Comparative review of the literature of automated testing tools

Preprint · July 2020

DOI: 10.13140/RG.2.2.36836.19848

2 authors:

Anand Singh Gadwal
Shri Vaishanav Institute of Technology & Science
6 PUBLICATIONS **21** CITATIONS
SEE PROFILE

Lalji Prasad
SAGE University
32 PUBLICATIONS **66** CITATIONS
SEE PROFILE

Comparative review of the literature of automated testing tools

Anand Singh Gadwal
Department of IT, SVIIT/SVVV University, Indore, MP, India, anand.gadwal@gmail.com

Dr. Lalji Prasad
Department of CSE, SIRT/SAGE University, Indore, MP, India, lalji.research@gmail.com

ABSTRACT

To develop premium quality software which satisfies client's requirement, it is necessary to use automation software testing frameworks and tools adequately. Numerous research studies have been done previously in the field of software testing and on automation testing tools however, there is necessity for detailed standards. Comparative study and analysis have been conducted based on similar characteristics like platform support, scripting language used, browser compatibility etc., of a range of tools that are used for functional, load and management testing purpose. We also have tools that support manual testing but here we are targeting on web based automation testing tools only. This paper present review of literature in direction to find and sum up available open source and commercial automated web testing tools with challenges coupled to them. This research will help the testing teams to select the appropriate one as per the requirement. The results of the review shows majorly used tools are Selenium Webdriver, UFT, Ranorex, RFT, JMeter and Appvance, depends upon budget and environment. In published literature, topics related with automated web testing tools are gaining more importance. Although, there is no unique technique or framework available that can fully support automated web testing and fulfill all requirements.

CCS CONCEPTS

• Software and its engineering • Software creation and management • Software verification and validation

KEY WORDS

Software testing, web application, testing framework, automation testing tools

1. INTRODUCTION

Automation testing is established research domain, from research point of view. Automation testing can be defined as utilization of software testing tools to minimize the human involvement, recurring activities and reveal bugs cannot be unmask by manual testing.

Various kinds of QA techniques and methods to ensure software quality exist that involve preventing defects or detecting existing defects. Those QA activities that focus on detecting existing defects are also called verification and validation activities, which is defined by the IEEE Standard Glossary of Software Engineering Terminology as ''the process of determining whether the requirements for a system or component are complete and correct, the products of each development phase fulfill the requirements or conditions imposed by the previous phase, and the final system or component complies with specified requirements'' [1].

Internet and digital information made considerable impression on various facet of humankind, including IT industry, business, education, government, culture and so on. Web based applications are very much complex, dynamic in nature intend to introduce new challenges to testing process. Main outcomes of defects in web based applications are loss in profit and integrity with additional financial expenses. The strain of web application testing is diverse.

Primary, they follow distributed architecture using hyper text transfer protocol. Subsequent, different applications are written in different languages on client and server side.

The growing size and complexity of modern Software system increases the need for test automation [2]. To perform automation testing on these swift growing applications, several techniques have been suggested by number of researchers in previous years. Now it is essential to properly recognize and pursue the state of the art and come up with overview of the trends in this focused sphere, as the published literature increases in number in established research domain. We present an organized review of literature on the web application testing tools and frameworks research area in this paper; intended to detect automation testing techniques, tools and open problems. So as to opt fair among them, comparative analysis of these tools is needed**.**

In today's world more or less all big business or companies are shifting towards automation. Numbers of automation testing tools are available in the market, commercial and open source both like Selenium Webdriver, UFT, Test complete, Watir, Sahi, Ranorex, Load Runner, JMeter, Soap UI, Test Studio, Silk Test, RFT, Coded UI, and Appvance. But the challenge is to prefer suitable one.

Choosing the right software test automation tool is not trivial, and recent industrial surveys indicate lack of right tools as the main obstacle to test automation [3]. The focus of this planned review of the published literature on automation testing research is to collect accomplishment, in such a way that developers and testers have straightforward access to relevant information, helpful to boost the efficacy of tool selection.

2. REVIEW OF RELATED LITERATURE

Dianxiang Xu et al. [4] present an automated test generation technique for integrated functional and security testing of software systems. To improve testing productivity and reduce costs, it is highly desirable to automate test generation and execution. Automation enables more test cycles due to repeatable tests and more frequent test runs. S Gojare et al. [5] discussed details of Selenium Webdriver and proposed a design of automated testing framework, using Selenium Webdriver and TestNG. Using this framework tester can easily write their test cases efficiently and in less time.

Inspection and testing techniques are currently mostly performed in an isolated manner. The integration of inspection and testing techniques is a promising research direction for the exploitation of additional synergy effects [6]. Writers developed solution, from the ground up and leveraged and extended freely available automation and test libraries such as Selenium WebDriver and NUnit respectively. They also talk about the challenges faced and how they overcame them, as well as provide technical insights on real world concerns such as managing test brittleness, and integrating the web tests into an existing Continuous Integration and Continuous Deployment pipeline [7]. Demonstrates the taxonomy of different automated testing tools comprising of functional, management and load testing [8]. The main advantages of adopting the web for developing software products include: no installation costs, automatic upgrade with new features for all users, universal access from any machine connected to the Internet and being independent of the operating system of clients [9]. Conducted a comparative study of automated testing tools such as the Quick Test Professional, selenium, Watir, Sahi etc. based on criteria such as the efforts involved with generating test scripts, capability to play back the scripts, result reports, speed and cost [10]. Through open source automated testing tools, the cost of the entire testing process, as well as the time it takes to perform the testing process, has significantly reduced. The primary objective of this research paper is to analyze the web testing tools Selenium and Sahi as to compare their features and performance so that a particular user can select a tool that is suitable in terms of usability and features required for a specific task [11]. The survey showed that benefits of test automation were related to test reusability, repeatability, test coverage and effort saved in test executions. The limitations were high initial invests in automation setup, tool selection and training [12]. The present paper discusses the need of automation testing in the process of software development, in order to provide high quality, robust and reliable software product. Some reliable approaches how to build a testing framework are investigated [13]. The

research is about the analyzing of the different features of automated testing tools such as Selenium, QTP/UFT, Test Complete, Ranorex, Watir, Sahi, and Soap UI [14]. In this paper, authors have designed an automatic software testing framework for web applications based on the Selenium and JMeter [15]. The primary aim of this paper is to offer a comparative study on commercial and open source web automation testing tools which will assist the developers to opt for the appropriate tools as per the demands [16].

This paper provides a feasibility study for the most commonly used testing tools; we conducted a comparative study of five open source tools to determine their usability and effectiveness [17]. This article presents a comprehensive study of test automation tools and frameworks. Firstly, automated testing and their categories were explained, followed by an explanation of the various test automation frameworks. Finally, a brief explanation and comparison of some of the most commonly used automation tools was presented [18].

Authors conducted a survey for organizations and experts involved in software testing to identify the current practices and opportunities for improvements in software testing methods and tools. The survey results are supposed to be used to determine the necessity of the international standard for the capabilities of STMTs [19].
The Objective of this Paper is to find how to find a set of different emerging tools and methodologies to test a software system to ensure the quality constrain in developed product. We will do the comparison of different testing tools on the basis of existing literature and also do the comparative study of different automated testing methodologies which is helpful in the selection of testing tool and methodology which is helpful in terms of Cost and Time [20]. This paper provide a feasibility study for commercial and open source web testing tools helping developers or users to pick the suitable tool based on their requirements [21]. In software engineering practice, evaluating and selecting the software testing tools that best fit the project at hand is an important and challenging task [22].
The paper discusses the concepts, optimized software testing, software testing types and comparative study of the performance testing tools. Performance tools can be considered as the best according to their applications [23]. Authors found that projects written in Go, PHP, and JavaScript are the ones that most adopt automated support, with adoption percentage ranging from 84.9% to 100% of the project corpus [24].
V Garousi et al. [25] found that major commercial or open-source software nowadays includes automated test suites to verify its functionality. This is specially the case for software projects which evolve through many versions since automated testing pays off the most in the case of regression and repetitive testing.

3. RESULTS AND ANALYSIS

For this paper, the automated software testing tools chosen are the following:

A. Selenium: Selenium is an open source testing toolkit to test web application that supports different browser, platforms, and operating system.
B. UFT: Unified Functional Testing, formerly QTP is a graphical interface record-playback automation tool. It is the part of HP quality center tool suite.
C. Ranorex Studio: Ranorex is a graphic user interface automation framework used for testing desktop, web-based, and mobile applications.
D. Test-Complete: TestComplete is an application that helps automate software quality tests for websites, web applications, and Windows desktop applications.
E. Watir: Watir is a simple, flexible and open source tool used for automation testing.
F. Sahi-Pro: A Sahi Pro is an open source cross platform testing tool used for web application testing.
G. Load Runner: A Load Runner is a software testing tool developed by Hewlett Packard and is used to test applications, check system behavior and performance under load.

H. Apache-JMeter: It is developed by Apache Software Foundation and is open source tool. This tool again used as a load testing tool for determining the performance of various web applications.
I. Soap UI: A Soap UI is an open source testing tool used for web service testing.
J. Telerik Test Studio: It comes with many features that are available to users through a transparent GUI. It also provides support for recording test scripts as a plug-in for the Internet Explorer.
K. Silk Test: A is an automation robust tool for testing web and enterprise applications. It is functional testing tool as well as regression testing tool which is cost effective and test applications efficiently in a well manner.
L. Rational Functional Tester: A is an automated testing tool that is used to determine the performance of web or server based applications.
M. Coded UI: A is an automated testing framework that used for analyzing and testing user interfaces. Developers create a coded UI test that can test the user interface for an application functions correctly.
N. Appvance: This testing tool uses functional and performance techniques to test these applications such as web, AJAX applications. Modern applications are very difficult to test but Appvance gain its popularity just because of the fact that it solves that problem.

On the basis of the literature review, we came to know that a few of open source tools have some limitations like programming knowledge whereas the commercial one has some fine features like understandability and technical support. For that reason selection of tool should be entirely based on the environment, project requirements, tester's knowledge and budget constraint.

3.1 EVALUATION PARAMETER

Evaluation can be done on the basis of different characteristics or parameters of automation tools, so this need to find out features for comparative analysis.

We used the criteria for performing analysis from a set of characteristics considered important by practitioners in test tool selection. The criteria to be evaluated: a. Applicability b. Compatibility c. Configurability d. Cost-Effectiveness e. Cross–Platform Support f. Easy to Use g. Expandability h. Further Development i. Maintenance of Test cases & Data j. Performance k. Popularity l. Programming Skills and m. Reporting Features [22].

Now, to meet research point of the study i.e. comparison of software testing tools; features/characteristics are shown in a table below [21, 22, 26, 27, 28]:

Characteristics	Meaning
OS Compatibility	Operating systems supported
Browser Compatibility	Browser tools supported
Extendibility	The degree to which software can be extend, add functionality.
Record playback	Ability of tools to record scripts
Script language	Programming languages used to edit test scripts or for the creation of testing scripts
Ease of learning	How easy the tool is used
Data driven	The ability of tool to reduce efforts like making it possible to make the scripts access the different sets of input data from external source like data tables, excel sheets
Programming skills	Programming skills needed
Cost effectiveness	Whether free or licensed
Function	Type of testing supported
Report generation	How result is represented
Modifiability	Quality of being modifiable according to user requirement.

Table1. Characteristics of software testing tools

3.2 COMPARATIVE ANALYSIS

Comparative analysis on different selected automated software testing tools of choice is shown in table, on the basis of evaluation parameters.

Criteria/ Tool	Developer	Platform/OS Compatibility	Browser Compatibility	Extendi-bility	Programming Skills	Cost	Modifi-ability	Language
Selenium Framework [5]	Jason Huggins	Cross platforms	Cross Browser	Limited	Needed	Open source	Yes, modifiable	Java Ruby, python, php C#, .net
UFT [14]	HP	Windows	Chrome, Firefox, IE	Up to only certain extent	Not required. Recommended for advanced test scripts	Comm -ercial	Limited	Vbscript (supports java,.net, Delphi)
Test-Complete [18]	SmartBear	Windows	Chrome, Firefox, Opera, IE	Up to only certain extent	Needs to have	Comm -ercial	Limited	Vbscript, C#, jscript C++, delphi
Watir [20]	Bret P. and P. Rogers	Windows, Mac, Linux	Chrome, Firefox, Opera, IE, Netscape, Safari	Limited extendi-bility	Partial	Open source	Yes, modifiable	Ruby
Sahi-Pro [10]	Tyto	Windows, Linux, Mac	Any Browser	Limited extendi-bility	Partial	Open source	Supports but limited	Javascript but supports Ruby
Ranorex Studio [14,21]	Ranorex GmbH	Windows	Chrome, Firefox, Opera, IE, Netscape, Safari	Not much extendible	Partial	Comm -ercial	Limited	Vb script but supports .net, C++, C#, python
Load Runner [23]	HP	Windows, Mac, Linux	Any Browser	Up to only certain extent	Partial, but script can be complex and difficult to understand	Comm -ercial	Limited	C, Vb, Vbscript, C#, Javascript
Apache-Jmeter [15]	Apache	Cross platforms	No support for crossbrowser testing	Yes, extendible	Not required.	Open source	Yes, modifiable	Groovy, Java
Soap UI [14]	SmartBear	Windows	Chrome, Firefox, IE	Yes, extendible	Partial	Open source	Yes, modifiable	Java
Telerik Test Studio[8]	Telerik	Windows Vista and Higher	All Browsers	Not much extendible	Required	Comm -ercial	Limited	VB.Net-C#
Silk Test [21]	Microfocus	Windows	Cross Browser	Up to certain extent	Partial	Comm -ercial	Supports but limited	VB.Net
Rational Functional Tester [20]	IBM	Windows, Linux	Chrome, Firefox, IE	Up to only certain extent	Required	Comm -ercial	Limited	Java, VB.net
Coded UI [21]	Microsoft	Windows only	IE Only	Extendibl e up to certain extent	Partial	Comm -ercial	Supports but limited	VB.Net, C#
Appvance [15]	Appvance IQ	Cross platforms	Cross Browser	Yes, extendible	Partial	Comm -ercial	Modifiable	Javascript

Table2. Comparative analysis of the characteristics of automation software testing tools

4. CONCLUSIONS

As we are moving towards automation in every field, software automating testing is a superior option for testing teams. Presently in market a number of automated software testing tools are available, as discussed in literature also. For this study, twelve tools were selected that are frequently used in for automation testing of web based applications. We performed a comparative analysis on the basis of their characteristics.

In selecting tools, if the project cost is to be given higher consideration, open source tools such as Selenium is the better option. If the availability of support, ease of learning, report generation are to be considered, licensed tools such as Micro Focus UFT is a good option [29].

This review concludes that, thorough research is needed to improve the quality of tools in various aspects. Still there is no single solution available by which we can achieve complete automation in testing. However, tools can be used in integration to accomplish testing requirement.

FUTURE WORK

As per our judgment a best testing tool is: open source, freely available, easy to configure and use. In future these tools can be compared on the basis of experiments, for the better results.

REFERENCES

[1] IEEE Standard Glossary of Software Engineering Terminology," in IEEE Std 610.12-1990 , vol., no., pp.1-84, 31 Dec. 1990, doi: 10.1109/IEEESTD.1990.101064.

[2] A. Bertolino, "Software Testing Research: Achievements, Challenges, Dreams," Future of Software Engineering (FOSE '07), Minneapolis, MN, 2007, pp. 85-103, doi: 10.1109/FOSE.2007.25.

[3] Päivi Raulamo-Jurvanen, Mika Mäntylä, and Vahid Garousi. 2017. Choosing the Right Test Automation Tool: A Grey Literature Review of Practitioner Sources. In Proceedings of the 21st International Conference on Evaluation and Assessment in Software Engineering (EASE'17). ACM, New York, NY, USA, Article 3, 10 pages. https://doi.org/10.1145/3084226.3084252.

[4] Xu, D., Xu, W., Kent, M., Thomas, L., & Wang, L. (2015). An Automated Test Generation Technique for Software Quality Assurance. IEEE Transactions on Reliability, 64(1), 247–268. doi:10.1109/tr.2014.2354172.

[5] Satish Gojare, Rahul Joshi, Dhanashree Gaigaware, "Analysis and design of Selenium testing tool web driver automation testing framework," published by Elsevier, ISBCC 15, pp. 341 346, 2015.

[6] Frank Elberzhager, Jürgen Münch, Vi Tran Ngoc Nha, A systematic mapping study on the combination of static and dynamic quality assurance techniques, Information and Software Technology, Volume 54, Issue 1, 2012, Pages 1-15, ISSN 0950-5849, https://doi.org/10.1016/j.infsof.2011.06.003.

[7] V. Debroy, L. Brimble, M. Yost and A. Erry, "Automating Web Application Testing from the Ground Up: Experiences and Lessons Learned in an Industrial Setting," 2018 IEEE 11th International Conference on Software Testing, Verification and Validation (ICST), Vasteras, 2018, pp. 354-362, doi: 10.1109/ICST.2018.00042.

[8] K Shaukat, "Taxonomy of automated software testing tool", International Journal of Computer science and innovation," vol. 2015, pp. 7-18, 2015.

[9] S. Dogan, A. Betin-Can and V. Garousi, "Web application testing: A systematic literature review,"*Journal of Systems and Software*, vol.91, pp. 174-201, 2014.

[10] V Malik, M Ghalan, "Comparative study of automated web testing tools", Volume 6 Issue 3-January 2016, 367-374.

[11] Satheesh, A., & Singh, M. (2017). Comparative Study of Open Source Automated Web Testing Tools: Selenium and Sahi. *Indian journal of science and technology*, *10*, 1-9.

[12] Dudekula Mohammad Rafi, Katam Reddy Kiran Moses, K. Petersen and M. V. Mäntylä, "Benefits and limitations of automated software testing: Systematic literature review and practitioner survey," 2012 7th International Workshop on Automation of Software Test (AST), Zurich, 2012, pp. 36-42, doi: 10.1109/IWAST.2012.6228988.

[13] Elior Vila, Galia Novakova, and Diana Todorova. 2017. Automation Testing Framework for Web Applications with Selenium WebDriver: Opportunities and Threats. In Proceedings of the International Conference on

Advances in Image Processing (ICAIP 2017). Association for Computing Machinery, New York, NY, USA, 144–150. DOI:https://doi.org/10.1145/3133264.3133300.

[14] Heidilyn V. Gamido, Marlon V. Gamido, Comparative review of the features of automated software testing tools, International Journal of Electrical and Computer Engineering (IJECE) Vol. 9, pp. 4473~4478, ISSN: 2088-8708, 2019.

[15] F. Wang and W. Du, "A Test Automation Framework Based on WEB," 2012 IEEE/ACIS 11th International Conference on Computer and Information Science, Shanghai, 2012, pp. 683-687, doi: 10.1109/ICIS.2012.21.

[16] R. K. Lenka, U. Satapathy and M. Dey, "Comparative Analysis on Automated Testing of Web-based Application," 2018 International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), Greater Noida (UP), India, 2018, pp. 408-413, doi: 10.1109/ICACCCN.2018.8748374.

[17] Stouky A., Jaoujane B., Daoudi R., Chaoui H. (2018) Improving Software Automation Testing Using Jenkins, and Machine Learning Under Big Data. In: Jung J., Kim P., Choi K. (eds) Big Data Technologies and Applications. BDTA 2017. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 248. Springer, Cham.

[18] Umar, Mubarak Albarka & Chen, Zhanfang. (2019). A Study of Automated Software Testing: Automation Tools and Frameworks. 8. 217-225.

[19] J. Lee, S. Kang and D. Lee, "Survey on software testing practices," in IET Software, vol. 6, no. 3, pp. 275-282, June 2012, doi: 10.1049/iet-sen.2011.0066.

[20] Ibrahim, Jawwad & Hanif, Sundas & Shafiq, Sobia & Faroom, Saeed. (2019). Emerging Trends in Software Testing Tools & Methodologies: A Review. International Journal of Computer Science and Information Security,. 17. 108-112.

[21] Monier, Mohamed & El-mahdy, Mahmoud. (2015). Evaluation of automated web testing tools. International Journal of Computer Applications Technology and Research. 4. 405-408. 10.7753/IJCATR0405.1014.

[22] Päivi Raulamo-Jurvanen, Simo Hosio, and Mika V. Mäntylä. 2019. Practitioner Evaluations on Software Testing Tools. In Evaluation and Assessment in Software Engineering (EASE '19), Copenhagen, Denmark. ACM, NewYork,NY, USA. https://doi.org/10.1145/3319008.3319018, April 15–17, 2019.

[23] A. Jacob and A. Karthikevan, "Scrutiny on Various Approaches of Software Performance Testing Tools," 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, 2018, pp. 509-515, doi: 10.1109/ICECA.2018.8474876.

[24] Rômulo Martins da Silva, Cafer Cruz, Heleno de S. Campos, Leonardo G. P. Murta, and Vânia de Oliveira Neves. 2019. What is the adoption level of automated support for testing in open-source ecosystems? In Proceedings of the IV Brazilian Symposium on Systematic and Automated Software Testing (SAST 2019). ACM, New York, NY, USA, DOI:https://doi.org/10.1145/3356317.3356325.

[25] Vahid Garousi, Mika V. Mäntylä, When and what to automate in software testing? A multi-vocal literature review, Information and Software Technology, Volume 76, 2016, Pages 92-117, ISSN 0950-5849, https://doi.org/10.1016/j.infsof.2016.04.015.

[26] Senthilkumar, R. & Thangavelu, Arunkumar. (2016). A Survey on Prioritization of Software Quality Attributes. Indian Journal of Science and Technology. 9. 10.17485/ijst/2016/v9i44/86988.

[27] Gorton, Ian. (2011), "Essential Software Architecture," second edition, Springer-verlag berlin Heidelberg, pp. 23-38, 2011, 978-3-540-28714-8, DOI 10.1007/3-540-28714-0.

[28] Päivi Raulamo-Jurvanen, Kari Kakkonen, and Mika Mäntylä. 2016. Using Surveys and Web-Scraping to Select Tools for Software Testing Consultancy. Springer International Publishing, Cham, 285–300. https://doi.org/10.1007/978-3-319-49094-6_18.

[29] Jiang, Z. M. and Hassan, A. E. (2015). A survey on load testing of large-scale software systems. IEEE Transactions on Software Engineering, 41(11):1091–1118.

[30] Dudekula M. Rafi, Katam R. K. Moses, Kai Petersen and Mika V. Mäntylä. 2012. Benefits and limitations of automated software testing: Systematic literature review and practitioner survey. In Proceedings of the 7th International Workshop on Automation of Software Test IEEE Press, 36-42.

[31] X. Wang and G. He, "The research of data-driven testing based on QTP," Computer Science & Education (ICCSE), 2014 9th International Conference on. pp. 1063–1066, 2014.

[32] Paruchuri Ramya , Vemuri Sindhura , P. Vidya Sagar (2017), Testing using selenium web driver. Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), DOI: 10.1109/ICECCT.2017.8117878 IEEE Xplore.

[33] Vila, E., Novakova, G., and Todorova, D. (2017). Automation testing framework for web applications with selenium webdriver: Opportunities and threats. In Proceedings of the International Conference on Advances in Image Processing, ICAIP 2017, pages144–150, New York, NY, ACM.