

A Practical T-P³R² Model to Test Dynamic Websites

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Abstract

Present day web applications are very complex as they employ more objects (controls) on a web page than traditional web applications. This results in more memory leaks, more CPU utilizations and longer test executions. Furthermore, today websites are dynamic meaning that the web pages are loaded according to the users input. Higher complexity of web software means more insecure website. This increases the attack surfaces. In this paper, it is proposed to use both Test-Driven Development (TDD) and white-box testing together to handle the dynamic aspects of web applications. Also, it proposes a new practical T-P³R² model to cope with dynamism of websites.

Keywords: Dynamic website testing, TDD, Web Application Trees (WAT), Path testing.

1. Introduction

A web application generally consists of a set of correlated static or dynamic web pages and other components which integrate pages to form a system (Xuang, 2011). Testing only the static web pages is not sufficient. The need today is to test dynamically created web pages. In AJAX (Asynchronous Javascript and Xml) based applications, for instance, the content is also created dynamically. The controls are dynamically loaded and unloaded as per user inputs. Be it a single-page Ajax application or a multi-page Ajax application, its thorough testing is the need. Even Ajax-based applications are being hacked today easily. Pinning down the origin and perpetrator of a particular cyber intrusion can be very difficult. But it is not impossible. The ultimate objective is to test a web application for better quality and easier maintenance. To cope with dynamism, we need a new test model and a new CASE TOOL to capture all possible execution flows, as is done for traditional software.

Even Ajax based applications are not secure. Both reliability –based testing approaches (like black box testing, white-box testing etc.) and adequacy based testing (like mutation testing) can cover only 65% of the errors. TDD is a programming technique that focuses on conformity of code to tests (Jorgensen, 2006).

2. Literature Review

Dynamically created HTML pages are typically comprised of several atomic sections from a server program that prints HTML (Ye Wu, 2004). A composition rule is used to model internal structure of individual server components. The composition is usually done dynamically and is affected by the control flow of the server component. A brief literature review is cited below:-

Ye Wu, Jeff Offut and Xiaochen Du propose a model based on atomic sections which allow tools to build the equivalent of a control flow graph for web applications. But they consider graphs only and graphs are problematic when they contain cycles. They have not reused any of the dynamically created paths further.

Zhongsheng Qian, Huaikou Miao, Hongwei Zeng propose a practical model to test web applications. But it focuses on static websites only.

Jorgensen Andersen, Jan Roar Edvardsen in their thesis suggest TDD of Ajax based applications but don't consider path testing and TDD together.

Sangeeta Sabharwal, Ritu Sibal, Chayanika Sharma use Genetic Algorithms to prioritize the test cases.

Xuan Peng and Lu Lu [5] focus on Request Dependence Graphs (RDG) to cope with dynamism of websites. Their approach attains higher path coverage and more error predictions with smaller test suites. It considers user sessions and the transition relations not covered in the original user sessions set would not be covered in their user session- based RDG.

Hamzeh Al Shaar and Ramzi Haraty model three aspects of a web application—the client-side pages navigated by the user, the server side programs executed at runtime and the architectural environment hosting the application. They present a technique for automated black box regression testing.

Quingling Wang, Qin Liu, Na Li and Yan Liu propose an ACT tool (Automatic Convert Tool) to convert any old web project to an Ajax application. This is because an Ajax application outperforms the client-server architecture in terms of data transfer volume, data transfer time and overall transmission time.

Filippo Ricca, Paolo Tonella and Alessandro Marchetto compare existing black-box and white-box testing techniques with their newly developed state-based testing techniques to test Ajax-based applications. But it involves more effort and more complex test cases. Even more than double, testing hours are required to prepare test environments.

Ali Mesbah and Arie van Deursen use a schema-based clustering technique extract a navigational model of web applications and identifies candidate user interface components to migrate to a single-page Ajax interface. They developed RETJAX tool to accomplish the task.

Danny Roest, Ali Mesbah and Arie van Deursen apply pipelined oracle comparators to cope with the dynamic behavior of a website. They developed a CRAWLJAX tool for the same. They further modified this tool by developing and adding some more plugins (collectively known as ATUSA) for invariant-based testing and test suite generation. But no focus on security is made.

Although various techniques exist in the literature that describes the elements of dynamically created web pages, their interactions have been modeled, yet websites fail as far as their security is concerned. To prevent this, an extensive and thorough dynamic web application testing is needed. The research in this paper proposes a new model that uses TEST DRIVEN DEVELOPMENT (TDD) and basis path testing together for better test coverage thereby increasing web security also.

3. Capturing Defects Using T-P³ R² Model on Dynamic Websites

White-box testing can cover more errors than black-box testing. But when both white-box and black-box approaches are used together, they can cover more number of errors as compared to white-box or black-box testing alone. But it may be time consuming to use both the techniques together. To overcome these problems, a new test model is proposed in this paper and is shown in figure-1.

This model is explained in the following steps:-

Step-1 a) Use TDD to get tested and refactored code.

b) Consider this code (may be a servlet running on a server-side) as obtained in step1a above.

Step-2 a) Derive its Base Sections / Simple Sections (BS/SS). Note here that only output statements are annotated as base sections.

b) Combine the Base Sections into Derived or Complex sections (CS). Form their regular expressions/composition rules. Both BS and CS define how many HTML pages can be created dynamically.

Step-3: Draw its WAG/Page-Flow-Diagram (PFD) (both at Intra-level or Inter-level) (Zhongsheng 2008).

Step-4: Convert this WAG (at the Intra-level) into an equivalent Web Application Tree (WAT)/Page-Test-Tree (PTT) (Zhongsheng 2008).

Step-5: a) Now, apply basis path testing on the WAT as obtained in step-4 above. This intra-level component will comprise of base and derived (simple and complex) sections.

b) **R**euse these paths for white-box testing at these nodes.

c) **R**eports based on test cases are generated.

The research in this paper proposes to convert WAG (comprising of AS and CS) into WATs as trees don't contain cycles. The research is conducted by doing basis path testing at intra-component level to cope with the testing of dynamic websites. So, the methodology used is –

$$\text{Dynamic testing} = \text{TDD} + \text{Basis Path Testing} \quad (1)$$

TDD alone can result in 100% unit level testing and Basis Path Testing locates 65% of the errors (Sangeeta, 2011). Furthermore, the testing effort, cost and time are reduced as complete unit testing has already been done TDD approach. The paths of WAT can also be reused to do subsequent white-box testing of the server code.

As TDD approach has already finished writing of the test cases and code to satisfy those test cases, so a significant reduction in testing cost, time and manpower is obtained from the proposed **T-P³R² model**. The paths when reused for white-box testing of websites can further enhance testing thereby making websites more secure.

4. Future Work

The future directions involve generation of test cases for white-box testing directly from the black box paths, reducing the number of test cases, developing and implementing the T-P³R² Tool for automations for both Ajax-based and Non-Ajax based applications.

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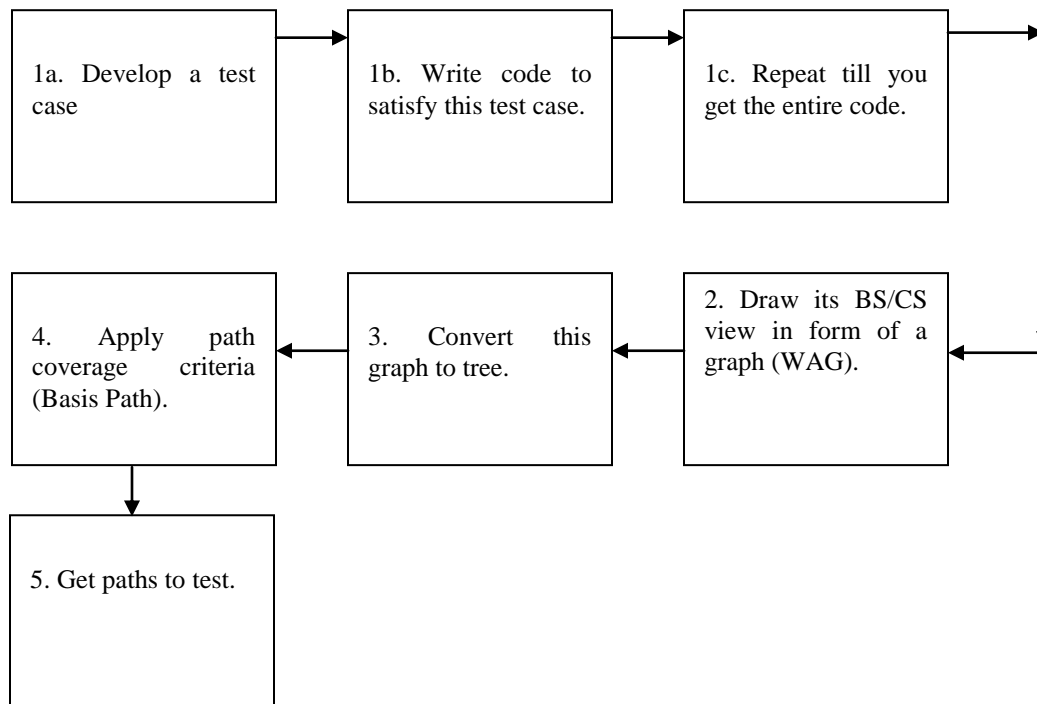


Figure 1. A New Modified T-P³ R² Model for Testing Dynamic Websites.

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