Emily Riehl

Contact Information

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Research Interests

Topics in category theory related to homotopy theory: e.g., quasi-categories, ∞-categories, (∞, n)-categories, model categories, weak factorization systems, the small object argument, homotopy type theory, simplicial categories, simplicial sets, derived functors, functor calculus, Reedy categories, and multivariable adjunctions and mates.

Academic Appointments

Johns Hopkins University, Baltimore, MD

Assistant Professor, July 2015–present

Harvard University, Cambridge, MA

Benjamin Peirce Postdoctoral Fellow and NSF Postdoctoral Fellow, July 2011–June 2015

Visiting Positions

Max Planck Institute for Mathematics, Bonn, Germany

"Higher structures in Geometry and Physics" Trimester Program participant, January 2016

Hausdorff Research Institute for Mathematics, Bonn, Germany

"Homotopy theory, manifolds, and field theories" Trimester Program participant, May–June 2015

Mathematical Sciences Research Institute, Berkeley, CA

Research Member, January–May 2014

Education

University of Chicago, Chicago, IL

Ph.D. in Mathematics, June 2011; M.A. in Mathematics, June 2009

- Thesis: "Algebraic model structures" advised by J. Peter May.

University of Cambridge, Churchill College, Cambridge, UK

Certificate of Advanced Study in Mathematics (Part III) with Distinction, June 2007

- Essay: "Higher category theory" advised by Martin Hyland.

Harvard University, Cambridge, MA

A.B. Mathematics, *magna cum laude*, June 2006

- Thesis: "Lubin-Tate formal groups and local class field theory" advised by Frank Calegari.

Awards

Simons Visiting Professorship, 2016

Principal Investigator, "Reimagining the Foundations of Infinite Dimensional Category Theory," National Science Foundation Grant DMS-1551129, 2015–2018

Harvard University Certificate of Teaching Excellence, 2014, 2015

AMS-Simons Travel Grant, 2014

National Science Foundation Mathematical Sciences Postdoctoral Research Fellowship, 2011–2014

National Science Foundation Graduate Research Fellowship, 2006–2011

Churchill Scholarship, The Winston Churchill Foundation of the United States, 2006

Barry M. Goldwater Scholarship, 2005

Harvard University Certificate of Distinction in Teaching, 2004, 2005, 2006

3rd Place in Intel Science Talent Search, 2002

Books

Category Theory in Context, Aurora: Modern Math Originals, Dover Publications, 2016, xvii+240 pp. also available from www.math.jhu.edu/∼eriehl/context.pdf

Categorical Homotopy Theory, New Mathematical Monographs, 24. Cambridge University Press, 2014, xviii+352 pp. also available from www.math.jhu.edu/∼eriehl/cathtpy.pdf

Publications

Kan extensions and the calculus of modules for ∞-categories, with D. Verity, to appear in *Algebr. Geom. Topol.* (2016), 1-84, arXiv:1507.01460

Fibrations and Yoneda's lemma in an ∞-cosmos, with D. Verity, *J. Pure Appl. Algebra* **221(3)** (2017) 499–564, arXiv:1506.05500

The Kan Extension Seminar: An Experimental Online Graduate Reading Course, *Notices Amer. Math. Soc.* **61** (2014), no. 11, 1357–1358.

Coalgebraic models for combinatorial model categories, with M. Ching, *Homol. Homotopy Appl.* **16** (2014), no. 2, 171–184. arXiv:1403.5303

Completeness results for quasi-categories of algebras, homotopy limits, and related general constructions, with D. Verity, *Homol. Homotopy Appl.* **17** (2015), no. 1, 1–33. arXiv:1401.6247

Left-induced model structures and diagram categories, with M. Bayeh, K. Hess, V. Karpova, M. Kedziorek, and B. Shipley, *Contemp. Math.* **641** (2015), 49–81. arXiv:1401.3651

Homotopy coherent adjunctions and the formal theory of monads, with D. Verity, *Adv. Math* **286** (2016), 802–888. arXiv:1310.8279

Six model structures for DG-modules over DGAs: model category theory in homological action, with T. Barthel and J.P. May, *New York J. Math* **20** (2014), 1077-1159. arXiv:1310.1159

The 2-category theory of quasi-categories, with D. Verity, *Adv. Math.* **280** (2015), 549–642. arXiv:1306.5144

The theory and practice of Reedy categories, with D. Verity, *Theory Appl. Categ.* **29** (2014), no. 9 (2014), 256–301. arXiv:1304.6871

Cyclic multicategories, multivariable adjunctions and mates, with E. Cheng and N. Gurski, *J. K-theory* **13** (2014), no. 2, 337–396. arXiv:1208.4520

Homotopical resolutions associated to deformable adjunctions, with A.J. Blumberg, *Algebr. Geom. Topol.* **14** (2014), no. 5, 3021-3048. arXiv:1208.2844

On the construction of functorial factorizations for model categories," with T. Barthel, *Algebr. Geom. Topol.* **13** (2013), no. 2, 1089–1124. arXiv:1204.5427

Bohmann, A.M., A comparison of norm maps, with an appendix by A.M. Bohmann and E. Riehl, *Proc. Amer. Math. Soc.* **142** (2014), no. 4, 1413–1423. arXiv:1201.6277

Monoidal algebraic model structures, *J. Pure Appl. Algebra* **217** (2013), no. 6, 1069–1104. arXiv:-1109.2883

Levels in the toposes of simplicial sets and cubical sets, with C. Kennett, M. Roy, M. Zaks, *J. Pure and Appl. Algebra* **215** (2011), no. 5, 949–961. arXiv:1003.5944

On the structure of simplicial categories associated to quasi-categories, *Math. Proc. Camb. Phil. Soc.* **150** (2011), no.3., 489–504. arXiv:0912.4809

Algebraic model structures, *New York J. Math.* **17** (2011), 173–231. arXiv:0910.2733

A Sharp Bound for the Degree of Proper Monomial Mappings Between Balls, with J. D'Angelo, S. Kos, *J. Geom. Anal.* **13** (2003), no. 4, 581–593.

On the intersections of polynomials and the Cayley-Bacharach theorem, with E. Graham Evans, Jr., *J. Pure and Appl. Algebra* **183** (2003), no. 1–3, 293–298.

Preprints

Complicial sets, an overture, (2016), 1–24, arXiv:1610.06801

Directional derivatives and higher order chain rules for abelian functor calculus, with K. Bauer, B. Johnson, C. Osborne, and A. Tebbe, (2016), 1–46, arXiv:1610.01930

∞-category theory from scratch, with D. Verity, (2015), 1–53, arXiv:1608.05314

A necessary and sufficient condition for induced model structures, with K. Hess, M. Kedziorek, and B. Shipley, (2015), 1–49, arXiv:1509.08154

Teaching

Johns Hopkins University, Baltimore, MD

Instructor in Mathematics, 2015–present

- *Category Theory in Context* — a graduate-level topics course
- *Algebraic Topology II* — a graduate-level course
- *Calculus III* — and undergraduate-level course

Masters Thesis Advisor, 2016–present

- Lyne Moser "Derivators and basic localizers"

Harvard University, Cambridge, MA

Instructor in Mathematics, 2012–2015

- *Categorical Homotopy Theory* — a graduate-level topics course
- *Topology I* — an undergraduate-level course (twice)
- *Fun and Games with Discrete Mathematics* — a one-week "Wintersession" course
- *Introduction to Mathematical Logic* — an undergraduate-level course
- *Category Theory in Context* — an undergraduate-level topics course

Faculty Supervisor in Mathematics, 2012–2015

- Undergraduate senior thesis project by Marina Lehner "All Concepts are Kan Extensions"
- Undergraduate reading courses in category theory, simplicial homotopy theory, quasi-category theory, higher category theory, and topos theory.

Teaching Fellow in Mathematics, 2011

- *Multivariable Calculus*

University of Chicago, Chicago, IL

Directed Reading Program, mentor for undergraduates, 2008–2010

- Projects involving category theory and knot theory

Research Experience for Undergraduates, mentor, 2008–2010

- Projects involving topics in algebraic topology, category theory, and number theory

College Fellow in Mathematics, 2008–2009

- *Elementary Number Theory*, mentor: J. Boller
- *Basic Geometry*, mentor: D. Hermann
- *Introduction to Algebraic Topology*, mentor: T. Fiore

Invited Presentations

Topology of manifolds: a conference in honour of Michael Weiss' 60th birthday, "Homology without

simplices," University of Lisbon, June 2016.

Johns Hopkins Applied Physics Laboratory Colloquium, "A solution to the stable marriage problem," June 2016.

Higher Structures in Geometry and Physics Workshop, Invited lecture series, "Weak complicial sets," MATRIX, Melbourne, June 2016.

Homotopy Type Theory and Univalent Foundations Workshop, "Towards a synthetic theory of $(\infty, 1)$-categories," Fields Institute, Toronto, May 2016.

Midwest Topology Seminar, Ohio State University, "Model-independent ∞-category theory in the homotopy 2-category," May 2016.

Rochester Topology Seminar, "Model-independent ∞-category theory in the homotopy 2-category," April 2016.

CMU Homotopy Type Theory Seminar, "Towards a synthetic theory of $(\infty,1)$-categories," April 2016.

Higher structures in Geometry and Physics Opening Conference, Max Planck Institute for Mathematics, Bonn, "On model-comparison results for ∞-categories," January 2016.

Workshop on category theory and algebraic topology, Université catholique de Louvain, "Model-independent ∞-category theory in the homotopy 2-category," September 2015.

Young Topologists Meeting, EPFL Lausanne, Invited lecture series, "∞-category theory from scratch," July 2015.

MIT Topology Seminar, "The formal category theory of (∞, n)-categories," March 2015.

Texas Undergraduate Topology and Geometry Conference, UT Austin, "Self-similiar spaces," February 2015.

Indiana University Colloquium, "On the duality between 'free' and 'forgetful' constructions," January 2015.

University of Virginia Colloquium, "On the duality between 'free' and 'forgetful' constructions," January 2015.

Notre Dame Colloquium, "On the duality between 'free' and 'forgetful' constructions," January 2015.

UCLA Colloquium, "On the duality between 'free' and 'forgetful' constructions," January 2015.

Indiana University Topology Seminar, "The formal category theory of $(\infty, 1)$-categories," December 2014.

University of Illinois at Urbana-Champaign Topology Seminar, "The formal category theory of $(\infty, 1)$-categories," December 2014.

Georgia Tech Geometry and Topology Seminar, "On the duality between 'free' and 'forgetful' constructions," December 2014.

Johns Hopkins University Colloquium, "On the duality between 'free' and 'forgetful' constructions," December 2014.

Boston College Colloquium, "On the duality between 'free' and 'forgetful' constructions," November 2014.

Cornell University Oliver Club Colloquium, "On the duality between 'free' and 'forgetful' constructions," November 2014.

Johns Hopkins University Topology Seminar, "Toward the formal theory of higher homotopical categories," October 2014.

Topologie workshop, Mathematisches Forschungsinstitut Oberwolfach, "Toward the formal theory of

(∞, n)-categories," September 2014.

Institute for Basic Science, Center for Geometry and Physics, Pohang, Korea, "A universal approach to universal algebra," August 2014.

Days of the Federation de Recherche en Mathématiques de Paris Centre, Institute Henri Poincaré, "The formal theory of adjunctions, monads, algebras, and descent," June 2014.

Reimagining the Foundations of Algebraic Topology, MSRI, "The formal theory of adjunctions, monads, algebras, and descent," April 2014.

Graduate Student Topology and Geometry Conference, Young Faculty Speaker, "Quasi-category theory you can use," University of Texas at Austin, April 2014.

University of Western Ontario Geometry and Topology Seminar, "Homotopy coherent adjunctions, monads, and algebras," March 2014.

Committee of Academic Sponsors Postdoc Talk, MSRI, "Categorical definitions in algebraic topology," February 2014.

AMS Special Session on Homotopy Theory, "Homotopy coherent adjunctions," January 2014.

MIT Topology Seminar, "Cell complex presentations for (generalized) Reedy categories," November 2013.

Wesleyan University Colloquium, "Homotopy coherent adjunctions," November 2013.

Wesleyan University Topology Seminar, "Algebraic model categories," November 2013.

University of Chicago Topology Seminar, "Algebraic perspectives on (generalized) Reedy categories," October 2013.

Northwestern Topology Seminar, "Algebraic perspectives on (generalized) Reedy categories," September 2013.

Conference on Type Theory, Homotopy Theory, and Univalent Foundations, Centre de Recerca Mathemàtica, "Made-to-order weak factorization systems," September 2013.

Algebra/Geometry/Topology Seminar, University of Melbourne, "Homotopy coherent adjunctions and the formal category theory of quasi-categories," July 2013.

International Category Theory Conference, "The formal theory of homotopy coherent monads," July 2013.

Special Session on Progress in Higher Categories, CMS Summer Meeting, Halifax, "The formal category theory of quasi-categories," June 2013.

Informal Dynamics and Geometry Seminar, PechaKucha: Mathematics 20x20, Harvard University, "A solution to the stable marriage problem," March 2013.

Stanford University Topology Seminar, "Homotopy coherent adjunctions and the formal category theory of quasi-categories," December 2012.

MIT Topology Seminar, "The formal category theory of quasi-categories," November 2012.

Wayne State University Topology Seminar, "Homotopy coherent adjunctions of quasi-categories," November 2012.

University of Virginia Topology Seminar, "Homotopy coherent adjunctions of quasi-categories," November 2012.

Workshop on Higher Dimensional Algebra, Categories and Types, University of Ljubljana, "Homotopy coherent adjunctions of ∞-categories," June 2012.

Friends of Mathematics Junior Faculty Lecture, "The algebra and geometry of ∞-categories," May 2012.

Midwest Topology Seminar, Northwestern University, "Lifting properties and the small object argu-

ment," March 2012.

MIT Topology Seminar, "Algebraic model structures and cellularity," December 2011.

Special Session on Homotopy Theory and Its Applications, Association for Women in Mathematics 40th Anniversary Conference, "Algebraic model structures," September 2011.

Special Session on Homotopy and Categories, CMS Summer Meeting, Edmonton, "Algebraic model structures," June 2011.

University of Sheffield, Invited seminar series, "Algebraic model structures and cellularity," April 11-14, 2011.

University of Illinois at Urbana-Champaign Topology Seminar, "Algebraic model structures," October 2010.

Friends of Mathematics Lecture and Honoraria, "Lubin-Tate formal groups and local class field theory," Harvard University, April 2006.

University of Illinois at Urbana-Champaign, "On the properties of Tits graphs," August 2002.

Contributed Presentations

International Category Theory Conference, Halifax, "Higher order chain rules for abelian functor calculus," August 2016.

98th Peripatetic Seminar on Sheaves and Logic, Doorn, the Netherlands, "A model-independent calculus of pointwise Kan extensions for ∞-categories," January 2016.

International Category Theory Conference, "Virtual equipments for ∞-categories," July 2015.

MSRI Postdoc Seminar, "Toward a formal theory of adjunctions, monads, and descent," March 2014.

MSRI Connections for Women: Algebraic Topology, "Limits of quasi-categories with (co)limits," January 2014.

Samuel Eilenberg Centenary Conference, "The formal theory of homotopy coherent monads," July 2013.

Basic Notions Seminar, Harvard University, "Weighted limits and colimits," November 2012.

Category Theory OctoberFest, Centre de Recherche en Théorie des Catégories, Montreal, "Parametrized mates," October 2012.

Northwestern Topology Seminar, "Homotopy coherent adjunctions," August 2012.

International Category Theory Conference, "Cellularity, composition, and morphisms of algebraic weak factorization systems," July 2011.

International Category Theory Conference, "Algebraic model structures," June 2010.

New York City Category Theory Seminar, City University of New York Graduate Center, "Natural weak factorization systems in model structures," May 2010.

The Third Morgan-Phoa Mathematics Workshop, Australian National University, Canberra, "An advertisement for natural weak factorization systems in model structures," January 2010.

Additional talks in the Australian Category Seminar, University of Chicago Topology and Category Theory Proseminar, University of Chicago Pizza Seminar, Cambridge Part III Seminars, and Harvard Math Table.

Selected Service

Co-Organizer of the Mid-Atlantic Topology Conference and Co-PI for the associated NSF grant DMS-1619569, 2016. **Co-Organizer** of the Mathematics Research Community on Homotopy Type Theory, 2017. **Member** Scientific Committee for the International Category Theory Conference, 2016.

Organizer of the Kan Extension Seminar, an online graduate reading course in category theory, 2014,

2017. **Co-Host** of the n-Category Café, 2013-present.

Member of NSF review panels for the Division of Mathematical Sciences; **Member** of the Churchill Scholarship Screening Committee, 2014; **Member** of the AMS Web Editorial Group, 2015–2019 (chair 2017); **Member** of the AMS Mathematics Research Communities Advisory Board, 2017–2020; **Member** of the Scientific Committee for the International Category Theory conference, 2016.

Editor for Homology, Homotopy, and Applications (2015-present) and Cahiers de Topologie et Géométrie Différentielle Catégoriques (2014-present). **Referee** for Advances in Mathematics, Algebraic and Geometric Topology, American Mathematical Monthly, Annals of Mathematics, Applied Categorical Structures, Forum Mathematicum, Geometry and Topology, Journal of Pure and Applied Algebra, Mathematical Structures in Computer Science, New York Journal of Mathematics, Theory and Applications of Categories, and Transactions of the AMS; **Reviewer** for MathSciNet and Zentralblatt.

Member of the Qualifying Exams Committee 2011, the Colloquium Committee 2012, and the Graduate Admissions Committee 2015; Junior **Advisor** 2012-2013; Undergraduate Thesis **Supervisor** 2013-2014; **Assistant Director of Graduate Studies** 2014-2015 at Harvard. **Diversity Champion** for the mathematics department at Johns Hopkins 2015-present.

Prime Time Lecture at Hampshire College Summer Studies in Mathematics, 2005; **Instructor** and **Course Developer** in mathematics for Reach Cambridge, 2007; **Keynote speaker** at the Expanding Your Horizons Conference in Normal, IL, 2009; **Presenter** at Girls' Angle, the Boston Math Circle, and the Berkeley Math Circle, 2013-2014; **YouTube lectures** for Girls' Angle (2012) and Numberphile (2014).