

# WCAG4All, a tool for making web accessibility rules accessible

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**Abstract**—Nowadays, web accessibility is recognized as a fundamental right of people with disabilities. But imposing accessibility by law is not enough: the main problem is the lack of a widespread culture of accessibility among webmasters that often do not know how to answer to accessibility requirements and what must be done to develop accessible web sites. Moreover, accessibility guidelines are legal documents that are not accessible to web developers. WCAG4All is a tool that helps them to understand what are the aspects that must be considered during the development process.

**Index Terms**—accessibility, WCAG, accessible web sites

## I. INTRODUCTION

Since the beginning, web accessibility aimed to promote the e-participation of people with disability in the new world of technology and web. Today, the compliance with accessibility regulations does not provide only a better experience to all the possible users, but also better indexing by search engines.

Since 1997, the W3C is at work to spread the accessibility culture among web designers and developers in the world, providing standards and guidelines to define what must be done to make a web site accessible. From a legal point of view, in most countries, accessibility is a mandatory requirement for web sites of all the public institutions and organizations. Since the ratification of the Convention on the Rights of Persons with Disabilities (CRPD) [1], 92% of the States Parties promulgated laws in favour of accessibility, but only 63% have planned strategies to eliminate physical and digital barriers to accessibility [2].

However, imposing accessibility by law is not enough: the main problem is the lack of awareness of the webmasters about the accessibility requirements and what must be done to develop accessible web sites. The WCAG documents are very detailed, but for most people working on the web, they are too technical. In other words, accessibility guidelines are not *accessible* to web developers. The result is that most of them perceive accessibility like a cost, instead of a feature that can make their web sites more usable for all possible visitors.

In this paper, we propose WCAG4All: a useful, complete, effective and easy to use web site to spread accessible culture. Our goal is to give to webmasters a tool that allows them to know in advance what are the aspects that must be considered to create an accessible web site. WCAG4All is based on the Italian accessible regulations, but since they are based on WCAG, it can be easily adapted to other countries regulations.

Moreover, WCAG4All also shows that developers do not need particular effort to apply accessible principles to web sites, but it is mostly about the correct use of web technologies.

## II. ACCESSIBILITY REGULATIONS

The CRPD [1], approved by the United Nations in 2006, is the first international recognition of the accessibility right for people with disabilities. Article 9 encourages the UN States Parties to identify and remove all obstacles and barriers to accessibility of public structures and facilities, both in the physical world (i. e., buildings, roads, schools) and in ICT services. CRPD entered into force on May 3, 2008, [3] and 182 States of the 193 UN States Parties had already ratified it with national laws [4]. Regarding the web accessibility, most of the countries promulgate laws indicating as a technical reference and requirements the W3C guidelines about web accessibility, i. e., the WCAG [5].

The European Union had promoted the rights of all its citizens and the creation of an inclusive society for everybody. In 2000, the EU presented *eEurope2002*, a project whose aim was to guarantee the right to e-participation even to those groups of the population that had more necessities and difficulties, e. g., the elderly and people with disabilities. Moreover, in 2001 the European Commission published a communication entitled “*eEurope 2002: Accessibility of Public Web Sites and their Content*” [6] to invite the Member States to implement the WCAG 1.0 guidelines in all public web sites. After the ratification of CRPD, the EU intensified its commitment about disability and a new strategy was approved [7]. Its three most important results are the European Accessibility Act [8], the Directive 2016/2102 [9] and the European standard for ICT Accessibility [10]. All these documents aimed at the creation of ICT products and services based on a unique standard for all the manufacturers and at fostering a common regulation about accessibility among all the European Countries: in fact, the Directive 2016/2102 represents a commitment for all the public organization and institutions to update their web sites and mobile apps to be conformed to the AA level of conformance of the WCAG 2.0 [5]. In 2018, after the publication of the new WCAG 2.1 [11] by the W3C, the EU updated the standard for ICT Accessibility [12] and notified all the Member States that public web sites are expected to conform to the WCAG 2.1 [13].

Italy was a pioneer in web accessibility: in fact, immediately after the presentation of the European project *eEurope2002*, Italy published a sequence of guidelines between 2001 and 2002 to explain how to *design, develop* and *maintain* a web site to facilitate the use by people with disabilities. In January 2004, an important law was approved, “*Regulation to facilitate the access of persons with disabilities to ICT tools*” [14]. This law represented a commitment for all public institutions and organizations to develop accessible web sites that guarantee the access to information and online services also to people with disabilities in respect of the Article number 3 of the Italian Constitution that states the principle of equality.

Beside the definition of guidelines, the Italian Parliament also regulated the procedure to verify if they have been applied. In 2012, Italy instituted a new organism, the *Agency for Digital Italy (AGID)*<sup>1</sup>, to guide the nation through the digital revolution. AGID has to monitor that the public administration respected the web accessibility laws and also to report and take action among those that do not respect the regulations. In 2013, Italy received from the EU the request to harmonize the web sites’ requirements to the WCAG 2.0 and in 2018, with a new reform, the web accessibility regulation was updated to the WCAG 2.1. Therefore, in 2019 AGID published the new “*Guidelines for the accessibility of IT tools*” [15] where the technical reference lists all the success criteria of A and AA levels of the WCAG 2.1 [11], [12].

AGID also provided a form for the “*Accessibility Declaration*” [16] and one for the “*Self-evaluation*” [17]. Public entities are required to update their web sites to make them conformed to the WCAG 2.1, and also to fill the “*Accessibility Declaration*” form that must be published on the web sites so that the users can be aware of what are their levels of accessibility. The “*Self-evaluation*” declaration, instead, presents a list of requirements that must be respected, i. e., all the success criteria of A and AA levels of the WCAG 2.1, and for each of them, the organization can declare if the criteria were satisfied or not and add some notes about each criterion. The self-evaluation form helps to understand if all the criteria were fulfilled and how to fill the accessibility declaration.

The EU puts some constraints in the Directive 2016/2102 [9] regarding the period of time given to the Member States and their public organization to conform their web sites to the new regulation:

- before September 23, 2019, all new web sites and mobile apps, not published before September 23, 2018, must be conformed to the regulation;
- before September 23, 2020, all web sites must be conformed to the regulation;
- before June 23, 2021, all mobile apps must be conformed to the new regulation.

### III. RELATED WORKS

Even if many works in literature address the problem of accessibility of web sites, very little has been done to improve

knowledge about accessibility guidelines among web developers. Many authors developed tools to improve accessibility for a particular category of users with disabilities [18]–[22], e. g., a browser’s extension for users with dyslexia [20], web sites designed for children with Autism Spectrum Disorders [21] or the use of voice speakers to improve users interaction with the web sites [18]. These works propose solutions for a particular situation and a restricted set of users, e. g. inaccessibility of CAPTCHA for visually impaired users [23], [24], but do not help the diffusion of knowledge about the accessibility problem as a whole.

A contribution in this direction is given by authors that analyse the current situation of accessibility of web sites [25]–[27], mobile applications [28], or both [29], [30]. Considering a period of 14 years, the authors of [27] demonstrated that websites’ improvements in accessibility are mainly due to the advent and use of new and more intrinsically accessible technology rather than to an actual effort by websites creators into this direction. As a result, Web accessibility is still a main issue and even top-traffic and government web sites suffer from multiple violations of accessibility rules [22], [27].

One of the reasons for this situation is that developers often find accessibility rules difficult to understand, apply and verify. Sloan et al [31] discussed the need for an all-encompassing methodology for determining the level of accessibility of web resources and the requirement that the results of such a procedure are as meaningful as possible to developers. The authors stated that accessibility evaluation methods are unsatisfactory in the scope and presentation of their results. Mirri et al [32] discussed a screening application able to compute accessibility-related metrics. The proposed tool is specifically intended for enabling public institutions to face and (hopefully) solve accessibility issues; yet, it can provide metrics and a synthesis of time evolution of web sites to any web site manager. Snider et al [33] studied the questions asked about accessibility, both through information searches and direct queries, within a large multinational corporation over a period of two years, finding an emphasis on topics covering enterprise requirements for testing, recording, and reporting compliance. They realized a question-answering accessibility conformance chatbot.

Another open issue is the study of the effectiveness of the web accessibility guidelines in the coverage of the real problems encountered by impaired users during navigation. Calvo et al [29] reported that many web sites are still not accessible since AA level of the WCAG 2.00 does not cover all the problems encountered by users with disabilities. The study was conducted by seven accessibility experts who had evaluated 62 mobile and desktop web sites as well as mobile applications. The experts highlighted potential issues which were not covered by the guidelines but could deeply affect the navigation of people with disabilities. Power et al [34] conducted an empirical study involving 32 blind users and showed that many problems faced by these users cannot be captured by the WCAG. Only 50.4% of 1383 accessibility issues were covered by the WCAG 2.0. Therefore, not only

<sup>1</sup>In Italian, *Agenzia per l’Italia Digitale*.

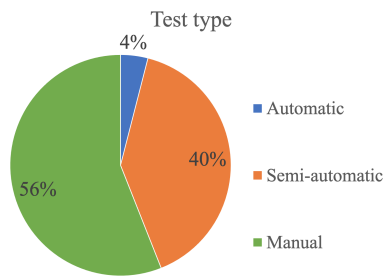


Fig. 1: Percentage of manual, automatic or semi-automatic tests.

very few developers know and implement the WCAG but, the WCAG are often inadequate to fully guarantee accessibility.

#### IV. ACCESSIBILITY TESTS AND TOOLS

Many tools have been developed to evaluate the accessibility of web pages; they are available as web or desktop applications or browser extensions and most of them are based on the WCAG standard.

To cover all the accessibility issues according to the WCAG standard, we defined 150 tests, that will be discussed in Section V. A test can be classified as manual, semi-automatic and automatic. As depicted in Figure 1, most tests (56%) need human interaction because they evaluate the level of comprehension of information in the page or they ask the developer to perform a specific task, e. g., verifying the possibility of surfing the web site only using a keyboard.

40% of the tests are classified as semi-automatic, i. e., a tool can find out a specific problem, but human interaction is needed to evaluate the results of the test: e. g., most tools report when the same link anchor is used more than once on a web page. People using screen readers can be disoriented when the same anchor bring them to different destinations. A simple solution is to provide an alternative title. More advanced tools are able to report which titles are used for repeated anchors, but only a human being can establish if the alternative title is efficient and comprehensible for users.

Only a small subset of the tests (4%) is completed automatic, such as the ones that validate the page to the standard or control the presence of broken links. Automated tools reduce the time needed to perform a web accessibility evaluation because they are much faster than human revision. Moreover, the tools provide feedback to the user highlighting the problems and some possible solutions, so the webmaster can focus on a specific aspect and figure out a solution starting from the tool suggestions. Besides, some of the tools can be used during the designing process, for example, to choose a colour palette that is compliant with the regulations.

We analyzed many tools, but as described in Figure 2, none of them covers all the needed tests. Therefore, to perform an exhaustive web accessibility evaluation, webmasters need to integrate the feature of different tools. In fact, some tools are specific for a single characteristic such as the evaluation of colours or the reading level. However, cross-validation

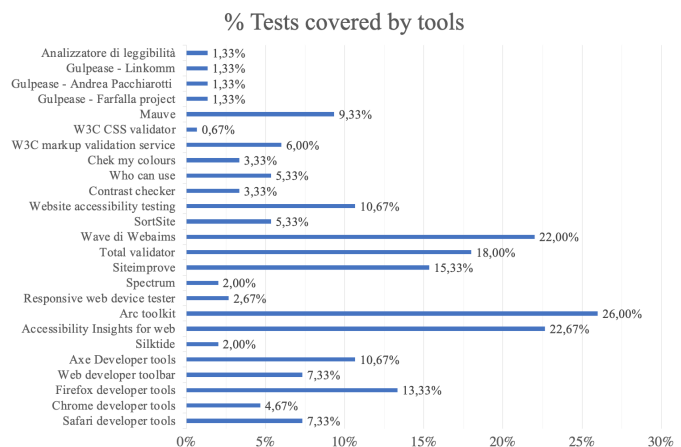


Fig. 2: Percentage of tests covered by each tool

using different tools allows to identify possible false-positive problems.

According to our analysis, the most complete tool is Arc Toolkit developed by The Paciello Group<sup>2</sup>. This browser extension can analyze the webpage and evaluate its conformance to the WCAG2.1, highlighting errors and warnings and also providing corrections. Besides, for each element, it indicates what the screen reader reads for that particular element, which is a very important feature to understand if the webpage is comprehensible. Unfortunately, it covers only 26% of the tests.

WAVE by WebAims<sup>3</sup> and the Axe developer tools<sup>4</sup> features are really close to Arc Toolkit. Accessibility Insight for web<sup>5</sup> is a web extension that allows first to run an automatic evaluation of conformance to WCAG2.1, and then, guide the user to a more specific analysis providing a list of specific tests with visual help that highlights the element that is being evaluated. For example, to evaluate the heading structure, all headings are squared.

Some tools like Total Validator<sup>6</sup>, Dynomapper<sup>7</sup> and Sort-site<sup>8</sup> are not free, but they provide a very important feature especially for huge web sites: they allow to run only once the tool to analyze the whole web site.

The ideal situation to spread the culture of web accessibility and to facilitate its evaluation is to develop tools to cover a higher number of tests and, at the same time, to increase the number of automatic tests: e. g., a simple improvement could be the integration of the technology of online translator with the analysis of the source code of the page to automatically verify if the attribute lang is correctly used. However, even with the development of new and better technologies and artificial intelligence, the role of human interaction will continue to be central for accessibility.

<sup>2</sup><https://www.paciellogroup.com/toolkit/>

<sup>3</sup><https://webaim.org/>

<sup>4</sup><https://www.deque.com/axe/>

<sup>5</sup><https://accessibilityinsights.io/>

<sup>6</sup><https://www.totalvalidator.com/>

<sup>7</sup><https://dynamapper.com/>

<sup>8</sup><https://www.powermapper.com/products/sortsite/>

## V. WCAG4ALL

WCAG4All<sup>9</sup> has been created to provide web designers and web developers a tool, in particular a web site, where they can efficiently consult a list of web accessibility rules and tests. The aim is both to make designers and developers aware of what are the accessibility guidelines that should be addressed in a web site and how to verify if the web site is compliant or not with the accessibility regulations.

Accessibility should be considered from the very beginning of the designing process of a web site and through the whole development process. All technical choices regarding a web site must be made taking into account accessibility issues.

Initially, WCAG4All was developed to help webmasters of the University of Padua to fill the “*Accessibility Declaration*” form [16]. They need to understand which tests must be passed to be compliant with the relevant legislation. This means that they must learn not only the law detailed in Section II but also the underlying accessibility principles. Then, they must be able to associate an appropriate test to each control point of the regulation. The last phase is to plan the required changes, in case the test found some problems.

For this reason, we are initially interested in Italian regulation and we implemented WCAG4All only in Italian. But since the Italian regulation has received an EU Directive, its contents may apply to all the Member States of the European community and it could be sufficient to provide a translated version of the web site to use it across Europe. Moreover, the EU Directive states that web sites must conform to the AA level of WCAG 2.1, which are widely used as a normative reference all over the world.

We defined 150 tests derived from the Italian “*Guidelines for the accessibility of IT tools*” [15], whose requirements are equivalent to the WCAG 2.1 A and AA conformance levels success criteria. Moreover, also the AAA conformance level success criteria of the WCAG 2.1 have been included, as well as some techniques suggested by W3C and other best practices related to web accessibility, such as the CSS validation which is not a mandatory requirement for the WCAG.

However, the huge number of tests must not discourage webmaster from applying the accessibility principles to the web: a web site seldom covers all the aspects that are evaluated by the whole list of tests. For example, we use as case study the web site of our department (see Section VI) which is a simple informative web site without any particular interaction by the user, and require to run only 90 tests over 150.

WCAG4All has a very simple structure and is made of three sections: the homepage, the accessibility tests and the test details. The homepage guides the visitor into the accessibility topic and the Italian regulation and it is also described how the tests have been defined starting from the Italian and international web accessibility guidelines.

The accessibility tests page contains the whole list of tests and for each of them, it is possible to read the goal, the category, if the test can be performed automatically or

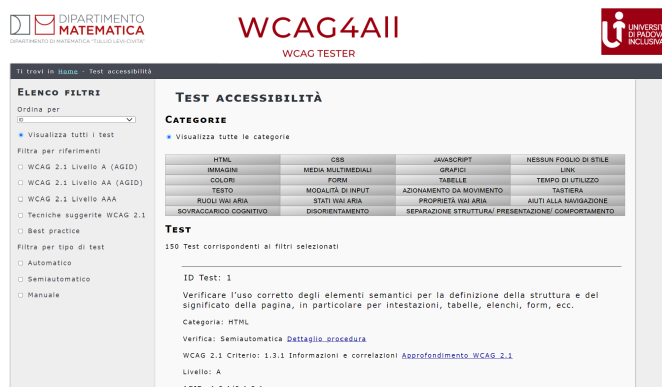


Fig. 3: The accessibility tests page of WCAG4All.

Test Categories				
HTML	CSS	JavaScript	Keyboard	No stylesheet
8 tests	5 tests	7 tests	10 tests	3 tests
Image	Multimedia	Charts	Link	Colors
4 tests	18 tests	2 tests	9 tests	8 tests
Form	Tables	Usage Time	Text	Input Mode
16 tests	3 tests	5 tests	18 tests	4 tests
Movements	Content - layout - behaviour separation			
2 tests	3 tests			
Aids to navigation	Cognitive Overload		Disorientation	
4 tests	3 tests		12 tests	
WAI ARIA				
Roles	States		properties	
2 tests	2 tests		2 tests	

TABLE I: Categories of the tests.

semiautomatically or it must be performed manually, and which is the origin of its definition.

Figure 3 depicts the tests page. The tests have been grouped according to the aspect of the web page that is controlled (e.g. images, text, etc.) and this represents the category of a test. We identified 23 categories, shown in Table I, defined according to the element being tested.

The origin of a test can be the A, AA and AAA conformance levels of WCAG 2.1, WCAG 2.1 suggested techniques or best practice. The web site allows the user to filter the results of visible tests for each of these three groupings: category, type, and origin. Moreover, if the test has been defined from the WCAG, the conformance level is also written and if it has a correspondence in the Italian guidelines the number of the corresponding success criteria is marked as AGID.

The test details page contains a detailed procedure about how to verify the compliance with that particular requirement and, if any, a list of automated tools to run the test. In this way, WCAG4All helps the webmaster to associate a test, and possibly, a tool, to each control point.

The 150 tests defined allow to exhaustively cover all the AGID requirements and to verify the compliance with the AAA level success criteria of WCAG 2.1, with the main accessibility techniques recommended by the W3C and other known best practices to ensure the best possible experience for users and good positioning of the web site in the response

<sup>9</sup>available at <https://web.math.unipd.it/accessibility/>

Accessibility guidelines		
WCAG 2.1	WCAG 2.1 Tips	Best Practises
115 tests	14 tests	21 tests
Test type		
Automatic	Semi-automatic	Manual
6 tests	60 tests	84 tests

TABLE II: Types and accessibility guidelines used for the defined tests.

Level	Origin
1	Error WCAG2.1 level A or AA
2	Warning WCAG2.1 level A or AA
3	WCAG2.1 level AAA or suggested techniques for WCAG
4	Best practice
5	Hints

TABLE III: Levels of priority and origin

pages of the search engine. The origins and types of the tests are summarized in Table II.

WCAG4All also cover AGID regulation since its control points correspond to WCAG 2.1 level A and AA success criteria; therefore 82 tests out of the total 150 allow to verify compliance with AGID regulations. In most cases, the tests suggest which tool can be used to automate and speed up the verification process, but the developer has always an important role since he/she must take the correct decision about how to correct the possible errors. Moreover, he/she must recognize false positives.

## VI. CASE STUDY

WCAG4All was used to evaluate the web site of the Department of Mathematics at the University of Padua. The errors were denoted with 5 levels of priority, as described in Table III. The main difference between errors found by tests of level 1 and 2 is that the first type of errors prevents users from accessing the content of the web site, therefore they must be solved, while the errors related to level 2 are mostly comprehension problems found by the tools that need human evaluation. Errors related to level 1 usually do not allow the validation of the web page or the interaction with some components.

We also divided errors into 4 categories:

- validation errors: the source code does not respect the standard;
- navigation errors: there are issues in the page that make difficult the interaction with input devices or assistive technologies;
- layout errors: there are issues in the layout of the web sites, e. g., colours with low contrast, incorrect word or line space, etc., that make difficult to understand the content;
- comprehension: there is ambiguous or difficult content to understand.

We have done 3 evaluations of the web site and Table IV reports the total number of tests with negative results and the total numbers of errors in the web pages.

Date	Failed tests	Errors
04/06/2020	51	1180
23/06/2020	18	276
26/06/2020	7	95

TABLE IV: Numbers of failed tests and errors for each evaluation phase

The first evaluation gave a huge number of errors and we analyzed them to find the correct solution and also to make sure if some of them were a false-positive. The focus was on errors of the levels of priority 1 and 2, but level 3 were solved as well. The web site has been created using a CMS framework and the source code didn't often respect the standards, therefore there was a huge number of validation errors. Besides, most of the comprehension problems derived from a lack of attention to what is presented to the screen readers, but also links were not sufficiently clear neither visually nor for screen readers. We pointed out that each anchor should point out if the content of the link is not a web content or if it starts downloading a large file or if it brings to a page in a different language. Another important issue was that some of the sections of the pages were not reachable using only the keyboard to interact with the web site.

Something that was not considered during the design process, and turned out to be a problem, was how to use colours to show if a link was visited or not: this is an example of how important it is to spread the awareness of accessibility regulations among webmasters. Since the colour palette was defined starting from the institutional colours of the University, it was difficult to find out a combination that respected both the identity of the institution and the constraints coming from the regulation about the use of colour and contrast.

However, since the web site was built starting from a template, many errors were replicated in different pages and it was sufficient to solve the problem only once to remove many errors, reducing the time need for corrections.

During the second evaluation, we could notice that many issues were solved, but, at the same time, new errors were added. In particular, there were still errors in the semantic use of standard elements. For this reason, we suggested the webmasters should use the validation service of the W3C every time a change in the structure was made, to avoid validation problems that lead to incomprehension also for the search engine that should index the page.

In the third evaluation, only a few hints were left: for example, we suggested to control if the emphasis of the text was used correctly or considering writing the extended version of an acronym.

In conclusion, in three evaluations, spread during about twenty days, it was possible to reduce consistently the number of errors in the web site and make it complaint with the WCAG and Italian regulation, applying very simple changes. This work demonstrates the importance of considering accessibility from the very beginning of the creation of a web site, verifying

frequently if the source code is valid and all the elements are comprehensible for all the possible users of the web site.

## VII. CONCLUSIONS

Accessibility assessment of a site is an important process that considers the needs of an audience who can access the web site with a wide range of devices, in different situations and contexts. Although many tools exist to help this process, our study showed that they do not cover all the possible tests, and human evaluation is still necessary and really important.

Moreover, web developers often do not know accessibility regulations, since there is no widespread culture about this topic and the guidelines themselves are legal documents very difficult to read and understand.

For this reason, we implemented WCAG4All, a tool which aims at allowing web developers to create accessible content consciously. We ask some web developers to evaluate our tool and we obtain very positive results: the users particularly appreciate the possibility to connect a test (and possibly a tool) to every single point of control of the accessibility rules.

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