

Curriculum Vitae

Paolo Tonella

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EDUCATION

- 1999 **PhD** (thesis title: *Code Analysis in Support to Software Maintenance*)
Faculty of Engineering, Department of Electronics, University of Padua, Italy
- 1992 **MSc** (awarded as the best student who graduated in 1992)
Faculty of Engineering, Department of Electronics, University of Padua, Italy

EMPLOYMENT HISTORY

- 2018 – **Full Professor** at Università della Svizzera Italiana (USI), Lugano, Switzerland.
- 2007 – 2018 **Head of Software Engineering** at Fondazione Bruno Kessler, Trento, Italy.
- 2013 – **Honorary Professor** at University College London, UK.
- 1994 – 2007 **Researcher** at IRST (Istituto per la Ricerca Scientifica e Tecnologica), Trento, Italy.

STEERING COMMITTEES (selection)

- 2010 – 2017 *ACM International Symposium on Software Analysis and Testing (ISSTA)*
- 2006 – 2009; 2012 – 2015 *IEEE International Conference on Software Maintenance and Evolution (ICSME)*

PROJECTS

I participated in several research projects on software analysis and testing, including industrial and European projects, among which:

- [p1] **IBT** (2007-2010): Industrial project with IBT (Informatica Bancaria Trentina), for the reengineering of a large (8 million lines of code) legacy application and its migration toward a modern, object-oriented architecture. Project leader.
- [p2] **SEAC** (2014-2015): Industrial project with SEAC, a company that has reengineered their software system from the old platform (Cobol/ISAM) to the .NET platform with Microsoft SQL Server. The objective of this project was to support such reengineering effort, by introducing an agile development process and by adopting automated tools for testing. Project leader.
- [p3] **CERN** (2000-2007): Development of the C++ static analysis tool *RuleChecker* for CERN, Geneva, within the Alice Large Hadron Collider (LHC) experiment. Project leader.
- [p4] **FITTEST** (2010-2013): FP7 European project n. 257574. Development of the model based testing tool *ReAjax*. Workpackage leader.
- [p5] **Aspire** (2013-2016): FP7 European project n. 609734. Automated code protection and obfuscation.
- [p6] **Gauss** (2017-2020): MIUR/PRIN project. Methodological enablers needed to identify, integrate, and manage emergent systems of systems.
- [p7] **Precrime** (2019-2023): ERC Advanced grant. The PRECRIME project will introduce a new type of testing, called anticipatory testing, which is activated at run-time by self-assessment oracles: oracles that observe and report unexpected execution contexts.

SUPERVISION OF STUDENTS AND POSTDOCS

I have supervised and co-supervised several MSc students, ten PhD students and nine Postdocs. Among them: **Filippo Ricca** (2000-2003, now with the University of Genova), **Mariano Ceccato** (2003-2006, now with FBK) and **Cu Duy Nguyen** (2005-2009, now a data scientist and security expert at POST Luxembourg).

TEACHING

At Università della Svizzera Italiana (USI), *Master in Software and Data Engineering*, I teach “*Information Modeling and Analysis*” and “*Knowledge Management*”. Over the years, I have taught several BSc and MSc classes at the University of Trento, among which the graduate courses “*Software Analysis and Testing*” and “*Security Testing*”. The latter was part of the EIT (European Institute of Technology) ICT Labs curriculum on *Security and Privacy*.

REVIEWS AND EDITORIAL BOARDS

I regularly review papers submitted to journals such as TSE, TOSEM (awarded as a distinguished referee in 2007-2008, 2009-2010 and 2011-2012), EMSE, JSS, STVR, JSEP, IST and conferences such as ICSE, FSE, ISSTA, ICST, ASE, ICSME, ICPC. I am/was in the editorial board of:

- 2017 – *ACM Transactions on Software Engineering and Methodology*
- 2013 – 2017 *IEEE Transactions on Software Engineering*, IEEE Computer Society
- 2011 – *Empirical Software Engineering*, Springer
- 2013 – *Journal of Software: Evolution and Process*, Wiley

AWARDS (selection)

- 2018 **ICST 2008 Most Influential Paper (MIP) award:** *State-Based Testing of Ajax Web Applications*, Proc. of ICST 2008, International Conference on Software Testing, pp. 121-130, Lillehammer, Norway, April 9-11, 2008.
- 2017 **Best paper award and ACM SIGSOFT Distinguished paper award:** *How Professional Hackers Understand Protected Code while Performing Attack Tasks*. Proc. of the IEEE Int. Conference on Program Comprehension (ICPC), Buenos Aires, Argentina.
- 2016 **Distinguished paper award:** *Clustering-Aided Page Object Generation for Web Testing*. Proc. of the IEEE Int. Conference on Web Engineering (ICWE), Lugano, Switzerland.
- 2011 **ICSE 2011 Most Influential Paper (MIP) award:** *Analysis and Testing of Web Applications*, Proc. of ICSE 2001, International Conference on Software Engineering, pp. 25-34, Toronto, Canada, May 12-19, 2001.
- 2006 **Alice award:** Prize given by the Alice experiment at CERN, Geneva, to project partners, in recognition of successful collaboration.

ORGANISATION OF CONFERENCES

- 2015 *Int. Symp. on Search Based Soft. Engineering (SSBSE)*, Bergamo, Italy; General Chair
- 2012 *Int. Conference on Software Maintenance (ICSM)*, Riva del Garda, Italy; General Chair
- 2011 *Int. Conference on Software Maintenance (ICSM)*, Timișoara, Romania; Program Chair
- 2010 *Int. Symposium on Software testing and Analysis (ISSTA)*, Trento, Italy; General Chair
- 2007 *Int. Conference on Program Comprehension (ICPC)*, Banff, Canada; Program Chair

INTERNATIONAL COLLABORATIONS

I have been actively involved in several international collaborations, which resulted in exchange of researchers, joint publications and research visits. I have co-supervised a PhD student with Prof. Mark Harman and Prof. David Clark from University College London, UK, where I regularly spend part of my research time. Among others, I have also worked with Prof. Gregg Rothermel from NC State University, Raleigh, USA; Prof. Alessandro Orso from Georgia Institute of Technology, Atlanta, USA.

Major scientific achievements

SUMMARY OF RESEARCH CONTRIBUTIONS AND IMPACT

I have given foundational contributions to Software Engineering in the areas of code analysis and software testing. My work on object-oriented code analysis, published in the comprehensive book “Reverse Engineering of Object-Oriented Code”, Springer, 2005, laid the foundations for the reverse engineering of object-oriented systems. My ICSE MIP award winning paper, “Analysis and Testing of Web Applications”, initiated a new stream of research devoted to the development of testing techniques tailored to the specific features of web applications. My ISSTA 2004 paper “Evolutionary Testing of Classes” is recognized as a milestone for the automated generation of object oriented test cases, taking the form of method invocation sequences. One of the most widely used Java test case generators, *EvoSuite*, can be traced back to this seminal ISSTA paper and to the associated tool, *eToc*, developed by me.

LEADERSHIP

At Università della Svizzera Italiana (USI), which I joined in August 2018, I lead the TAU (Testing AUtomed) research group, which aims at making software testing activities partially or fully automated. The current team consists of 4 postdocs and two PhD students. The target team size is between 10 and 15 people, most of which funded under the ERC Advanced grant Precrime.

When I was at Fondazione Bruno Kessler (2007-2018), I have led the Software Engineering (SE) research unit. The unit consisted of around 15 people. Under my guidance, the unit became a world leader in the areas of software requirements and testing, with publications and contributions in all top-ranked journals and conferences in the field (TSE, TOSEM, ICSE, FSE). The SE group has attracted several industrial and European funds over the years, reaching a self-funding capacity that has been on average above 60%.

PUBLICATIONS

I wrote over 150 peer reviewed conference/workshop papers, among which 19 ICSE/FSE/ISSTA papers, and over 50 journal papers, among which 8 TSE/TOSEM papers. My H-index (according to Google scholar) is 56. I was ranked among the top-50 Software Engineering scholars in an article published by the Communications of the ACM (vol. 50, n. 6, pp. 81-85, June 2007). I regularly publish papers at the major software engineering conferences and journals, including ICSE (Int. Conf. on Software Engineering), FSE (Foundations of Software Engineering), TOSEM (ACM Transactions on Software Engineering and Methodology) and TSE (IEEE Transactions on Software Engineering), as well as major software testing venues, such as ISSTA (Int. Symposium on Software Analysis and Testing) and ICST (IEEE Int. Conference on Software Testing, Verification and Validation).

SELECTED PUBLICATIONS

- [s1] Nargiz Humbatova, Gunel Jahangirova, Gabriele Bavota, Vincenzo Riccio, Andrea Stocco, Paolo Tonella: *Taxonomy of Real Faults in Deep Learning Systems*. Proceedings of the 42nd International Conference on Software Engineering (**ICSE**), 2020
- [s2] Andrea Stocco, Michael Weiss, Paolo Tonella: *Misbehaviour Prediction for Autonomous Driving Systems*. Proceedings of the 42nd International Conference on Software Engineering (**ICSE**), 2020
- [s3] Gunel Jahangirova, David Clark, Mark Harman, Paolo Tonella: *An Empirical Validation of Oracle Improvement*. IEEE Transactions on Software Engineering (**TSE**), 2020
- [s4] Annibale Panichella, Fitsum Kifetew, Paolo Tonella. *Automated Test Case Generation as a Many-Objective Optimisation Problem with Dynamic Selection of the Targets*. IEEE Transactions on Software Engineering (**TSE**), vol. 44, n.2, pp. 122-158, 2018.
- [s5] Gunel Jahangirova, David Clark, Mark Harman, Paolo Tonella. *Test oracle assessment and improvement*. In Proc. of the International Symposium on Software Testing and Analysis (**ISSTA**), pp. 247-258, 2016.

- [s6] Mariano Ceccato, Alessandro Marchetto, Leonardo Mariani, Cu D. Nguyen, Paolo Tonella. *Do Automatically Generated Test Cases Make Debugging Easier? An Experimental Assessment of Debugging Effectiveness and Efficiency*. ACM Transactions on Software Engineering and Methodology (**TOSEM**), vol. 25, n. 1, pp. 5:1-5:38, 2015.
- [s7] Paolo Tonella, Roberto Tiella, and Cu Duy Nguyen. *Interpolated N-Grams for Model Based Testing*. Proc. of the 36th International Conference on Software Engineering (**ICSE**), Hyderabad, India, May 31 - June 7, 2014.
- [s8] Fitsum Meshesha Kifetew, Annibale Panichella, Andrea De Lucia, Rocco Oliveto, Paolo Tonella. *Orthogonal Exploration of the Search Space in Evolutionary Test Case Generation*. In Proc. of the International Symposium on Software Testing and Analysis (**ISSTA**), Lugano, Switzerland, July 15-20, 2013.
- [s9] Cu D. Nguyen, Alessandro Marchetto, Paolo Tonella. *Combining Model-based and Combinatorial Testing for Effective Test Case Generation*. Proc. of the International Symposium on Software Testing and Analysis (**ISSTA**), pp. 100-110, June 2012.
- [s10] Mariano Ceccato, Alessandro Marchetto, Leonardo Mariani, Cu D. Nguyen, Paolo Tonella. *An Empirical Study about the Effectiveness of Debugging When Random Test Cases are Used*. In Proc. of the 34th International Conference on Software Engineering (**ICSE**), pp. 452-462, June 2012.
- [s11] Filippo Ricca, Massimiliano Di Penta, Marco Torchiano, Paolo Tonella, Mariano Ceccato. *How Developers' Experience and Ability Influence Web Application Comprehension Tasks Supported by UML Stereotypes: A Series of Four Experiments*. IEEE Transactions on Software Engineering (**TSE**), vol. 36, n. 1, pp. 96-118, January-February 2010.

INVITED TALKS (selection)

- 2019 Invited talk: *How to test a system based on deep learning*, CHOOSE Forum, Zurich, Switzerland, November 2019
- 2019 Invited talk: *What is a bug in deep learning applications?* 61st CREST Open Workshop (COW) on Statistics, Learning, Genetic Improvement and Testing for Programs. London, UK, October 2019
- 2014 Distinguished lecture: *Model-based Testing in the Era of Web 2.0*, at the University of Luxembourg, June 2014 (available at: <https://www.youtube.com/watch?v=TnuiEGS6iyc>)
- 2012 – 2018 Summer school lecture: *Search Based Test Case Generation*, at ISSSE (Int. Summer School on Software Engineering), TAROT (Training And Research On Testing), SIESTA (Int. Summer School on Software Engineering), GASES (International Genoa Software Engineering PhD School)
- 2010 Invited talk: *Research Challenges in Service Testing*, at the 2nd International Workshop on Principles of Engineering Service-Oriented Systems (PESOS), Cape Town, South Africa
- 2010 Invited talk: *Better Together: Hybridized Search Based Techniques*, at the Second International Symposium on Search Based Software Engineering (SSBSE), Benevento, Italy
- 2009 Distinguished lecture: *Research challenges in model based/search based testing*, at Queen's University, Kingston, Canada
- 2006 Distinguished lecture: *Test Case Prioritization using the Case Based Ranking Methodology*, at Ecole Polytechnique Montreal, Canada

INDUSTRIAL IMPACT AND TOOL DEVELOPMENT

- [i1] **SEAC** (2014-2016): Industrial project with SEAC, a company that has reengineered its software system from the current platform (Cobol/ISAM) to the .NET platform with Microsoft SQL Server. Such reengineering effort was supported by FBK with the introduction of an agile development process and of automated tools for testing. Project leader.

- [i2] **IBT** (2007-2010): Industrial project with IBT (Informatica Bancaria Trentina), for the reengineering of a large (8 million lines of code) legacy application and its migration toward a modern, object-oriented architecture. Project leader.
- [i3] **FITTEST** (2010-2013): Development of the model based testing techniques for future internet applications and of the associated tool *ReAjax*, within the FITTEST FP7 European project n. 257574. Workpackage leader.
- [i4] **CERN** (2000-2007): Development of the C++ static analysis tool *RuleChecker* for CERN, Geneva, within the Alice Large Hadron Collider (LHC) experiment. Project leader.

The most widely used search-based test generator for Java, *EvoSuite* (<http://www.evosuite.org>), includes the MOSA (Many Objective Sorting Algorithm) algorithm developed by my collaborators and me, among the available test generation engines. According to the experimental results, MOSA is the best performing engine among those available in *EvoSuite* [s4].