

# Analysis and Testing of Web Applications

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**The Problem:** Web applications are complex, software-intensive systems, providing hypertextual contents, computational facilities and services. Furthermore, they typically work in a distributed, asynchronous fashion. Correspondingly, the quality of Web applications is a complex, multidimensional attribute. The problem of improving the quality of Web applications involves several aspects, including the extraction of suitable models, testing, restructuring, assessment of multilingual alignment and accessibility.

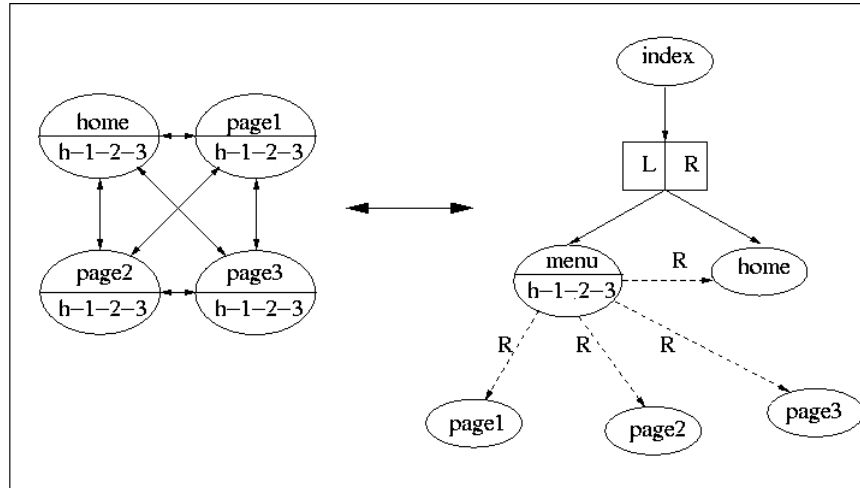


Figure 1: An example of Web application restructuring. After identifying menu candidates by means of concept analysis, the original navigation structure is replaced by a new, frame-based one.

**Motivation:** The current situation in the development of Web applications is somewhat similar to the early development of software systems, when quality was totally dependent on individual skills and lucky choices. In fact, most Web applications have insofar been developed without following a formalized process model. Requirements are not captured and the architecture and detailed design of the system are not considered. Developers quickly move to the implementation phase and deliver the system without testing it. Finally, no documentation is usually produced about the internal organization of the application. While this kind of practice was motivated by the characteristics of the first generation of Web sites, things are now quickly changing and increasing demand exists for better techniques, methodologies and processes.

**Previous Work:** Many works have been dedicated to the problem of Web site design. They include languages, models and graphical notations useful for the specification of Web sites [R1],[R2]. On the contrary, only a few works deal with Web site maintenance and restructuring [R3],[R4]. In this context, for example, many problems related to the analysis of dynamically generated pages are still open. Several tools support the user during functional testing of Web sites, almost all of which exploit a capture/replay mechanism. Only few proposals address the problem of structural testing of Web applications [R5],[R6].

In the recent past, our work focused on the analysis of “static” Web sites, i.e., sites in which pages are not generated at run-time by a server side script. For these, a set of analysis techniques have been devised and implemented. The outcome of these analyses can be used to automatically restructure a Web site (see Fig. 1), by means of program transformations [P1].

**Approach:** Our approach moves from the observation that several methods for the analysis and comprehension of traditional software exist that could be fruitfully adapted to the study of Web applications. The overarching idea is therefore that of identifying specific problems in the development of Web applications, and to resort, for their solution, to well established software engineering methods. Of course, one cannot expect these to work without some kind of “porting” or adaptation – one that oftentimes involves radical and creative rethinking of models, techniques and algorithms.

**Preliminary Results:** Recently, the problem of handling dynamic sites has been considered and structural testing techniques for these sites have been investigated [P2],[P3]. Also we have been working on the problem of the consistency of multilingual sites, exploiting static code analysis and natural language processing [P4]. Finally, an activity has been started for the assessment of Web site accessibility.

#### **Main Publications:**

[P1] F. Ricca, P. Tonella, and Ira D. Baxter: “*Web Application Transformations Based on Rewrite Rules.*” Inf. and Soft. Tech., 2002. In the press.

[P2] F. Ricca and P. Tonella: “*Analysis and Testing of Web Applications.*” In Proc. of ICSE’2001, Int. Conf. on Soft. Eng., pp. 25-34, Toronto, Canada, May 12-19, 2001.

[P3] F. Ricca and P. Tonella: “*Testing Processes of Web Applications.*” Ann. of Soft. Eng., Vol. 14, pp. 93-114, 2002.

[P4] P. Tonella, F. Ricca, E. Pianta and C. Girardi: “*Restructuring Multilingual Web Sites.*” In Proc. of ICSM 2002, Int. Conf. on Software Maintenance, Montreal, Canada, October 2002.

**Impact:** Given the novelty of the problems we are presently tackling, our primary target are the scientific communities of reference. Contributions are therefore regularly presented at major international events and/or submitted for specialized publications. In the context of the WebFAQ (Web: Flexible Access and Quality) project, two research prototypes were also developed and tested: ReWeb, for the reverse engineering of Web applications; and TestWeb, for Web Applications testing.

**Future Work:** Many are the topics that appear to offer interesting research opportunities. With respect to Web application analysis, the automatic identification of conceptual clusters of Web pages – based both on the structure of the site and on its content – may help build an abstract and useful view of the site. Restructuring techniques could also be employed to migrate a static Web site toward a dynamic Web application. Statistical testing could be a good complement to structural testing. Automatic generation of form input data could be used in the production of test cases. Tools assessing and improving Web site accessibility will be also investigated.

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**Collaborations:** University of California, Riverside, USA; University of Durham, UK, and with the Università di Napoli, Italy. We are also involved in the organization of WSE, the IEEE International Workshop on Web Site Evolution.

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- [R4] G.A. Di Lucca, A.R. Fasolino, F. Pace, P. Tramontana and U. De Carlini: “*Comprehending Web Applications by a Clustering Based Approach.*” In Proc. of IWPC 2002, 10th Int. Workshop on Program Comprehension, pp. 261-270, June 26-29, 2002, Paris, France.
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- [R6] G.A. Di Lucca, A.R. Fasolino, F. Faralli, U. De Carlini: “*Testing Web applications.*” In Proc. of ICSM 2002, Int. Conf. on Software Maintenance, Montreal, Canada, October 2002. In the press.