Adapting web content for low-literacy readers by using lexical elaboration and named entities labeling

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ABSTRACT

In this paper we describe a web content adaptation tool for assisting low-literacy readers to access online information. The“Educational FACILITA” tool provides innovative features and the design of more intuitive interaction models. Especially, we propose an interaction model and web application that explore the Natural Language Processing tasks of lexical elaboration and named entity labeling for improving web accessibility.

Categories and Subject Descriptors

H.3.1 [**Content Analysis and Indexing**]: Dictionaries, Linguistic processing, Thesauruses;; H.5.3 [**Group and Organization**]: Web-based interaction; H.5.4 [**Hypertext/-Hypermedia**]: User issues

General Terms

Design, Human Factors

Keywords

Web content adaptation, Web accessibility, Natural language processing

1. INTRODUCTION

The large capacity of Web for providing information leads to multiple possibilities and opportunities for users. The development of high performance networks and ubiquitous devices allow users to retrieve content from any location and in different scenarios or situations they might face in their lives. Further to retrieving information, current technologies also enable users to contribute to the authoring of content on the Web by means of forums, blogs and wikis, in the so called “Web 2.0” [33].

Unfortunately the possibilities offered by the Web are not necessarily currently available to all. Individuals who do not have completely compliant software or hardware that are able to deal with the latest technologies, or have some kind of physical or cognitive disability, find it difficult to interact with web pages, depending on the page structure and the ways in which the content is made available. In this context, Web accessibility studies work towards implementing processes and recommendations that lead the design of interfaces that have their access granted for all users regardless of the special needs they might present.

The pre-eminent reference when addressing Web accessibility is the WCAG (Web Content Accessibility Guidelines) [19, 12]. The WCAG establish a set of guidelines that discuss accessibility issues and provide accessibility design solutions [30, 31]. It requires the manual implementation of technological and design solutions by Web developers and content authors [34, 32]. However, there is no guarantee that the guidelines will be followed. Freire et al., for example, conducted a survey about accessibility awareness of people involved in Web development in Brazil [13] and the web accessibility in Brazilian Municipalities websites [11]. Their conclusions were that web accessibility is far from being actually considered in Brazil and that much work remains to be done.

WCAG documents address not only structure and technological aspects. Guideline 14 in WCAG 1.0 (to ensure that documents are clear and simple) and Guideline 3.1 (to make text content readable and understandable) in WCAG 2.0, for example, provide recommendations about how the content should be made available to users. However, Web developers are not always responsible for content preparation and authoring in a Website.Moreover, in the current “Web 2.0” context, users, without any prior knowledge about the guidelines, directly participate in the content authoring process of Web applications. This may make it even more difficult to develop completely WCAG conformant Websites.

Since 2001, the INAF index (National Indicator of Functional Literacy) has been annually computed to measure the levels of functional illiteracy of Brazilian population. The 2009 report presented a still worrying scenario: 7% of the individuals were classified as illiterate; 21% as literate at the rudimentary level; 47% as literate at the basic level; and only 25% as literate at the advanced level [22]. Thus, we argue that an assistive technology for adapting web content is an urgent necessity for digital inclusion of low literacy

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people, specially when we consider that a large portion of Brazilian people (about 28%) are functional illiterate.

In this scenario, we present in this paper a Web technology and Natural Language Processing (NLP) combined solution to adapt web content for poor literacy readers. Particularly, mainly following WCAG, we explore the NLP tasks of lexical elaboration and named entity labeling to assist poor readers having access to web content. We developed an interaction model and a web application to provide such functionalities.

Our on-line tool, called "Educational FACILITA"[1], is part of a bigger project – PorSimples [1] – on Text Simplification for Brazilian Portuguese language , which aims at producing tools for aiding web text authors to produce simpler texts and for assisting (poor) readers to have access to relevant written material.

Although the work described in this paper was originally designed for addressing a local (Brazilian Portuguese) issue, our solution was intended to be generic enough to be applied for other languages. In fact, most of our decisions were based on prominent works on Text Adaptation for other languages, some of which will be reported in the next section.

In the next section we briefly introduce the main related works in the area, while our proposal is described in Section 3. Some final remarks are made in Section 5.

2. RELATED WORK

The WCAG checkpoint 14.1 (WCAG 1.0) and success criteria 3.1.5 (WCAG 2.0) discuss the importance of Websites containing textual content with reading levels that match users reading skills.

In order to automatically adapt Websites to the WCAG checkpoint 14.1 "Use the clearest and simplest language appropriate for a site's content" (WCAG 1.0) and the success criteria 3.1.5 "Reading Level" (WCAG 2.0), Watanabe et al. developed the Facilita application [34]. Facilita works as a browser plug-in and uses Automatic Summarization and Syntactic Simplification operations to adapt Website textual content into accessible versions that would be more adequate for low literacy users.

The present work builds up on Watanabe et al. Facilita application [34], however, instead of only simplifying texts available on web pages, we automatically provide textual elaboration (EL) using synonyms for the words which we classify as difficult to be understood by low-literacy readers and also add semantics for specific textual elements available on the Web page. Specifically, the semantics that we add is related to named entities recognition and classification (NERC), which is a task generally associated with the area of information extraction (IE). Following we review several works related to our proposal.

2.1 Content Presentation and Interaction

Many studies report on the development and design of interfaces for low literacy individuals [33, 34, 24, 20, 18, 27, 14]. In order to enhance the content comprehension of the content, the studies use different kinds of media and communication modes that partially or totally replace the textual content available on the interfaces.

One of the ways to replace the textual media on the interfaces used in previous studies is the voice and audio interface. Text-to-Speech and automatic speech recognition are used to provide input information on the applications [24].

The use of graphical representations for content presentation is another commonly referenced resource for the design of interfaces for low literacy users. Medhi et al. [20] state that graphical representation comprehension depends on the domain that the information represents and the culture context of users. Besides the graphical representation use for presenting information, some studies describe the use of color for indexing information [18], videos tutorials [27] and tabular information for structuring data [14], among others.

Although many of the discussed studies have successfully evaluated the effectiveness of the approach developed on them empirically, none of them deal with automatic generation of content or were deployed on the Web architecture.

The automatic content generation context and deployment over the Web architecture implies some technological restrictions on the applications and interfaces implementation. For example, when addressing the context of automatic generation of content, it is very complex to implement the automatic retrieval of images or graphical representations that fully address the main theme of a Web page or even replace it entirely.

Specifically, when considering the technological restrictions imposed by the Web architecture, the use of audio and voice interfaces is important. Although speech versions of the content can be offered by technologies such as applets for static content, the automatic speech recognition or text-to-speech resources have very restrict uses on the Web platform. Multimodal development technologies, such as the XHTML+Voice [3], already address this issue, but the XHTML+Voice technology currently is only available for the English language. Regarding the Portuguese language, the "Internet Browser with Speech Recognition and Syntesis"[1] aims at the development and improvement of an Internet browser with speech recognition and synthesis functionality for this language, however the project is currently on initial stages.

Web pages often contain pop-up, ads information, and complementary information that might distract or make it difficult for users to access the main content of a Web page. Gupta et al. [15] implemented an automatic content extraction mechanism in order to aid visually impaired and blind users read a page by not having the screen reader software to read all the clutter in the page before reaching the main content. The approach used by Gupta et al. describes the use of a host of heuristics that filters web page's clutter (adds, animations and extraneous links) to provide users with a more accessible version of the web page. They use the DOM structure of a web page in order to navigate through its content and extract information that might disturb users searching and reading the content. Although the approach used by Gupta et al. removes extraneous content from the web page and might change its layout, it does not adapt the inner parts of the elements that were not filtered. The approach is responsible for deciding on which elements will be displayed, however it does not affect the content that is inside them.

Bigham and Ladner [6] introduce the Accessmonkey framework as a contribution towards the goal of automatically

[1] http://vinho.intermidia.icmc.usp.br/watinha/Educational-Facilita/

[1] http://www.bv.fapesp.br/projetos-pipe/637/navegador-internet-reconhecimento-sintese-fala

helping users with special needs interact with the Web. Bigham and Ladner's work suggests the use of a Javascript framework to deliver browser plugins that automatically adapt the webpage in order to make it more accessible to users. Even though the use of local scripting languages might provide a great deal of possibilities for the development of web accessibility solutions, the study does not focus on how to adapt the webpages textual content. Our approach resembles the use of a Javascript framework since we rely on the use of Jetpack[2], a Javascript language framework aimed at implementing Firefox browser addons. Our work directly addresses the textual adaptation scenario on webpages, describing other resources that are required to provide the assistance.

2.2 Text adaptation and NLP

Text adaptation is a very well known practice used in educational settings. Young [36] mentions two different techniques for text adaptation: Text Simplification and Text Elaboration. The first can be defined as any task that reduces the lexical or syntactic complexity of a text while trying to preserve meaning and information and it is subdivided into Syntactic Simplification, Lexical Simplification, Automatic Summarization, and other techniques. Text Elaboration aims at clarifying and explaining information and making connections explicit in a text, using definitions, synonyms or hypernyms of the text words. Text simplification can be used to maximize the comprehension of low literacy users since mismatching the reading level of the application textual media with the reading skills of users can impact severally on the users access to the application [4, 26].

Specifically for English language learners (ELLs), educational research suggests that text adaptation can facilitate both reading comprehension of content and English language skills development [7]. According to Yano et al. [35], text modifications seem to have positive effects on second language comprehension. Another study by Urano [28] also present some support for the assumption that lexical modification, or at least lexical elaboration, facilitates second language reading comprehension. The results from his study confirmed that elaboration is more favorable than simplification in terms of vocabulary acquisition. Moreover, he also states that one occurrence of each target word with lexical elaboration may not be sufficient to acquire its meaning, although more advanced learners may be able to learn some of the words with only one occurrences. Although our envisioned user is different from the ones of Urano, we follow this study by using two Portuguese thesauruses for presenting simpler synonymies for complex words.

Petersen and Ostendord [23] show two important operations for lexical adaption for bilingual education: (a) to remove unnecessary information from the text, and (b) to add information that better explains difficult terms. Our work follows the second option since weuse short definitions from Wikipedia to define some text entities and propose the use of other Web applications and Social Web resources to improve the identification and to better explain the textual entities found on a Web page.

Elhadad [10] investigates how to improve access to medical literature for health consumers, focusing on medical terminology. They present a method to predict automatically in a given text which medical terms are unlikely to be understood by a lay reader. With regards to improving reader comprehension, they propose a method to provide appropriate definitions, as mined from the World Wide Web, for the terms predicted to be unfamiliar. For English, some lexical resources are available, like the MRC Psycholinguistic Database, which helps to identify difficult words using psycholinguistic measures, but no such resources exist for Portuguese. To deal with the Portuguese language, we have compiled a list of simple words composed of words supposed to be common to youngsters (from Biderman[5]), a list of frequent words (from news texts for children) and a list of concrete words available in Janczura et al. [17].

Burstein et al. [7] presents ATA, an educational tool that generates various text adaptation types: vocabulary support (word substitutions by easier ones), generation of English and Spanish marginal notes, and English and Spanish text-to-speech synthesis. While this work addresses second language learners, we focus on low-literacy readers.

Devlin and Unthank [9] present the HAPPI (Helping Aphasic Peolple Process Information) project. In their work, they present the use of a textual simplification method that replaces words that are not understood by users with words which have the same meaning but are more common. Devlin and Unthank's approach was implemented in a Web application that allows users to copy and paste texts from different sources, instead of having the simplified version of the same text presented to users. Additionally the paper also describes the retrieval of other kinds of media (images and audio with spoken versions of the word) to represent the concept to users). Devlin and Unthank's assistance model of textual simplification (lexical simplification, more specifically) is very similar to the one that we are carrying out. However, instead of focusing on text simplification, our work reports the use of text elaboration methods (lexical elaboration) and named entities labeling. The main audience of both works is also different,since our application aims at low literacy individuals.

Named Entities (**NE**s) primarily refer to proper names and targets names of persons, locations, and organizations, which are very often the answers to the common "W questions" *Who?* and *Where?*. The extended named entity task, also includes numeric phrases, such as dates, times, monetary amounts, and percentages, which are often the answers to other common questions *When?* and *How Much?*

NEs are currently being used in a varied range of applications, such as the identification of entities in molecular biology [16], text classificational [2] and question answering [21].

Uren et al.[29] present the use of information extraction and named entities recognition methods to produce annotations which could be highlighted with Magpie Semantic browser to enhance search performance. For Portuguese, there is a system from Cortex-Intelligence company that performs NE annotation for text mining purposes. The system may be tested at www.cortex-intelligence/engine. Such works differ from ours, since they envision other applications than text adaptation for poor readers.

Another important difference among the studies is that our work developed specific ways of interacting with users on the Web. Our Web interface prototype was developed integrated to the browser (like a plug-in or add-on for browsers), and by taking this approach it becomes possible to auto-

[2] https://jetpack.mozillalabs.com/

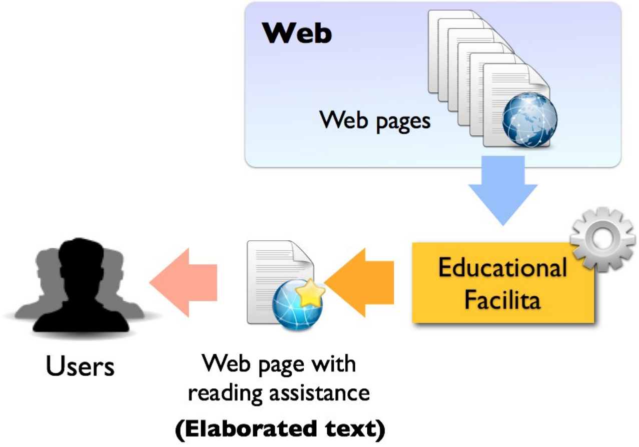


Figure 1: General schema of Educational FACILITA

matically extract the textual content to be passed on to the textual processing operations, to have users activating the assistance directly from the Web page, and to present the results directly on the Web application in which the user was reading the original content.

3. EDUCATIONAL FACILITA

In Brazil, a large part of the population faces difficulties with reading and comprehending texts depending on text size and linguistic complexity; therefore, access to media that use texts as their primary way to convey information is limited. In this scenario, we developed Educational FACILITA, which is a Web application aimed at assisting users in understanding textual content available on the Web.

The WAI (Web Accessibility Initiative) through the WCAG 2.0 in the Success Criteria 3.1.3 acknowledges the importance of providing mechanisms to help users to understand unusual words that might be presented on Web sites. Educational FACILITA, in this context, automatically adaptsthe content of Web sites in order to provide mechanisms that present users with synonymous or short definitions for words, which are classified as unusual, or difficult ones to be understood by the users. Educational FACILITA also displays additional and complementary information about named entities (NEs) that are contained on the Web sites text. Educational FACILITA'S assistance is illustrated on Figure 1, representing the reading assistance mechanisms automatically included on the web page to be presented to the end users.

It is expected that these additional information presented in the text by the proposed approach would help users better understand Websites's textual content and allow users to learn the meaning of new or unusual words/expressions.

In order to present the reading assistance to users, Educational FACILITA makes use of the following NLP (Natural Language Processing) modules: Lexical Elaboration (Section 3.1.1) and Named Entities Recognition and Pos-Classification (Section 3.1.2).

We were also very careful with the interface design of Educational FACILITA. Given our envisioned final user, it is necessary to develop an interface that takes low-literacy individuals limitations into account, implementing interactions that are simple to use, and more adequate to the users computer skills.It is worth observing that Educational FACILITA requires two resources: (a) the browser Firefox 3.5 previously installed, and (b) the Jetpack installed.

In this context, we also report the development and integration of different Web technologies that were used with the intention of keeping the application's interaction as simple and as natural as possible. As a result, Educational FACILITA became able to automatically identify the textual content on the Web page, and insert the reading assistance mechanisms in the original Web page itself, without having to change its design or functionality. Therefore Educational FACILITA requires less effort of users.

In the following sections, we first describe our NLP modules (Section 3.1), the key features designed for Educational FACILITA (Section 3.2), and the implementation details (Section 3.3), including the proposed architecture and the technological requirements.

3.1 NLP Modules

3.1.1 Lexical Elaboration

The first part of the lexical simplification consists of tokenizing the original text and marking the words that are considered complex. In order to judge a word as complex or not, we use 3 dictionaries created for the PorSimples Project, as cited in Section 2: one for common words to youngsters, one composed of frequent words, and one of concrete words. If a word is not in the simple words dictionary and is not a proper noun, we assume it to be a complex word.

The lexical elaboration module also uses the Unitex-PB dictionary[3] for finding the lemma of the words in the text, so that it is possible to look for it in the simple words dictionary.

The problem of looking for a lemma directly in a dictionary is that there are ambiguous words and we are not able to deal with word senses. For instance, in Portuguese, the word "canto" may mean the noun "corner", as well as the verb "sing".

For dealing with the Part of Speech (PoS) ambiguity, we use the MXPOST POS tagger [25] trained over NILC tagset[4], whose purpose is to automatically tag the text and identify each word PoS category.

After the text is tagged, the words from the text that are not proper nouns, prepositions and numerals are selected, and their POS tags are used to look for their lemmas in the dictionaries. The tagger does not ahve not a 100% precision and some words may not be in the dictionary. Hence, we look for the lemma only (without the tag) when we are not able to find the word-lemma combination in the dictionary. Still, if we are not able to find the word, the lexical elaboration module assumes that the word is complex and marks it.

The last step of the process consists in providing simpler synonymies for the marked words. For this task, we use the thesauruses TeP 2.0[5] and PAPEL[6] for Portuguese language2. This operation is carried out when the user clicks

[3] http://www.nilc.icmc.usp.br/nilc/projects/unitex-pb/web/dicionarios.html

[4] http://www.nilc.icmc.usp.br/nilc/TagSet/ManualEtiquetagem.htm

[5] http://www.nilc.icmc.usp.br/tep2/

[6] http://www.linguateca.pt/PAPEL/

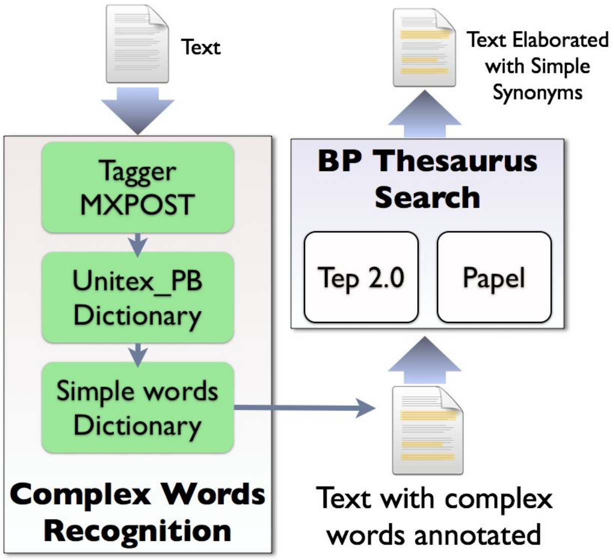

Text
Tagger MXPOST
Unitex_PB Dictionary
Simple words Dictionary
Complex Words Recognition
Text with complex words annotated
BP Thesaurus Search
Tep 2.0
Papel
Text Elaborated with Simple Synonyms

Figure 2: Complex words processing

on a marked word. It triggers a search in the thesauruses for synonymous words that are also in the common words dictionary. If simpler words are found, they are listed in order, from the simpler to the more complex ones. To determine this order, we used Google API to search each word in the web: we assume that the more frequently a word happens, the simpler it is. Although this may lead to some imprecision, it is a good approach to the problem.

As far as we know, TeP has about 45,000 words grouped into 20,000 synonym clusters. PAPEL is a larger repository, with about 100,000 words.

The general process of annotating and dealing with complex words is shown in Figure 2.

3.1.2 Named entities recognition and pos-classification

Following results from educational research that suggests that text adaptation can facilitate both reading comprehension and vocabulary acquisition, we added encyclopedia knowledge as additional information for some terms from the text. Particularly, we added information from Wikipedia. Figure 3 shows the general architecture.

The chosen terms are the named entities (NEs), which were already defined in Section 2, to which we add small extracts from Wikipedia. We look for extracts that define the NE under focus, which generally appear in the beginning of the Wikipedia documents.

Names of people, places and organizations are examples of NEs, e.g., "João Almeida", "Rio de Janeiro" and ' 'Petrobrás". NE recognition (NER) corresponds to the task of automatically identifying such terms. The sentence below shows an example of a sentence with a NE identified:

`<NE class="PersonName">Alberto Santos Dumont</NE> was a Brazilian inventor.`

It is important to notice that the NER task may be also manually carried out. Usually, if the annotation task is well defined, humans perform better than NER systems.

In previous evaluations of NER systems for Portuguese conducted by Linguateca[7], one of the best systems was Rembrandt [8], achieving a general accuracy of about 57%. It classifies NEs into 9 general classes, which in turn may be subcategorized into other 47 classes, and accesses Wikipedia for improving its categorization and indexing the NEs. Therefore, besides the class of a NE, the system also retrieves its basic definition from Wikipedia. The system is freely available and open source.

For this project, we had to adapt Rembrandt to our final users. The first adaptation was the redefinition of the classes, in order to remove complex subcategories and to change difficult class names to more common ones. These changes make the NE labels more easily understandable by poor readers. For instance, the subcategory "ephemeris" of the class "happening" was renamed to "historical event". Such decisions were based on consults to several information sources, as TeP 2.0, Wikipedia, and dictionaries.

We also verified whether the first sentences of Wikipedia pages were really the definition of NEs. We performed a statistical test with a group of 10 randomly selected pages from DBPedia, which is a sample of Wikipedia with 250,000 articles. In 9 out of this 10 groups we got a positive answer, what results in a 95% confidence level for our hypothesis. Our estimate is that 73.5% of Wikipedia articles are definition sentences.

3.2 Key features

One of the biggest concerns when dealing with low-literacy users is related to their lack of computer experience. Taking that into account, all of our design decisions were made with focus on simplicity of interaction, in order to require less effort from users.

The first key feature of Educational FACILITA is to automatically extract textual content from the Web page currently being accessed (viewed) by the user. The second one is to integrate the reading assistance mechanism on the same Web page that activated Educational FACILITA.

In order to implement the functionalities, Educational FACILITA makes use of the following textual processing modules:

- **Readability module**: some of the text processing techniques that we use require the establishment of concrete relations among the words that belong to a phrase in the text. From this stage we can identify phrases inside any Web page that is being presented to users we adapted theReadabilityapplication1 to only identify the main textual content present into Web pages. The Readability Module selects a specific element from the DOM tree of the Web page as the main element of the document, in which it becomes easier to indentify phrases.

- **Lexical Elaboration**: this module evaluates the complexity of each word separately. Accordingly to the result of this evaluation Educational FACILITA will present the user with synonyms for the complex words. The synonyms provided by Educational FACILITA are simpler, therefore more easily understood by users.

- **Named Entities Recognition**: this module is responsible for identifying and presenting users with information about named entities in a text. In order to

[7] http://www.linguateca.pt/harem/

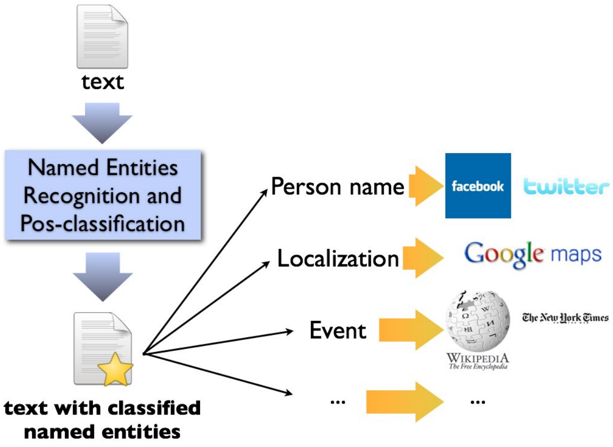

text
Named Entities Recognition and Pos-classification
text with classified named entities
Person name
facebook
twitter
Localization
Google maps
Event
WIKIPEDIA The Free Encyclopedia
The New York Times
...
...

Figure 3: Named Entities processing

make this information available to users, we use Rembrandt to both label the named entities and also direct them to theircorrespondent link in the Wikipedia[8]. It is important to notice that the Named Entities Recognition methods identify theclassof the named entities present in the text. And by doing that we can extend Educational FACILITA prototype to search for references about the named entity identified in other resources available on the Web, in the future. For example, if we find the named entity "New York", the named entity recognition system would identify it as being of the class "Location". With that information we could look for a reference of the named entity found in the Google Maps Web application[9] and present the query's result to the user. It is important to notice also that even though there are possibilities of integrating Educational FACILITA with others Web applications like the one mentioned previouly, currently the prototype only implements the Wikipedia short definition and image extraction routines. This kind of operation is illustrated on Figure 3.

The three modules work as presented on Figure 4. First we execute the readability module on the Web page to identify the main text contained in it. Next we simultaneously run the Named Entity Recognition and the Lexical Elaboration modules having as input the main text identified by the Readability module. Next, we integrate the outputs from both the Named Entity Recognition and the Lexical Elaboration modules into a single HTML code. Finally, we insert the HTML code into the Web page which activated the Educational FACILITA assistance.

It is worth noticing the Educational FACILITA was implemented, initially, just for Brazilian Portuguese. Given that the applications and modules already implemented are devoted to this language. However, porting Educational FACILITA to other languages just require the replacement of the NLP modules (Section 3.1) by other modules with the same functionality for the respective languages of interest, preserving the same architecture.

To avoid interfering the accessibility mechanisms or design characteristics already implemented on the Web site that activated the reading assistance, while integrating the generated mechanisms on the Web page, Educational FACILITA attempts to change the page's functionality and design at minimal rates.

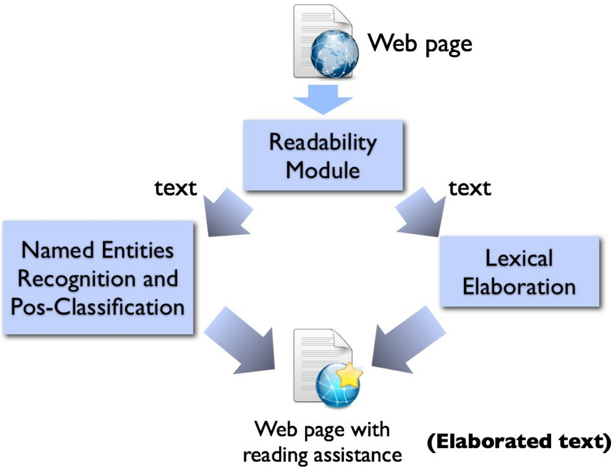

Web page
Readability Module
text
text
Named Entities Recognition and Pos-Classification
Lexical Elaboration
Web page with reading assistance
(Elaborated text)

Figure 4: Educational FACILITAs modules integration.

The integration with minimal changes of original web design exploited in Educational FACILITA was achieved just by adapting the Web page parts pointed out by the textual processing methods. Our approach respects the existent Web mechanisms. For example, when our approach points out accessibility issues in parts of the original Web page that we identify some kind of mechanism or functionality already implemented (such as a link or anchor) Educational FACILITA chooses to keep the previously implemented functionality unchanged.

3.3 Web implementation

Educational FACILITA'S development required several resources that are not directly available for common Web technologies. A few clear examples of development limitations of currently available resources imposed by the Web platform include:

- **Same-origin policy**: the same-origin policy is a security restriction imposed on the client scripts (like JavaScript) that operate in a Web application. The policy restricts the use of HTTP (HyperText Transport Protocol) remote requests that target domains that are different from the domain that originated the Web page?s interaction. It means that Educational FACILITA would not be able to directly request information from other sources, like Wikipedia or Google Maps.

- **HTTP Proxy approach**: to adapt existing Web applications structure and content, a development alternative, from the Web platform point of view, would be to implement an HTTP Proxy. HTTP Proxy would be able to act in the middle of common Web interaction, between the user and the Web page that activated Educational FACILITA. However, in order to activate the reading assistance, it would be necessary

[8] http://www.pt.wikipedia.org
[9] http://maps.google.com

to redirect the user to the Web application proxy, literally changing the entire context of the previous Web page, which activated Educational FACILITA. This approach is implemented by Google Translate application[10], and might break the Web page's local scripting functionality, due to Javascript incompatibilities.

For those reasons, Educational FACILITA was implemented on the browser application level, instead of being developed on the common Web applications level. We used the Mozilla Jetpack platform[11], and developed Educational FACILITA as an extension for the Firefox Browser[12]. By choosing the browser level platform of development we also had advantage of the browser features to enhance Educational FACILITA's design and functionality. Examples of the browser features that are not available on the Web application level include:

- No restriction over HTTP remote requisitions
- Better control over browser persistent data (allowing the implementaion of cache strategies)
- Browser interface components management functions (tabs, notifications, menus).

The use of browser level routines also facilitates the integration of the different text processing modules that are required to Educational FACILITA. Each of the three modules (Section 3.2) is implemented in a different environment, in a way that they cannot necessarily be implemented in Javascript or in the Jetpack Platform. For example, the Lexical Elaboration module was developed in PhP, while the Named Entities recognition runs over Groovy[13] in Java language. These requirements lead us to use webservices to deliver the modules functionality together in Educational FACILITA.

From the technological point of view, the designed architecture is illustrated in Figure 5. In Figure 5, we also illustrate how other services and data resources such as Facebook and Google Maps could be integrated in Educational FACILITA.

4. EDUCATIONAL FACILITA PROTOTYPE

The Educational FACILITA prototype that we implemented runs as a Jetpack Extension for the Firefox Browser.

The assistance is made available to end users by means of the following interactions:

1. Activating the Educational FACILITA link, which inserts the Reading Assistance mechanisms in the web page.
2. Browsing the highlighted textual entities, presented by the JetPack feature (Figure 6); the highlighted textual entities could be every difficult or complex word and named entities identified in the text.
3. Clicking on the highlighted words or expressions, that user could be interested in seeing the synonymous (Figure 7) or additional information, as illustrated on Figure 8.

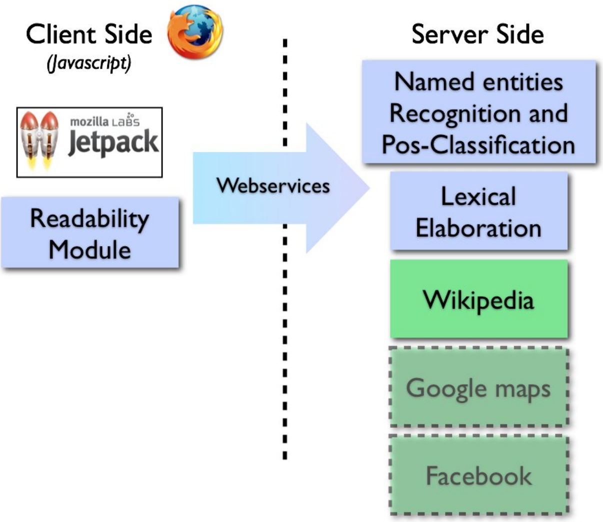
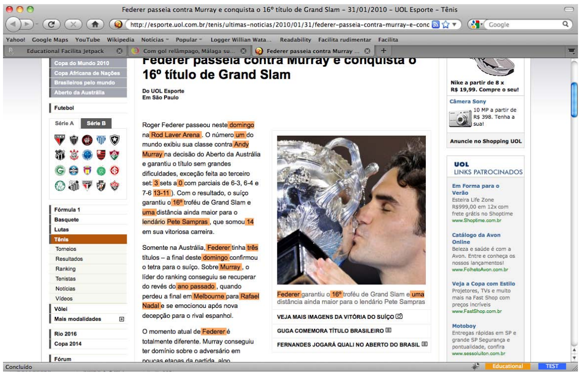


Figure 5: Educational FACILITAs modules integration.


Federer passeia contra Murray e conquista o 16º título de Grand Slam – 31/01/2010 – UOL Esporte – Tênis

http://esporte.uol.com.br/tenis/ultimas-noticias/2010/01/31/federer-passeia-contra-murray-e-conc

Federer passeia contra Murray e conquista o 16º título de Grand Slam

Do UOL Esporte
Em São Paulo

Roger Federer passeou neste domingo na Rod Laver Arena. O número um do mundo exibiu sua classe contra Andy Murray na decisão do Aberto da Austrália e garantiu o título sem grandes dificuldades, exceção feita ao terceiro set: 3 sets a 0 com parciais de 6-3, 6-4 e 7-6 13-11). Com o resultado, o suíço garantiu o 16º troféu de Grand Slam e uma distância ainda maior para o lendário Pete Sampras, que somou 14 em sua vitoriosa carreira.

Somente na Austrália, Federer tinha três títulos – a final deste domingo confirmou o tetra para o suíço. Sobre Murray, o líder do ranking conseguiu se recuperar do revés do ano passado, quando perdeu a final em Melbourne para Rafael Nadal e se emocionou após nova decepção para o rival espanhol.

O momento atual de Federer é totalmente diferente. Murray conseguiu ter domínio sobre o adversário em poucas etapas da partida, algo

Federer garantiu o 16º troféu de Grand Slam e uma distância ainda maior para o lendário Pete Sampras

VEJA MAIS IMAGENS DA VITÓRIA DO SUÍÇO
GUGA COMEMORA TÍTULO BRASILEIRO
FERNANDES JOGARÁ QUALI NO ABERTO DO BRASIL

Figure 6: Screenshot of Educational FACILITA presenting the highlighted textual entities on the Web page.

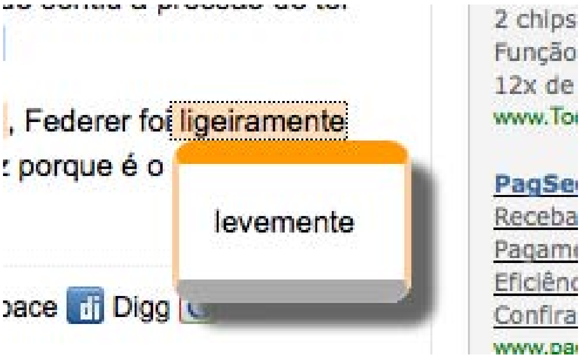
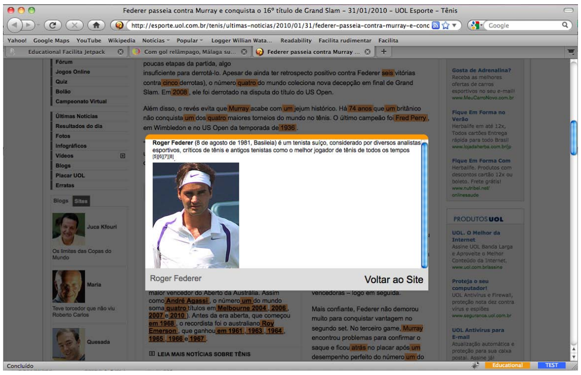


Figure 7: Screenshot of Educational FACILITA presenting synonymous for the selected word.

[10] http://translate.google.com.br
[11] https://jetpack.mozillalabs.com/
[12] http://br.mozdev.org/
[13] groovy.codehaus.org/


Federer passeia contra Murray e conquista o 16º título de Grand Slam – 31/01/2010 – UOL Esporte – Tênis
http://esporte.uol.com.br/tenis/ultimas-noticias/2010/01/31/federer-passeia-contra-murray-e-conc
Google
Yahoo!
Google Maps
YouTube
Wikipedia
Notícias
Popular
Logger Willian Wata...
Readability
Facilita rudimentar
Facilita
Educational Facilita Jetpack
Com gol relâmpago, Málaga su...
Federer passeia contra Murray ...
Fórum
Jogos Online
Quiz
Bolão
Campeonato Virtual
Últimas Notícias
Resultados do dia
Fotos
Infográficos
Vídeos
Blogs
Placar UOL
Erratas
Blogs
Sites
Juca Kfouri
Os limites das Copas do Mundo
Maria
Teve torcedor que não viu Roberto Carlos
Quesada
LEIA MAIS NOTÍCIAS SOBRE TÊNIS
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poucas etapas da partida, algo insuficiente para derrotá-lo. Apesar de ainda ter retrospecto positivo contra Federer seis vitórias contra cinco derrotas), o número quatro do mundo coleciona nova decepção em final de Grand Slam. Em 2008 , ele foi derrotado na disputa do título do US Open.

Além disso, o revés evita que Murray acabe com um jejum histórico. Há 74 anos que um britânico não conquista um dos quatro maiores torneios do mundo no tênis. O último campeão foi Fred Perry , em Wimbledon e no US Open da temporada de 1936 .

Roger Federer (8 de agosto de 1981, Basileia) é um tenista suíço, considerado por diversos analistas esportivos, críticos de tênis e antigos tenistas como o melhor jogador de tênis de todos os tempos [5][6][7][8].

Roger Federer

maior vencedor do Aberto da Austrália. Assim como André Agassi , o número um do mundo soma quatro títulos em Melbourne 2004 , 2006 , 2007 e 2010). Antes da era aberta, que começou em 1968 , o recordista foi o australiano Roy Emerson , que ganhou em 1961 , 1963 , 1964 , 1965 , 1966 e 1967 .

vencedoras – logo em seguida.

Mais confiante, Federer não demorou muito para conquistar vantagem no segundo set. No terceiro game, Murray encontrou problemas para confirmar o saque e ficou atrás no placar após um desempenho perfeito do número um do

Figure 8: Screenshot of Educational FACILITA presenting additional information about the highlighted named entity.

After activating Educational FACILITA, the browser displays a "Loading" message. The textual processing operations executed on Educational FACILITA currently take quite amount of time to be completed, especially those that run on the Server Side of the applications. While the "Loading" message is presented, the user is allowed to switch <tabs> or windows, and continue interacting with other Web applications.

At the end of processing the textual operations, the user is prompted with a notification on the top right of the screen, and the <tab> that activated Educational FACILITA resource changes to another color (orange in this prototype). Both interface components (notification and <tab> presentation control) are specific features that are only possible to be developed on the Browser level of applications.

Finally, the user is presented with the same Web page that activated the reading assistance, but the complex words and named entities are highlighted in a different color.

5. FINAL REMARKS

This paper presented the proposal of an online tool with educational purposes. It has not been evaluated so far, although we have indicatives from literature that this path is worth following. The evaluation is in preparation to be performed in the near future and is expected to be in large scale, with children and adults under alphabetization process.

To the best of our knowledge, the system we propose is unique, as it is evidenced by our section on related work. Its main innovation comes from the final user that we envision, which demands new solutions and the design of more intuitive interaction models. Our evaluation must also consider this at some moment.

The usual lack of computer experience of poor literacy readers may still motivate other future solutions. For instance, we can mention the adaptation of our already adapted content to screen readers, as well as the portability of our text adaptation model to other computational platforms, as tablets, with the drawbacks of possibly having high software reengineering and hardware costs.

Finally, as Educational FACILITA is part of PorSimples – a Text Simplification project – it may also benefit from other modules under development, e.g., a summarization module, which would probably enrich even more the user experience.

In future steps, we envision to have the tools and respective modules, that have been under our concerns, with an improved performance of PLN processing and, simultaneously, to evolve the technical solutions, regarding the technological evolutions in Web according to W3C standards, as well the accessibility guidelines.

We also intend to exploit the semantic of named entities in such way that if "São Paulo" is shown, a map to get a view of this city could be presented to end users, by integrating the Google Maps resource available.

6. ACKNOWLEDGMENTS

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