Classification of Software Accessibility Evaluation Tools: A Statistical Analysis

José R. Hilera

Department of Computer Science
University of Alcalá (Spain)
jose.hilera@uah.es

Abstract. To check the accessibility of a software product, such as a web page, a desktop application, a mobile application or an electronic document, evaluators can use different types of resources that help them in the evaluation, as automatic evaluation tools, assistive technologies or disability simulators. This paper proposes criteria for the classification of tools used in software accessibility evaluation, presents a list with more than four hundred tools available in the market, and shows a basic statistical analysis elaborating contingency tables and graphs for statistical variables as the category, type, scope and licence of the tools.

Palabras clave: Software accessibility, mobile accessibility, web accessibility, software evaluation tool, a11y.

1. Introduction

Accessible software is one that, when designed, built, maintained and updated, principles are respected and techniques are applied to guarantee equality and non-discrimination in access by users, in particular persons with disabilities and old people [1]. In other words, the software must be able to be used by anyone, including those with disabilities. The concept of software includes web pages, desktop applications, mobile applications or electronic documents.

To ensure that a software is accessible, the requirements established by different standards, laws and recommendations must be met, such as the EN301549 standard, required in the European Union for web and mobile applications of public sector bodies [2]. Most of the standards are based on the WCAG 2.1 guidelines [3].

To verify that a software meets the accessibility requirements, it is usual for the evaluators to start using an automatic evaluation tool, although it must be considered that the results of these tools are not conclusive and it is always necessary to perform a manual check as well. Ideally, people with different types of disabilities should participate to check whether the use of the software presents them some kind of barrier. If these people cannot be counted on, the evaluators can put themselves in the place of a person with a disability and try to use the software being evaluated with assistive technologies commonly used by these people, such as a screen reader, used by people

who are blind or low vision disabled. But they could also use a tool that is capable of simulating some type of disability, such as color blindness.

Therefore, there are different types of tools that can be used during the evaluation. In the next section a method of classifying these tools is proposed. In section 3, a classification carried out by the author from 2014 to 2021 is presented, which includes 484 tools and is available on the Web[1]. In section 4 a statistical analysis of these tools is carried out.

2. Classification criteria

The main lists of accessibility evaluation tools are usually focused on the evaluation of web pages, as is the case of the list maintained by the World Wide Web Consortium (W3C), which currently includes 159 tools [4]. Other lists can easily be found on the web, but they tend to include a small number of tools and without detailed classification criteria. In 2016, a comparative analysis of tools was carried out based on a previous classification of 126 automatic evaluation tools, not only of web pages, but also of other types of software [5]. Currently, the only extensive list that has been found with tools oriented to all types of software is the one created by the author of this work with 484 tools [6], and it will be the one that is taken as a reference to establish the classification criteria of the tools. In this context, we understand by software any non-hardware resource that may be susceptible to be used by people with disabilities, which includes web pages, but also desktop applications, mobile applications or electronic documents, including multimedia resources.

As an accessibility evaluation tool, not only automatic evaluation tools should be considered, but also those that can help to carry out checks manually, for example, simulating some type of disability of potential users.

Four criteria are proposed for the classification of software accessibility evaluation tools: category, type, scope and licence. First of all, a tool should belong to a **category**, which could be one of the following:

- Assistive Technology: It is a software tool that is used by people with disabilities, which allows to test accessibility by putting the evaluator in the user's place. Some subcategories of assistive technology are: Braille Interface, Magnifier, Screen Reader, Switch Interface, Text Web Browser, User Interface Customizer, or Voice Assistant.
- Automatic Evaluation Tool: Tool that checks accessibility automatically.
- Checklist: It is a list (it can be a simple document) that helps to record the compliance or not of accessibility requirements.
- Monitoring Service: It is a service, normally paid, that obtains accessibility reports, either instantaneously, or after a set deadline when the report is completed with content provided by experts or users with disabilities.
- Remediation Tool: Tool that automatically corrects accessibility errors, usually in a web page.

---

[1] https://josehilera.github.io/a11y-lists/a11y-evaluation-tools.html

- User Simulator: Software that simulates some type of user, for example users with a visual disability, that allows to put the evaluator in the user's place to check the potential barriers presented by the content accessed with the simulated disability.
- Visualization Tool: Tool that displays or marks elements of a web page or, in general, the user interface on the screen, helping the evaluator to check certain accessibility requirements.

The second classification criterion is the **tool type** that indicates the specific type of the tool according to how it is used or installed:

- Application Plugin: It is an extension of some known application (web or desktop).
- Authoring Tool Plugin: It is an extension of some known application (web or desktop) for editing, for example a text editor or a software development environment.
- Browser Plugin: It is an extension for a web browser. It can be for a specific browser (Chrome, Firefox, Edge, etc.) or a bookmarklet valid for any browser.
- Command Line Tool: The tool is executed from a shell of an operating system.
- Desktop Application: The tool is a stand-alone application.
- Document: The tool is a simple digital document, for example, a Word document, a pdf or a spreadsheet.
- Mobile Application: It is an application to be executed on a mobile device, such as a smartphone or a tablet.
- On Demand service: The user must make a formal request or registration to be able to use the services offered by the tool.
- Online Tool: It is a tool that is used online through a web browser.
- Testing Library: The tool is not an application ready to be used by an evaluator, but it is offered as a library so that the evaluators can create their own tool using this library.
- Web API: The tool offers its functionality through the Web in the form of an API installed on a server, usually with REST technology. In some cases, the API can be downloaded and the evaluator can install it on its own local server in stand-alone mode.
- Web Application: The tool is an application that the evaluator has to install on a web server in order to use it.
- Web Form: It is a simple web page that includes a form that can be filled in, downloaded and used in local mode as a simple document, without associated functionality on the server.
- Web Page Plugin (widget): It is an extension to be integrated in a web page.

The third criterion is the **scope** that indicates the object or property whose accessibility is to be evaluated. It can be one of the following:

- Color Contrast: The tool is specific to assess the appropriate contrast between colors.
- Desktop Application: The tool evaluates the accessibility of a desktop application.

- Document: The tool evaluates the accessibility of the content of a document, such as pdf, docx, pptx, xslx, epub, video, animation.
- Javascript Code: The tool analyses the existence of accessibility problems if a certain JavaScript code is executed.
- Mobile Application: The tool detects accessibility problems in a smartphone or tablet application.
- Software: The tool (usually a checklist) can help evaluate the accessibility of any non-web software.
- Text Readability: When it is a specific tool to evaluate the readability of a piece of text.
- User Interface: The tool (usually an assistive technology or an user simulator) helps to evaluate possible accessibility problems presented by the user interface of any type of application or document.
- Web Page: The tool evaluates the accessibility of an individual web page.
- Web Site: The tool evaluates the accessibility of a group of web pages, normally included in the same website.

And finally the last criterion is the **licence** that indicates the conditions of use of the tool. It can be one of the following:
- Commercial: It is necessary to pay to use the tool.
- Free: It is not necessary to pay to use the tool.
- Open Source: In addition to free use, it is possible to obtain the source code of the tool.
- Trial: It is a commercial tool, but there is a trial or demo version with limitations

3. Classification of tools

Taking into account the above criteria, since 2014 the author has been collecting information on the existing tools on the market and has classified them by assigning values to each criterion in each case, creating a list of 484 tools [6]. As an example, Table 1 shows an extract from the list, with a selection of different tools with different combinations of values in the criteria. For example, the first tool in the list is "Accessibility Scanner"[2]. It is a free Android mobile application that automatically evaluates some accessibility characteristics of Android mobile applications. For this reason, it has been classified in the "Automatic Evaluation Tool" category, of the "Mobile Application" type, with a "Mobile Application" scope and a "Free" licence. Another example may be "PDF Accessibility Checker (PAC)"[3], which is a free desktop application that allows automatic evaluation of the accessibility of pdf documents. In this case, it has been classified in the "Automatic Evaluation Tool" category, of the "Desktop Application" type, with a "Document" scope and a "Free" licence. A third example is "Myndex Color Vision Deficiency Simulator"[4], a tool that is freely used

---

[2] https://play.google.com/store/apps/details?id=com.google.android.apps.accessibility.auditor
[3] https://pdfua.foundation/en/pdf-accessibility-checker-pac
[4] https://www.myndex.com/CVD/

online using a web browser, and allows to simulate different visual deficiencies on the image that appears on the screen. It has been classified in the "User Simulator" category, of the "Online Tool" type, with a "User Interface" scope and a "Free" licence.

Table 1. Examples of tools included in the classification [6].

TOOL	CATEGORY	TYPE	SCOPE	LICENCE
Accessibility scanner	Automatic Evaluation Tool	Mobile Application	Mobile Application	Free
Axe Android	Automatic Evaluation Tool	Testing Library	Mobile Application	Open Source
Colour Contrast Analyser (CCA)	Automatic Evaluation Tool	Desktop Application	Color Contrast	Open Source
EqualWeb	Automatic Evaluation Tool	Web Page Plugin	Web Page	Trial
IBM Equal Access NPM Accessibility Checker	Automatic Evaluation Tool	Command Line Tool	Web Page	Open Source
JAWS	Assistive technology	Desktop Application	User Interface	Commercial
Monsido Web Governance Platform	Monitoring Service	On demand service	Web Site	Commercial
Myndex Color Vision Deficiency Simulator.	User Simulator	Online Tool	User Interface	Free
No Coffee -- Vision Simulator for Chrome	User Simulator	Browser Plugin	Web Page	Free
OAW	Automatic Evaluation Tool	Web Application	Web Site	Open Source
PDF Accessibility Checker (PAC)	Automatic Evaluation Tool	Desktop Application	Document	Free
Tenon	Automatic Evaluation Tool	Online Tool	Web Site	Free
The A11y Machine	Automatic Evaluation Tool	Command Line Tool	Web Page	Open Source
Visual ARIA	Visualization tool	Browser Plugin	Web Page	Open Source
VoiceOver	Assistive technology	Mobile Application	Mobile Application	Free
VPAT	Checklist	Document	Web Site	Free
WAVE	Automatic Evaluation Tool	Online Tool	Web Site	Free
WCAG-EM Report Tool	Checklist	Web Form	Web Site	Open Source
Web Accessibility Checker	Automatic Evaluation Tool	Authoring Tool Plugin	Web Page	Free
WP ADA Compliance Check Plugin	Automatic Evaluation Tool	Application Plugin	Web Site	Free

4. Statistical analysis

A statistical analysis of the data collected from the 484 tools found on the market has been carried out. Table 2 shows the types of tools by each category. It can be seen that the most common category of tools is Automatic Evaluation Tool (AET), with 342 tools, that is, 71% of the total. Regarding the type of tool, it is also observed that the most common type is the online tool, with a total of 133 tools (27%). The combination that is repeated the most is precisely that of the automatic evaluation tool category with the online tool type, with a total of 121. The second most common type of tools are plugins for web browsers, there are currently 113 tools, of which the majority (68) are automatic evaluation tools.

Table2. Type of tool by category (AT=Assistive Technology, AET=Automatic Evaluation Tool, CK=Checklist, MS=Monitoring Service, US=User Simulator, VT=Visualization Tool).

| TYPE OF TOOL	AT	AET	CK	MS	US	VT	TOTAL
Application Plugin	0	9	0	0	0	1	**10**
Authoring Tool Plugin	0	38	0	0	2	0	**40**
Browser Plugin	11	68	0	0	4	30	**113**
Command Line Tool	0	28	0	0	0	1	**29**
Desktop Application	16	30	0	0	3	4	**53**
Document	0	0	22	0	0	0	**22**
Mobile Application	15	8	3	0	3	0	**29**
On demand service	0	1	0	7	0	0	**8**
Online Tool	1	121	1	1	8	1	**133**
Testing Library	0	31	0	0	0	0	**31**
Web API	0	1	0	0	0	0	**1**
Web Application	0	5	0	1	0	0	**6**
Web Form	0	0	7	0	0	0	**7**
Web Page Plugin	0	2	0	0	0	0	**2**
TOTAL	**43**	**342**	**33**	**9**	**20**	**37**	**484**

Another interesting analysis can be the combination shown in Table 3, of the tool category with its scope (object or property whose accessibility is to be evaluated). It can be seen that the most common is that the available tools help to evaluate the accessibility of web pages. If we take into account that a website includes several pages, we could add both cases, with a total of 225 + 87 = 312 tools, which is 64% of the total. As in the previous case, the most common is that they are automatic evaluation tools (AET), with a total of 157+71=228 tools that automatically evaluate the accessibility of web pages or websites. The third most common scope is that of mobile applications, with a total of 47 tools that help evaluate the accessibility of these applications. Although it does not appear in the table, it can be seen in [6] that 18 of these 47 tools are mobile applications, two of which are listed in Table 1, it is Google's Accessibility Scanner, which is an Google app for Android that automatically evaluates some accessibility characteristics of Android applications; and VoiceOver, an Apple app for iOS that works as a screen reader on iOS devices.

Table3. Scope by category (AT=Assistive Technology, AET=Automatic Evaluation Tool, CK=Checklist, MS=Monitoring Service, US=User Simulator, VT=Visualization Tool).

SCOPE	AT	AET	CK	MS	US	VT	TOTAL
Color Contrast	0	43	0	0	0	0	**43**
Desktop Application	1	3	0	0	0	2	**6**
Document	3	25	1	0	0	0	**29**
Javascript Code	0	2	0	0	0	0	**2**
Mobile Application	15	28	4	0	0	0	**47**
Software	0	0	1	0	0	0	**1**
Text Readability	0	12	0	0	0	0	**12**
User Interface	14	1	0	0	15	2	**32**
Web Page	10	157	20	0	5	33	**225**
Web Site	0	71	7	9	0	0	**87**
TOTAL	**43**	**342**	**33**	**9**	**20**	**37**	**484**

Regarding the licence, in Figure 1 (left) it can be seen that the vast majority of the 484 available tools can be used without paying, as 43.2% are free and 37.6% are open source.

An important category of tools are the assistive technologies (AT), as they are software tools that allow the evaluator to understand how people with disabilities access the software. Tables 2 and 3 show that there are 43 tools of this type. Figure 1 (right) details the different subcategories of assistive technologies, verifying that the most common are screen readers, with 32.6% of the total. It must be taken into account that in the classification of tools only software tools are considered, so other types of hardware assistive technologies are not included, such as Braille keyboards, push buttons, etc., although applications that allow simulate some of them, such as applications that simulate Braille keyboards for Android and iOS, have been included.
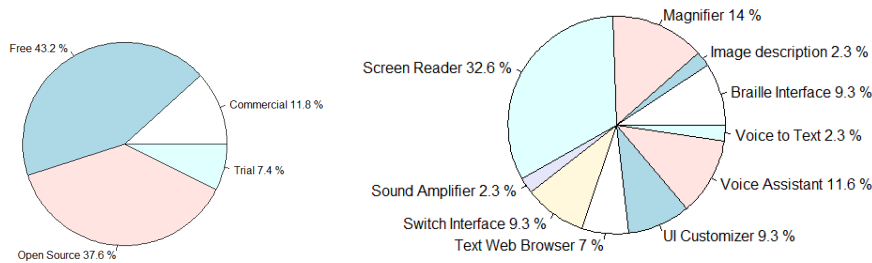
Fig1. Distribution of the types of licence for the use of all tools (left). Distribution of the different subcategories in the assistive technology category (right).

5. Conclusions

After collecting data on the existing tools on the market that can help in the evaluation of software accessibility, it can be concluded that most of the existing tools are currently focused on the automatic evaluation of the accessibility of web pages and websites, and

these are tools available for use online. Although it can also be found automatic evaluation tools of mobile applications or electronic documents.

Unfortunately, none of these tools can fully assess the accessibility of the software, so it is necessary for the evaluator to perform manual checks, using other tools, some of them free to use, such as assistive technologies, disability simulators or visualization tools, that can be used to verify if evaluated software presents barriers to users with different types of disabilities, in order to determine if the software is really accessible.

6. References

1. European Union (2016). *Directive (EU) 2016/2102 on the accessibility of the websites and mobile applications of public sector bodies*. https://eur-lex.europa.eu/eli/dir/2016/2102/oj
2. ETSI (2019). *EN 301549 V3.2.1 Accessibility requirements for ICT products and services*. https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf
3. W3C (2018). *Web Content Accessibility Guidelines (WCAG) 2.1*. https://www.w3.org/TR/WCAG21/
4. W3C (2021). *Web Accessibility Evaluation Tools List*. https://www.w3.org/WAI/ER/tools/
5. Timbi-Sisalima, C., Martín, C. I., Otón, S., Hilera, J. R., Aguado-Delgado, J. (2016). *Comparative analysis of online web accessibility evaluation tools.* 25th International Conference on Information Systems Development (ISD2016). https://core.ac.uk/download/pdf/301369965.pdf
6. Hilera, J.R. (2021). *a11y-evaluation-tools list*. https://josehilera.github.io/a11y-lists/a11y-evaluation-tools.html