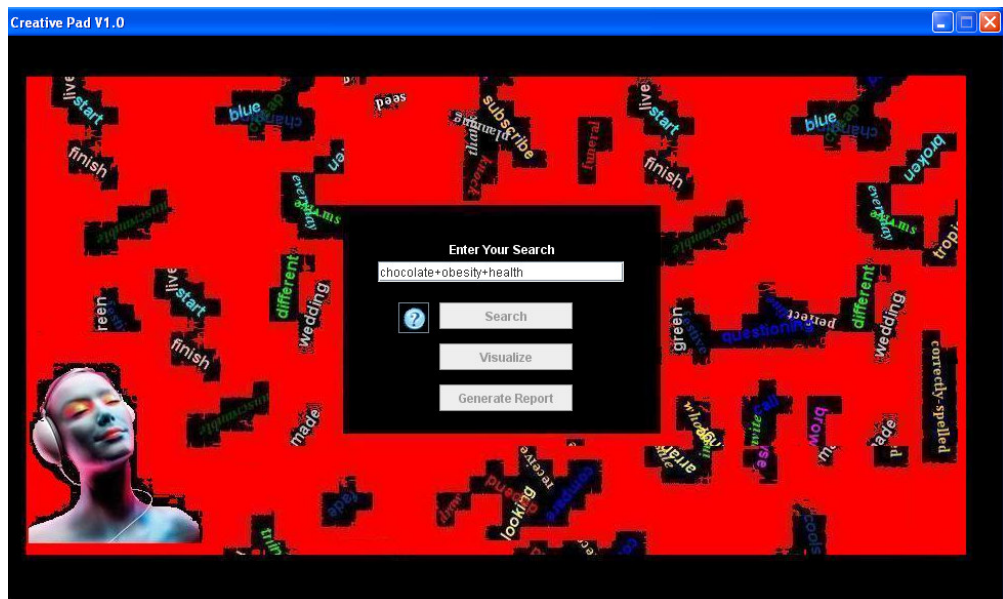


Figure 4.2 Main page of application

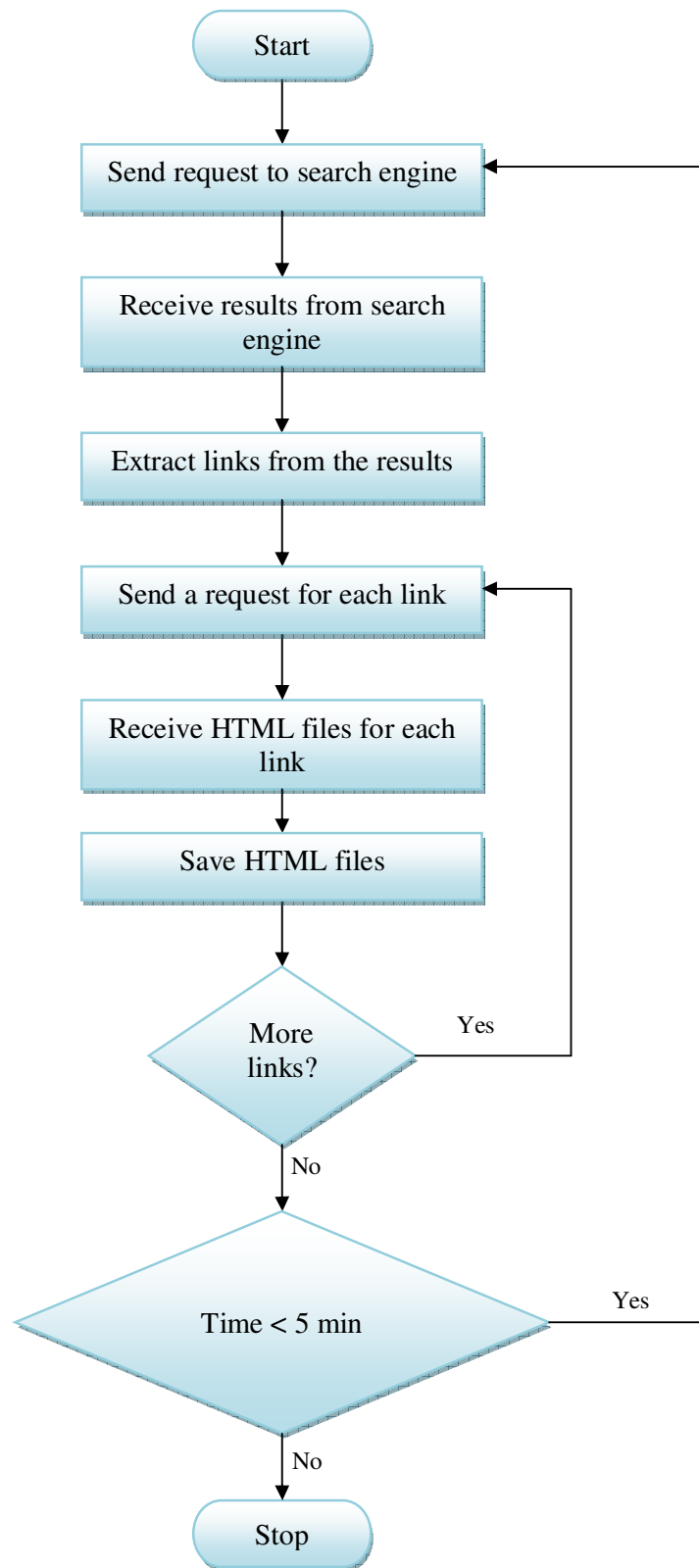


Figure 4.3 A flowchart for the search process

Figure 4.4 shows the code used to do the Search. Note that this code accepts up to three keywords in any single query. This is thought to be sufficient for the current prototype.

The response from the search engine consists of a series of links to the appropriate HTML pages. Creative-Pad then sends a request for each link to retrieve the HTML files. The search process is terminated automatically when elapsed time of search reaches five minutes. It is found that a five minute search is adequate for retrieving sufficient data for brainstorming as discussed in chapter 5. Furthermore, a 'STOP' button is implemented on the main page that allows the end user to terminate the process sooner.

```

private String formQuery(String searchKeyword, int s){
    String sk = searchKeyword.trim();
    String query = null;
    if(sk.contains("+")){
        int index = sk.indexOf("+");
        String firstToken = sk.substring(0, index);
        String secondToken = sk.substring(index+1, sk.length());
        firstToken = firstToken.trim();
        secondToken = secondToken.trim();
        if(firstToken.contains(" ")){
            firstToken = firstToken.replaceAll(" ", "+");
        }
        if(!secondToken.contains("+")){
            query = "http://www.altavista.com/web/results?itag=ody&q="
                +firstToken+"%2B"+secondToken+"&stq=" + (10*s);
        }else{
            secondToken = secondToken.trim();
            int secondIndex = secondToken.indexOf("+");
            String newSecondToken = secondToken.substring(0, secondIndex);
            String thirdToken = secondToken.substring(secondIndex+1, secondToken.length());
            if(thirdToken.contains(" "))thirdToken = thirdToken.replaceAll(" ", "+");
            query = "http://www.altavista.com/web/results?itag=ody&q="
                +firstToken+"%2B"+newSecondToken+"%2B"+thirdToken+"&stq=" + (10*s);
        }
    }else{
        if(sk.contains(" ")){
            sk.replaceAll(" ", "+");
        }
        query = "http://www.altavista.com/web/results?itag=ody&kgs=1&kls=0&q="
            + sk + "&stq=" + (10*s);
    }
    return query;
}

```

Figure 4.4 Code excerpt for Internet search

4.1.2. Convert HTML to text

HTML files are files that contain both text and formatting instructions. The latter is not needed and so the instructions must first be removed. Furthermore, it is not the content of each file per se that is interesting but rather words which are related in some interesting ways to the search terms. Consequently, when the formatting instructions are removed from each HTML files, these files are then combined into one single temporary text file. It is easier to search for related words in a single file rather than in multiple files.

Figure 4.5 shows the steps involved in converting all the HTML files into a single temporary file. Converting HTML files into text files is done by using a Java library program named Htmlparse.jar (*HTML Parser*, 2006).

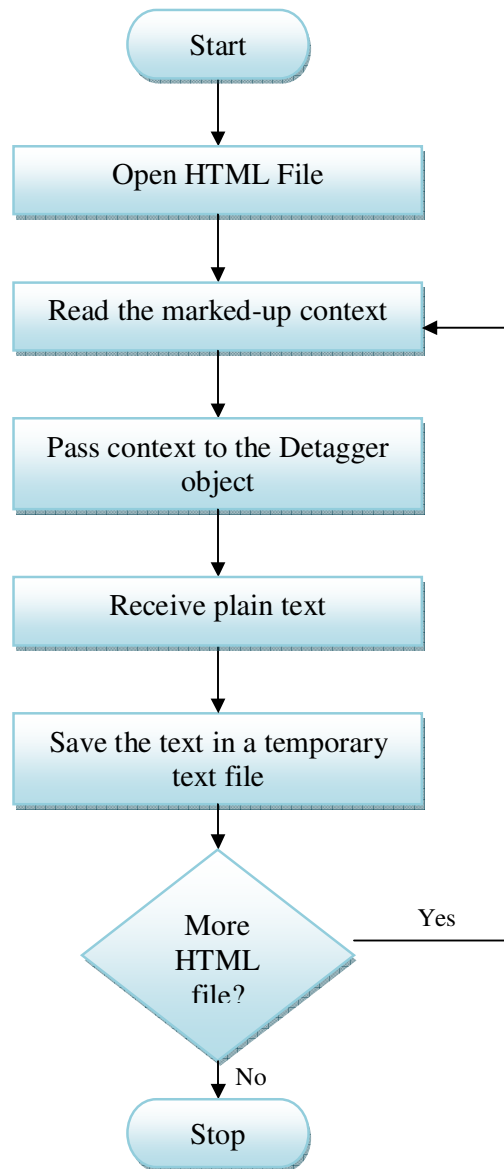


Figure 4.5 Conversion of HTML to text flowchart

4.1.3. Break down the text into sentences

In this step of the process, lines containing the search keyword or key phrase are extracted from the body of the detagged text. At first, all the text is read to the memory of the computer and is passed to an instance of the StringTokenizer class from Java.Util package. This object will break the passed text into lines. The code below (Figure 4.6) is a part of the PhraseExtractor.Java class showing the StringTokenizer in action.

```
while (( paragraph = br.readLine()) != null){
    StringTokenizer st = new StringTokenizer(paragraph, ".!?");
    while(st.hasMoreTokens()){
        String line = "";
        int lineLen = 0;
        line = st.nextToken();
        System.out.println(searchword);
        lineLen = line.length();

        if(line.length()<=150){
            this.totalNumberOfLines++;
            int len = searchPhraseParts.length;
            for(int j=0; j<len;j++){
                String phrasePart = searchPhraseParts[j];
                StringTokenizer st2 = new StringTokenizer(line);
                while(st2.hasMoreTokens()){
                    String lineToken = st2.nextToken();
                    lineToken = trimText(lineToken);
                    if(lineToken.equalsIgnoreCase(phrasePart)){
                        extractedLines.put(lineIndex, line);
                        lineIndex++;
                        findAdjectivesAndverbs(line);
                        break;
                    }
                }
            }
        }
    }
}
```

Figure 4.6 StringTokenizer

In the next step, when a line is extracted and if it contains the keyword or keywords or a combination of keywords, it will then be saved. To illustrate this part of the process with an example, consider the user has conducted a search with keywords as follows:

- Chocolate
- Health
- Obesity

If a line contains any of these words, or any combination of them like 'chocolate + health' or 'chocolate + obesity', it will be saved.

These lines saved are stored in a hash table for further processing when looking for adjectives and verbs as well as the time that final lines are selected to be visualized. The keys in the hash table are line numbers and corresponding to each line number is the line. Figure 4.7 illustrates the sequences taken in this process.

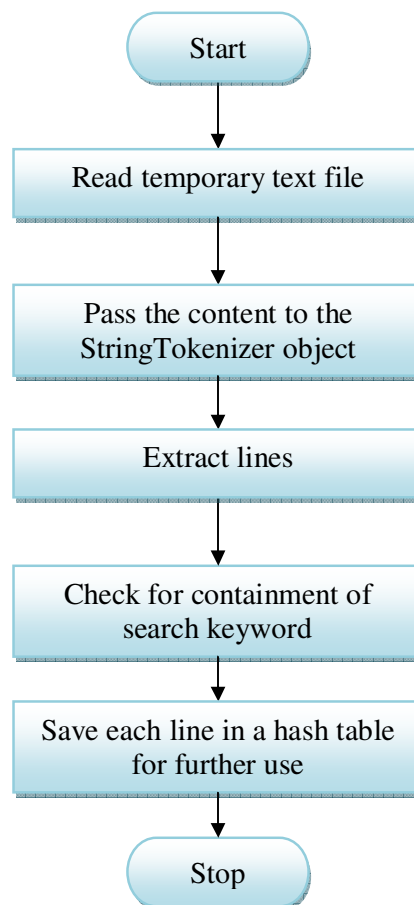


Figure 4.7 Break down text into the sentences

4.1.4. Extracting adjectives and verbs from the sentences

In the final step of this stage, we have lines of text which are deemed related to the search terms. This stage aims to extract words for presentation to the user which might help the user to come up with a creative idea. For the current experiment, Creative-Pad aims to extract adjectives and verbs from these sentences as these two parts-of-speech appear to be “more exciting/useful”. In later versions, one might want to extract other categories.

Thus, the algorithm works as follows.

1. Breaking down a line into its forming words.
2. Check each word against a lexicon to determine its part of speech.
3. IF part of speech == “Adjective” OR part of speech == “Verb” THEN
 save the word.
4. IF more Lines == “True” go to 1 Else go to 5.
5. Eliminate repeated words.
6. Eliminate common words.

FastTag.Java is used to determine each word’s part of speech. The code of this class is published under GPL (General Public License) and the developer is Mark Watson (markw@markwatson.com). Appendix A contains the list of common words currently eliminated by Creative-Pad. Consider the result of an example search. Creative-Pad was given the search term, “chocolate + health”, and returned 730 words after a 5 minute search. After removing common and repeated words, it returns 410 words. It is interesting to note that the total number of the words extracted in a search has a direct relation with the internet connection speed. A faster connection provides the

application with a better chance to retrieve more HTML files from the Internet and consequently having a larger depository of sentences for data extraction.

4.2 Multimedia presentation

Multimedia presentation of the selected content during the previous phases is the most vital phase of the Creative-Pad. During this phase, the user selects words which he/she thought to be of interest and/or stimulating. If the user could pick out such words from those presented to him/her, then this phase would be successful. Consequently, the words selected in the previous phase are presented to the user using a multimedia presentation. It is hoped that such a presentation, invoking visual multimedia elements accompanied by music, would help to promote creative thinking and idea generation. Audio and visual elements can immerse the user deeply into the program and by isolating him/her from the surroundings protect him/her from all the distractions and keep him in a world full of hints and clues related to the domain that the generated idea belongs to. This step of the application process is broken down into the following sub-phases and described in the respective sections:

4.2.1. Presentation of extracted words

4.2.2. Initial ideas generated

4.2.3. Presentation of sentences

4.2.4. Main idea generation

4.2.1 Presentation of extracted words

The selected words are presented in a multimedia format which includes animation, music and other visually appealing factors like different text colors and fonts

to stimulate and provoke the user's mind. There is also a collection of instrumental music in the system which is selected randomly every time the user runs the application.

Pre-presentation processes in this phase are as follows.

1. Forming array of the length 150 words to hold the words.
2. Choose a presentation pattern.

Experiments with Creative-Pad revealed that up to 150 words can be illustrated on the screen before it gets too congested and distracting for the user. To prevent this problem, words are divided into string arrays of 150 words and these arrays are presented sequentially one after the other. Before the visualization of a new array, the screen is refreshed and cleaned from the previous words. For example, if the total number of the words to be displayed is 443, the system will distribute them into two arrays of size 150 and one array of size 143. Figure 4.8 illustrates the visualization of an array of words.

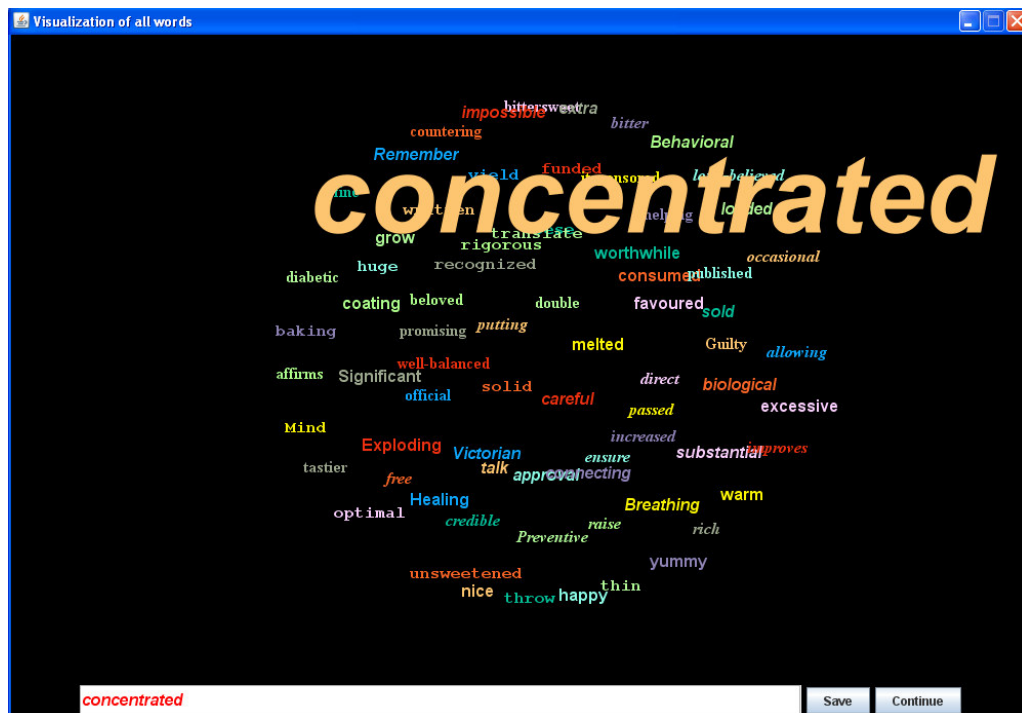


Figure 4.8 Presentation of extracted words

Based on the number of words to present, Creative-Pad chooses 2 different patterns for presentation follows.

- Star
- Circle

If the number of words is equal or less than 35 words, the system opts for the star pattern and if the number of words is greater than 35, the system selects the circle pattern. Figures 4.9 and 4.10 show these two different presentation patterns.

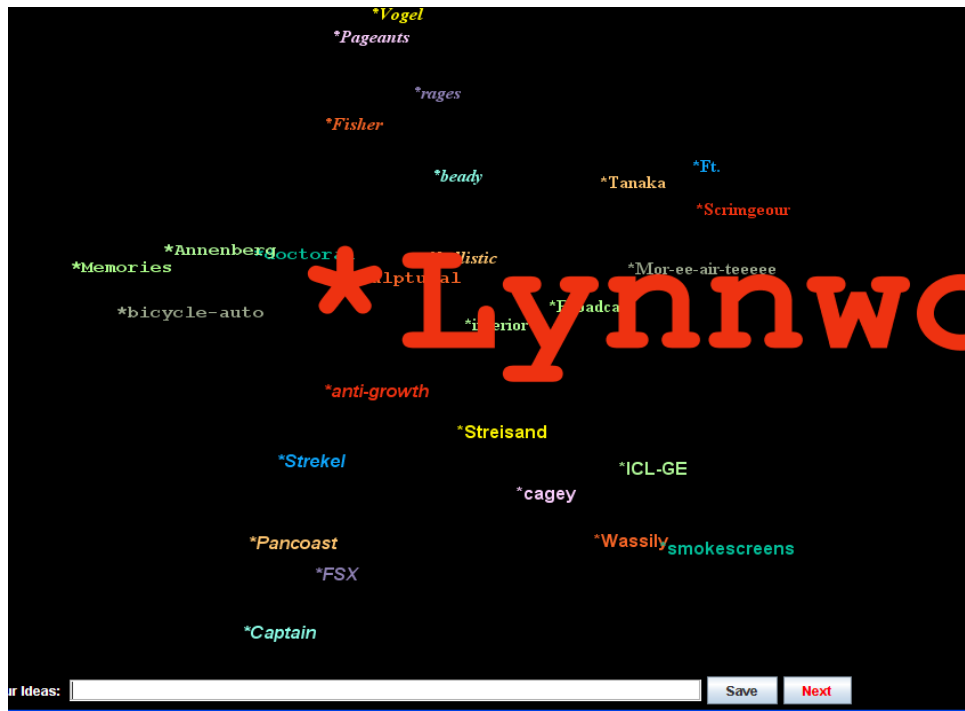


Figure 4.9 Star pattern

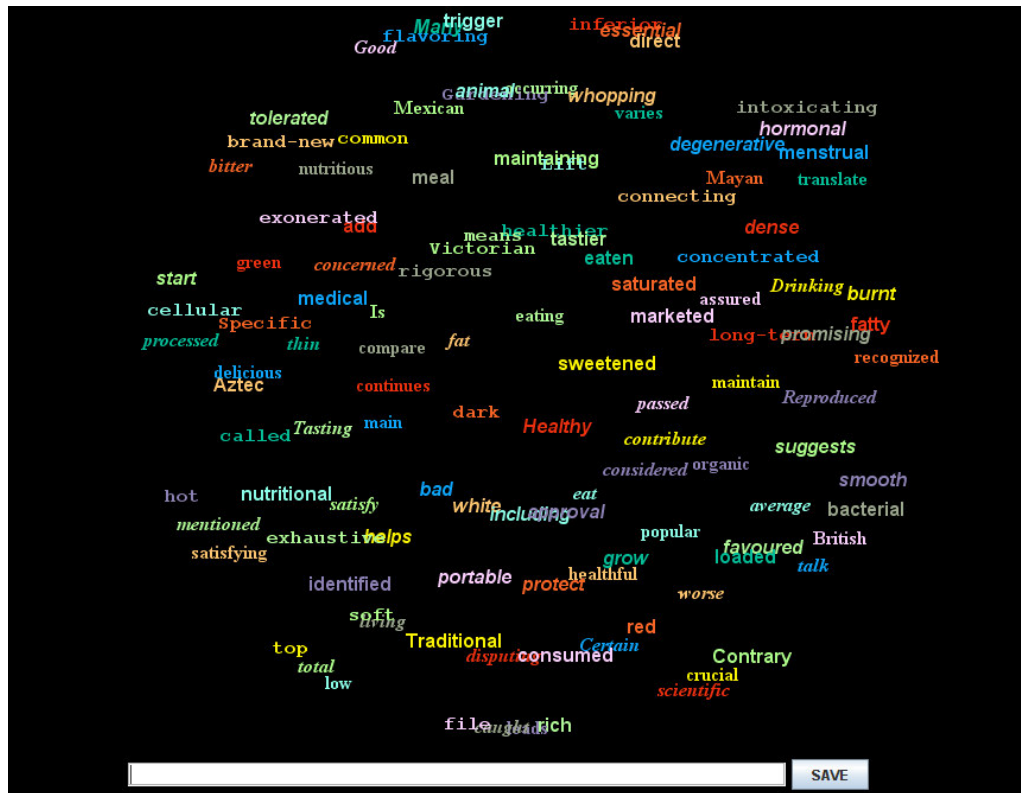


Figure 4.10 Circle pattern

As it can be seen in Figure 4.8, the user interface of this phase has a text box that shows a word simultaneously with its appearance in an animated form on the screen. As the word shrinks down, the user can save the word by clicking on either the save button on the interface or the enter button on the keypad. Moreover, after all the words are visualized and before moving to visualization of a new set of words, Creative-Pad will halt for a few seconds to provide the user with time to save any other words that they might find appealing.

4.2.2. Initial ideas generated

After the first stage, it is expected that the user has selected some words which are interesting or inspiring. In this stage, these selected words are displayed briefly to

Another important task of the Creative-Pad in this phase is generating random words. The number of random words created depends on the number of the selected words by the user. Based on the number of selected words, 10, 20 or 30 random words are added to the words selected by the user. If the user does not select any words in the previous stage, 30 random words are generated automatically. Random words are selected from a lexicon of word which the system uses every time. Unlike the words filtered by Creative-Pad, these random words can have any part of speech like noun or adverb.

4.2.3. Presentation of sentences

After the user has formulated some new ideas based upon the words displayed, Creative-Pad starts to extract and present sentences which contain words that the user has selected. It is argued that if the user has selected certain words from those displayed, he/she would have some interests in those words. This stage then attempts to display the sentences themselves as an extra stimulus for creative thinking. However, if the user fails to save any word, then Creative-Pad will automatically show 50% of all the sentences extracted from the text. Again, the presentation of sentences is accompanied with different multimedia elements such as animation and music similar to the presentation of the words. There is also a text box at the bottom of the page that allows the user to save any sentences which appeal to him/her by entering the line number in the box and press the save button (Figure 4.12).

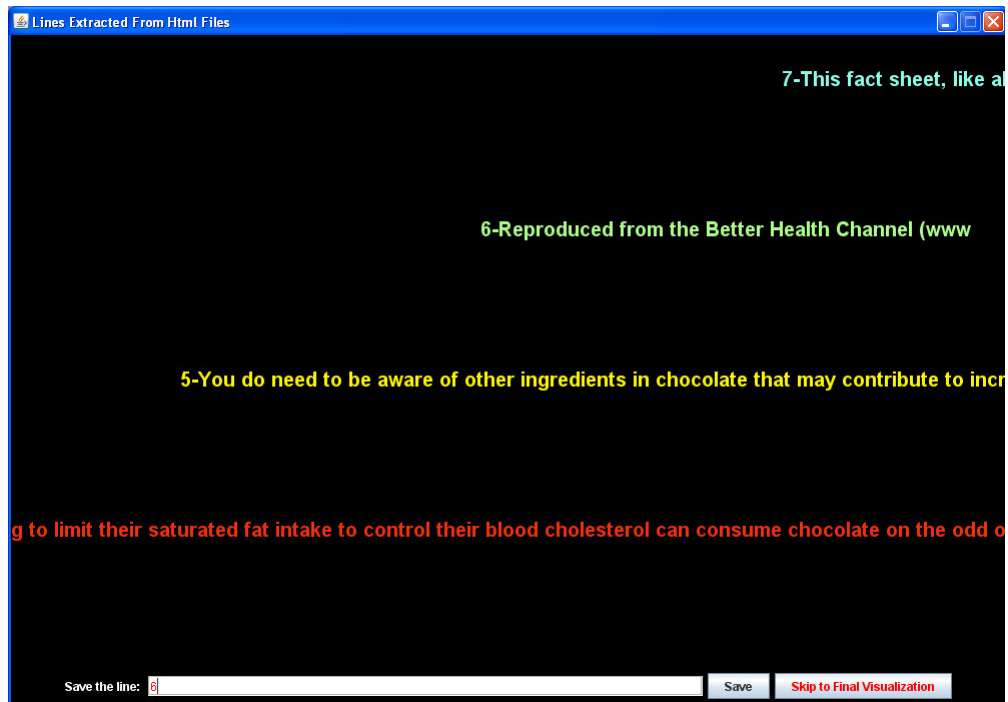


Figure 4.12 Presentation of sentences

4.2.4. Main idea generation

The last sub-phase in the multimedia presentation phase is the main idea generation phase. In this stage, all the words and sentences selected by the user during previous stages of visualization are shown on the screen. Sentences and words appear on the screen and stay for 10 seconds and then are smoothly faded away to be replaced by some new sentences or words. This fine transition of words and sentences accompanied with music helps user to be creative and come up with ideas which can be saved by entering them in a text box at the bottom of the page. Figure 4.13 shows a system screen shot of this phase.

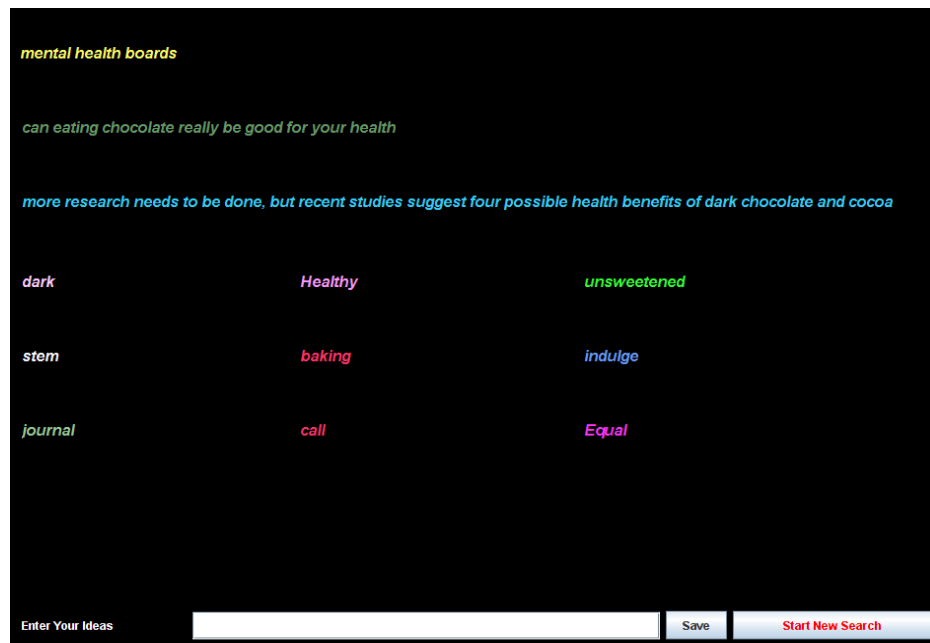


Figure 4.13 Main idea generation phase

4.3. Report

Creative-Pad has a report generation module. It generates a report containing the following for every search and visualization performed.

- All the words extracted and filtered by Creative-Pad
- All the words selected by user
- All the random words
- All the lines selected by user
- Ideas that user generated and saved

This module allows the user to save this report as a text file or print it out.

Figure 4.14 shows a sample report generated by the system.

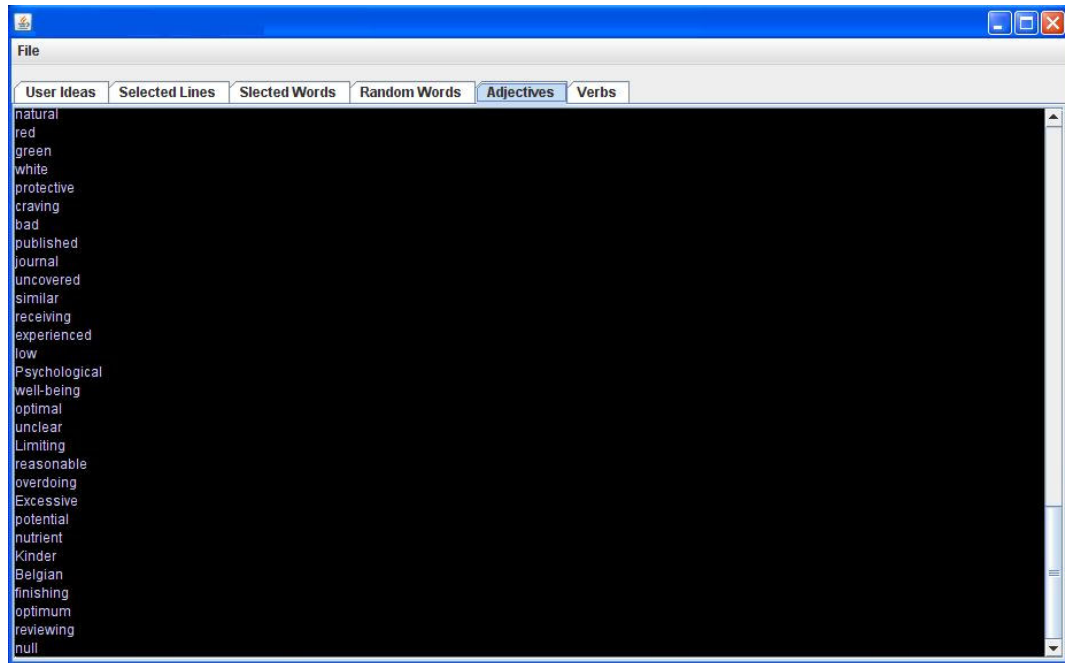


Figure 4.14 Report interface

Chapter 5

Performance and Results

The success of the system implementation can be viewed in different ways and depends on the research objectives. A number of questions can be asked. Will Creative-Pad be able to help one to come up with a creative idea? Could a creative director use it to come up with a good new advertisement? Such questions could not be precisely answered without a proper field trial using numerous users and thus answering these questions is beyond the scope of this project. The success of the implementation should be measured in terms of whether the prototype developed has attracted the attention of creative directors and whether the current prototype could help one to evaluate the soundness of the idea underlying the development of Creative-Pad. The answer to both questions is yes. The prototype is currently being used at the Auckland University of Technology in New Zealand.

This chapter will discuss the lessons learned in developing Creative-Pad as a new creative-support tool. There are two important novelties in the development of Creative-Pad as a creative-support tool. The first is its access to the Internet for related ideas and second is its environment for creative thinking. Each of these novelties will be discussed in sections 5.1 and 5.2 respectively. Note that developing and testing Creative-Pad is done in the Neural Network Laboratory housed in the second floor of the Main Building, Faculty of Computer Science and Information Technology, University of Malaya. The following information details the specifications of the hardware used as well as the Internet connection and time of testing.

System specifications: Intel core DUO, 2.20 GHZ, 2 GB of RAM

Internet connection: ADSL

Time: Mostly testing hours was during working hours to simulate typical situation in an advertising office.

5.1 Searching

Compared to other systems evaluated in chapter 2, Creative-Pad is the only one which searches the Internet for related ideas. The use of the Internet as a source of information opens the door not only to a vast amount of information but also to the contemporary and the most up-to-date ideas. The latter is most important and especially for an application such as the design of a new creative advertisement. It also avoids the disadvantage in other systems in their use of any repository of information; it does not require complex and expensive updating.

This section discusses the various factors that affect the performance of the search process as is currently implemented in Creative-Pad. The lessons learned here will provide a basis for future work.

5.1.1 Duration of search

This feature is very hard to measure because it depends on a combination of factors such as Internet connection speed, search engine used and the search keywords entered. For instance, if the user searches for “chocolate” which has a wide range of related material in the Internet, the probability of finding related information in a shorter span of time is higher than finding information for “car + coffee + obesity”.

In the earlier versions of Creative-Pad, the duration of search was limited to 2 minutes. After testing the system for different keywords, the duration of search was increased to 5 minutes. The selection of 5 minutes was made based on a series of trials using Creative-Pad. It turned out that a search of less than 5 minutes usually resulted in insufficient number of HTML files being retrieved which in turn lowered the quality and quantity of words found. A search of more than 5 minutes, however, often produced too many HTML files. While having more files has the advantage of having more words, it does not necessary improve the quality of words found. Furthermore, it increases the processing time and the wait often annoys the user. On average, a 5-minute search produces about 45 HTML files.

Finally, it is worth mentioning again that these results are subject to change. A very fast Internet access speed may produce sufficient number of HTML files in 2 minutes than an average access speed retrieved in 5 minutes. Consequently, Creative-Pad displays to the user how many files have been retrieved and gives the user the option of stopping the search when he/she thinks the search result is enough.

5.1.2 Search results

Every new version of Creative-Pad was tested using six sets of search keywords test cases. These test cases are listed below.

1. Chocolate + health + obesity
2. CPU + fast
3. Flat screen + TV
4. Sleek + mobile
5. Green tea + health

6. Spacious + car

Tables 5.1, 5.2 and 5.3 tabulate the number of HTML files, lines retrieved, total words, unique words, adjectives and adverbs found for each set of test cases above. Table 5.1 contains statistics of an older version of the system without the omission of the common words. Table 5.2 contains results of version of the system which includes the omission on common words. The duration of search for both sets of results was 2 minutes. Table 5.3 tabulates the results obtained under similar circumstances as in Table 5.2 with exception that the duration of search was 5 minutes. The six test cases are shown in detail in Appendix B.

Table 5.1 Without omission of common words. Search time is 2 minutes.

Number Case	HTML files	Lines	Total words	Unique words	Adj.	Verb
1	27	3117	25529	404	334	70
2	22	1939	12816	128	104	24
3	22	1851	8946	94	75	19
4	34	3297	18945	141	115	26
5	28	2362	15130	322	275	47
6	26	2578	17251	349	291	49

Table 5.2 With omission of common words. Search time is 2 minutes.

Number Case	HTML files	Lines	Total words	Common words	Unique words	Adj.	Verb
1	18	4095	1407	112	171	150	21
2	12	631	962	88	84	71	13
3	13	956	939	48	183	167	16
4	13	1039	592	48	130	112	18
5	14	1212	6720	441	1008	881	127
6	10	352	408	31	74	60	14

Table 5.3 With omission of common words. Search time is 5 minutes.

Number Case	HTML files	Lines	Total words	Common words	Unique words	Adj.	Verb
1	49	7171	7531	464	434	360	78
2	43	4121	5712	468	283	232	51
3	38	4061	3230	147	107	85	22
4	51	3341	3584	204	224	183	31
5	55	4140	21635	1586	3403	2900	503
6	33	1821	2131	132	154	124	30

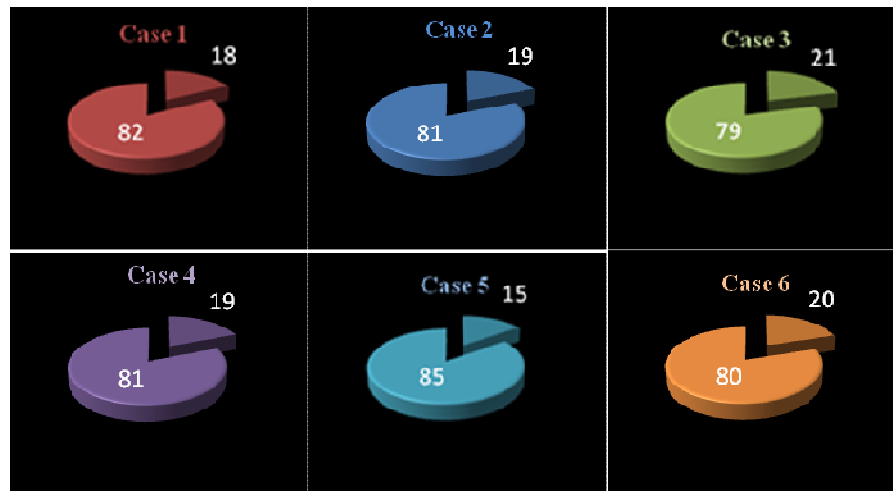


Figure 5.1 Verbs and adjectives percentage

Figure 5.1 shows that, in all the six cases, the number of verbs found is about $\frac{1}{4}$ the number of adjectives. The following shows the percentages of the extracted adjectives.

Case 1: 82.67%

Case 2: 81.25%

Case 3: 79.78%

Case 4: 81.56%

Case 5: 85.40%

Case 6: 80%

On average, 82.13% of the words are adjectives.

Table 5.4 shows that on average the system displays 7.20% of the total words. This figure indicates many of the words retrieved from the Internet are not “useable”. This is as expected since the task here is to search for creative ideas and not simply related ideas.

Table 5.4 Percentage of omitted and unique words

Words Cases	% Omitted (Common)words	% Unique words
1	6.16	5.76
2	8.19	4.95
3	4.55	3.31
4	5.69	6.25
5	7.33	15.72
6	6.19	7.22
Average	6.35	7.20

However, how do we measure the usefulness of the words selected? Quality of the search results and relevancy of words are very subjective issues. It is dependent on too many unknown and immeasurable factors such as the knowledge of the user, the level of familiarity of the user with respect to the search terms, IQ level of the user and so on. For example, if the user is not familiar with the subject, every single word would be new and informative and may inspire his/her mind to come up with a creative idea. Yet, for a very common subject like “chocolate”, well-known descriptors such as dark, sweet, white, fine and others could still be inspiring and especially when they are presented to the user as part of a collection of other associative words. Hence it is concluded that one should not decide too soon which words should be kept and which words should be omitted. In this research, we assume that every single word can be stimulating for a user, except for some very common words (see appendix A). Much

more need to be investigated on how words should be selected. Appendix B contains a list of extracted words after the omission of common words. Words are sorted in descending order based on their frequency of repetition. The frequency is the number next to each word in the list.

5.2 An Environment for Creative Thinking and Its Contribution

In implementing Creative-Pad, this research strives to provide an environment for creative thinking. While it was noted that Creative-Pad was created to help the user to brainstorm for ideas, Creative-Pad itself is a silent partner. It supplies ideas for the user and it is up to the user's own creative power to come up with the ideas. Thus, it is important to create a thinking environment for the users. Attempts to do so include:

- Different stimuli to provoke thoughts – Users are given two different stimuli, words and sentences, to provoke thoughts.
- Visualization of words - The results of the Internet search are displayed in a 2D visual presentation with different colors and fonts in an animated form.
- Provisions of background music – Words are presented with some nice music being played at the background.
- Thinking time – Users are given a short time to think creatively after the display of words and again after the display of sentences. It is assumed that the creative process is a sub-conscious process and so the users are almost required to come up with ideas instantaneously. As one uses Creative-Pad, it drives one's thinking power, keeping in the line with the system.

- Reviewing time – Users are given a record of the events and also the option to replay the visualization process. This gives the user time to reflect upon the initial ideas developed.

Creative-Pad has a report generation module. It generates a report containing the following for every search and visualization performed.

- All the words extracted and filtered by Creative-Pad
- All the words selected by user
- All the random words
- All the lines selected by user
- Ideas that user generated and saved

This module allows the user to save this report as a text file or print it out.

Chapter 6

Conclusion and Future Work

6.1 Conclusion

This research has successfully implemented a new creativity support tool, Creative-Pad, and reviewed related work on creativity and creativity support tools. Creative-Pad is now currently in use and the implementation results are mind stimulating. The key features of Creative-Pad are summarized as follows.

- Using the Internet as a source of information;
- Extracting adjectives, verbs, and sentences that are thought to be stimulating;
and
- Providing a simple and yet stimulating environment to promote creative thinking.

In spite of all the aforementioned strengths, Creative-Pad has some limitations and these will be discussed in the next section as ideas for future work.

6.2 Future work

There are two important aspects that are believed, if improved, will provide significant enhancement of the current prototype for research progress.

1. Searching problem – The search process can be improved in many ways. For example, depending on the search term, certain links might not be too useful (such as links leading to social networking sites or business sites). Hence, some

criteria should be developed to decide which links to use. Criteria should also be developed to evaluate somehow as to how stimulating are the words and sentences selected. Note that it is not the individual words alone that is important but also the class of words selected. There is not much gain to present similar words to the user as they presumably will lead to a single idea, if any. Perhaps, we need an analysis of the semantics of words and the context in which the words appear. Note that even the HTML files themselves should be ranked in some ways and a combination of search engines should be used.

2. Presentation problem – The user interface needs improvement to be more immersive. Using more intelligently designed graphical shapes and demonstrations of selected words in a more mesmerizing atmosphere accompanied with music might produce a better system. At the moment, words are presented with no ordering criteria. Should we present more frequently occurring words first or the rare words first? Should we present words around a theme or at random? Should we provide more interactions between the words presented and the user? For example, should the user be allowed to click on interesting words which will lead to words related to those words?

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Appendix A

List of common words

0	52	96	are
1	53	97	area
10	54	98	areas
11	55	99	aren't
12	56	a	around
13	57	a's	as
14	58	able	aside
15	59	about	ask
16	6	above	asked
17	60	according	asking
18	61	accordingly	asks
19	62	across	associated
2	63	actually	at
20	64	adj	available
21	65	after	away
22	66	afterwards	awfully
23	67	again	b
24	68	against	back
25	69	ain't	backed
26	7	all	backing
27	70	allow	backs
28	71	allows	barely
29	72	almost	be
3	73	alone	became
30	74	along	because
31	75	alpha	become
32	76	already	becomes
33	77	also	becoming
34	78	although	been
35	79	always	before
36	8	am	beforehand
37	80	among	began
38	81	amongst	begin
39	82	an	beginning
4	83	and	behind
40	84	another	being
41	85	any	beings
42	86	anybody	believe
43	87	anyhow	below
44	88	anyone	beside
45	89	anything	besides
46	9	anyway	best
47	90	anyways	beta
48	91	anywhere	better
49	92	apart	between
5	93	appear	beyond
50	94	appreciate	big
51	95	appropriate	billion

both	differently	faces	greetings
brief	do	fact	group
but	doer	facts	grouped
by	does	fairly	grouping
c	doesn't	far	groups
c'mon	doest	felt	h
c's	doeth	few	had
came	doing	fewer	hadn't
can	don't	fifteen	happens
can't	done	fifth	hardly
cannot	dost	fifty	has
cant	doth	find	hasn't
caption	down	finds	hast
case	downed	first	hath
cases	downing	five	have
cause	downs	followed	haven't
causes	downwards	following	having
certain	during	follows	he
certainly	e	for	he'd
changes	each	former	he'll
chi	early	formerly	he's
circa	edu	forth	hello
clear	eg	forty	help
clearly	eight	found	hence
cm	eighteen	four	henceforth
co	eighty	fourteen	her
co.	either	from	here
com	eleven	ft	here's
come	else	further	hereafter
comes	elsewhere	furthered	hereby
con	end	furthering	herein
concerning	ended	furthermore	hereupon
consequently	ending	further	hers
consider	ends	g	herself
considering	enough	gamma	hi
contain	entirely	gave	high
containing	epsilon	general	higher
contains	especially	generally	highest
corp	et	get	him
corresponding	eta	gets	himself
could	etc	getting	his
couldn't	even	give	hither
course	evenly	given	hopefully
currently	ever	gives	how
d	every	go	howbeit
db	everybody	goes	however
definitely	everyone	going	hundred
delta	everything	gone	hz
described	everywhere	good	i
despite	ex	goods	i'd
did	exactly	got	i'll
didn't	example	gotten	i'm
didst	except	great	i've
differ	f	greater	ie
different	face	greatest	if

ignored	latterly	much	omega
ii	lb	must	omicron
iii	lbs	my	on
immediate	least	myself	once
important	less	mz	one
in	lest	n	one's
inasmuch	let	name	ones
inc	let's	namely	only
inc.	lets	nay	online
indeed	like	nd	onto
indicate	liked	near	open
indicated	likely	nearly	opened
indicates	little	necessary	opens
inner	ln	need	or
inside	lo	needed	order
insofar	long	needing	ordered
instead	longer	needs	ordering
interest	longest	neither	orders
interested	look	never	other
interesting	looking	nevertheless	others
interests	looks	new	otherwise
into	ltd	newer	ought
inward	m	newest	our
iota	made	next	ours
is	mainly	nine	ourselves
isn't	make	nineteen	out
it	makes	ninety	outside
it'd	making	nm	over
it'll	man	no	overall
it's	many	nobody	own
its	may	non	oz
itself	maybe	none	p
iv	me	nonetheless	part
ix	mean	noone	parted
j	meantime	nor	particular
just	meanwhile	normally	particularly
k	member	not	parting
kappa	members	nothing	parts
keep	men	novel	per
keeps	merely	now	perhaps
kept	mi	nowhere	phi
kg	might	nu	pi
km	million	number	place
know	mine	numbers	placed
known	miss	o	places
knows	ml	obviously	please
l	mm	of	plus
lamda	more	off	point
large	moreover	often	pointed
largely	most	oh	pointing
last	mostly	ok	points
lately	mr	okay	possible
later	mrs	old	pre
latest	ms	older	present
latter	mu	oldest	presented

presenting	sent	take	thorough
presents	serious	taken	thoroughly
presumably	seriously	taking	those
pro	seven	tau	thou
probably	seventeen	tell	though
problem	seventy	ten	thought
problems	several	tends	thoughts
provides	shall	th	thousand
psi	shalt	than	three
put	she	thank	through
puts	she'd	thanks	throughout
q	she'll	thanx	thru
que	she's	that	thus
quite	should	that'll	thy
qv	shouldn't	that's	thysself
r	show	that've	to
rather	showed	thats	today
rd	showing	the	together
re	shows	thee	too
really	sides	their	took
reasonably	sigma	theirs	toward
recent	simply	them	towards
recently	since	themselves	tried
regarding	six	then	tries
regardless	sixteen	thence	trillion
regards	sixty	there	truly
relatively	small	there'd	try
respectively	smaller	there'll	trying
rho	smallest	there're	turn
right	so	there's	turned
room	some	there've	turning
rooms	somebody	thereafter	turns
roughly	somehow	thereby	twelve
s	someone	therefore	twenty
said	something	therein	twice
same	sometime	thereof	two
saw	sometimes	thereon	u
say	somewhat	theres	un
saying	somewhere	thereupon	under
says	soon	these	unfortunately
sec	sorry	theta	unless
second	specified	they	unlikely
secondly	specify	they'd	unlikely
seconds	specifying	they'll	until
secs	state	they're	unto
see	states	they've	up
seeing	still	thine	upon
seem	stop	thing	upsilon
seemed	sub	things	us
seeming	subscribe	think	use
seems	such	thinks	used
seen	sup	third	useful
self	sure	thirteen	uses
selves	t	thirty	using
sensible	t's	this	usually

uucp	what's	whom	xxii
v	what've	whomever	xxiii
value	whatever	whomsoever	xxiv
various	whatsoever	whose	xxix
very	when	whoso	xxv
vi	whence	whosoever	xxvi
via	whenever	why	xxvii
vii	whensoever	will	xxviii
viii	where	willing	y
viz	where's	wish	yd
vs	whereafter	with	ye
w	whereas	within	yea
want	whereby	without	year
wanted	wherefore	won't	years
wanting	wherein	wonder	yes
wants	whereinto	work	yet
was	whereof	worked	you
wasn't	whereon	working	you'd
way	wheresoever	works	you'll
ways	whereupon	would	you're
we	wherever	wouldn't	you've
we'd	wherewith	x	young
we'll	whether	xi	younger
we're	which	xii	youngest
we've	while	xiii	your
welcome	whilst	xiv	yours
well	whither	xix	yourself
wells	who	xv	yourselves
went	who'd	xvi	z
were	who'll	xvii	zero
weren't	who's	xviii	zeta
what	whoever	xx	
what'll	whole	xxi	

Appendix B

Results for test cases

Test case 1: 'Chocolate + health + obesity'

Total number of adjectives: 361

Total number of verbs: 73

Total number of adjectives and verbs before filtering repeated words: 7531

Total number of omitted words: 646

Following listing contains extracted words and their frequencies

dark 34	favorite 4	powerful 2
eating 30	Net 4	Victorian 2
fat 26	real 4	including 2
eat 19	low 4	eaten 2
Healthy 18	meal 4	start 2
Beautiful 12	Prevent 4	exonerated 2
Optimal 11	Related 4	dense 2
National 10	fatty 4	Traditional 2
bad 10	happy 4	Mexican 2
medical 8	anti-aging 3	degenerative 2
overweight 8	living 3	consumed 2
natural 7	considered 3	nutritious 2
contribute 7	main 3	passed 2
white 7	Specific 3	rigorous 2
enjoy 7	saturated 3	approval 2
sweetened 7	chemical 3	Guilty 2
reduce 7	hot 3	reading 2
Dental 7	adds 3	Vascular 2
means 6	maintaining 3	consult 2
moderate 6	growing 3	Tasting 2
treat 6	Linked 3	Lift 2
Mental 6	continues 3	yummy 2
Compare 6	virtual 3	diabetic 2
delicious 5	Stuffed 3	impossible 2
offers 5	satisfies 3	craving 2
essential 5	United 3	warm 2
add 5	healthful 3	affirms 2
healthier 5	green 3	long-believed 2
red 5	bitter 3	consuming 2
helps 5	processed 3	excessive 2
called 4	leading 3	top 2
protect 4	controversial 3	potential 2
based 4	lead 3	recognized 2
concerned 4	addictive 3	scientific 2
cardiovascular 4	melts 2	connecting 2

grow 2
 balanced 2
 acceptable 2
 Member-created 2
 behavioral 2
 Sexual 2
 Extend 2
 constitutes 2
 INTERACTIVE 2
 Tells 2
 Chronic 2
 advisory 2
 Alternative 2
 Updated 2
 tastier 2
 long-term 2
 maintain 2
 satisfy 2
 rich 2
 popular 2
 thin 2
 concentrated 2
 portable 2
 marketed 2
 total 2
 cellular 2
 menstrual 2
 organic 2
 major 2
 beneficial 2
 affect 2
 appears 2
 retain 2
 whitish 2
 cool 2
 regular 2
 Healing 2
 Verify 2
 Parenting 2
 damn 2
 activating 2
 Exposed 2
 lower 2
 excess 2
 increased 2
 left 2
 caffeine-free 2
 lacks 2
 Exploding 2
 itsponsored 2

raise 2
 risky 2
 joint 2
 Straight 2
 improve 2
 endothelial 2
 perfect 1
 wholesome 1
 filling 1
 brings 1
 feeling 1
 energizes 1
 raises 1
 passionate 1
 official 1
 assured 1
 Gardening 1
 favoured 1
 Aztec 1
 Mayan 1
 disputing 1
 common 1
 suggests 1
 nutritional 1
 varies 1
 promising 1
 identified 1
 occurring 1
 trigger 1
 worse 1
 average 1
 translate 1
 talk 1
 Reproduced 1
 exhaustive 1
 darker 1
 free 1
 funded 1
 Breathing 1
 Morbid 1
 Additional 1
 Highlighted 1
 putting 1
 calculating 1
 contributes 1
 responsible 1
 liable 1
 file 1
 reducing 1
 metabolic 1

lose 1
 occasional 1
 unsweetened 1
 fix 1
 activated 1
 justify 1
 potent 1
 derived 1
 throw 1
 increasing 1
 detrimental 1
 Remember 1
 eight-year-old 1
 sweeten 1
 preventing 1
 two-week 1
 tantalizing 1
 assigned 1
 recommend 1
 direct 1
 legitimate 1
 ancient 1
 assumed 1
 religious 1
 ceremonial 1
 steeped 1
 concocted 1
 bite 1
 remind 1
 favorable 1
 exert 1
 sitting 1
 seek 1
 prompt 1
 starting 1
 subscribes 1
 undated 1
 provided 1
 Wyoming 1
 donated 1
 publish 1
 winning 1
 receive 1
 Belgian 1
 fullest 1
 probable 1
 expensive 1
 effective 1
 offset 1
 pure 1

defined 1	unprocessed 1	Infant 1
marked 1	akin 1	relevant 1
issued 1	fruity 1	Reversing 1
parking 1	secret 1	Understanding 1
enjoyable 1	convey 1	specializes 1
doable 1	naturally-occurring 1	Learn 1
introduced 1	conveying 1	shocking 1
dealing 1	wide 1	critical 1
Call 1	play 1	flown 1
Spread 1	grab 1	formulated 1
Continuing 1	ideal 1	antibacterial 1
studied 1	pungent 1	discarded 1
Preventive 1	fermentation 1	resist 1
Screening 1	alkalizing 1	stick 1
Internal 1	roasting 1	clogging 1
Print 1	choose 1	domestic 1
material 1	studying 1	sugary 1
owned 1	providing 1	kill 1
whopping 1	surprised 1	audio 1
Drinking 1	perceived 1	founded 1
soft 1	comprises 1	Send 1
animal 1	accompany 1	produce 1
loaded 1	established 1	wonderful 1
intoxicating 1	serving 1	negative 1
smooth 1	reap 1	Compared 1
satisfying 1	feel 1	richer 1
inferior 1	determine 1	feels 1
burnt 1	acquire 1	coming 1
Contrary 1	Rating 1	deep 1
flavoring 1	savory 1	digestive 1
hormonal 1	shown 1	immune 1
bacterial 1	thwart 1	delayed 1
leads 1	past 1	grown 1
mentioned 1	clinical 1	contributing 1
brand-new 1	exacerbating 1	weaving 1
crucial 1	streaking 1	Protects 1
British 1	rises 1	true 1
caught 1	prolonged 1	asaturated 1
tolerated 1	opening 1	raising 1
calls 1	seal 1	comparable 1
worldwide 1	dry 1	single 1
hardening 1	attracted 1	swear 1
biggest 1	attracting 1	lean 1
positive 1	deal 1	swallow 1
relieve 1	ultra 1	hankering 1
launched 1	modern 1	Beware 1
tutorial 1	bound 1	huge 1
sees 1	enforce 1	sold 1
excited 1	stringent 1	scrutinizes 1
imagine 1	Current 1	moving 1

granted 1	created 1	rotate 1
skeptical 1	Well-Being 1	chosen 1
medicinal 1	distribute 1	smoking 1
warn 1	fit 1	induced 1
fastest 1	unwanted 1	rapid 1
billion-a-year 1	defends 1	significant 1
acquired 1	filled 1	improves 1
Francisco-based 1	eventual 1	live 1
baking 1	extends 1	munch 1

Test case 2: 'CPU+ fast'

Total number of html files: 43

Total number of adjectives: 232

Total number of verbs: 51

Total number of adjectives and verbs before filtering repeated words: 5712

Total number of omitted words: 468

Following listing contains extracted words and their frequencies

Speed 57	real 4	stored 3
Thermal 14	execute 4	standard 3
String 13	cool 4	external 3
running 10	Extreme 4	depends 3
processing 10	close 4	write 3
cooling 9	read 4	bringing 2
cooler 8	basic 3	focusing 2
perform 7	testing 3	bound 2
internal 6	runs 3	bigger 2
Central 6	Hyper-Threading 3	disable 2
wait 6	overclocked 3	Benchmark 2
Serial 6	supposed 3	ensure 2
mathematical 5	lies 3	introduced 2
proper 5	depending 3	Sorting 2
overclocking 5	stable 3	monitoring 2
slower 5	set 3	means 2
signal 5	developed 3	prevent 2
reduce 5	grow 3	current 2
accurate 5	Unreal 3	lower 2
built 5	measured 3	resulting 2
pairing 4	initial 3	low 2
limited 4	keeping 3	Burn 2
enable 4	critical 3	optimized 2
aims 4	hot 3	gaming 2
overheating 4	run 3	slowing 2
providing 4	fastest 3	lead 2
nominal 4	performs 3	takes 2
sends 4	thinking 3	computing 2
shut 4	sitting 3	Compared 2

expensive 2	processed 1	contents:Thermal 1
stands 2	essential 1	MonitorTestbed 1
directs 2	vain 1	MethodsHyper-
speaking 2	tackles 1	Threading 1
spends 2	odd 1	Thecentral 1
idle 2	exact 1	main 1
waiting 2	modifies 1	temporary 1
conventional 2	intended 1	short 1
retrieved 2	protect 1	simulated 1
requires 2	heating 1	comparable 1
send 2	continue 1	owned 1
Pin 2	depend 1	relates 1
installing 2	electric 1	CPU-Central 1
install 2	coming 1	referred 1
Measuring 2	correct 1	biggest 1
decide 2	talk 1	typical 1
upgrading 2	Suppose 1	fixed 1
upgrade 2	determines 1	hold 1
Check 2	omitted 1	Dual 1
Ranking 2	shown 1	separate 1
global 2	left 1	Adding 1
combined 2	null 1	evaluate 1
acceptable 2	integrated 1	choose 1
writing 2	calibrated 1	similar 1
closer 2	manufacturing 1	female 1
coupling 2	receives 1	connects 1
incredible 2	insufficient 1	Troubleshooting 1
specializes 2	generates 1	careful 1
vast 2	cooled 1	bend 1
feel 2	notched 1	break 1
vital 2	slow 1	match 1
Net 2	fatal 1	contributing 1
overvolting 2	special 1	clocked 1
pushes 2	shuts 1	trapped 1
dependent 2	Simple 1	larger 1
effective 2	smooth 1	spend 1
assume 2	increasing 1	sells 1
top 1	synthetic 1	difficult 1
carry 1	testbed 1	flatter 1
produce 1	Killing 1	occurs 1
Posts 1	discuss 1	demanding 1
robust 1	heated 1	simpler 1
operate 1	remains 1	launched 1
conducts 1	constant 1	enhancing 1
determine 1	resorted 1	ultimate 1
full 1	dropping 1	Join 1
raw 1	hang 1	compares 1
compress 1	pure 1	worldwide 1
losing 1	wrong 1	specific 1
original 1	reached 1	quick 1

crippled 1	Relative 1	cheapest 1
caching 1	announces 1	build 1
addressing 1	mobile 1	Buy 1
outrun 1	sweeter 1	afford 1
regular 1	Personal 1	sold 1
multiple 1	wears 1	solid 1
proportional 1	damaging 1	peopleplanning 1
optimal 1	replaced 1	heavy 1
related 1	double 1	scientific 1
dedicated 1	major 1	crunching 1
prompt 1	low-end 1	clocking 1
efficient 1	midrange 1	safer 1
professional 1	high-end 1	Changing 1
offers 1	rough 1	
Corporate 1	late 1	
Individual 1	compare 1	

Test case 3: 'flat screen + TV'

Total number of html files: 38

Total number of adjectives: 86

Total number of verbs: 21

Total number of adjectives and verbs before filtering repeated words: 3230

Total number of omitted words: 147

Following listing contains extracted words and their frequencies

Flat 319	pricing 3	planning 2
buying 14	Search 3	visual 2
Digital 13	Full 3	housed 2
Stand 11	trilingual 3	metal 2
shopping 8	viewing 3	featuring 2
standard 7	corporate 3	looping 2
flat-panel 7	Shipping 3	audio 2
hang 6	solid 3	vivid 2
Console 6	finish 3	preferred 2
Buy 6	Promotional 3	thin 2
monitor 6	create 3	expected 2
Lift 6	perfect 3	giving 2
watching 4	Imprinted 3	boost 2
large-screen 4	choose 3	worldwide 2
Matching 4	Enjoy 3	sitting 2
unique 3	breath-taking 3	popular 2
versatile 3	sporting 3	falling 2
offers 3	simple 2	improving 2
Zoom 3	Enhanced 2	choosing 2
rating 3	interlaced 2	larger 2
true 3	black-framed 2	main 2
accurate 3	thick 2	stylish 1

narrower 1	local 1	liquid 1
vibrant 1	Distressed 1	crystal 1
playing 1	Note 1	red 1
set 1	stand-alone 1	green 1
Patterned 1	losing 1	blue 1
Vertical 1	rises 1	shines 1
rich 1	Expect 1	varying 1
lifelike 1	pay 1	Forget 1
realistic 1	Imprint 1	hooking 1
displayed 1	Improve 1	pan-and-scan-formatted
Explained 1	Gaming 1	Rear 1
black 1	Swiveling 1	Fit 1
Direct 1	tiny 1	differentiate 1

Test case 4: 'sleek + mobile'

Total number of html files: 51

Total number of adjectives: 181

Total number of verbs: 33

Total number of adjectives and verbs before filtering repeated words: 3584

Total number of omitted words: 204

Following listing contains extracted words and their frequencies

mobile 147	digital 3	developed 2
Sleek 89	versatile 3	introduced 2
estimated 14	due 3	dual 2
slim 7	fixed 3	innovative 2
VIRGIN 6	Featured 3	distinguish 2
Boost 6	helps 3	ordinary 2
popular 5	Faster 3	dedicated 2
Computing 5	Cheap 3	stay 2
easy 5	running 3	inspirational 2
designed 4	connected 2	equipped 2
Delivers 4	Bring 2	consists 2
High-power 4	exclusive 2	everyday 2
stylish 4	alluring 2	Adjustable 2
superb 4	featuring 2	powerful 2
cool 4	classic 2	Continued 2
hard 4	ultra 2	launched 2
tiny 4	carrying 2	grow 2
functional 4	full 2	acquired 2
Annual 4	Current 2	penetrated 2
designing 4	optimized 2	focused 2
including 3	meet 2	ensure 2
sounds 3	Personal 2	rich 2
enables 3	includes 2	pricing 2
lower 3	runs 2	Verbatim 2
Powered 3	communicate 2	sleek-looking 2
set 3	messaging 2	feeds 2

micro 2	extraordinary 1	Browse 1
black 2	Improved 1	Morning 1
jack 2	extends 1	created 1
technological 2	enabling 1	massive 1
Unfold 2	Sporting 1	poised 1
svelte 2	casing 1	Moving 1
released 2	weighing 1	worthwhile 1
kicks 2	engineering 1	bringing 1
special 2	purchased 1	comprehensive 1
wireless 2	compelled 1	holds 1
hosted 2	suffering 1	marvel 1
Awaken 2	waiting 1	proper 1
continues 2	public 1	ostensible 1
combining 2	notesUsed 1	preferred 1
elected 1	replaced 1	regular 1
establish 1	adhered 1	thicker 1
provided 1	rear 1	Unique 1
comfortable 1	Largest 1	refers 1
hold 1	accurate 1	graphic 1
action-packed 1	held 1	Adding 1
Dare 1	responsible 1	excellent 1
vivid 1	sophisticated 1	personalize 1
striking 1	Browsing 1	carry 1
hair-raising 1	empowers 1	bulky 1
animated 1	compact 1	feel 1
Ratchet 1	Speed 1	play 1
Choose 1	feed 1	called 1
TRENDY 1	fix 1	Tap 1
maximum 1	Related 1	emanating 1
Virtual 1	quick 1	worst 1
inject 1	dirty 1	top 1
transforms 1	Relevant 1	ready 1
offers 1	nice 1	revamp 1
terminal 1	nervous 1	attracting 1
Low-cost 1	compatible 1	widespread 1
brought 1	mentioned 1	leading 1
embedded 1	suggests 1	revolutionary 1
stand-alone 1	operating 1	exist 1
add 1	decent 1	takes 1
implemented 1	Portable 1	strategic 1
existing 1	Perfect 1	reflects 1
incorporate 1	vital 1	potential 1
specific 1	close 1	dynamic 1
deliver 1	determine 1	exciting 1
produced 1	Reserved 1	

Test case 5: 'Green Tea + health'

Total number of html files: 61

Total number of adjectives: 626

Total number of verbs: 99

Total number of adjectives and verbs before filtering repeated words: 25425

Total number of omitted words: 1726

Following listing contains extracted words and their frequencies

green 942	processed 11	Brewing 7
Drinking 111	free 11	excellent 7
extract 87	enjoy 11	medicinal 7
black 79	low 11	anti-aging 7
leaves 66	potential 11	preliminary 7
Japanese 57	lowers 10	significant 7
lower 36	Protective 10	multiple 7
Helps 35	Special 9	intestinal 7
Powerful 29	Unfermented 9	Delivers 7
reduce 29	steaming 9	limited 7
prevent 29	total 9	perfect 6
healthy 26	Based 9	lowering 6
called 26	inhibit 9	dried 6
consumed 23	inhibits 9	reduces 6
protect 23	protecting 9	grow 6
enhances 23	trial 9	ENTERTAINING 6
shown 22	fresh 8	EMPTY 6
organic 21	animal 8	Anti-Cancer 6
natural 21	consuming 8	unique 6
cardiovascular 20	Healthier 8	harmful 6
learn 19	Boost 8	determine 6
medical 19	suggests 8	prevents 6
Chinese 18	amino 8	play 6
Decaffeinated 18	main 8	receiving 6
effective 17	recommend 8	healthful 6
preventing 16	potent 8	avoid 6
reducing 16	appears 8	Syed 6
red 16	major 8	functional 6
human 16	Oral 7	ancient 6
scientific 15	consult 7	valued 6
gastric 15	due 7	broad 6
esophageal 15	offers 7	deters 6
reduced 14	herbal 7	positive 6
fat 14	bad 7	Dietary 6
Population-based 14	start 7	Clinical 6
treat 14	produced 7	rejects 6
beneficial 13	Asian 7	Drops 6
fermented 13	bring 7	varied 5
chemical 13	Growing 7	slow 5
dental 13	grown 7	aging 5
rich 13	studied 7	current 5
provide 12	develop 7	regular 5
including 12	active 7	undergo 5
Drink 12	poisoning 7	causing 5

compared 5	processing 4	common 4
Published 5	offering 4	extra 4
healing 5	Iced 4	Acute 4
simple 5	Exploring 4	Critical 4
Adapted 5	slight 4	undesirable 4
popular 5	bitter 4	standardized 4
nutritional 5	expected 4	caffeinated 4
steeped 5	coronary 4	Mega 4
Buy 5	Emerging 4	demonstrated 4
National 5	conflicting 4	combined 4
favorite 5	colorectal 4	sufficient 4
derived 5	concentrated 4	Randomized 4
qualified 5	clotting 4	controlled 4
increased 5	Systematic 4	citrus 4
responsible 5	gastrointestinal 4	Principal 4
developed 5	preventive 4	Alternative 4
United 5	cross-sectional 4	Feeding 3
average 5	prospective 4	primary 3
ovarian 5	Scavenging 4	sold 3
Inhibitory 5	habitual 4	fermentation 3
related 5	nontoxic 4	documented 3
steamed 5	diabetic 4	explored 3
numerous 5	Treats 4	contribute 3
affects 5	kill 4	preventative 3
arterial 5	baked 4	counteract 3
brewed 5	aged 4	researching 3
Mental 5	inflammatory 4	left 3
complex 5	fighting 4	comprehensive 3
maintain 5	drying 4	describing 3
inconclusive 5	previous 4	stimulating 3
established 4	short 4	largest 3
written 4	secret 4	protected 3
full 4	lies 4	welcomes 3
break 4	considered 4	hot 3
epidemiological 4	Buddhist 4	stronger 3
led 4	extraordinary 4	bacterial 3
suppress 4	prolong 4	severe 3
fed 4	cultivates 4	Long-term 3
produce 4	follow 4	ultraviolet 3
Official 4	modern 4	achieve 3
disease-fighting 4	creates 4	Direct 3
credible 4	immortal 4	inexpensive 3
Compound 4	stops 4	Fight 3
Identified 4	restricts 4	continue 3
provided 4	improve 4	reading 3
Rendering 4	International 4	respected 3
Cancerous 4	remain 4	bringing 3
Harmless 4	ageing 4	mountain-dwelling 3
dark 4	helping 4	impede 3
fragrant 4	applied 4	key 3

Buying 3	Israeli 2	breastfeeding 2
involve 3	rejuvenating 2	administered 2
Adding 3	damaged 2	hospital 2
affect 3	Toughen 2	setting 2
introduced 3	Australian 2	irregular 2
prudent 3	strengthen 2	unstable 2
crucial 3	health-conscious 2	mixed 2
radical 3	cream-colored 2	thinning 2
driven 3	powered 2	ineffective 2
acquired 3	Constant 2	anti-psychotic 2
reap 3	Mind 2	increasing 2
remains 3	Relating 2	Mechanistic 2
unclear 3	Illustrated 2	WJReduced 2
heard 3	enlarge 2	northern 2
harvesting 2	takes 2	biological 2
referred 2	ready 2	signaling 2
leads 2	forget 2	transformed 2
immune 2	nice 2	chronic 2
ordinary 2	darker 2	Enhancing 2
pertaining 2	warm-weather 2	pooled 2
refers 2	skip 2	Probable 2
similar 2	cancels 2	low-density 2
sampling 2	Seed 2	historic 2
pricing 2	picking 2	fecal 2
native 2	wide 2	survival 2
preserves 2	astringent 2	epithelial 2
nutrient 2	produces 2	Net 2
soft 2	tranquilizing 2	worldwide 2
experimental 2	neutralize 2	hard 2
suppressed 2	raises 2	providing 2
closer 2	male 2	affordable 2
suspected 2	late 2	represent 2
conducted 2	experienced 2	pleasurable 2
confirm 2	rectal 2	blood-sugar-lowering 2
lesser 2	opposite 2	write 2
WHITE 2	draw 2	safe 2
relevant 2	stimulated 2	tested 2
informative 2	sensitive 2	facial 2
Send 2	ulcerative 2	soothing 2
update 2	regulate 2	Promote 2
possesses 2	damaging 2	varies 2
remarkable 2	toxic 2	steeping 2
registered 2	isolated 2	French 2
attesting 2	confers 2	testimonial 2
helpful 2	burn 2	oxidized 2
surfacing 2	affected 2	negative 2
wondering 2	prepared 2	retain 2
upper 2	pediatric 2	suppresses 2
familiar 2	psychological 2	loves 2
popularize 2	Pregnant 2	linking 2

profitable 2	monitored 2	eludes 2
seventeenth 2	Beats 2	investigating 2
created 2	suggesting 2	benevolent 2
twentieth 2	Myocardial 2	diverse 2
paralleled 2	filled 2	lend 2
heated 2	cellular 2	indigenous 2
typical 2	structural 2	cancer-combating 2
interfere 2	favorable 2	recommends 2
blood-thinning 2	induced 2	Note 2
proven 2	maintained 2	touted 2
restrict 2	non-supplemented 2	perennial 2
build 2	corroborate 2	dating 2
antioxidising 2	inducing 2	slowing 2
restrain 2	expensive 2	required 2
strong 2	represented 2	therapeutic 2
combines 2	unprecedented 2	well-designed 2
milder 2	Beware 2	drawn 2
non-alcoholic 2	don 2	low-quality 2
sloping 2	stated 2	caused 2
European 2	obtain 2	predominant 2
joint 2	salivary 2	specific 2
regarded 2	tea-fed 2	considerable 2
elevate 2	well-confirmed 2	Caffeine-containing 2
moderate 2	holds 2	Double-blinded 2
inhibiting 2	vasodilating 2	placebo-controlled 2
meal 2	advised 2	photoaging 2
leave 2	evening 2	refractory 2
feeling 2	postmenopausal 2	Cholesterol-lowering 2
clean 2	logical 2	theaflavin-enriched 2
bleeding 2	excessive 2	cancer-fighting 2
wise 2	mild 2	simulated 2
switching 2	periodontal 2	preserving 2
Selecting 2	destroy 2	tied 2
purchasing 2	bactericidal 2	thrives 2
yellow 2	discussed 2	lighter 2
brown 2	extensive 2	targeting 2
aromatic 2	reviewed 2	soluble 2
sells 2	protects 2	receive 2
recognizes 2	deserves 2	shoot 2
flavonoids—plant-	mention 2	Bathing 1
derived 2	microsomal 2	Diapering 1
bottled 2	Peroxynitrite-	Bedding 1
explores 2	scavenging 2	Nursing 1
blocking 2	galactosamine-induced	Grooming 1
keeping 2	2	Clothing 1
predisposed 2	purified 2	wonderful 1
Myriad 2	mesenteric 2	sweet 1
Choose 2	iron-induced 2	crisp 1
hoping 2	cerulein-induced 2	Celebrating 1
live 2	endotoxin-induced 2	Victorian 1

renew 1	promotional 1	thwart 1
distinguish 1	material 1	uncover 1
cured 1	consists 1	tucked 1
yield 1	curative 1	explains 1
destroying 1	Heal 1	Promising 1
Meet 1	talking 1	Journal 1
Pictured 1	discovered 1	pleasant 1
traveling 1	wild 1	pass 1
amazed 1	cultivated 1	Self-reported 1
wide-ranging 1	traditional 1	Sexual 1
conferred 1	confirms 1	broken 1
ill 1	mythological 1	minimized 1
relaxing 1	assert 1	Maintaining 1
refreshing 1	boiled 1	neglected 1
calming 1	dwelling 1	custom-made 1
busy 1	agree 1	digestive 1
capable 1	throbbing 1	oxygen-related 1
Soak 1	impending 1	physiological 1
volatile 1	Wholesale 1	binding 1
requires 1	Optimum 1	intraoral 1
warm 1	risking 1	cooking 1
Assorted 1	donate 1	throwing 1
successful 1	after-tax 1	grilled 1
consumes 1	scrutinizes 1	brings 1
health-promoting 1	moving 1	fosters 1
pick 1	risky 1	diagnosing 1
standing 1	eat 1	treating 1
Yexing 1	Well-Being 1	prescribing 1
Archeological 1	distribute 1	served 1
boiling 1	defends 1	stay 1
Botanical 1	Additional 1	alert 1
cultivate 1	absorb 1	Turkish 1
hotter 1	steep 1	Western 1
abdominal 1	publishing 1	warns 1
light-induced 1	Emotional 1	bogus 1
aqueous 1	Circulatory 1	flavoring 1
subscribes 1	Attacks 1	reserved 1
Authentic 1	fresh-brewed 1	INTERACTIVE 1
paramount 1	Linked 1	fired 1
superior 1	stimulates 1	lessen 1
means 1	concentrate 1	advisory 1
retarding 1	calm 1	Cool 1
ensuing 1	stimulate 1	Editorial 1
deprived 1	recorded 1	powdered 1
recognized 1	centuries-old 1	retained 1
Unrated 1	Lose 1	eaten 1
privileged 1	Suited 1	approximate 1
convinced 1	imbibing 1	supporting 1

Test case 6: 'spacious + car'

Total number of html files: 33

Total number of adjectives: 126

Total number of verbs: 28

Total number of adjectives and verbs before filtering repeated words: 2131

Total number of omitted words: 132

Following listing contains extracted words and their frequencies

Spacious 60	involves 2	developed 1
choose 11	evaluating 2	worldwide 1
Zoom 9	ATTACHED 2	afford 1
Pedal 9	EXTRA 2	regarded 1
Cheap 7	Selling 2	defined 1
Rental 6	Meet 2	close 1
perfect 6	considered 2	final 1
hold 6	pairing 2	produced 1
buying 5	sprung 2	assemble 1
Add 5	nice 2	annual 1
adjustable 4	Italian 2	quiet 1
grows 4	Hire 2	comfortable 1
modern 4	maroon 2	stay 1
Choosing 4	retail 1	tiny 1
compact 4	luxurious 1	capable 1
Driving 4	largest 1	handle 1
black 4	generating 1	growing 1
feels 3	Compare 1	Coming 1
advertise 3	Financing 1	insure 1
aware 3	Global 1	attracts 1
wedding 3	wrong 1	low 1
brown 3	ample 1	fetch 1
interior 3	enormous 1	paid 1
classic 2	stepping 1	RELAX 1
full 2	weighing 1	COVERED 1
larger 2	basic 1	ENJOY 1
built 2	built-in 1	GRASSY 1
buy 2	monochrome 1	chubby 1
hiring 2	pleased 1	stare 1
entire 2	continues 1	previous 1
solid 2	up-dated 1	transverse 1
easy 2	unused 1	flexible 1
Romanian 2	purchased 1	versatile 1
called 2	changing 1	read 1
affordable 2	located 1	Navigating 1
huge 2	walk 1	Bad 1
international 2	reach 1	Refinancing 1
run 2	developing 1	Personal 1
bigger 2	all-new 1	ease 1

historical 1
linked 1
registered 1
Swedespeed 1
independent 1
affiliated 1
endorsed 1
expected 1
exacting 1
arouses 1
strong 1
dashing 1
aggressive 1

stylish 1
sophisticated 1
constitutes 1
imposing 1
appears 1
grow 1
distinctive 1
agile 1
protective 1
due 1
pronounced 1
slender 1
dynamic 1

adorn 1
Featured 1
featuring 1
net 1
Vintage 1
suitable 1
carrying 1
striking 1
blue 1