Jan Hoffmann

Carnegie Mellon University – Computer Science Department

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Research Interests

My mission is to discover beautiful mathematical ideas that have a real-world impact, shape the way programmers think, and help to create better software. I am currently working on quantitative verification, type systems, static resource analysis of programs, probabilistic programming, proof assistants, and programming languages for digital contracts.

Education

Ludwig-Maximilians-Universität and TU Munich — **Munich**
Ph.D. in Computer Science — *2008–2011*
Advisor: Prof. Martin Hofmann. Grade: magna cum laude.
Topic: Types with Potential: Polynomial Resource Bounds via Automatic Amortized Analysis.

Ludwig-Maximilians-Universität — **Munich**
Diplom mit Auszeichnung (Master with Honors in Computer Science) — *2001–2007*
Grade: 1.0 (best possible).
Major: Theoretical Computer Science. Minor subject: Mathematics.

Positions

Carnegie Mellon University — **Pittsburgh**
Tenure-Track Assistant Professor — *2015–present*
In the Computer Science Department of the School of Computer Science.

Yale University — **New Haven**
Associate Research Scientist — *2012–2015*
Topic: Quantitative Verification. Support: NSF VeriQ (PI) and DARPA HACMS (Key Personnel).

Yale University — **New Haven**
Postdoctoral Associate — *2011–2012*
In the group of Prof. Zhong Shao. Topic: Verification of Lock-Free Data Structures.
Support: DARPA HACMS (Key Personnel) and DARPA CRASH.

Microsoft Research — **Cambridge, UK**
Research Intern — *Feb. – Apr. 2011*
Mentors: Andrew Kennedy and Nick Benton. Topic: Operational Semantics in Coq.

Ludwig-Maximilians-Universität and TU Munich — **Munich**
Research Assistant — *2007–2011*
In the group of Prof. Martin Hofmann. Topic: Automatic Resource Bound Analysis.

University of California, San Diego — **San Diego**
Master Thesis — *Jan. – Jun. 2007*
Advisor: Prof. Samuel R. Buss. Topic: DLL Algorithms and Resolution Proofs.

Professional Activities

Organizer

Martin Hofmann Memorial Meeting, with L. Beringer, S. Jost, U. Schöpp, and D. Sannella — 2019
19th Workshop on Logic and Computational Complexity (LCC'18) (Co-Chair) — 2018
3rd Logic Mentoring Workshop (LMW'18) (Co-Chair) — 2018

Dagstuhl Seminar *Resource Bound Analysis*, with M. Gaboardi, R. Wilhelm, and F. Zuleger 2017
LOLA 2016 - Syntax and Semantics of Low-Level Languages (Co-Chair) 2016
Annual PUMA Workshop, Venice, Italy. 2009

Guest Editor

Journal of Automated Reasoning, Special Issue *Automatic Resource Bound Analysis* 2015–17

Committee Member

Program Committee – LOLA 2019 - Syntax and Semantics of Low-Level Languages 2019
Program Committee – European Symposium on Programming (ESOP'20) 2019
Steering Committee – Logic Mentoring Workshop 2018–pres.
Program Committee – Symposium on Principles of Programming Languages (POPL'19) 2018
Review Panel – National Science Foundation (NSF) 2018
Program Committee – Student Research Competition at PLDI 2018 (PLDI'18 SRC) 2018
Program Committee – International Colloquium on Automata, Languages and Programming (ICALP'18) 2018
Program Committee – European Symposium on Programming (ESOP'18) 2017
Program Committee – Joint Workshop on Developments in Implicit Computational Complexity and Foundational and Practical Aspects of Resource Analysis (DICE-FOPARA'17) 2017
Program Committee – Int. Conf. on Formal Structures for Computation and Deduction (FSCD'17) 2017
Program Committee – Conf. on Programming Language Design and Implementation (PLDI'17) 2016–17
External Review Committee – Conference on Computer Aided Verification (CAV'16) 2016
Program Committee – Conf. on Found. of Software Science and Comp. Structures (FOSSACS'16) 2015
Program Committee – Developments in Implicit Computational Complexity (DICE'15) 2015
External Review Committee – Symposium on Principles of Programming Languages (POPL'15) 2014

University Service

Ph.D. Admissions Committee – Computer Science Department, Carnegie Mellon 2019–2020
Organizer of the Computer Science Department's Open House – Carnegie Mellon 2019–2020
Member of the Doctoral Review Committee – Computer Science Department, Carnegie Mellon 2018–pres.
Organizer of the weekly PLunch Meeting – Carnegie Mellon 2015–pres.
Organizer of the PoP Seminar – Carnegie Mellon 2015–pres.
Master Admission Committee – Computer Science Department, Carnegie Mellon 2015-2016

Teaching and Mentoring

Current PhD Students and Post-Docs

Stefan Muller, Post-Doc 2018–present
David Kahn, PhD Student 2018–present
Di Wang, PhD Student 2017–present
Ankush Das, PhD Student 2015–present

Current BS Students

Charles Yuan, BS Student 2018–present

Former Students

Prachi Laud, BS Student (now Software Engineer at Facebook) 2017–2018
Yue Niu, BS Student (now PhD students at Carnegie Mellon) 2017–2018
Chan Ngo, Post-Doc (now Senior Research Engineer at Aptiv) 2016–2018
Nicholas Roberts, BS Student 2018–2019
Benjamin Lichtman, BS Student (now Software Engineer at Microsoft) 2016–2017
Quentin Carbonneaux, PhD Student (co-advised with Zhong Shao) 2013–2017

Courses Taught

15-312: Principles of Programming Languages (with Stephanie Balzer) Carnegie Mellon, Spring 2019
15-411/15-611: Compiler Design Carnegie Mellon, Fall 2018
Introduction to Types and Semantics Oregon PL Summer School, Summer 2018
15-312: Principles of Programming Languages Carnegie Mellon, Spring 2018
15-411/15-611: Compiler Design Carnegie Mellon, Fall 2017

15-312: Principles of Programming Languages (with Bob Harper) — Carnegie Mellon, Spring 2017
15-411/15-611: Compiler Design — Carnegie Mellon, Fall 2016
Type-Based Resource Analysis — Oregon PL Summer School, Summer 2016
15-819: Advanced Topics in Programming Languages: Resource Analysis — Carnegie Mellon, Spring 2016
CPSC730: Advanced Formal Methods Topics (with Zhong Shao) — Yale, Fall 2012
CPSP721: Advanced Programming Language Topics (with Zhong Shao) — Yale, Spring 2012

Grants and Awards

Gift
Jane Street Capital *2019*

Research Grant
National Science Foundation (NSF) *2018–2021*
Title: *SHF: Small: Resource-Guided Program Synthesis.* PIs: Jan Hoffmann (CMU) and Nadia Polikarpova (UCSD). $250,000 (CMU component). Award No. 1812876.

Research Grant
National Science Foundation (NSF) *2018–2022*
Title: *SaTC: CORE: Medium: Automated Support for Writing High-Assurance Smart Contracts.* PIs: Jan Hoffmann (CMU), Bryan Parno (CMU), and Andrew Miller (UIUC). $800,000 (CMU component). Award No. 1801369.

Research Contract
DARPA Assured Autonomy *2018–2022*
HRL subcontract. CMU PIs: J. Dolan, D. Held, J. Hoffmann, S. Mitch, F. Pfenning, and A. Platzer.

Gift
Jane Street Capital *2018*
With Jean Yang

Schmidt Sciences Grant
The Eric and Wendy Schmidt Fund for Strategic Innovation *2017–2018*
Title: *An Automated Algorithm Designer.* With Carl Kingsford, Nina Balcan, Mor Harchol-Balter, Guy Blelloch, Anupam Gupta, and Jan Hoffmann.

Google Research Award
Google Inc. *2016*
Title: *Automated Static Resource Regression Analysis.*

Dagstuhl Seminar (Organizer)
Schloss Dagstuhl *2016*
Title: *Resource Bound Analysis.* Date: July, 2017.
With Marco Gaboardi, Reinhard Wilhelm, and Florian Zuleger.

Research Contract
DARPA STAC – Space/Time Analysis for Cybersecurity *2015–2019*
Title: *CURB: Calculating and Understanding Resource Bounds to Detect Space/Time Vulnerabilities.*
$6,230,090, 4 years, Award FA8750-15-C-0082 PIs: A. Loginov (GrammaTech),
T. Reps (U Wisconsin), J. Hoffmann (CMU) and Z. Shao (Yale); Yale/CMU component: $1,448,531.

Research Grant
National Science Foundation (NSF) *2013–2016*
Title: *VeriQ: Formal Quantitative Software Verification in Realistic Application Scenarios.*
$449,721, 3 years, Award CCF-1319671, PIs: Zhong Shao and Jan Hoffmann.

Ph.D. Scholarship
DFG Research Training Group (Graduiertenkolleg) PUMA *2008–2011*
PUMA is a joint graduate school (doctoral training center) of LMU Munich and TU Munich.
It is supported by the German Research Foundation (DFG).

Foreign Education Scholarship
German National Academic Foundation (Studienstiftung) *2007*
For a six months' stay at University of California, San Diego.

Student Scholarship
German National Academic Foundation (Studienstiftung) *2005–2007*

For studying computer science at Ludwig-Maximilians-Universität Munich.

Software

Quantitative CompCert
A formally-verified C compiler that preserves quantitative properties *2013–present*
We modified Xavier Leroy's CompCert compiler and used the Coq Proof Assistant to prove the preservation of quantitative properties during compilation of C to x86 assembly. This enables the verification of stack-space bounds at the C level. This artifact was approved by the *PLDI'13 Artifact Evaluation Committee.* (Project Website)

C^{4}B
A compositional certified resource-bound analyzer for C programs *2013–present*
We designed and implemented a system for statically determining a symbolic bound on the resource usage of C programs. The system is based on a fully-automatic amortized resource analysis. (Project Website)

Resource Aware ML
A system for automatic derivation of resource bounds for functional programs *2009–present*
For my Ph.D., I designed and implemented a system that automatically derives polynomial resource bounds for functional programs at compile time. We are currently integrating the analysis systems with INRIA's OCaml compiler. (Project Website)

CertiKOS
A formally-verified hypervisor kernel *2012–2015*
In the DARPA HACMS and DARPA CRASH programs, we use the Coq Proof Assistant and the verified CompCert C compiler to implement and verify the realistic hypervisor kernel CertiKOS. (Project Website)

Publications

In Peer-Reviewed Conferences

1. D. Wang and J. Hoffmann.
   Type-guided worst-case input generation.
   In *46th Symposium on Principles of Programming Languages (POPL'19)*, 2019.

2. Y. Niu and J. Hoffmann.
   Automatic space bound analysis for functional programs with garbage collection.
   In *22nd International Conference on Logic for Programming Artificial Intelligence and Reasoning (LPAR'18)*, 2018.

3. A. Das, J. Hoffmann, and F. Pfenning.
   Parallel complexity analysis with temporal session types.
   In *23rd International Conference on Functional Programming (ICFP'18)*, 2018.

4. A. Das, J. Hoffmann, and F. Pfenning.
   Work analysis with resource-aware session types.
   In *33th ACM/IEEE Symposium on Logic in Computer Science (LICS'18)*, 2018.

5. V. C. Ngo, Q. Carbonneaux, and J. Hoffmann.
   Bounded expectations: Resource analysis for probabilistic programs.
   In *39th Conference on Programming Language Design and Implementation (PLDI'18)*, 2018.

6. D. Wang, J. Hoffmann, and T. Reps.
   Pmaf: An algebraic framework for static analysis of probabilistic programs.
   In *39th Conference on Programming Language Design and Implementation (PLDI'18)*, 2018.

7. B. Lichtman and J. Hoffmann.
   Arrays and References in Resource Aware ML.
   In *2nd International Conference on Formal Structures for Computation and Deduction (FSCD'17)*, 2017. PDF.

8. Q. Carbonneaux, J. Hoffmann, T. Reps, and Z. Shao.
Automated Resource Analysis with Coq Proof Objects.
In *29th International Conference on Computer-Aided Verification (CAV'17)*, 2017. PDF.

9. V. C. Ngo, M. Dehesa-Azuara, M. Fredrikson, and J. Hoffmann.
Verifying and Synthesizing Constant-Resource Implementations with Types.
In *38th IEEE Symposium on Security and Privacy (S&P '17)*, 2017. PDF.

10. A. Das and J. Hoffmann.
ML for ML: Learning Cost Semantics by Experiment.
In *23rd International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS'17)*, 2017. PDF.

11. E. Çiçek, G. Barthe, M. Gaboardi, D. Garg, and J. Hoffmann.
Relational Cost Analysis.
In *44th Symposium on Principles of Programming Languages (POPL'17)*, 2017. PDF.

12. J. Hoffmann, A. Das, and S.-C. Weng.
Towards Automatic Resource Bound Analysis for OCaml.
In *44th Symposium on Principles of Programming Languages (POPL'17)*, 2017. Artifact submitted and approved. PDF.

13. Q. Carbonneaux, J. Hoffmann, and Z. Shao.
Compositional Certified Resource Bounds.
In *36th Conference on Programming Language Design and Implementation (PLDI'15)*, 2015. Artifact submitted and approved. PDF.

14. J. Hoffmann and Z. Shao.
Automatic Static Cost Analysis for Parallel Programs.
In *24th European Symposium on Programming (ESOP'15)*, 2015. PDF.

15. J. Hoffmann and Z. Shao.
Type-Based Amortized Resource Analysis with Integers and Arrays.
In *12th International Symposium on Functional and Logic Programming (FLOPS'14)*, 2014. PDF.

16. Q. Carbonneaux, J. Hoffmann, T. Ramananandro, and Z. Shao.
End-to-End Verification of Stack-Space Bounds for C Programs.
In *35th Conference on Programming Language Design and Implementation (PLDI'14)*, 2014. Artifact submitted and approved. PDF.

17. G. Scherer and J. Hoffmann.
Tracking Data-Flow with Open Closure Types.
In *19th International Conference on Logic for Programming, Artificial Intelligence and Reasoning (LPAR'13)*, 2013. PDF.

18. H. Liang, J. Hoffmann, X. Feng, and Z. Shao.
Characterizing Progress Properties of Concurrent Objects via Contextual Refinements.
In *24th International Conference on Concurrency Theory (CONCUR'13)*, 2013. PDF.

19. J. Hoffmann, M. Marmar, and Z. Shao.
Quantitative Reasoning for Proving Lock-Freedom.
In *28th ACM/IEEE Symposium on Logic in Computer Science (LICS'13)*, 2013. PDF.

20. J. Hoffmann, K. Aehlig, and M. Hofmann.
Resource Aware ML.
In *24rd International Conference on Computer Aided Verification (CAV'12)*, 2012. PDF.

21. N. R. Krishnaswami, N. Benton, and J. Hoffmann.
Higher-Order Functional Reactive Programming in Bounded Space.
In *39th Symposium on Principles of Programming Languages (POPL'12)*, 2012. PDF.

22. J. Hoffmann, K. Aehlig, and M. Hofmann.
Multivariate Amortized Resource Analysis.
In *38th Symposium on Principles of Programming Languages (POPL'11)*, 2011. PDF.

23. J. Hoffmann and M. Hofmann.
Amortized Resource Analysis with Polymorphic Recursion and Partial Big-Step Operational Semantics.
In *8th Asian Symposium on Programming Languages (APLAS'10)*, 2010. PDF.

24. J. Hoffmann and M. Hofmann.
Amortized Resource Analysis with Polynomial Potential.
In *19th European Symposium on Programming (ESOP'10)*, 2010. PDF.

25. D. Baumeister, F. Brandt, F. A. Fischer, J. Hoffmann, and J. Rothe.
The Complexity of Computing Minimal Unidirectional Covering Sets.
In *Algorithms and Complexity, 7th International Conference (CIAC'10)*, 2010. PDF.

26. F. Brandt, M. Brill, F. A. Fischer, and J. Hoffmann.
The Computational Complexity of Weak Saddles.
In *Algorithmic Game Theory, Second International Symposium (SAGT'09)*, 2009. PDF.

In Peer-Reviewed Journals

27. J. Hoffmann and Z. Shao.
Type-Based Amortized Resource Analysis with Integers and Arrays.
J. Funct. Program., 2015. PDF.

28. D. Baumeister, F. Brandt, F. A. Fischer, J. Hoffmann, and J. Rothe.
The Complexity of Computing Minimal Unidirectional Covering Sets.
Theory of Computing Systems, 2013. PDF.

29. J. Hoffmann, K. Aehlig, and M. Hofmann.
Multivariate Amortized Resource Analysis.
ACM Trans. Program. Lang. Syst., 2012. PDF.

30. F. Brandt, M. Brill, F. A. Fischer, and J. Hoffmann.
The Computational Complexity of Weak Saddles.
Theory of Computing Systems, 2010. PDF.

31. F. Brandt, M. Brill, F. Fischer, P. Harrenstein, and J. Hoffmann.
Computing Shapley's Saddles.
ACM SIGecom Exchanges, 8, 2009. PDF.

32. J. Hoffmann.
Finding a Tree Structure in a Resolution Proof is NP-Complete.
Theoretical Computer Science, 410(21-23), 2009. PDF.

33. S. R. Buss, J. Hoffmann, and J. Johannsen.
Resolution Trees with Lemmas: Resolution Refinements that Characterize DLL Algorithms with Clause Learning.
Logical Methods in Computer Science, 4(4), 2008. PDF.

34. S. R. Buss and J. Hoffmann.
The NP-hardness of Finding a Directed Acyclic Graph for Regular Resolution.
Theoretical Computer Science, 396(1-3), 2008. PDF.

Theses

35. J. Hoffmann.
Types with Potential: Polynomial Resource Bounds via Automatic Amortized Analysis. PhD thesis, Ludwig-Maximilians-Universiät München, 2011. PDF.

36. J. Hoffmann.
Resolution Proofs and DLL-Algorithms with Clause Learning. Diploma Thesis, LMU München, 2007. PDF.

Other Papers

37. A. Das, S. Balzer, J. Hoffmann, and F. Pfenning.
Resource-aware session types for digital contracts, 2019. Working paper.

38. T. Knoth, D. Wang, J. Hoffmann, and N. Polikarpova.
Resource-guided program synthesis, 2019. Working paper.

39. D. Wang, J. Hoffmann, and T. Reps.
A denotational semantics for nondeterminism in probabilistic programs, 2018. Working paper.

Talks

Resource-Aware Session Types
Invited talk 4th Workshop on Behavioral Types (BEAT '19); Lisbon, Portugal — January 2019

Programming Languages for Smart Contracts
CyLab Partners Conference; Pittsburgh, PA — October 2018

Resource Analysis for Probabilistic Programs
Invited talk at the meeting of the IFIP working group 1.9/2.15 "Verified Software"; Oxford, UK — July 2018

Resource Analysis for Probabilistic Programs
Invited talk at the 9th International Workshop on Developments in Implicit Computational Complexity (DICE '18); Thessaloniki, Greece — April 2018

Resource Analysis for Probabilistic Programs
ESOP 2018 Program Committee Workshop; Paris, France — December 2017

Resource Bound Analysis and Static Analysis
Invited talk at the 9th Working Conference on Verified Software: Theories, Tools, and Experiments (VSTTE '17); Heidelberg, Germany — July 2017

Towards Automatic Resource Bound Analysis for OCaml
Symposium on Principles of Programming Languages (POPL'17); Paris, France — January 2017

Resource Aware ML
University at Buffalo; Buffalo, NY — December 2017
Invited talk at the 5th South of England Regional Programming Language Seminar; Oxford; UK — January 2017
Max Planck Institute for Software Systems; Saarbrücken; Germany — June 2016

Automatic Resource Bound Analysis and Linear Optimization
Invited talk at the workshop *Beyond Worst-Case Analysis* at the Simons Institute; Berkeley; CA — November 2016

Static Analysis for Finding Space/Time Vulnerabilities
CyLab Partners Conference; Pittsburgh; PA — September 2016

Type-Based Resource Analysis
Lecture series at the Oregon Programming Languages Summer School); Eugene; OR — June 2016

Certified Resource Bounds in the CompCert Compiler
Invited talk at Mathematical Foundations of Programming Semantics (MFPS'16); Pittsburgh; PA — Mai 2016

Resource Aware Programming
Principles of Programming (PoP) Group Retreat; Seven Springs; PA — October 2015

Compositional Certified Resource Bounds
Conf. on Programming Language Design and Implementation (PLDI'15); Portland; OR — June 2015

Automatic Static Cost Analysis for Parallel Programs
European Symposium on Programming (ESOP'15); London; UK — April 2015

Formal Reasoning about Quantitative Properties of Software
University of Colorado Boulder; Boulder, CO — March 2015
Carnegie Mellon University; Pittsburgh, PA — February 2015
University of Illinois at Urbana-Champaign; Urbana-Champaign, IL — February 2015
University of Waterloo; Waterloo ON, Canada — January 2015
Heriot-Watt University; Edinburgh, UK — January 2015
TU Munich (Department of Computer Science); Munich, Germany — November 2014
Boston University; Boston MA — October 2014
Northeastern University; Boston MA — October 2014
MIT; Boston MA — April 2014
Harvard University; Boston MA — April 2014

Formal Verification of Quantitative Software Properties
TU Munich (Institute for Advanced Study); Munich, Germany — November 2014

End-to-End Verification of Stack-Space Bounds for C Programs
Workshop on Higher Order Computation: Types, Complexity, Applications; Paris, France — June 2014

Type-Based Amortized Resource Analysis with Integers and Arrays
Int. Symp. on Functional and Logic Programming (FLOPS'14); Kanasawa, Japan — June 2014

Tracking Data-Flow with Open Closure Types
Int. Conf. on Logic for Prog., Art. Intel. and Reasoning (LPAR'13); Stellenbosch, South Africa — December 2013

Characterizing Progress Properties of Concurrent Objects via Contextual Refinements
DARPA HACMS-CARS site visit; New Haven, CT — September 2013

Quantitative Reasoning for Proving Lock-Freedom
ACM/IEEE Symposium on Logic in Computer Science (LICS'13); New Orleans, LA — June 2013
University of Pennsylvania; Philadelphia, PA — February 2013
DARPA CRASH PI meeting; San Diego, CA — November 2012
DARPA CRASH-CertiKOS site visit; New Haven, CT — October 2012

Resource Aware ML
Int. Conf. on Computer Aided Verification (CAV'12); Berkeley, CA — July 2012

Polynomial Amortized Resource Analysis
DFG PUMA site visit; Munich, Germany — June 2012
Dissertation defense at LMU; Munich, Germany — October 2011

Higher-Order Functional Reactive Programming in Bounded Space
PUMA Workshop; Traunkirchen, Austria — October 2011

Multivariate Amortized Resource Analysis
Université Paris 7 - Denis Diderot; Paris, France — September 2011
UPENN; Philadelphia, PA — June 2011
Yale University; New Haven, CT — June 2011
IST Austria; Vienna, Austria — June 2011
Microsoft Research; Cambridge, UK — March 2011
Symposium on Principles of Programming Languages (POPL'11); Austin, TX — January 2011
PUMA Workshop; Szentendre, Hungary — October 2010

Amortized Resource Analysis with Polymorphic Recursion and Partial Big-Step Op. Sem.
Asian Symposium on Programming Languages (APLAS'10); Shanghai, China — November 2010

Analysing Sorting Algorithms in Resource Aware ML
University of Kassel; Kassel, Germany — November 2010

Automatic Amortized Resource Analysis
National DFG GK Workshop; Dagstuhl, Germany — June 2010

Amortized Resource Analysis with Polynomial Potential
European Symposium on Programming (ESOP'10); Cyprus — March 2010
PUMA Workshop; Venice, Italy — October 2009

A Purely-Functional SAT Solver
PUMA Kickoff Meeting; Spitzingsee, Germany — October 2008

DLL-Algorithms and Resolution Proofs
Fall School: Logic and Complexity; Prague, Czech Republic — September 2008

Languages

German: Native
English: Fluent
French: Elementary

References

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