Symbolic Execution

Symbex Simplifying Constraints, constraint solving

Symbolic Execution

Dennis Andriesse

Symbolic Execution:

Symbolic Execution and Quantitative Reasoning Corina S. Păsăreanu,2022-05-31 This book reviews recent advances in symbolic execution and its probabilistic variant and discusses how they can be used to ensure the safety and security of software systems Symbolic execution is a systematic program analysis technique which explores multiple program behaviors all at once by collecting and solving symbolic constraints collected from the branching conditions in the program The obtained solutions can be used as test inputs that execute feasible program paths Symbolic execution has found many applications in various domains such as security smartphone applications operating systems databases and more recently deep neural networks uncovering subtle errors and unknown vulnerabilities We review here the technique has also been extended to reason about algorithmic complexity and resource consumption Furthermore symbolic execution has been recently extended with probabilistic reasoning allowing one to reason about quantitative properties of software systems The approach computes the conditions to reach target program events of interest and uses model counting to quantify the fraction of the input domain satisfying these conditions thus computing the probability of event occurrence This probabilistic information can be used for example to compute the reliability of an aircraft controller under different wind conditions modeled probabilistically or to quantify the leakage of sensitive data in a software system using information theory metrics such as Shannon entropy This book is intended for students and software engineers who are interested in advanced techniques for testing and verifying software systems *Symbolic Execution and Quantitative Reasoning* Corina S. Păsăreanu,2020-05-13 This book reviews recent advances in symbolic execution and its probabilistic variant and discusses how they can be used to ensure the safety and security of software systems Symbolic execution is a systematic program analysis technique which explores multiple program behaviors all at once by collecting and solving symbolic constraints collected from the branching conditions in the program The obtained solutions can be used as test inputs that execute feasible program paths Symbolic execution has found many applications in various domains such as security smartphone applications operating systems databases and more recently deep neural networks uncovering subtle errors and unknown vulnerabilities We review here the technique has also been extended to reason about algorithmic complexity and resource consumption Furthermore symbolic execution has been recently extended with probabilistic reasoning allowing one to reason about quantitative properties of software systems The approach computes the conditions to reach target program events of interest and uses model counting to quantify the fraction of the input domain satisfying these conditions thus computing the probability of event occurrence This probabilistic information can be used for example to compute the reliability of an aircraft controller under different wind conditions modeled probabilistically or to quantify the leakage of sensitive data in a software system using information theory metrics such as Shannon entropy This book is intended for students and software engineers who are interested in advanced techniques for testing and verifying software systems **Testing Techniques in**

Software Engineering Paulo Borba,Ana Cavalcanti,Augusto Sampaio,Jim Woodcook,2010-07-30 The Pernambuco School on Software Engineering PSSE 2007 was the second in a series of events devoted to the study of advanced computer science and to the promotion of international scienti c collaboration The main theme in 2007 was testing Testing is nowadays a key activity for assuring software quality The summer school and its proceedings were intended to give a detailed tutorial introduction to the scienti c basis of this activity and its state of the art Theseproceedingsrecordthecontributionsfromtheinvitedlecturers Eachof thechaptersistheresultofathoroughrevisionoftheinitialnotesprovidedtothe participants of the school The revision was inspired by the synergy generated by the opportunity for the lecturers to present and discuss their work among themselves and with the school s attendees The editors have tried to produce a coherent view of the topic by harmonizing these contributions smoothing out di erences in notation and approach and providing links between the lectures We apologize to the authors for any errors introduced by our extensive editing Although the chapters are linked in severalways each one is su ciently se contained to be read in isolation Nevertheless Chap 1 should be read rst by those interested in an introduction to testing Chapter 1 introduces the terminology adopted in this book It also provides an overview of the testing process and of the types functional structural and so on anddimensions unit integration andsoon ofthetestingactivity Themain strategies employed in the central activity of test selection are also discussed Most of the material presented in this introductory chapter is addressedin more depth in the following chapters *Fundamental Approaches to Software Engineering* Luciano Baresi,2006-03-16 This book constitutes the refereed proceedings of the 9th International Conference on Fundamental Approaches to Software Engineering FASE 2006 held in Vienna Austria in March 2006 as part of ETAPS The 27 revised full papers two tool papers presented together with two invited papers were carefully reviewed and selected from 166 submissions The papers are organized in topical sections **Runtime Verification** Saddek Bensalem,Doron A. Peled,2009-09-23 The RV series of workshops brings together researchers from academia and industry who are interested in runtime verification The goal of the RV workshops is to study the ability to apply lightweight formal verification during the execution of programs This approach complements the offline use of formal methods which often use large resources Runtime verification methods and tools include the instrumentation of code with pieces of software that can help to test and monitor it online and detect and sometimes prevent potential faults RV 2009 was held on June 26 28 in Grenoble France adjacent to CAV 2009 The program included 11 accepted papers Two invited talkswere given by Amir Pnueli on Compositional Approach to Monitoring Linear Temporal Logic Properties and Sriram Rajamani on Verification Testing and Statistics The program also included three turorials **Automated Technology for Verification and Analysis** Dang Van Hung,Mizuhito Ogawa,2013-08-30 This book constitutes the refereed proceedings of the 11th International Symposium on Automated Technology for Verification and Analysis ATVA 2013 held at Hanoi Vietnam in October 2013 The 27 regular

papers 3 short papers and 12 tool papers presented together with 3 invited talks were carefully selected from73 submissions The papers are organized in topical sections on analysis and verification of hardware circuits systems on chip and embedded systems analysis of real time hybrid priced weighted and probabilistic systems deductive algorithmic compositional and abstraction refinement techniques for analysis and verification analytical techniques for safety security and dependability testing and runtime analysis based on verification technology analysis and verification of parallel and concurrent hardware software systems verification in industrial practice and applications and case studies   *Blockchain and Trustworthy Systems* Jiachi Chen,Bin Wen,Ting Chen,2023-11-24 The two volume set CCIS 1896 and 1897 constitutes the refereed post conference proceedings of the 5th International Conference on Blockchain and Trustworthy Systems BlockSys 2023 which took place in Haikou China during August 8 10 2023 The 45 revised full papers presented in these proceedings were carefully reviewed and selected from 93 submissions The papers are organized in the following topical sections Part I Anomaly detection on blockchain edge intelligence and metaverse services blockchain system security empirical study and surveys federated learning for blockchain Part II AI for blockchain blockchain applications blockchain architecture and optimization protocols and consensus   <u>Advances in Computers</u> ,2019-01-30 Advances in Computers Volume 113 the latest volume in this innovative series published since 1960 presents detailed coverage of new advancements in computer hardware software theory design and applications Chapters in this updated release include A Survey on Regression Test case Prioritization Symbolic Execution and Recent Applications to Worst Case Execution Load Testing and Security Analysis Model Based Test Cases Reuse and Optimization Advances in Using Agile and Lean Processes for Software Development Three Open Problems in the Context of E2E Web Testing and a Vision NEONATE Experiences with replicable experiments and replication kits for software engineering research and Advances in Symbolic Execution Provides in depth surveys and tutorials on new computer technology Covers well known authors and researchers in the field Presents extensive bibliographies with most chapters Includes volumes that are devoted to single themes or subfields of computer science

Formal Methods and Software Engineering Shengchao Qin,Zongyan Qiu,2011-10-23 This book constitutes the refereed proceedings of the 13th International Conference on Formal Engineering Methods ICFEM 2011 held in Durham UK October 2011 The 40 revised full papers together with 3 invited talks presented were carefully reviewed and selected from 103 submissions The papers address all current issues in formal methods and their applications in software engineering They are organized in topical sections on formal models model checking and probability specification and development security formal verification cyber physical systems event B verification analysis and testing refinement as well as theorem proving and rewriting   <u>NASA Formal Methods</u> Mihaela Bobaru,Klaus Havelund,Gerard Holzmann,Rajeev Joshi,2011-04-06 This book constitutes the refereed proceedings of the Third International Symposium on NASA Formal Methods NFM 2011 held in Pasadena CA USA in April 2011 The 26 revised full papers presented together with 12 tool papers 3 invited talks and 2

invited tutorials were carefully reviewed and selected from 141 submissions The topics covered by NFM 2011 included but were not limited to theorem proving logic model checking automated testing and simulation model based engineering real time and stochastic systems SAT and SMT solvers symbolic execution abstraction and abstraction refinement compositional verification techniques static and dynamic analysis techniques fault protection cyber security specification formalisms requirements analysis and applications of formal techniques **PROCEEDINGS OF THE 23RD CONFERENCE ON FORMAL METHODS IN COMPUTER-AIDED DESIGN – FMCAD 2023** Alexander Nadel ,Kristin Yvonne Rozier,2023-10-13 The Conference on Formal Methods in Computer Aided Design FMCAD is an annual conference on the theory and applications of formal methods in hardware and system in academia and industry for presenting and discussing groundbreaking methods technologies theoretical results and tools for reasoning formally about computing systems FMCAD covers formal aspects of computer aided system testing Model Checking Software Susanne Graf,Laurent Mounier,2004-02-27 Since 1995 when the SPIN workshop series was instigated SPIN workshops have been held on an annual basis in Montr eal 1995 New Brunswick 1996 Enschede 1997 Paris 1998 Trento 1999 Toulouse 1999 Stanford 2000 Toronto 2001 Grenoble 2002 and Portland 2003 All but the rst SPIN workshop were organized as satellite events of larger conferences in particular of CAV 1996 TACAS 1997 FORTE PSTV 1998 FLOC 1999 the World Congress on Formal Methods 1999 FMOODS 2000 ICSE 2001 2003 and ETAPS 2002 This year again SPIN was held as a satellite event of ETAPS 2004 The co location of SPIN workshops with conferences has proven to be very successful and has helped to disseminate SPIN model checking technology to wider audiences Since 1999 the proceedings of the SPIN workshops have appeared in Springer Verlag s Lecture Notes in Computer Science series The history of successful SPIN workshops is evidence for the maturing of model checking technology not only in the hardware domain but increasingly also in the software area While in earlier years algorithms and tool development aroundtheSPINmodelcheckerwerethefocusofthisworkshopseries forseveral years now the scope has been widened to include more general approaches to software model checking techniques and tools as well as applications The SPIN workshop has become a forum for all practitioners and researchers interested in model checking based techniques for the validation and analysis of communication protocols and software systems Practical Binary Analysis Dennis Andriesse,2018-12-11 Stop manually analyzing binary Practical Binary Analysis is the first book of its kind to present advanced binary analysis topics such as binary instrumentation dynamic taint analysis and symbolic execution in an accessible way As malware increasingly obfuscates itself and applies anti analysis techniques to thwart our analysis we need more sophisticated methods that allow us to raise that dark curtain designed to keep us out binary analysis can help The goal of all binary analysis is to determine and possibly modify the true properties of binary programs to understand what they really do rather than what we think they should do While reverse engineering and disassembly are critical first steps in many forms of binary analysis there is much more to be learned This hands on guide teaches you how to tackle the fascinating but

challenging topics of binary analysis and instrumentation and helps you become proficient in an area typically only mastered by a small group of expert hackers It will take you from basic concepts to state of the art methods as you dig into topics like code injection disassembly dynamic taint analysis and binary instrumentation Written for security engineers hackers and those with a basic working knowledge of C C and x86 64 Practical Binary Analysis will teach you in depth how binary programs work and help you acquire the tools and techniques needed to gain more control and insight into binary programs Once you ve completed an introduction to basic binary formats you ll learn how to analyze binaries using techniques like the GNU Linux binary analysis toolchain disassembly and code injection You ll then go on to implement profiling tools with Pin and learn how to build your own dynamic taint analysis tools with libdft and symbolic execution tools using Triton You ll learn how to Parse ELF and PE binaries and build a binary loader with libbfd Use data flow analysis techniques like program tracing slicing and reaching definitions analysis to reason about runtime flow of your programs Modify ELF binaries with techniques like parasitic code injection and hex editing Build custom disassembly tools with Capstone Use binary instrumentation to circumvent anti analysis tricks commonly used by malware Apply taint analysis to detect control hijacking and data leak attacks Use symbolic execution to build automatic exploitation tools With exercises at the end of each chapter to help solidify your skills you ll go from understanding basic assembly to performing some of the most sophisticated binary analysis and instrumentation Practical Binary Analysis gives you what you need to work effectively with binary programs and transform your knowledge from basic understanding to expert level proficiency *Deductive Software Verification – The KeY Book* Wolfgang Ahrendt,Bernhard Beckert,Richard Bubel,Reiner Hähnle,Peter H. Schmitt,Mattias Ulbrich,2016-12-19 Static analysis of software with deductive methods is a highly dynamic field of research on the verge of becoming a mainstream technology in software engineering It consists of a large portfolio of mostly fully automated analyses formal verification test generation security analysis visualization and debugging All of them are realized in the state of art deductive verification framework KeY This book is the definitive guide to KeY that lets you explore the full potential of deductive software verification in practice It contains the complete theory behind KeY for active researchers who want to understand it in depth or use it in their own work But the book also features fully self contained chapters on the Java Modeling Language and on Using KeY that require nothing else than familiarity with Java All other chapters are accessible for graduate students M Sc level and beyond The KeY framework is free and open software downloadable from the book companion website which contains also all code examples mentioned in this book Tests and Proofs Martina Seidl,Nikolai Tillmann,2014-07-07 This book constitutes the refereed proceedings of the 8th International Conference on Tests and Proofs TAP 2014 held in York UK in July 2014 as part of the STAF 2014 Federated Conferences The 10 revised full papers and 4 short papers presented together with two tutorial descriptions were carefully reviewed and selected from 27 submissions The papers cover topics in the following four research areas test generation bridging semantic gaps integrated development processes and bounded

verification   Logic-Based Program Synthesis and Transformation Maribel Fernández,2021-02-12 This book constitutes the refereed proceedings of the 30th International Conference on Logic Based Program Synthesis and Transformation LOPSTR 2020 which was held during September 7 9 2020 The 15 papers presented in this volume were carefully reviewed and selected from a total of 31 submissions The book also contains two invited talks in full paper length The contributions were organized in topical sections named rewriting unification types verification model checking and probabilistic programming program analysis and testing and logics   **Tests and Proofs** Bernhard Beckert,Reiner Hähnle,2008-04-04 This volume contains the research papers invited papers and abstracts of torials presented at the Second International Conference on Tests and Proofs TAP 2008 held April 9 11 2008 in Prato Italy TAP was the second conference devoted to the convergence of proofs and tests It combines ideas from both areasfor the advancement of softwarequality To provethe correctnessof a programis to demonstrate through impeccable mathematical techniques that it has no bugs to test a programis to run it with the expectation of discovering bugs On the surface the two techniques seem contradictory if you have proved your program it is fruitless to comb it for bugs and if you are testing it that is surely a sign that you have given up on anyhope of proving its correctness Accordingly proofs and tests have since the onset of software engineering research been pursued by distinct communities using rather di erent techniques and tools And yet the development of both approaches leads to the discovery of c mon issues and to the realization that each may need the other The emergence of model checking has been one of the rst signs that contradiction may yield to complementarity but in the past few years an increasing number of research e orts have encountered the need for combining proofs and tests dropping e lier dogmatic views of their incompatibility and taking instead the best of what each of these software engineering domains has to o er   Computational Science -- ICCS 2005 V.S. Sunderam,2005-05-12 The three volume set LNCS 3514 3516 constitutes the refereed proceedings of the 5th International Conference on Computational Science ICCS 2005 held in Atlanta GA USA in May 2005 The 464 papers presented were carefully reviewed and selected from a total of 834 submissions for the main conference and its 21 topical workshops The papers span the whole range of computational science ranging from numerical methods algorithms and computational kernels to programming environments grids networking and tools These fundamental contributions dealing with computer science methodologies and techniques are complemented by papers discussing computational applications and needs in virtually all scientific disciplines applying advanced computational methods and tools to achieve new discoveries with greater accuracy and speed   Formal Methods for Components and Objects Frank S. de Boer,Marcello M. Bonsangue,Stefan Hallerstede,Michael Leuschel,2010-11-11 All modern industries rely on large and complex software systems In order to construct such large systems in a systematic manner the focus of the development methodologies has switched in the last two decades from functional to structural issues Formal methods have been applied successfully to the verification of medium sized programs in protocol and hardware design However their application to the development of large systems

requires a greater emphasis on specification modeling and validation techniques supporting the concepts of reusability and modifiability and their implementation in new extensions of existing programming languages like Java This state of the art survey presents the outcome of the 8th Symposium on Formal Methods for Components and Objects held in Eindhoven The Netherlands in November 2009 The volume contains 17 revised contributions submitted after the symposium by speakers from each of the following European IST projects the IST FP6 project BIONETS on biologically inspired services evolution for the pervasive age the IST FP7 project COMPAS on compliance driven models languages and architectures for services the IST FP6 project CREDO on modelling and analysis of evolutionary structures for distributed services the IST FP7 DEPLOY on industrial deployment of advanced system engineering methods for high productivity and dependability the IST FP7 project HATS on highly adaptable and trustworthy software using formal methods the IST FP7 project INESS on integrated European railway signalling system the IST FP7 project MOGENTES on model based generation of tests for dependable embedded systems the IST FP6 project PROTEST on property based testing and the IST FP7 project QUASIMODO on quantitative system properties in model driven design of embedded systems   Proceedings of the Ninth International Joint Conference on Artificial Intelligence International Joint Conferences on Artificial Intelligence,1985

Reviewing **Symbolic Execution**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is truly astonishing. Within the pages of "**Symbolic Execution**," an enthralling opus penned by a highly acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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