ACT2019 School Application

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1 General Information

1.1 Background

In November, I graduated with a BSc. in Computer Science (with a concentration in theoretical computer science) and a BSc. in Pure Mathematics and I'm currently awaiting a decision on my grad school admission. Possible projects include diagrammatic languages via string diagrams, topological models of counterfactual logic, or something else involving synthetic differential geometry and category theory. In the meantime I'm sitting in on graduate level courses on algebraic topology and algebra where I'm applying category theory and spending my spare time attending category theory seminars and studying. During my undergrad I attended a graduate level courses in category theory, computability, and modal logic. I've also self taught myself lambda calculus, some type theory (ITT, some HoTT), some categorical logic, and I'm currently working towards developing a better understanding of category theoretic diagrammatic languages.

1.2 Order of Project Preference

1. Pieter Hofstra
   Complexity classes, computation, and Turing categories
2. David Spivak
   Toward a mathematical foundation for autopoiesis
3. Miriam Backens
   Simplifying quantum circuits using the ZX-calculus
4. Bartosz Milewski
   Traversal optics and profunctors

5. Tobias Fritz
   Partial evaluations, the bar construction, and second-order stochastic dominance

6. Mehrnoosh Sadrzadeh
   Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces

1.3 Commitment to Travel to Oxford

I'm currently a little tight on money – though I can commit to going, it would be extremely helpful if there were some financial support available to help cover the cost of flight and/or accommodation.

2 Statement

Communication is one of the biggest problems facing society today and it is our responsibility to alleviate it as best we can. When people fail to communicate we begin to encounter problems at every level of society. People become polarized against their families, friends, and neighbors; academics and industry workers fail to understand and solve the technical problems we face; individuals may even fail to manage their own personal lives (self-communication). Although, when people communicate well we become capable of achieving things we never imagined. With that in mind, my research interests revolve around:

- Developing an understanding of how different types of abstract machinery are interrelated and hopefully seeing new connections that allow us to transfer theorems between them.
- Re-interpretting existing abstract machinery to see if this opens up new applications or ways of thinking.
- Formalizing new abstract machinery that can more accurately capture and convey a concept or procedure.

One project I'm interested in is to formalize some new variations of Charles Sanders Peirce's gamma graphs (a visual modal logic) using string diagrams and to generalize the technique to capture Harmen Van Den Berg's knowledge graphs (of which Peirce's graphs are a special case). All of the projects I have discussed with potential supervisors involve category theory and compositionality in some capacity. My ultimate goal is to do work that illuminates the hearts and minds of people everywhere. The applied mathematics school and (compositionality and azimuth project as well) are doing important work that I would very much like to be a part of. Participating in the school would contextualize my category theory background, help me find interesting research topics, and strengthen my chances of getting into grad school.

Mohamar Rios Flores

Software Developer

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About me

A Mexican citizen who grew up in the United States as an out of status immigrant and managed to immigrate to Canada and attend university as an adult. A very eclectic person who loves all things challenging and interesting.

Very interested in using mathematics and technology to help solve the big problems in society.

Skills

- LaTeX
- Haskell
- Information Visualization
- Node.js/Javascript
- D3
- C++
- Java
- Database Design
- Linux

Education

2013 - 2018 **B.Sc. Pure Mathematics** University of Calgary

2013 - 2018 **B.Sc. Computer Science** University of Calgary
with a concentration in *Theoretical Computer Science*

Experience

2006 - 2007 **Nodal Voice Order Specialist** StarTek/AT&T

- Managed service orders for AT&T's 10% largest customers (such as Oracle) who used a variety of unique and exotic services.
- Worked with several of AT&T's legacy databases.

2014 - 2018 **Representative and VP External** SUM-C

- Organized club events.
- Managed the website, tutor list, and newsletter.
- Held office hours during which I provided mathematics help to students.

2017 - 2017 **Magic the Gathering related web scraper** Small E-Commerce Client
The client needed a fast and practical way to populate large amounts of product data on their e-commerce site, so I wrote up an asynchronous solution using Node.js that scraped publicly available information and dispensed it in the format desired by the client.

2017 - 2018 **Callysto Creator** PIMS/Callysto

- Prepared educational materials with interactive visualizations as Jupyter notebooks by utilizing Python and Javascript.
- Developed and maintained a Python package that allowed coworkers to embed and manipulate Geogebra visualization applets into Jupyter notebooks using Python.
- Work was submitted through github and goals were organized and tracked through Agile processes (e.g. sprint meetings).

Volunteering

2015 - 2017 **Volunteer** CALMECA

- General preparation and cleanup for events.
- Sold alcoholic and non-alcoholic beverages.

2017 - 2017 **Staff** Expo Latino

- Tracked the number of people in the beer gardens.
- Sold alcoholic and non-alcoholic beverages.

2016 - 2018 **Volunteer** CAMP Festival

- Life model for a drawing workshop.
- Video operator.
- Stage manager for a conference room.

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To whom it may concern,

This is a letter of recommendation for Mr. Mohamar Rios, who is applying to the ACT school for 2019. I highly recommend him for admission. The letter which follows below had been adapted from a letter supporting his admission to MSc programs in mathematics - I hope to cosupervise him with Richard Zach, a philosopher in Calgary.

Mr. Mohamar Rios is an unusual applicant for ACT. He is currently an undergraduate student, but one who has attained a very broad education. He is a double major in computer science and pure math. In addition, he has completed many of the philosophy courses pertaining to symbolic logic (perhaps he has completed all of them, I'm not sure). This makes him a very diverse undergraduate student with a breadth of knowledge that is superior to most. This background makes him perfectly suited for his proposed area of research in logic and topology, which he is hoping to pursue as a graduate student. Indeed, his performance in the relevant courses is very good. Although he has not yet engaged in any formal research, his background preparation is good enough to demonstrate that he is ready to begin.

Mr. Rios is highly curious and motivated. After completing a course in modal logic (which was the culmination of several other courses) and a course in topology, he made connections between research in philosophy and mathematics and developed his own research problem. His research question is whether or not certain logical systems in which there are two "if/then" implications rather than one can be modelled as topological spaces. Questions such as these have important implications in philosophy and computer science. The interface of math, computer science and philosophy is most frequently phrased in terms of category theory - and it is for this reason that I think the ACT school will directly benefit his future research. I was impressed by both the sophistication of his proposed research question, and by the knowledge base required in order to formulate such a question. Since we first began to talk about this, Mr. Rios has been reading research papers in the subject and has presented both his research plan and the current state of the literature to me already. He has an excellent grasp of his topic. In doing so, he has demonstrated independence and initiative that show a lot of promise.

Mr. Rios is an active member of both the undergraduate math club at Calgary (SUM-C) and the University of Calgary chapter of the AWM. He has also been hired by PIMS to do some programming for the Syzygy project, which is used for research and teaching mathematics using a variety of coding experiences. In all of these things, Mr. Rios has shown himself to be a reliable colleague who acts with compassion towards his fellow students.

I first met Mr. Rios when he took my undergraduate topology class. In my topology class, I asked the students to work in team every class. Mr. Rios is an excellent collaborator who is always receptive to other students. He was also very good at explaining difficult concepts in plain english. I frequently planned teams so that I could put him with students who would most be able to benefit from his skills.

He has very good communication skills, and with maturity and confidence I think he will become someone who engages in leadership positions. He has already started to do so in his role as VP external with SUM-C. He has demonstrated his ability to make and execute plans - the work done by SUM-C has been a huge benefit to our department.

In summary, I think that Mr. Rios will be a very good ACT participant.

Sincerely,

Kristine Bauer
Associate Professor
Department of Mathematics & Statistics
University of Calgary