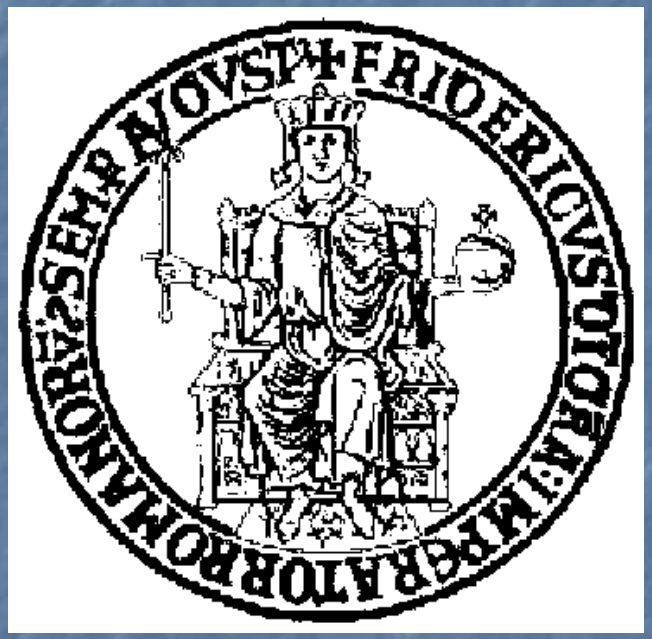
Web Application Testing in Fifteen Years of WSE



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Web Application Testing

- Web application testing has always been a relevant and attractive topic
  - Due to the widespread diffusion and success of WAs in the modern society
  - And to the growing need for dependable, usable, effective, … quality apps
- Two decades of contributions in this area
  - Hundreds of papers in the literature dealt with this topic over the last two decades [1]

[1] V. Garousi, A. Mesbah, et al. "A systematic mapping study of web application testing, " Information and Software Technology, vol. 55, no. 8, pp. 1396–1374, Mar. 2013.

Web application testing : a selection of contributions from past WSE editions

Area	Topics	Number of papers	WSE Editions
WA Testing	Generic issues in Web testing	1	2007
Testing the Functionality	White-box testing	3	2002, 2005, 2006
	User-session based testing	1	2006
	Model-based Testing		2007
	Regression Testing	1	2009
	Testing large Web applications	2	2004

Area	Topics	Number of papers	WSE Editions
Testing non-functional requirements	Accessibility assessment	4	2002, 2003, 2005, 2011
	Security and Vulnerability	5	
	Robusteness testing	1	2009
	Performance testing	1	2004
Web Service	Web Service testing	1	2006
Rich Internet Application (RIA) testing	RIA testing automation	1	2010

A fast survey about the contributions provided by some of these papers...

- A preliminary contribution:
- The peculiarities of testing Web applications and the necessity for specialized skills in this field were remarked by Parveen, Tilley and Gonzalez in 2007 [2]

T. Parveen, S. Tilley, and G. Gonzalez, "On the Need for Teaching Web Application Testing," in 9th IEEE International Workshop on Web Site Evolution, 2007

Techniques for Testing the functionality of Web apps …

- Three relevant contributions by Ricca and Tonella:
  - **2002**: white-box coverage criteria over two models of the application under test (a navigation model and a control flow model) [4]
  - **2005**: a roadmap for testing the functionality of a Web application and a comparison between techniques for *functional testing, code coverage testing and model based testing* [5]
  - **2006**: a *Web fault taxonomy* considering specific characteristics of a Web application that are likely to introduce faults in Web applications' behavior [6]

Techniques for Testing the functionality of *large* Web apps

- 2004**:** Bedi and Schroeder [7] focused on challenges of testing large scale e-commerce applications based on server-side scripting languages.
- 2004: Sneed [8] reported his experience and resulting insights about testing a complex Web system.

Black-Box and Model Based techniques

- 2002: Di Lucca and Di Penta [9] showed the necessity for analysing actions/events provided by the browser (such as the usage of backward and forward buttons) in order to discover navigation inconsistencies in Web applications
- 2006: Di Lucca, Fasolino and Tramontana [10] described a technique for downsizing test suites obtained from a set of user-sessions data
- 2007: Dai and Chen [11] used an inter-connection dependence model for generating sequences of Web pages that are potentially fault prone and for capturing cross-tier faults in multi-tier Web applications.

Regression Testing

- A specific problem of WA: finding solutions for effectively comparing output executions to find real differences among them .
  - 2009: Soechting et al. [12] proposed a technique to measure syntactic differences in the tree-structured output of Web apps for reducing the number of false positives in regression testing.

Rich Internet Application (RIA) testing

- RIAs with their enhanced UI, responsiveness, and new implementation technologies renewed the scenarios of Web application testing.
- 2010: Amalfitano, Fasolino and Tramontana analysed the most critical open issues in RIA testing automation and proposed a classification framework of testing techniques based on:
  - goal of the technique (such as finding generic faults or application–specific ones)
  - test case generation approach (i.e., code-based, requirement-based, by crawling, by user-session-data, by hybrid approaches)
  - types of testing oracles
  - categories of tools supporting testing automation.

Testing non-functional requirements: accessibility

- 2002: Kirchner analyzed the features of existing tools for verifying Web pages against accessibility guidelines and correcting accessibility problems.
- 2003: Kirchner presented a benchmark composed by a set of Web pages containing violations to guidelines and checkpoints defined by the WAI.
- 2005: Di Lucca, Fasolino, and Tramontana proposed a meta-model for representing the parts of the application involved in accessibility problems and a tool for accessibility analysis
- 2011: Kienle et al. presented a survey of articles from past WSE editions entitled "the past, present and future of Web Accessibility"

Security and Vulnerability assessment

- 2005: Di Lucca, Fasolino, Tramontana, ... proposed an approach for Cross Site Scripting (XSS) vulnerability detection in a Web application.
- 2006: Muthuprasanna et al. presented a technique to detect and prevent SQL-Injection Attacks (SQLIA) in WA
- 2007: Merlo et al. proposed a two-step technique for finding SQL-Injections vulnerabilities
- 2012: Alalfi, Cordy, and Dean introduced a Model Driven approach (based on Prolog) to support the assessment of security properties in dynamic Web applications.
- 2010: Yagi et al. investigated the distribution of malwares on Web applications and used honeypot's traffic patterns for the detection of malware files present in Was.

Robustness testing and Web Service Testing

- 2009: Xu et al. proposed an innovative three-steps approach (based on an ontology written in the Web Ontology Language for Services (OWL-S)) for generating robustness test data as invalid inputs.
- 2006: Sneed et al. presented a Web Service testing technique and a tool for simulating the usage of Web services and generating and validating system test data.

Web Application Testing: from the past to the present

- Web applications evolved significantly over the last two decades, from the first static WA...
- Technologies, platforms, development approaches changed considerably: :
  - more complex and dynamic multi-layered systems
  - business logic implemented both at the client and at the server side
  - asynchronous interactions between layers (see RIAs and AJAX)
  - Developed using CMS, Frameworks, Model-driven approaches…
  - Adaptable, Context aware, Mobile Web applications

WAs in the next future…

- Growing complexity
- Will integrate more and more services, components, applications, and multimedia
- Will be able to adapt themselves to evolving execution environments and operating contexts
- Will have to be accessed by mobile devices, equipped with heterogeneous hardware, operating systems, and execution platforms...

Web application testing: future perspectives…

- New solutions of Web testing automation will be increasingly needed, for testing more and more complex apps
  - The applicability and effectiveness of search-based, model-based, and crawling-based techniques will have to be investigated
  - Suitable strategies for integration and system testing of complex Web applications will be needed

Web application testing: future perspectives

- New testing frameworks and environments will be necessary, with runtime monitoring capabilities
  - To cope with the issues of testing dynamic and self-adaptive Web applications
- New testing infrastructures also exploiting the computational capabilities of Service oriented architectures and Cloud computing will have to be designed
  - to cope with the fragmentation issues of testing applications running on heterogeneous execution platforms and including heterogeneous components

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