ABSTRACT
The increase of aging people and the possibilities that are extended to the Internet users have led studies into improvement of web accessibility solutions for older people [30]. Most older adults present some decline in their cognitive, visual, hearing and motor skills [13]. Nowadays, however, the Web faces new technological challenges that extend the initial idea of cross-platform and inter-operational nature of the HTML and HTTP. The challenges are posed as accessibility barriers and consider the skills, capabilities, culture, languages, disabilities, among other characteristics related to the user as a human being, in contrast to the hardware and software requirements previously addressed. The human characteristics of the challenge can be seeing as the ultimate barrier of the initial Web requirements of cross-platform and inter-operational environment, and goes towards social inclusion of people whatever differences they might present in the Web. In this paper we propose the establishment of a new set of success criteria that address older users accessibility into the normative document of WCAG 2.0. The proposed recommendations were identified from a composition of usability studies with real older users and were tested for different scenarios.

Categories and Subject Descriptors
H.2.2 [Design Tools and Techniques]: User Interfaces; H.5.4 [Hypertext/Hypermedia]: User issues

General Terms
Accessibility, Human Factors

Keywords
Web accessibility, middle-age adults, elderly

1. INTRODUCTION
Brazil is experiencing an unprecedented growth in the number of elderly people and others that soon will become old, which in this work, we call middle-aged adults. It is estimated that in the period 2000 to 2050 will occur the greatest increase in the proportion of elderly, from 5.1% to 14.2% and that by 2025 the population over 60 years will reach 34 million people [30]. The United Nations estimates that by 2050 one in five people will be over 60 years old. The estimate is that in Europe in the near future there will be about 17.6% of elderly in the countries comprising the European Union in 2010 and that this proportion will reach 20.7% in 2020 [3].

As a consequence of this global phenomenon it can be observed that most older persons suffer with the reduction or loss of their abilities. Difficulties related to vision, cognition and motor coordination constraints increase with the passing of years [7] [10] [19] [24]) and are not unique problems to older adults. These limitations also apply to other user groups, including, for example, persons with low vision, attention deficit, developmental delay, limited reading proficiency, among other restrictions.

It is noteworthy that age is just a variable that acts on the aging process. According to Neri [21], there is no biological or physical factor that accurately indicates the point in time that ends maturity and start the old age. The factors that influence this process are: gender, socioeconomic status, conditions of physical and mental health, habit and lifestyle, among others.

There are many elderly people who are not influenced by aging criticism while maintaining their ability to perform day-by-day activities without major problems and can even use the web without any resistance or barrier. In literature, studies show that the constant practice of what was learned also helps to reduce the difficulties and resistance.

There are several initiatives with the purpose of providing guidance, guidelines or heuristics that help developers building web pages more suitable for interaction with older people. Indeed, when the guidelines and recommendations are used, the improvements are not only enjoyed by the public elderly, but also for all other groups that had difficulties or deficiencies in the interaction. However, there is still great resistance by the developers in the implementation of such recommendations. The quest for productivity and attractive design has put the human aspect of interaction in the background.

With the aim of adapting WCAG accessibility recommendations for the older audience and to remedy some problems that still persist on webpages, work has been done with field observation and users testing activities, in order to identify and list the accessibility indicators that target the older.
The pre-eminent reference on web accessibility [22],[23], the WCAG (Web Content Accessibility Guidelines), establish a set of guidelines that discuss accessibility issues and provide accessible design solutions for users with disabilities [40]. The WCAG is of particular relevance to developers of Web resources, because not only have been promoting with successful around the world but also their guidelines have been adopted by many organizations and are increasingly being adopted at a national level [8].

The simplicity of the WCAG approach has helped in raising the profile on web accessibility [15]. However the guidelines still lack of recommendations and design solutions that address older users [30]. There are efforts being directed into these issues [25], but they have not yet being integrated as part of the general guidelines presented at the WCAG 2.0 document.

The article is organized as follows: Section 2 presents concepts of usability and accessibility; in Section 3 are shown the main problems associated with aging that influence the interaction of middle-aged adults with Web pages; Section 4 presents related works; in Section 5, the WAI model is presented with their adaptations to meet the older adults; in Section 6 are held discussions on the adaptation approach used in this work; and Section 7 provides the final remarks and future work.

2. USABILITY AND ACCESSIBILITY

Recently, the concepts of accessibility and usability have been extensively studied and exploited in the development of Web interfaces. The term usability is a concept related to several components, traditionally associated with five attributes: learnability, efficiency, ease of storage, low error rate and user satisfaction, which can be considered as a set of independent quality attributes or as a single attribute consisting of all of them [22]. According to Nielsen, while developing Web applications, there are some basic principles that should be considered [23]:

- Clarity in information architecture: it is essential that the user can discern what is priority and what is secondary in a website;
- Ease of navigation: users should be able to access the desired information within three clicks;
- Simplicity: the structure of a website should be simple in order to make easier the understanding of content, or delete information without compromising the system integrity;
- Content Relevance: the design of a website should focus, above all, the content of information provided; o Maintain consistency: consistency is a powerful usability principle on the Web. Keeping presentation consistency among different web pages improves the learnability of the application and give users confidence while operating the website.
- Time bearable: the load time of pages must necessarily be short, so that user does not lose interest; o User focus: again, all principles can be summarized in one, the focus should be on the users’ activities.

The term accessibility has several meanings that are dependent on the context in which users operate. In general, accessibility refers to the fact that something is accessible to users regardless of the means of access and their individual problems or limitations. In the area of information systems consists of a quality attribute that can be described through the development of flexible design solutions to accommodate the diverse needs of a large portion of users, regardless of age, disability or technology.

Web-accessibility corresponds to the possibility that any user using any agent (software or hardware that retrieves and serializes Web content), can understand and interact with the content of a website [31].

With the goal of promoting accessibility in the development of Web pages and make them accessible to a growing number of people, a committee formed by large companies and called the W3C (World Wide Web Consortium) established the WAI (Web Accessibility Initiative) Model of accessibility, which consists of a set of documents containing guidelines to ensure the accessibility of the Web to people with disabilities, or for people who access the Web in special conditions of environment, equipment, technologies and different browser. In Brazil, the initiative for accessibility resulted in the elaboration of the e-MAG model, which currently is at version 2.0, and deals with the accessibility guidelines for the construction and adaptation of content from the Brazilian government on the Internet [8].

Although the concepts of usability and accessibility are being further investigated and applied in systems interface design, some questions remain regarding the overlap of some concepts. As distinct orientations, both concepts are trying to solve similar problems, but were written in different contexts or with different focus. The concepts of usability and accessibility are easily distinguishable when you consider that a web page, for instance, can be very intuitive and easy to use, but inaccessible due to lack of ALT tags in images. Thus, this page is usable by people with no disabilities, but inaccessible to people who need a screen reader. Moreover, another page can have all the ALT tags properly filled in all the charts, but present a confused design that affect the interaction of users.

Literature is not clear on how strong is the relationship between accessibility and usability. Several questions arise in relation to assessments of accessibility and usability, with regard to adherence to the guidelines. For instance, a site that has a high degree of compatibility with accessibility guidelines can be considered as also having a high degree of usability? Does accessibility and usability evaluations map similar problems? Although there are points of conflict when it prioritizes accessibility in relation to usability and vice versa, Petrie et al. [25] emphasize the idea that both concepts should be considered in an integrated way to reach the “universal usability”. Universal Usability emerges as a way to combine and reduce the gap between the principles of usability and accessibility guidelines.

3. ELDERLY USERS AND WEB

Web pages interaction has great potential to support older adults carrying out their day-by-day tasks, mainly as a way to offset the declines from the natural aging process, such as sensory declines, or loss of cognitive abilities physical. The Web is no longer just a means of entertainment for young people. Today we can already observe greater concern and greater number of requests by businesses for the creation or adaptation of web sites aimed to conquer and meet the older
4. RELATED WORK

Abou-Zahra et al. [1] present the goals and studies for creating the document WAI-AGE. Initial studies for the creation of this document started about 2007 and the document presents five goals:

1. To inform the development of extensions on WAI guidelines and supplemental educational materials which can better promote and meet the needs of people who have accessibility needs related to ageing;

2. Better inform the ongoing work of W3C/WAI with regard to the needs of the elderly, and to create an ongoing dialog between ageing communities and disability communities, and other stakeholder groups on the needs of people who have accessibility needs related to ageing;

3. To provide educational resources focused towards industry implementors, including developers of mainstream technologies, assistive technologies, and Web designers and developers.

4. To provide educational resources focused towards organizations representing and serving ageing communities, and towards individuals with accessibility needs related to ageing.

5. To promote increased harmonisation of Web accessibility standards so as to further build a unified market for technology developers and expedite the production of Web accessibility solutions.

The WAI-AGE document was published on 2008, and since then, field studies were conducted to validate the guidelines presented in the WAI-AGE. These studies were able to verify certain points without more detailed information, particularly with issues concerning the elderly population. Kurniawan and Zaphiris [16] gathered various published studies that proposed Web design guidelines for older people (both industrial and academic papers) to remove the overlaps, to categorize them in a meaningful way and to verify the usefulness of those guidelines with the target user group addressed by the guidelines: older Web users. They selected 32 guidelines submitted to validation by heuristic evaluation. The article achieved the development of a manageable and robust set of guidelines for designing and evaluating ageing-friendly websites, however, it didn’t report on validation for the guidelines proposed.

The work of Sayago and Blat [29] aimed at being as much relevant as possible to real-life scenarios, where older people tend to look for more complex online information such as medication, accommodation and traveling. The work focused on three tasks, which are likely to be the most predominant ones: basic search (Google); advanced search (Google Advanced Search); and directories (Yahoo! Directory). It was reported that older people found complex online information 3 times faster by using basic search than by means of advanced search or directory.

5. WAI ACCESSIBILITY MODEL AND THE WCAG 2.0

WAI (Web Accessibility Initiative) is an organization created by the W3C that establish principles and rules of design and development of sites that are accessible to people with special needs [18]. WAI promotes a tripartite model of accessibility, with the goal of universal Web accessibility in theory provided by full conformance with each of three components [5]:

- Analysis by the N/N Group [6], report that older people view the Web as a means of socialization, which encourages contact with family and friends as well as a source of information. Parts of these users also use the Web to search for their own interests, for financial management, shopping, online courses for the development of new skills, among others. However, most older people have faced great difficulties in interacting with Web pages, either through lack of experience with computer technologies and a lack of motivation due to the insecurity and difficulty in learning new concepts [9]. Also it is noteworthy the lack of understanding by the developers that the elderly have different needs of younger users, both in motivating its use and modeling the interaction. Although there are several initiatives that provide guidelines for developing usable and accessible Web pages, the search for productivity and interesting design means that many developers focus less attention to the human aspect and develop interfaces that do not meet the specific needs of this audience.

- We found several studies about the effects of aging on cognitive process, in literature. Most of them focused their studies on major cognitive functions such as memory, reasoning, problem solving, language, among others. The skills that present declines during the aging process are especially those that require more effort in working memory [28] [32], processing speed [2], and spatial perception, where the first deficits usually appear around 40 years old and may become more pronounced after 50 years on [20].

- Older people often present difficulties and resistances in reading text on computer screen. It is common to see their anxiety in actions. These activities if conducted without prior reading of content can lead older people into error situations that end up frustrating their expectations and causing them to abandon the interaction. Working memory, which is the ability to keep information active and requiring temporary storage and manipulation of that information, also decreases with age and appears as a limiting factor for reading comprehension, speech, manipulation of quantitative representations, among others [9].

- According to Fisk et. al [9] older adults are slower and less successful in acquiring new procedures in comparison with young people, once they process information more slowly. Differences between ages increase according to the complexity of the task, particularly with respect to tasks that require coordination of multiple tasks simultaneously.

- With regard to attention, both visual selective attention (scanning a visual display) as the dynamic visual attention (redirecting the focus of attention) show declines during aging. Therefore it is important to create mechanisms that try to facilitate their orientation and capture their attention [9].

- Aiming to bring accessibility guidelines to the specific needs of older people, we propose an adaptation of guidelines, in order to maximize the capabilities and minimize the limitations of older people in their interactions with the Web as a way to promote greater social inclusion, facilitate the acquisition of services and provide better quality of life to this audience that grows more and more.
WCAG - Web Content Accessibility Guidelines present a series of recommendations about how to make Web content more accessible for users with disabilities [40]. The WCAG specification provides guidelines for Web content developers.

ATAG - Authoring Tool Accessibility Guidelines provide recommendations that assist the design of Web content authoring tools that produce accessible Web sites [34]. The ATAG specification provides guidelines for Web content authoring tools developers.

UAAG - User Agent Accessibility Guidelines provide recommendations for the development of user agents that lower web accessibility barriers for people with disabilities [35]. The specification considers as a User Agent any kind of software that retrieves and renders Web content. Furthermore, the UAAG conformant User Agents also have the possibility of matching and communicating with Assistive Technologies to improve the Web experience of users. The UAAG specification provides guidelines for User Agent developers.

The pre-eminent reference on web accessibility [15, 11], the WCAG (Web Content Accessibility Guidelines), establish a set of guidelines that discuss accessibility issues and provide accessible design solutions for users with disabilities [40]. The WCAG is of particular relevance to developers of Web resources, because not only have they been promoting with successful around the world but also their guidelines have been adopted by many organizations and are increasingly being adopted at a national level [36].

The first version of the guidelines, WCAG 1.0 [33], became a W3C recommendation on 1999, when most web pages implementation was based on HTML. Therefore, the WCAG 1.0 was developed to support accessible solutions for the HTML technology [14, 27].

Nowadays, however, web sites use a great deal of different technologies. The new generation of the Web (Web 2.0) and their RIA - Rich Internet Applications are build with dynamic interactions [12] and require specific technologies like: ECMAScript, HTMLHTTPRequest, SVG - Scalable Vector Graphics, SMIL - Synchronized Multimedia Integrations Language, Flash, Java Applets, among others [20].

The design of RIA components extend the use of HTML with a new set of development patterns and standards, but they are not addressed in the WCAG 1.0 document. The WCAG 1.0 guidelines classify the use of these technologies as harmful for users even when they are designed as accessible technologies.

Another limitation observed in WCAG 1.0 is related to the subjectivity of the checkpoints [4]. The subjectivity present on the guidelines statements make it difficult to evaluate WCAG 1.0 full conformance [27]. That WCAG 1.0 characteristic led the United States government to choose the Section 508\(^1\) as the standard legal accessibility solution for USA websites instead of the WCAG 1.0.

Considering that the WAI elaborated the WCAG 2.0. The WCAG 2.0 was based on the WCAG 1.0, but the guidelines were written to be technologically neutral, being applicable to technologies available now and in the future [14]. The guidelines also provide objective testable criterias, that can be evaluated with a combination of automatic testing and human evaluation [27, 40].

The WCAG 2.0 main document (normative specification) do not describe the technological conditions required to deliver accessible solutions on websites [27]. The normative specification address the design solutions with a higher abstraction avoiding the technical details of web applications. The main document is complemented with a non-normative section that address the technological details required to implement the guidelines [14, 38]. The idea of keeping the technological description of solutions separately of the normative WCAG specification, allows changes and updates in the non-normative document as technology evolves and advances. The non-normative section is supposed to address technical extensions while keeping the normative section unchanged in its recommendations and evaluation criterias [27].

The WCAG 2.0, just as WCAG 1.0, define accessible design solutions that allow disabled users to interact and use web applications [40]. Although the guidelines address a great deal of usage scenarios, they do not cover all possible combinations and levels of disabilities.

The simplicity of the WCAG approach has helped in raising the profile on web accessibility [15]. However the guidelines still lack of recommendations and design solutions that address older users [13]. There are efforts being directed into these issues [39], but they have not yet being integrated as part of the general guidelines presented at the WCAG 2.0 document.

The guidelines are organized in four principles [37]:

**Perceivable**: interface components must be designed in ways that the user can perceive.

**Operable**: interface components must be designed in ways that the user can operate them.

**Understandable**: information and interface components must be understandable.

**Robust**: content must be compatible with a wide variety of user agents.

Each guideline contain Success Criterias that specifically describe the design solutions required to conform the web site with the accessible recommendations of WCAG 2.0 [37]. The Success Criterias must address accessibility problems that impact on disabled users, differently of usability aspects that are applied for all general users. The Success Criteria were elaborated to be objective testable on web interfaces.

The Success Criterias are classified accordingly to their impact on the accessibility of a web site. This classification separates success criterias into level A, level AA and level AAA, in which Success Criterias classified as level A represent more severe impacts on the accessibility of a website if not designed. The classification considers the following aspects on the criterias [27, 37]:

- Compatibility of the solution with assistive technologies
- Applicability of the solution for all websites and types of content
- Understandability of the solution by content authors
- Presentation, functionality, esthetic or expression limitations imposed by the design solution

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\(^1\)http://www.section508.gov
6. ADAPTATION AND INCLUSION OF NEW SUCCESS CRITERIA

We present the new Success Criteria organized according to the WCAG 2.0 Principles which they are supposed to integrate.

6.1 Perceivable

- **Success Criteria 1.3.4**: The webpage must present a functionality that reads aloud the content.
  *Rationale*: reducing visual effort and keep the attention on the webpage’s content. This Success Criteria integrates the guideline 1.3 - Adaptable.

- **Success Criteria 1.4.10**: Webpage main content must be presented in the visual field of the user, 15% left and right, and 20% top margins.
  *Rationale*: during field observations it was reported that older users fix their attention on the screen center, ignoring information presented in lateral bars, header and footer. This Success Criteria integrates the guideline 1.4 - Distinguishable.

- **Success Criteria 1.4.11**: The webpage must highlight the main elements that compose it, such as: links, menus, buttons and others.
  *Rationale*: older users present difficulties in identifying and distinguishing interface components on web applications. Therefore it is required to highlight the distinctions among components in the presentation. For instance, older users have difficulties in differentiating navigational mechanisms from content. This Success Criteria integrates the guideline 1.4 - Distinguishable.

6.2 Operable

- **Success Criteria 2.1.4**: Webpage presentation must not use scroll bars.
  *Rationale*: older users do not perceive the existence of scroll bars and generally do not complete tasks that require using this interface component.

- **Success Criteria 2.1.5**: Webpage must not use pop-ups windows.
  *Rationale*: older users tend to have the reaction of shock and confusion (often think that caused some error) when scroll bars appear on their screens.

- **Success Criteria 2.1.6**: The interface must present voice over functionalities.
  *Rationale*: older users prefer talking to reading during their interaction with the Web.

- **Success Criteria 2.2.6**: Dropdown menus must be slow enough to be activated even by users who present low motor skills.
  *Rationale*: older users have difficulties with moving menus and end up selecting wrong options.

- **Success Criteria 2.3.3**: Multimedia content must make available options to control the execution and speed of the presentation.
  *Rationale*: multimedia content affect the user’s attention with relation to the focus on tasks and often can not be understood by the user due to its high execution speed.

- **Success Criteria 2.4.11**: There can’t be links with identical labels that refer to different URLs.
  *Rationale*: older users get used to the interface presented and therefore any re-label to reference other
than the URL that was used originally defined, should be avoided.

- **Success Criteria 2.4.12**: There can’t be broken links.
  **Rationale**: Broken links frustrate the expectations of older users.

- **Success Criteria 2.4.13**: Links must refer to the exact topic their label describes.
  **Rationale**: Older users have greater difficulty in locating information. When they are redirected to the home page of a website, instead of the exact topic location that described the issue the user is looking for, they often abandon the search for the desired topic.

- **Success Criteria 2.4.14**: Adjacent links must provide enough click space in order to avoid errors.
  **Rationale**: Older users have difficulties with clicking in small areas of links.

- **Success Criteria 2.4.15**: Adjacent images or icons must be part of the click space of links.
  **Rationale**: Small images or icons adjacent to the links often confuse users, since they tend to click on images instead of links.

- **Success Criteria 2.4.16**: The webpage must differentiate the visited links from the non-visited ones.
  **Rationale**: Older users tend to forget the links for which they have already sailed, due to cognitive deficits.

- **Success Criteria 2.4.17**: The webpage must display separately menu options already selected and the ones that were not selected yet.
  **Rationale**: Cognitive deficits due to older users tend to forget which menu options have visited.

- **Success Criteria 2.4.18**: Options in menus must be pointing to the page correct execution/task.
  **Rationale**: Due to difficulty in identifying the right task or information, older users get frustrated when they are redirect to webpages that do not refer to the action that they expected.

- **Success Criteria 2.4.19**: The dropdown menus must provide only one level of options.
  **Rationale**: Older users have great difficulty in interacting with dropdown menus with several levels, triggering the wrong options.

- **Success Criteria 2.4.20**: The present intermediate options in the menus, when triggered, they must have a page containing your options and subsequent alternative elements such as buttons and links.
  **Rationale**: Frequently, older users activate intermediate options of the menu, while attempting to reach the ultimate goal.

- **Success Criteria 2.4.21**: There should be direction to the homepage of the website in all secondary webpages.
  **Rationale**: Older users easily confuse themselves and are more likely to access the wrong page.

- **Success Criteria 2.4.22**: Icons used on webpage must lead the user to make associations with real-world objects.
  **Rationale**: Older users try to relate the information they visualize on the web page with real-world objects in an attempt to build a mental model of the task and remember it later.

- **Success Criteria 2.4.23**: The page must present a feature that allows the user to view a summary of their past experiences.
  **Rationale**: It is important to users review a successful experience as a way to encourage them to do it again, and so reduce their insecurity and the amount of errors while performing a task or navigation.

### 6.3 Understandable

- **Success Criteria 3.1.7**: The webpage must not have the same presentation layout for links and other interface components that doesn’t accept clicks.
  **Rationale**: Older users tend to present difficulties identifying interactive components of the interface, from the ones that do not present this behavior.

- **Success Criteria 3.1.8**: The web interface must not present to many informations in order not to cause a cognitive overload in older users.
  **Rationale**: Older people deficits might include cognitive disabilities. Therefore webpages layout should be designed with a minimalist and simplistic design.

- **Success Criteria 3.2.6**: The initial webpage of systems must provide a clear identification of which parts of the web application can be accessed with and without authentication.
  **Rationale**: Older users can find it difficult to identify the functionalities that need authentication.

- **Success Criteria 3.2.7**: The webpage must not present functionalities with the same description and labels for different contexts.
  **Rationale**: Older users can find it difficult to identify and distinct the functionalities of the system.

- **Success Criteria 3.3.7**: The webpage must provide informations describing the data format and domain for form inputs.
  **Rationale**: Older users present difficulties in filling forms, and therefore require the presentation of examples and explanations about how to complete the task.

- **Success Criteria 3.3.8**: The webpage must present all necessary information to complete a task.
  **Rationale**: Older users require longer time than young users to execute complex tasks, like form filling, payment confirmations, among others. This generally leads to the session expiration within the application. Therefore the webpage must present explanations, previously, about how to proceed in order to complete the task.

- **Success Criteria 3.3.9**: The webpage must provide interactive resources to assist the input of data.
  **Rationale**: The webpage must be capable of predicting user difficulties and assist them either by text presentation or voice messages.
• **Success Criteria 3.3.7:** The webpage must make available different ways of filling form informations besides keyboard input.

**Rationale:** older users present great difficulties in using the keyboard for typing sequences of numbers.

• **Success Criteria 3.3.7:** The webpage must present the option of reporting errors in a simple and programmatic way.

**Rationale:** older users feel confident about reporting difficulties and experiences for the webpage developer.

7. **FINAL REMARKS**

Although the guidelines are important, they aren’t sufficient for optimal accessibility. The guidelines contribute to minimize the recurring errors in projects that people, who present special needs, are facing, as is the case of users middle-aged adults, elderly and disabled.

Providing web accessibility in general still presents challenges, but for older users in particular, became a major concern for developers.

Providing web accessibility for an audience with features heterogeneous so means not only develop websites consistent with the recommendations and guidelines, but provide means for less experienced users can overcome the barriers with which they encounter in their interactions with the Web, and that often lead to the total withdrawal of such experience.

The growth in Web usage has happened in parallel with its own evolution, since the Web left being just a repository for information that offered static webpages to its users and its own evolution, since the Web left being just a repository for information that offered static webpages to its users and now offers support for various activities of their lives.

Currently, in addition to providing applications for communication, entertainment and online services, it must be also offered support for the realization of interaction between users and resources available on the Web.

The growth of Web use by adults of middle age, elderly or special needs has motivated the development of techniques to produce usable web pages and available, to allow their use with the highest level of independence possible.

8. **REFERENCES**


