

APPLICATION TO ACT 2019 SCHOOL

SIMON CHO

Relevant background: A large portion of my work thus far has focused on the features of categories of metric spaces from the perspective of categorical semantics. Now there is already a rich study of the logical structure of (essentially) categories of metric spaces from the model theoretic perspective, a subject called *metric model theory* or *continuous logic*. My work was to develop a natural metric analogue/generalization of the usual categorical semantics in such a way that the “obvious” categorical formulations of logical notions such as *predicate* or *quantification* in this “continuous semantics” agree with the existing corresponding notions in continuous logic.

Ph.D.: I completed my PhD in May 2017, and my thesis was in two parts: 1) an application of continuous logic to proof mining in fixed point theorems in functional analysis, and 2) a precursor to my work on the “continuous” categorical semantics described above.

Order of project preference:

- (1) Toward a mathematical foundation for autopoiesis
- (2) Partial evaluations, the bar construction, and second-order stochastic dominance
- (3) Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces
- (4) Complexity classes, computation, and Turing categories
- (5) Simplifying quantum circuits using the ZX-calculus
- (6) Traversal optics and profunctors

Travel commitment to Oxford: I am fairly certain that I can travel to Oxford in the summer; I can likely find funding for (part of) the flight, but lodging/remaining costs would have to be out of pocket, so any funding by ACT 2019 would help greatly.

Statement of interest: Over the past decades, category theory has been utilized to spectacular effect in logic, algebraic topology/geometry, and related areas. The reason for such success - its singular ability to provide grounds for comparison between a priori separate frames of thought, indeed to formalize such comparisons or relationships themselves as mathematical objects (e.g. functors) - is what I find fascinating about category theory, and why I am enthusiastic about continuing my research in a direction that extends the applicability of category theory beyond its established modes of usage.

I am specifically interested in the ACT 2019 projects because they look to leverage well-developed frameworks (such as categorical semantics) in novel ways to shed light on tough questions (such as the “whole-thingness” of a system or the structure of natural language) in an applied context, which I lack previous exposure to but am excited to learn about. This would also be an opportunity for me to connect with people in the community of the field of applied category theory who have similar interests and diverse perspectives, which I consider an important part of continuing my academic career in this direction.

Curriculum Vitae

Simon Seamoon Cho
seamooncho@gmail.com

RESEARCH INTERESTS	Category Theory, (Metric) Model Theory, Applied Topology
EMPLOYMENT	University of Michigan , Ann Arbor, MI Postdoctoral Assistant Professor September 2017 - present
EDUCATION	University of Pennsylvania , Philadelphia, PA Ph.D., Mathematics, May 2017, advisors: Henry Towsner and Robert Ghrist University of Cambridge , Darwin College, Cambridge, UK M.A.St., Pure Mathematics, June 2012 Columbia University , New York, NY B.A., Mathematics and Physics, <i>cum laude</i> , May 2011
PAPERS	S. Cho, <i>Categorical semantics of metric spaces and continuous logic</i> , submitted, arXiv:1901.09077, 2019. S. Cho, <i>An application of continuous logic to fixed point theory</i> , submitted, arXiv:1610.05397, 2019. S. Cho, <i>Continuity in enriched categories and metric model theory</i> , PhD thesis (available http://math.lsa.umich.edu/~simoncho/thesis.pdf), 2017.
TEACHING	University of Michigan , Ann Arbor, MI Instructor , 2017 - present <ul style="list-style-type: none">• Math 582: Introduction to set theory, Winter 2019• Math 217: Linear algebra, Fall 2018• Math 215: Vector calculus, Winter 2018• Math 481: Introduction to mathematical logic, Fall 2017 University of Pennsylvania , Philadelphia, PA Master TA , 2015 - 2017 <ul style="list-style-type: none">• Mathematics TA training, 2015 - 2017 <i>Master TAs organize and run the TA training program at the beginning of each academic year, and provide pedagogical development and guidance throughout the year.</i> Instructor , 2015 <ul style="list-style-type: none">• Math 170: Ideas in mathematics, Summer 2015 Teaching assistant , 2014 - 2017 <ul style="list-style-type: none">• Math 361: Differential forms & measure theory (undergraduate), Fall 2016 <i>with Dr. Lechao Xiao</i>• Math 360: Real analysis (undergraduate), Spring 2016 <i>with Dr. Lechao Xiao</i>• Math 110: Calculus for Wharton students, Spring 2015 <i>with Prof. Robin Pemantle</i>• Math 202: Introduction to proofs in analysis, Fall 2014 <i>with Prof. Herman Gluck</i>• Math 114: Multivariable calculus, Spring 2014 <i>with Dr. Martha Yip</i>

- Math 114: Multivariable calculus, Fall 2014
with Prof. Wolfgang Ziller

Columbia University, New York, USA

Grader, 2010-2011

- Math W4392: Introduction to Quantum Mechanics II, Spring 2011
with Prof. Brian Greene
- Math W4391: Introduction to Quantum Mechanics I, Fall 2010
with Prof. Brian Greene
- Phys C1602: Thermodynamics, Electricity, and Magnetism, Spring 2010
with Prof. Erick Weinberg

TALKS

Midwest Homotopy Type Theory Seminar, University of Western Ontario, May 2018

Topology Seminar, University of Western Ontario, February 2018

Logic Seminar, University of Michigan, September 2017

Capsule Talk, University of Michigan, August 2017

CONTRIBUTED PRESENTATIONS

Kan Extension Seminar II, CT 2017, Vancouver, July 2017.

Logic and Set Theory Contributed Talks, Joint Mathematics Meetings, Atlanta, January 2017.

Weekly lecture series on homotopy type theory (sole speaker), University of Pennsylvania, every week of Spring 2015.

Graduate Student Seminar, *Introduction to homotopy type theory*, University of Pennsylvania, March 2015.

Graduate Geometry-Topology Seminar, *Nielsen-Thurston classification of surface automorphisms*, University of Pennsylvania, February 2014.

Graduate Geometry-Topology Seminar, *Introduction to orbifolds*, University of Pennsylvania, October 2013.

Columbia College Science Research Symposium, *The theory of signal processing in the Q/U Imaging Experiment*, Columbia University, April 2010.

CONFERENCES ATTENDED

International Category Theory Conference (CT) 2018, University of Azores, July 8-14, 2018.

Midwest Homotopy Type Theory Seminar, University of Western Ontario, May 26-27, 2018.

International Category Theory Conference (CT) 2017, Vancouver, July 16-22, 2017.

Mathematics Research Communities Workshop on Homotopy Type Theory, Snowbird, June 4-10, 2017.

Joint Mathematics Meeting, Atlanta, January 4-10, 2017.

Association for Symbolic Logic 2016 Annual North American Meeting, University of Connecticut, May 23-26, 2016.

Workshop on Homotopy Type Theory and Univalent Foundations in Mathematics, The Fields Institute, May 16-20, 2016.

Thurston Legacy Conference, Cornell University, June 23-27, 2014.

Geometry and Groups After Thurston, Trinity College Dublin, August 27-31, 2013.

SERVICE	<p>Organizer of the weekly learning seminar on homotopy type theory, University of Michigan, Winter 2018.</p> <p>Co-organizer of the AMS Special Session on Homotopy Type Theory, Joint Mathematics Meetings, January 2018.</p> <p>Instructor for Michigan Math Circle, high school section, September/October 2017.</p> <p>Scorer for local branch of the National Math and Science Competition event organized by the Philadelphia chapter of the Korean-American Scientists and Engineers Association (KSEA), April 2016.</p> <p>Organizer for weekly lecture series on homotopy type theory, University of Pennsylvania, Spring 2015.</p> <p>Co-organizer of the prospective graduate student open house, University of Pennsylvania, Spring 2014 and Spring 2015.</p>
AWARDS	<p>Mathematics Good Teaching Award, University of Pennsylvania, 2015.</p> <p>Mathematics Good Teaching Award, University of Pennsylvania, 2014.</p> <p>Harry J. Carman Fellowship, Columbia University, 2011</p> <p>William C. and Esther Hoffman Beller Scholarship, Columbia University, 2009</p> <p>KASF General Scholarship, Korean-American Scholarship Foundation, 2009</p> <p>KSEA General Scholarship, Korean-American Scientists & Engineers Association, 2009</p>
REFERENCES	<p>Prof. Andreas Blass Professor of Mathematics at University of Michigan ablass@umich.edu</p> <p>Prof. Robert Ghrist Professor of Mathematics at University of Pennsylvania ghrist@math.upenn.edu</p> <p>Prof. Henry Towsner Associate Professor of Mathematics at University of Pennsylvania htowsner@math.upenn.edu</p>



Applied Category Theory <act2019school@gmail.com>

recommendation for Simon Cho

Andreas Blass <ablass@umich.edu>

Mon, Jan 28, 2019 at 9:43 AM

To: act2019school@gmail.com

Dear Colleagues,

I'm writing to support Simon Cho's application to participate in the Applied Category Theory 2019 School. Simon is in the second year of a three-year postdoctoral appointment in my department, the Mathematics Department of the University of Michigan. He received his Ph.D. from the University of Pennsylvania in 2017, under the supervision of Henry Towsner.

Simon's research involves interactions between category theory, logic, and homotopy theory. Most of his work so far focuses on continuous model theory and its generalizations. In particular, he has developed category-based semantics for continuous logic, and he has extended certain proof-mining techniques from continuous logic to a larger context that allows certain functions to be discontinuous but constrained to behave well with respect to geodesics. In addition, Simon organized a seminar last year for the purpose of learning about homotopy type theory.

I've learned a good deal by talking with Simon and attending his seminar. I'm confident that his presence in your summer school will benefit not only him but the other participants who work with him.

Please let me know if you need any additional information about Simon.

Sincerely yours,
Andreas Blass
(Professor of Mathematics,
University of Michigan).

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📄 mrkgnao.github.io

🌐 [mrkgnao](#)

Soham Chowdhury

Background

- 2018– **B.Sc. (Hons) in Mathematics**, *Scottish Church College*, Kolkata.
- 2017 **Selected to attend “Modern Mathematics” International Summer School 2017**, *Jacobs University*, Bremen, Germany.
Did not attend owing to an overlap with other academic commitments.
- 2016 **Canada/USA Mathcamp**, Colby College, Waterville, ME.
Attended a six-week summer program on a full merit scholarship.
- Wrote an **expository paper** under my academic advisor David Roe, presenting the results of Artin–Whaples 1945, “Axiomatic characterization of fields by the product formula for valuations”, on the number-theoretic analogy between number fields and function fields.
 - Took classes on, among other topics,
 - algebraic number theory
 - analytic number theory
 - elliptic curves
 - algebraic topology
 - homotopy limits
- 2015 **Selected to attend Hampshire College Summer Studies in Mathematics**, *Hampshire College*, Amherst, MA.
Did not attend.

Academic interests

- Analogies between number theory and geometry
- Analogies between logic, computation, and categories
- Number theory
- Algebraic and arithmetic geometry
- Algebraic topology
- Category theory and homotopical algebra
- Expressive type systems and program correctness
- Development of interpreters and optimising compilers for functional programming languages

Languages

English Fluent

Bengali Fluent

Hindi Fluent

German Conversational

Soham Chowdhury: other information

January 30, 2019

Relevant background

1. Basic category theory, at the level of the most of Mac Lane’s *Categories for the Working Mathematician*. Yoneda, (co)limits, adjunctions, monads, monoidal categories, abelian categories, diagram-chasing, (snake, four, five)-lemmas, and string diagrams.
2. For *Partial evaluations, the bar construction, and second-order stochastic dominance*: experience writing interpreters and implementations of type systems, practical familiarity with implementing small- and big-step evaluation rules, and experience with metaprogramming in Haskell and Emacs Lisp.
3. For *Traversal optics and profunctors*: proficiency in the programming language Haskell, experience using the Haskell `lens` library, experience developing an in-progress pedagogical reimplementations of it¹, and basic familiarity with the theoretical and implementation-level underpinnings of both van Laarhoven and profunctor optics.
4. abstract algebra at the level of Artin’s *Algebra* or Aluffi’s *Algebra: Chapter 0*, including Galois theory; basic homological algebra
5. commutative algebra at the level of the first few chapters of Atiyah–Macdonald’s *Introduction to Commutative Algebra*
6. experience with mathematical writing and exposition, in the form of an expository paper² in number theory presenting the results of Artin and Whaples (“Axiomatic characterization of fields by the product formula for valuations”, 1945) on the number-theoretic analogy between number fields and function fields

Order of project preference

From most to least preferred:

1. Simplifying quantum circuits using the ZX-calculus
2. Toward a mathematical foundation for autopoiesis
3. Complexity classes, computation, and Turing categories
4. Traversal optics and profunctors

¹<https://github.com/mrknao/silica>

²<https://github.com/mrknao/nf-ff/raw/master/main.pdf>

5. Partial evaluations, the bar construction, and second-order stochastic dominance
6. Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces

Ability to commit to attending

I will require financial aid for travel and cannot commit to coming to Oxford otherwise.

Why the ACT2019 School interests me

The work that excites me the most occurs at the intersection of apparently unrelated fields, often with category theory serving as a bridge between different worlds. The “project” of the emerging field of applied category theory agrees with this interest, and the ACT2019 School offers me the chance to not only observe such work being done, but to participate in it myself as a researcher working with experts on topics I find it stimulating to think about, and on questions that may inspire further work of my own.

My introduction to pure mathematics consisted of me finding myself led to group theory (through my interest in solving Rubik’s cubes in the fewest moves possible) and categories (through my interest in the categorical underpinnings of how the programming language Haskell improved upon “imperative” control structures). Since then, I’ve gravitated towards certain parts of mainstream pure mathematics, broadly centered around number theory and categories, I’ve always made sure to maintain an interest in (how my studies relate to) logic, applied mathematics, functional programming, physics, economics, and philosophy and the sciences more generally. Many things I have taken an academic interest in since have vindicated this decision: my experience reading type theory papers and implementing type systems in Haskell, for instance, provide motivation for type-theoretic parts of topos theory, which I came to as a student of algebraic geometry looking to understand sheaves. As someone who would like to go on to a career in research, I’m excited to pick up more influences of this nature that can open my eyes to unfamiliar, productive viewpoints on mathematical and scientific topics I am interested in working in.

I’m also looking forward to meeting and working alongside peers with similar goals of becoming categorically-minded generalists who, as was said of algebraic geometers by Mumford, “secretly [plot] to take over the rest of mathematics”, and perhaps also to go on to the rest of the sciences and as many of the other arenas of human endeavour as they can.



To Whom it may Concern

It is my pleasure to recommend Soham Chowdhury unreservedly for the Applied Category Theory 2019 School to be held at the University of Oxford.

Soham is presently a student of B. Sc. Second year with Honours in Mathematics at the Department of Mathematics, Scottish Church College, Kolkata. I know Soham for about a year and a half as a student in my Department. He has always been a motivated student with a clear interest in mathematics and science and a drive to understand things clearly. His participation in lectures has always struck me as being singularly earnest, and he often raises thought-provoking questions that demonstrate the depth to which he engages with the material and creates his own directions of inquiry within the topic.

Soham intends to pursue an academic career in Mathematics after his undergraduate education. I strongly believe that academic experiences of this nature are important in broadening the scope of what a bright young student thinks about, and is important if they are to produce high-quality work of their own later. The ACT2019 School will also give him the chance to explore some areas which are not a part of his undergraduate curriculum (for example category theory, type theory, and logic) in greater depth than independent study alone can provide. He will benefit both personally, as a student of mathematics seeking to expand his knowledge, and professionally as a prospective researcher gaining early research experience as an undergraduate working on advanced topics under a world-class mentor.

I am confident Soham would do very well as a participant in the ACT2019 School, and am happy to recommend him strongly for the School.

Dr. Kalyan Kumar Chakrabarti

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Associate Professor

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