## **2022 IEEE Conference on** Software Testing, Verification and Validation (ICST 2022)

**Virtual Conference** 4-13 April 2022



**IEEE Catalog Number: CFP22TVV-POD ISBN**:

978-1-6654-6680-6

## Copyright © 2022 by the Institute of Electrical and Electronics Engineers, Inc. All Rights Reserved

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.

 IEEE Catalog Number:
 CFP22TVV-POD

 ISBN (Print-On-Demand):
 978-1-6654-6680-6

 ISBN (Online):
 978-1-6654-6679-0

ISSN: 2159-4848

#### Additional Copies of This Publication Are Available From:

Curran Associates, Inc 57 Morehouse Lane Red Hook, NY 12571 USA Phone: (845) 758-0400

Fax: (845) 758-2633

E-mail: curran@proceedings.com Web: www.proceedings.com



# 2022 IEEE Conference on Software Testing, Verification and Validation (ICST) ICST 2022

### **Table of Contents**

Message from the General Chairs	xi
Message from the Program Chairs	. xiii
Organizing Committee	xiv
Program Committee	
Keynotes	xix
Sponsors	
Research Track	
GUI Test Transfer from Web to Android Jun-Wei Lin (University of California, Irvine, USA) and Sam Malek (University of California, Irvine, USA)	1
Machine Learning Based Invariant Generation: A Framework and Reproducibility Study Jan Haltermann (University of Oldenburg, Germany) and Heike Wehrheim (University of Oldenburg, Germany)	12
FRIT: Focused Testing through Deep Reinforcement Learning	24
Metamorphic Fuzzing of C++ Libraries Andrei Lascu (Imperial College London, United Kingdom), Alastair F Donaldson (Imperial College London, United Kingdom), Tobias Grosser (University of Edinburgh, United Kingdom), and Torsten Hoefler (ETH Zurich, Switzerland)	35
Smoke Testing of Cloud Systems	47
Testing Software in Production Environments with Data from the Field  Luca Gazzola (University of Milan-Bicocca, Italy), Leonardo Mariani (University of Milan-Bicocca, Italy), Matteo Orrú (University of Milan-Bicocca, Italy), Mauro Pezzè (Università della Svizzera Italiana, Switzerland; SIT Schaffhausen Institute of Technology, Switzerland), and Martin Tappler (Graz University of Technology, Austria; Silicon Austria Labs, TU Graz - SAL DES Lab, Austria)	58

Applying Symbolic Execution to Test Implementations of a Network Protocol Against Its  Specification	0
Hooman Asadian (Uppsala University, Sweden), Paul Fiterău-Broștean (Uppsala University, Sweden), Bengt Jonsson (Uppsala University, Sweden), and Konstantinos Sagonas (Uppsala University, Sweden)	
A Survey on How Test Flakiness Affects Developers and What Support They Need to Address It 8 Martin Gruber (University of Passau, Germany) and Gordon Fraser (University of Passau, Germany)	2
Evaluating Features for Machine Learning Detection of Order- and Non-Order-Dependent Flaky	_
Tests	3
JavaScript Instrumentation for Search-Based Software Testing: A Study with RESTful APIs	5
Patterns of Code-to-Test Co-Evolution for Automated Test Suite Maintenance	6
An Empirical Study of IR-Based Bug Localization for Deep Learning-based Software	8
Automated Repair of Responsive Web Page Layouts	0
To Seed or Not to Seed? An Empirical Analysis of Usage of Seeds for Testing in Machine Learning Projects	1
Learning Projects	1
Learning Realistic Mutations: Bug Creation for Neural Bug Detectors	2
TESRAC: A Framework for Test Suite Reduction Assessment at Scale	4
Symbolic Verification of Message Signatures in MPI	5
Providing Real-Time Assistance for Repairing Runtime Exceptions using Stack Overflow Posts 19 Sonal Mahajan (Fujitsu Research of America, Inc.) and Mukul R. Prasad (Fujitsu Research of America, Inc.)	6

As Code Testing: Characterizing Test Quality in Open Source Ansible Development	208
POWER: Program Option-Aware Fuzzer for High Bug Detection Ability	220
Automated Detection of TalkBack Interactive Accessibility Failures in Android Applications  Ali S. Alotaibi (University of Southern California, USA), Paul T.  Chiou (University of Southern California, USA), and William G.J.  Halfond (University of Southern California, USA)	232
A Qualitative Study on the Sources, Impacts, and Mitigation Strategies of Flaky Tests	244
Automating Differential Testing with Overapproximate Symbolic Execution	256
Industry Track	
FAUSTA: Scaling Dynamic Analysis with Traffic Generation at WhatsApp  Ke Mao (Meta), Timotej Kapus (Meta), Lambros Petrou (Meta), Ákos Hajdu (Meta), Matteo Marescotti (Meta), Andreas Löscher (Meta), Mark Harman (Meta), and Dino Distefano (Meta)	267
Less is More: Simplification of Test Scenarios for Autonomous Driving System Testing	279
Repairing Fragile GUI Test Cases Using Word and Layout Embedding  Juyeon Yoon (KAIST, Republic of Korea), Seungjoon Chung (KAIST,  Republic of Korea), Kihyuck Shin (Samsung Electronics, Republic of  Korea), Jinhan Kim (KAIST, Republic of Korea), Shin Hong (Handong  Global University, Republic of Korea), and Shin Yoo (KAIST, Republic  of Korea)	291
Comparing Fuzzers on a Level Playing Field with FuzzBench	302
Robustness Assessment and Improvement of a Neural Network for Blood Oxygen Pressure Estimation	312

Automatic Error Classification and Root Cause Determination while Replaying Recorded  Workload Data at SAP HANA
Neetha Jambigi (University of Innsbruck, Austria), Thomas Bach (SAP, Germany), Felix Schabernack (SAP, Germany), and Michael Felderer (University of Innsbruck, Austria)
Testing a PL/I Compiler Using Precomputation-based Program Generation
SUPERNOVA: Automating Test Selection and Defect Prevention in AAA Video Games Using Risk Based Testing and Machine Learning
Translating EULYNX SysML Models into Symbolic Transition Systems for Model-Based Testing of Railway Signaling Systems
Harvesting Production GraphQL Queries to Detect Schema Faults
A Framework for Automated API Fuzzing at Enterprise Scale
Testing Tools
ASSESSOR: A PO-Based WebDriver Test Suites Generator from Selenium IDE Recordings
CITRUS: Automated Unit Testing Tool for Real-World C++ Programs
Model-based Testing of Scratch Programs
RiverGame — A Game Testing Tool using Artificial Intelligence

SIFT: A Tool for Property Directed Symbolic Execution of Multithreaded Software
TACKLETEST: A Tool for Amplifying Test Generation via Type-Based Combinatorial Coverage 444 Rachel Tzoref-Brill (IBM Research, Israel), Saurabh Sinha (IBM T.J. Watson Research Center, USA), Antonio Abu Nassar (IBM Research, Israel), Victoria Goldin (IBM Research, Israel), and Haim Kermany (IBM Research, Israel)
Tool Demo
DTLS-Fuzzer: A DTLS Protocol State Fuzzer
Journal First
Summary of An Effective Formulation of the Multi-criteria Test Suite Minimization Problem 459 Okan Örsan Özener (Ozyegin University, Turkey) and Hasan Sözer (Ozyegin University, Turkey)
Summary of SWFC-ART: A Cost-Effective Approach for Fixed-Size-Candidate-Set Adaptive Random Testing through Small World Graphs
Summary of Model Checking C++ Programs
An Experimental and Practical Study on the Equivalent Mutant Connection: An Evolutionary  Approach
Documentation-based Functional Constraint Generation for Library Methods
Learning-based Mutant Reduction Using Fine-grained Mutation Operators

### **Posters**

Locating Code Omission Error Due to Incorrect Polymorphic Method Call	. 465
Poster: A gCov based New Profiler, gMCov, for MC/DC and SC-MCC	. 469
Poster: EBFL-An Ensemble Classifier Based Fault Localization	. 473
Doctoral Symposium	
Automated GUI-Based Software-Testing Using Deep Neuroevolution  Daniel Zimmermann (FZI Research Center for Information Technology,  Germany)	477
Automated Program Repair and Test Overfitting: Measurements and Approaches using Formal Methods  **Amirfarhad Nilizadeh (University of Central Florida, USA)	. 480
Debugger-Driven Embedded Fuzzing  Max Eisele (Robert Bosch GmbH, Germany)	. 483
Model-Based Testing for System-Level Safety of Autonomous Underwater Robots	. 486
Author Index	489