Richard A. Eisenberg

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Research Interests

Programming languages, functional programming, dependent type theory, proof-carrying code, generic programming. I want to make programs correct and elegant by construction.

Appointments

2016 – present: Assistant Professor, Bryn Mawr College

Education

Sep 2016: PhD, University of Pennsylvania, Philadelphia, PA
Dissertation: *Dependent Types in Haskell: Theory and Practice*
Advisor: Stephanie Weirich

Harvard University, Cambridge, MA
June 2003: M.S., Computer Science
June 2003: B.A., Physics, *magna cum laude* with highest honors

Publications

ICFP'19 (conditional acceptance): S. Weirich, P. Choudhoary, A. Voizard, R. A. Eisenberg. *A Role for Dependent Types in Haskell*. In *Proceedings of the ACM on Programming Languages,* Vol. 3, Issue ICFP (ICFP '19), ACM, 2019.

Haskell'18 (acceptance rate: 43%): R. A. Eisenberg, J. Breitner, and S. Peyton Jones. *Type Variables in Patterns*. In *Proceedings of the 2018 ACM SIGPLAN Symposium on Haskell* (Haskell '18), ACM, 2018, pp. 94-105.

Haskell'18 (43%): D. Otwani and R. A. Eisenberg. *The Thoralf Plugin: For Your Fancy Type Needs*. In *Proceedings of the 2018 ACM SIGPLAN Symposium on Haskell* (Haskell '18), ACM, 2018, pp. 106-118.

ICFP'17 (35%): J. G. Morris and R. A. Eisenberg. *Constrained Type Families*. In *Proceedings of the ACM on Programming Languages,* Vol. 1, Issue ICFP (ICFP '17), ACM, 2017. Article 42, 28 pages.

ICFP'17 (35%): S. Weirich, A. Voizard, P. H. Azevedo de Amorim, R. A. Eisenberg. *A Specification for Dependently-Typed Haskell*. In *Proceedings of the 22nd ACM SIGPLAN International Conference on Functional Programming* (ICFP '17), ACM, 2017. Article 31, 29 pages.

PLDI'17 (14%): R. A. Eisenberg, S. Peyton Jones. *Levity Polymorphism*. In *Proceedings of the 2017 ACM SIGPLAN Conference on Programming Language Design and Implementation* (PLDI '17). ACM, 2017. pp. 525-539.

Haskell'16: M. Pickering, G. Érdi, S. Peyton Jones, R. A. Eisenberg. *Pattern Synonyms*. In *Proceedings of the 2016 ACM SIGPLAN Symposium on Haskell* (Haskell '16), ACM, 2016. pp. 80-91.

JFP'16: J. Breitner, R. A. Eisenberg, S. Peyton Jones, S. Weirich. *Safe Zero-cost Coercions for Haskell*. In *Journal of Functional Programming*, Vol. 26. Cambridge University Press, 2016. 79 pages.

ESOP'16 (33%): R. A. Eisenberg, S. Weirich, H. Ahmed. *Visible Type Application*. In *Programming Languages and Systems*: *25th European Symposium on Programming* (ESOP '16). LNCS 9632, Springer, 2016. pp. 229-254.

Wadlerfest '16 S. Peyton Jones, S. Weirich, R. A. Eisenberg, D. Vytiniotis. *A reflection on types*. In *A List of Successes that Can Change the World*, a festschrift in honor of Phil Wadler. LNCS 9600, Springer, 2016. pp. 292-317

Haskell'15 (39%) J. Stolarek, S. Peyton Jones, R. A. Eisenberg. *Injective Type Families for Haskell*. In *Proceedings of the 2015 ACM SIGPLAN Symposium on Haskell* (Haskell '15), ACM, 2015. pp. 118-128.

Haskell'14 (43%) T. Muranushi, R. A. Eisenberg. *Experience Report: Type-checking Polymorphic Units for Astrophysics Research in Haskell*. In *Proceedings of the 2014 ACM SIGPLAN Symposium on Haskell* (Haskell '14), ACM, 2014. pp. 31-38.

Haskell'14 (43%) R. A. Eisenberg, J. Stolarek. *Promoting Functions to Type Families in Haskell*. In *Proceedings of the 2014 ACM SIGPLAN Symposium on Haskell* (Haskell '14), ACM, 2014. pp. 95-106.

ICFP'14 (33%) J. Breitner, R. A. Eisenberg, S. Peyton Jones, S. Weirich. *Safe Zero-cost Coercions for Haskell*. In *Proceedings of the 19th ACM SIGPLAN International Conference on Functional Programming* (ICFP '14), ACM, 2014. pp. 189-202.

POPL'14 (23%) R. A. Eisenberg, D. Vytiniotis, S. Peyton Jones, S. Weirich. *Closed Type Families with Overlapping Equations*. In *Proceedings of the 41st ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages* (POPL '14), ACM, 2014. pp. 671-683.

OOPSLA'13 (26%) C. DeLozier, R. A. Eisenberg, S. Nagarakatte, P.-M. Osera, M. M. K. Martin, and S. Zdancewic. *Ironclad C++: A Library-Augmented Type-Safe Subset of C++*. In *Proceedings of the 2013 ACM SIGPLAN International Conference on Object Oriented Programming, Systems, Languages, & Applications* (OOPSLA '13), ACM, 2013. pp. 287-304.

ICFP'13 (30%) S. Weirich, J. Hsu, and R. A. Eisenberg. *System FC with Explicit Kind Equality*. In *Proceedings of the 18th ACM SIGPLAN International Conference on Functional Programming* (ICFP '13), ACM, 2013. pp. 275-286.

Haskell'12 (41%) R. A. Eisenberg and S. Weirich. *Dependently Typed Programming with Singletons*. In *Proceedings of the 2012 Haskell Symposium* (Haskell '12), ACM, 2012. pp. 117-130.

Technical Reports

2017 R. A. Eisenberg and S. Peyton Jones. *Levity Polymorphism (extended version)*. Bryn Mawr Technical Report MS-1079, 2017.

2015 R. A. Eisenberg. *System FC, as implemented in GHC*. University of Pennsylvania Technical Report MS-CIS-15-09, 2015.

2015 R. A. Eisenberg. *An Overabundance of Equality: Implementing Kind Equalities into Haskell*. University of Pennsylvania Technical Report MS-CIS-15-10, 2015.

2015 J. Stolarek, S. Peyton Jones, R. A. Eisenberg. *Injective Type Families for Haskell (extended version)*. Politechnika Łódzka Technical Report, 2015.

2014 R. A. Eisenberg, J. Stolarek. *Promoting Functions to Type Families in Haskell (extended version)*. University of Pennsylvania Technical Report MS-CIS-14-09, 2014.

2014 J. Breitner, R. A. Eisenberg, S. Peyton Jones, S. Weirich. *Safe Zero-cost Coercions for Haskell (extended version)*. University of Pennsylvania Technical Report MS-CIS-14-07, 2014.

2013 R. A. Eisenberg, D. Vytiniotis, S. Peyton Jones, S. Weirich. *Closed Type Families with Overlapping Equations (extended version)*. University of Pennsylvania Technical Report MS-CIS-13-10, 2013.

2013 P.-M. Osera, R. A. Eisenberg, C. DeLozier, S. Nagarakatte, M. M. K. Martin, S. Zdancewic. *Core Ironclad*. University of Pennsylvania Technical Report MS-CIS-13-06, 2013.

2013 S. Weirich, J. Hsu, R. A. Eisenberg. *System FC with Explicit Kind Equality (extended version)*, University of Pennsylvania Technical Report MS-CIS-15-11, 2013.

Research-related open-source contributions

GHC core developer

Core developer for the Glasgow Haskell Compiler (GHC), the main compiler for the Haskell functional programming language. Principal contributions:

- Levity polymorphism, based on *Levity Polymorphism* (PLDI'17)
- Kind equalities, based on *Kind Equalities* (ICFP'13)
- Visible type application, based on *Visible Type Applications* (ESOP'16)
- New solver for type equality, based on *Safe Zero-cost Coercions* (JFP'16)
- Roles, based on *Safe Zero-cost Coercions* (ICFP'14)
- Closed type families, based on *Closed Type Families* (POPL'14)

Haskell packages

The *singletons* package, described in the Haskell'12 and Haskell'14 papers.

The *units* package, described in the Haskell'14 experience report.

Presentations

May 2019 *Generalized Newtype Compiling: Don't let you types slow you down*. IFIP Working Group 2.0, Bordeaux, France

Sep 2018 *Type Variables in Patterns*. Haskell Symp., St. Louis, MO, USA

Sep 2017 *Constrained Type Families*. ICFP, Oxford, UK

Jun 2017 *Levity Polymorphism*. PLDI, Barcelona, Spain

Sep 2016 *A Dependent Haskell Triptych*. Haskell Implementors' Workshop, Nara, Japan

Apr 2016 *Visible Type Application*. European Symposium on Programming, Eindhoven, Netherlands

Aug 2015 *Levity Polymorphism in Dependent Haskell*. Haskell Implementors' Workshop, Vancouver, Canada

Sep 2014 *Dependent Haskell*. Haskell Implementors' Workshop, Gothenburg, Sweden

Sep 2014 *Safe Zero-cost Coercions for Haskell*. ICFP, Gothenburg, Sweden

Jan 2014 *Closed Type Families with Overlapping Equations*. POPL, San Diego, CA, USA

Sep 2013 *System FC with Explicit Kind Equality*. ICFP, Boston, MA, USA

Sep 2013 *GeneralizedNewtypeDeriving is now Type-safe: How Roles Save the Day*. Haskell Implementors' Workshop, Boston, MA, USA

Sep 2012 *Dependently Typed Programming with Singletons*. Haskell Symp., Copenhagen, Denmark

Funding

2017 *SHF: MEDIUM: Collaborative Research: The Theory and Practice of Dependent Types in Haskell*. R. A. Eisenberg and S. Weirich (PIs). NSF 1704041, $949,964, 7/2017-7/2021.

Honors and Awards

2017 Morris and Dorothy Rubinoff Award, U. of Penn.
Awarded to a doctoral candidate whose dissertation may lead to innovative applications of computer technology

2016 Penn Prize for Excellence in Teaching by Graduate Students, U. of Penn.

One of 10 graduate students across the university recognized for our teaching, nominated by undergraduates

2014-16 Graduate Student Fellowship, Microsoft Research
One of 12 doctoral students chosen among candidates from U.S. and Canada.

2013-14 Fellowship for Teaching Excellence, U. of Penn. Center for Teaching and Learning
Nominated & selected as the graduate student departmental advocate for teaching.

2011-12 John Henry Towne Fellowship, U. of Penn. School of Engineering & Applied Science
Awarded to exceptionally qualified first-year doctoral students.

2002, 2003 John Harvard Scholarship
Awarded to undergraduates in the top 5% of their class

2001 Harvard College Scholarship
Awarded to undergraduates in the top 10% of their class

Professional Experience

Dec 2015 – Mar 2016 Consultant, Awake Networks, Mountain View, CA. My task is to help design an efficient domain-specific language embedded in Haskell to be used in a networking security product.

Summer '13 Research Intern, Microsoft Research, Cambridge, UK. Mentored by Simon Peyton Jones.

Summer '02 Software Design Engineer Intern, Microsoft, Redmond, WA

Summer '01 Software Engineer Intern, Actuality Systems, Inc., Reading, MA

Research Advising

Undergrad thesis advisor

E. Feng. *Verification of Dijkstra's Algorithm in Idris*. Bryn Mawr College, 2019.

S. Depew. *Visualizing Algorithms with Android.* Bryn Mawr College, 2019.

K. J.-C. Liao. *I Am The Senate: Introducing* Palpatine*, a Vote Counter for Australian Senate Ballots written in Idris with Verification of Totality and Cardinality*. Haverford College, 2018.

R. Xu. *Comparison Between Program Verification Techniques in Dependent Haskell and Liquid Haskell*. Bryn Mawr College, 2018.

X. Zhang. *A Tale of Two Provers: A Comparison of Dependent Haskell and F**. Bryn Mawr College, 2018.

J. Henck. *A Supercompiler for an Object-Oriented Language.* Bryn Mawr College, 2017.

Undergrad Ind. Study advisor

M. Nguyen. *Types and Programming Languages / Type System Implementation*. Fall 2018.

M. Yacavone. *Cubical Type Theories*. Fall 2018.

E. Feng. *Verifying Functional Algorithms in Idris*. Fall 2018.

D. Otwani. *Type-Level Finite Maps*. Fall 2017 – Spring 2018.

R. Xu and X. Zhang. *Verification Languages*. Fall 2017.

R. Xu and X. Zhang. *Types and Programming Languages*. Spring 2017.

M. Yacavone. Ind. Study: *Homotopy Type Theory in Coq*. Spring 2017.

Summer science research advisor

M. Nguyen. *Visible Kind Application*. Summer 2018.

N. Adnane. *Improving GHC Error Messages*. Summer 2018.

E. Feng and P. Thiel. *Merging Term and Type Parsers*. Summer 2018.

M. Yacavone. *Explicit Variable Quantification*. Summer 2018.

Teaching

Higher Education

Instructor, Bryn Mawr College
- CMSC 110: Introduction to Computing (27 undergrads), fall 2016
- CMSC 113: Computer Science I (avg. 26 undergrads), fall 2017, spring 2018
- CMSC 206: Introduction to Data Structures (26 undergrads), spring 2018
- CMSC 231: Discrete Mathematics (21 undergrads), fall 2017
- CMSC 245: Principles of Programming Languages (avg. 25 undergrads), fall 2018 (x2)
- CMSC 246: Programming Paradigms (32 undergrads), spring 2017
- CMSC 350: Compiler Design (16 undergrads), spring 2019
- CMSC 380: Modern Functional Programming (24 undergrads), spring 2017
- CMSC 399: Senior Conference (11 seniors), spring 2019

Instructor, U. of Penn.
- CIS194: Haskell Programming (12 students, mostly undergrad), fall 2014
- CIS190: C++ Programming (19 students, mostly undergrad), fall 2012

Head TA
- CS50: Introduction to Computer Science (~100 undergrads), fall 2002, Harvard U.

TA
- CIS552: Advanced Programming (~40 students, grad & undergrad), fall 2013, U. of Penn.
- CIS120: Programming Languages & Techniques (~100 undergrads), spring 2013, U. of Penn.
- CS50: Introduction to Computer Science (~200 undergrads), fall 2001, Harvard U.
- CS50: Introduction to Computer Science (~300 undergrads), fall 2000, Harvard U.

High school

2008-11 The American School in London, London, UK
The American School in London is a private, co-educational K-12 school with an American curriculum.

Taught computer science and math, including AP Computer Science in Java

Mentored high-school and middle-school FIRST robotics teams

Created new Digital Electronics course from scratch, including outfitting the lab

2003-08 Northfield Mount Hermon School, Mount Hermon, MA
Northfield Mount Hermon is a private, co-educational boarding high school.

Taught computer science and math, including AP Computer Science in Java

Dorm parent (3 years) and director (2 years), overseeing 40 students. Received the Parents Council Award for Excellence in Residential Life (2005).

Professional Activities

- Aug 2019 Program Committee chair: Haskell Symposium
- Aug 2019 External Review Committee member: Int'l Conference on Functional Programming (ICFP)
- Jun 2019 Invited Speaker: ZuriHac, Zurich, Switzerland.
- May 2019 Invited guest/speaker: IFIP Working Group 2.8, Bordeaux, France
- Sep 2018 Program Committee co-chair: Workshop on Type-Directed Development (TyDe)
- Sep 2018 Distinguished Papers Committee member: ICFP
- Sep 2018 External Review Committee member: ICFP
- Sep 2018 Program Committee member: Implementation of Functional Languages (IFL)

Apr 2018 Invited Speaker: *Stitch: The Sound Type-Indexed Type Checker,* New York City Haskell Users' Group, NY

Sep 2017 Invited Panelist: *Careers in Programming Languages*, Prog. Lang. Mentoring Workshop

Sep 2017 Program Chair: Haskell Implementors' Workshop

May 2017 Organizer: GHC implementation workshop, a 2-week gathering of compiler writers

Jan 2017 - present Member: GHC Steering Committee, for reviewing proposals for updates to GHC

Sep 2016 Program Committee member: Haskell Symposium

Sep 2016 Program Committee member: TyDe

Mar 2016 Invited participant: Dagstuhl Seminar *Language Based Verification Tools for Functional Programs,* Wadern, Germany

Nov 2015 - present Member: Haskell Prime Committee, for updating the standard for the Haskell language

Nov 2015, Oct 2014 Organizer: Hac Phi, a yearly weekend-long Haskell exchange, Philadelphia, PA

Oct 2015 Awardee: Center for Teaching & Learning Teaching Certificate, U. of Penn.
Earning this certificate requires participation in ongoing conversations about teaching and participating in a teaching observation & reflection.

Aug 2015 Program Committee member: Haskell Implementors' Workshop, Vancouver, Canada

May 2015 Invited speaker: *A Practical Introduction to Haskell GADTs,* LambdaConf, Boulder, CO

Oct 2014 Invited speaker: *Dependent Types for Haskell*. New York City Haskell Users' Group, NY

Outreach

Summer 2018 Google Summer of Code mentor, supervising the start of implementation of a dependently-typed core language in GHC, performed by Ningning Xie of the University of Hong Kong

Aug 2015 Organized and ran *Stencyl Boot Camp*, an introduction to programming for middle- and high-school students, West Tisbury, MA

Apr 2014 Led workshop to high school students on introduction to programming with Scratch for Women in Computer Science Day, U. of Penn.

Nov 2013 Presented introduction to Haskell at the Charter School of Wilmington, Wilmington, DE

Feb 2013 Consulted with educators at Merion Mercy Academy, a Catholic girls' high school, about starting a computer science program, Merion Station, PA

Feb 2013 Volunteered as Pit Coordinator at FIRST LEGO League regional championship, Philadelphia, PA