

# ALUN CENNYTH STOKES

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## RESEARCH INTERESTS

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My interests lie in **mathematics and computing**, particularly **number theory** and **symbolic algebra**. Currently, I study **dessins d'enfants** and (often) the computation of **Belyi maps** from permutation representations and passports. For this, I write software products (here, in all of **Julia**, **Python**, and **CUDA**) for **high-performance, parallel, and distributed computing**. Perhaps what most people are interested in is my experience across a broad range of **machine learning (ML)** methods, particularly with **modern ML** techniques – including **natural-language processing (NLP)**, **computer vision (CV)**, **some more standard neural networks** (including adversarial and generative networks), and **graph neural networks (GNNs)**. What I bring to the table beyond many data scientists is the rigorous mathematical training in ideas such as  **$\sigma$ -algebras**, **Borel spaces**, **measure theory**, **topology**, and the like – all of which give me the fundamental understanding to work more meaningfully with these models as a data scientist.

## EDUCATION

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**Master of Science (Pure Mathematics)**

September 2021 - April 2023

*McMaster University*

Supervisor: *Dr Cameron Franc*

**Bachelor of Integrated Science (Mathematics & Statistics)**

September 2017 - June 2021

*McMaster University*

Honours: *summa cum laude* (10.8/12 cGPA)

Supervisor: *Dr Cameron Franc*

*The Search for Self-Contained Numbers*

## PUBLICATIONS

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- [1] **Stokes, A.** Hum, W., Zaslavsky, J. **STEM Fellowship Journal**. 6(1): 1-5. Available at [A Minimal-Input Multilayer Perceptron for Predicting Drug-Drug Interactions](#).
- [2] <sup>†</sup> **Stokes, A.** Automatically Solving Square-Piece Jigsaw Puzzles using Convolutional Neural Networks with Gradient Boosted Decision Trees. **The Undergraduate Journal**. (12th edition). Accessible at: [Automatically Solving Square-Piece Jigsaw Puzzles](#).
- [3] <sup>†</sup> \* **Stokes, A.** The search for self-contained numbers: k-special 3-smooth representations and the Collatz conjecture. **MacSphere**, 2021, [Online]. Available at: [The search for self-contained numbers](#).

*Entries marked with <sup>†</sup> have **not** been peer-reviewed.*

*Entries marked with \* are theses.*

## EMPLOYMENT

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**Graduate Research and Teaching Assistant (Current)**

September 2021 - April 2023

*McMaster University*

*Dr Cameron Franc, various*

- Continuing my theoretical work on dessins d'enfants for my research.
- Working as a teaching assistant in at least 2 courses per semester at both the graduate and undergraduate level.

**Research Assistant (Number Theory and Symbolic ML)**

May 2021 - August 2021

*McMaster University*

*Dr Cameron Franc*

- Investigated machine learning strategies to discriminate non-congruence finite-index subgroups of the modular group and compute Belyi maps corresponding to dessins d'enfants.
- Designed symbolic evolutionary learning framework to allow number theoretic and algebraic problems to be exactly (rather than probabilistically) taught subgroup property identification.

**Data Scientist (NLP and the CPI)**

June 2020 - August 2020

*Statistics Canada**Consumer Prices Division (Serge Goussev)*

- Employed numerous NLP methods for hierarchical data structure mapping to aid in calculating the consumer price index.
- Included data manipulation and cleaning before use, and exploratory data techniques to determine appropriate methods.
- Learned to quickly write several literature reviews on current state-of-the-art methods and technical reports on the results of my work.

**Research Assistant (Quasi-Hyperbolicity and GNNs)**

May 2020 - July 2020

*McMaster University**Drs George Dragomir and Andy Nicas*

- Built on recent work to investigate how quasi-hyperbolicity could be exploited to reduce roughness and distortion in graph embeddings.
- Using GNNs, I achieved unprecedented (and previously unseen) accuracy at the task using novel node features to encode global structure at the node level.

**Research Assistant (CNNs for Biomedical Applications)**

May 2019 - May 2020

*McMaster University**Dr Ned Nedialkov*

- Developed novel convolutional neural networks to segment photoacoustic cancerous breast tissue images.
- Used sophisticated techniques to mitigate the unique style of photoacoustic noise not present in other medical imaging.
- Developed data pipeline and infrastructure with an automated experiment tracking, ranking, monitoring, and batching software to train 100s of models simultaneously for aggressive hyperparameter optimization.
- Networks used for intrasurgical device to assess tumour boundary *during* operations without a radiologist, which may likely reduce reoccurrence rate.

**FUNDING, GRANTS, AND AWARDS****Ontario Graduate Scholarship**

\$ 15,000

May 2022 - April 2023

**Competitive****NSERC USRA**

\$ 8,120

May 2021 - August 2021

**Competitive****Oriel College (Oxford University) General Funding**

£10,000

<sup>†</sup> *Declined***Non-competitive****Dean's Honour List***Awarded all 4 years of undergraduate degree*

September 2017 - April 2021

**Non-competitive****McMaster Stewart Award**

\$ 3,750

May 2020

**Competitive****STEM Fellowship Big Data Competition**

\$ 3,000

July 2019

**Competitive**

**McMaster President's Award**

\$ 2,500

September 2017

**Non-competitive**

<sup>†</sup> indicates an award was declined due to not attending the funding institution.

**TEACHING ASSISTANTSHIPS****McMaster University***Graduate Topics in Risk Management (Financial Mathematics)**Introductory Number Theory*

January 2022 - April 2022

MFM 763

MATH 3H03

- As part MFM 763, I had to learn the CreditMetrics system and other fintech concepts (eg. bond pricing) in order to effectively teach these graduate students (often my seniors) the content.

**McMaster University***Numerical Linear Algebra**Linear Algebra I*

September 2021 - December 2021

MATH 3NA3

MATH 1B03

**McMaster University***Introduction to Discrete Mathematics*

January 2021 - April 2021

CS 1DM3

**INVITED TALKS AND SEMINARS****Algebra and Algebraic Geometry Seminar***McMaster University*

November 2021

*An Introduction to Belyi Maps*

- Gave a 30-minute presentation on dessins d'enfants, their relevance, and pertinent computational techniques used in my research open to McMaster's math faculty and graduate students.

**CANDEV***Government of Canada*

January 2020

*Transformer Embeddings to Identify Course Redundancies*

- Gave a short talk on our use of transfer-learning with a transformer model to cluster courses offered by the Canadian School of Public Service and identify redundancies in course offerings.
- Received several offers to interview given the quality of our work (led to StatCan job!)

**Undergraduate Big Data Competition***STEM Fellowship*

July 2019

*Predicting in-vivo Drug Interactions Without Drug Structure*

- A talk given with coauthors on our ML model for predicting *in-vivo* drug-drug interactions using only analytical chemical properties (which was *not* in the literature at the time).
- Used around 1.2 million drug interactions for model training.
- Conference held at York University.

**TECHNICAL SKILLS****Languages<sup>†</sup>****Major Libraries<sup>†</sup>****Software & Tools****Operating Systems<sup>†</sup>****Misc.****Python, Julia**, Java, SQL, C/C++, CUDA, MATLAB.**SageMath**, Pytorch, HomotopyContinuation.jl, Tensorflow.**L<sup>A</sup>T<sub>E</sub>X**, Git, Zotero, Macaulay2.**GNU/Linux** (Ubuntu, primarily), MacOS, Windows

Cloud-based computing (AWS &amp; GCP), high adaptability – both to technical issues, and methodological ones.

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## NON-TECHNICAL SKILLS

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<b>Working Environments</b>	Work well in both <b>independent</b> and team settings
<b>Communication</b>	Strong <b>technical written skills</b> , confident public orator
<b>Growth</b>	I am quite good at taking and retaining what I learn from all my various experiences.
<b>Client Interaction</b>	<b>Fastidious note-taking</b> and my ability to quickly learn has led to quite good feedback from both <b>academic supervisors</b> and <b>commercial clients</b> I've worked with.
<b>Teaching &amp; Leadership</b>	My extensive experience TAing and tutoring has given me a good sense of confidence when making well-informed decisions for a group, and <b>relaying complex information in a digestible way</b> to others.

<sup>†</sup>Listed in order of proficiency

***Bolding** indicates preferentiality*

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## OTHER PROJECTS

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<b>Global Undergraduate Awards</b>	September 2021
<i>Dr Ned Nedialkov</i>	<i>Fully Automated Jigsaw Puzzle Solving by Hybrid ML</i>
<ul style="list-style-type: none"> <li>• Won first place in North America for a paper on modular CNN with random forest classification technique to solve square-piece jigsaws.</li> <li>• Reported state-of-the-art piece-wise matching accuracy (around 98% on 16×16 pixel piece pairs and 99% on 32×32).</li> </ul>	
<b>National Big Data Competition</b>	June 2020
<i>Dr Yasaman Amannejad</i>	<i>Medication Recommendation by Matrix Factorization</i>
<ul style="list-style-type: none"> <li>• Devised a matrix factorization-based recommender system to predict effective drugs for treating several mental illnesses, given a patient's history with other drugs.</li> <li>• Performed data-scraping of approximately 50,000 records from Drugs.com.</li> </ul>	