

# Brandon Shapiro

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## Research Interests

Higher categories, applied category theory, combinatorial homotopy theory, algebraic K-theory.

I am especially interested in polynomial functors as a formalism for open dynamics, higher category structures with arbitrary cell shapes, characterizing presheaf models of  $(\infty, n)$ -categories, the  $K$ -theory of finite sets, and computational properties of algebraic structures.

## Employment

2022-2023 **Research Associate**, *Topos Institute*.  
Research the theory of polynomial functors with David Spivak.

## Education

2017-2022 **PhD Student in Mathematics**, *Cornell University*, Advisor: Inna Zakharevich.  
2019 **Master of Science in Computer Science**, *Cornell University*.  
2017 **Bachelor of Arts with Highest Honors in Mathematics**, *Brandeis University*.  
2017 **Bachelor of Science in Computer Science**, *Brandeis University*.  
2017 **Bachelor of Arts in Physics**, *Brandeis University*.  
2016 **Brandeis India Science Scholars Program**, *Indian Institute of Science*.

## Papers

- 2021 **Duoidal Structures for Compositional Dependence**. *Submitted for publication*. With David Spivak. [[arXiv:2210.01962](https://arxiv.org/abs/2210.01962)]
- 2021 **Dynamic Operads, Dynamic Categories: From Deep Learning to Prediction Markets**. *Applied Category Theory*, 2022 (Accepted). With David Spivak. [[arXiv:2205.03906](https://arxiv.org/abs/2205.03906)]
- 2022 **A Shape Independent Theory of Enrichment**. *Preprint*. [[arXiv:2205.12235](https://arxiv.org/abs/2205.12235)]
- 2021 **Familial Monads as Higher Category Theories**. *Preprint*. [[arXiv:2111.14796](https://arxiv.org/abs/2111.14796)]
- 2021 **A Gillet-Waldhausen Theorem for Chain Complexes of Sets**. *Preprint*. With Maru Sarazola. [[arXiv:2107.07701](https://arxiv.org/abs/2107.07701)]
- 2021 **Partial Evaluations and the Compositional Structure of the Bar Construction**. *Submitted for publication*. With Carmen Constantin, Tobias Fritz, and Paolo Perrone. [[arXiv:2009.07302](https://arxiv.org/abs/2009.07302)]
- 2021 **Weak Cartesian Properties of Simplicial Sets**. *Submitted for publication*. With Carmen Constantin, Tobias Fritz, and Paolo Perrone. [[arXiv:2105.04775](https://arxiv.org/abs/2105.04775)]
- 2018 **Densities of Hyperbolic Cusp Invariants**. *Proceedings of the American Mathematical Society*, Volume 146, Number 9, **4073-4089**, 2018. With Colin Adams, Rose Kaplan-Kelly, Michael Moore, Shruthi Sridhar, and Josh Wakefield. [[arXiv:1701.03479](https://arxiv.org/abs/1701.03479)]
- 2017 **specgen: A Tool for Modeling Statecharts in CSP**. *Nasa Formal Methods* **282**, 2017. With Chris Casinghino.
- 2016 **Nonstandard Neutrino Interactions In Supernovae**. *Physical Review D* **94**, 093007, 2016. With C.J. Stapleford, D.J. Väänänen, J.P. Kneller, and G.C. McLaughlin. [[arXiv:1605.04903](https://arxiv.org/abs/1605.04903)]

## Honors and Awards

- 2021 **Bättig Prize for Excellence and Promise in Mathematics**, Cornell University.
- 2017 **National Defense Science & Engineering Graduate Fellowship**.
- 2017 **Summa Cum Laude**, Brandeis University.
- 2017 **Arnold Shapiro Prize in Mathematics**, Brandeis University.
- 2017 **Michtom Prize in Computer Science**, Brandeis University.
- 2016 **Phi Beta Kappa**, Brandeis University Chapter, Junior Year Inductee.
- 2016 **Outstanding Presentation Award**, MAA MathFest 2016.
- 2013 **Presidential Merit Scholarship**, Brandeis University.
- 2013 **National Merit Scholarship**, Brandeis University.

## Conference Talks

- 2022 **Dynamic Operads for Evolving Organizations**. Applied Category Theory, Glasgow.
- 2022 **Familial Monads for Higher and Lower Category Theory**. Workshop on Polynomial Functors, Online. (Invited)
- 2021 **Compositional Structure of Partial Evaluations**. Categories and Companions Symposium, Online.
- 2019 **Shape Independent Category Theory**. Category Theory OctoberFest, Baltimore.
- 2019 **Types as Weak  $\omega$ -Groupoids**. School and Workshop on Univalent Foundations, Birmingham. (Invited, Expository)
- 2018 **Cell Shapes for Higher Structures**. Young Topologists Meeting, Copenhagen. (Expository)
- 2016 **The Geometry of Knots**. With S. Sridhar. MAA MathFest, Columbus, OH.
- 2016 **Cusp Density: Dense or Knot?** Unknot III, Columbus, OH.

## Seminar Talks

- 2020 **Compositional Structure of Partial Evaluations**. MIT Categories Seminar, Online.
- 2020 **Cubical  $\omega$ -Categories and Cubical  $\Theta$** . MSRI Cubical Sets Seminar, Online.
- 2020 **Test Category Structure of Cubes**. MSRI Cubical Sets Seminar, Online.
- 2020 **Constructing Cubes from Semicubes**. MSRI Cubical Sets Seminar, Online.

## Teaching

- 2020-2022 **Directed Reading Program Mentor**, Cornell University
- 2021 **Calculus Instructor**, Cornell University, Math 1110
- 2019 **Applied Linear Algebra Teaching Assistant**, Cornell University, Math 2310
- 2018 **Geometric Group Theory Teaching Assistant**, Cornell University, Math 4560
- 2016 **Discrete Math Teaching Assistant**, Brandeis University, COSI 29a
- 2015 **Java Programming Teaching Assistant**, Brandeis University, COSI 12b
- 2015 **Java Programming Tutor**, Brandeis University, COSI 12b

## Local Seminars

- 2022-2023 **Berkeley Seminar**, *Topos Institute*, Organizer, Presenter
- 2018-2022 **Homotopy Group**, *Cornell University*, Organizer, Presenter
- 2017-2022 **Topology Seminar**, *Cornell University*, Presenter
  - 2020 **Logic Seminar**, *Cornell University*, Presenter
  - 2019 **“What is...?” Seminar**, *Cornell University*, Organizer
  - 2018  **$\infty$ -Category Theory Reading Group**, *Cornell University*, Presenter
  - 2018 **Homotopy Type Theory Group**, *Cornell University*, Organizer, Presenter
- 2017-2022 **Olivetti Club**, *Cornell University*, Presenter
- 2016-2017 **Floer Homology Group**, *Brandeis University*
  - 2015 **Haskell and Type Theory Group**, *Brandeis University*

## --- Workshop Participation

- 2021 **Equivariant Algebra Seminar**, *electronic Computational Homotopy Theory group*, Presenter
- 2019 **Applied Category Theory Adjoint School & Workshop**, *University of Oxford*  
Project on partial evaluations & categorical probability, led by Tobias Fritz, Paolo Perrone.
- 2019 **School & Workshop on Univalent Foundations**, *University of Birmingham*  
Group on formalizing category theory in UniMath.
- 2018 **Homotopy Theory Summer**, *Berlin Mathematical School*
- 2018 **Talbot Workshop**, *Government Camp, OR*  
Model Independent  $\infty$ -Category Theory. Mentored by Emily Riehl, Dominic Verity.
- 2016 **SMALL REU**, *Williams College*
- 2015 **Internship Project**, *Draper Laboratories*, Formal Methods Group  
Developed and implemented in Haskell a translation model from statecharts into CSPm
- 2014 **Computational Astrophysics REU**, *North Carolina State University*

## --- Extracurricular

- 2020 **Julia Robinson Math Festival Volunteer**, *Cornell University*
- 2018-2022 **Incoming Graduate Student Mentor**, *Cornell University*
- 2018-2022 **Class Representative**, *Cornell University*
  - 2018 **Math Department Spring Concert Organizer**, *Cornell University*
  - 2018 **Guest Speaker on College Math**, *Walt Whitman High School*
- 2016-2017 **Math Club Founder and President**, *Brandeis University*
- 2015-2017 **Undergraduate Mathematics Department Representative**, *Brandeis University*