

Curriculum Vitae

PERSONAL INFORMATION

Paolo Tonella

Nationality: Italian

Date of birth: March 5, 1968; male; married (2 children: Chiara and Silvia)

Web site: <http://selab.fbk.eu/tonella>

Researcher unique identifiers: ORCID=0000-0003-3088-0339, Research ID=C-1702-2015

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

PAST AND CURRENT POSITIONS

- 2007 – **Head of Software Engineering** at Fondazione Bruno Kessler.
Fondazione Bruno Kessler (FBK) is an excellence research centre funded by the Autonomous Province of Trento, Italy.
- 2010 – **Senior (Level 1, equiv. to Full Professor) Researcher** at Fondazione Bruno Kessler; since 2017, holding the National Scientific Habilitation as **Full Professor**.
- 2013 – **Honorary Professor** at University College London.
This title was awarded in recognition for the fruitful, long-term collaboration with the Department of Computer Science at University College London, UK.
- 2003 – 2010 **Level 2 (equiv. to Associate Professor) Researcher** at IRST, Trento, Italy.
- 1994 – 2003 **Researcher** at IRST (Istituto per la Ricerca Scientifica e Tecnologica), Trento, Italy.

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

I have led the Software Engineering (SE) research unit at FBK since 2007. The unit consists of 15 people, divided into tenured researchers, Postdocs and PhD students. The SE group is recognized as 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%.

INTERNATIONAL COLLABORATIONS

I am actively involved in several international collaborations, which resulted in exchange of researchers, joint publications and research visits. I am co-supervising 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. I am also working with Prof. Mauro Pezzè from University of Lugano, Switzerland; Prof. Gregg Rothermel from University of Nebraska, Lincoln, USA; Prof. Alessandro Orso from Georgia Institute of Technology, Atlanta, USA.

AWARDS (selection)

- 2011 **ICSE 2011 Most Influential Paper (MIP) award:** *Analysis and Testing of Web Applications*, Proc. of ICSE 2011, International Conference on Software Engineering, pp. 25-34, Toronto, Canada, May 12-19, 2011.
- 2017 **Best reviewer award**, at the IEEE Int. Conference on Program Comprehension (ICPC), Buenos Aires, Argentina.
- 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.
- 2012 **Best paper award:** S. Medini, G. Antoniol, Y. G. Guéhéneuc, M. Di Penta, P. Tonella, *SCAN: an Approach to Label and Relate Execution Trace Segments*. Proc. of the Working Conference on Reverse Engineering (WCRE), Kingston, Ontario, Canada, 2012.
- 2009 **Best paper award:** Alessandro Marchetto and Paolo Tonella. *Search-Based Testing of Ajax Web Applications*. In Proceedings of the International Symposium on Search Based Software Engineering (SSBSE), Windsor (London), UK, 2009.
- 2008 **Most influential WSE paper award:** Paolo Tonella and Filippo Ricca. *Dynamic Model Extraction and Statistical Analysis of Web Applications*. Proc. of the International Workshop on Web Site Evolution (WSE), pp. 43-52, Montreal, Canada, October 2002. Award presented at WSE 2008.
- 2006 **Alice award:** Prize given by the CERN/Alice experiment to project partners, in recognition of successful collaboration.

SUPERVISION OF STUDENTS AND POSTDOCS

I have supervised and co-supervised several MSc students, eight PhD students and six 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

Over the years, I have taught several BSc and MSc classes at the University of Brescia and at the University of Trento, among which the following graduate courses and tutorials:

- 2012 – 2017 *Security Testing* (University of Trento); the course is part of the EIT (European Institute of Technology) ICT Labs curriculum on *Security and Privacy*
- 2009 – 2012 *Software Analysis and Testing* (University of Trento)
- 2000 – 2001 *Software Engineering* (University of Brescia)
- 2002 – 2004 *Software Evolution and Testing* (CERN Summer School)
- 2012 – 2014 *Search Based Test Case Generation* (ISSSE: Int. Summer School on Software Engineering, and TAROT: Training And Research On Testing summer school)
- 2005 *Reverse Engineering of Object Oriented Code* (Tutorial). Int. Conf. on Software Engineering (ICSE), May 17, 2005. St. Louis, Missouri, USA
- 2004 *Formal Concept Analysis in Software Engineering* (Tutorial). Int. Conf. on Software Engineering (ICSE), May 24, 2004. Edinburgh, Scotland, United Kingdom

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. I am in the editorial boards 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

CONFERENCE PROGRAM COMMITTEES (since 2011)

- 2018 Program Committee: ICSE, ISSTA
- 2017 Program Committee: ICSE, ASE, ICST, ICPC, ICSME
- 2016 Program Committee: ICSE, ISSTA, FSE, ICST, ICPC, ICSME, SSBSE
- 2015 Program Committee: ICSE, FSE, ICST, ICPC, ICSME
- 2014 Program Committee: ICSE, FSE, SSBSE
- 2013 Program Committee: FSE, ICST, ISSTA, ICPC, SSBSE, CSMR
- 2012 Program Committee: ICSE, ICST, ISSTA, CSMR
- 2011 Program Committee: ICST, SSBSE, WCRE, CSMR, ICSM

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)*

PUBLICATIONS

I wrote over 150 peer reviewed conference/workshop papers, among which 15 ICSE/FSE/ISSTA papers, and over 50 journal papers, among which 7 TSE/TOSEM papers. My H-index (according to Google scholar) is 48. 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 (last 10 years)

- [s1] 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**), Preprint, 2017.
- [s2] 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.
- [s3] 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.
- [s4] 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.
- [s5] Alberto Goffi, Alessandra Gorla, Andrea Mattavelli, Mauro Pezze', and Paolo Tonella. *Search-Based Synthesis of Equivalent Method Sequences*. Proc. of the 22nd ACM SIGSOFT International Symposium on the Foundations of Software Engineering (**FSE**), Hong Kong, November 16-21, 2014.
- [s6] Cu Duy Nguyen, Alessandro Marchetto, Paolo Tonella. *Automated Oracles: an Empirical Study on Cost and Effectiveness*. Proc. of the 9th Joint Meeting on the Foundations of Software Engineering (**FSE**), St. Petersburg, Russia, pp. 136-146, August 18-26, 2013.

- [s7] 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.
- [s8] 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.
- [s9] 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.
- [s10] 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.

Most of the selected papers [s1][s2][s3][s5][s7][s9][s10] are in co-authorship with researchers from institutions different from FBK, showing that I am at the core of a research collaboration network that includes national (e.g., Politecnico of Torino, University of Milan, University of Sannio) and international (e.g., University College London, University of Luxembourg, University of Lugano) partners. Several of the selected papers [s1][s4][s7][s8] deal with *automated test case generation*, a key component of my research. *Empirical validation* of the research results *with the involvement of humans* (developers) is another central element of my research [s3][s9][s10]. The effectiveness of automatically generated *test case oracles* and the *improvement of test oracles* are the objects of the investigations reported in the FSE 2013 and ISSTA 2016 papers [s2][s6]. *Search-based algorithms* play a fundamental role in my research. The selected papers include various original applications of search-based algorithms to code analysis and testing problems [s1][s5][s7]. Another core component of the published research is *model inference* and *model based test case derivation* [s4][s8].

INVITED TALKS (selection)

- 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>)
- 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
- 2006 Distinguished lecture: *Test Case Prioritization using the Case Based Ranking Methodology*, at Ecole Polytechnique Montreal

ORGANISATION OF SCIENTIFIC EVENTS

I contributed to the organization of several Software Engineering workshops and conferences, among which:

- 2015 *Int. Symposium 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

PROJECTS, INDUSTRIAL IMPACT AND TOOL DEVELOPMENT

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.

I have been instrumental to innovation and technology transfer carried out in collaboration with important software companies in the banking and business management sectors [p1][p2]. My contribution to the renovation of existing systems consisted of supporting the definition of the new software architecture, applying a new software development process and creating novel, custom tools for code analysis and testing. Within European projects, I have been workpackage leader and I have coordinated the activities that led to the development of research tools, among which *RuleChecker* and *ReAjax*, as well as to the empirical validation of such tools [p3][p4][p5].

In 2004 I developed the Java test case generator *eToc* (see ISSTA 2004 paper), which influenced many of the test case generators subsequently developed for Java, among which *EvoSuite* (<http://www.evosuite.org>), the currently most widely used search based test generator for Java.