

# DR AZALEA RAAD

Director of the UK Research Institute on Verified Trustworthy Software Systems (VeTSS)  
(last updated: September 2023)

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**Nationality:** British  
**Languages (native fluency):** English, Farsi, Turkish  
**Languages (intermediate):** German  
**Languages (basic):** French

## EMPLOYMENT

**Senior Lecturer at Imperial College London** **July 2022 – Present**  
Department of Computing

**Lecturer at Imperial College London** **October 2019 – July 2022**  
Department of Computing

**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

**Research Associate at Imperial College London** **January 2017 – June 2017**  
Group: Verified Trustworthy Software Specification  
Manager: Philippa Gardner

## FUNDING

**Principal Investigator** **September 2023 – August 2026**  
EPSRC Standard Grant  
Project Title: "SACRED-MA: Safe and Secure Remote Direct Memory Access"  
Amount: £750,000

**Co-Director** **December 2022 – November 2026**  
Directorship of the UK Research Institute Verified Trustworthy Software Systems (VeTSS)  
Amount: £750,000

**Principal Investigator** **October 2022 – September 2023**  
Research Gift by Meta  
Project Title: "Automated Generation and Detection of Exploits via Incorrectness Logic"  
Amount: \$50,000

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

## 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

## 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

The thesis was awarded the *Corporate Partnership Prize*

## PUBLICATIONS

### *Specifying and Verifying Persistent Libraries*

Léo Stefanescu, **Azalea Raad**, Viktor Vafeiadis

European Symposium on Programming (ESOP), 2024 (under submission)

### *Intel PMDK Transactions: Specification and Concurrency*

**Azalea Raad**, Ori Lahav, John Wickerson, Brijesh Dongol

European Symposium on Programming (ESOP), 2024 (under submission)

### *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 (under submission)

### *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

### *Memento: A Framework for Detectable Recoverability in Persistent Memory*

Kyeongmin Cho, Seungmin Jeon, **Azalea Raad**, Jeehoon Kang

Programming Language Design and Implementation (PLDI), 2023

### *The Path to Durable Linearizability*

Emanuele D’Osualdo, **Azalea Raad**, Viktor Vafeiadis

Principles of Programming Languages (POPL), 2023

### *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**

### *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**

*Concurrent Incorrectness Separation Logic*

**Azalea Raad**, Josh Berdine, Derek Dreyer, Peter O’Hearn  
Principles of Programming Languages (POPL), 2022

*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

*Revamping Hardware Persistency Models*

Kyeongmin Cho, Sung-Hwan Lee, **Azalea Raad**, Jeehoon Kang  
Programming Language Design and Implementation (PLDI), 2021

*PerSeVerE: Persistency Semantics for Verification under Ext<sub>4</sub>*

Michalis Kokologiannakis, Ilya Kaysin, **Azalea Raad**, Viktor Vafeiadis  
Principles of Programming Languages (POPL), 2021

*Persistent Owick-Gries Reasoning*

**Azalea Raad**, Ori Lahav, Viktor Vafeiadis  
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2020

*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

*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

*Persistency Semantics of the Intel-x86 Architecture*

**Azalea Raad**, Gil Neiger, John Wickerson, Viktor Vafeiadis  
Principles of Programming Languages (POPL), 2020

*Weak Persistency Semantics from the Ground Up*

**Azalea Raad**, John Wickerson, Viktor Vafeiadis  
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2019

*Effective Lock Handling in Stateless Model Checking*

Michalis Kokologiannakis, **Azalea Raad**, Viktor Vafeiadis  
Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2019

*Hyperstate Space Graphs for Automated Game Analysis*

Michael Cook, **Azalea Raad**  
Conference on Games (Cog), 2019, **Winner of the best paper award**

*Model Checking for Weakly Consistent Libraries*

Michalis Kokologiannakis, **Azalea Raad**, Viktor Vafeiadis  
Programming Language Design and Implementation (PLDI), 2019

*On Library Correctness under Weak Memory Consistency*

**Azalea Raad**, Marko Doko, Lovro Rožić, Ori Lahav, Viktor Vafeiadis  
Principles of Programming Languages (POPL), 2019

*On the Semantics of Snapshot Isolation*

**Azalea Raad**, Ori Lahav, Viktor Vafeiadis

Verification, Model Checking and Abstract Interpretation (VMCAI), 2019

*Persistence Semantics for Weak Memory*

**Azalea Raad**, Viktor Vafeiadis

Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2018

*On Parallel Snapshot Isolation and Release/Acquire Consistency*

**Azalea Raad**, Ori Lahav, Viktor Vafeiadis

European Symposium on Programming (ESOP), 2018

*Inferring Design Constraints from Game Ruleset Analysis*

Michael Cook, Simon Colton, **Azalea Raad**

IEEE Conference on Computational Intelligence and Games (CIG), 2018

*Abstraction, Refinement and Concurrent Reasoning*

Doctoral Thesis, 2017

*Verifying Concurrent Graph Algorithms*

**Azalea Raad**, Aquinas Hobor, Jules Villard, Philippa Gardner

Asian Symposium on Programming Languages and Systems (APLAS), 2016

*DOM: Specification and Client Reasoning*

**Azalea Raad**, José Fragoso Santos, Philippa Gardner

Asian Symposium on Programming Languages and Systems (APLAS), 2016

*CoLoSL: Concurrent Local Subjective Logic*

**Azalea Raad**, Jules Villard, Philippa Gardner

European Symposium on Programming (ESOP), 2015

*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)

*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

*A Sip of the Chalice*

**Azalea Raad**, Sophia Drossopoulou

Functional Techniques for Java-like Programs (FTfJP), 2011

*Ludic Considerations of Tablet-Based Evo-Art*

Simon Colton, Michael Cook, **Azalea Raad**

EvoMusArt Workshop at European Conference on Applications of Evolutionary Computation, 2011

## SELECTED KEYNOTE AND INVITED TALKS

**Invited Talk**

**September 2023**

*Principles of Persistent Programming*

Trends in Concurrency Theory (TRENDS)

|   |                       |
|---|-----------------------|
| <b>Invited Talk</b><br><i>Under-approximation for Scalable Bug Detection</i><br>Young Researchers Workshop on Concurrency Theory (YR-CONCUR)                          | <b>September 2023</b> |
| <b>Keynote Talk</b><br><i>Principles of Persistent Programming</i><br>Federated Conference on Distributed Computing Techniques (DisCoTec)                             | <b>June 2023</b>      |
| <b>Keynote Talk</b><br><i>Incorrectness Logic for Scalable Bug Detection</i><br>Mathematical Foundations of Programming Semantics (MFPS)                              | <b>June 2023</b>      |
| <b>Invited Talk</b><br><i>Incorrectness Logic for Scalable Bug Detection</i><br>Conference on High Confidence Software and Systems conference (HCSS)                  | <b>May 2023</b>       |
| <b>Invited Talk</b><br><i>Incorrectness Logic for Scalable Bug Detection</i><br>Iris Workshop   | <b>May 2023</b>       |
| <b>Keynote Tutorial</b><br><i>Incorrectness Logic and Under-approximation: Foundations of Bug Catching</i><br>Principles of Programming Languages (POPL)              | <b>January 2023</b>   |
| <b>Invited Talk</b><br><i>Incorrectness Logic for Scalable Bug Detection</i><br>Workshop on Dependable and Secure Software Systems (DSSS)                             | <b>October 2022</b>   |
| <b>Invited Talk</b><br><i>Extending Intel-x86 Consistency and Persistency</i><br>Novel Architecture and Novel Design Automation (NANDA) Workshop                      | <b>September 2022</b> |
| <b>Invited Talk</b><br><i>Scalable, Concurrent Bug Catching: Concurrent Incorrectness Separation Logic</i><br>Testing and Verification Symposium at Facebook, 2021    | <b>December 2021</b>  |
| <b>Keynote Tutorial</b><br><i>Beyond Weak Memory Consistency: The Challenges of Memory Persistency</i><br>Programming Language Design and Implementation (PLDI), 2021 | <b>June 2021</b>      |
| <b>Invited Talk</b><br><i>Compositional Bug Catching: Incorrectness Separation Logic</i><br>World Logic Day   | <b>January 2021</b>   |
| <b>Invited Talk</b><br><i>Specifying and Verifying Non-Volatile Memory</i><br>Verification of Distributed Systems (VDS)   | <b>June 2019</b>      |
| <b>Keynote Talk</b><br><i>Correctness in a Weakly Consistent Setting</i><br>Asian Symposium on Programming Languages and Systems (APLAS)                              | <b>December 2018</b>  |
| <b>Invited Talk</b><br><i>Verifying Concurrent Graph Algorithms</i><br>Northern Concurrency Workshop  | <b>January 2017</b>   |

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

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

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

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

## RESEARCH GROUP

### Post-Doctoral Researchers

- Guillaume Ambal October 2022 – Present
- Paulo de Vilhena April 2023 – Present

### PhD Students

- Shing-Hin Ho January 2023 – Present
- Pedro Carrott October 2023 – Present
- Julien Vanegue (funded by Bloomberg) October 2023 – Present

### Master's Students

- 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 project in computer systems

## AWARDS AND PRIZES

|   |             |
|---|-------------|
| <b>Distinguished Paper Award</b>  | <b>2022</b> |
| Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA)                        |             |
| <b>Distinguished Artifact Award</b> , European Symposium on Programming (ESOP)                    | <b>2022</b> |
| <b>Imperial College President's Award for Excellence in Research</b><br>(Early Career Researcher) | <b>2021</b> |
| <b>Best Paper Award</b> , Conference on Games (CoG)   | <b>2019</b> |
| <i>Hyperstate Space Graphs for Automated Game Analysis</i>  |             |
| <b>Corporate Partnership Prize</b> for Excellence and Outstanding Achievement                     | <b>2010</b> |
| <b>Gloucester Research Prize</b> for Academic Excellence  | <b>2009</b> |
| <b>David Howarth Project Prize</b> for Automated Generation of Compiler Test Cases                | <b>2009</b> |
| <b>Olav Beckman Project Prize</b>   | <b>2008</b> |
| <b>Imperial College Research Prize</b> for Cognitive Robotics Project                             | <b>2007</b> |

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| <b>Research Prize</b> (Sponsored by Deutsche Bank)                                | <b>2007</b> |
| <b>Prize for Excellence in First Year Computing</b> (Sponsored by Morgan Stanley) | <b>2007</b> |

## PROFESSIONAL SERVICES

### Organisation

- Organiser of the *Future of Weak Memory* workshop at POPL, 2024
- Organiser of the *Formal Methods for Incorrectness* workshop at POPL, 2024
- Organiser of Dagstuhl seminar on *Formal Methods for Correct Persistent Programming*, 2023
- Organiser of the *Concurrency Meeting* at the Isaac Newton Institute, 2022
- Co-chair of the *Student Research Competition at POPL*, 2022
- Organiser of Dagstuhl seminar 21462 on *Foundations of Persistent Programming*, 2021
- Co-chair of the *Student Research Competition at POPL*, 2021
- Organiser of the *Programming Languages Mentoring Workshop (PLMW)* at POPL, 2021
- Accessibility chair of *Programming Language Design and Implementation (PLDI)*, 2020
- Organiser of *Imperial Concurrency Workshop*, 2015
- Organiser of the Workshop on *Introduction to Verification and Testing (INVEST)*, 2014

### Program Committee Membership

- European Symposium on Programming (ESOP): 2024
- Principles of Programming Languages (POPL): 2023, 2020
- International Conference on Functional Programming (ICFP), 2022
- Computer-Aided Verification (CAV), 2022
- Programming Language Design and Implementation (PLDI): 2021, 2020 (external member)
- Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA): 2020, 2018 (external member)
- Verification, Model Checking, and Abstract Interpretation (VMCAI), 2021
- International Conference on Networked Systems (NETYS), 2020
- European Conference on Object-Oriented Programming (ECOOP), 2019
- Mathematical Foundations of Programming Semantics (MFPS), 2018
- Syntax and Semantics of Low-Level Languages (LOLA), 2018
- European Symposium on Programming (ESOP), 2017 (external reviewer)
- International Workshop on Aliasing, Capabilities and Ownership (IWACO), 2017
- Student Research Competition at POPL, 2020
- Student Research Competition at PLDI, 2019
- Student Research Competition at ICFP, 2019
- Student Research Competition Judge at the Asian Symposium on Programming Languages and Systems (APLAS), 2018

### Journal Reviews

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

## Panel Membership

- Member of the *What I wish I had known before attending graduate school* panel at the Programming Languages Mentoring Workshop (PLMW) co-located with OOPSLA, 2019
- Member of the *Grad School and Beyond* panel at the Programming Languages Mentoring Workshop (PLMW) co-located with POPL, 2019

## 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)