

Libby Farrell  
ACT 2019 School Application

**Explanation of Relevant Background:**

I have been studying category theory since my third undergraduate year. I primarily used *Category Theory in Context* by Emily Riehl, *Basic Category Theory* by Tom Leinster, and *Category Theory* by Steve Awodey as resources. From these books, I gained familiarity with categories, functors, natural transformations, and limits. Last semester I studied category theory as part of an independent study in algebraic topology during an excursion into homological algebra at the end of the semester. During this time, I reviewed categories, functors, and limits, and became familiar with adjoints and the Yoneda Lemma.

I have also completed two category theoretic projects for my coursework. My final paper for an independent study in mathematical logic was an expository report on elementary topoi and their relationship with set theory. This semester, I am giving a talk in the Grinnell College Mathematics and Statistics Students Seminar titled “When Are Two Things the Same?” as the final project for Algebraic Topology. The talk is an introduction to category theory for an undergraduate audience, and will cover categories, functors, and different ideas of “sameness” we encounter in category theory, such as object isomorphisms and a corollary of the Yoneda Lemma.

I am also familiar with some applied category theory from Tai-Danae Bradley’s *What is Applied Category Theory?* From Bradley’s book, I am familiar with some constructions often used in applied category theory such as monoidal categories, string diagrams, and compact closed categories. Last semester I took a theory of computation course, during which we studied formal languages, Turing machines, computability, and complexity theory, background which is relevant to Pieter Hofstra’s project on complexity classes, computation, and Turing categories.

**Ph.D. Expected Completion Date:**

I am a fourth year undergraduate, and intend on beginning a Ph.D. program fall of 2019.

**Order of Project Preference:**

1. Pieter Hofstra, Complexity classes, computation, and Turing categories
2. Mehrnoosh Sadrzadeh, Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces
3. David Spivak, Toward a mathematical foundation for autopoiesis
4. Miriam Backens, Simplifying quantum circuits using ZX-calculus
5. Tobias Fritz, Partial evaluations, the bar construction, and second-order stochastic dominance
6. Bartosz Milewski, Traversal optics and profunctors

**Commitment to Coming to Oxford:**

I have funding from my institution, so I can fully commit to coming to Oxford.

# Libby Farrell

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585-397-6994

## EDUCATION

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- **Grinnell College** Grinnell, IA  
*Bachelor of Arts in Mathematics (Major GPA: 3.79)* Expected May. 2019

## AWARDS

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- **Pamela Ferguson Prize** Grinnell, IA  
*Grinnell College Mathematics and Statistics Department* Spring 2018
  - Awarded annually to two students who have demonstrated the greatest achievement and promise in mathematics and statistics in the junior class.

## RESEARCH EXPERIENCE

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- **Undergraduate Researcher** Fresno, CA  
*California State University, Fresno - NSF REU* Summer 2018
  - Conducted research on the project Zero Distribution of a Sequence of Polynomials with a Three Term Recurrence under the advisement of Dr. Khang Tran.

## TEACHING EXPERIENCE

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- **Tutor** Grinnell, IA  
*Grinnell College Math Lab* Fall Semester 2016 - Present
  - Tutor Grinnell College calculus students in one-on-one and group settings.
  - Individually tutor Grinnell High School students in pre-calculus algebra classes.
  - Clarify concepts and provide homework help to students.
- **Teaching Assistant** Grinnell, IA  
*Grinnell College Mathematics and Statistics Department* Spring Semester 2018
  - Hold review sessions between lectures to review material and provide homework help to about 60 students in two sections of Linear Algebra.
  - Prepare materials for review sessions and exam preparation.
- **Teacher** Grinnell, IA  
*Grinnell College Liberal Arts in Prison Program* Spring 2018
  - Taught a class to 15 students at Newton Correctional Facility about mathematical games and puzzles.
  - During the 6-week course, we study a different game or puzzle each week, including tic-tac-toe and some of its variations, Sudoku, and Hex. Students learn how to play different games, practice solving puzzles, analyze games and puzzles for mathematical patterns and structures, develop winning strategies, and create their own games.
- **Grader** Grinnell, IA  
*Grinnell College Mathematics and Statistics Department* Fall Semester 2016 - Spring Semester 2017
  - Evaluate and grade problem sets.
  - Identify concepts and problems which students found difficult and communicate these to the instructor.
  - Graded for Differential Calculus, Calculus II, and Linear Algebra.
- **Algebra Review Session Mentor** Grinnell, IA  
*Grinnell College Math Lab* Spring Semester 2016
  - Facilitated weekly pre-calculus algebra review sessions for students enrolled in calculus courses.
  - Prepared mini-lectures and practice problems for weekly topics.

## LEADERSHIP EXPERIENCE

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- **Student Educational Policy Committee Member** Grinnell, IA  
*Grinnell College Mathematics and Statistics Department* Fall Semester 2017 - Present
  - Committee elected by math majors and statistics concentrators.
  - Responsible for fostering community within the department by planning study breaks and other events.
  - Aid in conducting departmental reviews and evaluating faculty candidates.
  - Founded and direct the Mathematics and Statistics Peer Mentor Program to pair upper-year math majors with students in introductory mathematics courses to foster community and encourage student involvement within the Mathematics and Statistics Department.
- **Co-Leader and Co-Founder** Grinnell, IA  
*Minorities in Mathematics and Statistics Meetings* Spring 2018 - Present
  - Hold weekly meetings to create a space for underrepresented students in the Mathematics and Statistics Department to foster relationships.

## ACTIVITIES

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- **Co-Founder and Co-Leader** Grinnell, IA  
*Grinnell College Math Club* Spring 2017 - Present
  - Prepare interesting problems to discuss and solve during meetings.
  - Find other fun math-related activities for meetings, including watching online videos or movies, doing crafts, and reading book excerpts or articles.
- **Team Member** Grinnell, IA  
*Tipping Point Math* Summer 2017 - Present
  - Create videos for educational YouTube channel Tipping Point Math.
  - Research topics, write scripts, create images and animations, edit audio and video while collaborating with professor and other student team members.
  - Created the Tipping Point Math website.
  - Wrote script and created the visuals for United States of Voronoi, shown at the 2018 Bridges film festival.

## TALKS GIVEN

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- **When Are Two Things the Same?** Grinnell, IA  
*Grinnell College Mathematics and Statistics Student Seminar* March 2019
- **Zero Distribution of a Sequence of Polynomials with a Three Term Recurrence** Baltimore, MD  
*Joint Mathematics Meetings* January 2019
- **Zero Distribution of a Sequence of Polynomials with a Three Term Recurrence** Grinnell, IA  
*Grinnell College Mathematics and Statistics Student Seminar* October 2018
- **Making Mathematics Accessible Through Online Videos** Grinnell, IA  
*Grinnell College Mathematics and Statistics Student Seminar* October 2017



# Grinnell College

## Mathematics and Statistics Department

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January 27, 2019

### Recommendation Letter for Libby Farrell

Dear Adjoint School, ACT 2019,

Libby Farrell was a student in my Combinatorics and Number Theory course in Fall 2016, and I ran an independent study with her and another student on Mathematical Logic in Fall 2018. From my experience with her in those courses, I can attest that Libby is an excellent student that has mastery of core mathematical ideas, very strong technical writing skills, and enthusiasm for mathematical thinking. As she discusses in her statement, she has had an independent interest in category theory for several years, and has done a significant amount of work outside of her courses to learn the fundamentals. I think that I can say with confidence that we have never had an undergraduate who took it upon themselves to learn about elementary topoi on the side! Moreover, she is the strongest mathematics student in her class, and plans to pursue a Ph.D. in mathematics starting next year.

In the Combinatorics and Number Theory course, Libby impressed me by being incredibly conscientious, and by always presenting her arguments with considerable attention to detail. In addition, I mentioned  $\text{\LaTeX}$  on the first day, and encouraged, but did not require, students to use it. Libby typeset all of her homework with  $\text{\LaTeX}$ , and spent the effort to present her work in a polished way.

I have taught independent studies in logic many times over the last 10 years. Libby definitely stands out as the student who found the subject the most natural, and who made the most progress. As she mentions in her statement, she ended the course by writing a 23 page paper about elementary topoi, including connections between them and some of the set theory material that we covered. In contrast to most undergraduate projects at this level, Libby demonstrated both significant depth of knowledge and an ability to communicate it clearly.

Although I can not speak directly about her research experience, I know that she did complete an REU this past summer and presented her work in a talk at the Joint Math Meetings a few weeks ago.

Overall, I enthusiastically recommend Libby for the ACT2019 School. I'm sure she has less background than some graduate students and post-docs, but I believe that she has enough knowledge to be an active participant. I expect that she will make the most of the opportunity, and that it will help her immensely in the transition to a graduate program.

Sincerely,

Joseph R. Milet  
Associate Professor of Mathematics  
Grinnell College

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Libby Farrell  
ACT 2019 School Statement of Interest

I began studying category theory during my third year after discovering Tai-Danae Bradley's blog *Math3ma* on Twitter. A few blog posts later, I was captivated. I have continued to study category theory since then. Although a course in category theory has not been available to me, I have incorporated it into my coursework whenever possible. Last semester, during an independent study on mathematical logic, I wrote a final paper on elementary topoi. This semester, I am giving a seminar talk on category theory as a final project for an independent study on algebraic topology. I look forward to continuing to pursue category theory next year in graduate school.

Each project at the ACT2019 School is exciting, although I am particularly thrilled about Pieter Hofstra's project on complexity classes, computation, and Turing categories. Last semester I took a theory of computation course, and it was one of my favorite courses I have taken. Using mathematics to study computers and to solve problems about computers was fascinating to me. Applying category theory to study computation is an exciting expedition I would love to partake in.

As a fourth year undergraduate looking forward to attending graduate school this fall, the ACT2019 School would be a highly beneficial experience for my career. At the ACT2019 School, I will have the exciting opportunity to become acquainted with a variety of research projects in applied category theory, as well as contribute to a research project. I will also meet senior researchers in the field and graduate students who are also interested in applied category theory during the ACT2019 School and at the ACT2019 Conference. These experiences will aid me in gaining the experience and creating the network I will need to find more opportunities in applied category theory and category theory as I begin my research career.