Project preference order: Milewski, Sadrzadeh, Fritz, Spivak, Hofstra, Backens

Background:

I have self-studied a lot of the category theory that I know now. I spent a lot of my free time reading books, including most of most of Leinster's Higher Operads, most of Kelly's Basics of Enriched Category Theory, other bits and pieces of Lurie's HTT, nLab pages, and many articles online like Bergner's introduction to infty cats, parts of Verity and Riehl's article on infty-cats.

I also had a reading course with Professor George Bergman on Categories Work and Freyd's Abelian categories, as well as a directed reading program (with Mikayla Kelley) on Homotopy Type theory (reading the HoTT book). For preparation, I briefly studied type theory and the lambda calculus. Later on, we moved on to studying factorization systems in categories.

Furthermore, I've had extensive coursework that used categories, like the graduate algebra and algebraic geometry courses (Math 245A Universal Algebra, Math 250A Graduate Algebra, 250B Commutative Algebra, Math 256A Algebraic Geometry) as well as a lower division course in Algebraic topology. I've also explored several other areas: I have taken several courses in Computer Science and computability theory.

Coming up, I am also co-facilitating a course on basic category theory at UC Berkeley. I hope to be

I expect to get my undergraduate degree in mathematics in Spring 2019.

Over my years as an undergraduate student, category theory has become one of my absolute favorite subjects of math. In contrast to the more dry, detailed, and even "dirty" approaches of material set theory (whose definitions are sometimes very arbitrary), I found the categorical approach to be much cleaner and much more elegant. In my brief studies into ETCS and Homotopy Type theory, I already loved how categories can be used to provide a very nice and natural foundations for mathematics, one that more clearly reflects how humans think. However, I unfortunately have never really stepped outside the realm of mathematics; I have only heard about the uses of categories in physics and computer science, but I never had a chance to dive deep.It's so weird, yet exhilarating, to see concepts that I largely associated with mathematics (profunctors, monoidal categories, monads, the bar construction) used in computer science and physics. I never knew categories could help in linguistics and autopoiesis!

Since I am applying for graduate school (to study category theory, probably), I believe this experience would be an excellent introduction to how "real" mathematics is done, as well as a nice taster to the wealth of categorical knowledge that is so lacking in Berkeley's undergraduate curriculum. Hopefully I'll be able to learn much more about how categories help in computer science (the area I know the most about out of all the projects), especially on how it is useful in functional programming. This opportunity may also help open new career paths for me: always I've seen category theory (and the other mathematics I love) as being quite pure; thus my route was always to attain a PhD. However, now that I can learn about the various new applied uses for categorical knowledge, perhaps this means I have a chance of being a researcher at places other than academia. I'm also incredibly excited at the chance to meet and work with such amazing mathematicians, some of whose books I've seen, as well as meeting peers who are also as crazy for category theory as I am.

Fei Yu Chen

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EDUCATION:

September 2015 - Present, University of California, Berkeley
Major in Mathematics, Expected Graduation May 2019

- GPA: 3.982
- Berkeley's Directed Reading Program (Fall 2016, Spring 2017)
    - Studied homotopy type theory, factorization systems in categories, and enriched categories with graduate instruction.
    - Attended two seminars for DRP students, gave talks on what I learned.
- Read of Folland's Real Analysis with a Graduate student direction (Summer 2017).
- Read Saunders Mac Lane's *Categories for the Working Mathematician*, and Freyd's *Abelian Categories* with direction from Professor George Bergman
- September 2018 - December 2018, attended learning seminar on Hochschild Homology with David Nadler
- Reading Course (Fall 2018): Read *Sheaves on Manifolds* by Kashiwara and Schapira with direction from David Nadler
- Clubs: Kendo Club, Mathematics Undergraduate Student Association, Cal Animage Association, SwingCal (decal).

WORK EXPERIENCE:

September 2016 - May 2017, Berkeley Math Circle

- Worked as an teaching assistant, handling children (elementary to middle level).
- Helped children understand difficult mathematical concepts

September 2017 - December 2017, Reader for Math H104 (Real Analysis), UC Berkeley

- Critiqued the argumentation of students, kept track of grades.

January 2018 - May 2018, Reader for Math 142 (Algebraic Topology), UC Berkeley

- Critiqued the argumentation of students, kept track of grades.

RESEARCH EXPERIENCE:

June 2018 - August 2018, Research Experience for Undergraduates, Kent State University

- Our group authored "On skew polynomial rings over locally nilpotent rings" (to appear in Communications in Algebra)
- Our group authored "On differential polynomial rings in several variables over locally nilpotent rings" (Submitted)
- Gave weekly presentations on our progress

ADDITIONAL SKILLS:

- Chinese and French: Conversational
- Basic programming knowledge in Python, Java, C++, and Haskell
- Pianist (received CM Musicianship)

KENT STATE UNIVERSITY

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http://www.kent.edu/math/profile/mikhail-chebotar

January 17, 2019

Dear Colleagues:

It is my great pleasure to write a reference letter for Mr Fei Yu (Dennis) Chen concerning his application for the ACT2019 School.

I have known Mr Chen since June of 2018 when he became a member of my research experience for undergraduates (REU) group. Jointly with his colleagues Hannah Hagan and Allison Wang, Dennis was studying skew polynomial rings in several variables. Prior joining the program Dennis has already taken some advanced algebra classes, such as Graduate Algebra, Algebraic Geometry, Universal Algebra and Category Theory, so though he had no serious background in Ring Theory, his mathematical culture was sufficient to start working in the area.

Let me first say some words about this project. The most famous open problem in Ring Theory known as the Koethe Conjecture asks whether a polynomial ring over a nil ring is Jacobson radical. A famous example due to Smoktunowicz shows that polynomial rings over nil rings need not be nil, and a theorem due to Puczyłowski and Smoktunowicz asserts that such rings cannot be mapped onto a ring with identity. Usually, these results are considered as natural bounds for the Koethe Conjecture. However, Beidar, Fong and Puczyłowski improved Puczyłowski-Smoktunowicz theorem: namely, they replaced the identity element by a nonzero idempotent. It was not known for 20 years whether a polynomial ring in several variables over a nil ring can be mapped onto a ring with identity. Very recently this question was answered positively using techniques from Convex Geometry in my joint work with Ke, Lee and Puczyłowski. However, it is still unknown whether a polynomial ring in several variables over a nil ring can be mapped onto a ring with a nonzero idempotent.

Recently, skew polynomial rings over locally nilpotent rings have received significant attention. One of the most important results was the solution to a problem by Shestakov: Smoktunowicz and Ziembowski proved that the differential polynomial ring over a locally nilpotent ring need not be Jacobson radical. This result is very surprising, because polynomial rings over locally nilpotent rings are locally nilpotent. It also means that working with skew polynomial rings adds an extra level of difficulty.

The project I offered to my REU students was motivated by two questions due to Greenfeld, Smoktunowicz and Ziembowski:

1. Can a skew Laurent polynomial ring over a locally nilpotent ring contain a nonzero idempotent?

2. Can a differential polynomial ring over a locally nilpotent ring be mapped onto a ring with a nonzero idempotent?

Very recently, I answered both questions in the negative, so I suggested my students to think whether these results can be extended to skew polynomial rings in several variables.

To my great surprise they solved the first problem pretty fast, and moreover they found a very short and elegant proof. My proof (for one variable) relied on the triangularization technique recently developed by Mesyan. Their proof (for many variables) was purely ring theoretic and it is much simpler and better than what I got for one variable. The second problem, however, was technically more involved and they had to use algebraic and combinatorial machinery to handle it (they still have a much better proof than what I got for one variable).

Let me stress that my REU group had no previous background in Noncommutative Ring Theory, a subject which is usually studied only in graduate school. So, during the program Dennis, Allison, and Hannah had to learn the basics of Radical Theory and Differential Algebra well enough to be able to read papers in the fields. Then when it came to working on the problems, Dennis was the driving force of my group. Even when the group was meeting with difficulties in the problem, it was his perseverance that kept the group moving forward as he never stopped looking for different approaches that would allow these difficulties to be overcome.

Their project culminated in two research papers. The first one has been already accepted in the 'Communications in Algebra' and the second one is submitted for publication to another internationally recognized journal. So far, this is the best result among all my REU groups and Dennis deserves a lot of credit for this success!

Dennis has outstanding analytical and logical skills, he has very strong work ethic and he is a perfectionist. Mr Fei Yu Chen is one of the very best students I have had the pleasure to work with during my mathematical career, so I give him the highest

recommendation.

Sincerely yours,

Mikhail Chebotar
Professor of Mathematics

CALCENTRAL

Academic Summary

Student Profile

Name	Fei Yu Chen
Student ID	26145252
Major	Undergrad Letters & Science Mathematics BA
Academic Career	Undergrad
Level	Senior
Terms Information	Expected Graduation **Spring 2019** **View Graduation Checklist** Spring 2019 will be your final term to complete all degree requirements. If you have questions, please contact your College Advisor.
Cumulative Units	**Total Units** 147.4 **Transfer Units** 42.4 **P/NP Total** 37 **P/NP Passed** 37
Cumulative GPA	3.982

Enrollment

Undergraduate Transfer Credit

Transfer Credit Report

Test Credit	**Units**
Advanced Placement (AP)	42.400
Total Test Units:	**42.400**

Fall 2015

Class	Title	Un.	Gr.	Pts.
COMPSCI 10	The Beauty and Joy of Computing	4.0	A+	16.0
L & S 1	Exploring the Liberal Arts	2.0	P	0.0
MATH H53	Honors Multivariable Calculus	4.0	A+	16.0
MATH 54	Linear Algebra and Differential Equations	4.0	A+	16.0

Honors to Date Dec 18, 2015

Spring 2016

Class	Title	Un.	Gr.	Pts.
COMPSCI C8	Foundations of Data Science	4.0	A+	16.0
L & S 70A	Physical Science	3.0	A+	12.0
MATH 24	Freshman Seminars	1.0	P	0.0
MATH 55	Discrete Mathematics	4.0	A+	16.0
MUSIC 29	Music Now	4.0	A+	16.0

Dean's List

Honors to Date May 13, 2016

Fall 2016

Class	Title	Un.	Gr.	Pts.
MATH H104	Honors Introduction to Analysis	4.0	A+	16.0
MATH 113	Introduction to Abstract Algebra	4.0	A+	16.0
MUSIC 20A	Basic Musicianship	2.0	A	8.0
PSYCH W1	General Psychology	3.0	A	12.0

Dean's List

Honors to Date Jan 10, 2017

Spring 2017

Class	Title	Un.	Gr.	Pts.
ESPM 50AC	Introduction to Culture and Natural Resource Management	4.0	P	0.0
MATH 142	Elementary Algebraic Topology	4.0	A+	16.0
MATH 185	Introduction to Complex Analysis	4.0	A	16.0
MATH 198BC	Berkeley Connect	1.0	P	0.0

Honors to Date Jun 08, 2017

Summer 2017

Class	Title	Un.	Gr.	Pts.

COMPSCI 61BL (Session C)	Data Structures and Programming Methodology	4.0	P	0.0
MUSIC 44 (Session D)	Voice Class	2.0	P	0.0
NUSCTX 10 (Session A)	Introduction to Human Nutrition	3.0	P	0.0

Fall 2017

Class	Title	Un.	Gr.	Pts.	Honors to Date Dec 15, 2017
MATH 198BC	Berkeley Connect	1.0	P	0.0	
MATH 245A	General Theory of Algebraic Structures	4.0	A+	16.0	
MATH 250A	Groups, Rings, and Fields	4.0	A+	16.0	
STAT C100	Principles & Techniques of Data Science	4.0	P	0.0	

Spring 2018

Class	Title	Un.	Gr.	Pts.	Honors to Date May 11, 2018
ENGLISH 198	Directed Group Study	1.0	P	0.0	
MATH 136	Incompleteness and Undecidability	4.0	A+	16.0	
MATH 160	History of Mathematics	4.0	P	0.0	
MATH 250B	Multilinear Algebra and Further Topics	4.0	A	16.0	

Fall 2018

Class	Title	Un.	Gr.	Pts.	Honors to Date Jan 07, 2019
GWS 102	Transnational Feminism	4.0	P	0.0	
MATH 199	Supervised Independent Study and Research	1.0	P	0.0	
MATH 256A	Algebraic Geometry	4.0	A-	14.8	
PHILOS 149	Special Topics in Philosophy of Logic and Mathematics	4.0	P	0.0	
PHYS ED 98	Supervised Group Study	1.0	P	0.0	

Spring 2019 Cancelled Jan 08, 2019

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