

**Background:**

I am currently working in industry as a data scientist, so I do not have a date for PhD completion, but prior to my current position I completed a BA in Mathematics and an MS in Computer Science at the University of Chicago. During that time, in addition to my mathematics coursework, I took courses on machine learning, statistical inference, and computational linguistics. More recently, I have been following the course David Spivak and Brendan Fong have been teaching on Applied Category Theory, which follows their book on the subject. Outside of mathematics, I have studied mereology from a philosophical perspective and some of my coursework focused on understanding emergent dynamics in groups. Ultimately, I think my background is most relevant to the projects titled "Toward a mathematical foundation for autopoiesis" and "Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces".

**Preferences:**

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

**Going to Oxford:**

I believe I can get approval from my current company for funding to go to Oxford upon acceptance but if not I may still be able to attend.

**Statement:**

When I first learned about applied category theory I was immediately drawn to the emphasis on studying the relationships between objects as opposed to the objects themselves. This not only provided a unique way of thinking about the mathematics I already knew, but also gave me a different sense of what kinds of problems can be approached mathematically. Having the opportunity to work on those kinds of problems is my primary motivation for applying to the ACT2019 School. For example, having worked in the past with approaches to autopoiesis from the perspectives of philosophy and political science, I would love the opportunity to contribute to a formal mathematical understanding of the topic. Beyond personal interest, I think that the ACT2019 School would directly benefit my career. Much of my work in the past has dealt with understanding dialogue statistically from the perspectives of computational linguistics and natural language processing. In that sense, the opportunity to participate in research to improve current formal models of dialogue would be invaluable. Furthermore, many of the topics have direct relevance to important questions in probability theory (such as the topic on stochastic dominance) and functional programming (such as the topic on optics), which are areas I touch on regularly in my work as a data scientist. More generally, I

think this would be an important and rare opportunity to work in a research environment outside of a graduate program. I want to begin applying to PhD programs, most likely in mathematics or statistics, in the next few years and as a result have been searching for opportunities to do research in mathematics while working in industry. As a result, I would appreciate the ability to gain more research experience in such an exciting area of mathematics.

# Ryan Teehan

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**Education:** M.S. Computer Science; B.A. Mathematics, The University of Chicago, GPA: 3.66

## Extracurricular Academic Work:

- University of Chicago Mathematics Directed Reading Program – Fall 2015: Representation Theory of Finite Groups: Random Walks on Finite Groups. Presented the results in January of 2016.
- Independent Reading: Shmuel Weinberger – Summer 2018: Discussed discrepancy theory as it relates to sampling techniques

## Relevant Coursework:

- TTIC 31240 – **Self-driving Vehicles** (see: <http://duckietown.org>) (Graduate)
  - Worked to build and program a small autonomous vehicle
  - Dealt with problems including, but not limited to, **lane estimation, localization, computer vision/image processing**
  - Independent project work involving Extended Kalman Filter Simultaneous Localization and Mapping (EKF SLAM)
- CMSC 35050 – **Computational Linguistics** (Graduate)
  - Covered information theory, statistical approaches to machine translation, HMMs, and deep learning (among other topics). Included an independent, open ended research project with other graduate students (see Projects)
- MATH 29700 – **Reading and Research: Spectral Clustering with Professor Steven Lalley**
  - Read papers on spectral methods in graphs including clustering, identification of community structure in networks, manifold learning, and diffusion methods with applications to data analysis and statistics.
- CMSC 35425 – **Topics in Statistical Machine Learning: Harmonic Analysis and Representation Theory** (Graduate)
  - Included discussion of Fourier analysis on finite groups, Fast Fourier Transforms, and signal processing

## Experience:

- Work Experience
  - **January 2019 – Present: Software Engineer: Big Data, Charles River Analytics**
    - Working on a probabilistic modeling tool for mechanical failure in Navy ships
    - Contributing to development of a distributed database for streaming analytics and immediate playback in Scala
  - **September 2018 – January 2019: Data Scientist, Infinite Analytics**
    - Reduced latency of **Spark** computations, implemented in Scala, by ~25%
    - Evaluating and implementing algorithms for dimensionality reduction of large (~ 300,000 x 7 million), sparse, binary matrices
    - Currently optimizing word embeddings to improve search results for customer search engines
  - **June – August 2018: Research Assistant, Deep Skies Lab**
    - Determining whether it is possible to approximate or beat the performance of a ResNet on a classification task for identifying strong gravitational lensing with a simple CNN after applying convolutional filters
    - Generating simulations of strongly lensed galaxies to train new neural networks using the **Lenstronomy** Python package
    - Worked with over 32,000 images in a high performance computing environment (including **GPU** computing)
  - **June 2017 – March 2018: Data Science Intern, Data Scientist, RMark Bio**
    - Worked with proprietary machine learning models (both self-developed and through Azure Studio) and network analysis to develop a recommendation system for medical researchers
    - Developed clustering algorithms for medical text documents and mixed numeric and categorical data
    - Built an influence modeling application using Gremlin-Python, Neo4J and CosmosDB Graph databases
    - Applied Microsoft Azure's face recognition API to images taken from proprietary databases
      - Dealt with ingest and processing of over 20,000 images
- Technical Experience
  - **Advanced proficiency in Python**, (Pandas, Numpy, Scikit-learn, TensorFlow, Keras, OpenCV, Networkx, etc.)
  - **Proficient in MATLAB, SQL, GPU computing**
  - **Experience with Microsoft Azure, Google Cloud, Java, ROS, and Linux**
  - **Some experience in Stata, R, Geoda, C, and C++**

## Projects:

- **Yelp Restaurant Recommender – 2017**
  - Text analysis of customer Yelp reviews using **Latent Semantic Analysis** and **Latent Dirichlet Allocation**
- **Multi-Word Expression Identification – 2018**
  - Working on developing a language independent method to identify multi-word expressions