JUST IN TIME INFORMATION RETRIEVAL AGENT TO SUPPORT TEXT CREATION, BASED ON THE MIXED INITIATIVE USER INTERFACE DESIGN

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Abstract

Information is seen as a valuable resource, but the quality and quantity of information retrieved at the moment of web information searching depend on both: the user’s query and the search engine’s features. This master thesis presents a just in time information retrieval (JITIR) agent that is based on the Google Search API to implement a web application. The thesis consists of the implementation and evaluation of the Pandora Editor\(^1\) which has as part of its main functionality an information search and retrieval agent. The motivation is to provide a new interaction paradigm to support documents writing. The interaction is oriented to enhance the text creation activity by having automated query formulation and reducing the user’s memory overload. The writer can use those queries to get relevant web results from Google search and improve his document content and quality.

For the project, three search scopes were defined: document level, thematic segments level and noun phrases level. For every scope, there is one methodology to extract words and phrases from the user’s current text. After being evaluated, those words will become into search queries. Once having the queries, the agent interacts with the Google Search API to retrieve web information that may be useful for the writer. These search levels will allow the user to choose the best web and images results provided by Google.

The application was tested following a controlled evaluation. The goal was to show if the new interaction paradigm implemented in the present project and the queries extracted thanks to the JITIR agent let the writers be more efficient than by formulating their own explicit queries and using a common text editor plus Google running in a browser. The quantitative results did not present a significant difference in terms of users efficiency while they were working with the Pandora Editor or a common editor plus a search engine. The tests applied showed that they were able to handle more information from the web by using the Pandora Editor though. The qualitative measures presented good results showing that the users found the Pandora Editor easier and more useful at the moment of creating documents or retrieving images compared with a common text editor.

**Keywords:** Just in time information retrieval agent, direct manipulation, mixed initiative interfaces, keywords extraction

\(^1\)Pandora Editor is the name given to the web application presented in this Master Thesis
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Chapter 1

Introduction

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This chapter contains a preliminary presentation about the Pandora Editor project, the background and motivation is detailed first; later, the main objective is explained; finally, the last section consists of the structure of the present report.
1.1 Background and motivation

At the moment a user has the need of specific information, the process of automatic searching and retrieving is done by an Information Retrieval (IR) system. An IR system uses technology tools in order to storage, organize and index a collection of documents or web pages before the search process starts. The IR system satisfies the user information request by matching his query with the indexed documents in order to retrieve the ones that are relevant for that query. While searching the Internet, the IR system uses search engines and web crawlers to cross the web and index the information.

In order to find any kind of information most people uses web search engines, so that search engines have a very high impact in the society and in the way information is found and used. Current web systems and technologies are not enough to support the processing needs for the quantity of dynamic, unstructured and distributed information [9]. By working with a search engine the users could find some disadvantages [1]:

- The information retrieved by a search engine generally differs from the others’ results (at least the retrieved order among search engines is different).
- Depending on the kind of query and user’s needs, it is the user who has to filter the retrieved information.
- The results retrieved for a query are extracted from the web and sometimes the web information is noisy.
- Few search engines are able to retrieve personalized information after monitoring the user’s search behaviour and preferences, but most of them does not.
- The quality of the results depends on the quality of the query and the imprecise keywords formulated by novice users could affect the entire search process.

A just in time Information Retrieval system (JITIR) accesses to the user’s current information in order to use it as input and finds, retrieves and evaluates new generated information that could be valuable for the user’s main task. The queries that are formulated by the JITIR agent are implicit in the user’s current context, so the work of the agent is proactive and as non-intrusive as possible [18].

A JITIR agent is an IR system where the query is generated from the user’s monitored environment, and it tries to deal with the Search and Retrieve process disadvantages mentioned before.

1.2 Project aim

The main goal of the Pandora Editor project is to implement and evaluate a document editor which includes an Information Search and Retrieval Agent as part of the user interface.

In detail, the agent extracts keywords from the user’s document, prepares the queries and by communicating with a web search engine, it retrieves relevant web and image results from the internet. The whole process that involves the user’s text preprocessing, query formulation and results retrieval is transparent for the writers. The Pandora Editor and the JITIR agent implemented make that the relevant web information related to the user’s document can be accessed easily and at the right time by presenting a simple user interface.
1.3 Report Content and Structure

The report details the theoretical basement of the project and presents the process followed until achieving the goal that was mentioned before. In the second chapter, the features of a JITIR agent and related work are explained. The chapter number three details the different technologies, tools and languages that supported the application development. The fourth chapter shows in detail the Pandora Editor: its architecture, the influence of the mixed initiative user interface for the design and the implemented modules together with the libraries used; the algorithms and some examples are also showed. The fifth chapter describes the user evaluation procedure: the testing plan, the results obtained and their analysis. Finally, the last chapter presents the limitations for the whole project, the conclusions and the future work that could be done.
Chapter 2

Mixed Initiative Just in Time Information Retrieval Agent

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In this chapter, the domain of Information Retrieval agents is discussed. The theoretical basements about the Mixed Initiative User Interface design is also treated. The chapter starts with IR agents in section 2.1, where the fundamentals, necessity and related work in this kind of systems are reviewed. The section 2.2 explains the comparison between both interaction design approaches: automated agents and direct manipulation. Section 2.3 discusses some issues about the work of JITIR Agents and the ways users interact with such type of applications depending on the interface design. To conclude, in section 2.4 I provide one alternative approach oriented to set a new interaction paradigm between the document writer and a JITIR agent.
2.1 Just in Time Information Retrieval Agents

While creating a document, the author will need some information to support the writing activity. This extra information or resources could be: recent news, images, historical references, specific knowledge, previous researches, etc. Therefore, one important task that the writer has to do in addition to the main document writing activity, is finding the extra information required. It is very sure that the document’s author will use a web search engine to get the knowledge needed. In this process, he will formulate and reformulate some queries, once he has some web results, he will try to get and evaluate the relevant ones to finally organize the main ideas, synthesize them and go on with the document creation.

The activities previously described show the diverse tasks done by the user and the interruptions are part of the work. Writing and searching are two different activities and also the technology provided presents two separated and multitasking interfaces: text editors and web search engines running on browsers. Consequently, the current designs do not help to the user in the interaction.

Concerning the user’s expertise, if he is not novice and knows exactly what he is looking for, it would be easy to formulate his query and get some relevant results from the search engine. On the other hand, a novice user could get lost with the quantity of information that there is in the web, and somehow it could get worse if he is not familiarized with the use of a search engine. Maybe he is not an expert in the topic he wants to write, so it is possible that he has no clue to start his search. As result, the fact of producing his queries again and again would be time and energy consuming. His goal is to write a document, and it is not spending most of the time being distracted by the search engines results.

The task of the JITIR agent is extracting keywords from the user’s text keeping the effects of interruptions as low as possible. The agent works as an assistant, so the user has no need to formulate queries because they are extracted directly from his own text. Later, the user can decide which of the results suggested by the JITIR agent will be helpful to support his writing process.

2.1.1 JITIR agent’s characteristics

A JITIR agent has some characteristics [19] [1] which differentiates it from other kinds of agents:

- It is autonomous: A software agent works in an independent way, and while it monitors the user’s environment it is able to make decisions without direct manipulation or intervention of the user.

- It is proactive: the query that is formulated by the agent is the result of the state of the user’s environment. At certain moment of time, the sensed situation limits the query, it means that it is not proposed by the user.

- It is not intrusive: some alarm systems used in devices make alert sounds or display small notification boxes. The goal is to let know the user about the activity to do, but also it has to be able to be ignored depending on the user’s cognitive load or his current task. The JITIR system interface design presents the resulted information in a way that warns the user, but he can still decide to ignored it, see it or postpone to review it when he has the need.
• It works within the user’s context: the JITIR agent will not take the user out of his current activity as any other notification system. The agent works by providing information that is useful for that activity, so the user must not change his context or work environment.

2.1.2 Related work

The design and development of a JITIR agent is based on the requirements it has to implement: the kind of user’s work environment to be sensed, the scope of information searched (user’s local documents, the web, user’s e-mails), the type of system (desktop, web or mobile application) and the way of displaying the results. Next, I am presenting brief descriptions of some JITIR systems\(^1\), what they do and the query formulation methods they apply.

One of the oldest works done in JITIR agents was developed at the Massachusetts Institute of Technology. It presents three agents [19]: the Remembrance Agent that is a system which presents a list of documents related to the current one that is being written or read by the user. It can be customized: the search could be done in the e-mails list for example, or it could take as input information the last 20 written words or the last 500. The second agent is Margin Notes that automatically add annotations to the web pages at the moment they are being loaded. The annotations show a list of the user’s documents related to that web page[18]. The last agent is Jimminy that presents information depending on the user’s physical environment: place, who he is talking to, the time of day. The results are shown via a head-mounted display attached to a wearable computer (off the desktop). The three systems use a back-end called Savant that works as an IR system providing ranked results by using documents similarity measures.

Watson is one JITIR system that retrieves information taking into consideration the documents that the user is manipulating. It computes term weights to choose what to include in a query [13]. The weighting method is to give higher weights to terms that appear more frequently in the document and to those that appear earlier or are emphasized in italics, in a section heading, etc.

Calvin, a personal learner information agent, monitors user’s documents accesses to present suggestions for other resources that were consulted in similar prior contexts. The algorithm used is WordSieve, that performs document indexing and retrieval. It generates context descriptions by using information about the sequence of accessed documents to identify words which indicate a shift in context [3]. The algorithm builds access profiles where the goal is to identify keywords that appear frequently in defined sequences or groups of documents that were accessed for a specific context.

In [11], the description of a JITIR agent for bloggers is presented. The Blogoduct system uses some heuristics in order to extract implicit queries from the document that the user is creating. In this research they compare and test lightweight NLP techniques and propose their heuristics for creating the queries.

Some other related works are described in [1] (SAIRE, ACQUIRE, PIA, IIRM) which are compared with Ubiquitous Web Information Retrieval Solution Agents. The goal of the agents (mobile and multi-agents) is to solve problems like security and privacy issues and associated restrictions related to the use of web information.

\(^1\)The examples of JITIR agents presented were chosen according to the scope of the master thesis
2.2 The Mixed Initiative User Interface

The Microsoft Research Labs presented some principles to develop user interfaces making automated services and direct manipulation work together [12]. In this section both strategies: automated agents and user direct manipulation are explained. Later, the advantages of coupling these two strategies to enhance user’s abilities at the moment of the interaction and the influences in the Pandora Editor design are shown.

2.2.1 Autonomous Interface Agents work

In the 90’s, some computer scientists started to develop specific programs called agents, which could be seen as end user assistants. The agent work is characterized for acting with certain level of intelligence by operating concurrently[15]. They may learn, adapt, make decisions, be independent, etc.

In summary, they are not direct manipulated interfaces, so that the user does not need to command any execution. Most of the autonomous agents interact with the user by presenting results or showing suggestions, in a way that its work can be visualized in the interface. In other words, some agent functionality is not only limited to be executed in the background. An intelligent agent interacts with the application as the same as the user does.

The problem that could appear in such applications is that not always the actions taken by the agent are expected. This design issue might rely on user anxiety and lack of predictability.

Some years ago, the idea of having conversational agents to let some kind of control to the user was considered. A conversational agent takes the shape of a person and the interaction with the user is direct, allowing him to make decisions about future actions. The anthropomorphic or conversational agents changed two relevant aspects: the agent’s design and the user interaction. Nowadays, the developed agents do not have anthropomorphic representations because it was seen that they degrade the user’s sense of responsibility and accomplishment. The interaction among humans is not a good reference in user interfaces design and “the users want to have the feeling they did the job”[20].

2.2.2 User Decision Making and direct manipulation

The goal of the directly manipulated interfaces is to present comprehensive and predictable displays to the users. The user is who has the responsibility of his actions and as a result he feels a complete control over the application [20]. The most important thing for this strategy of design is to know who the users are going to be and which tasks they are going to do. The features to be implemented in the interface are: reversible actions, immediate feedback, selection by pointing, visual ways of searching, visual presentation of results and rapid access items.

One drawback of this strategy is the strong dependence on visual representations. If the visual design is not good enough some gaps between the user’s goals and how to achieve them could be generated. In addition, direct manipulation stalls automation of tasks and prevents the user’s capabilities to increase while it is generally known that more automation implies more productivity.

2.2.3 Collaborative work Advantages: the Mixed Initiative proposal

The employment of the mixed initiative user interface allows a collaborative work between the intelligent agent, which is able to provide automated services, and the user, who is the centre of the application goals.

The Pandora Editor design implements an agent that takes care of the information retrieval processes in the background (value added automation) meanwhile its results are displayed in a simple interface that is directly manipulated by the user.

The user has the control about the moment he wants the agent starts its work, so that he is not distracted at any time by the agent. The design promotes rapid learning of the user and it attenuates the complexity of navigation. User productivity arises while he is creating the document\(^3\) because of the automated tasks done by the JITIR agent which minimizes the number of interactions. The agent work is invisible to the user. At the end, the user will see some links to the websites suggested plus relevant images related to the document context, which could help him to improve his writing.

2.3 Problem statement

Once that the related work (2.1.2) and also the Mixed Initiative User Interface proposal were presented (2.2.3), this section shows the Table 2.1 where a summary of the different JITIR applications seen, together with the interaction paradigms implemented for each are exposed.

As the table shows, the intention of those IR agents is to avoid the user to be overwhelmed with irrelevant retrieved information. With the use of a JITIR agent the time to integrate the result data with the main task is lower and the documents, data or web pages indexed can be found at the searching moment with less noisy information.

Each example presented has its own goal and indexation process. They have their way to extract the queries, present the results and monitor the context. Their main goals are focused on the functionality and the tasks the agents must do. They implement interaction designs that seem to be efficient to reach the Agent aim and somehow are less focused on different needs of information or customization that the user could require.

The section 2.4 shows a quick overview of the Pandora Editor. In this way, I am describing the differences among the related work reviewed and the JITIR agent done for the present master thesis in the Table 2.1.

\(^3\)See the results of the evaluation in the chapter 5
<table>
<thead>
<tr>
<th>JITIR Agent</th>
<th>Back-end</th>
<th>Query Extraction</th>
<th>User’s monitored environment</th>
<th>Information indexed</th>
<th>Interaction Paradigm</th>
<th>User Interface</th>
<th>Document Writing Support?</th>
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<td>Savant</td>
<td>Cosine Similarity metrics to extract keywords</td>
<td>Email/document being read/written</td>
<td>Mails/archive files</td>
<td>Autonomous Interface Agent</td>
<td>Fig 2.1</td>
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<td>Margin Notes 2000[19]</td>
<td>Savant</td>
<td>Cosine Similarity metrics to extract keywords</td>
<td>Web page being read</td>
<td>Personal files</td>
<td>Autonomous Interface Agent</td>
<td>Fig 2.2</td>
<td>Not directly</td>
</tr>
<tr>
<td>Jimminy (wearable) 2000[19]</td>
<td>Savant</td>
<td>Cosine Similarity metrics to extract keywords</td>
<td>Who the user is talking to; place</td>
<td>Personal files</td>
<td>Autonomous Interface Agent</td>
<td>Fig 2.3</td>
<td>Yes</td>
</tr>
<tr>
<td>Watson 1999-2006 [13]</td>
<td>Vector Space model/heuristics</td>
<td>Weighting algorithm to extract keywords</td>
<td>Document being read/written</td>
<td>Personal files, databases, web pages, Intranet</td>
<td>Application Adapter Paradigm</td>
<td>Fig 2.4</td>
<td>Yes</td>
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<tr>
<td>Blogoduct 2010 [11]</td>
<td>NLP techniques</td>
<td>keywords: tf-idf, nouns, name detection, phrases</td>
<td>BlogPost being written</td>
<td>Web - Image results (Google, Yahoo, Flickr)</td>
<td>Autonomous Interface Agent (web app)</td>
<td>Fig 2.6</td>
<td>Yes</td>
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<td>JITIR agent integrated with Windows Desktop Search [7]</td>
<td>NLP techniques</td>
<td>keywords: Relative Frequency Ratio to weight terms</td>
<td>Document being written in MS Word</td>
<td>Desktop Search system to retrieve personal files</td>
<td>Autonomous Interface Agent</td>
<td>Fig 2.7</td>
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<td>Pandora Editor</td>
<td>NLP techniques heuristics</td>
<td>Keywords whole text, keywords thematic segment and noun phrases</td>
<td>Document being written</td>
<td>Web - Image results (Google)</td>
<td>Mixed Initiative User Interface (web app)</td>
<td>Chapter 4</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Figure 2.1: The Remembrance Agent User Interface [19], it presents a list of documents related to the current one that is being written or read.

Figure 2.2: Margin Notes User Interface [19], it shows a list of the user’s documents related to the web page being load.

Figure 2.3: Jimminy User Interface [19], it retrieves information depending on the user’s physical environment.
Figure 2.4: Watson customized for Motorola User Interface [13], it retrieves information from the web, intranet, or personal data taking into consideration the documents that the user is manipulating.

Figure 2.5: Calvin web based User Interface [4], it monitors user’s documents accesses to present suggestions according to other resources that were consulted in similar prior contexts.
Figure 2.6: Blogoduct User Interface [11], it extracts implicit queries from the blog that the user is creating to retrieve relevant web resources.

Figure 2.7: JITIR Agent integrated with Windows Desktop Search User Interface [7], it retrieves personal resources from the desktop relevant to the document that is being written.
2.4 The Pandora Editor proposal

Searching and writing are two activities that most of the time are done together. Both activities complement each other as the same as tools like search engines complement text editors [11]. Switching from information seek to document writing represents the use of a lot of time and user’s cognitive overload.

The need of tools that can solve those problems has motivated the development of web IR new generation systems and IR agents as it was detailed before. The intention of the new search engines generation is the implementation of context driven information suppliers instead of having query based IR systems [5].

The implementation of intelligent agents in the IR field has proved that the users are able to retrieve, handle and use more relevant information [7] and somehow the search engines drawbacks are reduced. This project is oriented to find the correct way to combine a JITIR agent and the mixed initiative interface design so that the writers could be able to create documents in less time and with a good quality through a simple interaction. The chapter 4 provides a complete description of the Pandora Editor.
Chapter 3

Languages, Technologies and Tools

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The chapter number three presents the different technologies that were chosen to support the development process of the Pandora Editor. The first section compares some programming languages, technologies and tools showing the advantages and disadvantages oriented to the development of a Web application; and the second section presents a summary of the technologies chosen as a result of the previous analysis done.
3.1 Programming languages, technologies and tools that support web application development

In the previous chapter some JITIR agents were presented and as it was seen, most of them indexes and retrieves personal data that is stored in an intra-net or in the computer of the user. The propose of the Pandora Editor is to find information and images that exist in the web. In order to do this, there are APIs\(^1\) provided by commercial search engines and let the software developers to integrate the search engine in their applications. Next, three of the Search Engines APIs are analyzed.

3.1.1 Commercial Search Engines and their APIs

The APIs offered by three of the most used search engines are presented in this section in the Table 3.1. The analysis is done for: Google Search\(^2\), Yahoo Search\(^3\) and Bing Search\(^4\). The parameters taken into account to evaluate the APIs are the kind of search supported: web links, images, video, blogs, news, etc.; the cost of the queries depending on the number of queries or period of time; and the programming languages supported by the API.

<table>
<thead>
<tr>
<th>Search Engine</th>
<th>API last version</th>
<th>Search supported</th>
<th>Queries Cost</th>
<th>Languages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Custom Search</td>
<td>JSON/Atom API v1</td>
<td>Web and Images</td>
<td>100 search queries per day for free</td>
<td>HTML markup, javascript</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(20000 queries for $100 per year)</td>
<td></td>
</tr>
<tr>
<td>Google AJAX Search</td>
<td>v1.1 (depreciated library)</td>
<td>Web, Images, Video, Books, News, Blogs</td>
<td>unlimited</td>
<td>java (GWT), javascript</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yahoo BOSS Search</td>
<td>XML and JSON API v2</td>
<td>Web, Images, Video, News, Blogs (separated payment for each)</td>
<td>$0.80 per 1000 queries</td>
<td>XML, PHP</td>
</tr>
<tr>
<td>Bing Search</td>
<td>XML and JSON API v2</td>
<td>Web, Images, Video, News</td>
<td>$20 per 10000 queries (monthly)</td>
<td>jQuery, AJAX, C++ and Objective-C</td>
</tr>
</tbody>
</table>

\(^1\) Application Programming Interface to guide programmers to use and apply certain technology

\(^2\) https://developers.google.com/custom-search/docs/element

\(^3\) https://developers.google.com/custom-search/docs/element

\(^4\) https://developer.yahoo.com/boss/search/

\(^5\) http://datamarket.azure.com/dataset/bing/search
3.1.2 The Programming Languages and frameworks

The list of programming languages which support web application development is quite big. There are some tools and frameworks that together with the languages help the developers during the whole development process. The most popular languages are: PHP, Java (Java Servlets and JavaServer Pages), Javascript, Ruby, Python, C#, Visual Basic (ASP/ASP.NET). HTML and XML are not programming languages but are also used to create web applications. The Table 3.2 presents some languages and their characteristics.

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Java</th>
<th>PHP</th>
<th>.Net</th>
<th>Phyton</th>
<th>Ruby</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplatform</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hosting Availability</td>
<td>Wide</td>
<td>Wide</td>
<td>Costly</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Learning complexity</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Active community</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Third party libraries</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Development Frameworks</td>
<td>more than 30</td>
<td>more than 20</td>
<td>less than 10</td>
<td>more than 10</td>
<td>less than 10</td>
</tr>
</tbody>
</table>

Once that the Search Engines APIs and the programming languages were analysed, the decision about the technologies that are going to be used can be made. The next section presents the tools and technologies chosen.

3.2 Programming languages, technologies and tools selection

The Pandora Editor requires to process a considerable quantity of queries per user. As it was shown, the characteristics of Google AJAX search are adequate for the development of a project which is not going to be commercialized. The number of queries that can be processed are not limited and it supports web and image search together. It has not been a hard decision to make because Google provides a Google Developer site where the community and examples are provided. The Google AJAX Search API can be nicely embedded in Java projects through the use of Google Web Toolkit. This tools are explained next.

3.2.1 Web Application Framework

As it was mentioned before, the language chosen was Java but the application is composed by the client and server parts. Google Web toolkit (GWT) is a technology that helps the developers to program the client in java and later, the toolkit optimizes and compiles the code to JavaScript to finally have the browser-based application. GWT allows to embed JavaScript code into Java (JSNI) or implement the GWT query language GQuery.

The communication between the client and the server is done through GWT Remote Procedure Calls (asynchronously), and the server is the one that processes the text of the user to extract the keywords and formulate the queries. The plugin added to Eclipse was the GWT SDK 2.5.1.

6http://www.gwtproject.org/  
7http://code.google.com/p/gwtquery/
3.2.2 Google AJAX Search API

In 2010 some Google API Libraries were created specifically to run with GWT. One of those Libraries is the Google AJAX Search API\(^8\). Sadly, at the moment, the API is deprecated. However, the Google AJAX Search API version 1.1.0 worked correctly during previous tests done before the starting of the Pandora Editor project.

The API allows the creation of some search objects like Web, Image, Blog, Video, News and Books. For the Pandora Editor, only the search options of Web and Image are needed. The Google AJAX Search API permits the customization of the way the query is treated, the addition of search restrictions and the way of handle the results programmatically. The data structure that keep the results retrieved (SearchResultsHandler) just gives the possibility to access to the first four results.

3.2.3 Integrated Development Environment (IDE)

The IDE widely used that supports the development process in Java is Eclipse. The version to be used is Kepler for Java EE Developers together with the JDK\(^9\) version 7.

\(^8\)\url{https://code.google.com/p/gwt-google-apis/wiki/AJAXSearchGettingStarted}

\(^9\)Java Development Kit for Enterprise Edition
Chapter 4

The Pandora Editor

Contents

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In this chapter the description of the Pandora Editor is detailed. The first section
presents the architecture of the system; the second section shows the interface design for
the user interaction; and the final section exposes the Pandora Editor functionality and
the different modules developed.
4.1 The Pandora Editor Architecture

The Pandora Editor is a Client - Server web application. Every time that the user requires web information to support the document creation he may use the Pandora Agent.

The agent will check the current state of the text by taking the entire editor environment content. This content has to be preprocessed and once that it is ready, the keywords extraction can be done by calculating weights and evaluating them depending on the search scope.

The chosen keywords are going to be sent as queries to Google. One query may contain more than one word, so the Google API could help to make a final query words refinement (it adds scores to the words that conforms the query). Then, when the queries are processed by the Google Search Engine, the API will create a data structure per query and per kind of result (web or image). This data structure contains the retrieved results so they can be accessed by the agent. Finally, the agent will display the relevant web and image links.

The architecture of the agent is described next and the steps are enumerated according to the Figure 4.1.

---

Any time that the user has the need to get some useful information from the web, the JITIR agent will apply the next steps for each search scope façon 1:

1. The user asks the search request to the Pandora Agent.
2. The Pandora Agent will take the content of the editor and will send it to the server to be pre-processed.
3. The Preprocessing Service will receive the current user’s text and will pre-process

1Document level, Thematic Segments level and Noun phrases level

---
4. The Query Extraction Services will find the keywords by applying the corresponding algorithms. Formulation of the queries stage.

5. The Query or group of Queries is sent to the Pandora Agent.

6. The Agent will set the communication step with the Google AJAX Search API to send to it the queries formulated before.

7. Google will retrieve the results corresponding to each query.

8. The Agent will present the web and image results in the corresponding interface.

### 4.2 Interface Design

The design of the interface is based on the Mixed-Initiative User Interface which purpose is achieving the user’s needs and goals by implementing automated actions\(^3\) in unison with different metaphors or design conventions of direct manipulation interfaces.

The web application developed presents a simple text editor where the user can create his document. The Figure 4.2 shows a screen-shot of the welcome screen. In this view the user will have the Editor space where he can type to write the document. It also contains a table that will allow him to add some result images if there is the need. The user could choose among the 3 search scopes depending on the information results required. The final element is the Search button that will start the work of the Pandora agent search.

---

\(^2\) Application of Natural Language Techniques such as the use of regular expressions, removing of stopwords, sentences or paragraph extraction, POS, etc.

\(^3\) The implementation usually consists on the use of Artificial Intelligence learning techniques [10], users environment sensing and/or timing of services.
The second interface is the results view that is showed in the Figure 4.3 and has some elements:

- The Editor where the user can type and go on with the text creation.
- The table where he can add images by a drag and drop functionality.
- The panel that will display the different kinds of results from the web. The results can be web pages or images. If the result contains '*' and the representative colour is orange, it means that the results are for the Document Level. If the results are listed by numbers '1' '2' with a green colour it means that the results are for the Thematic Segments Level. If the results are listed by numbers in blue colour it means that the results are for the Noun Phrases Level. The user has also the option to select a word or a phrase in his text in order to start his own search. The results panel will present the results for user search showing a '-' .
- The Search button that depending on the Search Scope levels chosen will process and extracts the queries. The Search button also processes the user query if it detects that he selected a word or phrase in his text.
- There is the Text Processed button that will present a view of the text according to the previous search done: it will show the number of segments and also it will put in bold the noun phrases extracted.
- The full view button that will take the user to the Full or initial view of the application.

![Figure 4.3: The Pandora Editor - Results interface](image-url)
4.2.1 Feedback in the interaction

The Noun Phrases level search requires parsing the whole document in order to construct and identify the noun phrases in the user’s text. This functionality takes some time to be completed depending on the document length. The time is around 1 second per sentence detected. More detail about the library and algorithm is shown in the next section.

To let the user know about the time that the Noun phrases search will take, a message will be shown, allowing the user to cancel this search or to go on. The Figure 4.4 presents a screen shot of this message.

![Figure 4.4: The Pandora Editor - Option to cancel the Noun Phrases search](image)

The Figure 4.5 presents the feedback information related to the state of the current search. With this message, the user may realize that the Pandora Agent is working on finding the web and image results.

![Figure 4.5: The Pandora Editor - Feedback message about the current search state](image)
4.3 Implemented Modules

The functionality in the web application is focused on extracting the keywords from the user’s text. The keywords extracted should be meaningful according to the search scope. The main technique used was weighting the words that are part of the text by applying the tf-idf formula (Term Frequency-Inverse Document Frequency). This approach evaluates how representative or important is a word for a document in a collection. The importance of the word increases proportionally according to the number of times the word appears in the document but is offset by the frequency of the word in the corpus [16].

\[ \text{tf: number of times the word appears in the document.} \]
\[ \text{idf} = \log\left(\frac{N}{df}\right), \text{where N is the total number of documents and df is the total number of documents where the word was found.} \]

The weight for the word will be obtained by: \( \text{tf} \times \text{idf} \).

For instance, the agent’s work in the Document Level is to give a global vision of the whole document through the words extracted. More detail about the methods applied is explained in the next sections.

4.3.1 Document Scope

Indexing process, document classification, document summarization, web page retrieval, etc. need to find descriptive keywords for one document. In order to extract keywords or phrases that are meaningful for the document the IR techniques take the document and evaluate its content respect a collection of documents [17]. In the present project, the information analysis is done for a single document and there is no a group of documents behind that supports the methods for keywords extraction. The evaluation of a relatively short text is a little more complicated than having a corpus or collection of documents.

The details about the Document Scope Search are presented next.

4.3.1.1 Libraries

The main libraries used in this scope were from the java util package: the regex package in order to handle some regular expressions and the StringTokenizer class to separate the text into words.

4.3.1.2 Text Preprocessing

As the whole text is seen as a String, the first thing to do is to separate it in words. The class StringTokenizer will build an array of words found after tokenize the text according to the characters: ",.;, "¡¿()[]?!0123456789.

The technique of Stemming 4 was not applied to preprocess the text, but a class that identifies stopwords was developed. Therefore, to pre-process the text the English stopwords (it, the, an, so, etc.) were subtracted to not being considered as part of the user’s text and all the other words were handled all with low-case form.

Here an example is shown:

---

4Stemming helps to keep the basic form of the words: computer, computation, computing have the same base: comput
4.3.1.3 Descriptive Keywords Extraction

One technique that is used to extract keywords from the text when we do not have a corpus is to separate the text in segments or paragraphs and see the document as a collection of "documents". In this way we could apply the tf-idf formula to find the weight that the words have in each paragraph:

- \( \text{tf} \): number of times the word appears in the paragraph.
- \( \text{idf} = \log(\frac{N}{df}) \), where \( N \) is the total number of paragraphs and \( df \) is the total number of paragraphs where the word was found.

The weight for the word will be obtained by: \( \text{tf} * \text{idf} \).

To extract the keywords the next steps were followed:

- Separate the text into paragraphs.
- Pre-process the text per paragraph to have a list of words without stopwords.
- Find the frequency or the number of times that each word appears in the document (count setting the word in lower-case).
- Find the frequency or the number of times that the word appears in the paragraph (count setting the word in lower-case).
- Apply the tf-idf formula to find the weight for each word. The Figure 4.6 shows an example with a small list of words with the respective frequencies in the document and in the paragraph and their weights.
- Extract the keywords that would be part of the Query for the Document Level Search taking into account the next principles:
  - weight equal to 0 OR weight bigger than 3.5 AND
  - length of the word bigger than 4 AND
  - the word appears in more than half of the number of paragraphs OR the word appears more than 2 times in the paragraph.
  OR
  - the word starts with capital letter AND
  - the word appears in more than half of the number of paragraphs.

---

**Table 4.1: Stopwords Examples**

| the Stopword |
| alps |
| mountain |
| range |
| that Stopword |
| lies |
| within Stopword |
| switzerland |
4.3.1.4 Example

- Document (text taken from Wikipedia content about the Galpagos Islands):

The Galpagos Islands (official name: Archipilago de Coln, other Spanish names: Islas Galpagos) are an archipelago of volcanic islands distributed on either side of the Equator in the Pacific Ocean, 926 km (575 mi) west of continental Ecuador, of which they are a part.

The Galpagos Islands and their surrounding waters form an Ecuadorian province, a national park, and a biological marine reserve. The principal language on the islands is Spanish. The islands have a population of slightly over 25,000.[1] The islands are famed for their vast number of endemic species and were studied by Charles Darwin during the voyage of the Beagle. His observations and collections contributed to the inception of Darwin’s theory of evolution by natural selection.

The first recorded visit to the islands happened by chance in 1535, when the Bishop of Panam Fray Toms de Berlanga went to Peru to arbitrate in a dispute between Francisco Pizarro and Diego de Almagro. De Berlanga was blown off course, though he eventually returned to the Spanish Empire and described the conditions of the islands and the animals that inhabited them. The group of islands was shown and named in Abraham Ortelius’s atlas published in 1570. The first crude map of the islands was made in 1684 by the buccaneer Ambrose Cowley, who named the individual islands after some of his fellow pirates or after British royalty and noblemen. These names were used in the authoritative navigation charts of the islands prepared during the Beagle survey under captain Robert Fitzroy, and in Darwin’s popular book The Voyage of the Beagle. The then new Republic of Ecuador took the islands from Spanish ownership in 1832, and subsequently gave the islands official Spanish names.[2] The
older names remained in use in English language publications, including Herman Melville’s The Encantadas of 1854.

- Keywords extracted:
  Ecuador Galapagos Spanish islands Darwin Beagle

- Results retrieved in Figure 4.7

Figure 4.7: Example of results retrieved for a Document Level Search

4.3.1.5 Limitations

The content of the text editor written by the user must be as clean as possible. This is the reason that technically, the widget used as element to insert the text works with plain-text. For instance, it does not handle HTML content. It means that the sentences and paragraphs should be well defined.

Some sentences could be: 1. This is an easy example of sentence. 2. Am I writing a sentence? 3. This is only the beginning... 4. We need to show more examples! 5. As he said: "Everything changes".

The configuration the user has for his browser influences the kind of the results retrieved for a search. Therefore, it is necessary to have a browser which usage language and web results language is English.

4.3.2 Thematic Segmentation Scope

Normally, a document shows diverse subtopics expressed in the different segments or paragraphs. If we want to write about a musician, we could start with his biography; then we may mention his main works; later, his success around the world; etc. With the Thematic Segmentation level Search, the Pandora agent extracts a Query per each segment found in the user’s text. So, the results retrieved will be specific for each of the segments.

The details about the Thematic Segmentation Scope Search are presented next.

4.3.2.1 Libraries

Packages provided by the java libraries to process Strings are also used in this module. One external library was aggregated though. The name is UIMA Text Segmenter and allows the developer to divide the text in thematic segments.

4.3.2.2 Text Preprocessing

A text preprocessing was also done for this scope: tokenize the text according to the characters: ".;':"; and separate the English stopwords from the list of words found. The library to segment the text has its own approaches to preprocess the text: Stemming with the use of Porter Stemmer; the elimination of stopwords and also
the normalization of the sentences so that the size of a sentence does not influences in the whole text analysis.

4.3.2.3 Descriptive Keywords Extraction

To extract the keywords for each segment the next steps were followed:

- Apply the Text Segmenter library classes to separate the text into thematic segments.
- Pre-process the text to have a list of words per segment without the stopwords.
- Find the frequency or the number of times that each word appears in the whole document.
- Find the frequency or the number of times that the word appears in the segment.
- Apply the tf-idf formula to find the weight for each word. The Figure 4.8 shows an example with a small list of words with the respective frequencies in the document and in the segment and their weights.

<table>
<thead>
<tr>
<th>word</th>
<th>word frequency in the segment</th>
<th>word frequency in the document</th>
<th>tf-idf</th>
</tr>
</thead>
<tbody>
<tr>
<td>model</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
<tr>
<td>expansion</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
<tr>
<td>dominated</td>
<td>1</td>
<td>1</td>
<td>1.886</td>
</tr>
<tr>
<td>land</td>
<td>2</td>
<td>1</td>
<td>2.773</td>
</tr>
<tr>
<td>long</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
<tr>
<td>requirements</td>
<td>1</td>
<td>1</td>
<td>1.886</td>
</tr>
<tr>
<td>contrast</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>sacrificing</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>time</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
<tr>
<td>estates</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
<tr>
<td>farms</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>attractive</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>unproductive</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>cultivation</td>
<td>2</td>
<td>2</td>
<td>1.386</td>
</tr>
<tr>
<td>coffee</td>
<td>5</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>agriculture</td>
<td>2</td>
<td>1</td>
<td>2.773</td>
</tr>
<tr>
<td>possibility</td>
<td>2</td>
<td>1</td>
<td>2.773</td>
</tr>
<tr>
<td>farmer</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>new</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>market</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
<tr>
<td>local</td>
<td>1</td>
<td>2</td>
<td>1.386</td>
</tr>
<tr>
<td>remained</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>burn</td>
<td>1</td>
<td>1</td>
<td>1.386</td>
</tr>
<tr>
<td>small</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>based</td>
<td>1</td>
<td>2</td>
<td>0.693</td>
</tr>
</tbody>
</table>

Figure 4.8: Example of words with their frequencies in the document and in the segment

- Extract the keywords that would be part of the Query for that Thematic Segment Search taking into account the next principles:
  - weight equal to 0 AND
  - length of the word bigger than 4 AND
  - the word appears more than once in the segment.
  OR
  - length of the word bigger than 4 AND
  - the word appears more than once in the segment AND
The crisis that affected the large estates brought with it one of the most significant changes of the Colombian coffee industry. Since 1875 the number of small coffee producers had begun to grow in Santander as well as in some regions of Antioquia and in the region referred to as Viejo or Old Caldas. In the first decades of the 20th century a new model to develop coffee exports based on the rural economy had already been consolidated, supported by internal migration and the colonization of new territories in the center and western regions of the country, principally in the departments of Antioquia, Caldas, Valle, and in the northern part of Tolima. Both the expansion of this new coffee model and the crisis that affected the large estates allowed the western regions of Colombia to take the lead in the development of the coffee industry in the country.

This transformation was very favorable for the owners of the small coffee estates that were entering the coffee market. The cultivation of coffee was a very attractive option for local farmers, as it offered the possibility of making permanent and intensive use of the land. Under this productive model of the traditional agriculture, based on the slash and burn method, the land remained unproductive for long periods of time. In contrast, coffee offered the possibility of having an intense agriculture, without major technical requirements and without sacrificing the cultivation of subsistence crops, thus generating the conditions for the expansion of a new coffee culture, dominated by small farms. Although this new breed of coffee made of country farmers demonstrated a significant capacity to grow at the margin of current international prices, Colombia did not have a relatively important dynamism in the global market of this product. During the period between 1905 and 1935 the coffee industry in Colombia grew dynamically thanks to the vision and long term politics derived from the creation of the Federación Nacional de Cafeteros de Colombia (National Federation of Coffee Growers of Colombia) in 1927.

The union of local farmers and small producers around the Federation has permitted them to confront logistical and commercial difficulties that would not have been possible individually. With time and through the research made at Cenicaf, founded in 1938, and the Federation’s agricultural Extension Service, improved cultivation systems. More efficient spatial patterns were developed that permitted the differentiation of the product and supported its quality. Currently the Land of Coffee in Colombia includes all of the mountain ranges and other mountainous regions of the country, and generates income for over 500,000 coffee farming families.

- 4 segments were found and for each the Keywords extracted were:
  - Document Level: coffee country small Colombia farmers
  - 1st. segment: model coffee Antioquia regions country Caldas estates western crisis industry large Colombia
  - 2nd. segment: coffee agriculture possibility cultivation small Colombia
  - 3rd. segment: coffee Colombia
  - 4th. segment: Colombia
4.3.2.5 Limitations

The Thematic Segment Level Search will be able to work only if more than 1 segments were found. If this is not the case, the Pandora editor will limit the search for the Document Level search.

4.3.3 Noun-Phrases Scope

Through this scope the user will obtain results for some noun phrases extracted by the Pandora agent. For example, it would be helpful if he wants to have some information about phrases composed by proper nouns. Some examples will be shown later.

4.3.3.1 Libraries

To make this functionality work, one of the libraries that was used is the Stanford full parser\(^5\), with its release of January 2014. The package provides some options to the developers to work with different languages, some ways for training the algorithms and papers and examples to support the programming process.

The other library is the English Sentence Detector provided by the OpenNLP project\(^6\) of Apache, version 1.5. This library allows separating a plain text into well defined sentences.

4.3.3.2 Text Preprocessing

To use the library mentioned before, it is not necessary to make changes in the text. However, it must be separated into sentences. The parameter that the Stanford full parser receives is an English sentence for the scope of this project.

4.3.3.3 Descriptive Keywords Extraction

To extract the key - noun phrases from the user’s text the next steps were followed:

---

\(^5\)http://nlp.stanford.edu/software/lex-parser.shtml
\(^6\)https://opennlp.apache.org
• Apply the Sentence Detector library to separate the text into sentences.

• Apply the Stanford parser library for each sentence found.

• Extract the noun phrases detected by the Parser following the next principles:
  - noun phrase that contains two proper nouns OR
  - noun phrase that contains more than two words AND one of the words is a proper noun
  - do not choose the noun phrases extracted with the principles explained before if it contains a verb gerund or participle, a conjunction, a possessive pronoun, an adverb or an adjective.

4.3.3.4 Example

• Document (text taken from Wikipedia content about Walt Disney):
  Walter Elias "Walt" Disney was an American business magnate, animator, cartoonist, producer, director, screenwriter, philanthropist and voice actor. A major figure within the American animation industry and throughout the world, he is regarded as an international icon,[3] well known for his influence and contributions to the field of entertainment during the 20th century. As a Hollywood business mogul, he, along with his brother Roy O. Disney, co-founded Walt Disney Productions, which later became one of the best-known motion picture production companies in the world. The corporation is now known as The Walt Disney Company and had an annual revenue of approximately US$45 billion in the 2013 financial year.
  As an animator and entrepreneur, Disney was particularly noted as a film producer and a popular showman, as well as an innovator in animation and theme park design. He and his staff created some of the world’s most well-known fictional characters including Mickey Mouse, for whom Disney himself provided the original voice. During his lifetime he received four honorary Academy Awards and won 22 Academy Awards from a total of 59 nominations, including a record four in one year,[5] giving him more awards and nominations than any other individual in history.[6] Disney also won seven Emmy Awards and gave his name to the Disneyland and Walt Disney World Resort theme parks in the U.S., as well as the international resorts like Tokyo Disney Resort, Disneyland Paris, and Hong Kong Disneyland.
  He died on December 15, 1966, from lung cancer in Burbank, California. A year later, construction of the Walt Disney World Resort began in Florida. His brother, Roy Disney, inaugurated the Magic Kingdom on October 1, 1971.

• The list of the noun phrases extracted were:
  1. Walter Elias "Walt" Disney
  2. a Hollywood business mogul
  3. Roy O. Disney
  4. Walt Disney Productions
  5. The Walt Disney Company
  6. Walt Disney World Resort
  7. the Walt Disney World Resort
  8. Roy Disney
  9. the Magic Kingdom
4.3.3.5 Limitations

A parser algorithm as the one that is implemented in the Stanford Parser library requires some processing time to present the results [6]. Depending on the needs of the developer, the supporting NLP Stanford group suggests to use the Stanford Tagger instead of the Parser to avoid the processing cost to be high. Basically, the work of the Tagger is to label each word of a sentence assigning the corresponding Part Of Speech (POS) tag: This/DT, is/VBZ, an/DT, easy/JJ, sentence/NN, ./.; in that way, we could know if the word is a noun, a verb, a preposition, etc. For the Pandora Editor, the full Parser was required; so the main limitation is the time it takes to extract the noun phrases from each sentence. An example of a sentence Tagged and Parsed processed with the Stanford on-line parser service is shown in the Figure 4.11\(^7\).

The lexicalized probabilistic parser implemented in the Stanford Parser uses a Probabilistic Context-Free Grammar (PCFG) phrase structure and lexical dependency experts to have efficient exact inference. The lexicalized PCFG Parser algorithm can be studied in [8]. And the A* algorithm applied in the Stanford Parser can be seen in [14].

Basically in order to apply a PCFG parser, we need to have a set of rules that define the grammar, for example:

\[ \begin{align*}
\text{sentence} & \rightarrow \text{noun phrase} \\
\text{noun phrase} & \rightarrow \text{noun} \mid \text{noun phrase} \text{ verb phrase} \\
\text{verb phrase} & \rightarrow \text{verb} \mid \text{verb phrase} \text{ noun phrase} \\
\text{noun} & \rightarrow \text{noun} \mid \text{noun phrase} \\
\text{verb} & \rightarrow \text{verb} \\
\text{noun phrase} & \rightarrow \text{noun phrase} \text{ noun} \\
\text{verb phrase} & \rightarrow \text{verb phrase} \text{ verb}
\end{align*} \]

With those rules and the addition of conditional Probabilities (assigned by a function) for each the Parser will know how to find the structure of a sentence after tagging the words. With Lexicalization not only the rules mentioned before define the Parser, but also

---

\(^7\)http://nlp.stanford.edu:8080/parser/index.jsp
Figure 4.11: Example of a sentence Tagged andParsed with NLP Stanford libraries, using the online parser service

Rules of attachment, for example if we have the rule NP → NP(.) PP, the attachment will be through NP(.) or for the rule VP → VBD NP PP, the attachment will be through VBD. In the next image we can see an example:

```
NP(workers)

NNS(workers)
Workers

VBD(dumped)

NNP(sacks)
sacks

PP(into)

DP(a)

NNP(bin)
bin
```

Figure 4.12: Example of results retrieved for a Noun Phrases Level Search [8]
Table 4.2: Grammar rules or Phrase Structure Grammar example (Context-Free Grammar)

<table>
<thead>
<tr>
<th>Rule</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S \rightarrow \text{NP } \text{VP}$</td>
<td>0.8</td>
</tr>
<tr>
<td>$\text{VP } \rightarrow \text{V } \text{NP}$</td>
<td>0.4</td>
</tr>
<tr>
<td>$\text{VP } \rightarrow \text{V } \text{NP } \text{NP}$</td>
<td>0.05</td>
</tr>
<tr>
<td>$\text{NP } \rightarrow \text{D } \text{NP}$</td>
<td>0.2</td>
</tr>
<tr>
<td>$\text{NP } \rightarrow \text{NNP}$</td>
<td>0.35</td>
</tr>
<tr>
<td>$\text{NP } \rightarrow \text{N}$</td>
<td>0.05</td>
</tr>
<tr>
<td>$\text{NP } \rightarrow \text{Pron}$</td>
<td>0.4</td>
</tr>
<tr>
<td>$\text{VP } \rightarrow \text{Verb}$</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Chapter 5

User Evaluation

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In this chapter I present the details about the User Evaluation for the Pandora Editor application. First, the main aim of the tests is detailed. The next section explains the planning stage with all the steps descriptions. The section number three details the results obtained, and finally, the last section shows the analysis and conclusions for the evaluation.
5.1 User Evaluation Goal

The objective of the evaluation is to see if the results retrieved by the JITIR agent through Google by the use of auto-formulated queries are relevant for the user context. A second important point to measure is the user productivity in terms of time spent to create a document or find images and/or interruptions while doing the main activity.

The kind of evaluation applied is a Controlled Evaluation. It permits to test different design conditions and it is a scientific method which involves a hypothesis approach and statistical measures. All the steps followed during the user evaluation are described in this section.

5.2 Evaluation Planning

The next guidelines conforms the evaluation plan and state the phases needed before starting the user evaluation execution.

5.2.1 Hypothesis to test

Through the User Evaluation I want to test if there is a significant difference in the users productivity (efficiency and quality production) while using a text editor plus Google or by using the Pandora Editor. With the tests, the results will let us know if the users performance changes while doing a document writing task and a illustration through images task.

5.2.2 Independent variables

The independent variable to be analysed is the Interface to create a document and to find images with the support of web information results. This independent variable sets the two conditions that are part of the evaluation:

- C1 or condition 1: Text Editor + Google search in browser
- C2 or condition 2: The Pandora Editor

5.2.3 Dependent variables

The variables that are going to be measured are:

- For text creation:
  i. Number of links visited in Google vs number of links visited in the Pandora results.
  ii. Number of times the user formulated a query in Google vs queries proposed by the user in the Pandora Editor.
  iii. Length of the text produced.
  iv. Quality of the text produced.

- For finding images to represent a text:
  i. Number of images added.
  ii. Number of times the user formulated a query in Google vs queries proposed by the user in the Pandora Editor.
iii. Quality of the images added to represent the text.

5.2.4 Subject selection and assignment
The number of users to do the evaluation will be eight. Each user will test both conditions (within group test) and will do the Tasks 1.A, 1.B and the Tasks 2.A, 2.B according to the description in the Table 5.1.

The two tasks are divided in two groups. Each group has similar complexity tasks in order to keep a balance between both conditions. The time to complete the tasks is fixed. The tasks are:

- T1. Complete the text given.
  For this task the user will have to complete or improve a text provided.
  Time to complete the task: 8 minutes.
  Minimum length: 2 paragraphs (4 to 5 lines each).
  i. T1.A Sports in the world.
  The Appendix A contains the text provided and the instructions for the user.
  ii. T1.B Party organization.
  The Appendix B contains the text provided and the instructions for the user.

- T2. Illustrate the given text by adding images.
  For this task the user will have to represent the text given by using 10 pictures.
  Time to complete the task: 6 minutes.
  i. T2.1 Natural disasters: causes and effects.
  The Appendix C contains the text provided and the instructions for the user.
  ii. T2.2 Advances in medicine to improve health.
  The Appendix D contains the text provided and the instructions for the user.

5.2.5 Forms and documents required

- Training script. Appendix E contains the training script which allows the user to be familiarized with the Pandora Editor.

- Data Collection Forms. Appendix F contains the forms required at the moment of the evaluation, the 4 forms will be filled in per user. Some data need to be collected while the evaluation and other fields will be completed after the user test. (The Pandora Editor keeps a log file from where the information will be extracted).

- Evaluator Instructions script. Appendix G describes the steps that the evaluator must follow in order to succeed at the moment of the evaluation. Some steps need to be done first and some instructions to the user need to be explained.

- Qualitative measure questionnaire. Appendix H has a list of questions that are going to be filled in by the user after the execution of the tasks. This questionnaire has as main goal to measure subjective information about the user opinion and experience while using the Pandora Editor vs a Text Editor and Google.
<table>
<thead>
<tr>
<th>User</th>
<th>Condition</th>
<th>Task</th>
<th>Condition</th>
<th>Task</th>
<th>Task</th>
<th>Q1</th>
<th>Condition</th>
<th>Task</th>
<th>Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>C1</td>
<td>T1.B</td>
<td>C2</td>
<td>T1.A</td>
<td>1</td>
<td></td>
<td>C1</td>
<td>T2.B</td>
<td>C2</td>
</tr>
<tr>
<td>4</td>
<td>C1</td>
<td>T1.B</td>
<td>C2</td>
<td>T1.A</td>
<td>1</td>
<td></td>
<td>C1</td>
<td>T2.B</td>
<td>C2</td>
</tr>
<tr>
<td>7</td>
<td>C2</td>
<td>T1.B</td>
<td>C1</td>
<td>T1.A</td>
<td>1</td>
<td></td>
<td>C2</td>
<td>T2.B</td>
<td>C1</td>
</tr>
</tbody>
</table>
Table 5.2: Quality Measure for the Task 1 and Task 2

<table>
<thead>
<tr>
<th>Annotator</th>
<th>Document Creation</th>
<th>Images Illustration</th>
<th>For the Users</th>
</tr>
</thead>
</table>

5.2.6 Final step for the evaluation: Quality Tests

In order to measure the Quality of the images added in the Task 2, 4 extra users that are going to be identified as Annotators will be required. Every annotator will evaluate if the documents produced and if images added to the text are good. For this the Appendix I shows an example of what the annotators will evaluate.

Every annotator will evaluate all the documents and images produced by the 8 users.

5.3 Results Obtained

As it was said before, there is one general hypothesis to be tested. To do this, we need to do one test per dependent variable. The type of test applied will be Pared-samples t test\(^1\) for each dependent variable formulated.

In a t-test the independent variable help us to identify two mutually exclusive conditions: Text Editor + Google and The Pandora Editor, while the dependent variable identifies a quantitative dimension: number of words, number of images, quality rate, number of queries, etc.

With this kind of evaluation we will know whether the mean value of the dependent variable for one condition (Text Editor + Google) differs significantly from the mean value of the dependent variable for the second condition (The Pandora Editor).

To apply the t-test we have to set a Null Hypothesis (Ho.) and the data that will be useful is:

- \( n = 8 \) for the number of users.
- \( \alpha = 0.05 \) for 95 \% of confidence interval
- \( \text{dof} = n - 1 = 7 \) for the degree of freedom in a Pared Sample t-test

The critical value for \( t \) at \( \alpha = 0.05 \), two-tailed test, \( \text{dof} = 7 \) is \( \rho = (\pm)2.365 \) for the value extracted from the distribution table Student.

The formula to calculate the \( t \) value is:

\[
t = \frac{\bar{X}}{S} \sqrt{n} \tag{5.1}
\]

Were:
- \( \bar{X} \) = mean of the difference of the data between Condition 1 and Condition 2
- \( S \) = the Standard Deviation of the difference of the data between Condition 1 and Condition 2

---

\(^1\)The type of test chosen agrees with the evaluation context: 1 independent variable with 2 Conditions for a Experiment Within-group
Having $\rho = 2.365$, if the value $t$ is out of the range $-2.365$ and $+2.365$ the null hypothesis will be rejected so there is significant difference. If the evaluator prefers the use of Probabilities, he can work with $P(t)$ and if the probability $P(t) < 5\%$ the null hypothesis will be rejected so there is significant difference.

### 5.3.1 Results in Document Creation Experiments

1. Ho. There is no difference in the document length of a text produced in a text editor + Google or a text produced in the Pandora Editor.

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>207</td>
<td>177</td>
</tr>
<tr>
<td>2</td>
<td>153</td>
<td>305</td>
</tr>
<tr>
<td>3</td>
<td>148</td>
<td>212</td>
</tr>
<tr>
<td>4</td>
<td>221</td>
<td>204</td>
</tr>
<tr>
<td>5</td>
<td>170</td>
<td>184</td>
</tr>
<tr>
<td>6</td>
<td>231</td>
<td>221</td>
</tr>
<tr>
<td>7</td>
<td>176</td>
<td>162</td>
</tr>
<tr>
<td>8</td>
<td>239</td>
<td>270</td>
</tr>
</tbody>
</table>

$\bar{X}_{C1} = 193,125$  $\bar{X}_{C2} = 216,875$

$S^2_{C1} = 1283,268$  $S^2_{C2} = 2353,839$

$t = -1.11720064$

$P(t) = 0.300973476$

**Results:** The $t$ value of $-1.117$ does not fall within the critical region defined by the critical value of $2.365$, and the $p$-value of $0.30$ is greater than alpha of $0.05$. Therefore the null hypothesis is accepted. The average length of a text produced in the Pandora Editor ($\bar{X} = 216,875$, $S = 2353,839$) is not statistically greater than average length of a text produced in a text editor + Google ($\bar{X} = 193,125$, $S = 1283,268$).

2. Ho. There is no difference in the number of queries formulated by the user in Google with the number of user queries (text selection by the user to make his own search) formulated in Pandora.

$t = -1.667$

$P(t) = 0.139$

**Results:** The $t$ value of $-1.667$ does not fall within the critical region defined by the critical value of $2.365$, and the $p$-value of $0.139$ is greater than alpha of $0.05$. Therefore the null hypothesis is accepted. The average number of queries produced by the user in the Pandora Editor ($\bar{X} = 4,625$, $S = 15,982$) is not statistically greater than average number of queries formulated by the user in a text editor + Google ($\bar{X} = 2,75$, $S = 1,643$).
Table 5.4: Number of Queries Produced Test

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

$\bar{X}_{C1} = 2.75 \quad \bar{X}_{C2} = 4.625$

$S^2_{C1} = 1.643 \quad S^2_{C2} = 15.982$

3. Ho. There is no difference in the number of result links visited in Google and the number of links visited in Pandora.

Table 5.5: Number of Links Visited Test

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

$\bar{X}_{C1} = 3.25 \quad \bar{X}_{C2} = 4.625$

$S^2_{C1} = 2.5 \quad S^2_{C2} = 19.125$

$t = -1.151$

$P(t) = 0.287$

Results: The t value of -1.151 does not fall within the critical region defined by the critical value of 2.365, and the p-value of 0.287 is greater than alpha of 0.05. Therefore the null hypothesis is accepted. The average number of links visited by the user in the Pandora Editor ($\bar{X} = 4.625, S = 19.125$)is not statistically greater than average number of links visited by the user in a text editor + Google ($\bar{X} = 3.25, S = 2.5$).

4. Ho. There is no difference in the document quality produced by the users of a text editor and Google or the users of the Pandora Editor.

$t = 0.648$

$P(t) = 0.537$
Table 5.6: Document Produced Quality Test

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Annotators S² C1</th>
<th>Condition 2</th>
<th>Annotators S² C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3,222</td>
<td>1,333</td>
</tr>
<tr>
<td>2</td>
<td>2,778</td>
<td>2,333</td>
<td>3,111</td>
<td>1,333</td>
</tr>
<tr>
<td>3</td>
<td>2,667</td>
<td>0,333</td>
<td>3,667</td>
<td>2,333</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2,667</td>
<td>0,333</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2,333</td>
<td>1,333</td>
</tr>
<tr>
<td>6</td>
<td>3,333</td>
<td>2,333</td>
<td>3,667</td>
<td>1,333</td>
</tr>
<tr>
<td>7</td>
<td>3,333</td>
<td>0,333</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>3,333</td>
<td>1,333</td>
<td>2,667</td>
<td>2,333</td>
</tr>
</tbody>
</table>

\[ \bar{X} \text{ C1} = 3,0555 \]
\[ \bar{X} \text{ C2} = 2,875 \]

\[ S^2 \text{ C1} = 0,067 \]
\[ S^2 \text{ C2} = 0,4354 \]

Results: The t value of 0.648 does not fall within the critical region defined by the critical value of 2.365, and the p-value of 0.537 is greater than alpha of 0.05. Therefore the null hypothesis is accepted. The average quality rate of a text produced in the Pandora Editor (\( \bar{X} = 2.875, S = 0.435 \)) is not statistically greater than average quality rate of a text produced in a text editor + Google (\( \bar{X} = 3.055, S = 0.067 \)).

5.3.2 Results in Image Finding Experiments

1. Ho. There is no difference in the number of images added for a text by using a text editor + Google or by using the Pandora Editor.

Table 5.7: Number of Images Added Test

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

\[ \bar{X} \text{ C1} = 8.625 \]
\[ \bar{X} \text{ C2} = 9.5 \]

\[ S^2 \text{ C1} = 1,696 \]
\[ S^2 \text{ C2} = 1,143 \]

\[ t = -1.824855361 \]
\[ P(t) = 0.11 \]

Results: The t value of -1.823 does not fall within the critical region defined by the critical value of 2.365, and the p-value of 0.11 is greater than alpha of 0.05. Therefore the null hypothesis is accepted. The average number of images added to a text by
the user in the Pandora Editor ($\bar{X} = 9.5, S = 1.143$) is not statistically greater than average number of images added to a text by the user in a text editor + Google ($\bar{X} = 8.625, S = 1.696$).

2. Ho. There is no difference in the number of queries formulated by the user in Google to find the images with the number of user queries (text selection by the user to make his own search) formulated in Pandora to find images.

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>17</td>
</tr>
</tbody>
</table>

$\bar{X}_{C1} = 9.625$  $\bar{X}_{C2} = 10.5$

$S^2_{C1} = 4.839$  $S^2_{C2} = 18.286$

$t = -0.516247292$

$P(t) = 0.622$

Results: The t value of -0.516 does not fall within the critical region defined by the critical value of 2.365, and the p-value of 0.622 is greater than alpha of 0.05. Therefore the null hypothesis is accepted. The average number of queries that the user formulated in order to find representative images for a text in the Pandora Editor ($\bar{X} = 10.5, S = 18.286$) is not statistically greater than average number of queries that the user formulated in order to find representative images for a text in a text editor + Google ($\bar{X} = 9.625, S = 4.839$).

3. Ho. There is no difference in the quality of the images added by the users for a specific text by the use of Google or by the use of the Pandora Editor.

$t = 0.91712$

$P(t) = 0.39$

Results: The t value of 0.917 does not fall within the critical region defined by the critical value of 2.365, and the p-value of 0.39 is greater than alpha of 0.05. Therefore the null hypothesis is accepted. The average quality rate of the added images for a text by using the Pandora Editor ($\bar{X} = 2.817, S = 0.493$) is not statistically greater than average quality rate of the added images for a text by using a text editor + Google ($\bar{X} = 3.0417, S = 0.3529$).
### Table 5.9: Images Added Quality Test

<table>
<thead>
<tr>
<th>User</th>
<th>Condition 1</th>
<th>Annotators $S^2$</th>
<th>Condition 2</th>
<th>Annotators $S^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.7</td>
<td>0.833</td>
<td>3.3</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>2.867</td>
<td>0.967</td>
<td>2.3</td>
<td>0.467</td>
</tr>
<tr>
<td>3</td>
<td>2.367</td>
<td>0.567</td>
<td>3</td>
<td>1.167</td>
</tr>
<tr>
<td>4</td>
<td>2.8</td>
<td>0.7</td>
<td>2.133</td>
<td>0.933</td>
</tr>
<tr>
<td>5</td>
<td>2.6</td>
<td>1.6</td>
<td>2.967</td>
<td>1.1</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>1.2</td>
<td>4.1</td>
<td>1.133</td>
</tr>
<tr>
<td>7</td>
<td>3.433</td>
<td>1.4</td>
<td>1.933</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>2.567</td>
<td>0.867</td>
<td>2.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>

$$\bar{X}_{C1} = 3.0417$$  $$\bar{X}_{C2} = 2.817$$

$$S^2_{C1} = 0.353$$  $$S^2_{C2} = 0.493$$

### 5.3.3 Results obtained in the Questionnaire for qualitative measures

This results present the subjective view or perception of the users after doing the tasks and having used the interfaces: Text Editor + Google and The Pandora Editor.

1. How useful did you find the following user interface while writing the text? (Please, give a rate from 1: less useful to 5: most useful)

![Figure 5.1: Interfaces rate (Document creation task)](image)

Nonparametric Statistical Test:
Ho. There is not difference between the rates that measure how useful is the C1 Text Editor + Google and the rates obtained by the C2 Pandora Editor for the document creation task.

By applying Mann-Whitney U test (two-tailed):
$$\alpha = 0.05$$

The Z-Score is -1.6278. The p-value is 0.1031. The result is not significant at p = 0.05.
Table 5.10: Document writing task: how useful were the interfaces?

<table>
<thead>
<tr>
<th>Results</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of Ranks</td>
<td>52</td>
<td>84</td>
</tr>
<tr>
<td>Mean of Ranks</td>
<td>6.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Expected sum of ranks</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Expected mean of ranks</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>U-value</td>
<td>48</td>
<td>16</td>
</tr>
<tr>
<td>Expected U-value</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

2. How useful did you find the following user interface while adding images? (Please, give a rate from 1: less useful to 5: most useful)

Figure 5.2: Interfaces rate (Images Finding)

Nonparametric Statistical Test:
Ho. There is not difference between the rates that measure how useful is the C1 Text Editor + Google and the rates obtained by the C2 Pandora Editor for the image finding task.

By applying Mann-Whitney U test (two-tailed):
\( \alpha = 0.05 \)

Table 5.11: Image Illustration task: how useful were the interfaces?

<table>
<thead>
<tr>
<th>Results</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of Ranks</td>
<td>52.5</td>
<td>83.5</td>
</tr>
<tr>
<td>Mean of Ranks</td>
<td>6.56</td>
<td>10.44</td>
</tr>
<tr>
<td>Expected sum of ranks</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Expected mean of ranks</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>U-value</td>
<td>47.5</td>
<td>16.5</td>
</tr>
<tr>
<td>Expected U-value</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

The Z-Score is -1.5753. The p-value is 0.1141. The result is not significant at \( p = 0.05 \).
3. The Pandora Editor search results were useful at the moment to do the tasks?  
(Please, give a rate from 1: less useful to 5: most useful)

![Pandora Web/Image Results](image)

Figure 5.3: Pandora Editor Results Rate

4. What would you find useful to support you in document creation? - To have a list of topics related to the subject of my text  
- The information that a result link presents should be more specific to know if the web page is going to be useful or not for me  
- To add the references in my text every time that I am using this information  
- To have all the useful information in one single page

5. Do you have suggestions about the Pandora Editor application? - It would be useful to have links about the meaning of some vocabulary found in the text, as the same as places or people mentioned  
- Save the important links  
- I would like to have a search box to do my own search  
- A zoom option to see the images better  
- I would like to have more image results  
- I would like to choose only web results or only images  
- The icons assigned to the search levels are not so intuitive  
- The resize of the images in the table should be automatic  
- I would like to add the images directly in the text  
- To have shortcuts to avoid the use of the mouse

5.4 Result Analysis

According to the results there is no significant difference in the users productivity (efficiency and quality production) while using a text editor plus Google or by using the Pandora Editor. The users performance is similar for the two tasks done, document writing and images addition. However, the results show that the values obtained for the Pandora Editor are higher than those for the first condition: by using Pandora the users visited more links, generated more queries, added more images and wrote more words.
While measuring the quality, there is no significant difference for the document quality and images finding quality by the use of both conditions.

It is necessary to say that the results obtained for the Number of images added to illustrate a text given has a very low probability \( t = 0.11 \); which is so close to the minimal value accepted \( P(T) = 0.05 \) and it favours the Pandora Editor.

The subjective measures test done through the Questionnaire shows that 50% of the users rated the user interface of Pandora Editor with a value of 4 and the other half gave a value of 5; being 5 the highest value as 'very useful' for the document writing task. For the same task, the use of the Text Editor and Google got a rate of 4 from 62% of the users, but 25% of them rated this condition with a value of 3 while 1 (13%) user rated it with 5.

For the images addition task, the Pandora Editor interface was rated with 4 by half of the users, 38% of them valued it with 5 and 13% gave a rate of 3. For Google, 62.5% of the users rated its useful feature with 4 and 37.5% of them gave a value of 3.

The information to measure how useful both interfaces were shows that between 4 and 5 users evaluated them with a value of 4. This rate is high but it is not the maximum value of users satisfaction about utility of the tools. However, an average measure shows that the Pandora Editor reach 4.4 in interface useful rating while the text editor + Google got 3.8 in average. The statistical tests presented that the difference between the 'useful' rates for the two conditions is not significant.

The evaluation about how useful the Pandora Editor results were showed that 75% of the users rated them with a value of 4; the other 25% gave a rate of 5. It lets us know that in general, the results retrieved by the JITIR agent were enough to support both tasks done.

The results obtained for the questions 4 and 5 of the questionnaire about the user’s needs at the moment of writing a document and suggestions show that they have information requirements while doing a web search like: they would like to have easy access to the other links related to the topic they write, more relevant summary information of the link\(^2\), the automatic addition of references, links with the definition of important keywords in the text and more relevant images.

\(^2\)This information is called Snipped and generally underlines de keywords the user inserted in the Query
Chapter 6

Conclusions

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The final chapter describes the limitations for this version of the Pandora Editor. The conclusions and future work will be also detailed.
6.1 Limitations

The main limitation that the Pandora Editor has is that it cannot run off-line. It is a web application that sets a connection with Google Search, so for the version developed the user must have internet access.

The performance of the JITIR agent will be affected if the browser language or web pages results language configuration are not English. The NLP techniques applied are oriented to work with a user’s text written in English, so the browser configuration is important.

It is recommended the Pandora Editor runs in the browsers: Mozilla Firefox or Google Chrome. Despite the fact that a GWT web project is optimized to run correctly in most of the commercial browsers, some drawbacks were found by using the application in Internet Explorer.

As the JITIR Agent must monitor the user’s text to extract the queries, if the length of the text is too short, unusual sentences are detected or the content is not clear (plain text required) the results will not be relevant for that context.

6.2 Conclusions

This master thesis presents a research work on Just in Time Information Retrieval Agents that help or assist the user while he is creating a text. The agent is in charge of analyzing the user’s text and presenting some web and image link suggestions that are relevant to the topic that the user is writing. The Pandora Editor is a web application which implemented an agent that is going to extract keywords from the text and display links always that the user starts the search in any of the three scopes proposed: Document Level Search, Thematic Segments Level Search and Noun Phrases Level Search. The user is who has the control about the search scope choice and the moment of searching, based on the Mixed Initiative User Interface design.

The queries formulated by the agent are a combination of keywords and depending on the Search Scope, the algorithms to pre-process the text and give a weight to the words are specific. The Pandora Editor prototype works with English texts and the results found for each query send are retrieved thanks to the implementation of methods provided by the Google AJAX API.

The proposal of this project wanted to define an interaction paradigm to verify if the users of the Pandora JITIR agent were able to be more productive while creating a document or finding images than by using a text editor plus a search engine. The user evaluation showed that there is not a significant difference in terms of users’ efficiency while they were working with the Pandora Editor or a common editor. However the tests showed that they were able to handle more information from the web by using the Pandora Editor. The qualitative measures or subjective evaluation presented that the users found the interaction with the Pandora Editor more useful for both tasks done but the statistical tests presented that the difference between the ‘useful’ rates for the two conditions is not significant.

I could say that the results obtained did not present variation in the users’ performance and quality production tasks because they are used to work with Google daily, so it means a high degree of expertise working with a search engine and self-queries formulation. My final conclusion and recommendation for IR Agents evaluation is to choose a bigger group of users, let them to be well trained in the JITIR Agent (if the interface is simple, they do not need days to get familiar with it, but the process of knowing the application and
all the services it provides during certain period of time is very important); and prepare tasks that allow the users work more time under both test conditions.

The future work presented next is generally based on the suggestions given by the users who had the opportunity to participate in the User Evaluation stage of the Pandora Editor project. Pandora shows to be a friendly application that required around 5 minutes of training to be understood. If the future work ideas could be implemented there would be people using the tool in order to support them while they write a document.

6.3 Future work

There are useful proposals for the future work that can be done with the Pandora Editor idea. The implementation of more images retrieval seems to be a must, for example. During the evaluations, the users found that having a text editor together with web results in the same work environment is very useful but they still have information needs. Therefore, the implementation of more Search Scopes (Entity Search, recent related documents Search and similar topics Search) will be good to add.

Some field studies or careers depend a lot on document creation, so specific Pandora Editors could be developed. For example, a journalist writing about the latest news would like to have an editor and web results about news in the world, news in the country, articles from blogs, image, video or audio resources, maps to locate certain event and go for an interview, etc.

In the area of Collaborative IR the future work in Pandora could let the users interact each other if they have written or are writing about the same topic. Some networks could be developed around writers-topics.

Incorporate the references or citations automatically each time the writer uses others’ content (text or images) is one feature that would be appreciated by document authors as the same as the extension of more languages handling.
Bibliography


A.1 Text provided

So many people find that by practising any physical activity they can keep healthy and entertained. There is no a unique aim, one can do sports because of competition, for a good mental and physical condition, to increase the social relationships, to learn to be disciplined and reach a goal, to reduce stress, to enjoy, etc. Every sport has a group of norms which define it. These rules allow the sport to be recognized internationally. Sports are part of the people’s lives and practising a sportive activity is considered a human right. Generally, the propitious environmental conditions influence the way a sport is practised. According to the geographical situation and even cultural issues, one can see that a sport is practised in a country but not in others ...

A.2 Instructions

You are writing about different kinds of sports and some of them are practised in specific countries in the world. Some sports are very popular and of course there are famous sportsmen/women and sport teams.

Time to complete the task: 8 minutes.

Minimum length: 2 paragraphs (4 - 5 lines each).

1. For this task an initial text is provided. It will be shown when you start the task. Please, read it well.
2. The task is to improve or complete the text given by producing at least 2 paragraphs.
3. You should NOT add images for this task.
4. If you finish before the time given, please notify to the evaluator and do not close your Text Editor.

Remember: Assume that you are writing ‘Wikipedia Content’, so that your document could be published in the web.
Appendix B

Party Planning Task 1.B

B.1 Text provided

It is supposed that a party is something enjoyable. Why does it need to be planned? Depending on the kind of party one would like to have, there are always previous things to verify before the important event. The first thing to think about is the number of people who are going to be invited. It is better to have a list with their names, phone numbers and addresses, so that the organizer can think in the party place according to the number of guests. The next step is to choose an hour and date and reserve the place...

B.2 Instructions

What are the main steps to follow to organize a party? What should be considered to succeed in the organization? What would the guests like the most?

Time to complete the task: 8 minutes.

Minimum length: 2 paragraphs (4 - 5 lines each).

1. For this task an initial text is provided. It will be shown when you start the task. Please, read it well.
2. The task is to improve or complete the text given by producing at least 2 paragraphs.
3. You should NOT add images for this task.
4. If you finish before the time given, please notify to the evaluator and do not close your Text Editor.

Remember: Assume that you are writing 'a Magazine Content', so that your document could be published.
Appendix C

Natural disasters: causes and effects Task 2.A

C.1 Text provided

The Earth is dynamic and as a consequence, some natural phenomena occur. These phenomena are known as natural disasters and have their origin because of normal or abnormal behaviour in the interaction of the Earth Layers (lithosphere, biosphere, hydrosphere, atmosphere and exosphere). Phenomena like geological, biological, physical or chemical are produced normally by natural processes in the Earth. Natural Phenomena that occur in the lithosphere are earthquakes and volcanic eruptions; in the hydrosphere we have tsunamis and floods; in the atmosphere the disasters are hurricanes, tornadoes, electric shocks, thunders and lightning; in the biosphere: species extinction, changes in biodiversity, and forest fires and in the exosphere we have meteors and asteroids fall.

For example, earthquakes are a result of tectonic plate activity; they occur when the grinding or collision of plates along a fault line releases seismic energy that shakes the surrounding ground. While areas near major fault lines such as the San Andreas Fault are prone to Earth’s most frequent and intense seismic activity, earthquakes can affect nearly every location on the planet. A quake may last from several seconds to a few minutes, posing its greatest threat in its ability to collapse man-made structures. When disaster struck in Haiti on 12 January, 2010, it was the lithosphere that shook with a category 7 earthquake, resulting in the deaths of approximately 230,000 people, 300,000 injured and one million rendered homeless.

While certain geographic areas are particularly susceptible to specific natural disasters, no region on Earth is free from the risk of a cataclysmic event. Earth normal behaviour is also affected because of human activities. Human intervention and settlements can increase the frequency and severity of natural hazards and disasters. For instance, water and air pollution, waste increase, natural resources improper exploitation (forests, minerals), industrial activities and human population exponential increase, influence in the behaviour of the environment producing Earth phenomena.

In summary, the three components of a natural disaster are: the cause (the natural processes and interactions in the Earth Layers), the resultant phenomenon of their interaction (hurricane, tsunami, earthquake, flood, etc.) and the effects (kinds and level of damages that could be measure as calamity or catastrophe). An example could be: The cause: Ocean water warming plus atmospheric disturbances, the phenomenon: hurricane, and the effect: social and economic catastrophe.
C.2 Instructions

Add images to the text.

Time to complete the task: 5 minutes.

1. For this task a text is provided. It will be shown when you start the task. Please, read it well.
2. The task is to illustrate or represent the text given by adding 10 pictures.
3. You should NOT modify the text.
4. If you finish before the time given, please notify to the evaluator and do not close your Text Editor.

Remember: The images added should be the most adequate for the given text.
Appendix D

Advances in medicine to improve health Task 2.B

D.1 Text provided

Throughout the health care community, small groups of individuals work together as teams. Physicians, nurses, pharmacists, technicians, and other health professionals must coordinate their activities to make safe and efficient patient care a priority. But their training and experience must be complemented by medical equipment and technology. The investment in medical research and technology has big benefits and impact in diagnostics, procedures, prostheses, devices and medicines.

General practitioners and specialists prescribe drugs and order diagnostic tests. Surgeons and other specialists select appropriate procedures, prostheses and devices, while hospitals purchase large diagnostic and surgical equipment and administrative support systems. All of these decisions are influenced by a range of factors, some of which have promoted demand for new technologies and some of which have constrained it. Recent studies have shown the benefits of some advances in medicine: New cancer drugs account for 50 to 60 per cent of the gains in US cancer survival rates (which have increased from 50 to 63 per cent) since 1975. New and innovative medications for asthma have resulted in a 28 per cent decline in mortality from the condition in Australia over the 1990s. Cataract surgery results in an average gain of 1.25 quality-adjusted life-years. Insulin pumps for diabetes patients improve patient quality of life and prolong life by an average of five years by reducing diabetes-related complications.

There are some broad themes emerging from current research and development including: genomics research has the potential to provide a revolutionary set of tools for tackling disease, such as the development of biological treatments; increased targeting or personalization of medicine linked to the development of biological therapies; convergence of technologies such as drugs and devices, and blurring of the distinction between techniques traditionally used for diagnosis and for delivering treatment will continue; and the prospect of significant developments in the treatment of the major diseases of ageing (cancers, diabetes, dementia and arthritis), which are expected to impose the greatest disease burdens in future.
D.2 Instructions

Add images to the text.

Time to complete the task: 5 minutes.

1. For this task a text is provided. It will be shown when you start the task. Please, read it well.
2. The task is to illustrate or represent the text given by adding 10 pictures.
3. You should NOT modify the text.
4. If you finish before the time given, please notify to the evaluator and do not close your Text Editor.

Remember: The images added should be the most adequate for the given text.
Appendix E

Training Script

E.1 Pandora Editor Goal

The Pandora Editor is a web application that supports document creation. The main goal is to assist the writer with web and image information from the internet without having the user formulate search queries because the Pandora Agent will do this for the user by extracting the queries from his text.

E.2 Pandora Editor Search Scopes

While you are writing a document you can select the Pandora Search scopes to do a web and image search.

The three scopes are:
- Document Level: The Pandora Agent extracts a query from your document and sends it to Google. The query represents your whole document.
- Thematic Segment Level: The Pandora Agent extracts a query from each thematic segment. For example, if Pandora defined 3 segments in your text, 3 queries (one per segment) are going to be extracted and send to Google. The query is represents one segment.
- Noun Phrases Level: The Pandora Agent extracts some noun phrases which could be interesting to support your text creation. Every noun phrase extracted is going to be sent to Google.

Depending on the size of the text, the display of the search results could take some time, so you need to be a little patient.

Some Dialog boxes will be shown during the text processing and query searching. The aim is to let you know the current state of the Pandora Search.

E.3 Pandora Editor Interface Views

The application presents two different views to the user:

1. The full view has the Editor space where you can type to write the document. It also contains a table that will allow you to add some images if you want. You could choose among the 3 search scopes depending on your need. The final element is the Search button that will start the work of the Pandora agent search.
2. The results view which has some elements:

- The Editor where you can type and go on with your text.
- The table where you can add images by drag and drop functionality.
- The panel that will show you the different kind of results from the web. The results can be web pages or images. If the result contains '*' it means that the results are for the Document Level. (Orange colour)
  If the results are listed by numbers '1' '2' it means that the results are for the Thematic Segments Level. (Green colour)
  If the results are listed by numbers in blue colour it means that the results are for the Noun Phrases Level. (Blue colour)
  NOTE: at any time you can select a word or a phrase in your text in order to start your own search. The results panel will present the results for your own search showing a '-'.
- The Search button that depending on the Search Scope levels chosen will process and extract the queries. The Search button also processes your own query if it detects that you selected a word in your text.
- There is the Text Processed button that will present a view of your text according to the previous search done: it will show the number of segments and also it will put in bold the noun phrases extracted.
- The full view button that will take you to the Full or initial view of the application.
Appendix F

Data Collection Forms

F.1 Form to collect data: Text Editor + Google

The necessary data to collect for this condition are: number of queries formulated by the user, number of links visited from the search page and number of images the user added. The next figure F.1 shows the example form.

![Form for Text Editor + Google](image)

Figure F.1: Form to collect data: Text Editor + Google

F.2 Pandora Editor Evaluation Version to collect data

If the tasks are done by using the Condition 2 which is the Pandora Editor, there is no need of a form because one Pandora Editor Evaluation Version was implemented.

With this version the Data collected is: User ID, Name of the Task, Number of round, Document Length, Number of results clicked for each search scope, Number of results clicked for User Queries done and Number of User Queries generated. The figure F.2 shows an example.
Figure F.2: The Pandora Editor Evaluation Results Example (Document creation task)
Appendix G

Evaluator Instructions Script

G.1 Before the Evaluation

Before each test with the users, the evaluator should:
1. Delete the browser’s historical of websites previously visited.
2. Prepare the browsers links to maintain the Text Editor + Google environment and
   Pandora Editor environment opened.
3. Prepare the forms corresponding to the User ID.
4. Prepare a folder where to save the User results.

G.2 During the Evaluation

1. Apply the Pandora Editor Training script detailed in Appendix E.
2. Explain to the User the goal of the Evaluation.
3. Give to the User the Instructions per Task corresponding to the Tables 5.1 ans 5.2.
   The instructions are in the Appendixes A, B, C and D.
4. Save the User Evaluation results.
5. Ask the User to fill the Questionnaire of the Appendix H once that the tasks were
   completed.

G.3 After the Evaluation

Verify that all the previous steps were done correctly.
Appendix H

Qualitative Measure Questionnaire

1. How useful did you find the following user interface while writing the text? (Please, give a rate from 1: less useful to 5: most useful)

   1. Text Editor + Google

      ![Text Editor + Google]

      □ 1 □ 2 □ 3 □ 4 □ 5

   2. The Pandora Editor

      ![The Pandora Editor]
2. How useful did you find the following user interface while adding images to the text? (Please, give a rate from 1: less useful to 5: most useful)

1. Text Editor + Google

2. The Pandora Editor
3. The Pandora Editor search results were useful at the moment to do the tasks? (Please, give a rate from 1: less useful to 5: most useful)

4. What would you find useful to support you in document creation?

5. Do you have suggestions about the Pandora Editor?
Appendix I

Example of the Evaluation to measure the Quality

I.1 Measure the Quality of a Text

Is the content of the next text good to be published in Wikipedia or in a Magazine? Please, give a rate from 1 as very bad to 5 as very good.

I.2 Measure the Quality of the Images that represent the text

Please, read the next document:

Throughout the health care community, small groups of individuals work together as teams. Physicians, nurses, pharmacists, technicians, and other health professionals must coordinate their activities to make safe and efficient patient care a priority. But their training and experience must be complemented by medical equipment and technology. The investment in medical research and technology has big benefits and impact in diagnostics, procedures, prostheses, devices and medicines.

General practitioners and specialists prescribe drugs and order diagnostic tests. Surgeons and other specialists select appropriate procedures, prostheses and devices, while hospitals purchase large diagnostic and surgical equipment and administrative support systems. All

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1The extracts were taken from Impacts of Advances in Medical Technology in Australia, Productivity Commission Research Report, 2005
of these decisions are influenced by a range of factors, some of which have promoted demand for new technologies and some of which have constrained it.

Recent studies have shown the benefits of some advances in medicine: New cancer drugs account for 50 to 60 per cent of the gains in US cancer survival rates (which have increased from 50 to 63 per cent) since 1975. New and innovative medications for asthma have resulted in a 28 per cent decline in mortality from the condition in Australia over the 1990s. Cataract surgery results in an average gain of 1.25 quality-adjusted life-years. Insulin pumps for diabetes patients improve patient quality of life and prolong life by an average of five years by reducing diabetes-related complications.

There are some broad themes emerging from current research and development including: genomics research has the potential to provide a revolutionary set of tools for tackling disease, such as the development of biological treatments; increased targeting or personalization of medicine linked to the development of biological therapies; convergence of technologies such as drugs and devices, and blurring of the distinction between techniques traditionally used for diagnosis and for delivering treatment will continue; and the prospect of significant developments in the treatment of the major diseases of ageing (cancers, diabetes, dementia and arthritis), which are expected to impose the greatest disease burdens in future.

Are the next images good/adequate to represent the text previously read? Please, give a rate for each image from 1 as very bad representing the text to 5 as very good representing the text.
Appendix J

Digital content

J.1 Digital media attached

The DVD attached to the Master Thesis Report contains:

- The PDF file with the Master Project Report: Just in Time Information Retrieval Agent to support Text Creation, based on the Mixed Initiative User Interface Design.

- A folder with the source code of the Pandora Editor web application. To import and run the project it will be needed to add the GWT plugin to the Eclipse IDE and use 'Import App Engine Sample Apps' to choose the project folder in the DVD.

J.2 Access to the Pandora Editor

The Pandora Editor is running in the Google App Engine. The link for the users who would like to see the application is http://pandoraeditor.appspot.com/