Generating Test Suites for Software Load Testing

Alberto Avritzer
AT&T Bell Laboratories *

Elaine J. Weyuker
AT&T Bell Laboratories
and
Computer Science Dept.
New York University †

Abstract

Three automatic test case generation algorithms intended to test the resource allocation of telecommunications software systems are introduced. Although these techniques were specifically designed for testing telecommunications software, they can be used to generate test cases for any software system that is modelable by a Markov chain. In addition, three new stochastic measures of effectiveness are presented to be used to assess these algorithms. Each of these measures is a variant of a mutation score, but incorporates the association of a probability coefficient with each mutant.

These algorithms have been used successfully to perform load testing for some real industrial software systems. We present empirical results for five such systems. Early experience with the algorithms indicate that they are highly effective at detecting subtle faults that would have been likely to be missed if load testing had been done in the more traditional way, using hand-crafted test cases.

1 Introduction

There is a substantial software engineering literature that presents software testing strategies for various stages of the development cycle. Although these techniques vary in terms of the information used, the development stage at which they are intended to be applied, the degree of automation provided, and the amount of analytical and/or empirical evidence presented to show their effectiveness, what they all have in common, is that they are intended to be used for *correctness testing* which explicitly considers the *functionality* of the implemented system.

There is also a substantial literature that discusses techniques for the evaluation of the performance of software systems. These strategies typically check that any required system performance goals have been met. Although these goals may be listed in a requirements or specification document, and therefore could be considered to be part of the system functionality, in practice, this is typically considered a distinct form of validation, performed by different personnel, using a different repertoire of techniques.

Several recent papers [3, 4, 5, 9] have discussed *partition testing* strategies, or, as they are more properly called, *subdomain testing* strategies. Such strategies are characterized by the fact that they first divide the input domain into subsets known as *subdomains*, and then one or more element from each such subdomain is selected. The basis for the division may include such things as the implementation, the specification, or a set of expected faults. The resulting test case selection strategy is then said to be a *program-based*, *specification-based*, or *fault-based* strategy, respectively. Program-based testing is also known as *white-box* testing, and specification-based testing is also known as *black-box* testing. Of course, strategies could also be defined that combine two or more of these information sources.

In this paper we introduce black-box strategies that generate test cases for testing resource allocation, rather than system functionality. These algorithms are intended to be applied *after* the func-

* Author's address Room 2E-030, 480 Red Hill Road, Middletown, NJ 07748-3052, beto@eagle.hr.att.com

† Author's address AT&T Bell Laboratories, Room 2B-442, 600 Mountain Ave, Murray Hill, NJ 07974, weyuker@research.att.com

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Software testing Perspective describes a 10 year investigation into the underlying principles of CBSD By restricting attention to the simplest cases startling results are obtained Components are tested using only executable code Their behavior is recorded and presented graphically Functional and non functional behavior of systems synthesized from components are calculated from component tests alone No access to components themselves is required Fast accurate tools support every aspect of CBSD from design through debugging Case studies of CBSD also illuminate software testing in general particularly an expanded role for unit testing and the treatment of non functional software properties This unique book Contains more than a dozen case studies of fully worked out component synthesis with revealing insights into fundamental testing issues Presents an original fundamental theory of component composition that includes persistent state and concurrency based on functional software testing rather than proof of programs Comes with free supporting software with tutorial examples and data for replication of examples The Perl software has been tested on Linux Macintosh and Windows platforms Full documentation is provided Includes anecdotes and insights from the author s 50 year career in computing as systems programmer manager researcher and teacher Composing Software Components A Software testing Perspective will help software researchers and practitioners to understand the underlying principles of component testing Advanced students in computer science engineering and mathematics can also benefit from the book as a supplemental text and reference

Proceedings of the 1994 International Symposium on Software Testing and Analysis, ISSTA ,1994

Foundations of Software Testing Aditya Mathur,2007 This book presents sound engineering approaches for test generation selection minimization assessment and enhancement Using numerous examples it offers a lucid description of a wide range of simple to complex techniques for a variety of testing related tasks Resource description page   *Handbook of Software Fault Localization* W. Eric Wong,T.H. Tse,2023-04-21 Handbook of Software Fault Localization A comprehensive analysis of fault localization techniques and strategies In Handbook of Software Fault Localization Foundations and Advances distinguished computer scientists Prof W Eric Wong and Prof T H Tse deliver a robust treatment of up to date techniques tools and essential issues in software fault localization The authors offer collective discussions of fault localization strategies with an emphasis on the most important features of each approach The book also explores critical aspects of software fault localization like multiple bugs successful and failed test cases coincidental correctness faults introduced by missing code the combination of several fault localization techniques ties within fault localization rankings concurrency bugs spreadsheet fault localization and theoretical studies on fault localization Readers will benefit from the authors straightforward discussions of how to apply cost effective techniques to a variety of specific environments common in the real world They will also enjoy the in depth explorations of recent research directions on this topic Handbook of Software Fault Localization also includes A thorough introduction to the concepts of software testing and debugging their importance typical challenges and the consequences of poor efforts Comprehensive explorations of traditional fault localization techniques including program

logging assertions and breakpoints Practical discussions of slicing based program spectrum based and statistics based techniques In depth examinations of machine learning data mining and model based techniques for software fault localization Perfect for researchers professors and students studying and working in the field Handbook of Software Fault Localization Foundations and Advances is also an indispensable resource for software engineers managers and software project decision makers responsible for schedule and budget control **Search-Based Software Engineering** Thelma Elita Colanzi,Phil McMinn,2018-08-23 This book constitutes the refereed proceedings of the 10th International Symposium on Search Based Software Engineering SSBSE 2018 held in Montpellier France in September 2018 The 12 full papers and 7 short papers presented together with 3 keynotes 2 tutorials and 1 anniversary paper were carefully reviewed and selected from 21 submissions SSBSE welcomes not only applications from throughout the software engineering lifecycle but also a broad range of search methods ranging from exact Operational Research techniques to nature inspired algorithms and simulated annealing Chapter Deploying Search Based Software Engineering with Sapienz at Facebook is available open access under a Creative Commons Attribution 4 0 International License via link springer com **Software Testing in the Cloud: Perspectives on an Emerging Discipline** Tilley, Scott,Parveen, Tauhida,2012-11-30 In recent years cloud computing has gained a significant amount of attention by providing more flexible ways to store applications remotely With software testing continuing to be an important part of the software engineering life cycle the emergence of software testing in the cloud has the potential to change the way software testing is performed Software Testing in the Cloud Perspectives on an Emerging Discipline is a comprehensive collection of research by leading experts in the field providing an overview of cloud computing and current issues in software testing and system migration Deserving the attention of researchers practitioners and managers this book aims to raise awareness about this new field of study **Transactions on Pattern Languages of Programming V** Eugene Wallingford,Uwe Zdun,Christian Kohls,2025-03-20 The Transactions on Pattern Languages of Programming subline aims to publish papers on patterns and pattern languages as applied to software design development and use throughout all phases of the software life cycle from requirements and design to implementation maintenance and evolution The primary focus of this LNCS Transactions subline is on patterns pattern collections and pattern languages themselves The journal also includes reviews survey articles criticisms of patterns and pattern languages as well as other research on patterns and pattern languages This book the fifth volume in the Transactions on Pattern Languages of Programming series includes papers on patterns and pattern languages for engineering specific kinds of application and for improving processes as well as papers on the discovery validation and systemic use of patterns more broadly *Web Engineering Advancements and Trends: Building New Dimensions of Information Technology* Alkhatib, Ghazi I.,Rine, David C.,2010-01-31 Web Engineering Advancements and Trends Building New Dimensions of Information Technology examines integrated approaches in new dimensions of social and organizational knowledge sharing with emphasis on intelligent and

personalized access   FME 2002: Formal Methods - Getting IT Right Lars-Henrik Eriksson,Peter A. Lindsay,2003-08-02 This volume contains the proceedings of the 2002 symposium Formal Methods th Europe FME 2002 The symposium was the 11 in a series that began with a VDM Europe symposium in 1987 The symposia are traditionally held every 18 months In 2002 the symposium was held at the University of Copenhagen as part of the 2002 Federated Logic Conference FLoC 2002 which brought gether in one event seven major conferences related to logic in computer science as well as their a liated workshops tutorials and tools exhibitions Formal Methods Europe www fmeurope org is an independent association which aims to stimulate the use of and research on formal methods for software development FME symposia have been notably successful in bringing together a community of users researchers and developers of precise mathematical thods for software development The theme of FME 2002 was Formal Methods Getting IT Right The double meaning was intentional On the one hand the theme acknowledged the signi cant contribution formal methods can make to Information Technology by enabling computer systems to be described precisely and reasoned about with rigour On the other hand it recognized that current formal methods are not perfect and further research and practice are required to improve their foundations applicability and e ectiveness   **Safe Comp 97** Peter Daniel,2012-12-06 The safe and secure operation ofcomputer systems continues to be the major issue in many applications where there is a threat to people the environment investment or goodwill Such applications include medical devices railway signalling energy distribution vehicle control and monitoring air traffic control industrial process control telecommunications systemsand manyothers This book represents the proceedings of the 16th International Conference on Computer Safety Reliability and Security held in York UK 7 10 September 1997 The conference reviews the state ofthe art experience and new trends in the areas of computer safety reliability and security It forms a platform for technology transfer between academia industry and research institutions In an expanding world wide market for safe secure and reliable computer systems SAFECOMP 97 provides an opportunity for technical developers users and legislators to exchange and review the experience to consider the best technologies now available and to identify the skills and technologies required for the future The papers were carefully selected by the Conference International Programme Committee The authors of the papers come from twelve different countries The subjects covered include safe software safety cases management development security human factors guidelines standards certification applications industrial experience formal methods models andvalidation verification and testing SAFECOMP 97 continues the successful series of SAFECOMP conferences first held in 1979 in Stuttgart SAFECOMP is organised by the European Workshop on Industrial Computer Systems Technical Committee 7 on Safety Security and Reliability EWICS TC7   **Functional and Logic Programming** Matthias Blume,Naoki Kobayashi,Germán Vidal-Oriola,2010-04-11 This book constitutes the refereed proceedings of the 10th International Symposium on Functional and Logic Programming FLOPS 2010 held in Sendai Japan in April 2010 The 21 revised full papers presented together with 3 invited talks were carefully reviewed and selected from 49 submissions The

papers are organized in topical sections on types program analysis and transformation foundations logic programming evaluation and normalization term rewriting and parallelism and control *Software Architecture* Richard N. Taylor,Nenad Medvidovic,Eric Dashofy,2009-01-09 Software architecture is foundational to the development of large practical software intensive applications This brand new text covers all facets of software architecture and how it serves as the intellectual centerpiece of software development and evolution Critically this text focuses on supporting creation of real implemented systems Hence the text details not only modeling techniques but design implementation deployment and system adaptation as well as a host of other topics putting the elements in context and comparing and contrasting them with one another Rather than focusing on one method notation tool or process this new text reference widely surveys software architecture techniques enabling the instructor and practitioner to choose the right tool for the job at hand Software Architecture is intended for upper division undergraduate and graduate courses in software architecture software design component based software engineering and distributed systems the text may also be used in introductory as well as advanced software engineering courses   Tests and Proofs Laura Kovács,Karl Meinke,2022-06-21 This book constitutes the proceedings of the 16th International Conference on Tests and Proofs TAP 2022 which was held as part of Software Technologies Applications and Foundations STAF 2022 and took place in Nantes France in July 2022 The 6 full papers together with 1 invited extended abstract included in this volume were carefully reviewed and selected from 11 submissions They were organized in topical sections on formal analysis and proofs and effective testing   **Distributed Embedded Systems: Design, Middleware and Resources** Bernd Kleinjohann,Lisa Kleinjohann,Marilyn Wolf,2008-07-10 This year the IFIP Working Conference on Distributed and Parallel Embedded Sys tems DIPES 2008 is held as part of the IFIP World Computer Congress held in Milan on September 7 10 2008 The embedded systems world has a great deal of experience with parallel and distributed computing Many embedded computing systems require the high performance that can be delivered by parallel computing Parallel and distributed computing are often the only ways to deliver adequate real time performance at low power levels This year s conference attracted 30 submissions of which 21 were accepted Prof Jor g Henkel of the University of Karlsruhe graciously contributed a keynote address on embedded computing and reliability We would like to thank all of the program committee members for their diligence Wayne Wolf Bernd Kleinjohann and Lisa Kleinjohann Acknowledgements We would like to thank all people involved in the organization of the IFIP World Computer Congress 2008 especially the IPC Co Chairs Judith Bishop and Ivo De Lotto the Organization Chair Giulio Occhini as well as the Publications Chair John Impagliazzo Further thanks go to the authors for their valuable contributions to DIPES 2008 Last but not least we would like to acknowledge the considerable amount of work and enthusiasm spent by our colleague Claudius Stern in preparing theproceedingsofDIPES2008 Hemadeitpossibletoproducethemintheircurrent professional and homogeneous style   Understanding Analog Side Channels Using Cryptography Algorithms Alenka Zajić,Milos Prvulovic,2023-09-30 This book

offers the latest research results on analog side channels and their usage in cybersecurity It demystifies analog side channels and demonstrates new use cases for them The first part of this book discusses how analog side channels are generated the physics behind it the modeling and measurements of analog side channels and their analogies to wireless communication systems The second part of this book introduces new applications that benefit from leveraging side channels In addition to breaking cryptography algorithms it demonstrates how analog side channels can be used for malware detection program profiling hardware profiling hardware software attestation hardware identification and hardware Trojan detection Side channel is one of the methods for obtaining information about program execution Traditionally they are used in computer science to extract information about a key in cryptographic algorithms What makes them different from other ways of extracting information about program execution is that side channels rely on how a system implements program execution rather than what the program s algorithm specifies Analog side channels are particularly powerful because they are not easy to suppress or detect that someone is collecting information from the system Although they are very powerful tools they are poorly understood This book targets advanced level students in computer science and electrical engineering as a textbook Researchers and professionals working with analog side channels how to model them measure them improve signal to noise ratio and invent new signal processing techniques can also use this book Computer scientists and engineers who want to learn new applications of side channels to improve system security new techniques for breaking cryptography keys new techniques for attestation and new techniques for hardware Trojan detection will also want to purchase this book

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