Curriculum Vitæ

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Professor in Computer Science

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Birthday and birthplace: November 6, 1964; Modena (Italy)

Citizenship: Italian

Known languages: Italian (native), English (proficient), French (proficient), and Spanish (basic)

Education

(1993) PhD in Computer Science (CS), University of Pisa (Italy)

(1988) Master (*Laurea*) degree in CS, University of Pisa (Italy)

Past and current positions:

(2023–now) Full Professor in CS at the Department of Computer Science, University of Arizona (USA)

(2018-2023) Affiliate Faculty at IMDEA Software Institute, Madrid (Spain)

(2017-2018) Cátedra de Excelencia of the Comunidad de Madrid at IMDEA Software Institute (Spain)

(2015) Merit Professor at the Dept. of Computing and Information Systems, U. of Melbourne (Australia),

(2014) Research Scientist at IRDETO Canada

(2000-2023) Full Professor in CS at the Dipartimento di Informatica, University of Verona (Italy)

(1998-2000) Associate Professor in CS at the Dip. Scientifico e Tecnologico, University of Verona (Italy)

(1995-1998) Assistant Professor in Computer Science at the CS Department, University of Pisa (Italy)

(1993-1995) Researcher at the Laboratoire d'Informatique (LIX), École Polytechnique, Paris (France)

Main research interests (in order to interest)

Abstract interpretation, program analysis, and program verification
Semantics, computability, and foundation of programming languages and systems
Software engineering, language-based security, code transformation and optimization
Epistemology and history of Computer Science
Logic, universal algebra, lattice theory, congruence lattices, and closure operators

Institutional responsibilities & achievements

(2023–) ACM Distinguished Member
(2021-2023) Deputy Rector of the University of Verona
(2021-2022) Provost for Research of the University of Verona
(2018-2021) Head of the Computer Science Department of the University of Verona
(2013-2014) Member of the Board of Trustees of the University of Verona
(2012-2014) Chair of the Italian National Scientific Qualification committee for Computer Science
(2006-2012) Dean of the College of Science of the University of Verona
(2004-2006) Chair of the Research Committee of the University of Verona
(2001-2004) Chair of the Education and E-learning Committee of the University of Verona

Extended Synopsis

Research interests

I am mostly interested in abstract interpretation and formal methods with applications in any area of Computer Science, including: static program analysis, semantics, program synthesis, transformation and optimization, language-based security, code protection, white-box crypto, malware analysis, verification, model checking, logic, constraint programming, universal algebra, and lattice theory. I am also interested in epistemology and history of CS. I am author of more than 110 publications in international journals and conferences. In Google Scholar: more than 3700 citations, H-index 33, i10-index 76. The paper that has most marked my career is:

> R. Giacobazzi, F. Ranzato, and F. Scozzari. Making abstract interpretation complete.
> *Journal of the ACM*, 47(2):361-416, March 2000.

This paper introduced the problem of making abstract domains complete and provided the very first systematic method for minimally refining abstract domains to make them complete for any Scott-continuous function, hence including all computable functions. The paper opened a field: *the possibility of controlling the precision (and imprecision) by tuning abstract domains*. This allowed researchers and tool makers to develop methods and algorithms to reduce false alarms by minimal abstraction refinement. Recent developments of this idea are in [51, 50]. In particular [51] received the distinguished paper award at LICS'21 and a Meta Platforms Inc. award of $100,000 as support for this research. Its extended version appeared in the *Journal of the ACM* [3].

Summary of main achievements

Abstract interpretation: We introduced a number of transformations of abstract domains (see [40] for an early account) in order to tune their precision by: completeness refinement [97, 96, 95, 29, 88, 74], relational composition [103, 31, 30], complementation [104, 38], disjunctive completion [101, 34], Heyting Completion [98], Linear refinement [27], and compression [99, 16]. We also studied code transformations for improving the precision of program analysis with respect to a fixed abstract domain [14]. Recent achievements concern decidable properties of code transformations making a given program analysis precise/complete (viz., absence of false alarms) and the recursive properties of classes of programs for which these algorithms are precise [61, 8]. We proved that only straightforward abstractions are precise for all programs in a Turing complete language and that imprecision in program analysis is an intensional property of programs, as well as computational complexity. This sheds light on what can and cannot be automated in the false alarm removal process. We also introduced the notion of A^2I, for the optimization of program analysis by abstract interpretation of an abstract interpreter in [9]. In [4] we have reconstructed the history of abstract interpretation from its roots to the present days.

Static program analysis: We introduced deductive bottom-up and compositional methods for static analysis of logic programs [45, 111, 108, 107, 43, 72] and constraint logic programs [113, 109, 41]. I introduced the notion of *abductive program analysis* in 1994 [105, 35], an idea that inspired industrial tools such as *Infer* developed in Facebook. Specific domains have been studied in these contexts, notably for type inference [46], numeric constraint optimization [110], depth-k determinate computations, aliasing analysis for pipeline optimizations [116, 114], and approximation of indexed grammars [53]. We also developed the very first GPU-based implementation of an abstract interpreter based on weakly-relational numerical abstract domains (in particular octagons) in [78].

Program verification: We studied the properties of complete abstractions of Kripke structures, proving the connection between Counter-Example Guided Abstraction Refinement (CEGAR) and complete refinements for abstract interpretation [92, 91, 73, 69, 50], and also proved the intrinsic incompleteness of the state abstraction with respect to traces in *a la Kozen* temporal μ-calculi [90, 25]. We studied the intrinsic differences between program analysis and program verification from a computability perspective [56] and the relation between inductive and co-inductive proof methods in presence of abstraction

[55]. A completeness/incompleteness logic that combines over and under approximations has been introduced in [51, 3]. A proof for a program in this logic with respect to a pre- and post-condition (à la Hoare) guarantees that the abstract interpretation of the same program does not yield false alarms, i.e., it is precise/complete.

Security: We introduced the notion of *Abstract Non-Interference* as a generalization of non-interference for information flow in language based security [87, 84, 21, 22, 11]. This provides attack models as approximate analyses (static or dynamic) of programs, and more recently of learning systems [1]. This notion has been extended towards concurrent and timed programming languages for modeling timing and synchronization covert channels [81, 80, 77]. We introduced a semantic-based model for specifying code obfuscation algorithms [83, 82, 76, 23, 68, 67, 64, 63]. The idea is to view code obfuscation as a program transformation making a (possibly dynamic) analysis algorithm (attacker) incomplete/imprecise when it is applied to the transformed program. Viewing code protection as a code transformation deceiving an abstract interpreter helps in developing a comprehensive theory of *program understanding* where program analysis and program protection compete against each other [68, 18, 64]. Robust algorithms for code obfuscation [79] and SW watermarking [75] were systematically derived by specializing distorted interpreters driven by the attacker to defeat, with applications in control/data code obfuscation and in code fingerprinting [66, 57].

Malware and *Big Code* analysis: We contributed to the semantic-based analysis of metamorphic malware [71, 15]. Metamorphic signatures have been automatically extracted by abstract interpretation of a refined semantics modeling code evolution. In particular we introduced the notion of *regular metamorphism*, corresponding to abstractions of this semantics into finite state automata. We studied vulnerability aspects of *Address Space Layout Randomization* procedures (ASLR), in particular in the Windows 7 OS. In this context, to make compatible with Windows 7 an obfuscation technique based on memory relocations, implemented for the very first time in the W32.Relock malware, we discovered a critical ASLR vulnerability in Windows 7 [19]. We introduced a mixed syntactic-semantic representation of code fragments in terms of *abstract symbolic automata* [65, 60]. These automata, with corresponding operations for their transformation, provide the theoretical foundation for the similarity analysis and the mining algorithms in large software enclaves used in the tool developed in Cythereal Inc.

Semantics: We introduced the very first abstract interpretation based hierarchy of semantics for pure logic programs [102]. This work has been extended to resolution based-systems, including a number of resolution strategies [24]. We also studied semantic models for characterising control features in Prolog programs, such as: cut, backtracking, and arbitrary selection rules [115, 112, 44, 42]. We studied the semantics of programming languages form the point of view of systematic semantic design and observation power [93, 20]. In this field we applied systematic methods developed for domain construction to the design of semantics for programming languages as composition of abstractions of arbitrary transition systems, including trace models, compositional denotational models [100, 89], transfinite models of computation [28, 26], and logic-based models.

Lattice theory: Standard abstract interpretation theory is based on the isomorphism between the lattice of all abstract domains of a given concrete domain and the lattice of all its closure operators. The study of the theory of abstract interpretation has led us to original results in the algebraic theory of closure operators on complete lattices. We proved that the lattice of all closure operators of a continuous lattice is weakly relative pseudo-complemented [39]. This is the theoretical foundation for the operation of abstract domain complementation in [38]. We introduced the notion of meet- and join-uniformity for closure operators on complete lattices and proved the relevance of uniformity for reasoning about adjoint closure systems [33, 13]. We contributed to prove an embedding of the lattice of complete congruences on a continuous lattice into the lattice of all its closure operators [36, 32]. This provides a way to extend most properties of the lattice of closure operators to the lattice of complete congruences on continuous lattices.

Granted awards

(2022) WhatsApp Research Awards on Privacy Aware Program Analysis (with P. Cousot and F. Ranzato)

(2021) Amazon Research Award (ARA) 2021 – AWS Automated Reasoning (with F. Ranzato)

(2021) Meta Platforms Inc. unrestricted award of $100.000 as support to continue the research in [51]

(2020) Facebook Probability and Programming 2020 – Research Award (with F. Ranzato)

(2017) Talento Award by the Madrid Regional Government

(2013) Microsoft Research Software Engineering Innovation Foundation Award (SEIF Award)

(1993) Individual European HCM Human Capital and Mobility Award at Ecole Polytechnique, France

Invited talks in the last 10 years

(2021) Implicit Program Analysis – On the Properties of (In)Complete Abstract Interpretations. *Amazon Automated Reasoning Symposium Technical Talk*. Online, September 15, 2021.

(2019) Hacking program analysis: a systematic approach to code protection. *7th International Workshop on Verification and Program Transformation (VPT2019)*. April 2, 2019. Genova, Italy.

(2017) Abstract Interpretation for Program Security. *24th Static Analysis Symposium*, August 30th - September 1st, 2017, New York City, NY, USA.

(2015) Analysing Completeness in Program Analysis. *ETH Workshop on Software Correctness and Reliability*, October 2-3, 2015, ETH Zürich, Switzerland.

(2015) Protecting Code by Obfuscation. *PROLE 2015* Spanish Conf. on Programming and Computer Languages. Spet. 15-17. Santander, Spain.

(2014) Obscuring Code - Unveiling and Veiling Information in Programs. *16th Int. Symp. on Principles and Practice of Declarative Programming* (ACM PPDP 2014) and *24th Int. Symp. on Logic-Based Program Synthesis and Transformation* (LOPSTR 2014). September 8-11, 2014. Canterbury, UK.

Contribution to early career of researchers

I have been advisor of 15 PhD students at the following institutions: Université de Paris VII, U. of Siena, Ben-Gurion U., and U. of Verona. The most representative ones in terms of career follow-up are:

Prof. Francesco Ranzato: now Full Prof. U. of Padova.

Prof. Francesca Scozzari: now Associate Prof. U. of Chieti-Pescara.

Prof. Samir Genaim: now Associate Prof. Universidad Complutense de Madrid.

Prof. Isabella Mastroeni: now Associate Prof. U. of Verona and winner of the best PhD thesis award in Theoretical Computer Science by the Italian Chapter of EATCS in 2005.

Prof. Damiano Zanardini: now Associate Prof. at Universidad Politécnica de Madrid.

Prof. Mila Dalla Preda: now Associate Prof. U. of Verona, winner of the QINETIQ Award for research contributions with strong practical applications in 2006 and receiving the special mention from the a EATCS (European Association for Theoretical Computer Science) for PhD thesis in theoretical computer science. Mila was among the youngest PI being granted by the Italian Ministry of Research with a FIRB 2013 grant, with €522,743 for the project FACE (Formal Avenue for Chasing malwarE).

Dr. Enrico Visentini, now Senior SW Eng. at Power Reply.

Dr. Durica Nikolić, now Senior SW Eng. at Avaloq Evolution AG.

Dr. Marco Campion, now Post Doc at École Normale Supérieure in Paris.

Contribution to the scientific community (a selection)

(2024) Program Chair of the 31st Static Analysis Symposium (SAS'24), Pasadena USA, Oct. 20-22, 2004.

(2019) Analysis and Transformation for Declarative Program Development Subtitle AVERTIS, Nov. 29, 2019 IMDEA Software Institute, Madrid, Spain. Editor with John P. Gallagher and Pedro Lopez-Garcia of the Special Issue: *Analysis and Transformation for Declarative Program Development – Essays Dedicated to Manuel Hermenegildo on the Occasion of his 60th Birthday*, LNCS 13160, Springer Nature Switzerland AG 2022.

(2018) Chair of the Shonan Meeting No. 115: *Intensional and extensional aspects of computation: From computability and complexity to program analysis and security*, Shonan Village Japan, January 21-25, 2018.

(2017) Program Chair of the N40AI – *Next 40 Years of Abstract Interpretation* workshop co-located with POPL 2017 in Paris, January 21st, 2017, celebrating the publication of Cousot & Cousot POPL'77 seminal paper on abstract interpretation and chair and organizer of the *40 Years of Abstract Interpretation – An Interview with Patrick Cousot*, at POPL 2017.

(2012-2015) Steering Committee of *ACM Symp. on Principles of Programming Languages (POPL)*. Co-author of *Principles of POPL*, by D. Dreyer, J. Field, R. Giacobazzi, M. Hicks, S. Jagannathan, M. Sagiv, P. Sewell, P. Wadler. *SIGPLAN Notices* 48(4S): 12-16, 2013. DOI.

(2014) Chair of the Dagstuhl Seminar 14241 on *Challenges in analysing executables: Scalability, Self-modifying code and Synergy*, June 9–13, 2014.

(2013) Program Chair of *14th Verification, Model Checking, and Abstract Interpretation (VMCAI'13)*.

(2013) General Chair of *40th ACM Symposium on Principles of Programming Languages (POPL'13)*.

(2011) Editor of the Special Issue on the *3rd Int. Workshop on Programming Language Interference and Dependence - PLID 2007*, in *Mathematical Structures in Computer Science* 61(6), 2011.

(2010–now) Steering Committee of the ACM International Summer School on Information Security and Protection — ISSISP.

(2008) Chair of the *30 Years of Abstract Interpretation (30YAI)* workshop in honor of Patrick Cousot, January 09, joint with POPL 2008, San Francisco USA.

(2008-2014) Editor of the *Central European J. of Computer Science*, by Springer Verlag.

(2007) Editor of the Special Issue of *11th Static Analysis Symp.*, *Sci. of Comp. Prog.* 64(1):1-184, 2007.

(2004) Program Chair of the *SAS2004, 11th Int. Static Analysis Symp.*, and General Chair of *6th ACM Int. Conf. on Principles and Practice of Declarative Programming (ACM-PPDP'04)*, *20th ACM Workshop on Partial Evaluation and Semantics-Based Program Manipulation (ACM-PEPM'04)*, *Int. Symp. on Logic-based Program Synthesis and Transformation (LOPSTR'04)*. Verona, Italy.

(1993-2016) Steering Committee of *The Static Analysis Symposium (SAS)*.

Recent scientific projects

I was PI in National (Italian) and International (EU) research projects for a total budget of more than €2,500,000 from 2012 to 2022[1]. The current ongoing project is:

ODIN: *Abstract interpretation driven programming languages*, funded by AFOSR – the Air Force Office of Scientific Research under award number FA9550-23-1-0544, $839,740, 2023-2028. ODIN's ambition is to lay the foundation of a new discipline of programming where the code can be efficiently and precisely verified by simplified analyzers. Compliance of code wrt program analysis is a new, largely unexplored, frontier of programming that will provide the key technological advantage to make program analysis more widely used. ODIN will pioneer the research in fundamental aspects of programming languages: The interplay between semantics and analysis, the nature of false-alarms, how to isolate Domain Specific Languages (DSL) compliant with an analysis, how their expressivity changes when the analysis changes, how to bound the imprecision of the analysis, and which methods and operations can be used to build verifiable code within these DSL.

[1] In the Italian system, the PhD and Post-Doc positions are mostly supported by internal funds provided as fellowships by the University.

The two main projects closed in 2022 are:

ASPRA: *Analysis of Program Analyses*, funded by MIUR – Italian Ministry of Science, €863,000, 2019-2022. The ASPRA project aims at bridging abstract interpretation and coinductive up-to techniques for program analysis and verification from the perspective of the code properties that best fit a given abstraction. In program analysis this is related to the rate of false alarms, while in up-to techniques it concerns the chance of effectively devising a simplified proof. The idea is to analyze program analysis, i.e., to lift program analysis from properties of programs to properties of program analyzers and verifiers.

ATEN: *Cyberspace Surveillance Technologies*, funded by Fondazione Cariverona, €413,000, 2018-2022. Cyberspace surveillance means to collect and monitor complex and potentially unknown software systems, such as malware, and to analyze their behavior in order to recognize and prevent potential threats. Standard signature detection-based anti-malware are limited in scope and precision and can be easily foiled by reengineering or obfuscating code. ATEN wants to exploit this weakness by developing new methods and technologies for the automated analysis of large repositories of code in order to extract malware correlations. Correlations provide information for establishing connections between actors, useful in attribution of responsibilities in computer forensics and for early threat detection.

Industrial innovation

(2021) Co-founder of Vero4Chain s.r.l., a spin-off company of the U. of Verona for blockchain applications and services and smart contract analysis.

(2017–now) Scientific advisor in Cythereal Inc. Cythereal is based on [65, 60] and a patented technology that performs deep static and dynamic analyses for automatically determining code similarities in x86 binary executables for early malware detection and threat analysis. Cythereal is based in Lafayette, Louisiana (USA) and selected for incubation in TOPXIGHT Labs by Valmiki 504 LLC venture capital.

(2010) Co-founder of JULIA s.r.l., a spin-off company of the U. of Verona, now part of GrammaTech Inc. JULIA is general purpose Java analyzer (∼200K lines of Java Code) based on Abstract Interpretation for the fully automatic analysis of Java and Android apps. JULIA was subcontractor in the U.S. Air Force Research Laboratory/RITM Contract No. FA8750-12-C-0174, $291,000.00, through the U. of Washington, USA. JULIA has been awarded by the *Talento delle Idee* prize by Unicredit Bank and selected as one of the best 9 innovative projects in the area of ICT in the Working Capital Competition by Telecom Italia.

Major collaborations and official visits (a selection)

(Oct. 2017 – Sept. 2018) Cátedra de Excelencia of the Comunidad de Madrid at IMDEA Software Institute under the *Talento award program*. Most relevant publications are [57, 56, 9].

(May–June 2016 & April 2017) Visiting Professor at University of Hawaii at Manoa, Honolulu, USA. Most relevant publications are [55, 8].

(March–June 2015) Merit Professor at the Department of Computing and Information Systems, University of Melbourne, Australia. Most relevant publication is [59].

(Nov. 2014–Oct. 2015) Sabbatical year as Faculty at IMDEA Software Institute, Madrid, Spain. Most relevant publications are [63, 16, 15].

(May–Oct. 2014) Visiting Research Scientist at IRDETO Canada, working in white-box cryptography, software security and protection. Most relevant publications are [63, 61].

(Feb.–April 2014) Visiting Professor in CS at the Department of Computer Science of the University of Louisiana at Lafayette USA. Most relevant publication is [60].

(Nov.–Dec. 2010 & May–July 2011) Visiting Professor in CS at the Département d'Informatique (DI) of the École Normale Supérieure in Paris, France. Most relevant publications are [22, 72, 73].

(May & June 2009) Visiting Professor in CS at the Computer Science Department of the Universidad Complutense de Madrid (UCM), Madrid, Spain.

(June–Aug. 2008) Visiting Professor in CS at the Département d'Informatique (DI) of the École Normale Supérieure in Paris, France. Most relevant publication is [76].

(May & June 2000 & June & July 2002 & Aug.–Sept. 2006) Visiting researcher at the Laboratoire d'Informatique (LIX), École Polytechnique, France.

(May & June 1999) Visiting Scientist at the Department of Computer Science, KAIST – Korean Advanced Institute of Science and Technology, Taejon, South Korea.

(Nov. & Dec. 1997) Visiting Professor at the Department of Mathematics and Computer Science, Ben-Gurion University of Negev, Beer-Sheva, Israel.

Commissions of trust

(2022) Chair of GEP – Gender Equality Plan Commission of the University of Verona (document here).

(2012-2014) Chair of the Italian National Scientific Qualification committee for professorship in Computer Science in Italy (5 members, two years appointment). 898 candidates in 2012 and 182 in 2013.

(2012-2022) Board of evaluation of the Italian Minister of Research and Education (MIUR): Programma Operativo Nazionale Ricerca & Competitività (PON02 & PON03) in ICT, budget: €150,000,000.

(2005–now) Hiring Committee for Assistant, Associate and Full Professors (tenured) of the University of Catania, Cagliari, Padova, Pisa, Milan, Bologna, and Verona.

(2005-2022) Member of the evaluation committee of the EPSRC – Engineering and Physical Sciences Research Council (UK), the Israel Science Foundation (IL), the United States-Israel Binational Science Foundation (IL), the Estonian Science Foundation (EE), the Georgian's Shota Rustaveli National Science Foundation, and the Portuguese Foundação para a Ciência e a Tecnologia.

(2005-2022) Committee for habilitation for professor in France: Université Paris-Dauphine for Dr. M. Martel and Dr. L. Mauborgne; École Normale Supérieure de Cachan for D. Cachera, Université de Grenoble for D. Monniaux, and École Normale Supérieure in Paris for Dr. X. Rival.

(2000-2011) Member in PhD defences in the PhD programme in *Mathématique et Informatique* at École Poytechnique; *Informatique* at IRISA, U. de Rennes (FR); *Informatique* at INRIA Sophia Antipolis (FR); *Informatique* at LORIA, Institut National Polytechnique de Lorraine.

(2000-2004) Selection board for foreign students applying for the major in Computer Science at the École Normale Supérieure (ENS-Europe 00-01 and 01-02, Sélection Int. en Sciences 02-03 and 03-04).

Teaching

I have more that 30 years of experience in Academic (undergraduate and graduate) teaching in CS, with responsibility of courses in: Programming, Automata and formal languages, Computability and complexity, Program verification, Program analysis, Compilers, Programming languages, Security, and Malware analysis. Recently I was in charge of courses on philosophical and epistemological aspects of computing at the School of Law and the Dept. of Human Sciences. Below is the list of the main courses I was responsible for:

(2023–now) SCS 573: Theory of Computation at the CS Department of the University of Arizona.

(2021–2023) Professor of *Computational Technologies* at the Master of "Law of New Technologies", in the School of Law of the University of Verona

(2020–2023) Professor of *Epistemology and Philosophy of Science* at the Master in "Philosophical Sciences" of the University of Verona

(2017) Professor of *Code Obfuscation: a Hacking view on program analysis and understanding* at PhD and Master School in CS at the U. Politécnica de Madrid

(2015-2018) Professor of *Malware analysis and design* graduate program in CS of the U. of Verona

(2010-2015) Professor of *Semantics based code protection* at the 1st, 2nd, 3rd, 5th, 6th, 7th, 8th, and 10th ACM International Summer School on Information Security and Protection — ISSISP

(2008) Professor for the PhD course on *Software Protection* at UCM (U. Complutense de Madrid)

(2003-2017) Professor of *Prog. Languages & Compilers*, undergraduate major in CS of the U. of Verona

(2000-2013) Professor of *Static Analysis and Code Protection* graduate program in CS of the U. of Verona

(1999–2023) Professor of *Formal Languages, Automata, Computabilty and Complexity*, undergraduate major in CS of the U. of Verona

(1997) Professor of *Abstract Interpretation and Program Analysis* at PhD level at the Ben-Gurion University

(1995-1999) Teaching Assistant in *Programming Languages* (20h) and *Object Oriented Programming*, undergraduate major in CS of the University of Pisa

(1993) Professor of *Logic program analysis* at D.E.A.– I.M.A. (Informatique, Mathématiques et Applications) of Ecole Polytechnique, l'Ecole Normale Sup., and U. de Paris VI, VII e XI.

List of main publications

Journals

[1] R. Giacobazzi, I. Mastroeni, and E. Perantoni. Adversities in Abstract Interpretation - Accommodating Robustness by Abstract Interpretation. To appear on *ACM Transactions on Programming Languages and Systems*. 2024.

[2] M. Campion, M. Dalla Preda, R. Giacobazzi, and C. Urban. Monotonicity and the Precision of Program Analysis. The 51st ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2024), *PACMPL (POPL)*, POPL,(January 2024), 31 pages. 2024.

[3] R. Bruni, R. Giacobazzi, R. Gori, and F. Ranzato. A Correctness and Incorrectness Program Logic. *Journal of the ACM* 70(2) Article No.: 15, pp 1–45 ACM. April 2023. DOI. Extended version of [51].

[4] R. Giacobazzi and F. Ranzato. History of Abstract Interpretation. *IEEE Annals of the History of Computing*. IEEE Computer Society. 2022. DOI.

[5] M. Campion, M. Dalla Preda, and R. Giacobazzi. Partial (In)Completeness in Abstract Interpretation. The 49th ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2022), *PACMPL (POPL)* 6, POPL, Article 59 (January 2022), 31 pages. 2022. DOI.

[6] M. Campion, M. Dalla Preda, and R. Giacobazzi. Learning Metamorphic Malware Signatures from Samples. *Journal of Computer Virology and Hacking Techniques*. February 2021. DOI

[7] N. Marastoni, R. Giacobazzi, and M. Dalla Preda. Data Augmentation and Transfer Learning to Classify Malware Images in a Deep Learning Context. *Journal of Computer Virology and Hacking Techniques*. April 2021. DOI

[8] R. Bruni, R. Giacobazzi, R. Gori, D. Pavlovic, and I. Garcia. Abstract Extensionality: On the properties of incomplete abstract interpretations. The 47th ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2020), *PACMPL 4(POPL)* 28:1-28:28, 2020. DOI.

[9] P. Cousot, R. Giacobazzi, and F. Ranzato. A^2I: Abstract^2 Interpretation. *The 46th ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2019). PACMPL 3(POPL)* 42:1-42:31, 2019. **Distinguished Paper award at POPL 2019**. DOI.

[10] R. Bruni, R. Giacobazzi, and R. Gori. Code Obfuscation Against Abstraction Refinement Attacks. *Formal Aspects of Computing*. (2018) 30:685-711. DOI 10.1007/s00165-018-0462-6. DOI.

[11] R. Giacobazzi and I. Mastroeni. Abstract Non-Interference: A unifying framework for weakening information-flow. *ACM Transactions on Privacy and Security (TOPS)*. Volume 21 Issue 2, Article No. 9, February 2018. DOI.

[12] R. Giacobazzi, I. Mastroeni, and M. Dalla Preda. Maximal incompleteness as obfuscation potency. *Formal Aspects of Computing* 29(1):3-31, Springer Verlag, 2017. DOI.

[13] I. Mastroeni and R. Giacobazzi. Weakening additivity in adjoining closures. *Order* 33:503–516, Springer Verlag 2016. DOI.

[14] R. Giacobazzi and I. Mastroeni. Making abstract models complete. *Mathematical Structures in Computer Science* 26(4):658-701 2016. DOI.

[15] M. Dalla Preda, R. Giacobazzi, and S. Debray. Unveiling Metamorphism by Abstract Interpretation of Code Properties. *Theoretical Computer Science*. Volume 577(27):74-97 2015. DOI.

[16] R. Giacobazzi and F. Ranzato. Correctness Kernels of Abstract Interpretations. *Information and Computation*, Volume 237, October 2014, pages 187–203. DOI.

[17] D. Dreyer, J. Field, R. Giacobazzi, M. Hicks, S. Jagannathan, M. Sagiv, P. Sewell, and P. Wadler. Principles of POPL. *SIGPLAN Notices* 48(4S): 12-16, 2013. DOI.

[18] C. Collberg, J. Davidson, R. Giacobazzi, Y. Gu, A. Herzberg, and F. Wang. Towards Digital Asset Protection - Position paper. In Expert Opinions of the *IEEE Intelligent Systems*. 26(6):8-13, 2011. DOI.

[19] A. Fortunato, M. Passuello, and R. Giacobazzi. Relock-based vulnerability in Windows 7. *Virus Bulletin*, pages 16-20, VB August 2011. ISSN 1749-7027.

[20] I. Mastroeni and R. Giacobazzi. An Abstract Interpretation-based Model for Safety Semantics. *Journal of Computer Mathematics* 88 (4): 665–694. March 2011. DOI.

[21] R. Giacobazzi and I. Mastroeni. Adjoining classified and unclassified information by abstract interpretation. *Journal of Computer Security*, 18(5):751–797. 2010. DOI.

[22] R. Giacobazzi and I. Mastroeni. A Proof System for Abstract Non-Interference. *Journal of Logic and Computation*, 20: 449-479. 2010. DOI.

[23] M. Dalla Preda and R. Giacobazzi. Semantic-based Code Obfuscation by Abstract Interpretation. *Journal of Computer Security*, 17(6):855-908, 2009. DOI.

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