Dr Azalea Raad

Director of the UK Research Institute on Verified Trustworthy Software Systems (VeTSS)
(last updated: July 2025)

Reader and UKRI Future Leader Fellow
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Employment

Department of Computing, Imperial College London

- **Reader** — **July 2024 – Present**
- Senior Lecturer — July 2022 – June 2024
- Lecturer — April 2020 – June 2022

Consultant at Bloomberg, London — **September 2022 – Present**
Chief Technical Office

Consultant at Meta (formerly Facebook), London — **September 2020 – July 2022**
Infer Verification Team and Incorrectness Logic Lab

Postdoctoral Researcher at MPI-SWS — **July 2017 – March 2020**
Group: Programming Languages and Verification (PLV)
Managers: Derek Dreyer and Viktor Vafeiadis

Education

PhD in Theoretical Computer Science — **October 2010 – December 2016**
Imperial College London
Thesis: *Abstraction, Refinement and Concurrent Reasoning*
Supervisors: Philippa Gardner and Sophia Drossopoulou
Examiners: Derek Dreyer (MPI-SWS) and Matthew Parkinson (Microsoft Research)

Master of Engineering in Computer Science — **October 2006 – June 2010**
Imperial College London, graduated third in class with a First Class Honours Degree
Thesis title: *Smelling of Roses (ROles - Specification , Exploration, Scrutiny)*
Supervisors: Sophia Drossopoulou and Susan Eisenbach
Winner of the Corporate Partnership Prize

Grants and Funding

[F1] Co-Director — **December 2025 – November 2027**
Directorship of the UK Research Institute Verified Trustworthy Software Systems (VeTSS)
Amount: £550,000

[F2] Seed money for small grants through VeTSS — **August 2025 – July 2026**
Research gift from Defence Science and Technology Lab (DSTL)
Amount: £250,000

[F3] Principal Investigator **September 2024 – August 2026**
Grant from Defence Advanced Research Projects Agency (DARPA, US)
Project Title: *Proof of Bugs for All*
Amount: $750,000 (∼£600,000)

[F4] Principal Investigator **September 2023 – August 2026**
EPSRC Standard Grant
Project Title: *SACRED-MA: Safe and Secure Remote Direct Memory Access*
Amount: £1,115,000

[F5] International PhD Studentship **September 2023 – August 2027**
Sponsored by Bloomberg
Amount: £120,000

[F6] Industrial Case (iCASE) PhD Studentship **October 2023 – September 2027**
Sponsored by ARM
Amount: £35,000

[F7] Co-Director **December 2022 – November 2025**
Directorship of the UK Research Institute Verified Trustworthy Software Systems (VeTSS)
Amount: £750,000

[F8] Principal Investigator **October 2022 – September 2023**
Research Gift by Meta
Amount: $50,000 (∼£40,000)

[F9] Sole Investigator **October 2021 – September 2028**
UKRI Future Leader Fellowship
Project Title: PERSEVERE*: A Rigorous Foundation for Persistent Verification*
Amount: £1,500,000

[F10] Principal Investigator **April 2020 – March 2021**
UKRI VeTSS (UK Research Institute in Verified Trustworthy Software Systems)
Project Title: *Validating the Foundations of Verified Persistent Programming*
Amount: £100,000

Funding Total: £5,060,000

PUBLICATIONS

[P1] *Sufficient Conditions for Robustness of RDMA Programs*
Guillaume Ambal, Ori Lahav, **Azalea Raad**
European Symposium on Programming (ESOP), 2025
Conference Paper (Rank: A)

[P2] *Compositional Bug Detection for Internally Unsafe Libraries*
Pedro Carrott, Sacha-E'lie Ayoun, **Azalea Raad**
European Conference on Object-Oriented Programming (ECOOP), 2025
Conference Paper (Rank: A)

[**P3**] *IsaBIL: A Framework for Verifying (In)correctness of Binaries in Isabelle/HOL*
Matt Griffin, Brijesh Dongol, **Azalea Raad**
European Conference on Object-Oriented Programming (ECOOP), 2025
Conference Paper (Rank: A)

[**P4**] *Non-Termination Proving at Scale*
Azalea Raad, Julien Vanegue, Peter O'Hearn
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2024
Journal Paper, **Conference Paper** (Rank: A*)

[**P5**] *Semantics of Remote Direct Memory Access: Operational and Declarative Models of RDMA on TSO Architectures*
Guillaume Ambal, Brijesh Dongol, Haggai Eran, Vasileios Klimis, Ori Lahav, **Azalea Raad**
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2024
Journal Paper, **Conference Paper** (Rank: A*)

[**P6**] *Extending the C/C++ Memory Model with Inline Assembly*
Paulo Emílio de Vilhena, Ori Lahav, Viktor Vafeiadis, **Azalea Raad**
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2024
Journal Paper, **Conference Paper** (Rank: A*)

[**P7**] *Specifying and Verifying Persistent Libraries*
Léo Stefanesco, **Azalea Raad**, Viktor Vafeiadis
European Symposium on Programming (ESOP), 2024
Conference Paper (Rank: A)

[**P8**] *Intel PMDK Transactions: Specification and Concurrency*
Azalea Raad, Ori Lahav, John Wickerson, Brijesh Dongol
European Symposium on Programming (ESOP), 2024
Conference Paper (Rank: A)

[**P9**] *Challenges in Empirically Testing Memory Persistency Models*
Vasileios Klimis, Alastair F. Donaldson, Viktor Vafeiadis, John Wickerson, **Azalea Raad**
International Conference on Software Engineering (ICSE), 2024
Conference Paper (Rank: A*)

[**P10**] *A General Approach to Under-approximate Reasoning about Concurrent Programs*
Azalea Raad, Julien Vanegue, Josh Berdine, Peter O'Hearn
Conference on Concurrency Theory (CONCUR), 2023
Conference Paper (Rank: A)

[**P11**] *Memento: A Framework for Detectable Recoverability in Persistent Memory*
Kyeongmin Cho, Seungmin Jeon, **Azalea Raad**, Jeehoon Kang
Programming Language Design and Implementation (PLDI), 2023
Journal Paper, **Conference Paper** (Rank: A*)

[**P12**] *The Path to Durable Linearizability*
Emanuele D'Osualdo, **Azalea Raad**, Viktor Vafeiadis
Principles of Programming Languages (POPL), 2023
Journal Paper, **Conference Paper** (Rank: A*)

[**P13**] *Finding Real Bugs in Big Programs with Incorrectness Logic*
Quang Loc Le, **Azalea Raad**, Jules Villard, Josh Berdine, Derek Dreyer, Peter O'Hearn
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2022
🏆 **Winner of the distinguished paper award**
Journal Paper, **Conference Paper** (Rank: A*)

[**P14**] *View-Based Owicki-Gries Reasoning for Persistent x86-TSO*
Eleni Vafeiadi Bila, Brijesh Dongol, Ori Lahav, **Azalea Raad**, John Wickerson
European Symposium on Programming (ESOP), 2022
🏆 **Winner of the distinguished artifact award**
Conference Paper (Rank: A)

[**P15**] *Concurrent Incorrectness Separation Logic*
Azalea Raad, Josh Berdine, Derek Dreyer, Peter O'Hearn
Principles of Programming Languages (POPL), 2022
Journal Paper, **Conference Paper** (Rank: A*)

[**P16**] *Extending Intel-x86 Consistency and Persistency: Formalising the Semantics of Intel-x86 Memory Types and Non-Temporal Stores*
Azalea Raad, Luc Maranget, Viktor Vafeiadis
Principles of Programming Languages (POPL), 2022
Journal Paper, **Conference Paper** (Rank: A*)

[**P17**] *Revamping Hardware Persistency Models*
Kyeongmin Cho, Sung-Hwan Lee, **Azalea Raad**, Jeehoon Kang
Programming Language Design and Implementation (PLDI), 2021
Journal Paper, **Conference Paper** (Rank: A*)

[**P18**] *PerSeVerE: Persistency Semantics for Verification under Ext4*
Michalis Kokologiannakis, Ilya Kaysin, **Azalea Raad**, Viktor Vafeiadis
Principles of Programming Languages (POPL), 2021
Journal Paper, **Conference Paper** (Rank: A*)

[**P19**] *Persistent Owick-Gries Reasoning*
Azalea Raad, Ori Lahav, Viktor Vafeiadis
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2020
Journal Paper, **Conference Paper** (Rank: A*)

[**P20**] *Local Reasoning about the Presence of Bugs: Incorrectness Separation Logic*
Azalea Raad, Josh Berdine, Hoang-Hai Dang, Derek Dreyer, Peter O'Hearn, Jules Villard
Computer-Aided Verification (CAV), 2020
Conference Paper (Rank: A*)

[**P21**] *Data Consistency in Transactional Storage Systems: A Centralised Approach*
Shale Xiong, Andrea Cerone, **Azalea Raad**, Philippa Gardner
European Conference on Object-Oriented Programming (ECOOP), 2020
Conference Paper (Rank: A)

[**P22**] *Persistency Semantics of the Intel-x86 Architecture*
Azalea Raad, Gil Neiger, John Wickerson, Viktor Vafeiadis
Principles of Programming Languages (POPL), 2020
Journal Paper, **Conference Paper** (Rank: A*)

[**P23**] *Weak Persistency Semantics from the Ground Up*
Azalea Raad, John Wickerson, Viktor Vafeiadis
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2019
Journal Paper, **Conference Paper** (Rank: A*)

[**P24**] *Effective Lock Handling in Stateless Model Checking*
Michalis Kokologiannakis, **Azalea Raad**, Viktor Vafeiadis
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2019
Journal Paper, **Conference Paper** (Rank: A*)

[**P25**] *Hyperstate Space Graphs for Automated Game Analysis*
Michael Cook, **Azalea Raad**
Conference on Games (Cog), 2019
🏆 **Winner of the best paper award**
Conference Paper (Rank: B)

[**P26**] *Model Checking for Weakly Consistent Libraries*
Michalis Kokologiannakis, **Azalea Raad**, Viktor Vafeiadis
Programming Language Design and Implementation (PLDI), 2019
Journal Paper, **Conference Paper** (Rank: A*)

[**P27**] *On Library Correctness under Weak Memory Consistency*
Azalea Raad, Marko Doko, Lovro Rožić, Ori Lahav, Viktor Vafeiadis
Principles of Programming Languages (POPL), 2019
Journal Paper, **Conference Paper** (Rank: A*)

[**P28**] *On the Semantics of Snapshot Isolation*
Azalea Raad, Ori Lahav, Viktor Vafeiadis
Verification, Model Checking and Abstract Interpretation (VMCAI), 2019
Conference Paper (Rank: B)

[**P29**] *Persistence Semantics for Weak Memory*
Azalea Raad, Viktor Vafeiadis
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2018
Journal Paper, **Conference Paper** (Rank: A*)

[**P30**] *On Parallel Snapshot Isolation and Release/Acquire Consistency*
Azalea Raad, Ori Lahav, Viktor Vafeiadis
European Symposium on Programming (ESOP), 2018
Conference Paper (Rank: A)

[**P31**] *Inferring Design Constraints from Game Ruleset Analysis*
Michael Cook, Simon Colton, **Azalea Raad**
IEEE Conference on Computational Intelligence and Games (CIG), 2018
Conference Paper (Rank: B)

[**P32**] *Verifying Concurrent Graph Algorithms*
Azalea Raad, Aquinas Hobor, Jules Villard, Philippa Gardner
Asian Symposium on Programming Languages and Systems (APLAS), 2016
Conference Paper (Rank: B)

[**P33**] *DOM: Specification and Client Reasoning*
Azalea Raad, José Fragoso Santos, Philippa Gardner
Asian Symposium on Programming Languages and Systems (APLAS), 2016
Conference Paper (Rank: B)

[**P34**] *CoLoSL: Concurrent Local Subjective Logic*
Azalea Raad, Jules Villard, Philippa Gardner
European Symposium on Programming (ESOP), 2015
Conference Paper (Rank: A)

[**P35**] *Abstract Local Reasoning for Concurrent Libraries: Mind the Gap*
Philippa Gardner, **Azalea Raad***, Adam Wright, Mark Wheelhouse
Mathematical Foundations of Programming Semantics (MFPS), 2014
(* author list in alphabetical order – Raad and Wright have joint first authorship)
Conference Paper (Rank: B)

[**P36**] *Mechanic Miner: Reflection-Driven Game Mechanic Discovery And Design*
Michael Cook, Simon Colton, **Azalea Raad**, Jeremy Gow
EvoGames Workshop at European Conference on Applications of Evolutionary Computation, 2013
Workshop Paper

[**P37**] *A Sip of the Chalice*
Azalea Raad, Sophia Drossopoulou
Functional Techniques for Java-like Programs (FTfJP), 2011
Workshop Paper

[**P38**] *Ludic Considerations of Tablet-Based Evo-Art*
Simon Colton, Michael Cook, **Azalea Raad**
EvoMusArt Workshop at European Conference on Applications of Evolutionary Computation, 2011
Workshop Paper

Keynote and Invited Talks

[T1] Invited Talk **March 2025**
Incorrectness Logic & Under-Approximation: Foundations of Bug Detection
Program Analysis Seminar, University of Pisa

[T2] Invited Talk **November 2024**
Strength in Weakness: The Ubiquity of Weak Memory Models
Reach Emerging Architectures and Computing Horizons (Reach)
Institution of Engineering and Technology (IET)

[T3] Keynote Talk **September 2024**
Bug Detection at Scale
International Conference on Concurrency Theory (CONCUR)

[T4] Keynote Talk **January 2024**
Under-approximation for Scalable Bug Detection
ACM SIGPLAN International Conference on Certified Programs and Proofs (CPP)

[T5] Invited Talk **June 2024**
Bug Detection at Scale
Symposium on Games, Automata, Logics, and Formal Verification (GandALF)

[T6] Invited Talk **September 2023**
Principles of Persistent Programming
Trends in Concurrency Theory (TRENDS)

[T7] Invited Talk **September 2023**
Under-approximation for Scalable Bug Detection
Young Researchers Workshop on Concurrency Theory (YR-CONCUR)

[T8] Keynote Talk **June 2023**
Principles of Persistent Programming
Federated Conference on Distributed Computing Techniques (DisCoTec)

[T9] Keynote Talk **June 2023**
Incorrectness Logic for Scalable Bug Detection
Mathematical Foundations of Programming Semantics (MFPS)

[T10] Invited Talk **May 2023**
Incorrectness Logic for Scalable Bug Detection
Conference on High Confidence Software and Systems conference (HCSS)

[T11] Invited Talk **May 2023**
Incorrectness Logic for Scalable Bug Detection
Iris Workshop

[T12] Keynote Tutorial **January 2023**
Incorrectness Logic and Under-approximation: Foundations of Bug Catching
Principles of Programming Languages (POPL)

[T13] Invited Talk **October 2022**
Incorrectness Logic for Scalable Bug Detection
Workshop on Dependable and Secure Software Systems (DSSS)

[T14] Invited Talk **September 2022**
Extending Intel-x86 Consistency and Persistency
Novel Architecture and Novel Design Automation (NANDA) Workshop

[T15] Invited Talk **December 2021**
Scalable, Concurrent Bug Catching: Concurrent Incorrectness Separation Logic
Testing and Verification Symposium at Facebook, 2021

[T16] Keynote Tutorial **June 2021**
Beyond Weak Memory Consistency: The Challenges of Memory Persistency
Programming Language Design and Implementation (PLDI), 2021

[T17] Invited Talk **January 2021**
Compositional Bug Catching: Incorrectness Separation Logic
World Logic Day

[T18] Invited Talk **June 2019**
Specifying and Verifying Non-Volatile Memory
Verification of Distributed Systems (VDS)

[T19] Keynote Talk **December 2018**
Correctness in a Weakly Consistent Setting
Asian Symposium on Programming Languages and Systems (APLAS)

[T20] Invited Talk **January 2017**
Verifying Concurrent Graph Algorithms
Northern Concurrency Workshop

[T21] Invited Tutorial Talk **June 2015**
CoLoSL: Why Not Frame All the Way?
Mathematical Foundations of Programming Semantics (MFPS)

[T22] Invited Talk **May 2015**
CoLoSL: Concurrent Local Subjective Logic
Dagstuhl Seminar 15191: *Compositional Verification Methods for Next-Generation Concurrency*

[T23] Invited Talk **April 2015**
CoLoSL: Concurrent Local Subjective Logic
Theory Seminar at the University of Birmingham

[T24] Invited Talk **December 2014**
CoLoSL: Compositional Reasoning at Last!
Research Visit at the Max Planck Institute for Software Systems, Saarbrücken, Germany

Research Group VERITAS

Founder and Leader of Veritas Lab

Post-Doctoral Researchers

- Dragana Milovančević — July 2025 – Present
- Sacha-Élie Ayoun — September 2024 – Present
- Matthew Griffin — May 2024 – March 2025
- Paulo de Vilhena — April 2023 – Present
- Guillaume Ambal — October 2022 – Present

PhD Students

- Opale Sjöstedt — February 2025 – Present
- Raquel Sofia Silva — October 2024 – Present
- Julien Vanegue (funded by Bloomberg, part-time) — October 2023 – Present
- Pedro Carrott — October 2023 – Present
- Shing-Hin Ho — January 2023 – Present

Visiting Researchers

- Flavio Ascari — June 2024 – July 2024

Master's Students

- Max Stupple — October 2024 – Present
  🏆 Winner of the *ARM project prize* for an outstanding thesis in the area of computer systems
- Tiberiu Bucur — October 2022 – June 2023
  🏆 Winner of the Corporate Partnership Prize
- Ezra Sitorus — October 2022 – June 2023
- Aris Zhu — October 2022 – June 2023
- Rini Banerjee — October 2021 – June 2022
  🏆 Winner of the *ARM project prize* for an outstanding thesis in the area of computer systems

Summer Interns

- Caroline Cronjäger 2023, 2024
- Ines Wright 2024

Selected Awards and Prizes

🏆 **Imperial College President's Medal for Excellence in Impact** **2025**

🏆 **Distinguished Paper Award** **2022**
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA)

🏆 **Distinguished Artifact Award**, European Symposium on Programming (ESOP) **2022**

🏆 **Imperial College President's Award for Excellence in Research** **2021**
(Early Career Researcher)

🏆 **Best Paper Award**, Conference on Games (CoG) **2019**
Hyperstate Space Graphs for Automated Game Analysis

Professional Services

Additional Positions

1. *Research Institute on Verified Trustworthy Software Systems* (VeTSS)
   Role: Co-director
   Tenure: 2022–Present
2. ACM SIGPLAN Executive Committee
   Role: co-chair for diversity and mentoring
   Tenure: 2024–2027

Invitation-Only Events

1. Software Understanding for National Security (SUNS) Partnership Forum (March 2025)
2. BCS *IT Leaders Forum* (January 2025)
3. IFIP Working Group 2.1 on *Algorithmic Languages and Calculi*, Meeting 82 (November 2024)
4. BCS Roundtable on *Confidence in Service Delivery – Improving Our Resilience* (October 2023)
5. Dagstuhl Seminar 22492 (December 2022)
6. *Software, the Elephant in the Room* Roundtable, organised by National Preparedness Commission and BCS (November 2022)
7. Dagstuhl Seminar 15191 (May 2015)

Organisation

1. Organiser of Dagstuhl seminar on *Foundations of Disaggregated Memory and Heterogeneous Architectures*, 2026
2. Organiser of the *VeTSS Annual Conference*, 2025
3. Organiser of the *Theory and Practice of Static Analysis* workshop at POPL, 2025

4. Organiser of the Isaac Newton Institute Big Specification programme (2024)
5. Organiser of the *VeTSS Summer School,* 2024
6. Organiser of the *VeTSS Annual Conference*, 2024
7. Organiser of the *Future of Weak Memory* workshop at POPL, 2024
8. Organiser of the *Formal Methods for Incorrectness* workshop at POPL, 2024
9. Organiser of the *O'Hearn Fest* (Festschrift for Prof. Peter O'Hearn) at POPL, 2024
10. Organiser of Dagstuhl seminar on *Formal Methods for Correct Persistent Programming*, 2023
11. Organiser of the *VeTSS Annual Conference*, 2023
12. Organiser of the *VeTSS Summer School*, 2023
13. Organiser of the *Concurrency Meeting* at the Isaac Newton Institute, 2022
14. Co-chair of the *Student Research Competition at POPL*, 2022
15. Organiser of Dagstuhl seminar 21462 on *Foundations of Persistent Programming*, 2021
16. Co-chair of the *Student Research Competition at POPL*, 2021
17. Organiser of the *Programming Languages Mentoring Workshop (PLMW) at POPL*, 2021
18. Accessibility chair of *Programming Language Design and Implementation* (PLDI), 2020

Program Chair

- Conference on Verified Software: Theories, Tools,and Experiments (VSTTE), 2024

Program and Review Committee Membership

1. ACM SIGPLAN Research Highlights (2024–2027)
2. Programming Language Design and Implementation (PLDI): 2025, 2021, 2020 (external)
3. Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA): 2025, 2020, 2018 (external member)
4. European Symposium on Programming (ESOP): 2024
5. Principles of Programming Languages (POPL): 2023, 2020
6. International Conference on Functional Programming (ICFP), 2022
7. Computer-Aided Verification (CAV), 2022
8. Verification, Model Checking, and Abstract Interpretation (VMCAI), 2021
9. International Conference on Networked Systems (NETYS), 2020
10. European Conference on Object-Oriented Programming (ECOOP), 2019
11. Mathematical Foundations of Programming Semantics (MFPS), 2018
12. Syntax and Semantics of Low-Level Languages (LOLA), 2018
13. European Symposium on Programming (ESOP), 2017 (external reviewer)

14. International Workshop on Aliasing, Capabilities and Ownership (IWACO), 2017
15. Student Research Competition at POPL, 2020
16. Student Research Competition at PLDI, 2019
17. Student Research Competition at ICFP, 2019
18. Student Research Competition Judge at the Asian Symposium on Programming Languages and Systems (APLAS), 2018

PhD Examinations

1. Frank Busse, Imperial College London, 2025
2. Miguel Matos, University of Lisbon, 2024
3. Simon Friis Vindum, Aarhus University, 2023
4. Daniel Wright, University of Kent, 2023

Journal Reviews

- Journal of the American Computer Machinery, 2022
- Foundations and Trends in Programming Languages, 2020

Teaching

The Theory and Practice of Concurrent Programming **2021–Present**
Third year course (Imperial College London); co-designed the course

Models of Computation **2020; 2021**
Second year course (Imperial College London)

Logic and Reasoning **2020**
First year course (Imperial College London)